REVISED FINAL WATER QUALITY MONITORING PLAN

In response to 4e Condition 19 and Articles 409 and 410

FERC Order Issuing Amendment

BLUE LAKE HYDROELECTRIC PROJECT (FERC No. 2230) EXPANSION

Prepared by:

City and Borough of Sitka Electric Department

September, 2012

1.0 INTRODUCTION AND BACKGROUND

The City and Borough of Sitka, Alaska ("City") owns and operates the Blue Lake Hydroelectric Project (FERC No. 2230) near Sitka. Due to electrical load growth in the City, the City and Borough of Sitka Electric Department has proposed to raise the dam and construct other project features which will increase annual energy output at the Project. Actions to accomplish this new construction are called the Blue Lake Project Expansion Project("Project").

The new Project license was issued by the Federal Energy Regulatory Commission (FERC) in 2007. Changes of the scale necessary to achieve Expansion objectives require an amendment to the new license in order for the proposed construction and operation to take place. The Order Issuing Amendment of the license was in May of 2012. As part of the Amendment, FERC and reviewing state and federal resource agencies have submitted environmental and other conditions which the City must observe during and after construction.

1.1 Purpose and Need for This Plan

This Water Quality Monitoring Plan (Plan) has been developed in response to Articles 409 and 410 of the Amendment.

Article 409 concerns water quality monitoring during the Project construction period and specifies that:

"At least 60 days prior to ground disturbing activities, the licensee shall file with the Commission, for approval, a Construction Water Quality Monitoring Plan.
The plan shall identify at a minimum:

(1) exact locations of monitoring sites; (2) water quality parameters to be monitored including but not limited to turbidity and total organic carbon; (3) a frequency of monitoring

during all phases of construction which shall be at least daily; and (4) specific measures to be taken in the event that monitoring identifies unacceptable water quality conditions.

The licensee shall prepare the plan after consultation with the U.S. Forest Service, Alaska Department of Fish and Game, Alaska Department of Environmental Conservation, and the U.S. Fish and Wildlife Service. The licensee shall include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for the agencies to comment and make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan including any changes required by the Commission.

Article 410 concerns water quality monitoring during long-term Project operation, and specifies that:

"At least 60 days prior to ground disturbing activities, the licensee shall file with the Commission, for approval, a Long-Term Water Quality Monitoring Plan.
The plan shall include at a minimum:

(1) identification of all long-term water quality monitoring sites including Blue Lake, the powerhouses, and Sawmill Creek; (2) the specific water quality parameters to be monitored at each site, including but not limited to turbidity and total organic carbon; (3) the frequency of monitoring at each location which shall be at least weekly as well as the duration of monitoring during the term of the license; and (4) identification of specific measures to be taken in the event that monitoring indicates problems with water quality at the project.

The licensee shall prepare the plan after consultation with the U.S. Forest Service, Alaska Department of Fish and Game, Alaska Department of Environmental Conservation, and the U.S. Fish and Wildlife Service. The licensee shall include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for the agencies to comment and make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information."

Details of the proposed Expansion are described in the Order Issuing Amendment (City, 2012), available at the City's Project website:

(www.cityofsitka.com/departments/electric/bluelakeexpansion).

1.2 Documentation of Consultation

The City sent out the Preliminary Draft Water Quality Monitoring Plan on May 10, 2011 to all interested agencies, including the U.S. Forest Service, Alaska Department of Fish and Game, Alaska Department of Environmental Conservation (ADEC), and the U.S. Fish and Wildlife Service. This plan was sent out in preparation for the meeting scheduled for May 19, 2011 to discuss the Water Quality Monitoring Plan and other monitoring\mitigation for the Project. Comments were received in writing, after the meeting, from ADEC and incorporated into the Draft Water Quality Monitoring Plan. The City also incorporated input from the City Water Department and a comment from USGS on the FERC Draft EA. The Draft Plan was sent out with a 30 day comment period on June 14, 2012 and no comments were received.

The USFS commented on August 9, 2012. The comments are attached as Attachment IV. The City addressed all comments. Actions taken in response to the numbered comments are in Attachment V. All text additions related to comments or other City-related changes, are noted in italics in this final plan.

2.0 NEED for WATER QUALITY MONITORING

Several aspects of the Expansion are likely to affect water quality in both Blue Lake and Sawmill Creek, the lake's primary outflow waterway. These changes will be important during both construction and long-term operation of the Expansion because 1) Blue Lake is the source of unfiltered drinking water for the City of Sitka; and 2) Sawmill Creek harbors several species of anadromous (migratory) and non-anadromous fish.

Of particular concern are potential effects from flooding of 362 acres around Blue Lake by the 83-foot dam raise. Flooding of extensive coniferous and deciduous vegetation may cause increases in certain contaminant concentrations, either directly or after the water is processed by chlorination in the City's water treatment plant. *Analysis of the potential contaminant concentration were conducted by **CH2M**HILL and reported in technical memos Blue Lake Dam Raise Water Quality Monitoring dated January 15, 2010, and Dam Raise Water Quality Evaluation dated December 18, 2008. The monitoring program outlined in this plan is based largely on these memos. The memos are attached as Attachment I & II.*

As Sitka's water supply, Blue Lake's naturally high water quality obviates the need for water filtration as defined in the City's Watershed Control Plan. Any Project-related effects on Blue Lake water quality, particularly if suspended sediment or turbidity were increased, might require expensive water filtration. Similarly, any construction-related or other contaminants which enter Blue Lake and subsequently the City's drinking water system will require immediate attention. Long-term changes in the water temperature regime of Blue Lake will affect water temperature in Sawmill Creek with potential impacts to anadromous and resident fish there.

Therefore it will be necessary to document both construction period and long-term changes in Blue Lake and Sawmill Creek water quality conditions, under provisions of the following monitoring program.

3.0 WATER QUALITY MONITORING PROGRAM

3.1 EXISTING WATER QUALITY MONITORING

Because Blue Lake is the primary source of Sitka's municipal drinking water, the quality of water diverted to that use is strictly monitored by the Sitka Water Department. Monitoring takes place at tap on the raw water supply to the Water Department's treatment plant located at the lower portal. Diverted water is tested continuously and this testing program will be incorporated in both the construction-related and long-term operation water quality monitoring programs described in detail below.

3.2 WATER QUALITY MONITORING PROGRAM, GENERAL

Expansion-related water quality monitoring will address potential effects due to both construction and long-term operation, as described in the following sections. The program will be comprised of water quality monitoring to document both site-specific and non-point source inputs. At all times, in addition to monitoring at other locations and for other purposes, the City will conduct its required analysis of both raw and treated water to meet the City's Drinking Water Program requirements.

