COLORADO
Department of Public
Health & Environment

Dedicated to protecting and improving the health and environment of the people of Colorado

June 23, 2016

Paula Daukas
City and County of Denver
Board of Water Commissioners
1600 West 12th Avenue
Denver, Colorado 80204

Re: Section 401 Colorado Water Quality Certification No.: 4369
US Army Corps of Engineers 404 Permit No.: 200280762
FERC Project No. 2035
Project Name: Moffat Collection System
Location: Grand, Boulder, Park, Summit, Jefferson and Denver Counties
Water Course: South Boulder Creek, Gross Reservoir, North Fork South Platte River, South Platte River, Chatfield Reservoir, Fraser River, Williams Fork River, Blue River, and Colorado River
Reviewable Designation: COSPUS04, COSPUS06a, COSPUS06b, COSPUS14, COSPUS15, COSPBO04a, COSPBO04b, COSPBO15, COUCUC03, COUCUC08, COUCUC10a, COUCUC10b, COUCUC10C, COUCBL17

Dear Ms. Daukas:

The Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division (Division) has completed its review of the Moffat Collection System Project Clean Water Act (CWA) Section 401 Permit Application. We have also reviewed our preliminary determination with the issuance of the State of Colorado 401 Certification Public Notice (5 CCR 1002-82, § 82.5(B)) and have completed an antidegradation review pursuant to Regulation 31, Basic Standards and Methodologies for Surface Water (5 CCR 1002-31, § 31.8(3)).

Regulation 82 Requirements

Regulation 82, (5 CCR 1002-82) which addresses certifications under Section 401 of the Clean Water Act, directs the Division to consider antidegradation requirements indentified in the state's Procedural Regulation, Regulation 21 (5 CCR 1002-21), requirements contained in the Basic Standards and Methodologies for Surface Water, Regulation 31 (5 CCR 1002-31), the Basic Standards for Ground Water, Regulation 41 (5 CCR1002-41), as well as appropriate classifications and water quality standards, effluent limits, control regulations, Best Management Practices (BMPs), water quality mitigation measures and public comments. The Division is directed to provide either a regular certification, conditional certification, or to deny certification based upon review of the application and the applicable water quality requirements as listed in section 82.5(A)(1) of Regulation 82.

Section 82.5(B)(6) provides that "[c]ertifcation shall not be denied where the imposition of conditions or denial would result in material injury to water rights as prohibited under section 25-8-104 C.R.S." The pertinent part of § 25-8-104(1) states as follows:

> No provision of this article shall be interpreted as to supersede, abrogate, or impair rights to divert water and apply water to beneficial uses in accordance with the

> provisions of sections 5 and 6 of article XVI of the constitution of the State of Colorado, compacts entered into by the State of Colorado, or the provisions of articles 80 to 93 of title 37, C.R.S., or Colorado court determinations with respect to the determination and administration of water rights. Nothing in this article shall be construed, enforced, or applied so as to cause or result in material injury to water rights.... Nothing in this article shall be construed to allow the commission or the division to require minimum stream flows or minimum water levels in any lakes or impoundments.

Project Background

The Moffat Collection System Project is expected to provide larger water deliveries to the Denver metropolitan area by increasing the storage capacity of the existing Gross Reservoir by raising the current dam height. On the West Slope the project is expected to have impacts to the Fraser River and its tributaries, Grand Lake, Shadow Mountain Reservoir, the Colorado River after it enters Shadow Mountain Reservoir through Granby Reservoir and Windy Gap Reservoir to the confluence with the Williams Fork River and the Williams Fork River and its upper tributaries. Impacts have also been identified in the Blue River below Dillon Reservoir, North Fork South Platte River, Chatfield Reservoir, South Platte River and South Boulder Creek. The impacted portion of the Colorado River is identified as Upper Colorado River Basin segment 3. Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir are identified as Upper Colorado River Basin segment 12. Windy Gap Reservoir is Upper Colorado River Basin segment 13. The Colorado River from Shadow Mountain Reservoir to Granby Reservoir is Upper Colorado segment 2. The Williams Fork River and tributaries are Upper Colorado River Basin segment 8. The Blue River below Dillon Reservoir is Blue River segment 17.

The project impacts the following water bodies on the East Slope -North Fork South Platte River is Upper South Platte River Basin segment 4. South Platte River above Chatfield Reservoir is segment 6a. Chatfield Reservoir is Upper South Platte segment 6b. The South Platte River mainstem through Denver is Upper South Platte River segments 14 and 15. South Boulder Creek, Gross Reservoir and South Boulder Creek below Gross Reservoir are Boulder Creek segments 4a, 15 and 4b respectively.

All of these segments are "reviewable," meaning that an antidegradation review is required. The antidegradation review process requires a determination as to whether the activity is likely to result in significant degradation of the impacted waters. The Division's "significance determinations" consider the "net effect of the new or increased water quality impacts .... Taking into account any environmental benefits resulting from the regulated activity and any water quality enhancements or mitigation measures...." 5 CCR 1002-31, § 31.8(3)(c).

Division Comments and Antidegradation Review

The Division has reviewed information submitted concerning the Moffat Collection System Project against the requirements of Regulation 82 and the other applicable regulations cited herein. The construction activities described in the Moffat Collection System are expected to be only short-term in nature and are therefore not significant in the context of an antidegradation review. Operation of the Moffat Collection System Project does not involve discharges, but it does lead to potential long-term water quality impacts. These potential impacts and the required conditions to mitigate such impacts are explained in detail in the attached *Rationale for Conditional 401 Certification of the Moffat Collection System Project.*

Certification Statement

Based on the Division's analysis and evaluation, as further explained in the attached *Rationale for Conditional 401 Certification for the Moffat Collection System Project*, and based on consideration of the short-term impacts of construction activities and BMPs and conditions imposed by other agencies, as well as conditions on operation of the project as imposed by the Division, including the development of adaptive management practices in response to monitoring and assessed conditions, the Division concludes that there is reasonable assurance that the project will be conducted in a manner that complies with all applicable water quality requirements. *See* 5 CCR 1002-82, § 82.5(A)(3); 40 CFR § 121.2(a)(3). Therefore, this letter shall serve as official notification that the Division is issuing a "Conditional Certification" in accordance with 5 CCR 1002-82, § 82.5(A)(3). Conditions for this certification are included in the attached document, *Rationale for Conditional 401 Certification of the Moffat Collection System Project*.

This § 401 Water Quality Certification shall apply to both the construction and operation of the project for which a federal license or permit is required, and shall apply to the water quality impacts associated with the Moffat Collection System Project. This certification does not constitute a relinquishment of the Division's authority as defined in the Colorado Water Quality Control Act, nor does it fulfill or waive any other local, state, or federal requirements.

If you have any questions or need additional information, please contact John Hranac of my staff at (303) 692-3586.

Sincerely,

Patrick Pfaltzgraff
Director, Water Quality Control Division
Colorado Department of Public Health and Environment

Enclosures: *Rationale for Conditional 401 Certification of the Moffat Collection System Project*
Regulation 82.6 Certification Requirements

C: Tim Carey, US Army Corps of Engineers, Denver Regulatory Office, Littleton, CO
Kimberly D. Bose, Federal Energy Regulatory Commission, Washington, D.C.
Peter Yarrington, Federal Energy Regulatory Commission, Washington, D.C.
Steve Hocking, Federal Energy Regulatory Commission, Washington, D.C.
Lurline Underbrink Curran, Grand County Manager, Hot Sulphur Springs, CO
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Rationale for Conditional 401 Certification of the Moffat Collection System Project

The proposed Moffat Collection System Project (Moffat Project or project) will provide an additional 18,000 acre-feet per year (AF/y) to meet future demands of the Applicant[1] and its customers. It includes an enlargement of Gross Reservoir and will rely on existing infrastructure to fill the added storage capacity. Expansion of the dam and enlargement of the reservoir will have direct impacts to waters of the United States, including adjacent wetlands. Although the project does not discharge pollutants, it does involve significant "hydrologic modifications." By altering flows on both sides of the Continental Divide, the project directly affects the quantity and quality of aquatic habitat, and it indirectly affects water quality by changing contributions to mass balance for all constituents.

The project requires certification under Section 401 (certification) of the Federal Clean Water Act, and it is the responsibility of the Water Quality Control Division (Division) to determine whether to certify, conditionally certify or deny certification for the project. This certification applies to two federal actions required by the project: the Section 404 permit from the U.S. Army Corps of Engineers (Corps) and an amendment to the license from the Federal Energy Regulatory Commission (FERC) for a hydropower project[2]. The Corps, as the lead agency responsible for compliance with the National Environmental Policy Act (NEPA), prepared an Environmental Impact Statement (EIS), with the Final EIS (FEIS) issued on April 18, 2014.

Water Quality Control Commission (Commission) Regulation 82 provides direction to the Division concerning the nature and scope of the evaluation of potential water quality impacts, including those resulting from hydrologic modifications. The regulation, in section 82.5(A), specifies what the Division will review and consider in reaching its determination about certification. Items relevant to the determination for this project include the certification application, anti-degradation (AD) review, maintenance of water quality standards and protection of designated uses in waters in the affected area, information received in the public comment period, and commitments already made by the Applicant for mitigation of anticipated impacts and enhancements to water quality that may yield environmental benefit.

The "Request for Clean Water Act Section 401 Water Quality Certification Final Report" (Final Report) dated June 2015 provides the Applicant's

[1] City and County of Denver, acting by and through its Board of Water Commissioners (Denver Water)
[2] Project No. 2035

characterization of water quality impacts and a catalog of the commitments the Applicant has made to mitigate those impacts or otherwise improve water quality in the project area. The Division generally agrees with much of the Applicant's characterization of impacts and also recognizes the value of the commitments the Applicant has made to improve water quality. The Division's ability to issue a certification for this project is based on a determination of "reasonable assurance" that the proposed mitigation and enhancement measures will perform as expected and counteract the predicted adverse impacts of the project. Thus, the Division is imposing conditions on the certification as a means of clarifying expectations for, and assessing the performance of, these mitigation and enhancement measures.

Development of Conditions

The Division seeks to satisfy two objectives by imposing conditions. The first objective is to ensure that significant water quality impacts are mitigated wherever possible. Opportunities for direct mitigation are relatively limited insofar as the impacts are the result of hydrologic modifications and not the discharge of pollutants. The challenge is to craft conditions that are effective and also consistent with section 25-8-104 of the Water Quality Control Act, as specified in Regulation 82[3]. Although it is beyond the Division's authority to unilaterally impose a condition inconsistent with section 25-8-104, such a condition could be included if the Applicant finds it acceptable[4].

The second objective is to provide reasonable assurance that the Applicant's commitments to mitigate the impacts of the project and enhance water quality provide the expected benefits. The 401 certification application lists the existing commitments and associated agreements. These mitigation and enhancement measures, if successful, may contribute to "net environmental benefit" as it relates to the significance determination in the AD review.

Each commitment for mitigation or an enhancement measure in the Final Report makes a prediction, usually based on modeling, about the expected benefit. Consequently, there is an implicit, but untested, assumption that the proposed measures will be successful in mitigating impacts or improving some aspect of water quality. The Division will impose conditions to clarify expectations and to determine the actual benefit after the mitigation and enhancement measures have been implemented and the project has been completed.

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[3] Section 82.14: "There may be hydrologic modification impacts that can be mitigated without materially injuring water rights. The Commission believes that it has a responsibility to assure the maximum practical water quality protection that does not conflict with the provisions of section 25-8-104."
[4] Section 82.5(A)(3)

The Division recognizes that the Applicant's commitments for mitigation and enhancement measures have been made in good faith and with the expectation that those measures will prove successful. There is no way to ensure success, however. Consequently, it is important to have a process for handling situations where those measures fall short and impairments[5] occur. Thus, conditions include a requirement for the Applicant to investigate sources and mechanisms contributing to the impairment and, if necessary, to develop an appropriate response.

There has been considerable discussion, including public comment, about including a condition that would require the Applicant to participate in the Learning by Doing (LBD)[6] process. The Division views LBD as a potentially valuable strategy for adaptive management that is well-suited for optimizing allocation of resources for maintenance and improvement of the stream environment. Through the certification process the Division and parties that commented on this issue have come to a resolution. The Division has not included the Applicant's participation in LBD as a condition because the Division only has authority to require the Applicant to comply with the conditions, and LBD includes multiple parties. However, the Applicant may fulfill its obligations under this 401 certification through participation in external groups and processes, including but not limited to LBD.

Lastly, the Division may modify the certification, by revising existing conditions or proposing new water quality conditions, based on new evidence or changed circumstances determined to result in significant water quality impacts due to the project. For example, the conditions presented below are based on an important assumption regarding another large water project – the Windy Gap Firming Project (WGFP) – that was also subject to the 401 certification process. The Moffat Project and the WGFP are each considered to be one of the Reasonably Foreseeable Future Actions affecting the other project. All previous

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[5] Throughout the text, the terms "impaired" and "impairment" refer in all instances to conclusions reached on the basis of water quality assessment protocols given in the Division's 303(d) Listing Methodology, which is revised biennially. A formal listing in Regulation 93 is not required for reaching an impairment conclusion.

