Coquitlam-Buntzen Water Use Plan

Monitoring Programs and Physical Works
Annual Report: 2010

- Assessment of Fisheries Access to Streams Tributary to Coquitlam River
- Coquitlam Dam Flow Release Interim Ramping Rate Monitoring
- Lower Coquitlam River Fish Habitat Requirements Study
- Assessment of Pink Salmon Passage in Lower Coquitlam River
- Coquitlam River Periphyton and Benthic Invertebrate Monitoring
- Lower Coquitlam River Temperature Monitoring
- Lower Coquitlam River Fish Productivity Index
- Lower Coquitlam River Substrate Quality Assessment
- Modification of Coquitlam Dam Release Facilities (Flow Release Valve)

For Water Licences 119709, 119710 and 119711

29 April 2010
BC Hydro Coquitlam-Buntzen Water Use Plan
Monitoring Programs and Physical Works Annual Report: 2010

1.0 Introduction

This document represents a summary of the Coquitlam-Buntzen Water Use Plan (WUP) monitoring programs and physical works to April 2010, as per the Coquitlam-Buntzen Order under the Water Act, dated 21 April 2005 and the amendment dated 8 March 2006.

A two year delay in implementation of the Coquitlam Dam flow release valve physical work requirement and associated modified instream flow regime due to ongoing dam safety upgrades resulted in delays of several monitoring programs, however, allowed two more years of evaluation of fish productivity associated with the base flow regime. Based on completion of the flow release valve modification and initiation of the modified flow regime on 22 October 2008 the second phase of effectiveness monitoring has been initiated.

Given a WUP commitment to complete fish productivity monitoring of the modified instream flow regime for a 9-year period the overall monitoring program duration required extension through 2017. This monitoring program extension and associated monitoring program budget increases was approved by the Comptroller of Water Rights (CWR) in March 2009.

During the summer of 2009 the modified flow releases provided by the new flow release valve were confirmed to be on average 2 cms higher than the target release since initiation in October 2008. It was confirmed by BC Hydro engineers that the flow rating curve for the new gate was not accurate leading to flow releases during the period being approximately 2 cms above the 1.1 to 2.2 cms target flows. Based on field calibration the rating curve was revised with refinement of flows to within the target levels in mid October 2009. Given the 9 year duration of the modified flow regime productivity monitoring, the long term data sets are unlikely to be significantly impacted with the results of the 2008 – 2009 monitoring period confounded by the higher than target flows.

2.0 Background

The water use planning process for BC Hydro’s Coquitlam-Buntzen storage/hydroelectric project was initiated in September 2000 and completed in March 2003. The conditions proposed in the WUP for the operation of the project reflect the March 2003 recommendations of the WUP Consultative Committee (CC).

In May 2004, the Coquitlam-Buntzen WUP was submitted to the CWR.

On 21 April 2005, BC Hydro was ordered to implement the conditions proposed in the Coquitlam-Buntzen WUP and prepare monitoring programs and physical works terms of reference (TOR).
On 24 October 2005 the Coquitlam-Buntzen WUP monitoring programs and physical works TOR were submitted to the CWR for review and approval.

On 2 December 2005, the CWR accepted the TOR for the physical works, Coquitlam Flow Release Valve with expected release valve installation by 1 September 2006 and initiation of the modified instream flow regime on 1 January 2007.

On 3 January 2006, the CWR accepted the TOR for all monitoring programs except the Lower Coquitlam River Habitat Suitability Criteria Development and Lower Coquitlam River Fish Productivity Indices programs. Revisions were made to the two TOR and submitted on 8 February 2006, and on 8 March 2006 the CWR accepted the Lower Coquitlam River Fish Productivity Indices monitoring program and rescinded the Lower Coquitlam River Habitat Suitability Criteria Development monitoring program from the Order.

On 10 January 2007, the Coquitlam-Buntzen TOR package was revised to account for:

- The proposed delay in the installation of the Coquitlam Dam Release Facility to 1 August 2007 and the associated change of date of the instream flow release to 1 September 2007;

- The proposed extension of study programs resulting from the extension of the Water Use Plan review period through 2016;

- Changes to the Lower Coquitlam River Habitat Requirements Study (formerly submitted as the Lower Coquitlam River Habitat Suitability Criteria Development)

The revised TOR was accepted by the CWR on 1 February 2007.