In the following sections, we describe the Expansion Water Quality Monitoring Program in three parts: 1) Construction Period Monitoring; 2) Long-Term Operation Monitoring; and 3) the City's Drinking Water Quality Monitoring.

In the following plan, the exact methods and equipment to be used for water quality monitoring have been deferred to a group of agency representatives qualified to speak for their respective agencies in the immediate pre-construction period. In particular, the Environmental Compliance Monitor (ECM), who has not been selected at the time of this plan, will have important input on these details. *The exact methods and equipment used for water quality must be based on the General Contractor's final work plan and schedule. The final work plan is not available until the contract is awarded. The monitoring will be the responsibility of the City.*

3.3 CONSTRUCTION PERIOD MONITORING Article 409

The Objective of construction period monitoring will be to determine whether, where and in which quantities deleterious materials are entering potentially-affected water bodies. Construction period monitoring will be done 1) at certain fixed sites and on specific time intervals, to document comparative changes over time; and 2) on a daily basis and at varying locations corresponding directly to active construction.

Construction period monitoring will document water quality of both Blue Lake and Sawmill Creek, emphasizing detection of:

- Sediment from excavation, road use or vegetation clearing;

- Petroleum products from vehicles and other construction equipment;
- Materials from decay and burning of vegetation in the potentially-inundated areas; and
- Blasting residue**.**

Construction activity will be concentrated near 1) Blue Lake dam and the proposed intake structure; 2) segments of the Blue Lake road which will be widened and those on which heavy equipment traffic may increase; 3) the Fish Valve Unit; and 4) the powerhouse/surge chamber areas.

In each of these areas, the City expects to generally emphasize sampling of water quality 1) in runoff water downslope of daily construction areas; and 2) in the effluent water from settling ponds; and 3) in the reservoir itself. *Turbidity and TOC will be measured at each construction area and settling pond with hand held equipment.*.

Water samples will be collected at various intervals depending on schedule and proximity to active construction sites. In all these areas, water quality sampling will be conducted at locations and time intervals agreed to after determination of both construction methods and the construction schedule *as defined by the general contractor's final work plan*. After these milestones are reached, the City will, prior to any ground disturbance, complete a detailed Construction-Related Water Quality Monitoring Plan documenting exact locations, constituents, methods and frequency of construction-related sampling. A draft of the plan will be reviewed and commented on by the appropriate state and federal resource agencies, and all comments will be addressed in the final plan which will be distributed to agencies required by FERC.

It is expected that the City, the ECM, (position and duties of whom are described in a separate plan) and other appropriate state and federal resource agencies will consult prior to and during construction to define the exact locations, water quality constituents, and sampling and analytic methods for this daily monitoring program.

The City will monitor the raw water for nitrates weekly for one month following the generation outage to establish that blast residue has been flushed from recently constructed tunnels and shafts.

3.4 LONG-TERM OPERATION MONITORING Article 410

The objective of this program will be to develop a continuous record of water quality conditions with which to detect trends and upon which to make comparisons of effects relative to different climatological and operational conditions. Results of these analyses and comparisons may be used to determine effects on the City's Drinking Water quality and on environmental conditions, particularly water temperature effects on aquatic resources in both Blue Lake and Sawmill Creek. *The monitoring outlined in the Long-term monitoring program will supplement the Construction Monitoring Plan and be performed at the same time. The continuous monitoring outlined in the long-term plan will provide instantaneous monitoring of construction activities.*

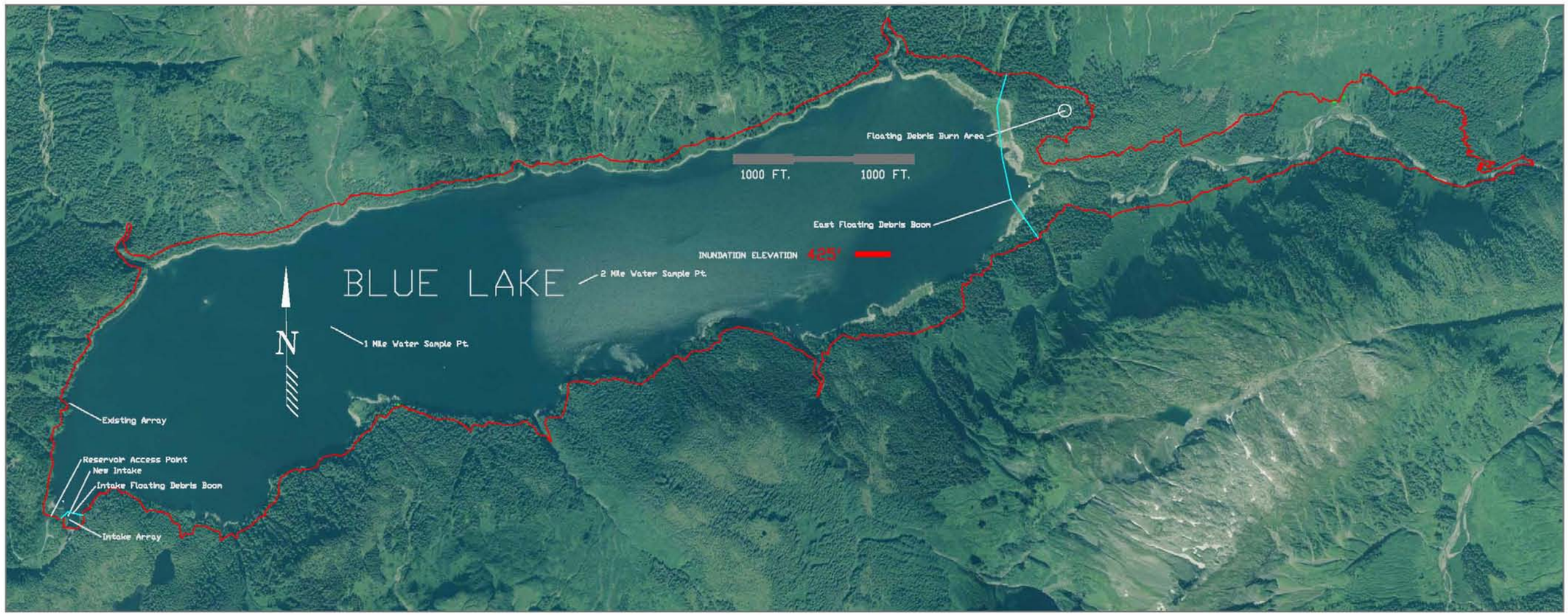
Generally, long-term monitoring will consist of continuous temperature monitoring in both Blue Lake and Sawmill Creek, and point- and time-specific sampling for an approved set of water quality constituents. Continuous temperature monitoring will disclose any changes in depth-integrated water temperature near the intake to help determine effects on fish populations in both Blue Lake and in Sawmill Creek downstream of the Fish Valve Unit and the Blue Lake powerhouse where intake water is released. Monitoring components in Blue Lake and Sawmill Creek are described separately below.