[6] Learning by Doing is a cooperative process that has a goal of maintaining or improving the "stream environment" in the project area. An adaptive management strategy is employed to make decisions about allocating resources to meet the goal. The management committee includes representatives from Denver Water, Grand County, the Colorado River Conservation District, Middle Park Water Conservancy District, Northern Colorado Water Conservancy District (Municipal Subdistrict), Colorado Parks and Wildlife, and Trout Unlimited. The Applicant has signed the 2012 Intergovernmental Agreement for the LBD Cooperative Effort, and the Applicant's participation is further required through other commitments, including the Colorado River Cooperative Agreement.

modeling of hydrology and water quality, as well as the environmental impact analysis, has assumed that both projects would receive the necessary permits and be operated concurrently. The Division has evaluated both projects in the 401 certification process and sees no reason to question the assumption that both will move forward for permitting. However, in the event that the WGFP does not receive a 404 permit, or if there are any other material changes to the assumptions that form the basis of the Division's certification that will adversely impact water quality to the extent that the conditions herein no longer yield an environmental benefit, then the Applicant must submit a request to the Division for a modification to the 401 certification.

General Considerations for Water Quality Monitoring

Water quality monitoring provides the information necessary for evaluating the performance of mitigation and enhancement measures. As such, there are general requirements regarding locations, sampling frequency, analytical precision, and reporting that affect the usefulness of the data for reaching conclusions about performance and about the possible occurrence of impairments as defined by the most recent version of the Division's 303(d) Listing Methodology. The general considerations for monitoring are specified in this section, and requirements specific to individual parameters are described within the conditions. General monitoring requirements are also added for Gross Reservoir, because water quality may change as a result of the enlargement of the reservoir, and for selected source water areas where public comment identified further need of data.

For sampling locations, preference is given to sites that have been sampled in the past, especially where the sites were important for assessing the potential for project impacts. The historical record at these sites establishes context for baseline conditions and for the magnitude and patterns of variability that will facilitate interpretation of data obtained in the future.

When the Division specifies site selection(s) in a condition, it is based on the assumption the site(s) will continue to fulfill the original purpose (e.g., provide continuity with the historical data record) and be accessible to the Applicant. The Division recognizes that factors beyond the Applicant's control may alter the representativeness of data at a particular location (e.g., construction of a beaver dam) or access to private land may be denied. When such situations arise, the Applicant will submit as soon as possible a proposed alternate location to the Division for approval.

Sampling frequency depends to some extent on the parameter, the nature of the expected impacts, and the needs for evaluating the performance of mitigation and enhancement measures. For stream temperature, continuous monitoring (15-min intervals) is required for establishing the temporal patterns

of variation and for assessing attainment[7] of standards. Water chemistry sampling in streams and in Gross Reservoir must be monthly or more frequent, with the caveat that Gross Reservoir may not be safe to sample under ice cover and some stream sampling locations identified in the conditions may not be accessible in winter. Biennial sampling for fish and annual sampling for aquatic macroinvertebrates are required.

Analytical precision determines the usefulness of data for constituents that are present in relatively low concentrations. Laboratory analyses must include an empirical determination of the method detection limit (MDL), and readings below the MDL are to be treated as non-detects. Readings between the MDL and the reporting limit must be reported as estimated concentrations (i.e., flagged accordingly and not shown as a "less than" value).

All monitoring data – lab and field results – must be compiled annually and provided to the Division in electronic form by April 1 following each calendar year of sampling. The requirement for sampling and reporting will begin as soon as the issuance of the 404 permit or the FERC license, whichever is later, and the obligation will remain in place until five years after the project is fully operational[8]. The annual report will include assessments of attainment utilizing the most recent edition of the Division's 303(d) Listing Methodology for all parameters specified in the conditions and a brief discussion of any impairments.

General Considerations for Response to Impairment

Based on the information provided in the application the Division expects that the mitigation or enhancement measures will be successful; however, there is no guarantee. It is possible that, despite best efforts, water quality will become, or continue to be, impaired. It is important to anticipate this possibility by including conditions that, if triggered, will specify a course of action to foster improved water quality to the extent possible. The course of action described below is essentially an adaptive management strategy for developing the appropriate remedial action.

For parameters included in the conditions, when an impairment is identified in annual reports submitted by the Applicant or through the Division's assessment process, the Applicant will be required to investigate sources and mechanisms in an effort to determine the extent to which operation of the Moffat Project

[7] Throughout the text, the term "attainment" refers consistently to situations where assessment of ambient water quality data shows that the applicable water quality standard is met.

[8] "Fully operational" is defined as the date of the initial fill of the Gross Reservoir enlargement, not including water that is part of the Environmental Pool.

causes or contributes to the impairment. The Applicant is well-positioned to investigate these impairments by having collected the data, through familiarity with the project area, and with the information to separate project effects from those attributable to full use of the existing system.

The Applicant will have one year following the detection of the impairment to prepare an impairment investigation report in which conclusions will be presented about the main source(s) and mechanism(s) at work, and the responsibility attributable to the project. Results of the impairment investigation will be discussed with the Division to determine what further actions are required of the Applicant. This report may be developed with contractor support or through external processes such as Learning by Doing. If, after diligently working on the impairment investigation, the Applicant requires more time to finish the impairment investigation the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the one year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

Where the Division concludes that operation of the project bears little or no responsibility for the impairment, the Division will use the impairment investigation report to facilitate development of a Total Maximum Daily Load (TMDL) consistent with regulatory requirements. If the Division concludes that operation of the project is primarily responsible for the impairment, the Division will require that the Applicant actively explore preparation of a Category 4b Plan[9] that will define the actions necessary to bring water quality back to attainment of the standard. In doing so, the Applicant will be encouraged to work with other significant contributors to impairment, if applicable.

A Category 4b Plan must ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, must be consistent with CRS 25-8-104, and must be submitted to the Division no more than two years after the Division's determination that the plan is applicable. If a Category 4b Plan cannot ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, is not accepted by the Division or the Environmental Protection Agency (EPA), or is precluded by or inconsistent with the water rights provisions in section CRS 25-8-104, then the Division anticipates a 303(d) listing and, in cooperation with the Applicant, preparation of a TMDL to bring water quality back to attainment of the

[9] A Category 4b Demonstration Plan addresses water quality impairments in a manner that makes the TMDL process unnecessary. The plan identifies mechanisms that are expected to result in attainment of water quality standards in a reasonable period of time.

standard. The Applicant, at its discretion, may agree to remedial actions to restore water quality that are inconsistent with the water rights provisions of CRS 25-8-104. If, after diligently working on the Category 4b Plan, the Applicant requires more time to finish the Category 4b Plan, the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the two year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

Rationales and Conditions

Conditions are organized by water quality parameters. Each condition is accompanied by a rationale that describes the anticipated impact, what is proposed for mitigation or enhancement, and what reliance is placed on commitments that the Applicant has made to other parties. An impact may be considered significant when it erodes assimilative capacity beyond what is allowed by the rules set forth in the AD review guidance in Regulation 31. Also, any impact that causes an impairment or contributes to an existing impairment is considered significant. In the case of cause-or-contribute impacts, the Division will include consideration of qualitative assessments, especially where modeling was not feasible or data were not available.

Temperature

The Applicant analyzed temperature impacts to the Fraser River, the Colorado River, and South Boulder Creek. Regarding the Fraser River and Colorado River, the predicted impacts of the project include the loss of assimilative capacity and increases in the number of exceedances of temperature standards. Conclusions for the Fraser River are based on results produced by a dynamic temperature model developed for the Fraser River by the Applicant and calibrated with recent temperature data. Predictions for the Colorado River are based on modeling work performed as part of a separate certification application for the Windy Gap Firming Project. Conclusions for South Boulder Creek are based on reservoir modeling conducted as part of the EIS process and additional analyses performed by the Division, as explained below. The Division has reviewed the modeling work and has determined it is credible.

Project diversions in the Fraser River basin will reduce stream flows with the expected impact of causing or contributing to existing impairments for temperature and further erosion of assimilative capacity. Specific areas of concern include Ranch Creek, the Fraser River, and St Louis Creek. According to the FEIS, the potential for impact extends to the Colorado River below the confluence with the Fraser River. A robust monitoring program will be especially important for identifying temperature impacts related to operation of the project. Conditions will be imposed to establish and maintain temperature monitoring stations at key locations.

The Applicant has made commitments to bypass flows from 15 July through 31 August in response to specific temperature action levels at specified locations in the Fraser River basin and in the Colorado River below Windy Gap Reservoir. The "Temperature Mitigation Response", which is presented in the Final Report, is a commitment to release up to 250 AF (at a rate of up to 4 cfs) when temperature action levels are reached at any of the following locations at which real-time temperature monitoring is required.

- Fraser River below Crooked Creek near Tabernash (USGS gage 09033300)
- Ranch Creek near Fraser, CO (USGS gage 09032000)
- Ranch Creek below Meadow Creek (USGS gage 09033100)
- Colorado River at the Windy Gap gage (CR-WGD; USGS gage 09034250)
- Colorado River upstream of the confluence with the Williams Fork River (CR-WFU)

The Division has two concerns about the list of locations proposed for triggering the Temperature Mitigation Response. The first is a need for assurance that the Applicant will be responsible for obtaining the data in the event that the operator (e.g., USGS) ceases to support the site. The second is the absence of a real-time temperature station in the Fraser River at Rendezvous Bridge, which is the last point on the mainstem of the Fraser with a Tier 1 (CS-I) classification for temperature. From that point to the confluence with the Colorado River, the mainstem of the Fraser (including USGS gage 09033300) is classified as Tier 2 (CS-II), which has less stringent temperature standards. In other words, exceedances of the temperature standard are more likely at Rendezvous Bridge than at the site below Crooked Creek. This problem can be remedied by adding a real-time monitoring site at Rendezvous Bridge, or by applying the CS-1 action levels, irrespective of the actual classification, at the existing real-time site below Crooked Creek.

The commitment for Temperature Mitigation Response is documented in the Fish and Wildlife Mitigation Plan (FWMP) and the Grand County Mitigation and Enhancement Coordination Plan (GCMECP). Because the response is not dependent on project operation, it may serve as an enhancement measure during the years of prior to project operation and as mitigation once the project is operational.

If the 250 AF available under the Temperature Mitigation Response has been bypassed, but temperature levels remain elevated, the Applicant has committed to bypass additional flows when the project is diverting[10]. Under

[10] The following definition is from the GCMECP: "After the Project is constructed, daily reservoir accounting will first credit the water diverted by Denver Water from the Williams Fork and Fraser basins to fill the existing, "Old Water" capacity of Gross Reservoir, which is 41,811 acre-feet. When the amount of Old Water in storage equals 41,811 acre-feet, the next increment of water put into storage at Gross

the heading of "Additional Actions for Elevated Stream Temperature" in the Final Report, the Applicant has committed to release up to 250 AF (at a rate of up to 4 cfs) when temperature action levels are reached at any of the specified locations in the Fraser basin. This commitment is documented in the GCMECP. In the sense that the Additional Actions bypass is tied to project operation, it would function as mitigation.

It is also possible that additional temperature mitigation can be accomplished with water dedicated for stream flows as described in the GCMECP[11]. However, these flows, which are a voluntary enhancement controlled through Learning by Doing, are not tied solely to temperature concerns. Consequently, there is no assurance that these flows will be available once the Temperature Mitigation Response and Additional Actions flows have been exhausted.

The Division recognizes that the Applicant's commitments for flow bypasses offer considerable potential for mitigation of temperature impact in the Fraser River Basin. Modeling work performed by the Applicant supports the argument for mitigation potential. However, it is not yet known if the mechanics of the response will yield successful mitigation in a real-life situation. One important step in that direction could be taken when the Applicant conducts a "Voluntary Pilot Project" (VPP), described in the GCMECP, to measure the effectiveness of flows bypassed in response to temperature triggers at different locations.

The Division's approach to conditions addressing temperature impacts is aimed at measures that will support and evaluate commitments the Applicant has made through the GCMECP. These conditions cover the locations and scope of monitoring, the capacity of bypass flows to alleviate temperature impacts, the relationship between temperature action levels and temperature standards, and the characterization of a *de minimis* temperature response to flow bypasses. In addition, the Applicant has agreed to conditions by which bypass flows are made available for VPPs that address temperature concerns and aid in development of a decision matrix.

Reservoir from the Williams Fork and Fraser basins will be counted as "Project Water." The Old Water is the first water stored in Gross Reservoir and the first water taken out of storage. Project Water does not include water stored from South Boulder Creek or flow-through water." "Flow-through water is water diverted and passed directly through Gross Reservoir to meet demand without being stored in the enlarged reservoir. Flow-through water is not considered Project Water because Denver Water could and would divert and pass through that water without the project."

[11] GCMECP II.3.C.a "LBD could coordinate use of the Fraser 1,000 acre-feet of bypasses … if stream temperature monitoring in the Fraser Basin indicates a need for action …."

Regarding South Boulder Creek, the concern is not about raising temperature, as was the case on the West Slope, but about significant alteration of the seasonal pattern of temperature. Consequently, impacts are related to the narrative standard[12] rather than a numeric standard. The current temperature regime at the Gross Reservoir outlet exhibits no diel variation and a greatly altered seasonal pattern of variation. The normal temperature patterns of South Boulder Creek have been altered since the reservoir was completed in 1954, and the existing alterations to the temperature pattern are not the responsibility of the project. Nevertheless, assessment of current conditions provides the basis for anticipating the additional impacts expected with operation of the project.