On 10 October 2007, a request for a further delay in the installation of the Coquitlam Dam Release Facility to 1 August 2008 and the associated change of date of the instream flow release to 1 September 2008 was submitted.

The delay was approved by the CWR on 29 October 2008.

On 2 January 2008, the Coquitlam-Buntzen TOR package was revised to account for:

- Program extension and associated budget increase for the Lower Coquitlam River Temperature Monitoring

- Methodology changes and associated budget increase for Lower Coquitlam River Substrate Quality Assessment

The revised TOR was accepted by the CWR on 16 April 2008.

On 2 July 2008, a request for a proposed budget increase and delay to 31 October 2008 for the installation of the Coquitlam Dam Release Facility as well
as associated change of date of the instream flow release to 31 October 2008 was submitted.

The revised TOR was accepted by the CWR on 1 October 2008.

On 9 February 2009, the Coquitlam-Buntzen TOR package was revised to account for:

- The proposed budget and schedule changes of study programs resulting from delay in initiation of modified flow regime and associated extension of the Water Use Plan review period through 2017;

- Proposed 1 year schedule adjustment of the Assessment of Pink Passage in Lower Coquitlam River

- Proposed budget increases for Lower Coquitlam River Temperature Monitoring, Coquitlam River Benthic Invertebrate Monitoring, and Lower Coquitlam River Fish Productivity Index

The revised TOR was accepted by the CWR on 23 March 2009.

The Order will be implemented until 2018, when BC Hydro will assess the results of the monitoring programs. As detailed in the Coquitlam-Buntzen WUP CC Report (2003), a review could be triggered sooner where warranted.

### 3.0 Status

The following table outlines the status and schedule for the Coquitlam-Buntzen WUP monitoring programs and physical works.
### Table 4.1-1: Status of Coquitlam-Buntzen WUP Monitoring Programs and Physical Works Implementation.

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<tbody>
<tr>
<td>Assessment of Fisheries Access to Streams Tributary to Coquitlam Reservoir</td>
<td>✓ ✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>U/W</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Lower Coquitlam River Fish Habitat Requirements Study</td>
<td>DEL¹  DEL¹ DEL¹ ✓ U/W</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
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<tr>
<td>Assessment of Pink Salmon Passage in Lower Coquitlam River</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
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<tr>
<td>Coquitlam River Periphyton and Benthic Invertebrate Monitoring</td>
<td>✓ DEL¹ DEL¹ ✓ U/W</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
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<tr>
<td>Lower Coquitlam River Fish Productivity Index</td>
<td>Smolt and Fry Outmigration Assessment</td>
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<td>Fry and Juvenile Standing Stock Assessment</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
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<tr>
<td>Fall Adult Salmon Escapement Surveys</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
<td>✓ ✓ ✓ ✓ ✓ U/W</td>
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**Legend:**
- ■ = Project to be undertaken/initiated in identified year
- U/W = Project is underway
- DEL = Project is delayed for this year
- ✓ = Project is complete for the year

**Footnotes:**
1. Program delayed due to postponement of required flow release structure modification and associated modified flow regime to 23 October 2008.
2. The installation of the release valve was delayed due to existing dam seismic upgrade repairs.
3. To fulfill committed 9 years of modified flow regime effectiveness monitoring program is expected to continue through 2017, however, based on Monitoring Committee support monitoring may terminate in 2016 based on sufficient data collection to confirm flow treatment to compare productivity benefits associated with two flow treatments.

### 4.0 Summary of Coquitlam-Buntzen WUP Monitoring Programs

This section outlines the status of the Coquitlam-Buntzen WUP monitoring programs as per the Order under the *Water Act* dated 21 April 2005 and the revisions to the monitoring program approved 1 February 2007, 16 April 2008, 1 October 2008 and 23 March 2009. The following table summarizes the monitoring programs results according to the key monitoring indicators for each program approved by the Monitoring Committee.
### Table 4.1-2: Summary of Coquitlam-Buntzen WUP Monitoring Program Results

