
BYPASSED REACH WATER TEMPERATURE MONITORING STUDY PLAN

Final

**LAKE CHELAN HYDROELECTRIC PROJECT
FERC Project No. 637**

March 16, 2001



**Public Utility District No. 1 of Chelan County
Wenatchee, Washington**

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SECTION 1: INTRODUCTION

1.1 General Description of the Watershed and the Bypassed Reach

The Lake Chelan watershed is located in Chelan County in north central Washington. Lake Chelan is bordered to the south by the Entiat and Chelan Mountains and Glacier Peak complex. To the north it is bordered by the Sawtooth Mountain Range. Lake Chelan is deep and narrow, extending northwesterly approximately 50 miles from the City of Chelan at its lower end to Stehekin at the head of the lake. Lake Chelan is a natural lake that developed within a broad glacial trough. The lake averages one mile in width, and has depths of over 1,480 feet.

The average surface area of the lake is 32,000 acres. The drainage area of the project at the dam is 924 square miles. The confluence of the Chelan River and Columbia River is approximately 1.5 miles southeast of the City of Chelan. The lake level and flow through the Chelan River were changed by the construction of a hydroelectric project in 1928.

The Lake Chelan Hydroelectric Project is located approximately 32 miles north of the City of Wenatchee on the Chelan River. The 3.9-mile long bypassed reach (Chelan River or gorge), the shortest river in Washington State flows from the lower end of Lake Chelan to the Columbia River. The Lake Chelan Hydroelectric Project consists of a 40-foot high concrete gravity dam located at the City of Chelan, a 2.2-mile long steel and concrete tunnel (penstock) that is 14 feet in diameter, and a powerhouse located at the confluence of the Chelan and Columbia rivers near the City of Chelan Falls. The vertical elevation drop between the dam and powerhouse is 401 ft. The powerhouse contains two Francis turbine units; each rated at 34,000 hp at 1,100 cfs and 377 feet net head that produce approximately 50 MW of electricity.

The 3.9-mile long bypass reach is comprised of four distinct sections (Figure 1). The 2.29-mile long upper section, Section 1, of the bypass reach below the dam is characterized by a relatively wide flood plain, low gradient, 55 ft/mile, and substrate comprised mainly of large cobble and boulders. Some spawning sized gravel is contained in the margins of the channel, deposited in these areas during high flow events during spring runoff. Section 1 is a broad, open valley with the stream channel receiving full sunlight exposure. There is essentially no topographical shading in Reach 1.

Section 2 of the bypass reach, 0.75-mile long and located in the upper end of the gorge, is characterized by a narrow channel, steep canyon walls, low gradient, 57 ft/mile, and cobble and boulder substrate that is much larger than the upstream section. This section appears to contain very little salmonid spawning size substrate. Most of the stream channel receives full sunlight exposure during the summer. There is some topographical shading at the lower end as the canyon narrows.

Section 3 of the bypass reach, referred to as the gorge area, is 0.38-mile long. The canyon walls are very steep and narrow. The gradient of the channel is very steep, 480 ft/mile. The stream channel is characterized by waterfalls, from 5 to 20 feet high, numerous cascades, bedrock

chutes, and large, very deep pools. The substrate is very large, with some boulders exceeding 20 feet in diameter. The south canyon wall is mostly cliff in the lower part of Reach 3, thus much of the stream channel receives topographical shading during the day.

Section 4 of the bypass reach is 0.49-mile long and located below the gorge area. It is characterized by a wide flood plain, having gravel/cobble/boulder substrate, and low gradient, 22 ft/mile. Section 4 extends from the bottom of the gorge section downstream approximately 2,600 feet to the confluence of the powerhouse tailrace. The broad valley floor in Reach 4 gives the stream channel full sunlight exposure throughout the day, with only a small area of topographical shading at the upper end of Reach 4.

1.2 General Description of the Relicensing Process

The Public Utility District No.1 of Chelan County (Chelan PUD) owns and operates the Lake Chelan Hydroelectric Project located on the Chelan River in Chelan, Washington. Chelan PUD is permitted to operate the project according to the terms and conditions contained in the existing license No. 637, issued by the Federal Energy Regulatory Commission (FERC) on May 12, 1981. The current license expires on March 31, 2004.

The original project license was issued by the Federal Power Commission, now FERC, in May 1926. The FERC granted the new 30-year license to Chelan PUD on May 12, 1981, retroactive to 1974 when the original 50-year license expired.