3.4.1 Blue Lake

Continuous Temperature Monitoring

To continuously monitor water temperature at various levels down to and below the actual point at which water will enter the proposed intake, the City will install the "Intake Array" consisting of electronic temperature measurement devices ("loggers") at various depths along a fixed vertical cable (Figure 1). (Note that a similar array is currently installed about 400 yards east of the existing intake. This array will be replaced by the Intake Array, because 1) it will be very difficult to extend the existing array upwards to El 425 due to topography and vegetation; and 2) measurements will be taken closer to the intake which is the area of most interest).

The Intake Array will extend downward from an anchor point fixed about 10 feet above El 425 (spill elevation of the Expansion dam height above mean sea level) to about El 200, or at a depth of about 225 feet below the post-Expansion spill elevation. Loggers will be emplaced approximately every 15 feet along the cable.



BLUE LAKE EXPANSION INUNDATION AREA

1646 ACRES, 362 ADDITIONAL ACRES

RESERVOIR WATER QUALITY MONITORING FEATURES

Figure 1

The loggers may be set to record water temperature at small intervals (matters of minutes) and may be left unattended for periods of months. The City has extensive experience with this monitoring system having installed an identical system (discussed earlier), and having retrieved data from that system for over 6 years.

Monitoring of Other Water Quality Parameters in Blue Lake

The City will also collect grab samples from two locations near the midline of Blue Lake during periods when weather and ice conditions permit boat access. These samples will be collected at points approximately 1 and 2 miles east of the dam, respectively (See Figure 1). The samples will be taken on a weekly or more frequent basis during construction (based on agreements reached between the City, ECM and other reviewing parties) and on a monthly basis, depending on lake access, for a specified period (to be approved by reviewing agencies) following construction. Exact methods for analysis of lake samples will be agreed upon among the City, ECM and other reviewing parties prior to construction. *These sites have been selected because the City believes that the bulk of the natural turbidity in Blue Lake comes from glacial runoff in Blue lake Creek. This turbidity generally settles out in the lake prior to reaching the intake. The City believes that monitoring these two sites will provide data that may predict a drinking water upset at the intake months in advance of the upset.*

Constituents sampled at these two sites will include, but not be limited to, the following, beginning at the onset of construction and lasting for an acceptable period determined in consultation with reviewing agencies:

- **Turbidity** (at various depths above and below the thermocline)**;**
- **Total Organic Carbon (TOC**);
- **Dissolved Oxygen (DO);**
- **pH** (at various depths above and below thermocline)**;**
- **Iron** (at various depths above and below thermocline)**;**
- **Manganese** (at various depths above and below thermocline)**;**
- **Total Dissolved Solids (TDS);**
- **Water Transparency** (using Secchi disc**);** and
- **Methyl Mercury** (quarterly sample during reservoir filling, annual after reservoir has spilled)

*The above list was compiled based the technical memo prepared by **CH2M**HILL and stakeholder comments.*

Exact constituents, sampling protocols and measurement methods will be determined based on agency comment and review of equipment and methods available at the time of the onset of monitoring.

3.4.2 Sawmill Creek

Both construction period and long-term monitoring will take place in Sawmill Creek. As in Blue Lake, the primary monitoring types will be 1) continuous temperature monitoring; and 2)

monitoring of other water quality parameters. Both monitoring programs will commence during construction to provide comparisons between pre- and with-project conditions.

In addition to these monitoring programs, the City will continue its continuous monitoring of drinking water quality at the Water Treatment Facility.

Sawmill Creek Continuous Temperature Monitoring

The primary concern for water temperature impacts in Sawmill Creek relates to effects from the new intake elevation which would be closer to the lake surface at all reservoir levels than is the current intake. This might cause water to be warmer at certain times of the year, with potential effects on aquatic resources in Sawmill Creek. All of Sawmill Creek from the output from the Fish Valve Unit to tidewater would be variously affected by the new intake location.

Continuous temperature monitoring will take place in Sawmill Creek at three locations, using the same loggers installed in Blue Lake. (Several loggers have been active in Sawmill Creek for more than five years; loggers at these sites will serve as good sites at which to compare pre- and with-Expansion effects.)

These locations generally will be: 1) downstream of the FVU outlet at a distance sufficient to allow for mixing of FVU and water from above the FVU; 2) upstream of the Blue Lake powerhouse, at an accessible location just upstream from the upper Sawmill Creek bridge; and 3) below the Blue Lake powerhouse tailrace at a downstream distance sufficient to allow mixing of tailrace and main Sawmill Creek water temperature. Sawmill Creek loggers will be set to monitor temperature at about the same intervals as the monitors in Blue Lake.

In addition, during 2010, the City commissioned a study of Sawmill Creek water temperature downstream of the powerhouse (EES 2010) to analyze potential temperature effects on pink and chum salmon populations in the stream reach from the powerhouse to low tide level. As part of this study, several additional continuous loggers were emplaced downstream of the powerhouse.

Monitoring of Other Water Quality Parameters

In addition to temperature, the City will periodically (no more than monthly) monitor certain constituents in Sawmill Creek, beginning at the onset of construction and lasting for an acceptable period determined in consultation with reviewing agencies. During construction, these measurements will be as often as daily, depending on instructions from the ECM. These measurements will be made at the same three locations as for continuous temperature monitoring discussed above. The constituents will be:

- **Turbidity;**
- **Dissolved Oxygen (DO);**
- **pH**; and
- **Total Dissolved Solids (TDS).**

These constituents will be measured using an approved apparatus, which, to the extent possible, uses direct readout meters instead of streamside analytic methods. Several field kits are available to do this sort of work, and the one or ones employed will be approved by reviewing agencies and other appropriate Stakeholders.

Water Quality Monitoring at the City's Water Treatment Plant and Fish Valve Unit.

The City routinely monitors Blue Lake water at a tap at the existing water treatment plant. All sampling and analysis are done according to ADEC requirements *and the Watershed Control Program*. These measurements and their associated frequency are as follows:

- Turbidity (continuously)
- Temperature (daily)
- pH (daily)
- Fecal Coliform (3 times per week)
- TOC (monthly)

The City will install a continuous raw water turbidity monitor at the Fish Valve Unit (FVU). This monitor will provide advanced warning via the water treatment plant SCADA system of water turbidity approaching the treatment plant.