The Division has reviewed the available data regarding the current temperature regime and finds that there is non-attainment of the narrative temperature standard. The details of the analysis are presented in the attached Appendix A. In brief, the maximum mid-summer temperature with the current reservoir is about 10 degrees less than would be expected for an un-impounded stream at the elevation of South Boulder Creek below the Gross Reservoir outlet, and the annual maximum temperature occurs in October rather than late July. The altered pattern and reduced temperatures caused by the current reservoir result in a loss of degree-days[13] that would normally sustain growth of aquatic organisms during the summer.

The existing temperature pattern is altered because the existing outlet releases water from the bottom of the reservoir. In the summer, the bottom layer (the hypolimnion) contains cold water, but the supply of cold water is usually exhausted by the end of the summer under current conditions. The proposed enlargement of Gross Reservoir (including the Environmental Pool) will almost triple the volume of the reservoir, and will greatly increase the volume of the hypolimnion. After the reservoir is enlarged, the larger volume of cold water in the hypolimnion will extend the period of time in which cold water will be released during the summer.

The impact of the Gross Reservoir enlargement on temperature in South Boulder Creek is predicted based on modeling work performed for the U.S. Army Corps of Engineers during the EIS process. Model results predict that maximum summer temperatures with operation of the project will be about six degrees colder than the current maximum temperatures. The lower summer temperatures mean that degree-days, which are already much less than is normal, will be further reduced by about 30%. In addition, the seasonal

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[12] Regulation 31, Table 1, footnote 5: "Temperature shall maintain a normal pattern of diel and seasonal fluctuations and spatial diversity with no abrupt changes and shall have no increase in temperature of a magnitude, rate, and duration deleterious to the resident aquatic life."

[13] The area under a graph of temperature over time.

temperature ranges will be consistently suboptimal for fry and adults[14]. Further details of the analysis are contained in Appendix A. The proposed Environmental Pool was not included in the temperature modeling, but it is expected to augment the temperature impact because it will add up to 5,000 AF to the volume of the reservoir. The additional volume is likely to increase the capacity of the project to release cold water throughout the summer.

The Division concludes that operation of the project, with or without the Environmental Pool, will contribute to an existing impairment with respect to the narrative temperature standard. Since the impairment is caused by release of cold water from the bottom of the reservoir, mitigation of the project impact could be achieved by releasing instead the warmer water from the top layer of the reservoir. Selective withdrawal would allow for mixing water from the two layers to obtain a desired temperature range. Concepts for addressing problems caused by a too-cold release have been studied[15], and there is considerable literature describing options, including multi-level withdrawal[16].

The Applicant has modeled outlet temperatures with one design option for a multi-level outlet works (MLOW); see Appendix A for more detail. Although the modeling did not include the Environmental Pool, useful conclusions can still be drawn. According to model results, installation of the MLOW would fully mitigate the temperature impact predicted with operation of the project. In other words, the project would no longer be expected to contribute to an existing impairment of the narrative temperature standard. Furthermore, the MLOW would also serve as an enhancement measure because it would yield a gain in degree-days of approximately 30% above current conditions.

The literature describes many examples where selective withdrawal has been installed, and there are also examples in Colorado. However, the mitigation and enhancement benefits that may be achieved involve cost and risk. The Applicant has provided several reasons that a requirement for selective withdrawal would not be a reasonable way to address the temperature impact of the project[17]. The capital cost is at least $6.5M ($11.5M if operating costs and lost hydropower revenue are included), but cost alone does not make the

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[14] See Appendix B1 of the Applicant's Final Report

[15] See review by JD Olden & RJ Naiman. 2010. Incorporating thermal regimes into environmental flows assessments: modifying dam operations to restore freshwater ecosystem integrity. Freshwater Biology 55: 86-107.

[16] For recent overview, see Rheinheimer et al. 2014. Optimizing selective withdrawal from reservoirs…. Journal of Water Resources Planning and Management DOI: 10.1061/(ASCE)WR.1943-5452.0000447.

[17] "Engineering and Cost Overview of a Multi-Level Outlet Works Concept and Environmental Pool", prepared by Denver Water Engineering Division, 12/9/2015. "Multi-Level Outlet Works (MLOW) Practicability", prepared by Denver Water, 4/29/2016.

requirement unreasonable. Instead, the more persuasive arguments are related to operational constraints and expectations for net benefit.

The Applicant has investigated several engineering options for selective withdrawal. A spillway radial gate was evaluated, but rejected for reasons related to cost and the complexity and safety of operation. In addition, predicted reservoir levels in August and September would routinely be too low to maintain release of warmer water from the upper layer. Siphons were considered, but were found to be expensive and would be complex to operate. An auxiliary outlet tower also was evaluated, but was judged by the Applicant to be costly in part because of the need for underwater construction for installation of infrastructure.

Installation of the MLOW is feasible, but operation of the MLOW would interfere with hydropower generation. There are technical and safety considerations, as well as concerns about fish entrainment, that combine to make it impracticable for water from the upper layer of the lake to be routed through the existing penstock. According to the Applicant, operating the MLOW would result in the loss of approximately 7.9 million kilowatt-hours of power production, which would mean an annual revenue loss of about $450,000.

The potential for environmental benefit from the MLOW applies to a relatively short stream reach (about 5 miles in length), and recent data suggest that the water warms noticeably over that distance. Even full mitigation of the project effect would not restore a normal seasonal pattern of temperature below the reservoir. Furthermore, full mitigation may not be possible in years when reservoir levels are too low to release warmer water through gates in the MLOW. Therefore, a condition for monitoring will be imposed in order to document the longitudinal extent of impact from temperature to the aquatic communities in South Boulder Creek.

Condition 1: The Applicant will obtain temperature data from three real-time monitoring locations and two data logger sites in the Fraser basin, as described below. Monitoring at these sites will begin as soon as practicable, but no later than one year after the date of issuance for the 404 permit or the FERC license, whichever is later, and will continue for not less than five years after the project becomes fully operational. The data from each calendar year and a report documenting exceedances of the temperature standard will be submitted to the Division by April 1 following each calendar year of sampling. If the USGS ceases data collection at a real-time site, or GCWIN ceases collection at a data logger site, the Applicant will be responsible for establishing and maintaining data collection at the site. The condition for the Applicant to obtain the data at a site is satisfied at that site if the benefit from bypass flows is shown to be *de minimis*.

- Fraser River below Crooked Creek near Tabernash, CO (USGS gaging station 09033300). Real-time temperature data are currently available

from the USGS. If the USGS ceases data collection at this site, the Applicant will be responsible for establishing and maintaining real-time data collection at the site.

- Ranch Creek near Fraser, CO (USGS gaging station 09032000). Real-time temperature data are currently available from the USGS. The Applicant will be responsible for establishing and maintaining real-time data collection at this site. The commitment also is captured in existing agreements.
- Ranch Creek below Meadow Creek (USGS gage 09033100). Real-time temperature data are currently available from the USGS. If the USGS ceases data collection at this site, the Applicant will be responsible for establishing and maintaining real-time data collection at the site.
- Fraser River at Rendezvous Bridge (GCWIN site FR-Rendezvous). Data logger site maintained by GCWIN.
- St. Louis Creek above Fraser River confluence (GCWIN site ST-LC). Data logger site maintained by GCWIN.

Condition 2: The fixed values for temperature action levels[18] that are specified in existing agreements may or may not continue to match applicable regulatory standards, which are subject to revision. The action levels are hereby modified to correspond to the lesser of the action level in the GCMECP or the applicable standard for Cold Stream Tier 1. The Division expects that lower thresholds may be developed for triggering bypass flows as more is learned about tailoring responses to avoid exceedances.

Condition 3: The Applicant will conduct a Voluntary Pilot Project[19] (VPP) in the Fraser basin using up to 1000 AF/y of environmental water in each summer in which water supply conditions allow, beginning no later than the date of issuance for the 404 permit or FERC license amendment, whichever is later. The VPPs will be executed in the 15 July to 31 August time period that will be the focus of the temperature mitigation response defined in the FWMP. This condition applies in the Interim Period, which ends when the project "becomes operational"[20]. Based on the amount of water expected to be available[21] for the VPP, the Applicant will prepare and submit a plan to the Division by 1 June each year outlining the objectives for the VPP and describing plan components such as the target stream (Fraser River or Ranch Creek), the source(s) for bypass flows, monitoring locations, and assessment metrics. (See Appendix B for further explanation of plan components and expectations for the VPPs in

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[18] As given in the GCMECP, the temperature action levels for the Fraser basin gages are 21.2 °C for the daily maximum and 17.0 °C for the weekly average temperature.
[19] GCMECP II.B.1.c.1
[20] As per the CRCA: "The capacity of Gross Reservoir has been enlarged, and water has been diverted and stored in the enlarged portion of Gross Reservoir."
[21] Availability is determined by snowpack, system-wide reservoir storage, maintenance and operations schedules, and summer forecasts.

general.) The plan must be submitted by 1 June each year, and the Division will make comments and may recommend changes within 30 days. The Division recognizes that subsequent adjustments to the plan may be necessary during the summer in order to respond to actual stream flow conditions, or to accommodate operational or maintenance considerations.

At the conclusion of each VPP, the Applicant will prepare a report characterizing the mitigation measures employed and evaluating the effectiveness of those measures in terms of the distance over which a benefit to temperature could be detected. Each report is due by 1 February so that the conclusions will inform development of a VPP for the next year in which bypass water is available.

Condition 4: The Final Report includes a provision that defines the Applicant's responsibilities[22] in the case where flow bypasses (released pursuant to Additional Actions for Elevated Stream Temperature) are shown to "have a *de minimis* effect in reducing stream temperature below the temperature response triggers at USGS gages 09032000, 09033300 or 09033100 when the Moffat Project is diverting…." This condition broadens the consideration of *de minimis* effect to include the GCWIN site at Rendezvous Bridge, and it requires a finding of *de minimis* effect at all four sites. Although determination of *de minimis* effect is made through the Learning by Doing process, the Division expects that results of VPPs will inform the process by casting the magnitude of effects in terms of distance from diversion points. The analysis of effects leading to a *de minimis* conclusion must be documented in a report submitted to the Division, and the Division must agree with the conclusion before the Applicant can discontinue these bypass flows.

Condition 5: If temperature monitoring indicates an impairment at any of the monitoring locations identified in Condition 1, the Applicant will perform investigations to determine what contribution operation of the project has made. The impairment investigation report and all supporting information will be submitted to the Division within 12 months after the impairment has been detected. If, after diligently working on the impairment investigation, the Applicant requires more time to finish the impairment investigation the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the one year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

If the Division concludes that operation of the project is primarily responsible for the impairment, the Division will require that the Applicant actively explore

[22] "Denver Water will contribute $1 million dollars to LBD for the exclusive purpose of designing and constructing projects to address stream temperature issues in the Fraser River Basin."

preparation of a Category 4b Plan that will define the actions necessary to bring water quality back to attainment of the standard. In doing so, the Applicant will be encouraged to work with other significant contributors to the impairment, if applicable.

A Category 4b Plan must ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, must be consistent with CRS 25-8-104, and must be submitted to the Division no more than two years after the Division's determination that the plan is applicable. If it becomes apparent that a Category 4b Plan cannot ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, or if such plan is not accepted by the Division or EPA, or is precluded by or inconsistent with the water rights provisions in section CRS 25-8-104, then the Division anticipates a 303(d) listing and, in cooperation with the Applicant, preparation of a TMDL. The Applicant, at its discretion, may agree to remedial actions to restore water quality that are inconsistent with the water rights provisions of CRS 25-8-104. If, after diligently working on the Category 4b Plan, the Applicant requires more time to finish the Category 4b Plan the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the two year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

Condition 6: The Applicant will monitor continuous stream temperature at four locations in South Boulder Creek, listed below. Monitoring at these sites will begin as soon as practicable, but no later than one year after the date of issuance for the 404 permit or the FERC license, whichever is later, and will continue for not less than five years after the project becomes fully operational. The data from each calendar year will be submitted to the Division by April 1 following each calendar year of sampling.

- South Boulder Creek at Pinecliffe (DW Station WS-RL-001)
- Gross Reservoir Outlet (FERC monitoring location)
- South Boulder Creek at a location between the reservoir outlet and the diversion point (to match the corresponding site for sampling benthic macroinvertebrates). The Applicant will submit a proposed location to the Division for approval before sampling begins.
- South Boulder Creek at Diversion Structure (DW Station WS-TL-002)

Nutrients

Reduction of flow in the Fraser River basin reduces the dilution of wastewater effluent, raising concerns about nutrient levels in the Fraser River, the Colorado River, and the Three Lakes system. According to the FEIS, total nitrogen concentrations at the mouth of the Fraser may increase by more than 40% due to cumulative impacts (including all RFFAs); however, the increase due

to the project alone is predicted to be less than 5%. Corresponding predictions for total phosphorus show a decrease in concentrations due to cumulative impacts and an increase of about 5% due to the project alone. Predictions are sensitive to assumptions about wastewater effluent concentrations, which are likely to be reduced significantly in the future as facilities respond to requirements mandated by Regulation 85.

