

**DRAFT RESERVOIR SEDIMENTATION STUDY PLAN  
BLUE LAKE PROJECT (FERC P-2230) EXPANSION**

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**INTRODUCTION and BACKGROUND**

This Draft Sedimentation Study Plan describes proposed studies related to the Blue Lake hydroelectric project Expansion. The Project is owned by the City and Borough of Sitka, Alaska, and operated by the City and Borough of Sitka Electric Department (collectively, the “City”).

The City is in the process of applying for an amendment to the Project’s existing FERC license to reflect two significant changes in Project design: 1) addition of a new generating turbine at or near the existing powerhouse and 2) raising the Project dam as much as 83 above the existing spillway level. The City is exploring feasibility of these changes because of recent electric load forecasts in the face of increasing diesel fuel costs. Details of elements of the proposed expansion are described in the Initial Consultation Document (ICD) which was distributed early in the license amendment process.

Raising the Blue Lake dam will increase the Blue Lake surface area from 1,225 acres to 1,655 acres, a total increase of 430 acres. The majority of this increase will take place in the valley of Blue Lake Creek, the lake’s primary inlet tributary (Figure 1). After the reservoir reaches the new full pool level, there will be a change in the sediment deposition and erosion patterns in the Blue Lake Creek valley.

During FERC-required consultation, the USDA Forest Service (USFS) and the Sitka Conservation Society (SCS) requested evaluation of the effects of the raised pool level on sediment deposition patterns in the potentially-inundated areas of the Blue Lake Creek valley. It is known that Blue Lake Creek is a significant spawning area for Blue Lake’s rainbow trout population, and that it is accessed for various forms of outdoor recreation.

Of particular interest in this study is the effect of deposition and lake level changes on fish habitat and passage in Blue Lake and Blue Lake Creek within the new reservoir operating levels.

In this study plan, land and water elevations are referenced in feet to mean low sea level and denoted “El”, as in El 342, El 425, etc. Also, Blue Lake Creek locations are noted by Stream Mile (SM) or distance in miles upstream from Blue Lake Creek’s confluence with Blue Lake (SM 0 is denoted on Figure 1).

## **STUDY OBJECTIVES**

The objectives of this Sedimentation Study are to:

1. Determine the extent of sediment deposition and erosion in the reaches of Blue Lake and Blue Lake Creek between El 342 (current maximum water level) and 425 (maximum Expansion-related water level), under Expansion-related reservoir operations; and
2. Evaluate fish habitat and passage characteristics in the potentially-affected areas of Blue Lake Creek based on projected stream gradient/width/depth and substrate characteristics.

## **PROPOSED STUDY METHODS**

### **STUDY AREA AND FEATURES**

The reservoir sedimentation study area will include 1) the eastern end of Blue Lake, down to approximately El 180, and 2) Blue Lake Creek, within the area of inundation defined by an Expansion-related maximum water surface elevation of El 425. The study area will not include other, smaller tributaries. In this plan, the term “potentially-inundated area(s)” will refer to stream and land features between El 342 and 425.

Within the study area are certain features which are important to the evaluation of sedimentation effects on fish passage and habitat, including the “lower barrier falls”, a steep cascade at SM 0.12 which impedes upstream migration of rainbow trout at all reservoir levels below El 335, and the “upper barrier falls”, a similar cascade at El 430, and SM 2.1 which impedes fish migration at all existing and Expansion-related reservoir elevations.

### **GENERAL APPROACH**

The overall approach of the reservoir sediment evaluations will be to compare pre-impoundment data on Blue Lake bed elevations with similar values measured recently which reflect sediment deposition after impoundment. These comparisons will provide insights into Expansion-related sediment deposition and erosion in the potentially-inundated areas. In addition, data on the timing of Blue Lake Creek streamflows, Blue Lake level fluctuations, and fish use of Blue Lake Creek will be compiled to evaluate seasonal changes to fish habitat within the potentially-inundated areas.

### **DATA SOURCES**

Pre-impoundment data sources include a Blue Lake land survey conducted in 1957 from El 180 to El 342, including lower Blue Lake Creek. From these surveys we may determine the gradients of the Blue Lake lakebed and Blue Lake Creek streambed prior to impoundment. Also available are historical data on mean daily Blue Lake inflows and lake levels as well as the timing of fish use in Blue Lake Creek.