3.4.3 Specific Measures if Monitoring Identifies Unacceptable Water Quality Conditions

Dam/Intake Area

Several measures are available if monitoring detects unacceptable conditions, depending on where the conditions occurred and which constituents were involved. If turbidity from construction or a heavy runoff and mud slide were to occur near the existing intake, experience has shown that the material would detected almost immediately by the drinking water supply testing program. This is because the intake is positioned on the lake bottom and because runoff material stops as it falls into position in front of the intake. Under these circumstances, immediate cessation of the activity would be required (if it was a construction-related event) and the tap from the penstock to the City's water treatment plant would be closed to keep contaminated water from going through the plant. During such a by-pass period, the City's water supply would come from emergency tanks. After the pulse of contaminated water passed, the tap at the water treatment plant would be re-opened.

After construction and activation of the new intake, bankside sediment will flow downgrade past the new intake and will not collect there. There may be a temporary peak in sediment or turbidity, but it should pass quickly. In such a case, the same by-pass procedure described above could be utilized. The offending activity on shore, however, will be suspended in any case until no more contamination occurs at the drinking water monitoring point.

Petroleum products spilled into the lake will float and will not mix in significant concentrations to be subject to entrainment into the intake. However, if such products remain until the lake

surface approaches spill level, they may migrate downstream into productive fisheries areas in Sawmill Creek. If it appears that petroleum or other floating contaminants are likely to spill from the Lake, much of the material may be absorbed by placing absorbent material along the log boom near the dam. This is specified in the City's Hazardous Materials Management Plan. Boats may also be deployed to use absorbent materials near the dam in such a case.

Water Quality Standards

ADEC oversees the City's drinking water program. Drinking water quality standards and monitoring are defined in the City's Watershed Control Program. Drinking water quality standards are generally more stringent than other standards and so they have used to establish water quality requirements in Blue Lake for this project. The RawWater Analysis is indicated in Appendix III.

The threshold values for raw water are:

- *Turbidity (continuously)* — *If turbidity exceeds 1.49 NTU additional sampling is required. If turbidity exceeds 5.0 NTU ADEC is notified*
- *pH (daily)* — *8.6 max-7.4min, 8.4 goal*
- *Fecal Coliform (3 times per week)* — *absence or presence report if present*
- *TOC (monthly)* — *1.34 mg/lmax- ND min, .7 typical*

Upper Blue Lake

Sediment input to upper Blue Lake, presumably from lake filling, would have to travel the entire length of the lake before entering the intake. It is likely that such materials, particularly sediment, would settle out between the upper and lower ends of the lake. However, if such an event occurred, it would be detected and dealt with just as a high-turbidity event would be addressed near the dam/intake area. *Erosion and sediment control within the burn area is addressed in the Sediment and Erosion Control Plan. Monitoring of the silt fences will be conducted daily when construction activity is taking place at the site. The burn area is within the inundated area which will be flooded annually, eroded by waves, and covered with sediment from Blue Lake Creek.*

4.0 Summary of Water Quality Monitoring Plans

Article 409 and 410 requires that the plans identify at a minimum the following 4 topics. Following each topic is a brief response to each topic:

(1) exact locations of monitoring sites

(2) water quality parameters to be monitored including but not limited to turbidity and total organic carbon.

- *The water quality parameters are indicated in the monitoring plan by section.*

(3) a frequency of monitoring during all phases of construction which shall be at least daily and weekly respectively

- *The frequency of monitoring is generally defined in each section of this plan. The exact frequency of monitoring must be dependent upon the construction activities and General Contractor's work plan. The work plan is not available until the job is awarded. Monitoring frequency are generally continuous at the FVU and the WTP, daily at each construction area and monthly in the lake.*

(4) specific measures to be taken in the event that monitoring identifies unacceptable water quality conditions.

- *See section titled Specific Measures if Monitoring Identifies Unacceptable Water Quality Conditions*

ATTACHMENT I
Blue Lake Dam Raise Water Quality Monitoring

Blue Lake Dam Raise - Water Quality Monitoring

PREPARED FOR: Mark Buggins/City and Borough of Sitka

PREPARED BY: Enoch Nicholson, P.E./CH2M HILL

REVIEWED BY: Mark Carlson, P.E., Ph.D./CH2M HILL

COPIES: Floyd Damron, P.E./CH2M HILL

DATE: January 15, 2010

The following technical memorandum summarizes CH2M HILL's recommendations for Water Quality Monitoring prior, during and following the Blue Lake dam raisee and resulting reservoir water level changes. The information provided is based on similar monitoring that was deemed useful by other water purveyors with similar dam raise projects that have occurred recently in their water supply. The recommended plan includes fewer parameters that are sampled less frequently than those often used by other water systems, but the sampling plan includes the essentials to monitor water quality throughout this project. In addition the sampling plan provides information for troubleshooting purposes in case an unexpected water quality issue occurs in the future.

The sample schedule in the following table is intended to be commenced as soon as possible but at least 1-2 years prior to the start of construction activities. The information collected prior to the start of the project activities will provide baseline data. The sampling should continue through construction and reservoir filling and should extend 2-3 years beyond the filling of the reservoir to monitor water quality stabilization and potential recovery.

It is assumed that all of the samples will be collected in the raw water sample tap of your water treatment plant. In addition to these samples, additional reservoir temperature and dissolved oxygen profiling of your reservoir would be extremely beneficial if conducted on a regular basis (ideally monthly, although we understand this is often not feasible in the winter months). This profile should be conducted near the intake and should extend to at least 50 feet below the intake structure. If you have not done so already, you should create a baseline elevation other than the water surface elevation as the high water elevation will be changing during the course of the project.

An online monitor you might consider is online Dissolved Oxygen monitor which can be helpful in developing correlations to iron and manganese water color issues should they occur at any time in the future. This online dissolved oxygen monitor could be installed at the raw water sample tap in a flow through mode.

Please let me know if you have any questions or if you need any additional information on these recommendations.