Modeling for the certification process adds consideration of assimilative capacity as required for the AD review. A significant impact is predicted for phosphorus concentrations through reduction of assimilative capacity in the Fraser River below Vasquez Creek. A similar issue may exist for nitrogen, but the potential cannot be assessed with modeling at this time due to insufficient data.

The Applicant has made monetary commitments that are available for, but not required to be used for, reducing the contribution of nutrients from wastewater treatment facilities. In the CRCA, the Applicant committed to "provide $2 million [to Grand County] to pay for measures to address water quality, including but not limited to improvements to the capacity of wastewater treatment plants."[23] However, because there is no firm commitment to invest in reduction of nutrient loads, the monetary commitment cannot be considered in the significance determination.

The Division regards nutrient reduction in wastewater effluent as one of the few opportunities for direct mitigation of predicted water quality impacts related to loss of assimilative capacity for nutrients. Furthermore, targeting wastewater treatment benefits water quality throughout the year, with or without operation of the project (i.e., it is both mitigation and enhancement). Reduction of nutrient loads from wastewater treatment facilities upstream of the Vasquez Creek confluence would be a logical target for addressing the predicted loss of assimilative capacity. However, WWTPs in the Fraser basin will soon need to comply with effluent nutrient limits set in Regulation 85, and the necessary improvements may even be completed before the project becomes fully operational. Consequently, the Division concludes that a condition to develop a plan for nutrient reduction is appropriate and useful for the purpose of accelerating the process that Regulation 85 has initiated.

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[23] Grand County, in the GCMECP, interprets the $2 million as a flexible resource for voluntary enhancement of water quality. The CRCA also contains a provision for $1 million to go into a "wastewater treatment plant fund" that would be administered by Summit County for permitted wastewater dischargers in Summit County. Although the monetary commitments are relatively large, there is no specificity with regard to the location or the expected amount of improvements to nutrient concentrations.

Condition 7: The Applicant will undertake a study of alternatives for the Winter Park WSD to meet the Regulation 85 nutrient limits and develop conceptual level costs consistent with requirements for a Project Needs Assessment[24] (PNA). Developing a PNA for early implementation of the Regulation 85 limits for nutrients at the Winter Park WSD wastewater treatment plant will set the stage for decreasing nutrient loads in the Fraser River upstream of the confluence with Vasquez Creek and will assist with Winter Park WSD's efforts to fund treatment plant upgrades as needed. The plan must be prepared and submitted to the Division's Engineering Review Unit for approval within one year of the date of issuance of the 404 permit or the FERC license, whichever is later.

Condition 8: The Applicant will monitor nutrient concentrations monthly (total phosphorus and total nitrogen) at the following sites:

- Fraser River below Buck Creek at Winter Park (USGS 09023750)
- Fraser River at Winter Park (USGS 09024000)
- Fraser River below Vasquez Creek at Winter Park (USGS 09025010)
- Vasquez Creek at Winter Park (USGS 09025000)

Monitoring at these sites will begin no later than the date of issuance for the 404 permit or the FERC license, whichever is later, and will continue for not less than five years after the project becomes fully operational. The data will be submitted annually to the Division along with a report documenting exceedances of the nutrient standards; the report is due by April 1 following each calendar year of sampling.

Condition 9: If monitoring of total phosphorus or total nitrogen concentrations in the Fraser River indicates a potential impairment[25], the Applicant will perform investigations to determine what contribution operation of the project has made. The impairment investigation report and all supporting information will be submitted to the Division within 12 months after the impairment has been detected. If, after diligently working on the impairment investigation, the Applicant requires more time to finish the impairment investigation the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the one year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

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[24] A PNA is required for the sources of federal funding for which the Winter Park WSD might be eligible to upgrade the Wastewater Treatment Plant to meet the Regulation 85 nutrients limits.

[25] Data are to be assessed against the appropriate interim numeric values in the event that numeric standards have not yet been adopted for the relevant segment(s).

If the Division concludes that operation of the project is primarily responsible for the impairment, the Division will require that the Applicant actively explore preparation of a Category 4b Plan that will define the actions necessary to bring water quality back to attainment of the standard. In doing so, the Applicant will be encouraged to work with other significant contributors to the impairment, if applicable.

A Category 4b Plan must ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, must be consistent with CRS 25-8-104, and must be submitted to the Division no more than two years after the Division's determination that the plan is applicable. If it becomes apparent that a Category 4b Plan cannot ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, or if such plan is not accepted by the Division or EPA, or is precluded by or inconsistent with the water rights provisions in section CRS 25-8-104, then the Division anticipates a 303(d) listing and, in cooperation with the Applicant, preparation of a TMDL. The Applicant, at its discretion, may agree to remedial actions to restore water quality that are inconsistent with the water rights provisions of CRS 25-8-104. If, after diligently working on the Category 4b Plan, the Applicant requires more time to finish the Category 4b Plan the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the two year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

Aquatic Life

There is no model for predicting a quantitative change in the Multimetric Index (MMI) score as a result of cumulative impacts of the project, but there is a logical basis for a qualitative prediction. It is the Division's view that the habitat loss and increased temperatures expected with flow reductions could adversely impact the aquatic macroinvertebrates unless mitigation measures are in place. The concern is particularly acute for those segments[26] in the project area where MMI scores indicate that problems are already occurring or are expected to occur.

There are five ways in which the Applicant has made commitments that may benefit aquatic communities – flushing flows, sediment control, bypass flows for temperature mitigation, habitat improvements, and creation of an Environmental Pool in Gross Reservoir. The first four measures are likely to

[26] The Fraser River and Vasquez Creek in segment COUCUC10a are currently listed as impaired (303d List). The Blue River below Lake Dillon in segment COUCBL17 and the Colorado River in segment COUCUC03 between Windy Gap Reservoir and Derby Creek are currently on the Monitoring & Evaluation List.

contribute to net environmental benefit. For the Environmental Pool, the enforceability of conditions is problematic for reasons discussed below.

Flushing flows have potential to improve habitat for macroinvertebrates in two areas - the Fraser River and Vasquez Creek – where the aquatic life use is currently impaired. Because commitments for flushing flows in the upper Williams Fork basin and the Fraser River basin (including the Fraser River and Vasquez Creek) will be enforced by the Off-License Agreement with the US Forest Service and the GCMECP through the 404 Permit, no additional conditions are imposed here. These commitments are likely to contribute to net environmental benefit.

The Applicant has made a commitment through the Fraser River Nonpoint Source Pollution Intergovernmental Agreement[27] to maintain and operate the Fraser River Sediment Pond, which will reduce sediment load to the upper Fraser River basin from traction sand used on Berthoud Pass. In addition, the Applicant has committed, through the Off-License Agreement, to develop Road Maintenance Plans for the Williams Fork and Fraser basins to reduce erosion that is contributing sediment to stream channels. When the plans are implemented, these commitments have potential to contribute to net environmental benefit.

Bypass flows for temperature mitigation also have potential to benefit aquatic macroinvertebrates in the upper Fraser River basin. The primary benefit, which is derived from temperature mitigation, is described above. The Division included these measures in its analysis of the net environmental benefit.

The Applicant has made significant monetary commitments to support habitat improvements on various stream segments.[28] The proposed habitat modifications may benefit fish and the macroinvertebrate community. These monetary commitments have the potential to yield environmental benefits. However, because the Applicant has not proposed the what-where-and-when details for these habitat modifications (with the exception of the Upper Colorado River Habitat Project, which specifies general location), there is uncertainty about the magnitude and location of the benefit. There is no way to incorporate the monetary commitments (other than the Upper Colorado River Habitat Project) for unspecified projects in the calculation of net

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[27] Parties include Colorado Department of Transportation, County of Denver, Grand County, and Town of Winter Park; signed 8 June 2011.

[28] In the FWMP, the Applicant committed $72,500 for restoration of cutthroat trout habitat, $750,000 for stream habitat restoration in the Fraser and upper Williams Fork basins, and $1.5 million for stream habitat improvements in the North Fork South Platte and/or mainstem of the South Platte. The Applicant has also committed to provide $1.5 million for habitat improvements as part of the Upper Colorado River Habitat Project.

environmental benefit because the application did not include information that would allow the Division to measure the success of these proposed measures.

Through previous commitments, the Applicant helped fund habitat improvements in South Boulder Creek between the Moffat Tunnel and Gross Reservoir. Although the projects do not represent commitments made specifically for the Moffat Project, they have value because the improvements were designed to accommodate future flows in upper South Boulder Creek.

The Applicant has committed to create additional storage for an Environmental Pool as part of the enlargement of Gross Reservoir. The commitment is documented in an IGA with the cities of Boulder and Lafayette, and in the FWMP. The additional storage would be filled with water owned by the cities, and the cities would manage releases from the Environmental Pool to bolster low flows in South Boulder Creek. The intent is to improve conditions for aquatic communities, especially downstream of the diversion dam. Modeling for the City of Boulder predicts that the Environmental Pool will reduce the extent and frequency of dry-up in South Boulder Creek. According to the Applicant and the Cities, 5000 AF is sufficient volume to "eliminate dewatering … to just downstream of East Boulder Ditch."

The Division recognizes that the Applicant and the cities have made significant financial commitments to the Environmental Pool and that CPW regards the Environmental Pool as an important mitigation and enhancement measure under its statute[29]. The loss of stream habitat, which will occur through construction of the dam and through inundation of stream channel when the enlarged reservoir is filled, is an impact in CPW's framework. The Environmental Pool provides compensatory mitigation by improving fish habitat with increased winter flows that are expected to reduce or eliminate dry-up points downstream.

The Division accepts CPW's position that the Environmental Pool can improve the flow regime of South Boulder Creek below the Applicant's diversion point. However, unlike CPW, the Division cannot consider this type of stream habitat loss to be an impact based on provisions in Regulation 82[30]. Therefore the Environmental Pool is not mitigation from the perspective of this certification, although it can be considered an enhancement. At the same time, the Division sees potential for the Environmental Pool to contribute to temperature impacts, as described previously. Consequently, the significance determination

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[29] CRS 37-60-122.2

[30] Section 82.12: "It is recognized that the construction and operation of water diversion, conveyance, and storage facilities may result in unavoidable and permanent changes in the water quality characteristics of any segment of a stream which is inundated by the facility. These regulations are not intended to apply to or regulate such impacts."

for the project must account for the impact to temperature as well as the enhancement to stream habitat.

The Applicant's responsibility for the Environmental Pool is limited to creating the additional storage. Other parties not subject to this certification are responsible for securing the water court decrees necessary to store water in the Environmental Pool and for managing the releases. In addition, the Applicant, or either of the cities, can terminate the IGA. Consequently, the Division is not including any conditions regarding the Environmental Pool because the Applicant alone cannot ensure that the Environmental Pool will be maintained and operated for the benefit of aquatic communities downstream.

The health of aquatic communities in South Boulder Creek between Gross Reservoir and the diversion point has not been well documented. Consequently, the current effect of cold summer temperatures on aquatic life is not known. It is important to document current conditions in preparation for assessing the impact, if any, of future changes in temperature that can be attributed to project operation. Conditions are imposed to facilitate that evaluation.

Condition 10: The Applicant will monitor the health of aquatic communities at four primary sites (see table below) chosen because of existing concerns due to low MMI scores. The health of the communities will be established by sampling benthic macroinvertebrates and calculating MMI scores. The macroinvertebrate sampling will be conducted using the Division's protocols[31], which are described in Policy Statement 10-1 Aquatic Life Use Attainment Methodology to Determine Use Attainment for Rivers and Streams (Policy 10-1). The Applicant will develop a Sampling Analysis Plan for the collection and preservation of benthic macroinvertebrates that will be reviewed by the Division prior to the start of macroinvertebrate sampling.

GCWIN Site	Description	Latitude	Longitude
FR-abvWPSD	Fraser above Winter Park SD	39.89445	-105.76821
FR-Rendezvous	Fraser at Rendezvous Bridge	39.93412	-105.7896
FR-CR83	Fraser at Tabernash below bridge on CR83	39.99053	-105.8299
VC-WP	Vasquez at Winter Park	39.9203	-105.78498

Sampling at the primary sites will be conducted in the fall of each year beginning after the issuance of the 404 permit or the FERC license, whichever is later, and continue for five years after the project becomes fully operational. A report assessing the data (raw data and MMI scores) and documenting any impairment of aquatic life will be submitted to the Division

[31] The Division is insistent on the prescribed methodology. Even if a different methodology is selected through the LBD process (as suggested in the GCMECP), compliance with these conditions requires use of the Division's methodology.

by June 1 following each calendar year of sampling. If there are concerns about the representativeness of conditions in a particular year (e.g., if there has been a flood or other natural disaster), alterations to the sampling may be accommodated upon prior approval by the Division.