Chelan PUD intends is seeking a new license to operate the Lake Chelan Hydroelectric Project and has begun the process referred to as “relicensing.” The FERC relicensing process is based on laws and regulations that require years of extensive planning, including environmental studies, agency consensus, and public involvement. The process to obtain a new license has changed considerably since the existing license was issued in 1981, primarily due to changes made to the Federal Power Act (FPA) as amended by the Electric Consumers Power Act (ECPA) in 1986. ECPA mandates that the FERC give equal consideration to the enhancement of existing environmental, recreation, fish, and wildlife resources, and to balance what are often competing uses of the water resources. ECPA also empowers the FERC to consider whether or not a project is consistent with federal and state comprehensive plans.

Chelan PUD has requested and received approval from the FERC to employ an alternative relicensing process for the Lake Chelan Project, as allowed under FERC’s Final Rule issued on October 29, 1997 (Docket No. RM95-16-000; Order No. 596). The Alternative Relicensing Process (ARP) is intended to expedite the licensing process by combining the pre-filing consultation and environmental review processes into a single process, and by improving and facilitating communications among the participants in the licensing process.

The first step taken by Chelan PUD in the Lake Chelan ARP was to solicit identification of issues from the participating stakeholders regarding all aspects of the Lake Chelan Hydroelectric Project that would need to be addressed during the relicensing process. Issues identified were discussed in public meetings and technical work groups and studies were initiated to obtain information necessary for decisions on resource protection issues relevant to the development of

a license application and environmental assessment. Additional studies, when needed, to refine or develop additional information on specific resource issues, are being planned for 2001.

1.3 Need Statement

The determination of a minimum instream flow program for the bypassed reach is a major resource issue that remains to be agreed upon by the relicensing stakeholders. A specific issue critical to the relicensing process is to develop data, which will be determined by the Natural Sciences Working Group, sufficient to obtain a Section 401 Water Quality Certification from the Washington Department of Ecology (DOE), which includes determination of effects of project operation on Lake Chelan and Chelan River water quality.

Section 401 Water Quality Certification requires compliance with Chapter 173-201A WAC, authorized by 33 USC 1313 and Chapter 90-48 RCW. For a Class A stream, the characteristic uses to be met or exceeded include water supply; fish migration, rearing, spawning and harvesting; wildlife habitat; and recreation (including aesthetic enjoyment). Water quality parameters include fecal coliform, dissolved oxygen, total dissolved gas, temperature, pH, turbidity, toxic materials, and aesthetic values. Fish migration, rearing, spawning and harvesting, wildlife habitat, and recreation (including aesthetics) have been addressed in other studies associated with this project.

In 1999 and 2000, the water quality parameters of dissolved oxygen, total dissolved gas, temperature and pH were studied in the bypassed reach under several flow conditions (Anchor, 2000; R2 and IA, 2000). Of these parameters, all were consistent with requirements for Class A water quality except temperature. Under natural conditions, water temperatures during summer exceed the maximum temperature standard for Class A waters. The standard states that temperature shall not exceed 18⁰ C due to human activities. When natural conditions exceed 18.0⁰ C, no human-caused temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3⁰ C (WAC 173-201A-030).

The Natural Sciences Working Group is working to reach agreement on fisheries resource management objectives and instream flows necessary to support these objectives for the bypassed reach. High summer water temperatures have been identified as probable limiting factor for cold-water species, including salmonids (R2 and IA 2000). The quantity of instream flow has an influence on the water temperatures that will develop as water passes through the bypassed reach. Thermal loading rates, influence of ground water temperature refugia, and development of stream channel characteristics and riparian vegetation are all factors substantially influenced by the volume of instream flows. Temperature data collected in 1999 and 2000 indicate that under relatively low flow conditions (50 cfs) ground water influence is sufficient to have a cooling effect on the Chelan River as it passes through Reach 3 of the bypassed reach (R2 and IA, 2000). Flow levels ranging from 80 cfs to 3,600 cfs were shown to increase in temperature by more than 0.3⁰ C for all flows through the bypassed reach (Anchor, 2000).