City and Borough of Sitka
Reservoir Inundation Water Quality Sampling Plan

Continuous Online Monitoring	**Approximate Sample Costs (Each)**
Turbidity (Existing)	NA
Temperature (Existing)	NA
pH (Existing)	NA
Weekly Monitoring	
Iron (Can be done easily by City)	Operator Time
Manganese (Can be done easily by City)	Operator Time
Fecal Coliforms (3x/week) (Existing – analyzed by City)	NA
Monthly Monitoring (In addition to weekly samples, send weekly samples to lab at same time)	
TOC	$40
DOC	$40
UV254	$30
Chlorophyll-A	$50
Apparent Color	$20
Quarterly Monitoring (In addition to monthly samples)	
Ammonia	$20
Alkalinity	$20
Bromide	$35
Calcium	$20
Hardness	$20
Magnesium	$20
TTHM (at normal DBP compliance sample point)	$75
HAA5 (at normal DBP compliance sample point)	$185

ATTACHMENT II
Dam Raise Water Quality Evaluation

Blue Lake Dam Raise Water Quality Evaluation

PREPARED FOR: Mark Buggins/ City and Borough of Sitka, Alaska

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Theresa Hlavinka/CH2M HILL

REVIEWED BY: Floyd Damron, P.E./CH2M HILL
Paul Berg, P.E./CH2M HILL
Mark Carlson, P.E./CH2M HILL

DATE: December 18, 2008

Introduction

The City and Borough of Sitka (CBS) draws surface water from Blue Lake through a tunnel and penstock system. This system provides joint supply to a hydroelectric power plant and the municipal water system.

In response to increasing power demands the CBS electric department is planning to increase the height of the Blue Lake Dam by 80 feet and add a third turbine to the Blue Lake hydroelectric plant. Dam construction is expected to be completed by December 2013 and the reservoir is expected to be completely full by December 2015. This will result in the Blue Lake reservoir increasing in depth by 80 feet.

The purpose of this technical memorandum is to assess potential water quality impacts of the dam raise project and CBS's ability to maintain filtration avoidance for its water system.

CBS currently operates as an unfiltered surface water system, relying on chlorine addition for primary and residual disinfection. By April 2014, the city must comply with the U.S. Environmental Protection Agency's Long-Term 2 Enhanced Surface Water Treatment Rule (LT2). LT2 requires that unfiltered systems either add a second disinfectant or transition to filtration. Based on previous Alaska filtration avoidance community studies completed by CH2M HILL, we determined that the most economical alternative for compliance with LT2 is for CBS to add Ultraviolet (UV) disinfection as the second primary disinfectant.

This technical memorandum:

1. Presents case studies summarizing water quality impacts observed in similar situations and the implications those impacts might have on CBS's water supply and treatment.
2. Identifies potential water quality impacts that could affect CBS's plans to meet the requirements of LT2 with a combination of UV disinfection and chlorination.
3. Describes potential water quality mitigation plans.
4. Provides conclusions and recommendations.

Summary of Case Studies

Because of the unique nature of the geography and geology of the CBS watershed, similar dam and reservoir raise case studies are a challenge to find. Below are two of the closest examples that could be found in the United States which are comparable to CBS's watershed.

City of Kodiak, AK

The City of Kodiak obtains surface water from Monashka Reservoir, a man-made reservoir constructed solely for water supply to the City of Kodiak. In October 2003, the City of Kodiak completed the process of raising its surface water elevation from 30 feet to 42 feet, to increase capacity from 1,510 acre-feet to 2,960 acre-feet. Like Blue Lake, the reservoir is surrounded by heavily forested vegetation. The newly inundated area was not logged or cleared prior to the dam raise which contributed to the water quality changes noted below. The area geology features a volcanic island with layers of sand, gravel, and ash over bedrock. The lake depth is much shallower than Blue Lake. Seasonal weather patterns are similar between Sitka and Kodiak in terms of monthly high/low temperature averages and precipitation[1]. Typical sunlight exposure and lake temperatures are also comparable to Blue Lake because Sitka and Kodiak and within 40 miles of being on the same latitude.

Prior to raising the surface water elevation by 12 feet, short term water quality impacts were anticipated. After the dam raise, actual observed impacts included increased color, chlorine demand and turbidity, especially during the first summer after the dam raise. This was partially caused by low precipitation the year after the dam raise project was completed. This resulted in little to no water going over the spillway which reduced any flushing action to remove contaminants from the Monashka reservoir. These impacts have slowly improved over the course of the last few years since the dam raise. One notable example was the chlorine dose required to maintain the target residual, which went from an average of 1.3 mg/L up to as much as 1.6 mg/L the summer following the dam raise, and is now back down to an average of 1.2-1.3 mg/L.

One change made at Kodiak was to vary the intake elevation in order to improve water quality. Taking water from elevations higher in the water column improved delivered water quality to Kodiak's water treatment facility.

In summary, the City of Kodiak experienced changes in their water quality, but the newly flooded watershed areas did not cause drastic water quality impacts. The City has been able to continue as a filtration avoidance community and as a result CH2M HILL has been retained to design their UV disinfection system to meet LT2 dual disinfection requirements.

City of Tacoma, WA

The City of Tacoma obtains surface water from a multi-level intake in the Eagle Gorge Reservoir. In 2007, the Corps of Engineers raised its surface water elevation from 132 feet to 162 feet, to increase storage capacity and improve conditions for salmon. The 100,000+ Acre Feet reservoir is surrounded by rich vegetation. The terrain around the reservoir is not nearly as steep and geology is composed of more sediment and less rock than Blue Lake.

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[1] Kodiak's average high annual temp. is 46° F, average annual low temp. is 34° F, and average annual rainfall is 68 inches. This compares to Sitka with average annual high temp. of 49°F, average annual low temp. of 39° F, and average annual rainfall of 86 inches.

The depth of the lake is slightly shallower than Blue Lake at 162 feet, and seasonal patterns are different from Sitka in that Tacoma has a warmer climate and receives more sunlight annually.

Prior to raising the surface water elevation by 30 feet, the City of Tacoma anticipated water quality impacts related to algae growth in the surface layer of water. This could potentially become a problem when water is drawn off from the top of the reservoir in order to accommodate fish passage. The reservoir has yet to be fully filled, but preliminary pool studies confirm that the primary concern with the change in reservoir level is increased algae in the upper portion of the reservoir during spring and summer periods when water must be drawn from the top of the reservoir. Additional studies are currently underway to assess the water quality of the reservoir, specifically regarding algae growth, total organic carbon (TOC), and temperature distribution.

In summary, the City of Tacoma's primary concern with the reservoir level increase is related to the need to draw water off the top of the reservoir during potentially high algae growth seasons. They have also noticed an increase in iron and manganese issues, but these are assumed to be related to other causes and not directly related to the dam raise.

