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Technical Memorandum

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LIST OF ABBREVIATIONS

BC	Brown and Caldwell
CFR	Code of Federal Regulations
cfs	cubic feet per second
cfu	colony forming units
COB	City of Bellingham
CWA	Clean Water Act
DO	dissolved oxygen
Ecology	Department of Ecology
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
HRT	hydraulic retention time
HSC	Hydrologic Serrvices Company
HSPF	Hydrological Simulation Program-Fortran
IWS	Institute for Watershed Studies
LWD	large woody debris
MF	Middle Fork
mgd	million gallons per day
mg/L	milligrams per liter
NO_3	nitrate
NTU	nephelometric turbidity unit
SaSI	salmonid stock inventory
SRP	soluble reactive phosphorus
TMDL	total maximum daily load
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TS	total solids
TSS	total suspended solids
T_VSS	total volatile suspended solids
UAA	use attainability analysis
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WADNR	Washington Department of Natural Resources
WDFW	Washington Department of Fish and Wildlife
WERF	Water Environment Research Foundation
WQ	water quality
WQS	water quality standards
WRIA	water resources inventory area
WWU	Western Washington University

1. INTRODUCTION

This technical memorandum discusses the feasibility of completing a use attainability analysis (UAA) to address potential water quality standards (WQS) issues in Mirror Lake and/or Anderson Creek. The City of Bellingham (COB) retained Brown and Caldwell (BC) to develop this evaluation under Contract No. 2008-0645.

The COB diverts water from the Middle Fork (MF) of the Nooksack River to Lake Whatcom via a tunnel linked with Mirror Lake and Anderson Creek. These diversions are used to augment the Lake Whatcom drinking water supply for the COB and Lake Whatcom Water and Sewer District, and to maintain Lake Whatcom water levels. The MF diversions are not treated (disinfection takes place after withdrawals at the water treatment plant near the Whatcom Falls park).

The state Department of Ecology (Ecology) has expressed concern that the MF diversion could affect compliance with state WQS in Mirror Lake and/or Anderson Creek. The WQS are based on the designated uses listed in the state WQS regulations.

The federal Clean Water Act (CWA) §101(a)(2) allows states and tribes to change designated uses by completing a UAA for the affected water bodies. A UAA is a regulatory tool available to states, tribes, and public and private proponents that can be used to modify the designated uses and applicable water quality criteria for a particular water body. In order for a designated use to be modified, the UAA must demonstrate that the water body meets at least one of the six candidate conditions specified in the federal regulations. Successful UAAs require public review and input, effective stakeholder involvement, regulatory review and approval (state and USEPA) and can take considerable time and resources. The COB would like to understand whether a UAA might be an appropriate mechanism for addressing certain WQS issues in Mirror Lake and Anderson Creek related to the MF diversion.

This memorandum summarizes the current WQS (designated uses and applicable water quality criteria) for the water bodies along with historical information related to land uses, fish and habitat surveys, lake bathymetry, and diversion operations from the MF Nooksack River.

2. BACKGROUND

This section summarizes the problem definition and provides background information regarding the MF diversion system, UAAs, and WQS.

2.1 Problem Definition

Ecology has expressed concerns about the impact of MF diversions on temperature in Anderson Creek (Ecology 2005b). The MF diversions typically flush water from Mirror Lake into Anderson Creek. During warm weather, the warm water flushed out of Mirror Lake may result in temperature criteria exceedances in Anderson Creek. In addition, the MF diversion water is sometimes turbid due to the glacial rock flour generated by glaciers on Mount Baker. Ecology has observed turbidity in the Anderson Creek outlet to Lake Whatcom. However, Ecology's 2008 integrated assessment did not identify temperature or turbidity issues for Anderson Creek. The Lake Whatcom total maximum daily load (TMDL) study included estimates of annual phosphorus loads attributable to the MF diversions ranging from 3 to 6 percent for the various scenarios (Ecology 2008). However, the relationships among turbidity and phosphorus and diverted flows versus flushed Mirror Lake water were not clear. BC has also been assisting Whatcom County and the COB with this TMDL and related tributary monitoring.

2.2 MF Diversion System

A dam diverts flow from the MF into an 8,900-foot-long tunnel, and then into a 9.5-mile-long 42" pipeline, which discharges to an approximately 600-foot-long open channel into Mirror Lake. The COB maintains a flowmeter in the 42" pipeline. The outlet of Mirror Lake is the beginning of Anderson Creek, which flows approximately 2.5 miles west into Lake Whatcom. See Figure 1 and Appendix A for more information. It is not clear if the channel flowing into Mirror Lake was constructed as part of the diversion or if a historical inlet stream flowed into Mirror Lake in this vicinity.

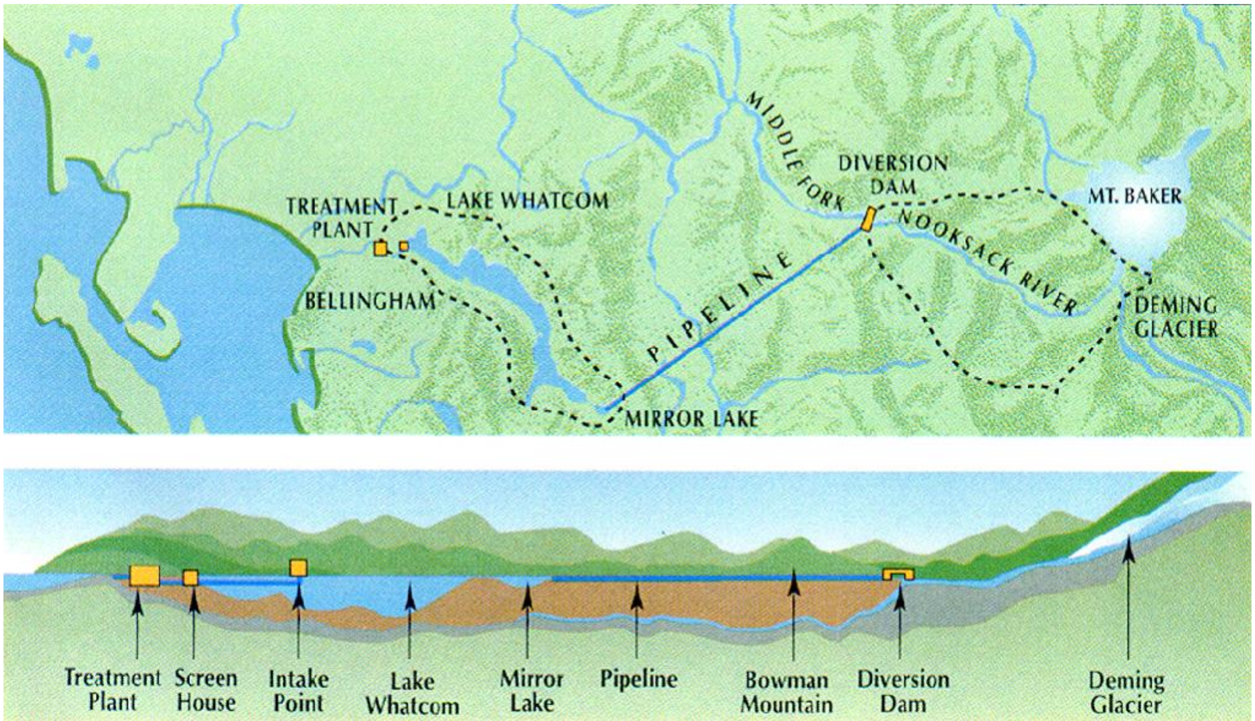

Figure 1. MF diversion system

(source: http://www.lakewhatcom.whatcomcounty.org/asub_fldrs/about_the_watershed/water_supply.shtml)

2.3 Operating Rules and Diversion Flows

The MF diversion is used for managing drinking water use and water levels in Lake Whatcom. The MF diversion began in 1962; since then, Mirror Lake has functioned as a settling pond for suspended sediment in the diverted water (Tracy, 2001). The COB has a water certificate to withdraw up to 125 cubic feet per second (cfs) from the MF and divert these flows to Lake Whatcom (Bellingham Comprehensive Plan, 2005). The water level of Lake Whatcom is controlled by an outlet structure on Whatcom Creek, and typically fluctuates between 311.5 and 314.0 feet above sea level. A maximum level of 314.94 is the 1953 court-mandated maximum level at which the COB can no longer artificially impede the flow of water down Whatcom Creek (COB, personal communication). The MF diversion is used to satisfy water demand while minimizing fluctuations of Lake Whatcom. In the early years since 1962, the diversion accounted for approximately 20 percent of the COB's water consumption on a yearly basis (Tracy, 2001). In recent years, the diversions have accounted for an average of just under 11 percent of total inputs to the lake, with no diversions at all in 2009 due to flood damage. See Table 1. Figure 2 shows the annual MF diversion volumes for the period of record. Annual diversion volumes have decreased since 1998 when the COB began reducing diversions voluntarily to help meet minimum in-stream flows in the MF Nooksack River. Figure 3 shows the annual volumes of the MF diversions and withdrawals from Lake Whatcom[1]. During the summer months, the diversion may supply as much as 80 percent of the surface inflow to Lake Whatcom (Tracy, 2001).

Table 1. Recent Diversion Inputs to Lake Whatcom (Estimated)[a]		
Year	Million Gallons	% of inputs
2004	5,095	12.4
2005	3,852	9.6
2006	4,155	11.0
2007	2,920	7.5
2008	4,902	13.7
2009	0[b]	0%
6-year average		9.0
5-year average thru 2008		10.84

[a] *Estimates provided by COB.*

[b] *Diversion system made inoperable by 01/06/09 flood.*

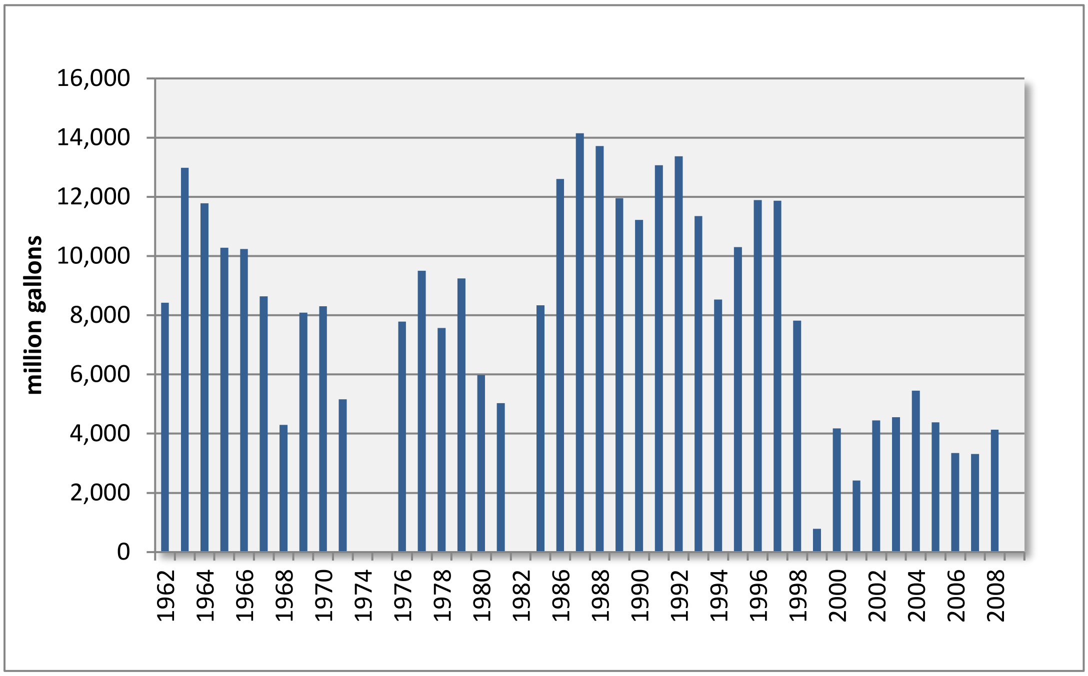

Figure 2. Annual volumes of MF diversions
(supplied by COB)

[1] The withdrawals are the sum of water supply (COB and Lake Whatcom Water and Sewer District) and Georgia Pacific (through the recent plant shutdown).