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<tbody>
<tr>
<td>Assessment of Fisheries Access to Streams Tributary to Coquitlam Reservoir</td>
<td>Barrier Identified?</td>
<td>N/A</td>
<td>Not studied</td>
<td>Initial Study</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Study not complete</td>
<td>Yes</td>
<td>Study is complete</td>
<td>Study is complete</td>
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<tr>
<td>Coquitlam Dam Flow Release Interim Ramping Rate</td>
<td>(a) Number of Rampdowns studied</td>
<td>N/A</td>
<td>Not studied</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2 (1)</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
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<td></td>
<td>(b) Average number of stranded fish observed</td>
<td>N/A</td>
<td>Not studied</td>
<td>6</td>
<td>15</td>
<td>13</td>
<td>0 (53)</td>
<td>3</td>
<td>68</td>
<td>143</td>
<td>140</td>
<td>35</td>
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<tr>
<td>Lower Coquitlam River Fish Habitat Requirements Study</td>
<td>(a) Deviation from assumed habitat preference</td>
<td>0</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Data in 2011 report</td>
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<td>(b) Deviation from recommended flow release</td>
<td>0</td>
<td>Not studied</td>
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<td>Not studied</td>
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<td>Not studied</td>
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<td>Not studied</td>
<td>Data in 2011 report</td>
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<tr>
<td>Assessment of Pink Salmon Passage in Lower Coquitlam River</td>
<td>Number of Days of Impeded Access</td>
<td>0</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
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<tr>
<td>Coquitlam River Periphyton and Benthic Invertebrate</td>
<td>(a) Benthos Abundance (animals/m²)</td>
<td>&gt; 20,000</td>
<td>Not studied</td>
<td>Not studied</td>
<td>75,000</td>
<td>27,000</td>
<td>Not studied</td>
<td>55,000</td>
<td>Not studied</td>
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<td>Data in 2011 report</td>
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<td>(b) Index of Biologic Integrity (IBI)</td>
<td>20</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>6.6</td>
<td>13.8</td>
<td>Not studied</td>
<td>9.6</td>
<td>Not studied</td>
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<td>Data in 2011 report</td>
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<tr>
<td>Lower Coquitlam River Temperature Monitoring</td>
<td>(a) Temperature Deviation from natural (Degrees Celsius)</td>
<td>0</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>-1.09</td>
<td>2.1</td>
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<td>(b) Degree of operational influence (Degrees Celsius)</td>
<td>N/A</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>0.95</td>
<td>0.95</td>
<td>1.4</td>
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<td>Data in 2011 report</td>
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<tr>
<td>Lower Coquitlam River Fish Productivity Index</td>
<td>(a) Coho Smolt Density/100m² (production)</td>
<td>9.3 (1834)</td>
<td>5.3 (9307)</td>
<td>7.8 (13849)</td>
<td>7.4 (13163)</td>
<td>7.8 (13819)</td>
<td>7.5 (13891)</td>
<td>4.7 (8387)</td>
<td>8.4 (14790)</td>
<td>13.8 (24487)</td>
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<td>Data in 2011 report</td>
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<td>(b) Steelhead Smolt Density/100m² (production)</td>
<td>2.0 (1911)</td>
<td>2.4 (4191)</td>
<td>1.3 (2308)</td>
<td>2.2 (3885)</td>
<td>2.2 (3842)</td>
<td>2.2 (3966)</td>
<td>2.4 (4277)</td>
<td>1.5 (2668)</td>
<td>3.2 (5944)</td>
<td>3.1 (5398)</td>
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<td>(c) Chum Fry Survival</td>
<td>9%</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>6.50%</td>
<td>8.1%</td>
<td>3.7%</td>
<td>14.1%</td>
<td>6.9%</td>
<td>12.0%</td>
<td>26.8%</td>
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<td></td>
<td>(d) Pink Fry Survival</td>
<td>13%</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>9.7%</td>
<td>9.7%</td>
<td>4.9%</td>
<td>9.9%</td>
<td>N/A</td>
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<tr>
<td>Lower Coquitlam River Substrate Quality Assessment</td>
<td>Substrate Quality (areal fraction of fine sand)</td>
<td>10%</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>Not studied</td>
<td>42.0%</td>
<td>36.0%</td>
<td>24.0%</td>
<td>14.6%</td>
<td>13.2%</td>
<td>15.8%</td>
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1. Salmonid Enhancement Program biostandards for Lower Fraser River natural egg-fry survival of chum and pink salmon - March 1997
3. Estimate of coho production based on stream alkalinity (Ptolemy 1992)
6. Emergency flood control operation in January 2004 resulted in scheduled ramping rates being exceeded and stranding observed.
7. Average difference in temperature from Coquitlam Dam release facility and reservoir surface temperature (1m below surface)
8. Revised adult enumeration analyses have resulted in retrospective changes to historic egg-fry survival results. See Decker et. al., 2008 for context.