The temperature data collected at flows below 100 cfs is limited to two weeks in August, 1999. Efforts to collect additional temperature data in 2000 were thwarted when temperature-recording devices were stolen. A more extensive data set is needed to better define the cooling effects of

ground water, existence of thermal refugia, and most significant factors contributing to temperature increases. In addition, selection of a predictive model to compare the relative benefits of different flow levels and other proposals to reduce thermal loading, such as channel modifications and planting of riparian areas for shading, would be useful for reaching agreement on minimum instream flows. This study plan details the scope and methods for collection of additional temperature data and collaborative selection of key questions and a temperature model for predictive comparison of alternative instream flows and other mitigative options.

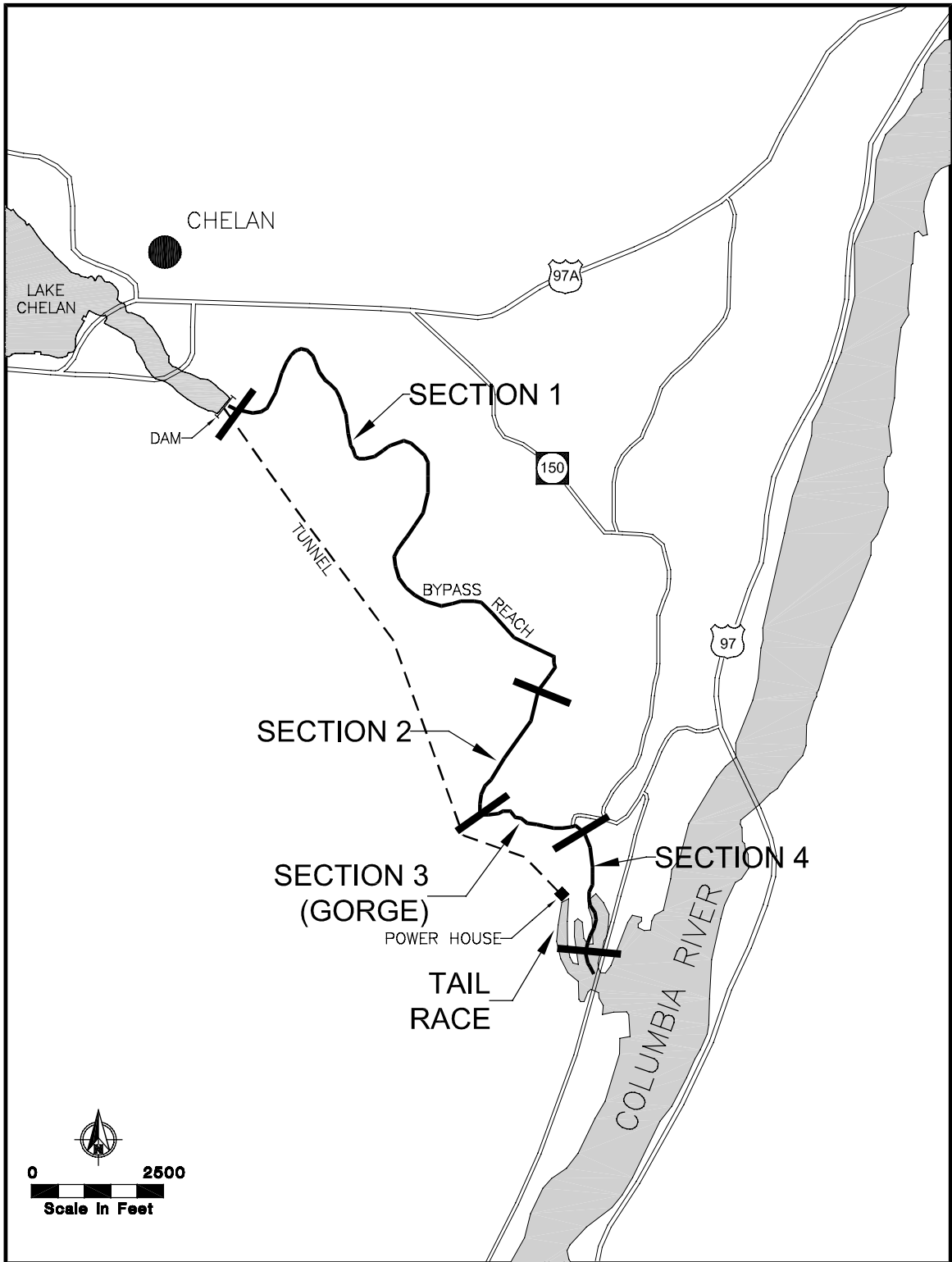


Figure 1: Bypass Reach Location Map

SECTION 2: STUDY GOAL

Primary goals of the bypassed reach water temperature monitoring study are to: 1) determine the change in water temperature through the bypassed reach at flow levels of 40, 80, 160 and 650 cfs; 2) determine the influence of ground water on temperature at different flows and existence, if any, of thermal refugia; and 3) select a model, calibrate with field data, determine primary sources of thermal loading, and compare predicted thermal effects of different flows and mitigative actions.