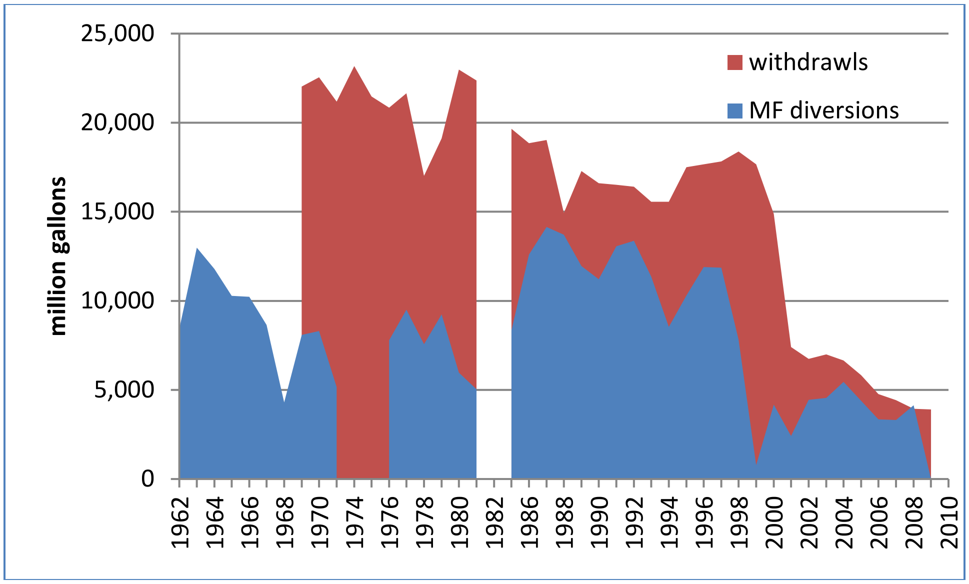

Figure 3. Annual MF diversions and withdrawals from Lake Whatcom (supplied by COB)

While the diversion tunnel capacity provides for up to 250 cfs, the capacity of the pipeline is limiting at approximately 90 cfs (HSC[2], 2005). At normal operation, the diversion contributes 40–60 million gallons per day (mgd) (60–90 cfs) to Lake Whatcom per day (Burns, 1991), which would provide an average daily flow of approximately 77 cfs.

Given the apparent excess capacity in the tunnel segment, in 1985, Robert Shipp negotiated an agreement with the COB for hydroelectric development rights at the head of the diversion. This hydroelectric facility was added near the midpoint of the diversion pipeline, near Hutchinson Creek. The HSC report (2005) mentions that the tunnel capacity is reduced to 67 cfs due to friction and pressure losses when the hydropower station is in use.

Since 1999, the COB has operated the MF diversions in concert with management of in-stream flow in the MF. In 1999, in-stream flow management in the MF was established to protect local fisheries needs and tribal fishing rights. Consequently, the operating rules since 1999 have resulted in a significant decrease in the annual volume of diverted water (HSC, 2005). Recent annual diversion volumes have dropped to about one half of the pre-1999 volumes of 30,000 acre-feet or more. The diversion has been operated in all months, with highest amounts during the May–July period (HSC 2005). Appendix B contains additional historical information on the diversions. The COB has been evaluating potential alternatives for modifying the diversions as environmental needs arise.

2.4 Mirror Lake

Mirror Lake is located at the head of a narrow valley bounded by steep forested hillsides. The valley bottom is gently sloping, forested land with occasional pastures, meadows, and wetlands in the vicinity. The parcel surrounding Mirror Lake allows for timber production for commercial purposes, and is mostly privately

[2] The HSC 2005 document was commissioned by the COB to conduct an analysis of the effects of the COB's withdrawal from the MF Nooksack on the downstream streamflow in the mainstem the Nooksack River.

owned. Tracy (2001) estimated that Mirror Lake has a surface area of approximately 12.7 acres and a volume of 321,900 m^3 (11,400,000 ft^3, 262 acre-feet).

Given the COB's practical maximum diversion rate of approximately 90 cfs, the hydraulic retention time (HRT)—the lake volume divided by maximum diversion inflow rate—of Mirror Lake could be as short as 35 hours during peak diversions. See Appendix A. The HRT during non-diversion periods has evidently not been estimated elsewhere. According to state WQS, water bodies with a mean HRT greater than 15 days are to be treated as a lake in setting designated uses. However, a mean HRT of 15 days for Mirror Lake would require an average inflow of approximately 9 cfs throughout the year. The lake has no current or historical outlet control and so it is unlikely to provide significant live storage (i.e., a relatively stable lake level would be expected during MF diversions).

Two studies have estimated substantial sediment loads deposited in Mirror Lake attributable to the diversions; Tracy (2001) used core samples to estimate a long-term average deposition rate of 1.3 in./yr, which equated to 56,500 ft3 per year. Tracy suggested that Mirror Lake has functioned as a settling pond for suspended sediment in the diverted water. Based on water samples and flow data, the 1984 MF of the Nooksack Diversion Monitoring Program (MF Monitoring Program, 1984) indicated that the average daily sediment loading attributable to the diversions was 48,683 pounds.

2.5 Effects of Diversion on Downstream Water Temperature

During warmer periods, the MF diversions would be expected to result in an initial pulse of warm water displaced from Mirror Lake, followed by cooler water once the lake has flushed and reached steady state. That is, if the temperature differential was adequate between the MF water and the Mirror Lake water, each time the diversion is turned on, a discernible pulse of warmer temperature could be experienced in Anderson Creek. When water temperatures are similar, this pulse would be less apparent, if at all. The largest temperature differential would be expected between spring and late summer given the solar gain for the lake and the cooler flows from the MF's mountain origins. Additionally, glacially fed streams often experience a rapid transition to turbid flows in the summer. This phenomenon occurs when turbidity in glacial meltwater flows begin to play a more dominant role after the annual snowpack has melted, which also corresponds to seasonal decreasing rainfall. The BC Task 2 will explore the 2007–2008 continuous water quality data for Anderson Creek to identify potential patterns like these.

As discussed earlier, the diversions could flush Mirror Lake in as little as 35 hours, assuming complete mixing. The initial pulse of warmer water would most likely cause only short-term spikes in Anderson Creek temperatures because the stream velocities would be expected to be elevated from the diversions. This short-term effect probably is of limited impact to salmonid species in Anderson Creek given the following flow of cooler water from the MF itself. The MF flows could even amount to an enhancement by providing higher flows of overall cooler water during the summer low-flow periods in Anderson Creek. Appendix C contains a summary of water quality data for Anderson Creek.

2.6 UAAs and Water Quality Standards

A UAA is a regulatory tool available to states, tribes, and public and private proponents that can be used to modify the designated uses and applicable water quality criteria for a particular water body. In order for a designated use to be modified, the UAA must demonstrate that the water body meets at least one of the six candidate conditions specified in the federal regulations. Washington State has regulations and guidance for completing UAAs; these are summarized in Section 3. Besides a UAA, changes to uses and/or criteria can be accomplished through three other procedures: site-specific criteria, short-term modifications, and variances. While site-specific criteria are intended to be a permanent change, short-term modifications and variances are granted only for finite periods of time until the uses/criteria can be met.

The CWA (§101[a][2]) established the goal of protecting and restoring the "fishable, swimmable" uses of surface waters nationwide, which have been translated into the WQS for most states. The WQS are comprised of the designated uses and associated numeric water quality criteria, which are outlined in Section 4 for Mirror Lake and Anderson Creek. In Washington State, Ecology established and administers the WQS and applies them to specific or general types of water bodies. The WQS are supposed to be reviewed and updated by states every 3 years using a process called the "triennial review" (required by the CWA), with subsequent U.S. Environmental Protection Agency (EPA) approval. A change to a water body's designated use via a UAA is subject to state and EPA approval before being adopted through the triennial review rulemaking process. Therefore, formal adoption of a UAA may take several years.

States typically assess water bodies for attainment of WQS on a biennial basis via the "integrated assessment" list required by the CWA §303(d) and §305(b). If these assessments indicate impairment, then the water body is added to the 303(d) listing and a TMDL would be scheduled for completion. It is important to define the existing and attainable uses for a water body because without appropriate pollutant loading allocations, a TMDL could result in serious economic implications with uncertain or limited if any corresponding environmental benefit.

Ecology's 2008 integrated assessment lists Anderson Creek for dissolved oxygen (DO) and bacteria, but does not contain an assessment of temperature or turbidity data[3]. The final mile of Anderson Creek before it enters Lake Whatcom is listed for DO as Category 2 and for fecal coliform bacteria as Category 5. Category definitions are provided in Appendix E. Category 2 is for waters that exhibit some evidence of a water quality problem but not enough for a TMDL. Category 5 listings comprise the 303(d) list of waters that will require a TMDL.

Given Ecology's concerns, Anderson Creek could be a candidate for 303(d) listing for the temperature and turbidity excursions. To result in such a listing, sufficient data would be needed to show exceedances of the water quality criteria applicable to the designated uses. As outlined in Section 4, the water quality criteria for temperature depend on certain calendar periods for the applicable designated uses for salmonid spawning and rearing. Turbidity criteria depend on concurrent upstream background levels. If a 303(d) listing was pursued, it appears that the next assessment opportunity is several years from now3.

Lake Whatcom has a pending TMDL, which applies to phosphorus and bacteria[4]. Most of the major tributaries, including Anderson Creek, are expected to have corresponding load allocations for these pollutants (Ecology, 2008). However, it is not clear what role the MF diversions would play with respect to phosphorus or bacteria transport to Lake Whatcom via Anderson Creek. Moreover, the difference between the MF diversions and the Anderson Creek watershed contributions has not been well studied. The pending Lake Whatcom TMDL will apply to Anderson Creek, which would in turn include the MF diversions, whether the diversion impacts are significant or not. This technical memorandum, however, does not address these potential issues.

[3] Ecology's 2008 integrated assessment began with a call for data in September 2006 and was completed in June 2008, with EPA approval in January 2009. See http://www.ecy.wa.gov/programs/wq/303d/2008/index.html. According to Ecology's Web site, the next (2010) integrated assessment will only cover marine waters, and the call for data was completed in October 2009: http://www.ecy.wa.gov/programs/wq/303d/2010/index.html.

[4] See http://www.ecy.wa.gov/programs/wq/tmdl/LkWhatcom/LkWhatcomTMDL.html.

3. USE ATTAINABILITY ANALYSIS REQUIREMENTS

This section outlines the federal and state UAA requirements and guidance.

3.1 Federal Requirements

The Code of Federal Regulations (CFR) Title 40 at 131.3(g) defines a UAA as a structured scientific assessment of the factors affecting the attainment of the use of a water body. According to §131.10(g), a UAA may include physical, chemical, biological, and economic factors and must demonstrate that attaining the currently designated use is not feasible because of any one of the six specific factors listed in Table 2.

Table 2. Applicable Conditions for Completing a UAA[a]

Condition	Description
1	Naturally occurring pollution concentrations prevent the attainment of the use.
2	Natural, ephemeral, intermittent, or low-flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met.
3	Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place.
4	Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use.
5	Physical conditions related to the natural features of the water body, such as lack of proper substrate, cover, or flow; or depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses.
6	Stringent controls would result in substantial and widespread economic and social hardship.

[a] *40 CFR 131.10(g).*

3.2 Washington State Requirements

The Washington Administrative Code (WAC) §173-201A-440 prescribes the following regulations for applying for a UAA:

1. Removal of a designated use for a water body assigned in this chapter must be based on a UAA.
2. A UAA proposing to remove a designated use on a water body must be submitted to the department in writing and include sufficient information to demonstrate that the use is neither existing nor attainable.
3. A UAA must be consistent with the federal regulations on designating and protecting uses (currently 40 CFR 131.10).
4. Subcategories of use protection that reflect the lower physical potential of the water body for protecting designated uses must be based upon federal regulations (currently 40 CFR 131.10[c]).
5. Allowing for seasonal uses where doing so would not harm existing or designated uses occurring in that or another season must be based upon federal regulations (currently 40 CFR 131.10[f]).