Water Quality Impacts and Possible Mitigations

Based on the CBS electric department's plan to raise the Blue Lake Dam, there are potential water quality impacts that could affect treatability of the water and the CBS's ability to maintain filtration avoidance status. The following contaminants have the potential to degrade water quality:

- Iron and manganese
- Phosphorus and nitrogen
- Organics
- Turbidity

Iron and Manganese

Increased levels of iron and manganese may occur if they are present in the lake's sediments. Increased water depth can lead to increased stratification periods. In highly stratified waters, the lower water levels receive little oxygen from the lake's surface. Natural decay often depletes the oxygen levels of the waters nearest the bottom of the lake. As the oxygen-reduction potential decreases, dissolved iron and manganese can be released from sediments. Dissolved iron and manganese do not have adverse health effects, but cause water discoloration and fixture staining. To avoid these problems these metals are limited by Secondary Maximum Contaminant Levels (SMCL) of 0.3 mg/L for iron and 0.05 mg/L for manganese. Furthermore, these inorganics may exceed acceptable levels required for UV disinfection by causing UV reactor fouling. The presence of iron and manganese in a significant concentration (approx. 0.1 mg/L for Iron and 0.05 mg/L for Manganese) would require reconsidering the feasibility of UV disinfection in lieu of filtration to meet LT2 requirements.

A primary source of iron and manganese is existing deposits in the lake sediments that come into solution when they come in contact with water that is low in dissolved oxygen.

When a lake is stratified, it features a warmer, well-mixed layer (the epilimnion) and a colder, deeper layer beneath (the hypolimnion). If the upper boundary of the hypolimnion or the duration of stratification were to increase as a result of raising the reservoir elevation, the result could be a substantial increase in iron and manganese concentrations for at least a portion of the year.

It is unknown whether Blue Lake's hypolimnion depth will increase after the dam is raised. A 2005 study concluded that Blue Lake's hypolimnion likely begins at a depth greater than 135 feet below water surface. Results were inconclusive as to how deep the hypolimnion begins. It is necessary to understand the degree of stratification in Blue Lake because this will indicate whether the intake structure draws water from the hypolimnion (which could potentially contain iron and manganese) or from the epilimnion. To fully understand the characteristics of Blue Lake, profiles need to be obtained for dissolved oxygen, temperature, and Secchi depth, which measures the depth of stratification in lakes. Dissolved oxygen and temperature were studied in 2006, and a new study of temperature at lower levels is currently underway. Based on a review of this new temperature study, a determination can be made as to whether or not iron and manganese sampling in the bottom of the lake needs to be conducted.

One potential mitigation alternative for potential stratification related concerns, such as iron and manganese, would be to in install a variable elevation intake structure that would allow water to be taken from selected levels in the lake to provide the best possible water quality. Changing the elevation of the Blue Lake intake on a seasonal basis could have a similar positive impact on water quality as is the case for Kodiak's Monashka Reservoir. This would not only be beneficial for drinking water, but may also provide benefit for fish habitat in Sawmill Creek.

If determined to be necessary based on the outcome of the temperature studies, samples for iron and manganese should be taken from the hypolimnion (if present) on a seasonal basis to determine if there are increased iron and manganese concentrations.

Phosphorus and Nitrogen

The primary concern related to phosphorus and nitrogen is that they serve as nutrients for algal growth. However, Blue Lake has low ambient levels of nutrients and any potential minor increase to nutrient levels as a result of the dam raise are not likely to be enough to cause significant algal growth. In addition, the side slopes are very steep, thus contributing very little to additional surface area containing vegetation and nutrients that will be exposed to sunlight after submergence. The overall environment of Blue Lake is not conducive to algae growth because of its low ambient levels of nutrients and sunlight because there is minimal depth to surface area ratio (a common indicator of nutrient concerns) as compared to other lakes of similar configuration.

It is unlikely that Blue Lake will have nutrient problems after the dam raise.

Organics

Organics are a concern for Blue Lake's water quality in that levels of total organic carbon (TOC) may rise and ultraviolet transmittance (UVT) may decrease. High levels of TOC can interfere with UV disinfection and cause disinfection byproduct formation. Any decrease in UVT would result in the need for larger reactors and additional power consumption.

Though unlikely, the worst case would be that the water becomes so opaque that UV disinfection is no longer feasible.

Low UVT is normally caused by dissolved organic material that results from the bacterial decay of naturally occurring vegetation such as leaf litter and woody material. This type of material is common in recently inundated areas, such as those areas that will be covered because of the increased dam height. However, since the volume of water that will be in contact with vegetation is very low compared to the total volume of the reservoir (2.5% inundated and 97.5% not in contact with vegetation), it is unlikely that the UVT will decrease enough to prevent the use of UV disinfection. In addition, Sitka is not prone to extended periods of warm, sunny weather as are experienced in most of the lower 48. Cool to cold conditions retard the rate of biological decomposition. One lesson learned from the Kodiak dam raise project is that it is beneficial to have a method to remove floating logs and other organic debris from areas near the intake in order to reduce the water quality impacts resulting from the debris decomposing at the surface of the water near the intake. For this reason we recommend that Sitka maintain a means of access to the reservoir and consider how floating debris could be removed from the reservoir, if necessary.

The decomposition of organics is not expected to be a significant water quality concern.

Turbidity

Inundation can increase turbidity if loosely bound soil enters the water column; typically because of underwater landslides or large areas of loosely bound soil are agitated by wave action. Two major concerns are associated with increased turbidity. First, turbidity levels could exceed MCL and filtration avoidance criteria (5 NTU, per the EPA Surface Water Treatment Rules). Second, increased turbidity levels could result in a decrease in UVT, and affect the ability to use UV disinfection on this water, as mentioned in the above section on Organics. If turbidity were to increase because of the dam raise, the increase would likely only last for several years. If this increase exceeded the parameters for UV disinfection it would likely not be mitigated without the addition of filtration to the treatment system.

Management of the way CBS controls future Blue Lake hydroelectric production and lake water levels could mitigate the effects of increase turbidity to the water supply system. Examples of management decisions include allowing higher than normal flows out of the lake in the existing tunnel and penstock system or flows over the spillway to assist in flushing turbidity out of the lake.

Turbidity is not expected to increase for extended periods of time because the large volume (282,000 ac-ft) and a long retention time (>150 days) provides ample opportunity for solids to settle. Additionally, 1.5-2 miles of the lake immediately upstream of the intake point is bounded by steep rock slopes which produce nearly the same effect as concrete walls. Currently, the lake has seen occasional increases in turbidity up to 5 NTU for short periods of time. These are likely due to mudslides or similar events in the watershed. Should soil slough off in a localized area and travel to the discharge point without the opportunity to disperse or settle a short-term period of high turbidity could result. These would be similar turbidity events to those experienced in the past, but likely with increased frequency.

It would be beneficial to survey the watershed to determine how much of the areas are loose soil on steep slopes that might slough off when inundated. The goal of this survey would be to note the size and prevalence of areas that are likely to cause underwater landslides

after the dam is raised. If large portions of the lake that are to be inundated are shown to have loose soil, this issue should be revisited.