BC Hydro  Page 6
4.1 Assessment of Fisheries Access to Streams Tributary to Coquitlam Reservoir

4.1.1 Overview

The objective of this monitoring program is to identify fish use and/or fish habitat potential in each of the three streams identified with potential fish access issues and to recommend physical works and/or operational constraints to restore fish access for all operations.

Monitoring Indicator (a): Barrier to fish passage identified (yes/no)

The program is comprised of a field reconnaissance, fish sampling and habitat prescription and is to be completed over a one-year period.

4.1.2 Status

This program was initiated in July 2006 with three fish sampling and habitat surveys completed according to schedule. The final program report was completed in January 2008.

The Coquitlam Monitoring Committee supported a report recommendation for full removal of the fish migration barrier confirmed at the mouth of the main tributary (Meech Creek). Barrier removal was completed in August 2009 through a funds and labour contribution from Metro Vancouver. Minor debris removal was conducted in January 2010. This site may require periodic debris clearing, which Metro Vancouver has agreed to do.

4.1.3 Interpretation of Data

Study complete, see 2008 annual report submission for details of 2006 – 2007 study implementation.

4.2 Coquitlam Dam Flow Release Interim Ramping Rate Monitoring

4.2.1 Overview

The objective of this monitoring program is to report on the fish stranding impacts in the lower Coquitlam River associated with the implementation of the interim ramping rate protocol for the Coquitlam Dam.

Monitoring Indicator (a): Stranding risk (number of fish stranded per area of dewatered habitat measured).

This program will involve the annual assessment of fish stranding following pre-spill operations at Coquitlam Dam. Up to 5 assessments per year will be funded.

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1 Aquatec Resources. 2008. Assessment of Fisheries Access to Stream Tributary to Coquitlam Reservoir. Prepared for BC Hydro, Burnaby, BC.
4.2.2 Status

Assessment of stranding risk associated with ramping rate operations was initiated in 2003 at the conclusion of the Coquitlam-Buntzen WUP, with the objective of refining a ramping-rate schedule prior to the start of the monitoring program. A ramping rate schedule was drafted into the monitoring TOR for implementation and monitoring over the review period.

The first program report\(^2\) was submitted in August 2006, which summarized the findings of three (3) rampdown assessments conducted between June 2005 and January 2006. The second program report\(^3\) was submitted in June 2007, which summarized the findings of two (2) rampdown assessments conducted between November 2006 and May 2007. The third program report\(^4\) was submitted in June 2008, which summarized the findings of three (3) rampdown assessments conducted between April 2007 and April 2008. The fourth program report\(^5\) was submitted in June 2009, which summarized the findings of four (4) rampdown assessments conducted between May 2008 and April 2009. The fifth program report is expected in June 2010.

4.2.3 Interpretation of Data

The current ramping rate schedule was developed based on fish stranding assessments compiled over several versions of Coquitlam Dam flow release operations. The results summarized in the 2006-2009 study reports indicate the ramping rate schedule recommended in the WUP is effective at reducing stranding, although additional information regarding stranding impacts during sensitive life history period such as juvenile salmon outmigration must be investigated before instituting final recommendations for this operation. It is anticipated that all stranding information will be evaluated at the end of the Coquitlam-Buntzen WUP review period.

It should be noted that fish stranding rates have increased since 2005 due to the requirement to maintain an interim maximum Coquitlam Reservoir El.149m. The 149m restriction led to an increase in the number of spills which increased our rate of stranding (or number of fish mortalities per year). This interim restriction was lifted once the dam safety upgrades were completed in October 2008; however, further testing is being conducted on gates at the Buntzen diversion tunnel. Currently there is no restricted elevation limit at this time; therefore our expectation is that the spill frequency will lessen and the rate of stranding should be reduced accordingly.

4.3 Lower Coquitlam River Fish Habitat Requirements Study

4.3.1 Overview

The objective of this study is to identify any changes to the habitat suitability criteria used in the Coquitlam-Buntzen Water Use Plan calculations of weighted useable area of habitat, and refine the habitat-flow relationships and flow release targets developed in the WUP.

Monitoring Indicator (a): Habitat suitability for species of interest

Monitoring Indicator (b): Flow target (Coquitlam Dam releases) for LB1 WUP

This program will involve direct instream observations of fish habitat use in the lower Coquitlam River for spawning and rearing salmon and steelhead species.