SECTION 3: STUDY AREA

The study area is the bypassed reach of the Chelan River, from dam forebay to confluence with the tailrace. The study sampling areas will be primarily located at the forebay, upper ends of Reaches 1, 2, 3 and 4 of the bypassed reach, the lower end of Reach 4 and the tailrace channel.

SECTION 4: METHODOLOGY

4.1 Field Investigations

Weather and inflows permitting, flow levels will be established with regulated spill from the Chelan Dam. To allow time for stabilization of conditions before the next daytime heating period, flow changes will be made at night. Each flow level will be maintained for 5 days. The flow levels will begin with the lowest flow, increasing sequentially to the highest flow to prevent bank storage of water from affecting the data for the next flow level and to reduce the time needed for the stream to stabilize to the new flow condition. The objective will be to obtain at least two days for each flow level with comparable conditions of air temperature and cloud cover. If representative daytime air temperatures and cloud cover for comparison to other flow levels do not occur within a 5 day period, the schedule may be adjusted to increase the number of days for that flow level until two days of comparable data are obtained.

Water temperature data will be collected hourly with recording thermographs (OnSet Computer Corporation, Model Optic StowAway Temp) at seven locations, the forebay of Chelan Dam, in the bypassed reach at the upstream end of each reach, in the downstream end of Reach 4 and in the tailrace measuring the powerhouse discharge. An additional recording thermograph will be placed to record air temperature in the bypassed reach between reaches 1 and 2. The forebay thermograph will be placed near the spillway at the depth of the spillway sill. The other thermographs will be placed in the stream channel at or near the streambed.

One temperature survey will be conducted at each flow level to seek thermal refugia at locations of known or suspected groundwater discharge. These surveys will be done no sooner than the third consecutive day at each flow level to allow groundwater discharge conditions to equilibrate to the flow level. The survey will be done with portable temperature probes or recording thermographs, sampling water temperatures near the substrate. Samples will be taken from pools and eddies where pockets of cooler water could exist without instantaneous dispersion through the rest of the water column.

4.2 Model Investigations

A number of models exist for predicting thermal effects on stream temperatures in response to environmental variables. These models all have different data requirements for input and calibration and they have different strengths and weaknesses in their predictive capabilities. Many of these models have wide application, readily understandable database structures, and published procedures for their use. These models include SNTMP (USGS Stream Network Temperature Model), SSTEMP (simpler spreadsheet version of SNTMP), TEMPEST (Timber, Fish and Wildlife (TFW) model, Adams and Sullivan, 1990), TEMP-86 (Oregon State University Model, Beschtra and Weatherred, 1987), QUAL-2E (EPA sponsored model), and MWAT (EPA), to name some of the most commonly used models for small to medium-sized streams.

Chelan PUD will conduct a workshop with the Natural Sciences Working Group to review available models, discuss data available or obtainable to support the use of the models and reach consensus on a model approach to evaluate the stream temperature effects of different minimum flow proposals and channel modifications. In this case the selected model will be primarily used to evaluate the sensitivity of the bypassed reach to variables that have potential for change through management decisions. These factors include minimum flow and riparian shading.

SECTION 5: TASK LIST

Task 1 – Modeling Workshop

1.1 Compile Relevant Information on Applicable Models

- 1.1.1 Prepare information packet on applicable models
- 1.1.2 Develop comparison matrix to show model fitness for evaluation of specific management actions (flow and riparian shading)
- 1.1.3 Develop comparison matrix on model complexity and data requirements

1.2 Schedule and Conduct Workshop

- 1.2.1 Determine attendance, date and location
- 1.2.2 Develop and publish agenda
- 1.2.3 Conduct Workshop
- 1.2.4 Select model