3.3 UAA Guidance

While the WAC provides UAA regulations, Ecology provides guidance for conducting a UAA (Ecology, 2005a draft). Ecology's guidance is a work in progress with related documents including Frequently Asked Questions (FAQ, Ecology, 2004a) and Response to Comments (Ecology, 2004b). Older EPA guidance focuses on technical details of methods and approaches relating to UAAs for freshwater aquatic life uses (EPA, 1983). The Water Environment Research Foundation (WERF) has developed a useful UAA handbook which includes many case studies and discussions of alternatives (WERF, 2005).

According to Ecology's draft UAA guidance (2005a), a UAA must be submitted to Ecology in writing and include sufficient information to demonstrate that a designated use either does not exist or is not attainable. Where information exists to show that the designated uses are nonexistent or unattainable, UAAs are used to either remove the designated use(s) or to revise designated uses into more accurate subcategories. Table 3 shows the situations in which water bodies' designated uses may or may not be fully supported (Ecology 2005a).

Table 3. When Designated Uses May or May Not Be Fully Supported[a]
If the designated use currently exists and water quality criteria to protect that use are being met (i.e., the use is being fully supported), then that use may not be downgraded.
If the designated use appears to be present (e.g., salmon use the area for spawning) but the water quality criteria that protect that use are not attainable, then the use is not considered to be fully supported. In this case it is possible to establish a new subcategory in the WQS that reflects this use.
If the designated use only occurs seasonally because of natural factors, then a seasonal use specific to this situation can be established in the WQS. Note that when a use is modified to apply only in a certain season (e.g., a seasonal recreational use is developed), then another use must still be present to protect uses in the "off season." The designated aquatic life uses and criteria in the WQS were designed to provide a healthy thermal environment that protects entire aquatic life communities on a year-round basis and therefore cannot be applied seasonally. Thus, in the case of aquatic life, new seasonal uses (not the designated uses defined in the standards) could be developed, and they would need to be accompanied by new criteria to protect those uses.

[a] *Source: Draft Use Attainability Analysis Guidance for Washington State (Ecology 2005a).*

After receiving a proposal to remove or modify a designated use via a UAA, Ecology will respond on whether to proceed with rulemaking or if more information is needed. Changing designated uses and applicable numeric criteria would be done through the triennial review process, which requires approval by the EPA. The decision to approve a UAA is subject to a public involvement and intergovernmental coordination process, including tribal consultation and an ESA consultation, if necessary. Implementation of changes can therefore require several years after completing a UAA. Figure 4 presents Ecology's flow chart for deciding to do a UAA.

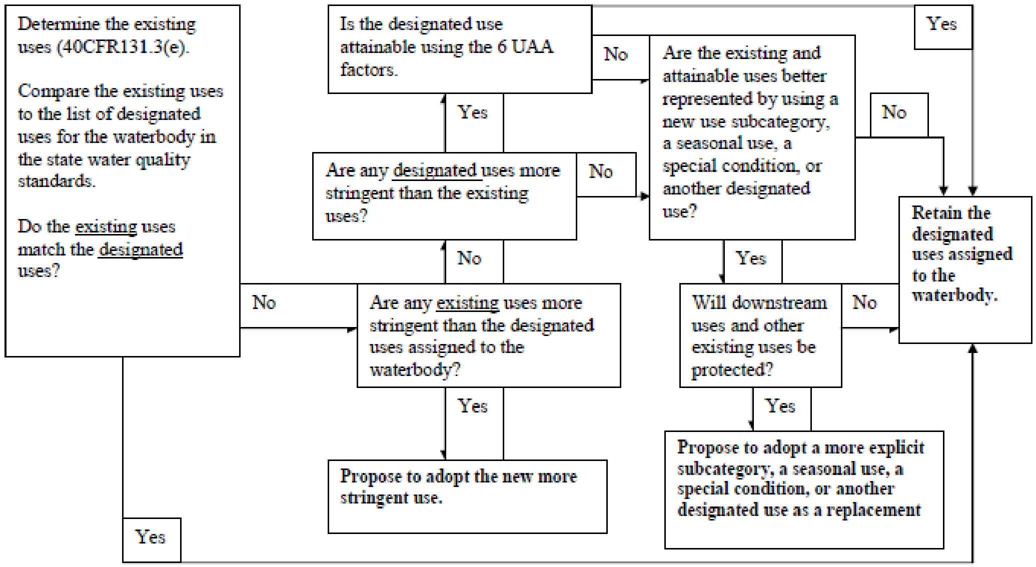

Figure 4. Summary flow chart of the decisions in a UAA
(source: Ecology 2005)

Ecology's guidance also notes the following important considerations:

- UAAs cannot be used to change (downgrade) numeric criteria to existing conditions, unless natural conditions prevent criteria attainment or site-specific criteria are appropriate.
- UAAs for groups of water bodies are not recommended because the entire group UAA could get rejected. Water bodies may be grouped if they have similar physical, chemical, and biological characteristics.
- A proposed change in use in one water body must not interfere with downstream uses and related criteria in another water body.
- A UAA is not limited to available data and more information may need to be collected.

The guidance also says that alternative criteria for a UAA may be established:

> When a water body does not meet its assigned criteria due to human structural changes that cannot be effectively remedied (as determined consistent with the federal regulations at 40 CFR 131.10), then alternative estimates of the attainable water quality conditions, plus any further allowances for human effects specified in this chapter for when natural conditions exceed the criteria, may be used to establish an alternative criteria for the water body.
>
> *(WAC 173-201A-260[1][b])*

It should be noted that Ecology's UAA guidance is a work in progress, and the 2005 draft has not been updated in recent years. The latest draft guidance contained several areas of expanded information and numerous modifications prompted by public comments made on the first-draft guidance. Ecology received a wide range of comments on the first draft, which indicated that there was still a lot to be learned about how the federal regulations for UAAs will apply among the many different types of water bodies in Washington.

According to its Web site[5], “Ecology does not plan to finalize the UAA guidance until we have the opportunity to actually work on a UAA and gain some experience that will aid us in answering the breadth of questions that were raised during review of the UAA guidance.” The 2005 draft will be used as a framework to work through UAAs in Washington.

4. APPLICABLE WATER QUALITY STANDARDS: DESIGNATED USES AND NUMERIC CRITERIA

The CWA requires states to develop and assign WQS to surface waters of the state. Typically, states assign particular classifications to specific or generic types of water bodies, which establish the “beneficial” or designated uses and associated numeric criteria needed to preserve and protect those uses. The WQS are composed of the designated use and the numeric criteria, as well narrative criteria and anti-degradation provisions. This section presents a description of the state WQS that apply to Mirror Lake and Anderson Creek. Ecology provides descriptions of designated uses and other related information on its Web page at http://www.ecy.wa.gov/programs/wq/swqs/desig_uses.html.

The WQS for surface waters of Washington state are established in WAC Chapter 173-201A (WAC, 2006). Table 602 in the WAC lists the designated uses applicable to particular surface waters of the state, grouped by water resources inventory area (WRIA). When not named in Table 602, all other surface waters of the state are to be protected for the default designated uses discussed in Section 4.1. Additionally, the following waters are to be protected for the added uses of core summer salmonid habitat and extraordinary primary contact recreation:

i. All surface waters lying within national parks, national forests, and/or wilderness areas.

ii. All lakes and all feeder streams to lakes (reservoirs with a mean detention time greater than 15 days are to be treated as a lake for use designation).

iii. All surface waters that are tributaries to waters designated core summer salmonid habitat, or extraordinary primary contact recreation.

iv. All fresh surface waters that are tributaries to extraordinary quality marine waters.

(WAC 173-201A-610 through 173-201A-612)

4.1 Designated Uses for Mirror Lake and Anderson Creek

Because Table 602 in the WAC does not list Lake Whatcom, Mirror Lake, or Anderson Creek[6], the default designated uses apply to these water bodies. The additional designated uses of core summer salmonid habitat and extraordinary primary contact are also applicable to Anderson Creek because Category ii above applies (Anderson Creek is a “feeder stream” to Lake Whatcom, which would be expected to have a mean HRT well in excess of 15 days). However, it is not clear if Category ii would also apply to Mirror Lake because the HRT without diversions has not been estimated, and during MF diversions, the HRT was estimated at less than 15

[5] http://www.ecy.wa.gov/programs/wq/swqs/uaa.html.

[6] Table 602 includes an “Anderson Creek” listed as a boundary point for a reach of the Nooksack River, but this is another Anderson Creek in WRIA 1 and not the stream addressed in this document.

days (see Section 2.4 and Appendix A). Therefore, the applicable designated uses for Mirror Lake and Anderson Creek are similar[7] and encompass the following list:

- core summer salmonid habitat7
- salmonid spawning rearing, and migration
- extraordinary primary contact recreation
- domestic, industrial, and agricultural water supply; stock watering
- wildlife habitat.
- harvesting
- commerce and navigation
- boating
- aesthetic values

4.2 Applicable Numeric Criteria

The numeric water quality criteria applicable to aquatic life uses encompass temperature, DO, turbidity, total dissolved gas, pH, and toxic substances. Because the nature of the MF diversions would most directly affect temperature and turbidity, these parameters are most relevant to a consideration of UAA feasibility unless other issues arise. Criteria for bacteria are invoked by the human contact uses and are not addressed in this document. Similarly, the water supply and other uses invoke toxics and narrative criteria that are also not related to the current UAA feasibility consideration.

The applicability of the multiple numeric criteria for temperature is driven by the corresponding aquatic life designated use(s). The core summer salmonid habitat and spawning/rearing aquatic life uses are applicable, and according to the WAC, these uses are distinguished by differences in the timing of salmonid uses as defined below.

> **Core summer salmonid habitat use**: the key identifying characteristics of this use are summer (June 15–September 15) salmonid spawning or emergence, or adult holding; use as important summer rearing habitat by one or more salmonids; or foraging by adult and sub-adult native char. Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing, and migration by salmonids. *(WAC 173-201A-200[1][a][ii])*

> **Salmonid spawning, rearing, and migration use**: the key identifying characteristic of this use is salmon or trout spawning and emergence (fry leaving gravels in spawning beds) that only occurs outside of the summer season (September 16–June 14). Other common characteristic aquatic life uses for waters in this category include rearing and migration by salmonids. *(WAC 173-201A-200[1][a][iii])*

4.2.1 Temperature

The aquatic life temperature criteria for fresh water are based on the 7-day average of the daily maximum temperatures (7-DADMax). The 7-DADMax criteria are 16.0°C and 17.5°C for core summer salmonid habitat and salmonid spawning, rearing, and migration, respectively. These criteria are not to be exceeded more than once in 10 years on average. According to the WAC definitions:

[7] The mean HRT of Mirror Lake is unknown; therefore, the applicability of the core-summer salmonid habitat use and associated temperature criteria is not known.

> The "7-DADMax" or "7-day average of the daily maximum temperatures" is the arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days prior to and the three days after that date."
>
> *(WAC 173-201A-020)*

The standards provide brief guidelines on sampling locations (i.e., well mixed, not in stagnant areas), with no further guidelines on monitoring frequency or minimum numbers of samples needed to determine the 7-DADMax. Ecology's policy for water quality assessments outlines how continuous and grab samples will be used for the integrated assessments. See Appendix E.

Ecology also incorporates into the WQS, maps of certain water bodies that require special temperature protection for spawning and incubation (Ecology, 2006a). The MF Nooksack, Anderson Creek, and Mirror Lake do not appear on these maps. Ecology also intends to develop a fish use database[8] in response to the federal agency biological opinion rendered under the ESA consultation with EPA for the 2006 WQS (i.e., the conclusion of the last triennial review). Ecology will collect spawning and rearing data from state and federal agencies and tribes and use these new data to propose changes to the aquatic life uses for streams and rivers in the state.