Condition 11: If monitoring of aquatic life indicates an impairment, the Applicant will use available indices to identify the stressor, if possible. Stressor identification work will be limited to indices that have been incorporated in the Listing Methodology applicable at the time the impairment is detected. The Applicant is not responsible for development of stressor identification tools. If a stressor is identified, the Applicant also will determine what contribution operation of the project has made to the identified stressor, or, if the project is not yet operating, the Applicant will predict the potential for the project to contribute to future impairment associated with the identified stressor. The impairment investigation report and all supporting information will be submitted to the Division within 12 months after the impairment has been discovered. If, after diligently working on the impairment investigation, the Applicant requires more time to finish the impairment investigation the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the one year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

The Division, in consultation with the Applicant, will decide if the Applicant will be required to develop a Category 4b plan for the identified stressor. If such plan is required, it must be submitted to the Division within two years. If a Category 4b Plan is precluded by CRS 25-8-104, the Division anticipates a 303(d) listing and, in cooperation with the Applicant, preparation of a TMDL to bring water quality back to attainment of the standard. If, after diligently working on the Category 4b Plan, the Applicant requires more time to finish the Category 4b Plan the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the two year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

Condition 12: The Applicant will monitor the health of aquatic communities at three sites in South Boulder Creek below Gross Reservoir. The health of the communities will be established by sampling benthic macroinvertebrates and calculating MMI scores. The macroinvertebrate sampling will be conducted using the Division's protocols[32], which are described in Policy Statement 10-1 Aquatic Life Use Attainment Methodology to Determine Use Attainment for Rivers and Streams (Policy 10-1). The Applicant will develop a Sampling

[32] The Division is insistent on the prescribed methodology. Even if a different methodology is selected through the LBD process (as suggested in the GCMECP), compliance with these conditions requires use of the Division's methodology.

Analysis Plan, including specifics of the proposed sampling locations, for the collection and preservation of benthic macroinvertebrates that will be reviewed by the Division prior to the start of macroinvertebrate sampling.

- South Boulder Creek immediately below Gross Reservoir
- South Boulder Creek at a location between the reservoir outlet and the diversion point (to match the corresponding site for temperature monitoring).
- South Boulder Creek upstream of the diversion point and the lentic zone it creates.

Sampling at the primary sites will be conducted in the fall of each year beginning after the issuance of the 404 permit or the FERC license, whichever is later, and continue for five years after the project becomes fully operational. A report assessing the data (raw data and MMI scores) and documenting any impairment of aquatic life will be submitted to the Division by June 1 following each calendar year of sampling. If there are concerns about the representativeness of conditions in a particular year (e.g., if there has been a flood or other natural disaster), alterations to the sampling may be accommodated upon prior approval by the Division.

If monitoring of aquatic life demonstrates that the project is responsible for degradation of aquatic life (as indicated with the MMI), the Applicant will be required to develop a Category 4b plan. The plan must be submitted to the Division within two years. If, after diligently working on the Category 4b Plan, the Applicant requires more time to finish the Category 4b Plan the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the two year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

Mercury

The potential impact of the Moffat Project on mercury in fish tissue in Gross Reservoir causes concern because mercury levels already are high enough to warrant a Fish Consumption Advisory (FCA). Although it is not yet possible to develop quantitative predictions for mercury in fish tissue in the enlarged reservoir, there are good reasons to expect problems based on recent scientific literature. Expectations are based on what is known about the biogeochemistry of mercury in reservoirs. The key process is methylation, which, under the proper conditions, yields an organic form of mercury. Methylated mercury then makes its way through the food chain over a period of several years[33].

[33] Lucotte, M, et al., 1999. Mercury in the Biogeochemical Cycle: Natural Environments and Hydroelectric Reservoirs of Northern Quebec. Berlin: Springer.

Two aspects of the reservoir enlargement are likely to create conditions conducive to methylation of mercury. When the enlarged reservoir fills, decay of newly-inundated organic matter creates a low-oxygen environment that favors methylation. The Applicant has a commitment per the FERC license to "prepare a final tree removal plan to remove as much organic matter as practicable from the inundation area." However, it is not possible at this time to predict if these measures will preclude additional methylation or diminish the present level of methylation.

Once the project is fully operational, interannual variation in supply of, and demand for, water will cause reservoir level to fluctuate, probably to a greater degree than occurs now. Greater fluctuations in lake level in the future may increase opportunities for mercury methylation by increasing the area that is alternately exposed and re-wetted. In addition, when lake level falls, the volume of the hypolimnion is reduced causing volumetric oxygen demand to increase, which also favors methylation of mercury.

The existing concern about mercury in fish tissue in Gross Reservoir is sufficient to impose a condition on the Applicant. However, it is also important to acknowledge the limitations that have been encountered in dealing with the problem from a statewide perspective. The problem of mercury in fish tissue in Colorado lakes has been addressed chiefly through monitoring and posting FCAs, as appropriate. The Applicant will be required to support this approach in Gross Reservoir.

Limiting the Applicant's role to monitoring and posting is a practical necessity. The nature and scope of the mercury problems in Colorado are too broad in scale to be resolved in Gross Reservoir alone. The importance of atmospheric sources of mercury and the complexity of the biogeochemical processes that influence concentrations in fish tissue require a statewide strategy. Accordingly, the Division plans to develop a strategy to address the problem statewide. However, in the event that impairment is detected in Gross Reservoir, the Applicant's responsibility for monitoring in that reservoir will be extended. Data collected at Gross Reservoir will benefit the Division's effort to address mercury impairments statewide.

Condition 13: The Applicant will work with the Division and CPW to support a biennial program to monitor mercury in fish tissue in Gross Reservoir. Field work to collect the fish will be performed consistent with CPW requirements, the EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, and the goal will be to obtain adequate representation of the important species as per the Water Quality Control Commission's Section 303(d) Listing Methodology. The sampling effort for Gross Reservoir will begin in the first field season after the enlarged reservoir has filled and will continue for five more years. The Applicant will submit a brief report summarizing the sampling completed during each field season; the report is due by April 1

following each calendar year of sampling. If mercury levels fall below the level of concern for the last three years, the monitoring obligation will end. In the event that there is impairment for mercury at the end of the five-year period, the obligation for monitoring will be extended for an additional five years, at which time the monitoring obligation will end.

If fish tissue analyses show that a FCA is required, the Applicant will work with the Technical Advisory Team (TAC)[34] of the Colorado Fish Consumption Advisory Committee to provide public education including the posting of signs with associated consumption advisories. The TAC will determine the design of the signs and the information to be included. The Applicant will incur the costs of the signs and be responsible for proper posting of such signs.

General Monitoring for Metals

The impacts with respect to metals are related to the way that flow alterations (reductions or additions) change mass balance contributions, because the project does not add pollutants. The antidegradation (AD) review revealed concerns about erosion of assimilative capacity, as well as potential "cause-or-contribute" concerns. The importance of flow alterations is seen clearly in the AD analysis for the Fraser River below Vasquez Creek. Mass balance calculations predict a significant loss of assimilative capacity (i.e., higher concentrations) for dissolved iron, but a gain in assimilative capacity (i.e., lower concentrations) for dissolved copper and zinc.

Existing exceedances of standards, chiefly for copper, increase the level of concern about the potential for the project to have water quality impacts. Some exceedances[35] were identified during the AD review, but the geographic extent of the exceedances has been expanded during recent assessments by the Division. Recently adopted changes to Regulation 93 identify four segments with copper exceedances in the project area (see table below for dissolved copper listings). A similar, but less pervasive concern exists for dissolved iron in the Fraser River from Vasquez Creek to the mouth.

Regulation 93 Listings for Dissolved Copper in the Project Area		
Segment	**Segment Description**	**List**
COSPBO04a	Mainstem of South Boulder Creek, including all tributaries from the source to the outlet of Gross Reservoir	303d
COSPBO04b	Mainstem of South Boulder Creek, including all tributaries from the outlet of Gross Reservoir to South Boulder Road	303d

[34] Members include representative from CPW, the Division, and the Disease Control and Environmental Epidemiology Division of the Colorado Department of Public Health and Environment.

[35] Fraser below Vasquez, Williams Fork at Sugarloaf, and South Boulder Creek below Moffat Tunnel.

Regulation 93 Listings for Dissolved Copper in the Project Area		
Segment	**Segment Description**	**List**
COUCUC08	Williams Fork below Kinney Creek	M&E
COUCUC10a	Vasquez Creek	303d

In view of the pervasiveness of elevated concentrations of dissolved copper and iron, and in response to comments received during the public comment period, the Division concludes that additional monitoring is warranted for metals. At the very least, it is important to gain a better understanding of the way in which operation of the project will re-distribute these metals in the affected watersheds.

Condition 14: The Applicant will monitor concentrations of total recoverable metals[36], dissolved metals[37], and hardness at the following locations selected on the basis of historical data record or proximity to important hydrologic features:

- Williams Fork above bridge at Sugarloaf Campground (Site WS-WF-004)
- Vasquez Creek above Vasquez Tunnel outfall (Site WS-WF-001)
- Vasquez Creek at Winter Park (USGS 09025000)
- Fraser River below Buck Creek at Winter Park (USGS 09023750)
- Fraser River at Winter Park (USGS 09024000)
- Fraser River below Vasquez Creek (USGS 09025010)
- Fraser River above Ranch Creek (USGS 09027100)
- South Boulder Creek above Moffat Tunnel outfall (WS-RL-018)
- South Boulder Creek at Pinecliff (WS-RL-001)
- South Boulder Creek at Diversion Structure (WS-RL-002)

Samples will be taken monthly except where winter conditions prevent access. Monitoring at these sites will begin no later than the date of issuance for the 404 permit or the FERC license, whichever is later, and will continue for five years after the project becomes fully operational. The data will be submitted annually to the Division along with a report documenting exceedances of the nutrient standards; the report is due by April 1 following each calendar year of sampling.

Condition 15: If monitoring indicates an impairment, the Applicant will perform investigations to determine what contribution operation of the project has made. The impairment investigation report and all supporting information will be submitted to the Division within 12 months after the impairment has been detected. If, after diligently working on the impairment investigation, the Applicant requires more time to finish the impairment investigation the

[36] Iron, arsenic, and chromium

[37] Arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, uranium, and zinc

Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the one year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

If the Division concludes that operation of the project is primarily responsible for the impairment, the Division will require that the Applicant actively explore preparation of a Category 4b Plan that will define the actions necessary to bring water quality back to attainment of the standard. In doing so, the Applicant will be encouraged to work with other significant contributors to impairment, if applicable.

A Category 4b Plan must ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, must be consistent with CRS 25-8-104, and must be submitted to the Division no more than two years after the Division's determination that the plan is applicable. If it becomes apparent that a Category 4b Plan cannot ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, or if such plan is not accepted by the Division or EPA, or is precluded by or inconsistent with the water rights provisions in section CRS 25-8-104, then the Division anticipates a 303(d) listing and, in cooperation with the Applicant, preparation of a TMDL to bring water quality back to attainment of the standard. The Applicant, at its discretion, may agree to remedial actions to restore water quality that are inconsistent with the water rights provisions of CRS 25-8-104. If, after diligently working on the Category 4b Plan, the Applicant requires more time to finish the Category 4b Plan the Applicant may request an extension from the Division. The Applicant must request the extension at least two months prior to the two year deadline and must explain the reason and need for the extension. The Division will review the request and determine whether to grant the extension.

Monitoring in Gross Reservoir

Gross Reservoir will be enlarged and the additional storage filled before the project will be fully operational. It is reasonable to expect that water quality in the enlarged reservoir will be similar to current conditions. However, that assumption should be tested through monitoring. One potential concern involves dissolved oxygen, which may be affected by the increased residence time and the larger hypolimnetic volume. The Division will impose a condition requiring general monitoring of water quality in the new reservoir.

Condition 16: The Applicant will monitor water quality in Gross Reservoir. Monitoring will begin no later than the ice-free season following issuance of the 404 permit or the FERC license, whichever is later, and will continue for not less than five years after the project becomes fully operational. The data will

be submitted annually to the Division along with a report documenting any water quality impairments. The report is due by April 1 following each calendar year of sampling.

Samples will be taken monthly during the ice-free season at a site in deep water near the dam. Analysis will include general field parameters[38], nutrients and biological collections[39], major ions[40] and metals[41].

Significance Determination

The AD review process is guided by Regulation 31, Section 31.8(3), which describes what is required for the significance determination. The first step is to determine if there are likely to be significant impacts to water quality, as has been done in the preceding section of this document. Significant impacts are expected, but there are also commitments for mitigation and enhancement measures (i.e., offsets) that may reduce the impacts or otherwise improve water quality.

The next step is to decide if the balance of impacts and offsets results in net environmental benefit. In cases like the present application, where requirements for direct mitigation could interfere with normal exercise of water rights, the offsets become especially important. At the same time, evaluation of offsets presents a challenge in that it requires a measure of subjectivity; it is a comparison of apples and oranges.

The Division has evaluated the offsets with the following questions:

1) Does the action provide direct mitigation? In other words, where a significant impact is predicted for a particular water quality parameter, would the offset lessen the impact at the appropriate place and time?
2) In addition to lessening a significant impact, would the action also improve conditions at other times or places or for other uses within the project area?
3) Would the action result in a measurable improvement to water quality for a parameter that may have been degraded previously, but is not further degraded by the project?

After reviewing the mitigation and enhancements measures for which the Applicant has already made commitments, the Division finds three that are

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[38] Vertical profiles of temperature, DO, conductance, pH, turbidity, and secchi depth
[39] Total Kjeldahl nitrogen, ammonia-nitrogen, nitrite+nitrate-nitrogen, ortho-phosphorus, total phosphorus, dissolved organic carbon, and chlorophyll-a.
[40] Calcium, magnesium, chloride, potassium, sodium, and sulfate
[41] Total recoverable form: iron, arsenic, and chromium; Dissolved form: arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, uranium, and zinc

especially noteworthy. These include: Voluntary Pilot Projects, the Colorado River Habitat Project, and sediment transport controls. Each merits additional comment.