Data sources for current conditions include:

- A LIDAR (Light Detection and Ranging) survey conducted in 2007, suitable to determine gradients within the Blue Lake Creek valley from El 342 to El 450;

- A 2008 land survey of Blue Lake Creek and Blue Lake from El 257 to El 342, when Blue Lake was at exceptionally low levels;
- Particle grain size and cross section data from the Blue Lake Creek stream channel measured in 2008;
- Three or four additional particle grain size grab samples that will be taken from the existing Blue Lake Creek delta area during a site visit (Spring 2009) to provide information on the grain size of material in the existing delta. These samples will be dried and sieved to provide grain size distribution data;
- Aerial oblique photography of the existing sediment deposit at the east end of the lake from El 260 to El 342, taken May 18, 2008; and
- Information on timing of fish use in Blue Lake Creek

## **ANALYSIS AND PREDICTION**

These data sources will allow plotting of pre-impoundment and post-impoundment bed profiles between El 180 and El 342 from which we may note the extent and gradient of original impoundment-related sediment deposition. A similar profile will be plotted for the potentially-inundated area. From this information, we may then generally predict sediment deposition and erosion in the potentially-inundated area(s).

Sediment deposition takes place in stream deltas as flowing water slows and is no longer able to transport entrained material. Larger material is deposited first, with progressively finer material being deposited further out on the delta and in the lake. In lakes and reservoirs with fluctuating water levels, material that was deposited at higher lake levels is entrained and moved out along the delta within the re-established stream channel, creating a complex and dynamic pattern of sediment deposits within the fluctuation zone.

The existing stream delta characteristics and deposition patterns will be used to help predict future deposition and stream characteristics in the Blue Lake Creek valley. The pre-impoundment (1957) and post-impoundment (2008) stream profiles will be plotted between El 180 and El 342 to determine the pattern and amount of deposition that has taken place in the upper end of the lake during the past 50 years, as well as changes in stream gradient. This profile will be supplemented with the aerial oblique photographs taken during low pool levels in 2008 to provide information on the morphology and grain size of the delta deposits in areas not adjacent to the existing, surveyed channel. This photo also shows the extent of buried stumps that can help to evaluate depth of deposits.

In order to evaluate fish passage and spawning habitat concerns in the Blue Lake Creek valley, existing hydrologic records of streamflow and lake levels will be plotted to determine lake level fluctuation and inflow patterns during critical migration and spawning periods. This information will be used to estimate the length of stream/delta that will be exposed as well as streamflows that are expected under the Expansion-related operating regime.

Concerns about fish passage in streams flowing over exposed delta deposits generally center on whether or not water depths are sufficient for upstream passage. Shallow water depths can develop in areas where the stream widens. Stream widths/depths across the existing delta will be used, along with the record of stream discharge, the stream channel survey, and the topography in the Expansion-related delta area to help determine if there are any areas that might develop into wide delta channels and potentially impede passage.

Deposition of fine-grained sediment can reduce the quality of spawning habitat. Based on the glacial nature of Blue Lake Creek, it is expected that there will be deposition of fine-grained material following lake expansion in the inundated channel in the Blue Lake Creek valley. As lake levels drop and the stream is temporarily re-established in the fluctuation zone, finer-grained substrate can be entrained and carried farther into the lake.

Three or four grab samples of material from the existing delta will be taken during a site visit in Spring 2009 to provide data on the grain size distribution of sediment in the delta and in Blue Lake Creek within the current fluctuation zone. The stream depth and local stream gradient will be measured using a hand level, tape, and stadia rod at each site. The samples will be dry-sieved and the results used to show the distribution of grain size within the current stream fluctuation zone. This particle size information will be useful to predict whether fine sediment might be flushed from the substrate as the lake level drops, and to help determine if the stream within the fluctuation zone will retain suitable spawning habitat. The stream depth and gradient measurements will be used to calculate shear stresses at the various measurement sites and to compare these forces with the critical shear stresses of the particle sizes from each grab sample. This will provide insight into the quality of spawning gravel (e.g., level of fine grained material) that can be expected in the Blue Lake Creek channel within the new fluctuation zone in areas of different stream gradients. Sediment transport in the stream reaches that are expected to be accessible during spawning periods will be estimated by calculating the grain size that can be entrained based on expected stream gradient and depth (estimated from inflow patterns during the spawning season) in the Expansion-related fluctuation zone.