The WQS recognize that not all waters are naturally capable of staying below the fully protective temperature criteria. When a water body is naturally warmer than the criterion, the WAC allows for an additional 0.3°C warming due to human activities considered cumulatively.

In addition to the maximum criteria outlined above, the WAC limits warming of otherwise cool waters due to human activities. When water is cooler than the criteria noted above, the allowable rate of warming due to nonpoint sources is 2.8°C (5.0°F), and for point sources spans the range of approximately 1.2° to 3.0°C, depending on the background temperature outside the mixing zone. For lakes, warming due to human activities can not increase the 7DADMax temperature more than 0.3°C above natural conditions.

4.3 Turbidity and Sediment

The WAC §200(1)(e) aquatic life turbidity criteria for fresh water are based on allowable excursions from "background" and are broken into two groups depending on the categories of designated uses as shown in Table 4. According to the WAC definitions:

> "Background" means the biological, chemical, and physical conditions of a water body, outside the area of influence of the discharge under consideration. Background sampling locations in an enforcement action would be up-gradient or outside the area of influence of the discharge. If several discharges to any water body exist, and enforcement action is being taken for possible violations to the standards, background sampling would be undertaken immediately up-gradient from each discharge. *(WAC 173-201A-020)*

[8] http://www.ecy.wa.gov/programs/wq/swqs/FishDataUpdates.html.

Table 4. Aquatic Life Turbidity Criteria in Fresh Water		
Category	**Background <50 NTUs**	**Background >50 NTUs**
Core summer salmonid habitat	5 NTU over background	10 percent increase in turbidity
Salmonid spawning, rearing, and migration	5 NTU over background	10 percent increase in turbidity

Because the turbidity criteria are based on background levels, an assessment of the turbidity criteria would need measurements collected at a suitable "background" location. Consequently, contemporaneous pairs of data are needed, whether from discrete measurements or from continuous sensors. Ecology's policy for water quality assessments outlines how continuous and grab samples will be used for the integrated assessments. See Appendix E. While the approach of concurrent sample pairs is the typical means of assessing turbidity criteria, it may be possible to compare impacts to pre-diversion "baseline" turbidity levels during baseflow periods.

Suspended sediment can also be subject to the narrative water quality standard to address the impacts sediment can have on the designated uses. Although there are currently no numeric criteria for sediment, under the toxics and aesthetics general criteria the following provision may be applicable to limit the effect of sediments on existing and designated aquatic life uses:

> (a) Toxic, radioactive, or deleterious material concentrations must be below those which have potential, either singularly or cumulatively, to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health…

(WAC 173-201A-260 [2][a])

5. EXISTING USES

This section provides an outline of the existing uses of Mirror Lake and Anderson Creek based on information provided by the COB and other sources as identified in the appendices. Additional information about uses may exist.

Existing uses are defined by the UAA Guidelines (Ecology, 2005) as follows:

> Those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the WQS. Water body surveys, historic records, and to a limited extent, anecdotal accounts should be relied on to determine existing uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of non-self-replicating introduced native species, do not need to receive full support as an existing use.

5.1 Mirror Lake

Table 5 compares the designated uses for Mirror Lake with a summary of information relating to the existence of these uses. In addition, Mirror Lake has been serving as an equalization and settling pond for the MF diversions. The COB foresees reliance on this source of water for domestic use and the continued need to operate the MF diversions in the future.

Table 5. Mirror Lake Existing Uses	
Designated use	**Existing uses**
Salmonid spawning, rearing, and migration	Mirror Lake is unlikely to provide salmonid spawning habitat due to barriers/obstacles to migration in Anderson Creek (Burns, 1991). Mirror Lake was regularly stocked with rainbow trout but current stocking levels are unknown given the dated information (Burns, 1991). The fine-grained substrate would be poor for spawning. Kokanee tend to spend their adult lives in lakes but it is less likely that adults would live in Mirror Lake because of the access limitations in Anderson Creek and the population living in Lake Whatcom. A 2001–2003 fish survey using a beach seine indicated that small three-spined stickleback were abundant, and although no salmonids were caught, two rainbow trout were apparently observed (Anchor, 2005).
Core summer salmonid habitat	See above. Also, three beach seining samples between June–September 2002 did not catch any salmonids (Anchor, 2005).
Extraordinary primary contact recreation	Swimming activity was not mentioned in information reviewed. The shores of Mirror Lake have no public or private development and only one unimproved shoreline access point is known. This access point is a steep dirt road. Numeric criteria for bacteria for human contact use are not germane to the current UAA feasibility consideration.
Domestic, industrial, and agricultural water supply	Apparently some use for firefighting water supply. No uses mentioned in information reviewed. Mirror Lake has been serving as part of the water supply system for conveying MF diversions to Lake Whatcom for COB water supply management.
Stock watering	Unknown. Unlikely or limited; no obvious stock kept in areas surrounding the lake.
Wildlife habitat	Unknown, but likely given persistent open water and the forested watershed and buffer surrounding most of the lake's perimeter.
Harvesting	Unknown, but reports of trout planting suggest that fishing is or has been likely.
Commerce and navigation	Unknown, unlikely.
Boating	Unknown, but steep dirt road access point on the north side could allow small hand-launched boat access. Trout plantings suggest fishing from a boat is or has been likely.
Aesthetic values	Aesthetic values would be limited to roadside viewing and via the dirt access road to the lake. Lake shore has no developed public or private properties.

5.2 Existing Uses Anderson Creek

Table 6 compares the designated uses with a summary of existing uses for Anderson Creek. In addition, Anderson Creek has been serving as a part of the conveyance system for the Lake Whatcom water supply.

Table 6. Anderson Creek Existing Uses	
Designated use	**Existing uses**
Salmonid spawning, rearing, and migration	Documented salmonid spawning uses for both cutthroat trout and Kokanee salmon (WADNR; 1997); however, the extent of the stream reach used was not clear. The 2001–2003 fish survey indicated juvenile rainbow and cutthroat trout and Kokanee (Anchor, 2005). Burns (1991) indicated a number of barriers in the stream that would impede fish passage. Rearing uses were not documented in the information reviewed. Anderson Creek is one of the major kokanee spawning streams in the Whatcom watershed (WADNR, 1997). Formerly, more of Anderson Creek may have been used for kokanee spawning but obstacles (including riprap) may be acting as barrier to the upper parts of the creek. Additional information regarding salmonid presence is provided in Appendix D.

Table 6. Anderson Creek Existing Uses	
Designated use	**Existing uses**
Core summer salmonid habitat	Beach seining samples during September 2001 and 2002 caught Rainbow trout (Anchor, 2005). Other known fish surveys did not cover the core summer period (June 15–Sept. 15). Several age classes of juvenile cutthroat were found in May 2002 which would suggest cutthroat presence in the core summer period, although fry emergence or summer presence was not documented. See Appendix D.
Extraordinary primary contact recreation	Unknown. Several private residences are located along the creek, but no public access points. Numeric criteria for bacteria invoked by the human contact use are not germane to the current UAA feasibility consideration.
Domestic, industrial, and agricultural water supply	Unknown. Several private residences are located along the creek, some of which appear to have fields that may be near the stream. No industry exists; there is evidence of historic logging and a railroad in the surrounding area. However, Anderson Creek is part of the water supply system for conveying MF diversions to Lake Whatcom for COB water supply management.
Stock watering	Burns (1991) suggests livestock use along the creek (waste, devegetation, water supply).
Wildlife habitat	Unknown, but likely given the forested watershed and riparian buffer along most of the stream.
Harvesting	Unknown. The limited public fishing access and the stream is relatively small.
Commerce and navigation	Unknown. Unlikely.
Boating	Unknown. The limited public fishing access and the stream is relatively small.
Aesthetic values	There are several private residences along the creek. Public access is limited to the single road crossing and the stream mouth at Lake Whatcom.

6. UAA FEASIBILITY

A UAA for Mirror Lake and/or Anderson Creek would need to meet at least one of the six regulatory conditions (also called "factors") in order to be considered feasible. Table 7 summarizes these conditions and their applicability for completing a UAA (assuming similar applicability for both water bodies). Condition 4 appears to be the most relevant to the MF diversions. Changes to the existing uses and/or applicable criteria via a UAA would result in updates to the state WQS and likely additions of the affected water bodies to Table 602. These changes must go through a defined process of "rulemaking" that requires public, Ecology, and EPA review before being finalized. The stakeholder involvement process is vital to begin early, but could encounter opposition that precludes or complicates completing a UAA.

The changes proposed by a UAA might also coincide with the triennial review. The last triennial review process in Washington was ostensibly completed in December 2006 after several years of public process and multiple periods of EPA review, partial approval, disapproval, and responses. Therefore, several years or more would be needed to realize a change in the standards justified by a UAA. The public review and scrutiny may raise issues that are currently unknown.

The UAA would most likely need to cover both water bodies. However, the Ecology guidance generally recommends not grouping water bodies for a UAA unless they have similar physical, chemical, and biological characteristics. A proposed use or criteria change in one water body must also not interfere with a downstream water body's use or criteria.

Apparently, only one UAA has been conducted in Washington State, which was for the Spokane River; however, it was withdrawn subject to ongoing TMDL negotiations[9]. Other states seem to have had more success with UAAs, and some examples suggest that only limited efforts were needed to complete UAAs accepted by state agencies and the EPA[10].

Table 7. Applicability of UAA Conditions for Mirror Lake and Anderson Creek

UAA condition	Description	Applicability for Mirror Lake and Anderson Creek	Discussion
1	Naturally occurring pollution concentrations prevent the attainment of the use.	Unlikely	The potential temperature and turbidity impacts of the diversions are not naturally occurring in the water bodies.
2	Natural, ephemeral, intermittent, or low-flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met.	Unlikely	Both water bodies appear to be perennial.
3	Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place.	Potentially applicable	Several evaluations likely needed to show that the diversion and stream barriers could not be appropriately mitigated. Consequently, an evaluation of diversion operation and habitat mitigation alternatives would need to be completed first, including the economic impacts.
4	Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use.	Potentially applicable	Similar to Condition 3.
5	Physical conditions related to the natural features of the water body, such as lack of proper substrate, cover, or flow; or depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses.	Potentially applicable	Updated fish habitat and use surveys needed to determine current status and if needed improvements are not feasible.
6	Stringent controls would result in substantial and widespread economic and social hardship.	Potentially applicable	Related to Conditions 3 and 4. If a TMDL was issued and the COB could not divert water to keep the lake levels up, then a study would need to be performed to understand the economic impact. The diversion pre-dates the 1975 existing use requirement, but it is not clear if Condition 4 could be used to justify the non-attainability of the aquatic life use, at least without an appropriate evaluation.

In order to proceed under any of the potentially applicable conditions listed in Table 7, the first step toward a UAA would need to show that one of the existing uses discussed in Table 5 and Table 6 is not being attained for either or both water bodies. The aquatic life uses are most pertinent because Ecology's concerns relate to the numeric criteria for aquatic life (temperature and turbidity). Therefore, a non-attainment of the aquatic life

[9] See Ecology's Web page "Spokane River Dissolved Oxygen" at http://www.ecy.wa.gov/programs/wq/tmdl/spokaneriver/dissolved_oxygen/historicalinfo-ross/public_process.html.

[10] See examples from the EPA at http://www.epa.gov/waterscience/standards/uses/uaa/casestudies/index.htm.

uses would amount to justifying either that salmonids cannot use the water bodies any time due to physical habitat limitations, or that salmonid spawning and rearing and adult holding does not occur in the core summer period. Table 8 summarizes the potential for determining attainment or non-attainment of these two designated uses.