Task 2 – Model Development

2.1 Prepare Database Information

2.1.1 Locate and compile all existing water quality data on bypass reach and tailrace

2.1.2 Compile relevant meteorological information

2.2 Model Runs

2.2.1 Input database information

2.2.2 Run calibration analyses

2.2.3 Review calibration analyses with Natural Sciences Working Group

Task 3 – Field Investigation

3.1 Prepare for Field Work

3.1.1 Procure recording thermographs

3.1.2 Prepare monitoring sites

3.1.3 Finalize flows to be tested

3.1.4 Schedule tests and deploy monitoring equipment

3.2 Conduct field study

3.2.1 Retrieve and download data weekly

3.2.2 Conduct refugia survey weekly

3.2.3 Adjust flow schedule, if needed

3.2.4 Retrieve thermographs

Task 4 – Analysis

4.1 Compile data and prepare documentation

4.2 Provide Natural Sciences Working Group with summary of data

4.3 Load data into model

4.4 Conduct model runs

Task 5 – Report Preparation

5.1 Prepare draft report

5.2 Natural Sciences Working Group review draft report

5.3 Prepare final report

5.4 Natural Sciences Working Group review final report

5.5 Publish final report

SECTION 6: ANALYSIS AND REPORTING

Chelan PUD will take the lead in analysis and reporting of this work, but it is intended to be a collaborative process with the Natural Sciences Working Group. Participating members of the Natural Sciences Working Group need to commit to meeting review comment deadlines and to providing their input to the model selection and calibration process. The intended result of this study is to provide scientific support for minimum instream flow recommendations as they relate to meeting water quality standards. The results of this study will be incorporated into the Environmental Assessment for the relicensing of the Lake Chelan Hydroelectric Project.

SECTION 7: STAFFING AND EQUIPMENT NEEDS

Chelan PUD will conduct this study in-house, but may hire technical experts as needed to assist in model database compilation and to advise on model calibration. Chelan PUD staff will oversee contracting and deliverable schedule for any technical assistance from consultants.

SECTION 8: SCHEDULE

Feb 12-16, 2001	Natural Sciences Working Group Model Workshop (one day, tentatively this week)
Feb 23, 2001	Comments Due on Draft Bypassed Reach Water Quality Monitoring Study Plan (including management alternatives to be modeled)
Feb 28, 2001	Distribute Final copy Bypassed Reach Water Quality Monitoring Study Plan
Feb 28, 2001	Chelan Relicense Public/Agency Meeting
Mar 15, 2001	Summary of Database Information to Natural Sciences Working Group
Mar 28, 2001	Chelan Relicense Public/Agency Meeting
Apr 18, 2001	Model calibration runs reported to Natural Sciences Working Group
Apr 25, 2001	Chelan Relicense Public/Agency Meeting
May 10, 2001	Natural Sciences Working Group comments on database and calibration runs due
May 23, 2001	Chelan Relicense Public/Agency Meeting
Jun 18–29, 2001	Install recording thermographs
Jun 27, 2001	Chelan Relicense Public/Agency Meeting
Jul 1-22, 2001	Conduct field study
Jul 25, 2001	Chelan Relicense Public/Agency Meeting
Jul 25, 2001	Report data to Natural Sciences Working Group
Aug 1, 2001	Report model runs to Natural Sciences Working Group
Aug 10, 2001	Draft report to NSWG for review
Aug 22, 2001	Chelan Relicense Public/Agency Meeting
Sep 10, 2001	Natural Sciences Working Group comments due on draft report
Sep 15, 2001	Final report issued

Table 1: Schedule for 2001.

ACTIVITIES						
S C H E D U L E		Model Workshop for NSWG	Database Preparation	Trial Model Runs <i>Report</i> <i>Model Runs</i>	Bypassed Reach Flows and Temperature Data	Reports <i>Model Runs</i> <i>Temp. Data</i> <i>Draft</i> <i>Final</i>
	Mid February	✕				
	February – March		✕			
	April		✕	✕		Model Runs
	May - June			✕	Install Equipment	Model Runs
	July			✕	✕	Data and Model Runs
	August			✕		Draft Report Issued
	September					Final Report Issued

SECTION 9: REFERENCES

Adams, T.N. and K.S. Sullivan. 1990. The physics of forest stream heating: a simple model. Timber/Fish/Wildlife Report No. TFW-WQ3-90-007, Washington Department of Natural Resources, Olympia, WA. 30 p.

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Beschta, R.L. and J. Weatherred. 1987. TEMP-86 Users Guide. Department of Engineering, Oregon State University, Corvallis, OR. 20 p.