4.3.2 Status

Initiation of this monitoring program has been delayed several years due to the inability to provide the required modified flow release from Coquitlam Dam. Based on the provision of the modified flow release in October 2008 this monitoring program was initiated in November 2008 to observe habitat requirements for chum and coho salmon. The two other components: steelhead spawning and juvenile rearing will be conducted in early spring and late summer of 2009 respectively. The first program report was finalized in March 2010 and is in the form of a memo as it mainly details the work and methodology and first year results conducted during 2008/2009. Once sufficient data is collected over the next three years, BC Hydro’s technical specialist will summarize the program results. The second program report is expected in March 2011.

4.3.3 Interpretation of Data

Data collection goals for adult salmon have been met for chum (160 redds from a goal of 200), but are still lacking for coho (36 redds) and steelhead (50 redds). Data collected from steelhead redds will exceed 100 in total following the 2010 survey period, as will chum redds will exceed 200 following the 2010 spawning period. However, for coho redds to exceed even 100 will likely take until 2011 at a minimum. The possibility of gathering enough data on Chinook redds appears to be uncertain at this point.

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4.4 Assessment of Pink Salmon Passage in Lower Coquitlam River

4.4.1 Overview

The objective of this monitoring program is to monitor the migration of returning pink salmon in odd years to determine if there are any flow-related partial or complete migration barriers in the Lower Coquitlam River corridor.

Monitoring Indicator (a): Number of days of unimpeded access

This program will involve direct stream-side observations at potential barriers during pink salmon migration and documenting passage issues.

4.4.2 Status

This monitoring program was initiated in August 2007 with the onset of pink salmon migration in the Coquitlam River and continued through the low flow September period. The first program report\(^7\) was finalized in January 2008. Given pink salmon returns in odd years the second year of assessment occurred in August 2009. The second program report\(^8\) was finalized in March 2010. The third program report is expected in March 2012 with field assessment in August 2011.

4.4.3 Interpretation of Data

The 2007 assessment confirmed no known fish passage barriers in the lower Coquitlam River during Treatment 1 flow regime which had been releasing between 0.8-1.4cms since 1999. The 2009 results indicate that at the lowest Port Coquitlam gage flow of 2.6cms there were no impeded access for migrating adult pink salmon at any of the index sites during the study period. Observations indicate the modified flow regime (Treatment 2) flow regime improved ease of access at the index sites and increased the availability of spawning habitat and as a result adults were in better physical condition to migrate, hold and spawn successfully. It is important to recognize during the survey flows fluctuated 2.0cms above the recommended target of the newly implemented Treatment 2 flow regime. If the 2011 observations indicate no impediments and that pink salmon migration is not an issue, a recommendation to conclude this monitor will be broached to the Coquitlam Monitoring Committee.

4.5 Coquitlam River Periphyton and Benthic Invertebrate Monitoring

4.5.1 Overview

The objective of this monitoring program is to develop a predictive model for evaluating periphyton and invertebrate benefits associated with Lower Coquitlam River flow alternatives.

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\(^7\) Ducharme, S. 2008. Assessment of Pink Salmon Passage in Lower Coquitlam River. Prepared for BC Hydro, Burnaby, BC.

\(^8\) Ducharme, S. 2009. Assessment of Pink Salmon Passage in Lower Coquitlam River. Prepared for BC Hydro, Burnaby, BC.
Monitoring Indicators (short term) (a): seasonal results of benthos monitoring (e.g. number of invertebrates/m², Index of Biologic Integrity [IBI]);
Monitoring Indicators (long term) (b): modeled results of benthos abundance and diversity indicators.

The monitoring program is comprised of several seasonal sampling periods, where environmental variables (e.g. temperature and flow) will be monitored to determine their influence on invertebrate and periphyton production.

4.5.2 Status

This program was initiated in 2003 and repeated in 2004 as part of a commitment to the Coquitlam-Buntzen WUP Consultative Committee to undertake monitoring at the conclusion of the WUP process. The third trial in this program resumed May 2006, and a final report⁹ was submitted December 2006. The three trials completed so far fulfills the Treatment 1 phase of our plan as outlined in the study program TOR.

The next phase of the trials associated with assessment of the modified flow regime (Treatment 2) was initiated in summer 2009 with a final report to be submitted in January 2011.