Table 8. Potential Attainability of Existing Aquatic Life Uses

Designated use	Potential for attainability	Potential for non-attainment
Salmonid spawning, rearing, and migration	Fish surveys showed that at least some portions of Anderson Creek were being used by resident salmonids for spawning and rearing and that the use was at least partially attained (see Appendix D). However, this information may need to be updated. Some enhancements to Anderson Creek could probably be completed to increase stream reaches available to salmonids.	Support for non-attainability via a UAA would have to show that the costs (and risks) of habitat enhancements were prohibitive. There are many examples across the region where similar barriers preventing salmonid access were removed to bring salmonid uses to additional stream reaches. Poor stream channel substrates have also been improved to promote spawning. Given the accessibility to salmonids and historical information documenting their presence, demonstrating that physical habitat limitations prevent the use attainment may not be realistic.
Core summer salmonid habitat	It is not clear if any attainment is being supported because none of the fish surveys adequately spanned the June 15–Sept. 15 window designated for this use. The temperature and turbidity effects related to the MF diversions would probably be most pronounced, if at all, during the core summer salmonid window.	An attainment assessment would be necessary. In this case, non-attainment evidence would need to be developed and presented that documents an absence of salmonid use in the summer window, and also that the associated numeric temperature (and potentially turbidity criteria) were also not being attained. Once the extent of non-attainment is clearer, then evaluations of alternatives would be needed to determine how much progress toward attainment is feasible.

Refining the use rather than removing the use entirely may be an easier path for a UAA. In this case, new use and criteria subcategories would need to be established and adopted. For example, a new subcategory of salmonid use and related criteria could conceivably be developed if the current temperature and turbidity excursions could be shown to not impact the salmonids using the water bodies. A potential justification could include that salmonids are known to seek refugia during elevated temperature pulses and eggs in gravels may be protected by cool hyporheic flows. Salmonids are also found throughout the region in streams that experience periodic or extended periods of turbidity from glacial rock flour[11] (Puyallup River, White River, etc.). The outcome of this path would still require rulemaking to set up the new subcategories and add Table 602 listings in the standards.

According to federal and state requirements, the cutoff for existing uses is November 1975. While the MF diversions have been operating since 1962, it is not clear if the diversion itself could be set as an existing use (e.g., “water supply”) for Mirror Lake and Anderson Creek. Moreover, if the temperature and water quality impacts from the diversion could not be mitigated, it is not clear if they could become the default conditions and prevail as the default criteria. There could be a conflict between lower temperatures for aquatic life uses and higher temperatures related to existing diversion uses.

Given the feasibility considerations presented above, the apparent overall alternatives that the COB could undertake are listed in Table 9 and arranged according to the related UAA condition. Where indicated in this table, a “habitat study” would evaluate the ability of the current physical habitat features in the water bodies to support salmonids. A “fish study” would evaluate the presence and condition of salmonid species such as cutthroat trout and kokanee salmon. A water quality study would evaluate the temperature and turbidity (and

[11] The types of phosphorus associated with suspended rock flour could have an impact on the Lake Whatcom TMDL.

possibly DO and pH) and indicate periods of attainment and exceedances of numeric criteria (Task 2 will provide a preliminary water quality evaluation).

Table 9. Potential Alternatives, Needs, and Outcomes

Condition	Alternatives to justify	Diversion operations study	Habitat study	Fish study	WQ study	Rulemaking needed	2012 integrated assessment	Outcomes
Status quo	There are no impacts		?	?	X		X	305(b) Category 1 listing
New operations rule	The new operations rules can be optimized to prevent water quality impacts	X			X		X	Optimized operating rules 305(b) Category 1 listing
UAA Condition 1	NA							NA
UAA Condition 2	NA							NA
UAA Condition 3	The new operation rules can only be changed to minimize water quality impacts	X	X	X	X	X		Partly mitigated operating rules New use and criteria subcategory Table 602 listing without both salmonid uses
UAA Condition 4	The new operation rules can only be changed to minimize water quality impacts	X	X	X	X	X		Partly mitigated operating rules New use and criteria subcategory Table 602 listing without both salmonid uses
UAA Condition 5	There are no salmonids using the core summer period when temperature/ turbidity excursions occur			X		X		Table 602 listing without core summer salmonid use
UAA Condition 6	Meeting current criteria has excessive costs	X				X		Table 602 listing without both salmonid uses

The first two alternatives listed in Table 9 would not require a UAA because they would demonstrate that existing uses and water quality criteria are being attained. In the first alternative "status quo", if the COB undertakes the water quality (WQ) study, it may be possible to generate adequate information to justify the status quo. In the second alternative, "new operations rule," if the COB undertakes the operations and WQ studies, it may be possible to optimize the MF diversion operations adequately to prevent non-attainment. For both of these alternatives, the water quality data study sets could be submitted to Ecology to show attainment of WQS, resulting in 305(b) Category 1 listings during the next integrated assessment (2012 or later).

Each of the remaining alternatives would use a UAA to result in new water-body-specific uses or criteria and specific listings in Table 602 of the WQS. The COB would most likely need to undertake the studies indicated, with the outcome that diversion operations could only be partly mitigated. While it is possible that summer conditions could preclude salmonids from accessing or using the water bodies, it is unlikely that this would be the case during the remainder of the year (higher flows). Consequently, only an alternative is listed for demonstrating non-attainment for core summer salmonid habitat use and not for year round salmonid spawning, rearing and migration. Neither economic nor technical analyses alone may be sufficient to justify a use change.

7. RECOMMENDATIONS

Before proceeding with further UAA consideration or development, BC recommends completing the Task 2 Anderson Creek and MF data evaluation (essentially equal to the "status quo" alternative listed in Table 9). The work for Task 2 (under Contract 2009-0645) will complete a review of the 2007–2009 continuous water quality data and put them into perspective with flow data and diversion records to help indicate the timing, extent, and duration of potential temperature exceedances[12]. Because the turbidity criteria require contemporaneous background data, only relative comparisons are possible (e.g., using pre-diversion baseflows, or data from nearby creeks such as Smith, Olsen, or Austin). These evaluations will help identify the potential to evaluate different operating rules for the MF diversion operations, such as slower ramping rates or different timing. Completing fish surveys and habitat studies might not be needed if this preliminary work shows that the operating rules can be optimized to prevent impacts from occurring.

Also, it would be important to understand what the recent Anderson Creek data suggest for temperature and turbidity impacts related to the MF diversions. Given low summer baseflows in Anderson Creek, the MF diversions may be an important source of cool water that is more important than the short-term impacts of flushing warm water out of Mirror Lake. Because no diversions occurred in 2009, contrasting the 2009 Anderson Creek data with prior year diversions might further illustrate the potential benefits of the MF diversions to Anderson Creek. Therefore, BC makes the following recommendations:

1. **Add simple water level pressure transducers** on the inlet and outlet of Mirror Lake to characterize the timing and duration of the diversions. Using two vented pressure transducers with onboard loggers (approximately $1K each) would be sufficient to characterize the basic pattern of lake level responses in diversion and non-diversion periods. Lower cost unvented transducers could be used at approximately half the cost for vented units, but the unvented level data would require barometric pressure correction (via a third unit suspended in the air, or via local weather station data). For this simple objective, absolute discharge measurements are not necessary (flow data would require more costly velocity data or a rating curve). Dense vegetation near the outlet may hinder upland access, but this location might be reachable by kayak or float tube, or via better access further down the outlet channel. A third pressure transducer located at the energy dissipater outlet of the diversion pipeline could help evaluate transit time in the open

[12] In addition, Task 2 will provide a sampling plan to help shed light on the forms of phosphorus associated with the glacial rock flour, which may be important for consideration in the pending Lake Whatcom TMDL.

channel inlet as well as baseflows during non diversion periods. However, that information is probably not as important as developing a better understanding of timing and duration of diversions through the lake.

2. **Continue the continuous monitoring** near the Anderson Creek mouth, and install temperature loggers at the inlet and outlet of Mirror Lake. Given natural diurnal fluctuations and potential effects of wind, weather, and runoff, plus the MF diversions, frequent temperature monitoring would be needed to characterize the daily maximum values. It would be important to understand the timing and duration of the daily maximum, especially if MF diversion operations are evaluated. Comparing water temperature between the Mirror Lake outlet and the Anderson Creek mouth would characterize net cooling or potential heating as flows pass through the stream channel.
3. **Evaluate operating rule alternatives** to assess the potential to reduce the temperature and turbidity impacts. Examples include alternatives such as flow rate ramping and altered timing periods to minimize the turbid influx from the MF while satisfying water supply needs for Lake Whatcom. Perhaps the COB's HFAM model could be used for this purpose.

The WERF guidance recommends investing time and resources at the beginning of a UAA process so that it is more efficient and effective in the long run. If the COB decides to proceed with a UAA, these investments should be made on reaching agreement on who should lead and be involved with the UAA; agreeing on a strategy to address potential issues for the related stakeholders and agencies, and defining the decision pathway and data needs (WERF 2005). If the COB wishes to pursue a UAA, beginning the stakeholder process early would be important.

8. LIMITATIONS

Document Limitations

This document was prepared solely for the City of Bellingham in accordance with professional standards and regulatory guidance and related procedures at the time the services were performed and in accordance with the contract between City of Bellingham and Brown and Caldwell. This document is governed by the specific scope of work authorized by City of Bellingham; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Bellingham and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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APPENDIX A: ADDITIONAL BACKGROUND INFORMATION

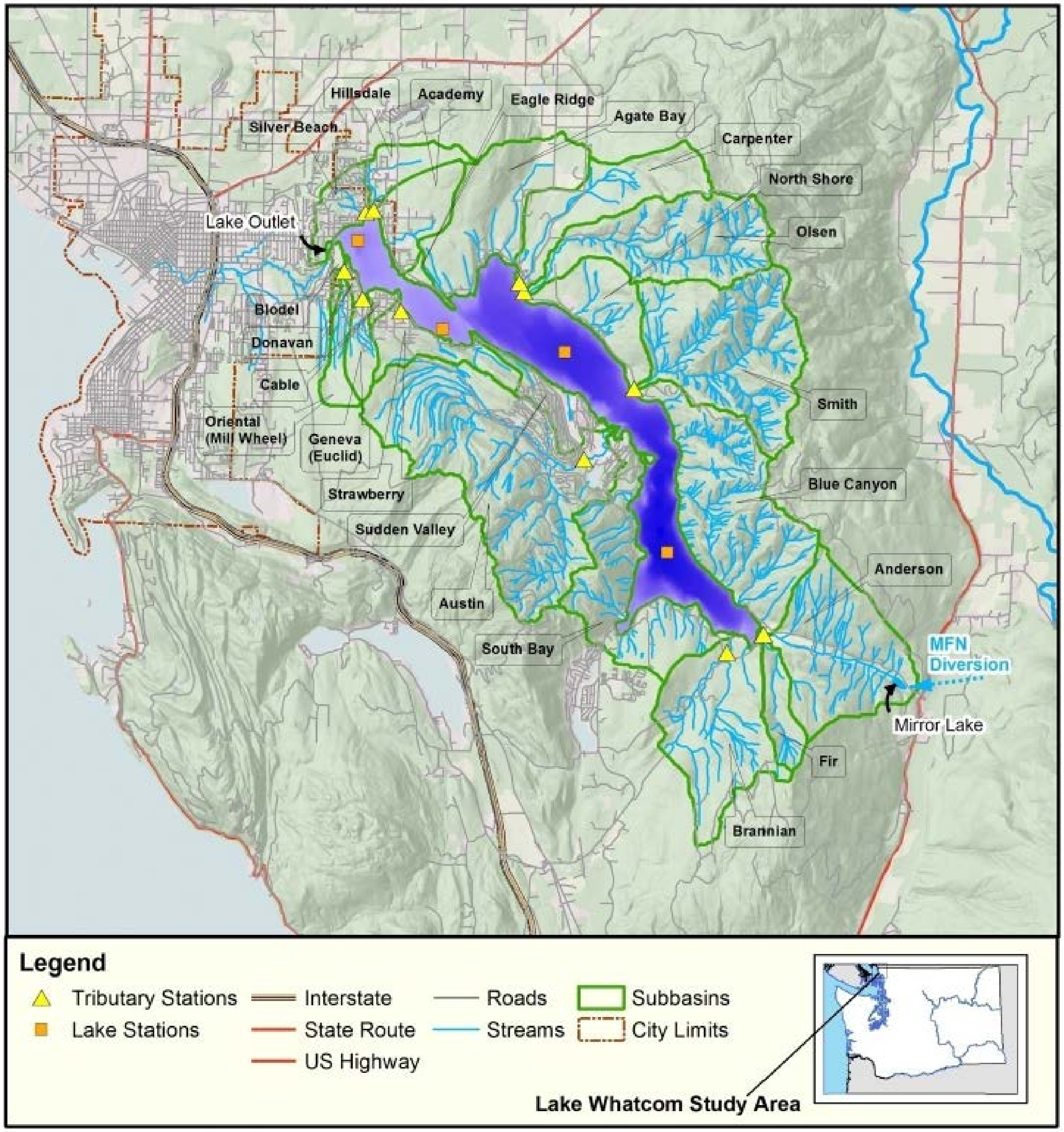

Figure ES-1. Lake Whatcom TMDL study area showing tributary watersheds and monitoring locations.