It is expected that the dam raise will have little long term effect on turbidity, but short-term effects could be realized

Conclusions and Recommendations

Two case studies, from the Cities of Kodiak, Alaska and Tacoma, Washington provide a comparison to the City and Borough of Sitka Blue Lake Reservoir. While Kodiak did not experience impacts to their filtration avoidance status, Tacoma experienced increased concentrations of manganese and algae.

Kodiak's geography, geology, and site conditions are comparable to Sitka. Kodiak's dam raise project was on a much smaller scale and on a much smaller water reservoir than is planned at the large Blue Lake reservoir. Therefore any impacts from the Kodiak dam raise project had much less potential for buffering water quality impacts.

Tacoma's experience relates to potential issues with algae at the top layers of the reservoir. However, the depth of the intake and climate and Blue Lake should eliminate the likelihood that algae will cause problems for CBS.

The primary concern at Blue Lake is potential iron and manganese as a result of changes in stratification conditions. At Sitka, iron and manganese are not expected to be present in high enough concentrations to interfere with UV disinfection, but manganese could potentially exceed the SMCL and become a nuisance to the residents staining fixtures and possibly laundry. For this reason, careful attention to stratification and iron and manganese levels in the hypolimnion should be made to confirm that these contaminants will not likely interfere with UV disinfection. It would also be worthwhile to pursue the possibility of a variable level intake structure, in order to provide water quality benefits to both downstream fish habitat and drinking water.

CH2M HILL recommends additional study to focus on the physical and chemical aspects of the lake to provide further definition in order to better define and confirm initial assumptions of water quality impacts. These recommendations as they relate to each water quality parameter are summarized in Table 1.

Table 1: Summary of Water Quality Impacts and Recommended Action Items

Water Quality Parameter	Potential Water Quality Impacts	Method of Entry/ Point of Origin	Risk Determination Action Items
Inorganics (Fe, Mn)	- MCL exceedence for iron and manganese	Bottom sediments	- Obtain seasonal DO and temperature profiles in lower portion of lake to determine if stratification occurs. - Seasonally sample hypolimnion for iron, manganese and UV-254 during potential periods of stratification.
Nutrients (Phosphorous, Nitrates)	- Algae blooms and associated taste and odor problems	Release from vegetation and soils	
Organics (TOC, DOC)	- Increased levels of total organic carbon (TOC) - UV reactor fouling - Disinfection byproduct formation - Decreased UV Transmittance	Submergence of vegetation and soils	- Include plan for removal of floating vegetation in reservoir should organics levels become an issue.
Turbidity (Suspended Solids)	- MCL exceedence for turbidity - Filtration avoidance criteria exceedence - Decreased UV Transmittance	Exposed loose soil in suspension	- Inspect the reservoir for areas of loose soil on steep slopes that might cause potential problems.

Based on information gathered from similar projects and evaluation of the Blue Lake reservoir, we recommend that the City and Borough of Sitka proceed with plans to design and install a UV disinfection system after additional information has been collected to confirm preliminary water quality assumptions. High levels of iron, manganese, turbidity or UV-254 absorbance in the hypolomnion near the bottom of the reservoir would trigger the need for a review of the conceptual design for LT2 compliance to determine if UV disinfection is still feasible.

While filtration is not expected to be needed at this point, additional consideration should be given during UV facility predesign to ensure a future filtration facility can be constructed in the system at a point that optimizes the use of UV disinfection within the process. If the UV facility is constructed at the current site of the Blue Lake treatment plant, it would not be practical to include filtration upstream of UV disinfection. This would mean that if filtration were added in the future, the UV disinfection system could be less effective during poor water quality periods. If filtration is installed, it is preferable to install it upstream of UV disinfection in order to provide a barrier to enhance performance of the UV system. Filtration could be required in the future due to more stringent drinking water regulations or due to deteriorated water quality from Blue Lake.

ATTACHMENT III
Raw Water Analysis

Blue Lake Raw Water

Contaminant/ Measurement	Frequency	Results	Range	Year
Turbidity*	Continually *Average Turbidity ~ 0.47	Avg. 0.47	0.18 - 5.49 >ntu's	2009
Temp	Daily		1.5 - 10* C	
pH	Daily		6.8 - 7.0	
UV254	Bi -Weekly		0.014 - 0.025	2009
TOC	Monthly		ND - 1.00 mg/L	
Fecal*	3 x Week *Median Fecal = 0 CFU per 100 mL		0-15 CFU/100mL	2009
Total Nitrate/ Nitrite-N	Annual		0.227 mg/L	2009
Alkalinity	peroidicaly		8-16 mg/L	
Inorganics	Wavier			2010
Nitrites	Suspended*	<MDL (1993)		2001
Cyanide	Waiver	< MLR		1999
Arsenic	Annual	ND		2009
Barium	Waiver	0.011 mg/L		1999
Beryllium	Waiver	<MRL		1999
Cadmium	Waiver	<MRL		1999
Chromium	Waiver	<MRL		1999
Antimony	Waiver	<MRL		1999
Selenium	Waiver	<MLR		1999
Thallium	Waiver	<MRL		1999
Mercury	Waiver	0.0002 mg/L		1999

* Nitrite sampling suspended UNLESS an annual Nitrate sample, collected after treatment, is

analyzed with a result of 50% or greater of the MCL set for Nitrate. Current standard is 10 mg/L.

MDL_____ Methoed Detection Limit
MRL_____ Methoed Reporting Limit
ND _____ Non Detect.

ATTACHMENT IV
Comments received from USFS August 9, 2012
Numbering added by the City

File Code: 2770
Date: August 9, 2012

Christopher Brewton
Utilities Director
City & Borough of Sitka
105 Jarvis Street
Sitka, AK 99835

Dear Mr. Brewton:

We reviewed the *Draft Water Quality Monitoring Plan, Blue Lake Hydroelectric Project (FERC No. 2230) Expansion*, prepared by the City & Borough of Sitka Electric Department, June 2012. Based on this review, we offer the following comments:

In February when we reviewed the FERC EA, we commented on the lack of information in this plan. The plan lacks the required details for review.

Article 409. *Construction Water Quality Monitoring Plan. At least 60 days prior to ground disturbing activities, the licensee shall file with the Commission, for approval, a Construction Water Quality Monitoring Plan.*

The plan shall identify at a minimum:

(1) Exact locations of monitoring sites; (2) water quality parameters to be monitored including but not limited to turbidity and total organic carbon; (3) a frequency of monitoring during all phases of construction which shall be at least daily; and (4) specific measures to be taken in the event that monitoring identifies unacceptable water quality conditions

Article 410. *Long-Term Water Quality Monitoring Plan. At least 60 days prior to ground disturbing activities, the licensee shall file with the Commission, for approval, a Long-Term Water Quality Monitoring Plan.*

The plan shall include at a minimum:

(1) identification of all long-term water quality monitoring sites including Blue Lake, the powerhouses, and Sawmill Creek; (2) the specific water quality parameters to be monitored at each site, including but not limited to turbidity and total organic carbon; (3) the frequency of monitoring at each location which shall be at least weekly as well as the duration of monitoring during the term of the license; and (4) identification of specific measures to be taken in the event that monitoring indicates problems with water quality at the project.