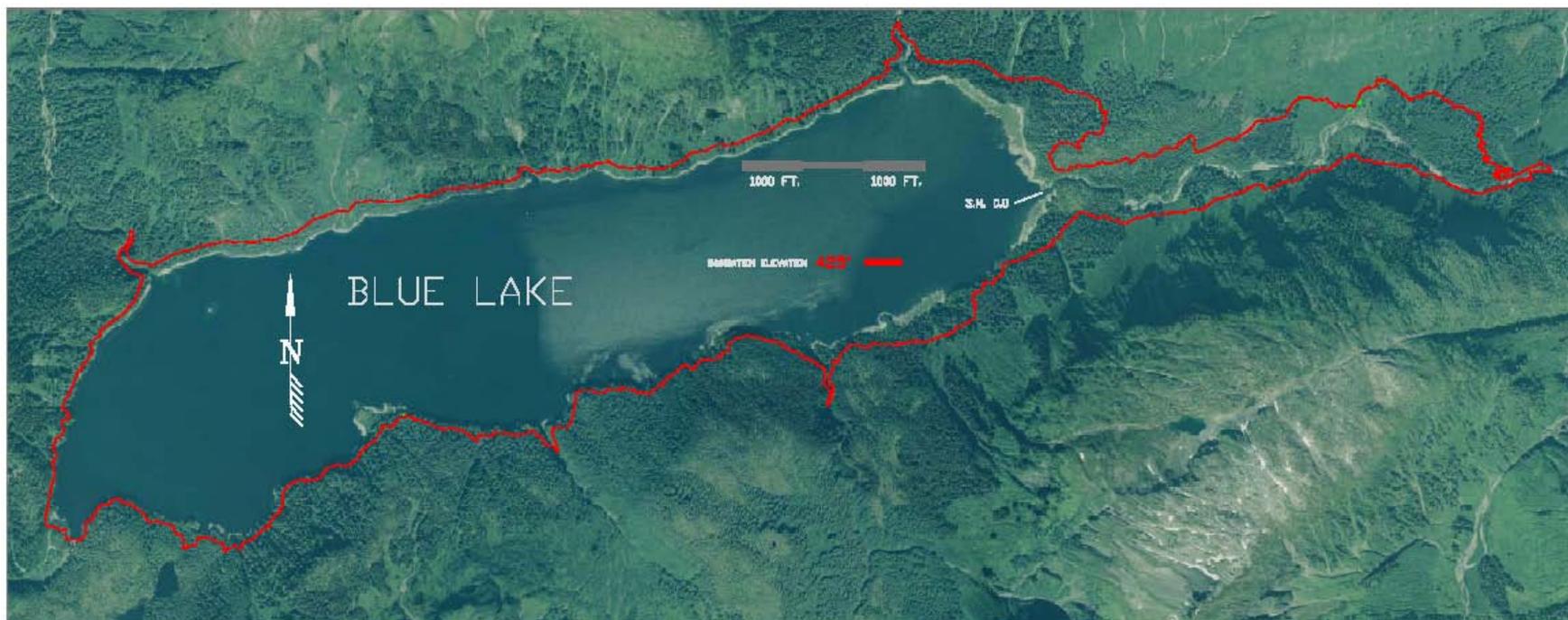
The following work products will be produced as part of this study:

- A report detailing study methods, data sources, analysis, results, and conclusions regarding the effects of lake expansion on sediment deposition and fish habitat (see study objectives).
- A profile of Blue Lake Creek between El 450 and 180 showing the pre-impoundment (1957) streambed, the post-impoundment (2008) streambed/delta, and the predicted Expansion-related stream/delta profile.
- A plan view figure showing the extent of the post-impoundment (2008) delta deposition area at the East end of Blue Lake and the predicted Expansion-related delta deposition area at the East end of Blue Lake in the Blue Lake Creek valley.
- A graph showing seasonal variations in inflow and lake levels in Blue Lake and fish use of Blue Lake Creek.

## **STUDY SCHEDULE**

The majority of data required for the sedimentation portion of this study has been collected in 2008. A site visit will be conducted in the Spring 2009 to look at stream/delta characteristics and collect supplemental information and grain size samples. A draft report will be issued following this site visit.

**Figure 1. Proposed Expanded Blue Lake Shoreline.**



BLUE LAKE EXPANSION INUNDATION AREA  
1655 ACRES, 430 ADDITIONAL ACRES