The figure above and table excerpts below are from the Ecology 2008 TMDL Water Quality Study Findings Report.

Table 7. Total Acres per Subbasin by Land Use Category – Base Scenario.

HSPF Subbasin Name	HSPF Land Use Category								Total Acres of Subbasin
	Agriculture	Deciduous Forest	Developed	Evergreen Forest	Mixed Forest	Open	Water/ Wetlands	Developed–Impervious	
Mirror Lake	-	54	-	8	33	25	13	-	134
Anderson Creek	77	591	6	1,015	756	126	6	2	2,579

Table 8. Percentages per Subbasin by Land Use Category – Base Scenario.

HSPF Subbasin Name	HSPF Land Use Category								Subbasin % of Study Area
	Agriculture	Deciduous Forest	Developed	Evergreen Forest	Mixed Forest	Open	Water/ Wetlands	Developed–Impervious	
Mirror Lake	-	**40.7%**	-	5.8%	**24.8%**	**18.9%**	9.9%	-	0.4%
Anderson Creek	3.0%	**22.9%**	0.2%	**39.3%**	**29.3%**	4.9%	0.2%	0.1%	8.3%

Table 9. Total Acres per Subbasin by Land Use Category – Full Buildout Scenario.

HSPF Subbasin Name	HSPF Land Use Category								Total Acres of Subbasin
	Agriculture	Deciduous Forest	Developed	Evergreen Forest	Mixed Forest	Open	Water/ Wetlands	Developed–Impervious	
Mirror Lake	15	41	13	2	21	25	13	3	133
Anderson Creek	283	415	90	986	643	132	5	24	2,579

Table 10. Percentages per Subbasin by Land Use Category – Full Buildout Scenario.

HSPF Subbasin Name	HSPF Land Use Category								Subbasin % of Study Area
	Agriculture	Deciduous Forest	Developed	Evergreen Forest	Mixed Forest	Open	Water/ Wetlands	Developed–Impervious	
Mirror Lake	**11.3%**	**30.9%**	**9.7%**	1.5%	**15.8%**	**18.9%**	9.4%	2.6%	0.4%
Anderson Creek	**11.0%**	**16.1%**	3.5%	**38.2%**	**24.9%**	5.1%	0.2%	0.9%	8.3%

Mirror Lake is located at the head of a narrow valley bounded by steep forested hillsides. The valley bottom is gently sloping, forested land with occasional pastures, meadows and wetlands. The parcel surrounding Mirror Lake allows for timber production for commercial purposes, and is mostly privately owned.

An abandoned railroad generally parallels Anderson creek a few hundred feet to the south. There are 20 land owners along the creek (Burns 1991). Most of the land owners are private though some small properties are owned by Washington Department of Natural Resources, Washington State Forest Board, and Whatcom County Park Board. The public properties are apparently not developed to provide access to the stream.

Tracy (2001) characterized Mirror Lake bathymetry using sonar, and estimated a lake volume of 321,900 m^3 (~11,400,000 ft^3) at an elevation of 111.59 m, which was the water surface elevation during diversion operations. Tracy estimated that Mirror Lake had a surface area of approximately 12.7 acres.

The following table summarizes HRT (volume divided by inflow rate) for the various inflow conditions.

HRT estimates based on Tracy (2001) Lake volume estimate

Mirror Lake volume, cubic m 321,900

Mirror Lake volume, cubic ft 11,374,558

condition	inflow rate, cfs	HRT, hrs	HRT, days
max practical diversion	90	35	1.46
average daily diversion	77	41	1.71
diversion during hydro power ops	67	47	1.96
15-day mean HRT	8.8	360	15

There have been two studies conducted with a goal of characterizing sedimentation in Mirror Lake with respect to the MF diversions. These are the 1984 water quality sampling (MF Monitoring Program, 1984) and the 2001 lake sediment coring by Tracy. The 1984 study entitled "Middle Fork of the Nooksack Diversion Monitoring Program: Program Review-1984"did not identify authorship and had "LW 6.003 Whatcom County Stormwater Library" stamped on the front page, and was supplied by Whatcom County as part of the Lake Whatcom Tributary Monitoring Project (MF Monitoring Program, 1984). The 1984 study had three monitoring sites which were at the diversion outfall to the inlet channel to Mirror Lake, on Anderson Creek at the outlet of Mirror Lake, and on Anderson Creek at the South Bay Drive Bridge.

Tracy (2001) collected core samples in Mirror Lake to characterize the sedimentation rates attributable to the diversion. The findings are summarized below and BC comments are included in italics:

- Mirror Lake has always trapped some sediment but the type and amount of sediment deposition increased after the diversion began.
- Most of the sediment deposited from the diversions was relatively fine, apparently because the Nooksack River water is first "filtered" (*apparently screened*) to remove coarse material (*larger than fine sand*).
- Sedimentation in Mirror Lake has been more rapid than in many lakes that have been cored for studies of glacial history.
- The sedimentation rate in Mirror Lake was 1.3 in./yr near the middle of the lake between 1962 and 2000.
- The average sedimentation over the diversion period (1962–2000) was about 56,500 ft^3 per year.
    - *This volume seems large and would amount to approximately 200 dump trucks.*
- The pre-diversion period was characterized by a silt and clay bed, a laminated strata, and deposits of gyttja, which is composed mostly of fine plant detritus, clay, and silt.
- The majority of post-diversion sediment in each core was medium and coarse silt.

The Middle Fork of the Nooksack Diversion Monitoring Program (MF Monitoring Program, 1984) had the following findings:

- The temperature averaged 9.2°C.
- The early season total and suspended solids averaged 24.7 mg/L and 11.8 mg/L, respectively.
- The highest concentrations on June 29, 1984 rose to 180.7 mg/L and 132 mg/L for total and suspended solids, respectively.
- Daily TSS loading for the diversion season averaged 48,683 pounds at the diversion outfall (inlet to Mirror Lake), with approximately half of this sediment deposited in Mirror Lake, and an estimated 25,724 pounds per day transported into Anderson Creek. At the South Bay Road crossing near the outlet to Lake Whatcom, Anderson Creek was estimated to have 34,644 pounds per day for the diversion season.
    - *This nearly 50 percent increase was not discussed, although it could be due in part to scour in the creek channel related to diversion flows.*

The temperatures in this study were much lower than the 7-DADMax criteria of 16°C and 17.5°C for core summer salmonid habitat and salmonid spawning, rearing, and migration, respectively.

Tracy characterized Mirror Lake bathymetry using sonar, and estimated a lake volume of 321,900 m^3 (11,400,000 ft^3) at an elevation of 111.59 m, which was the water surface elevation during diversion operations (Figure A1). Given the COB's practical maximum diversion rate of approximately 90 cfs the hydraulic retention time (HRT) of Mirror Lake would be approximately 35 hours (lake volume divided by maximum diversion inflow rate). At an average depth of 6 m (~20 ft), this HRT would be expected to provide sufficient time for settling fine sediments. Indeed, Tracey's core data provides evidence of the lakes ability to trap fine sediments in the silt and even clay fractions. Given turbid MF diversion flows attributable to glacial rock flour, some fraction of the finest suspended material would not be settled in the lake, and would most likely pass through Anderson Creek with no significant settling before entering Lake Whatcom. This potential for settling and transport could be verified by calculations.

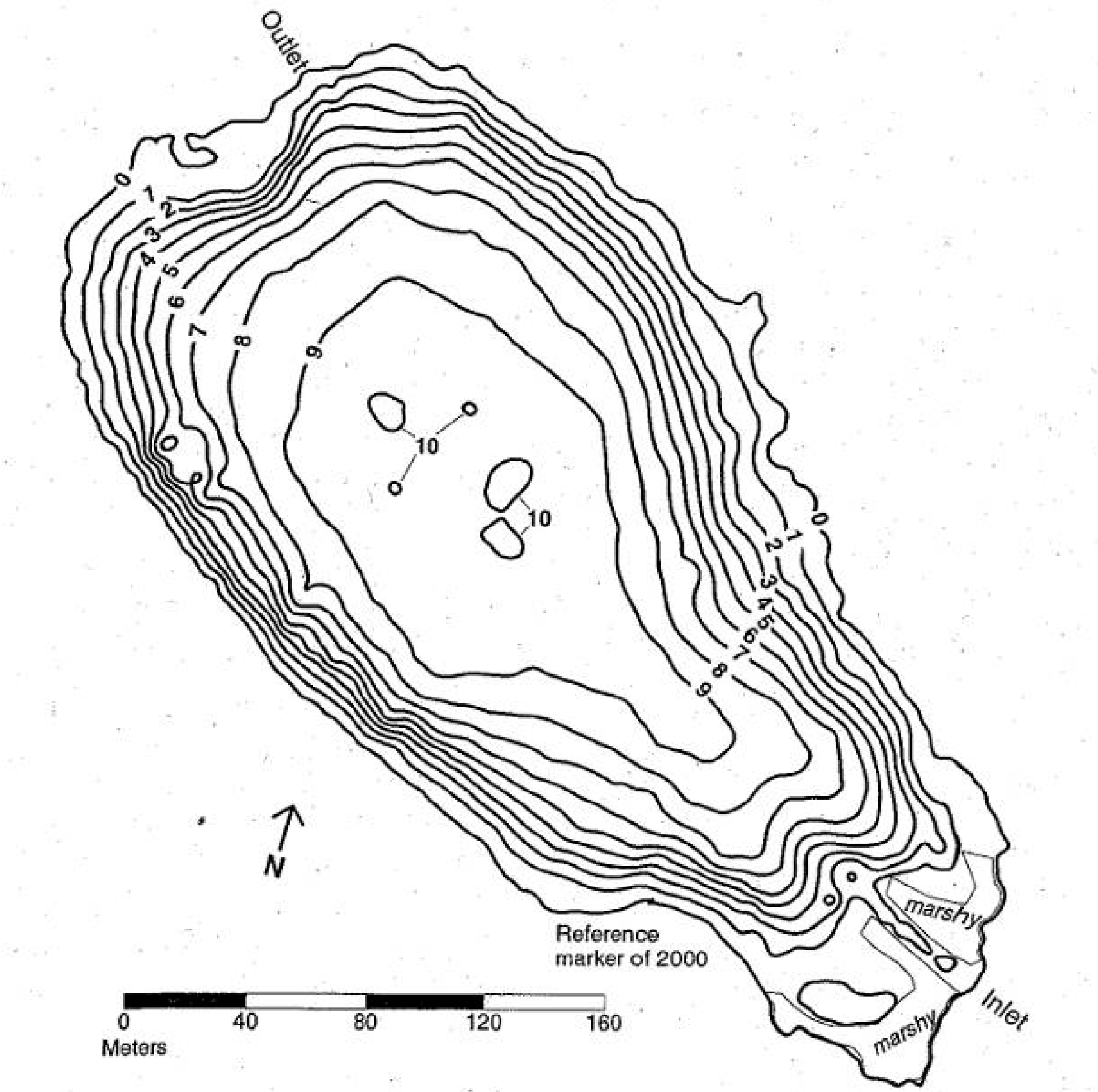

Figure A1. Bathymetry map from Tracy (2001)

APPENDIX B: DIVERSION FLOWS

The HSC document was commissioned by the COB to conduct an analysis of the COB's withdrawal from the MF on the downstream streamflow in the main stem of the Nooksack River. Figure B1 shows that the annual volumes since 1999 have been consistently lower than the 1986 thru 1998 annual volumes. According to the HSC report, "pre-hydro" and post-hydro" in these figures refers to conditions before/after the hydroelectric facility went online, apparently in 1986. It is not clear why data from 1971–1984 were not included in these HSC report figures. Figure B2 shows the mean monthly diversions for the three study periods. The "pre-hydro" flows tended to be higher than the "post-hydro" and "recent" periods in the drier summer months and lower or similar in the wetter fall and winter months.