The Applicant's commitment to use VPPs for assessing the effect of bypass flows on stream temperature is noteworthy in several respects. It represents a significant commitment of water that the Division could not require unilaterally. By manipulating bypass flows and monitoring longitudinal changes in temperature, the Applicant can establish the technical basis for a decision matrix that can assist the LBD process in optimizing bypass flows in response to elevated temperatures. In addition, results of the VPPs can provide the technical framework for defining a *de minimis* effect in terms of distance from the bypass source.

The Applicant has committed to funding for habitat restoration work in the Colorado River below Windy Gap Reservoir. Although the location and nature of the work have not been identified precisely, enough is known to assure that the work will be in specific segment of the project area.

Commitments for erosion control, the Fraser River Sediment Pond, and flushing flows are expected to benefit aquatic organisms in the Fraser and Williams Fork river basins. Reductions in stream flow expected with project operation would likely have exacerbated sediment issues, but the proposed measures are important steps for addressing those issues.

Finally, as follow-up to water quality monitoring, if the Division concludes that operation of the project is primarily responsible for any impairment, the Division will require that the Applicant actively explore preparation of a Category 4b Plan that will define the actions necessary to bring water quality back to attainment of the standard. In doing so, the Applicant will be encouraged to work with other significant contributors to impairment, if applicable.

A Category 4b Plan must ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, must be consistent with CRS 25-8-104, and must be submitted to the Division no more than two years after the Division's determination that the plan is applicable. If it becomes apparent that a Category 4b Plan cannot ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period, or if such plan is not accepted by the Division or EPA, or is precluded by or inconsistent with the water rights provisions in section CRS 25-8-104, then the Division anticipates a 303(d) listing and, in cooperation with the Applicant, preparation of a TMDL to bring water quality back to attainment of the standard. The Applicant, at its discretion, may agree to

remedial actions to restore water quality that are inconsistent with the water rights provisions of CRS 25-8-104.

A Category 4b Plan, or TMDL, is important because it establishes a pathway for water quality improvement where predictions may have over-estimated the benefit of proposed mitigation measures. In addition, even in the event that the impairment is not attributable to operation of the project, much of the exploratory work required to identify sources and causes will have been done and be available for future restoration planning efforts. Development of a Category 4b plan, or a TMDL, does not represent a mitigation measure per se, but it could be considered a component of net environmental benefit in the sense that it leads to improvement of water quality.

The Division concludes that the conditions imposed on the Applicant provide reasonable assurance that the commitments to mitigation and enhancement measures are sufficient to result in net environmental benefit. Therefore, the finding in regard to the significance determination is: no significant degradation.

Appendix A: Assessment of the Narrative Temperature Standard in South Boulder Creek below Gross Reservoir

Enlargement of Gross Reservoir is not expected to increase temperatures in South Boulder Creek below the reservoir. Consequently, the usual concerns about exceedance of the numeric temperature standards or loss of assimilative capacity do not apply. Instead, attention is focused on alteration of the "normal pattern" of temperature variation in a stream, which is covered by the narrative temperature standard. Assessing attainment of the narrative standard depends on having a definition for "normal pattern" of temperature variation in a stream, but no specific assessment protocol for the narrative standard is available in current listing methodology. These impediments, which have caused previous assessments to limit attention to the potential for impacts that can be evaluated with numeric standards, do not remove the Division's requirement to consider temperature impacts in terms of the narrative standard.

The assessment consists of three parts, beginning with a characterization of the normal pattern of seasonal temperature variation. This is followed by a characterization of the existing pattern of seasonal variation in South Boulder Creek and a comparison to the expected normal pattern. Finally, modeling is used to predict how operation of the project will change the seasonal temperature pattern and what might be accomplished with mitigation.

Normal Pattern

Assessment of the narrative depends first on establishing a frame of reference for the normal pattern of temperature. The Division has been reviewing temperature data throughout the state in preparation for a rulemaking hearing that will include consideration of temperature standards. That work has contributed to a better understanding of the seasonal patterns of temperature variation in streams. Some general characteristics are relevant and helpful for the purpose of explaining what is "normal".

Stream temperatures change seasonally in a sinusoidal manner with a maximum in late July. The pattern for streams mimics that of air temperature, and both are driven largely by solar radiation. For a pattern to be considered normal, stream temperatures should be warming from winter lows until July when the annual

maximum occurs; June should be warmer than May, and July should be warmer than June. Similarly, stream temperatures should be cooling after August; September should be cooler than August, and October should be cooler than September.

The shape of the normal seasonal pattern is common to most streams, but the maximum temperature reached in the summer varies with elevation. In addition, winter temperatures may be truncated at or near zero degrees. Not surprisingly, stream temperatures increase with decreasing elevation. At the elevation of South Boulder Creek immediately below Gross Reservoir (about 6975 ft), daily average temperatures of 18 to 20 degrees would be expected in late July.

Current Pattern

Impounding a stream has important implications for temperature in the stream below the reservoir. For large reservoirs that are deep enough to stratify in the summer, typical operation (i.e., bottom release) will release cold water for some portion of the summer months. How cold the release temperature will be and how long it will stay cold depend on the volume of the reservoir and the rate of release.

Cold summer temperatures at the outflow are the result of releasing water from the bottom of a stratified reservoir. Lakes of sufficient depth (greater than about 10 meters) usually form distinct layers in the summer; there is a warm layer on the top and a cold layer on the bottom. The layering begins shortly after ice-out and it effectively traps the cold water on the bottom. The water released from the bottom will remain cold until the volume of cold water is depleted or replaced with warmer inflows. In any case, the alteration to the normal pattern tends to be quite pronounced with large deep reservoirs.

Gross Reservoir was completed in 1954, and reservoir operation changed the seasonal temperature pattern in South Boulder Creek. The temperature of water at the outlet of Gross Reservoir is now measured routinely as part of a condition for the current FERC license. The water is cold early in the summer and the temperature increases gradually until reaching a maximum of about 11 ºC in mid-October (Figure 1). The seasonal pattern is much different than what would be considered normal in terms of both the magnitude and the timing of the maximum. It is obvious that September is now warmer than August, and October is warmer than September. That the stream continues to warm for two months after August is clear evidence that the normal seasonal pattern is not maintained.

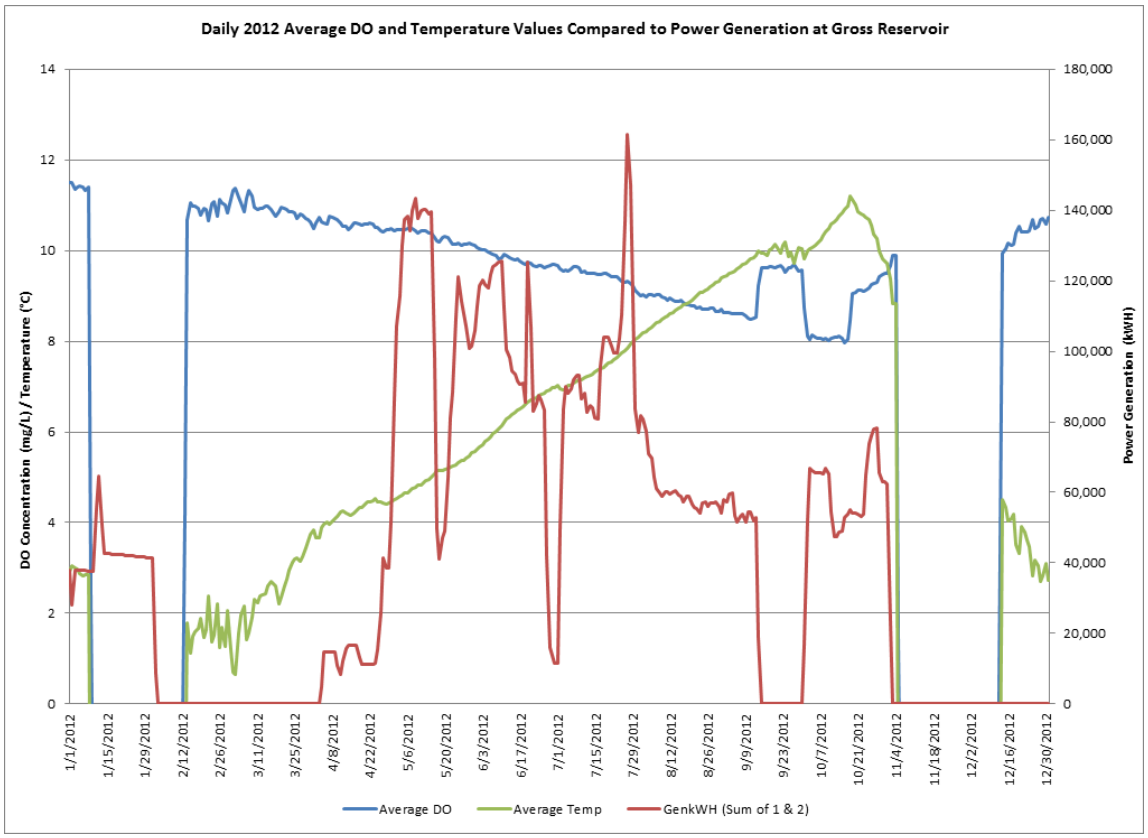

Figure 1. Temperature (green line) at the outlet of Gross Reservoir in 2012. Figure is taken from the 2012 annual report required by the FERC license.

A graphical comparison of temperatures in South Boulder Creek above and below Gross Reservoir would amplify the argument about alterations to the normal seasonal pattern, but adequate data are not available. An alternative is to use a surrogate stream at similar elevation where temperature data are available above and below a reservoir. Muddy Creek in Grand County is a reasonable choice for the comparison. It is impounded by Wolford Mountain Reservoir, and it is at an elevation similar to that of Gross Reservoir. In addition, real-time measurements of temperature are available above and below the reservoir (Figure 2). At the site above the reservoir, the seasonal pattern of temperature resembles a sine curve with a maximum in late July, which is the typical pattern for streams with minimal anthropogenic heat sources. Below the reservoir, however, the pattern bears little resemblance to the pattern observed above the reservoir. Summer temperatures below the reservoir can be 10 degrees cooler than they are upstream. Instead of the normal pattern where a maximum is reached in late July with temperatures decreasing after August, temperatures increase more or less linearly throughout the summer and into October. The maximum temperature below the reservoir occurs when stratification ends and the fully mixed lake is more or less isothermal. The effect of Gross Reservoir on temperature in South Boulder Creek is likely quite similar to the documented effect of Wolford Mountain

Reservoir on Muddy Creek.

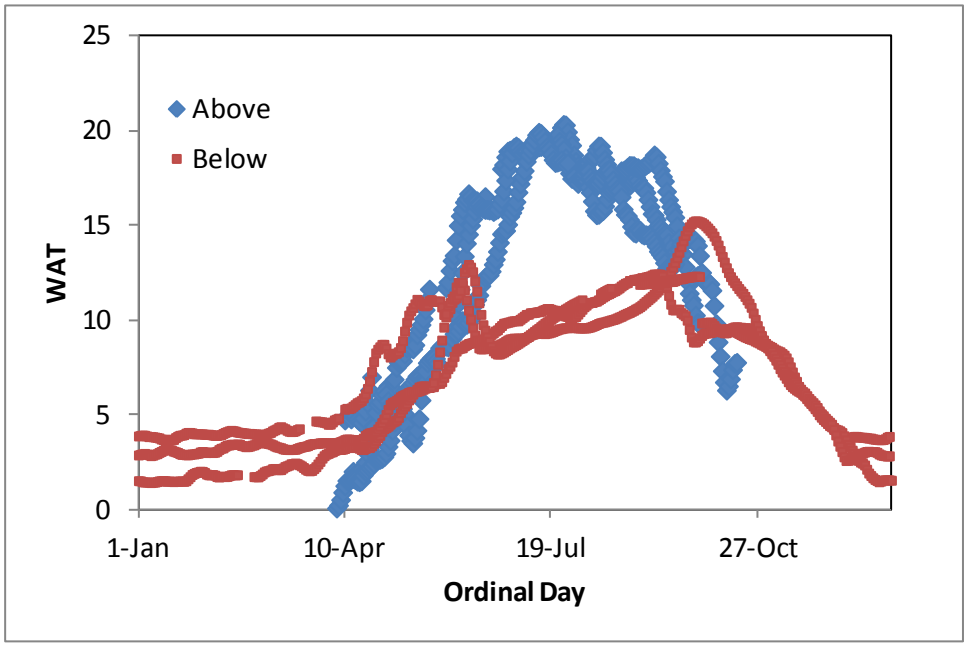

Figure 2. Weekly average temperatures in Muddy Creek above and below Wolford Mountain Reservoir. Data from WY2012-14 are plotted against ordinal day to highlight the seasonal pattern.

The Division concludes that construction of Gross Reservoir resulted in a significant alteration to the normal pattern of temperature variation in South Boulder Creek. The alteration is ecologically significant in that many degree days of warming have been lost in mid-summer, which would normally sustain growth of fish and other aquatic organisms. The alteration is sufficiently great to say that stream temperatures are no longer in attainment of the narrative standard. Although the existing impact of the reservoir is not the focus of the certification review, it is important for setting the stage for predicting the impact of the project.