USFS 1 Both Article 409 and 410 identify those items that will be included at a minimum. We recommend re-organizing the plan to follow the headings implied by the Articles (two kinds of plans, each one with a minimum of four types of information). We would further recommend that both plans include objectives and quality assurance.

USFS 2 NEED for WATER QUALITY MONITORING – In the second paragraph there is reference to increases in certain contaminant concentrations. These plans are the documents where specific details need to be addressed. What are the contaminants, and how are the four minimum types of information both during construction and long-term going to be addressed?

USFS 3 CONSTRUCTION PERIOD MONITORING – There is a bulleted list *emphasizing detection of* a variety of construction effects; however, there are no parameters of what and how to monitor.

USFS 4 The next to last paragraph: *Water samples will be collected at various intervals depending on schedule and proximity to active construction sites. In all these areas, water quality sampling will be conducted at locations and time intervals agreed to after determination of both construction methods and the construction schedule. After these milestones are reached, the City will, prior to any ground disturbance, complete a detailed Construction-Related Water Quality Monitoring Plan documenting exact locations, constituents, methods and frequency of construction-related sampling. A draft of the plan will be reviewed and commented on by the appropriate state and federal resource agencies, and all comments will be addressed in the final plan which will be distributed to agencies required by FERC.*- makes it evident that this document is not ready for review because it does not meet the requirements of Article 409.

USFS 5 LONG-TERM OPERATION MONITORING – Aside from general trends and effects, are there long-term objectives related to specific concerns, mitigations, project design, etc., that are being monitored?

Monitoring of Other Water Quality Parameters in Blue Lake

USFS 6 In the first paragraph, the City identifies two approximate sampling points. Why were these sites chosen?

USFS 7 There is a bulleted list of constituents sampled. What is the basis for each of these parameters? What are you trying to detect?

USFS 8 The last paragraph states: *Exact constituents, sampling protocols and measurement methods will be determined based on agency comment and review of equipment and methods available at the time of the onset of monitoring*. When will this comment and review occur?

USFS 9 ***Monitoring of Other Water Quality Parameters*** – this section raises the same questions as above.

USFS 10 ***Water Quality Monitoring at the City's Water Treatment Plant and Fish valve Unit*** – The final paragraph addresses monitoring for blast residue. This information belongs in the Construction Period Monitoring section.

USFS 11 ***Specific Measures if Monitoring Identifies Unacceptable Water Quality Conditions*** – What specifically constitutes unacceptable water quality conditions? Will you be using numeric water quality criteria (e.g. Alaska DEC, EPA)?

USFS 12 What measures will be taken in response to results for parameters other than turbidity (e.g. mercury, TOC, manganese). There should be a threshold and response for every constituent identified in these two plans. These constituents should be identified based on reporting requirements (from some regulatory agency) or for a well-defined study based on some of the effects identified in the FERC EA (e.g. effects from inundation plan to flood 362 acres of extensive coniferous and deciduous vegetation, potential effects to anadromous and resident fish).

If you have any questions please contact Clay Davis at (907) 747-4225 or email clayrdavis@fs.fed.us.

Sincerely,

/s/ Carol A. Goularte
CAROL A. GOULARTE
District Ranger

ATTACHMENT V

Table Showing How Numbered Comments Were Addressed.

Comment Number	Comment Summary	Action/Location or Answer
USFS 1	Recommend re-organizing plan and separating.	Page 11, section 4.0 added
USFS 2	Asking what the contaminants, and how the four minimum types of information both during construction and long-term going to be addressed	Analysis of the potential contaminant concentration were conducted by CH2MHILL and reported in technical memos Blue Lake Dam Raise Water Quality Monitoring dated January 15, 2010, and Dam Raise Water Quality Evaluation dated December 18, 2008. The monitoring program outlined in this plan is based largely on these memos. The memos are attached as Attachment III & IV.
USFS 3	Stating there are no parameters of what and how to monitor during construction	Page 4 and 5, Section 3.3, language added, however, the contractor's final work plan will have to be consulted for details.
USFS 4	Stating the plan does not meet the guidelines of Article 409	Page 4 and 5, Section 3.3, USFS will be given the contractor's final work plan before it is submitted to the FERC for review to ensure it meets the guidelines.
USFS 5	Asking if there are long-term objectives related to specific concerns, mitigations, project design, etc., that are being monitored	The monitoring outlined in the Long-term monitoring program will supplement the Construction Monitoring Plan and be performed at the same time. The continuous monitoring outlined in the long-term plan will provide instantaneous monitoring of

		construction activities.
USFS 6	Asking why the sampling points were chosen	Page 8, These sites have been selected because the City believes that the bulk of the natural turbidity in Blue Lake comes from glacial runoff in Blue lake Creek. More language added.
USFS 7	Asking why the list of constituents sampled were chosen and what the City is trying to detect.	Page 8, The list was compiled based the technical memo prepared by CH2MHILL and stakeholder comments.
USFS 8	Asking when Exact constituents, sampling protocols comment period will occur.	The known constituent and sampling protocols have been added to this plan. Additional constituent and protocols will be added based on the Contractor's final work plan prior to construction.
USFS 9	Asking when Monitoring of Other Water Quality Parameters comment period will occur.	Monitoring of other water quality parameters will be included for comment prior to construction.
USFS 10	Suggest moving the monitoring for blast residue to the Construction section.	The monitoring outlined in the Long-term monitoring program will supplement the Construction Monitoring Plan and be performed at the same time. The continuous monitoring outlined in the long-term plan will provide instantaneous monitoring of construction activities.
USFS 11	Asking what specifically constitutes unacceptable water quality conditions and Will you be using numeric water quality criteria (e.g. Alaska DEC, EPA)	Page 11, ADEC oversees the City's drinking water program. Drinking water quality standards and monitoring are defined in the City's Watershed Control Program. Drinking water quality standards are generally more stringent

		than other standards and so they have used to establish water quality requirements in Blue Lake for this project.
USFS 12	Asking what measures will be taken in response to results for parameters other than turbidity (e.g. mercury, TOC, manganese)	See section 3.4.3