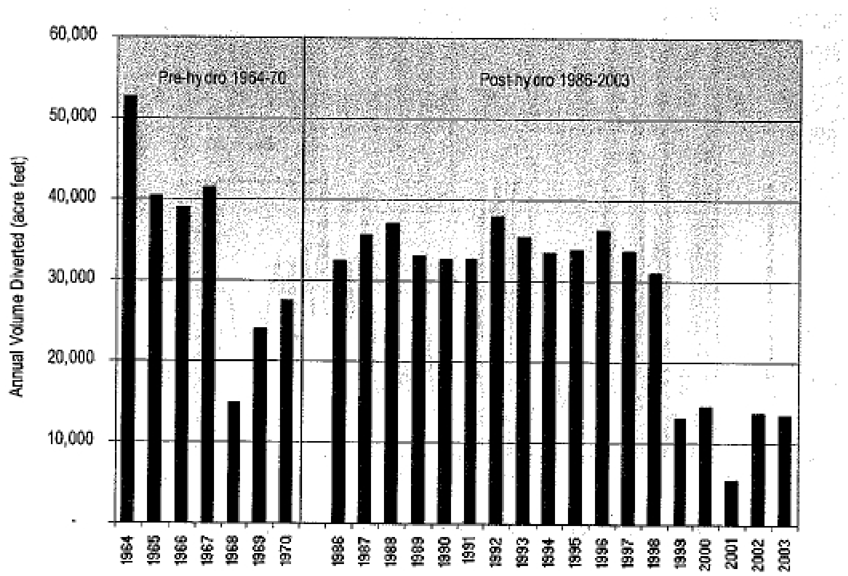

Figure B1. Annual diversions from the Middle Fork

(source: Figure 2 HSC 2005)

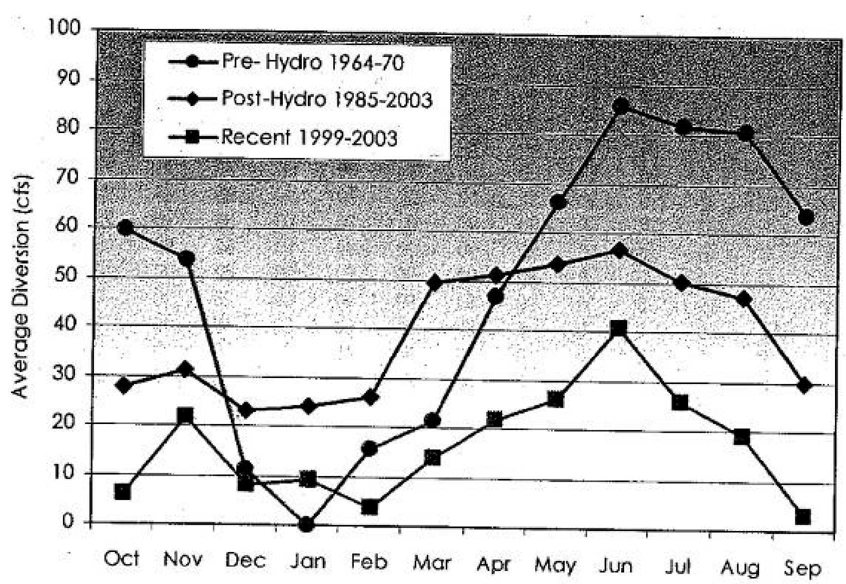

Figure B2. Mean monthly diversion for three time periods

(source: Figure 5 HSC 2005)

APPENDIX C: MIRROR LAKE AND ANDERSON CREEK WATER QUALITY DATA

Mirror Lake Water Quality Data

The Institute for Watershed Studies (IWS) at Western Washington University (WWU) has collected limited water quality data for Mirror Lake during 2006–2008. Applicable data from this study are provided in Table C1. These limited temperature data are not suited for an evaluation of temperature criteria. The turbidity data have no known contemporaneous background data from which to evaluate the excursion-based criteria. Also, it was not clear if the WWU data were surficial or at a particular depth, so potential stratification effects were not clear.

Table C1. Mirror Lake Data [a]

Date	Water temperature (°C)	Turbidity (NTU)
8/30/2006	19.5	0.8
4/19/2007	8.4	2.4
8/23/2007	18.5	24
4/17/2008	5.7	2.4
8/13/2008	15.8	10.7

[a] *Institute for Watershed Studies* http://www.ac.wwu.edu/~iws/

Anderson Creek Water Quality Data

Anderson Creek has several water quality data sets as summarized below. BC collected a recent data set for Whatcom County between June 2007 and November 2009 for the Lake Whatcom Tributary Monitoring Project (BC 2009a, 2009b). These data included numerous grab samples for phosphorus, TSS and turbidity collected during stormflows and bimonthly routine visits (e.g., baseflow), as well as continuous water quality data collected using a YSI datasonde (temperature, turbidity, specific conductance). The COB took over the continuous monitoring in November 2009.

Table C2. Anderson Creek Projects Managed by City of Bellingham Laboratory Staff[a]

Project name	Start date	End date	Study objective	Data output
Lake Whatcom TMDL	1/23/2002	6/19/2002	Support Lake Whatcom TMDL effort	Table displaying results of monthly (or more) grab sampling; COB: temperature, DO, conductivity, pH, turbidity, fecal, TSS, TvSS and alkalinity, IWS: TP, TN, NO3, SRP
Lake Whatcom Tributary Monitoring	1/16/2002	11/4/2003	Support Lake Whatcom TMDL effort	Continuous water temperature data; available in DOE EIM (or from COB). One monitoring site at Anderson Creek mouth
Water Temperature Monitoring in the Mirror Lake and Anderson Creek Watershed	mid May 2005	10/10/2005	1. Determine the maximum temperature increase and duration in Anderson Creek due to diversion outfall valve operation. 2. Assess current diversion outfall valve operation practices to determine if changes can be made to minimize the impact of water diversion through Mirror Lake on water temperatures in Anderson Creek.	Continuous water temperature data. Three monitoring sites, Anderson Creek mouth included. Report describing Washington state surface water temperature criteria, affect of outfall operation and rain on creek discharge, and water temperature data analysis. Report also contains a limited literature review table

Table C2. Anderson Creek Projects Managed by City of Bellingham Laboratory Staff[a]

Project name	Start date	End date	Study objective	Data output
Phosphorus Monitoring Program on Nooksack River Middle Fork and Anderson Creek	10/17/2006	5/1/2007	Characterize solids and the associated phosphorus loads from the Middle Fork, Mirror Lake and Anderson Creek.	Field notes and tables displaying results of rain event based grab samples. Six monitoring sites, Anderson Creek mouth included. Results include water temperature, DO, pH, conductivity, TSS, TvSS, TS, turbidity, discharge, TP, SRP, cumulative rain, and diversion operation. Solids loading is calculated from some of this data.
Lake Whatcom Tributary Continuous Monitoring	6/7/2007 COB took over this project in October 2008 and currently maintains the monitoring effort and data.	present	Continuously record turbidity and other parameters to provide baseline characterization of water quality in select tributaries to Lake Whatcom.	Currently five monitoring sites are maintained, Anderson Creek mouth included. Continuous data includes turbidity, water temperature, and conductivity. Grab samples include TP. Note, water level data from the YSI 600OMS sonde is measured with a non-vented pressure sensor and thus is sensitive to changes in barometric pressure. Data from a USGS real-time discharge monitoring station located at the Anderson Creek mouth will be used.

[a] Supplied by COB.

The Whatcom County Health and Human Services department sampled Anderson Creek as part of a septic system study (WC HHS, 2002). The samples were analyzed for DO, bacteria, orthophosphate, chloride, total organic carbon (TOC), TSS, BOD, ammonia, boron, and surfactants. Four sites in Anderson Creek were sampled on eight dates between September 25 and November 28, 2001. At all four locations the non-bacteria analytes were either non-detected or detected at very low levels. The fecal coliform (and enterococcus) results were below the Class A standard (200 cfu/100 ml) at the two upstream sites. The two downstream sites exceeded the bacteria standard in 12 percent and 38 percent of the samples.

This study found a maximum water temperature of 17.9°C on one sampling date at one location. However, no continuous data were collected and so the 7-DADMax cannot be calculated. Water temperatures decreased downstream, with the coolest temperatures recorded nearest the Anderson Creek mouth. The upstream most location was warmest, apparently because it was closest to Mirror Lake, where the open water surface creates a net heat gain. As the water flows downstream it was apparently cooled by several factors such as evapotranspiration, riparian shade, hyporheic interchange, and various tributaries. The temperature gradient was less on rainy days when the diversion was open (the cooler MF water or the surface runoff appears to have reduced the temperature at all of the sites).

The 1984 study (MF Monitoring Program, 1984) monitored at three locations as described in the previous section. The temperatures averaged 11, and 10.7°C, respectively. So during these late spring through summer months, the water tended to be coolest entering the lake and warmest leaving the lake. Approximately half of the sediment from the diversion (1,520,003 lbs of a total 3,732,286 lbs) was deposited in Mirror Lake from the diversion system over the diversion period.

APPENDIX D: FISH USE DATA FOR ANDERSON CREEK AND MIRROR LAKE

Several fish and habitat surveys have been performed for Anderson Creek and Mirror Lake as summarized below.

1**. Washington State Department of Natural Resources (WADNR), 1997**. The fish habitat assessment reviews performed by the WADNR reviewed the historical and existing conditions of the fish resources in Lake Whatcom, habitat requirements, results of habitat surveys, and habitat vulnerability. Most of the available habitat is already used throughout the Whatcom watershed, however Mirror Lake and Anderson Creek do have good potential for cutthroat trout rearing and spawning. Mirror Lake and Anderson Creek habitat has been impacted by sediment inputs from the water diversion (WADNR, 1997). Anderson Creek is one of the major kokanee spawning streams in the Whatcom watershed. Formerly, more of Anderson Creek may have been used for kokanee spawning but obstacles (including riprap) may be acting as barrier to the upper parts of the creek. Since there is potential for passage the barrier is described as difficult passage, however no kokanee were observed in fish surveys (summarized in Table D1) above mile 0.6 (kilometer 1). Prior to the 1997 report, information on natural production was scarce and included a few periodic spawner surveys in the mid-1970s and anecdotal information.

Table D1. Summary of Kokanee Spawning in Anderson Creek[a]

Date	Fish	Source	Comments
12/1/1974	5,000	Kraemer, 1994	Qualitative observation
11/7/1975	12	Kraemer, 1994	
11/18/1975	0	Kraemer, 1994	
11/28/1975	22	Unpublished data	
11/9/1995	0	WADNR	From mouth
11/21/1995	37	WADNR	Mouth to 50 m below trestle[b]

[a] *Per WADNR, 1997.*

[b] *Trestle location not specified in WADNR 1997.*

During the observations in fall 1995 lower Anderson Creek had the highest density of spawning kokanee. The kokanee spawn just below the riprap of an old railroad grade. This section has poor large woody debris (LWD) rating. The dominant substrate in Anderson Creek in segments 1 and 2 is gravel and the quality is considered fair. Specific locations of the railroad grade, trestle, and stream segments were not identified in this 1997 WADNR report. The redd scour and fines in gravel are also considered fair. Parts of Anderson Creek, Beaver Creek, and Brannian Creek have areas with the highest percentage of fine sediment compared with other Lake Whatcom tributaries.