4.5.3 Interpretation of Results

See 2008 annual report submission for details of 2006 study implementation.

4.6 Lower Coquitlam River Temperature Monitoring

4.6.1 Overview

The objective of this monitoring program is to identify if and how temperature in the lower Coquitlam River is influenced by reservoir operations.

Monitoring Indicator (a): Deviation of temperature regime from natural examples;
Monitoring Indicator (b): Correlation between temperature and reservoir operations.

This program will include the direct monitoring of stream and reservoir temperatures in the Coquitlam Watershed, as well as the analysis of local watersheds of similar characteristics to determine the level of impact due to operations.

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4.6.2 Status

The monitoring program was initiated in 2006 with the first data report\(^{10}\) submitted in May 2007. Year 2 of the monitoring program is complete, with a data report\(^{11}\) submitted in March 2008 and year 3 of the monitoring program is complete, with data report submitted in May 2009\(^{12}\). The year 4 summary report\(^{13}\) was provided in March 2010.

4.6.3 Interpretation of Results

Further comment on the results should be provided based on submission of the 2008 study year report as well as the final summary report pending discussion with BC Hydro’s technical specialist.

4.7 Lower Coquitlam River Fish Productivity Index

4.7.1 Overview

The objective of this monitoring program is to determine the fisheries benefits of two test flows and to enable a better understanding of trade-offs between fisheries, domestic water and power generation for the benefit of future water planning processes.

Monitoring Indicator (a): Smolt per spawner (stock productivity) for coho salmon and steelhead;
Monitoring Indicator (b): Fry per spawner for chum and pink salmon (fry survival).

Note: Monitoring indicators will remain limited to smolt productivity (fish per unit area) until sufficient data are collected to confirm stock productivity relative to brood strength and resulting smolt out-migrants.

This monitoring program is comprised of several study components involving the direct observation of salmon fry, smolts and adults in the Lower Coquitlam River:

- Electroshocking and snorkel observations of rearing fry and parr in several sites;
- Instream trapping of fry and smolt outmigrating from the system; and
- Observations of salmon adults returning to spawn

4.7.2 Status

This program was started in 2000 and enhanced in 2003 as part of a commitment to the Coquitlam-Buntzen WUP Consultative Committee to undertake monitoring at the conclusion of the WUP process. As a result, it is in its eight year of full implementation. The 2005/2006 study program report\(^{14}\), which is a summary of studies between 2000-2006, was submitted in May 2007. The 2006/2007 study program report\(^{15}\), which was a further summary of studies between 2000-2007, was completed February 2008. The 2007/2008 study program report\(^ {16}\), which was a further summary of studies between 2000-2008, was completed April 2009. The 2008/2009 study program report\(^ {17}\), which was a further summary of studies between 2000-2009, was completed March 2010. The 2009/2010 sampling is currently underway with a report due March 2011.

Delays in modification of the Coquitlam Dam release facility resulted in the extension of the Treatment 1 flow regime through 2008 with an additional two years of assessment (2000-2008). The modified flow regime (Treatment 2) assessment commenced in fall 2008 and is expected to extend through to spring 2017.

4.7.3 Interpretation of Data

Results of this monitoring program will be compared between flow regimes pre- and post-2008. As with the 2005/2006 and 2006/2007 reports, the 2007/2008 and 2008/2009 provides a retrospective analysis of productivity under Treatment 1, as summarized in Table 4.1.

The 2000-2009 results generally indicate that the Coquitlam River is meeting provincial biostandards for fish production:

- Steelhead smolt densities have ranged between 1.3-3.2 smolts/100m\(^2\), with most years exceeding the provincial biostandard of 2.0 smolts/100m\(^2\);
- Steelhead egg to fry survival is 6.8% on average, comparing to a long-term average on Keogh River of 6.5%;
- Coho smolt densities have ranged between 4.7-9.3 smolts/100m\(^2\) which is on the low end of reported densities in other Pacific Northwest streams (where off channel habitats dominate production); and
- Chum and pink salmon returns have been variable over the 2002-2009 monitoring years, however, markedly improved over pre-monitoring years with egg to fry survivals comparable to ranges reported in the literature.