Model Predictions

The Applicant has provided the Division with modeling results[1] that predict outlet temperatures before and after Gross Reservoir is enlarged. A comparison of modeled conditions with and without the project is the preferred basis for evaluating impacts because it is an apples-to-apples comparison that cannot be made with field data. Moreover, this type of comparison, which relies solely on modeled values, has been the principal basis for evaluating temperature impacts in the Fraser River.

[1] DRAFT Results of Preliminary Model Run of Selective Withdrawal in Gross Reservoir. Draft memo from Hydros Consulting, September 11, 2013.

When outlet temperatures are modeled for the base case (i.e., without the project), the maximum temperature is 13-15 degrees, and it occurs in late September (Figure 3). In contrast, the normal seasonal pattern for a stream at that elevation would likely reach a maximum in late July, and the maximum temperature that would approach 20 degrees. When the same scenario (hydrology and meteorology) is modeled with the project (Alt 1A), summer temperatures remain relatively constant at 7 or 8 degrees. In other words, the alteration of the pattern is sufficiently extreme that South Boulder Creek below the reservoir is likely to be in attainment the winter numeric standard throughout the year. That offers little opportunity for fish growth and would suppress productivity of the benthic invertebrates, which are an important food resource for the fish. The loss can be quantified in terms of degree-days, which is a metric frequently used for characterizing the thermal requirements for different life history stages. The model predicts a loss of about 260 degree-days with 1971 hydrology and 315 degree-days with 1972 hydrology. Operation of the project would reduce by about 30% the degree-days currently available for fish growth.

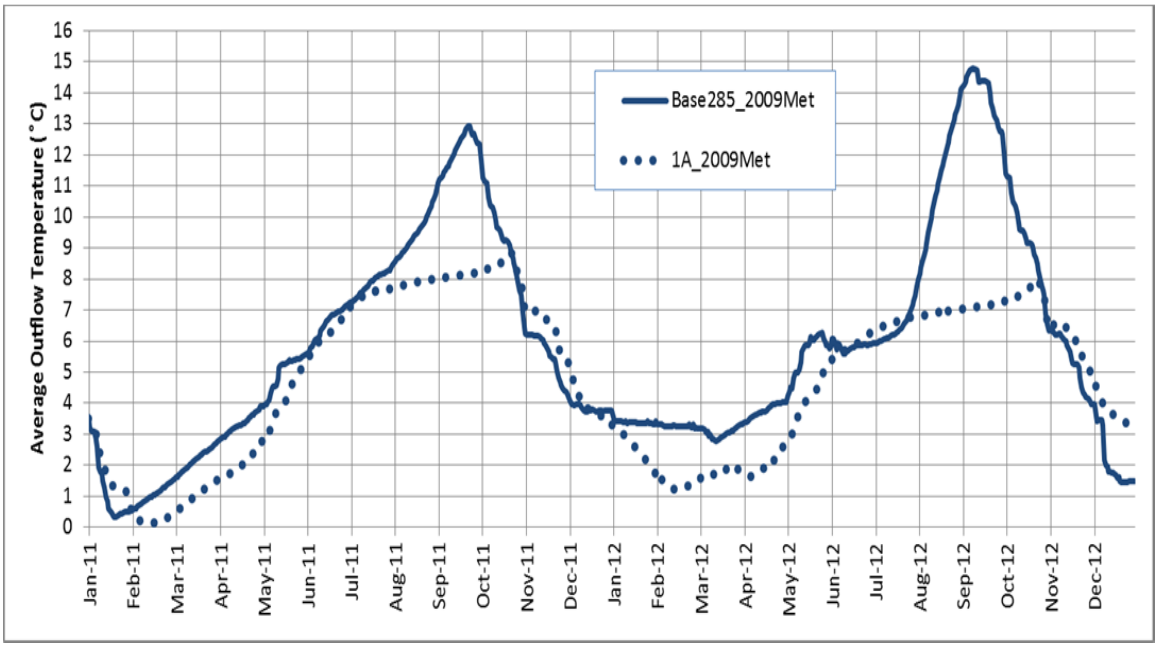

Figure 3. Simulated Outflow Temperatures from Gross Reservoir for Base285 and Alt1a, 1971 – 1972, 2009 Meteorological Inputs. From 2013 Hydros Draft Memo: "DRAFT Results of Preliminary Model Run of Selective Withdrawal in Gross Reservoir"

Operation of the project would essentially eliminate the small amount of warming that now occurs in late summer. By reducing summer temperatures and delaying the annual maximum compared to current conditions, operation of the project would further erode the seasonal pattern of temperature variation. The predicted impact is significant because it would contribute to an existing impairment. The impact could

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be greater with the Environmental Pool[2] because it would increase the volume of the reservoir. The Environmental Pool was not included in the modeling.

The Applicant has evaluated several engineering mitigation options based on a selective withdrawal concept, as discussed in the Division's Rationale document. One design scenario involving installation of a multi-level outlet works (MLOW) was selected for modeling. Results of the modeling show that the MLOW could fully mitigate the temperature impact predicted for the project (Figure 4). In addition, release temperatures with the MLOW would get warmer sooner and stay warm for more days than is the case today.

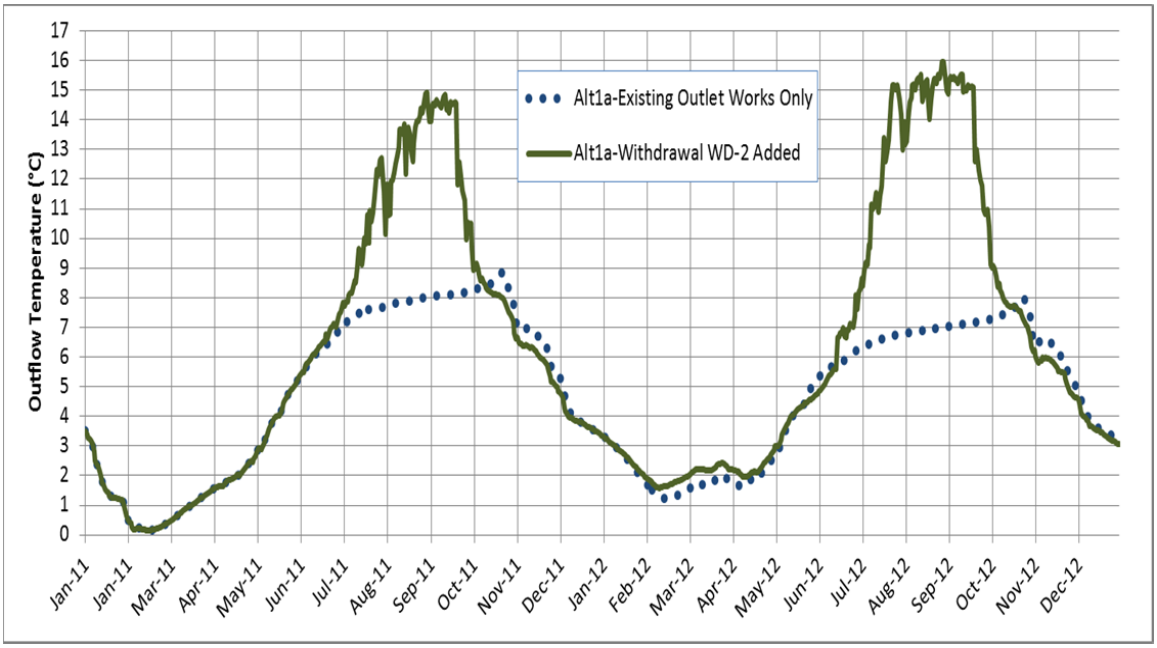

Figure 4. Simulated Gross Reservoir Outflow Temperatures for Alt1a With and Without Selective Withdrawal. From 2013 Hydros Draft Memo: "DRAFT Results of Preliminary Model Run of Selective Withdrawal in Gross Reservoir"

The comparison of current conditions (before) to future conditions with a multi-level outlet (after) can be sharpened by modifying[3] the original figures, as shown in the following two graphs. The first graph shows before-and-after with 1971 (Figure 5); Alt-1A is included for reference. The second graph shows the same comparison for 1972 (Figure 6). The two graphs suggest that the multi-level outlet could serve as both direct mitigation and enhancement, at least when hydrologic conditions are similar to those of 1971 and 1972. Maximum temperatures would be warmer than current conditions and would extend the time of warmer temperatures, although in neither case would a pre-impoundment temperature regime be restored. Operation of

[2] See the Rationale for a description of the Environmental Pool

[3] The original graphs had slight differences in time and temperature scales that were adjusted by re-sizing the figures.

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the project with the MLOW would increase the degree-days by 176 in the 1971 scenario and 400 in 1972.

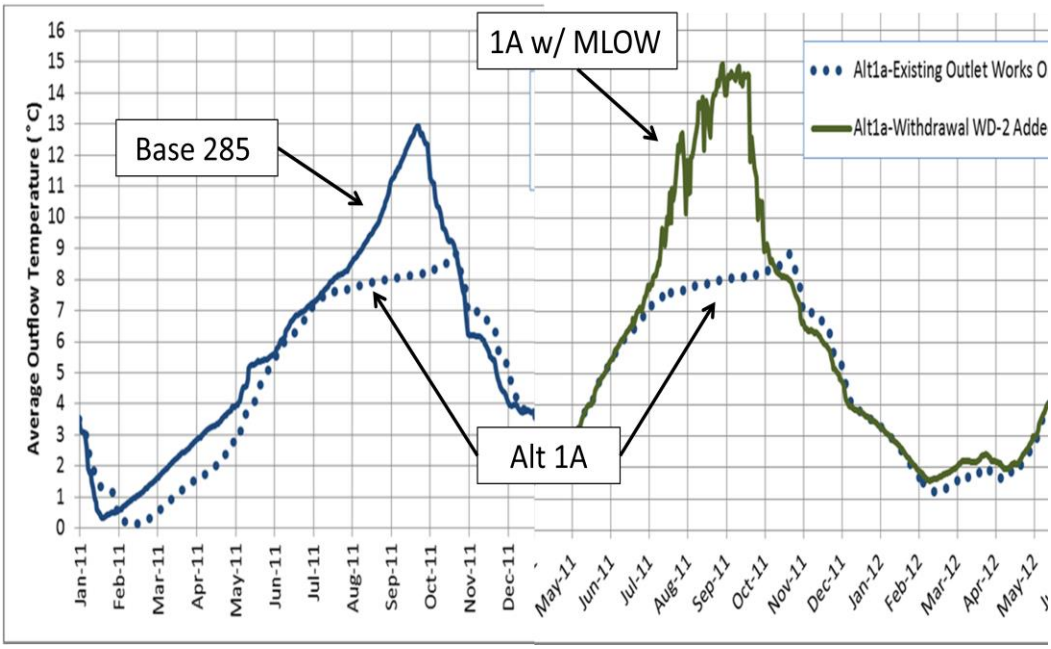


Figure 5. Comparison of outflow temperatures modeled with 1971 hydrology for current conditions (Base 285; left panel of graph) and project (Alt-1A w/MLOW; right panel of graph) plus multi-level outlet. Predictions without the MLOW are shown as dashed line on both panels. Composite of Figure 3 and Figure 4.

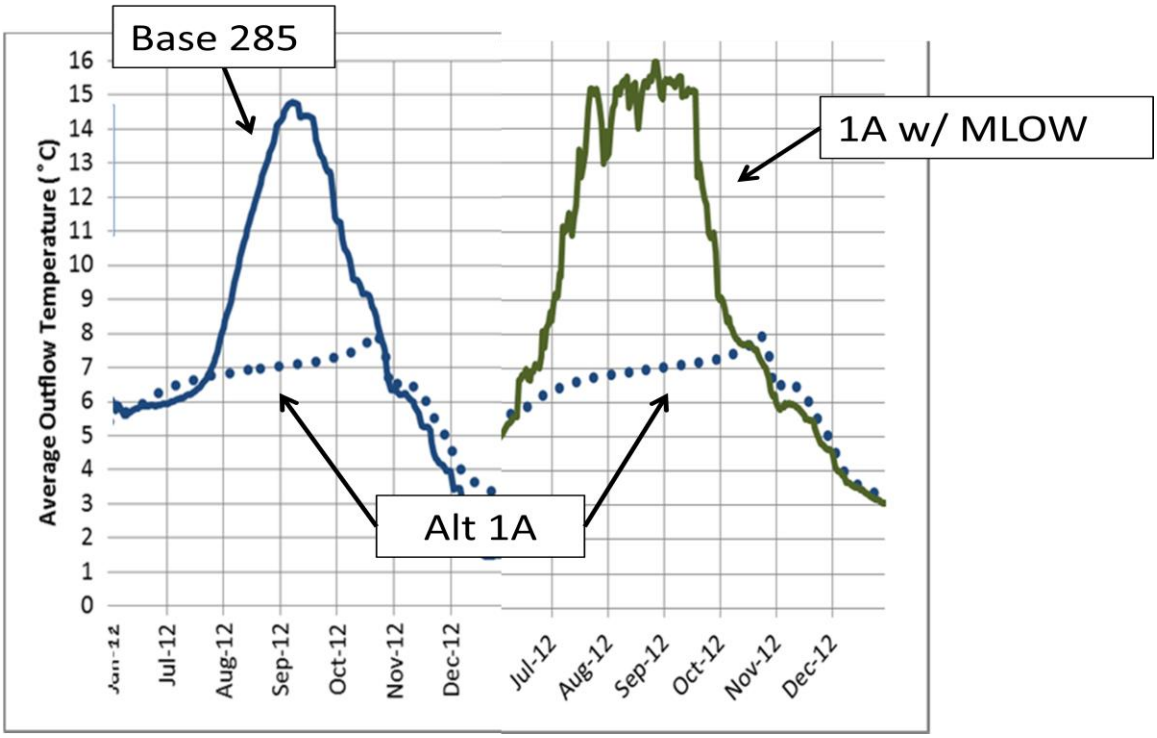


Figure 6. Comparison of outflow temperatures modeled with 1972 hydrology for current conditions (Base 285; left panel of graph) and project (Alt-1A w/MLOW; right panel of graph) plus multi-level outlet. Predictions without the MLOW are shown

as dashed line on both panels. Composite of Figure 3 and Figure 4.