The onset of kokanee spawning was not documented, but the Lake Whatcom kokanee generally spawn in several tributaries from late August through January, including Anderson, Austin, Olsen, and Smith Creeks. Kokanee are not dependent on Lake Whatcom for physical summer rearing habitat but are affected by water quality from the tributaries. Lake Whatcom cutthroat generally spawn from December to mid-June. During the 1994 spawning survey no spawning cutthroat were observed in Anderson Creek where spawning is known to occur.

2. **Washington Department of Fish and Wildlife (WDFW) 2002 and 2006**. The WDFW performed cutthroat trout spawner and juvenile fish surveys to tributaries to Lake Whatcom in 2002 and 2006, which ncluded Anderson Creek. The WDFW data are summarized in Tables D2 and D3, but according to WDFW it is unofficial and not yet published (personal communication with Mark Downen). Also, the WDFW has a salmonid stock inventory (SaSI), however SaSI does not list Anderson Creek (Web site accessed on December 17, 2009 http://wdfw.wa.gov/cgi-bin/database/sasi_search_new_db.cgi?keyword=01&field=4&search_sort=sort&srchtype=within&job=sear

ch&wria=wria). SaSi is a recovery effort at the local, state, and federal level to prevent further declines and improve the condition of already imperiled stocks of Washington's 11 species and subspecies of native salmonid fish.

Table D2. Cutthroat Trout Redds and Spawners Observed on Weekly Surveys of Four Major Tributaries to Lake Whatcom from 27 January to 1 July 2002[a].

Date	Anderson		Austin/Beaver		Olsen		Smith	
	Redds	Fish	Redds	Fish	Redds	Fish	Redds	Fish
27-Jan	7	0	2	0	3	0	0	0
4-Feb	8	0	5	0	6	0	1	0
11-Feb	2	0	0	2	11	2	1	0
18-Feb	11	0	21	0	22	0	3	0
25-Feb	21	0	26	3	19	0	7	0
4-Mar	25	0	29	1	36	0	11	0
11-Mar	16	0	31	6	33	6	8	1
18-Mar	6	3	23	0	9	0	6	0
25-Mar	11	0	24	0	47	18	3	1
1-Apr	15	1	51	1	31	5	21	2
8-Apr	5	1	29	3	12	0	3	0
15-Apr	1	0	13	0	23	7	17	3
22-Apr	4	1	13	10	23	1	5	0
29-Apr	2	0	17	0	18	0	21	7
6-May	5	2	9	2	16	3	12	0
13-May	1	0	16	0	26	4	7	3
20-May	2	0	7	0	10	1	30	0
26-May	0	0	5	0	11	0	12	2
3-Jun	0	0	3	0	7	4	11	3
15-Jun	0	0	6	1	10	5	7	1
21-Jun	0	0	1	0	3	2	5	0
1-Jul	0	0	0	0	0	0	0	0
Total	142	8	331	29	376	58	191	23
Total redds observed								1040
Total fish observed								118

[a] *Data obtained from WDFW, personal communication with Mark Downen.*

Table D3. Cutthroat Trout Redds Observed on Weekly Surveys of Four Major Tributaries to Lake Whatcom from 6 February to 25 June 2006[a]

Date	Anderson	Austin/Beaver	Olsen	Smith
6-Feb	5	1	2	0
13-Feb	17	12	12	3
20-Feb	13	18	7	0
27-Feb	7	10	2	3
6-Mar	10	9	6	4
13-Mar	18	10	21	7

Table D3. Cutthroat Trout Redds Observed on Weekly Surveys of Four Major Tributaries to Lake Whatcom from 6 February to 25 June 2006[a]				
Date	Anderson	Austin/Beaver	Olsen	Smith
20-Mar	19	33	12	5
27-Mar	31	21	29	10
3-Apr	20	24	23	11
10-Apr	26	21	30	13
17-Apr	11	6	13	7
24-Apr	5	11	15	33
1-May	2	9	38	24
8-May	5	19	12	28
15-May	2	5	9	18
23-May	3	14	2	3
29-May	2	4	3	12
4-Jun	0	2	1	7
11-Jun	0	2	5	9
18-Jun	0	0	2	7
25-Jun	0	0	0	0
Stream totals	196	231	244	204
Percent change	↑ 6.52%	↓ 2.03%	↓ 1.53%	↑ 4.6%
2006 Total				875
Total % change				↓ 8.51%

[a] *Data obtained from WDFW, personal communication with Mark Downen.*

During the 2002 WDFW survey, only eight cutthroat were found in Anderson Creek. There was an increase of 6.52 percent in the number of redds between the 2002 and 2006 surveys.

3. **Mirror Lake and Anderson Creek beach seining 2001–2003**. As part of the COB's Habitat Conservation Plan voluntarily prepared under Section 10 of the Federal Endangered Species Act, Mirror Lake and Anderson Creek had several beach seine samples collected periodically in 2001–2003 (Anchor, 2005). A beach seine net was used for sampling both water bodies, with samples collected in 2001 (September and November), 2002 (March, April, June, July, September, and December). In 2003, Mirror Lake was sampled only in January, and Anderson Creek was sampled only in March, April and May. Mirror Lake was samples near the "boat ramp" and diversion channel delta near the lake inlet. Anderson Creek was sampled approximately 1,000 feet upstream from Lake Whatcom (approximately 500 feet upstream of the USGS gage and continuous monitoring location under the Lake Whatcom Blvd. bridge). The following excerpts from the report summarize findings (the report also contains findings for fork length and habitat type where the fish were caught):

> "This sampling effort documented the presence of juveniles of the following two salmonid species and three non-salmonid species:
>
> - Rainbow trout
> - Cutthroat trout
> - Western brook lamprey (*L.richardsoni*)
> - Threespine stickleback
> - Sculpin
> - Kokanee (adults; *O. nerka*)
>
> Flow conditions and the presence of spawning adults or incubating eggs prevented sampling in Anderson Creek, including the presence of high numbers of spawning kokanee. Cutthroat trout were found in Anderson Creek during the sampling events in April and May of 2003, while rainbow trout were found during September sampling events in 2001 and 2002. Mirror Lake sampling did not include the capture of any salmonids."

APPENDIX E: ECOLOGY'S ASSESSMENT PROTOCOLS FOR TEMPERATURE AND TURBIDITY

The following excerpts are provided from Ecology's Water Quality Program Policy for the Assessment of Water Quality for the Clean Water Act Sections 303(d) and 305(b) Integrated Report (Ecology 2006b).

Temperature

Designated uses: Aquatic life
Numeric criteria: WAC 173-201A-030
Narrative criterion: WAC 173-201A-070 (1)
Unit of measure: Degrees Celsius (C) or Degrees Fahrenheit (F) Continuous: 7-Day Average of the Daily Maximum (7DADMax)

Assessment Information and Specific Data Requirements

The WQS for temperature set upper criteria limits due to human actions, and are designed to protect the most sensitive aquatic life uses (salmon spawning and rearing). The standards also allow a measurable increase (0.3°C) in water temperature above natural conditions due to human actions.

To make a listing decision for temperature, Ecology will first assess numeric temperature monitoring data to determine if there are exceedances. The warmest water temperatures of the year and criteria exceedances (values greater than the criteria) generally occur during a critical season which is the summer and early fall (June through September).

When continuous monitoring data (sampling intervals of 30 minutes or less) are available, Ecology will assess the 7-day average of daily maximum temperature measurements.

Category 1 Determination
Continuous monitoring for temperature during the critical season is required to place a water body segment in Category 1. Recent sequential data from at least 2 years must demonstrate consistent compliance with the criteria or established natural conditions.

Category 2 Determination
A water body segment will be placed in Category 2 when the data do not meet the requirements for a Category 5 determination but show at least one exceedance of the water quality criteria. A minimum number of samples is not required for a Category 2 determination.

Category 3 Determination
A water body segment will be placed in Category 3 when the available data are insufficient for any other category determination. This information will be maintained in Ecology's assessment database for future use. As additional data and information become available, Ecology will again assess all available data to make a new category determination according to this policy.

Category 4 Determination
A segment will be placed in Category 4a when EPA has approved a TMDL for temperature. A segment will be placed in Category 4b when EPA approves use of a pollution control project for temperature. Category 4c does not apply to pollutant parameters.

Category 5 Determination

Category 5 determinations are dependent on whether the sampling is single grab or multiple sampling events. Temperature exceedances at flow rates greater than the 7Q10 low-flow rate within the latest 10 years may be used to place a segment in Category 5 unless other information indicates that the exceedances are primarily natural or a significant amount of compliant data exists for the segment during the critical summer period. Flow rate and 7Q10 low-flow rate need not be reported, but if available the flow rate at time of sampling and the calculated 7Q10 low-flow rate will factor into the Category 5 determination.

A water body will be placed in Category 5 using single sample data when, (1) a minimum of three excursions exist from all data considered, and (2) at least 10 percent of single grab sample values in a given year do not meet the criterion.

Ecology will review the last 5 years in which data exist for the water body segment. Ecology will review up to 10 years of data until data from 5 years are represented. If fewer than 5 years of data are available, the assessment will be performed with the data available.

A segment will be placed in Category 5 for temperature if at least one 7-day average daily maximum value from multiple sampling events exceeds the criterion.

Ecology lists waters on the Category 5 list for temperature impairment when the numeric criteria are exceeded. In most cases, insufficient information exists to determine the level of human influence on temperature for each listed site. This approach assumes that human influences have contributed to the exceedance over the numeric criteria and the increase is measurable over natural conditions. While this approach may list waters as impaired for temperature without fully knowing the extent of the human influences, listings are based on existing and readily available information. In the absence of information, the water body will remain in Category 5 until further information or data are provided to fully determine the status of the water body.

After the data are assessed to determine water body segments that are exceeding temperature criteria, Ecology will take an additional step to determine if the water is impaired due to human influences. Any information provided through the public call for data that provide validation that human influences or natural conditions are contributing to the exceedances will be evaluated. In addition, Ecology will review land-use maps and work with appropriate regional field staff to make an initial determination that human actions could be influencing the temperature exceedances. If the determination is made that potential human influences exist that could impact temperature, the water body segment will be placed in Category 5. TMDL or other pollution control studies will determine the extent of human influences.

Turbidity

Designated uses: Recreational, Aquatic Life
Numeric criteria: WAC 173-201A
Narrative criteria: WAC 173-201A-070 (1)
Unit of measure: Nephelometric Turbidity Units (NTUs)

Assessment Information and Specific Data Requirements

Turbidity criteria are expressed as the difference between an upstream or background value and the increased value derived at a location downstream of a source of turbidity. The background value for turbidity is gathered at a location upgradient from the activity that is being investigated. Depending on the use-class, the acceptable difference is either 5 or 10 NTUs over background when the background is 50 NTUs or less. When background is greater than 50 NTUs, the acceptable maximum increase is either 10 or 20 percent. If more than one sample value is available for the same location and day, the average sample value will be used in the assessment. The upstream and downstream values are averaged independently.

Category 1 Determination
A minimum of 10 sample sets collected during separate storm runoff events is necessary for a Category 1 determination. If no more than 5 percent of all available data exceeds the criterion, the water body segment will be placed in Category 1.

Category 2 Determination
A water body segment will be placed in Category 2 if the threshold for placement in Category 5 is not achieved but there are events demonstrating exceedance in the latest 10 years. A minimum number of samples is not required for a Category 2 determination.

Category 3 Determination
A water body segment will be placed in Category 3 when the available data are insufficient for any other category determination. This information will be maintained in Ecology's assessment database for future use. As additional data and information become available, Ecology will again assess all available data to make a new category determination according to this policy.

Category 4 Determination
A segment will be placed in Category 4a when EPA has approved a TMDL for turbidity. A segment will be placed in Category 4b when EPA approves use of a pollution control project for turbidity. Category 4c does not apply to pollutant parameters.

Category 5 Determination
A water body segment will be placed in Category 5 if 10 percent or more sample values in the latest 10 years exceed the applicable criterion. A minimum of three exceedances is required for an impairment determination.