The total study area (m²) estimated for smolt production was reduced from 250,466 to 176,834 in 2009 for all years due to the study area changing downstream of the dam to the RST2 (rotary screw trap reach 2) location. In previous reports, the study area was defined as the dam downstream to the lower end of reach 1. This former approach required extrapolating smolt densities from the section of reach 2 immediately upstream of the RST2 to the section downstream of RST2 to the bottom of reach 1 (see p. 86 in the 2008-2009 study year report). It was agreed that it was better to exclude this lower section since there was zero data for smolt numbers in this area. Based on previous spring electrofishing and habitat quality, it is suspected that smolt density declines rapidly below RST2, which means that extrapolating smolt densities from reach 2 to this reach introduces a lot of error unnecessarily.

The 2006-2008 egg-to-fry survival and total smolt production numbers for steelhead, coho, chum and pink differed between the 2008 and 2009 reports because additional mark-recapture data was collected in 2009. Estimates for past years will continue to be refined as new MR sites are completed (p.71 in the report).

4.8 Lower Coquitlam River Substrate Quality Assessment

4.8.1 Overview

The objective of this monitoring program is to evaluate the effectiveness of the flushing flow provisions outlined in the Coquitlam-Buntzen WUP to increase fish productivity through improved substrate quality in the Lower Coquitlam River.

Monitoring Indicator (a): Substrate quality (areal fraction of fine sand)

Three seasonal surveys will be conducted on an annual basis where substrate sites are repeatedly sampled and analysed for surface area grain size distribution. Surface analysis will be calibrated with bulk sieve samples to ensure sampling is indicative of substrate quality. An assessment of linkages between substrate quality and fish productivity will be provided at the end of the review period.

4.8.2 Status

A preliminary survey in 2003 was conducted to evaluate best practices for substrate sampling, which then formed the basis of the recommended monitoring program. The first program report\(^{18}\) for the 2006 monitoring year was finalized in May 2007. Year 2 and 3 sampling was completed with the final reports\(^{19}\) and \(^{20}\) in

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April of 2008 and 2009. The fourth program report\textsuperscript{21} was finalized in March 2010. Year 5 sampling is currently underway with a report due March 2011.

4.8.3 Interpretation of Data

To date, substrate quality has been assessed at several critical locations in the river representing spawning and rearing habitats. The fine sand fraction assessed at each location will be integrated with known fish response representative for those areas to determine if substrate quality is a limiting factor affecting productivity. It is anticipated that a strong correlation between substrate quality and productivity will not be available until several years of quantitative assessments have been completed. Nonetheless, preliminary results indicate that the flushing flows appear to reduce the amount of fish sediment on the bed and that his translates to improved spawning success for both pink and chum salmon.

The secondary objective of assessing flushing flow effectiveness will also require several years of information before thresholds of flushing flows are understood and recommendations for implementation can be provided.

The highest (i.e. the “worst”) substrate quality assessment rating is summarized in Table 4-1; it would appear based on comparisons in 2000, 2003, 2006, 2007, 2008 and 2009 that substrate quality is improving. Through a combination of Coquitlam Dam releases and below dam inputs the confirmed flushing flow thresholds were achieved on several occasions in late 2007 with apparent improvement in substrate quality. There were no flows sufficient in duration to flush sediment during 2009 and none since the end of the 2008 monitor. Flows remained well below the threshold for flushing flow criteria throughout the data collection period in 2008, but several large, short duration flood flows since mid-October 2008 should influence January 2010 results. It is expected that the success of the program will require several more years of data collection and analysis before the management questions can be addressed.

5.0 Summary of Coquitlam-Buntzen WUP Physical Works

The following section outlines the status of the Coquitlam-Buntzen WUP physical works as per the Coquitlam Order under the \textit{Water Act}, dated 21 April 2005 and the revisions to the physical works program approved 1 February 2007, 29 October 2007 and 1 October 2008.

5.1 Coquitlam Flow Release Valve

5.1.1 Overview

The replacement of the existing low level outlet gate is required to facilitate the releases to the Coquitlam River ordered by the CWR and recommended in the Coquitlam-Buntzen WUP. This valve will have the capacity to provide 12 m\textsuperscript{3}/s

\textsuperscript{21} Northwest Hydraulics Ltd. 2010. Lower Coquitlam River Substrate Quality Assessment 2009 Annual Data Report. Prepared for BC Hydro, Burnaby, BC.
prescribed monthly fish flow releases from 22 October 2007 through the duration of the effectiveness monitoring in 2017.