Summary

With respect to the narrative standard, it is clear that temperature in South Boulder Creek below Gross Reservoir no longer shows a normal seasonal pattern, and operation of the project will further erode that pattern. However, this is only part of the information required to decide how this issue affects certification. Conclusions about conditions and the significance determination are presented in the Rationale document.

APPENDIX B: Guidance for Voluntary Pilot Projects

The Applicant has agreed to make bypass flows available for Voluntary Pilot Projects (VPPs) during the Interim Period. The Interim Period begins "upon issuance and acceptance by Denver Water of permits necessary for the Moffat Project" and continues until the project "becomes operational"[1]. VPPs conducted during the Interim Period will be devoted to evaluating the temperature benefit from bypass flows and for developing a decision matrix to guide subsequent bypass actions.

During the Interim Period, the amount of water available for VPPs is not fixed, but depends on snowpack, reservoir storage, summer forecasts, and maintenance or operational constraints on movement of water. A reasonable estimate of availability should be possible by May each year, which is ample time to establish a framework for the VPP to be conducted during the summer.

At least three locations offer potential for VPPs: Ranch Creek, Fraser mainstem, and St Louis Creek. Ranch Creek is especially important in view of the present magnitude and frequency of temperature exceedances; direct mitigation would be highly desirable. However, Ranch Creek is also a complicated location for a VPP because of diversions and the potential importance of the many beaver dams. The Fraser mainstem offers the best opportunity for investigating the longitudinal persistence of benefit from bypass flows because of the cold temperatures and availability of water in Vasquez Creek. However, temperature problems are not common in the mainstem above Granby.

The Applicant will submit a study plan by June 1st in each year for which bypass flows are available. The study plan will describe the objectives, monitoring locations, collection of ancillary data (e.g., air temperature, flows, travel times), and strategy for manipulating bypass flows. The plan should also explain circumstances where options for monitoring locations, and thus also for study design, are constrained by access to private land. The Division will review the plan and recommend any changes within 30 days.

Study Design

Each study will have general objectives related to evaluating the benefits of bypass flows. These objectives specify the stream to be evaluated (e.g., Ranch Creek), the strategy for manipulating bypass flows (amount, source, and scheduling), and the basis for detecting the benefit as the bypass water moves downstream. Although the

[1] As per the CRCA: "The capacity of Gross Reservoir has been enlarged, and water has been diverted and stored in the enlarged portion of Gross Reservoir."

time window for the studies is relatively brief (July 15 – August 31), there may sufficient time to evaluate multiple objectives with each VPP.

Ranch Creek and the Fraser River mainstem are well suited for study in the sense that both have real-time monitoring stations. Ranch Creek is more complicated in terms of options for bypass flows and by virtue of the numerous beaver dams along the reach of interest. One general approach would be to focus first on the Fraser River in order to test temperature metrics and develop a preliminary basis for estimating the longitudinal persistence of benefits from bypass flows.

The beaver dams along Ranch Creek pose special problems because they affect travel time and temperature in ways that must be considered in developing a study plan. Each beaver dam extends the residence time of water in the reach, and it warms the water more than would occur without the dam. Both factors are likely to affect the longitudinal persistence of benefits from bypass flows. The role of these factors could be evaluated initially without regard to bypass flows.

The VPPs are handicapped in a way because it is not possible to set up parallel streams – one with and one without bypass flows – that would facilitate a side-by-side comparison. Instead, it is necessary to vary bypass flows over short periods of time when weather conditions are expected to be relatively stable. For example, flow could be bypassed for three or four days followed by a similar period of time when there is no bypass. Alternation of flow regimes will make it easier to isolate the benefit of the bypass flows. In addition, the amount of each bypass can be varied according to the amount of water that is available, although it is important to begin with the maximum amount to make sure benefit can be detected.

There are several locations in the basin where bypass flows are available, and this offers options for mitigating elevated temperatures. However, for initial trials, it makes sense to manipulate the sources where bypass flows are likely to be largest. Having a single source, or closely spaced sources, makes it easier to determine the longitudinal extent of the benefit that bypass flows can provide. Smaller sources can be added later after a firm basis has been established for estimating the longitudinal extent of the benefit.

Scheduling bypass flows depends in part on travel times; how long does it take for the leading edge of bypass flows to reach the terminus of the study reach and how long does it take for the trailing edge to reach the terminus after the bypass flows are stopped. For example, if the travel time through the reach is approximately one day, then bypass flows should be scheduled for three or four days in order to get two or three days of stable conditions for data collection. Similar reasoning applies to the interval after bypass ceases.

Travel time determinations are an important element of scheduling decisions. Channel geometry along the Fraser mainstem may be sufficient to support these estimate, but that is unlikely to be the case in Ranch Creek due to the beaver dams. Dye tracer studies, or something comparable, are needed to provide an empirical

basis for travel times. These studies will also help determine the spacing for data loggers.

Real-time data for air temperature would be a significant addition to the studies. It would make it possible to validate that before and after bypass comparisons of stream temperature are made at times when air temperature is relatively stable.

Longitudinal Studies

For each VPP, data loggers must be closely spaced downstream of the bypass location; the real-time monitoring locations are also important, but do not provide adequate spatial resolution for assessing benefit. Ideally, the spacing should make it possible to measure the same parcel of water several times in a day. For example, if a parcel in lower Ranch Creek moves about 6 miles a day[2], placing loggers about 1 mile apart would result in a transit time of approximately 4 hours between adjacent loggers. As an initial trial, loggers could be deployed to cover a distance approximating a travel time of one day. Spacing or distance could then be adjusted as more is learned. The data loggers would be deployed only for the duration of the VPP and should be set to record at 15-min intervals, or more frequently.

The advantage of data from the data loggers, compared to sole reliance on the real-time sites, is that it is possible to frame benefit questions in terms of distance rather than just a yes or no answer. It is likely that the distance over which the benefit persists depends not only on the amount of the bypass, but also on the path it takes. In other words, we might predict that the benefit will travel farther in the Fraser River than in Ranch Creek due to factors that affect velocity (e.g., beaver dams and low gradient).

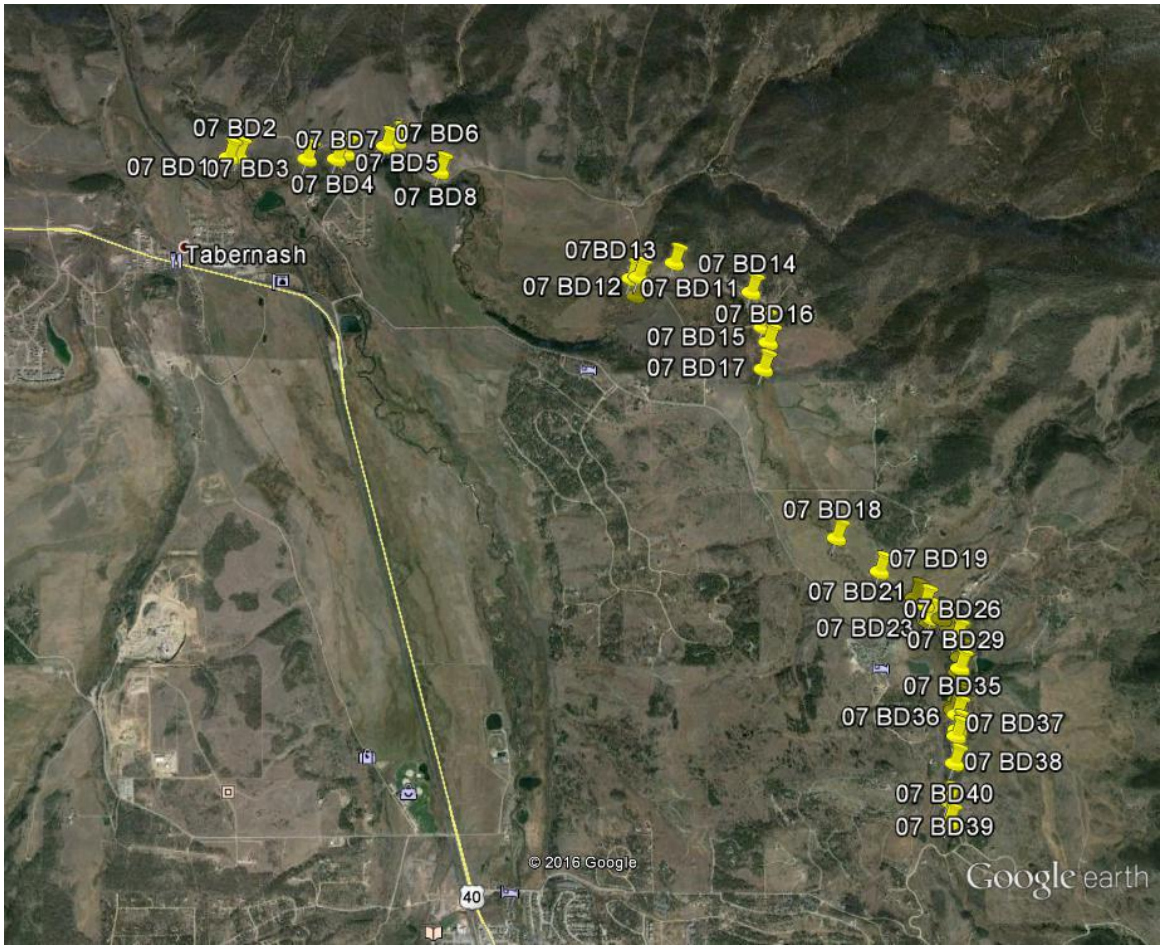
Beaver Dams

For Ranch Creek specifically, there is a need to understand more about the influence of beaver dams on stream temperature. Each beaver dam functions like a small low-head dam that creates a pool where width and depth are relatively insensitive to small variations in flow (i.e., the changes anticipated with bypass flows). Consequently, the beaver dams may result in more rapid attenuation of the benefit from bypass flows than would be expected in the absence of the dams. That information may prove valuable for developing the decision matrix and for reaching conclusions about *de minimis* benefit.

The Applicant has supplied information showing that there are almost 50 beaver dams between their diversion point and the mouth of Ranch Creek (see Figure below). The effect of beaver dams on stream temperature has been studied in other settings, and results of those studies yield some conclusions that can guide study design in Ranch Creek. Each beaver dam slows the velocity of the stream, and the longer residence

[2] Velocity is less than 1 fps at flows below 10 cfs based on field measurements at the two gages on Ranch Creek. The choice of 6 mi/d is approximate and simplifies calculations.

time warms the stream compared to what would happen in the absence of the dam. The dams also increase water depth, which tends to reduce the daily amplitude of temperature variation.



Concurrent measurement of temperatures above and below several of the ponds may yield important information about attenuation of bypass effects; this information may lead to conclusions about benefit on the basis of the number of beaver dams downstream of the bypass location. If beaver dams are found to strongly attenuate the bypass effect, bypass flows may yield little benefit in Ranch Creek. This type of study can be run concurrently with a longitudinal series of sites in Ranch Creek or the Fraser.

Data Analysis

The daily temperature data from streams generally conform to a sinusoidal time-series[3]. By fitting such a model to the data, several important characteristics can be determined at each site for each day or for a period of several days. Useful

[3] See, for example, G McRae & CJ Edwards. 1994. Thermal characteristics of Wisconsin headwater streams occupied by beaver: Implications for brook trout habitat. Transactions of the American Fisheries Society 123: 641-656.

characteristics include the minimum, maximum, amplitude, and time of maximum (phase shift); time above an arbitrary threshold or heating rate at a specific time of day3 might also be useful. Daily characteristics are used to define changes in temperature caused by transit through a reach or a beaver pond.

Bypass flows are turned on for a period of days and then turned off for a comparable period. The appropriate number of days depends on travel time through the reach, as explained previously. Daily temperature characteristics and the changes observed across reaches or the beaver ponds can then be segregated into groups according to whether flows were bypassed or not. The statistical approach for analyzing the data will depend on how much these characteristics change at individual sites over the course of the VPP, but could be as simple as a t-test. Results of the statistical test will help determine the longitudinal persistence of the bypass effect on stream temperature.

It is reasonable to expect that the daily amplitude and the daily maximum will be decreased when flow is bypassed; increasing the flow increases water depth, which means that heat transfers are occurring in a larger volume. The effect of bypass flows on stream temperature will dissipate over time whether the water is flowing in Ranch Creek or the Fraser River.