5.1.2 Status

The new gate assembly was installed in October 2008 with a final construction report completed in April 2009. Minor “black-operation” upgrades were successfully completed in September 2009.

As described in the Section 1.0 Introduction, field calibration of the new gate’s flow rating curve occurred in spring through summer 2009 with confirmation of a revised curve in October 2009.

6.0 Coquitlam - Buntzen WUP Monitoring Programs and Physical Works Costs

The following table summarizes the Coquitlam - Buntzen WUP monitoring programs and physical works costs approved by the Comptroller on 2 December 2005, 3 January 2006, 8 March 2006, 1 February 2007, 16 April 2008, 1 October 2008 and 23 March 2009 and the Actual Costs to 31 March 2008.
### Table 6-1: Coquitlam - Buntzen WUP Monitoring Programs and Physical Works Costs

<table>
<thead>
<tr>
<th>Monitoring Programs</th>
<th>Activity</th>
<th>Approved</th>
<th>Forecast</th>
<th>Variance</th>
<th>Explanation</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COQWLR ANNUAL REPORT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COQMON#1 ASSESSMENT OF FISHERIES ACCESS TO STREAMS</strong></td>
<td></td>
<td>110,224</td>
<td>34,826</td>
<td>$75,398</td>
<td>Original estimates overestimated and streamlined</td>
<td></td>
</tr>
<tr>
<td>Direct Management 001</td>
<td></td>
<td>16,322</td>
<td>6,851</td>
<td>$9,471</td>
<td>Study complete in 2007. Variance is the result of project management efficiencies.</td>
<td></td>
</tr>
<tr>
<td>Implementation 002</td>
<td></td>
<td>10,260</td>
<td>12,181</td>
<td>($1,921)</td>
<td>Study complete in 2007. Variance is the result of increased analysis required due to reporting quality issues.</td>
<td></td>
</tr>
<tr>
<td><strong>COQMON#2 COQUITLAM DAM FLOW RELEASE RAMPING INTERIM RATE DEVELOPMENT</strong></td>
<td></td>
<td>160,791</td>
<td>160,681</td>
<td>$110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct Management 001</td>
<td></td>
<td>55,353</td>
<td>55,316</td>
<td>$37</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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</tr>
<tr>
<td>Implementation 002</td>
<td></td>
<td>105,438</td>
<td>105,365</td>
<td>$73</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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</tr>
<tr>
<td><strong>COQMON#3 LOWER COQUITLAM RIVER HABITAT REQUIREMENTS STUDY</strong></td>
<td></td>
<td>115,374</td>
<td>114,846</td>
<td>$528</td>
<td></td>
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<tr>
<td>Direct Management 001</td>
<td></td>
<td>31,018</td>
<td>30,341</td>
<td>$677</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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<tr>
<td>Implementation 002</td>
<td></td>
<td>84,356</td>
<td>84,305</td>
<td>$51</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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<tr>
<td><strong>COQMON#4 ASSESSMENT OF PINK SALMON PASSAGE IN LOWER COQUITLAM RIVER</strong></td>
<td></td>
<td>70,698</td>
<td>70,222</td>
<td>$476</td>
<td></td>
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<tr>
<td>Direct Management 001</td>
<td></td>
<td>32,947</td>
<td>32,437</td>
<td>$510</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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<tr>
<td>Implementation 002</td>
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<td>37,751</td>
<td>37,785</td>
<td>($34)</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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<tr>
<td><strong>COQMON#5 COQUITLAM RIVER PERIPHYTON AND BENTHIC INVERTEBRATE MONITORING</strong></td>
<td></td>
<td>268,775</td>
<td>268,503</td>
<td>$272</td>
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<td></td>
</tr>
<tr>
<td>Direct Management 001</td>
<td></td>
<td>29,883</td>
<td>29,834</td>
<td>$49</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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<tr>
<td>Implementation 002</td>
<td></td>
<td>238,887</td>
<td>238,669</td>
<td>$218</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
<td></td>
</tr>
<tr>
<td><strong>COQMON#6 LOWER COQUITLAM RIVER TEMPERATURE MONITORING</strong></td>
<td></td>
<td>62,539</td>
<td>62,427</td>
<td>$112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct Management 001</td>
<td></td>
<td>12,969</td>
<td>12,847</td>
<td>$122</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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<tr>
<td>Implementation 002</td>
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<td>49,570</td>
<td>49,580</td>
<td>($10)</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
<td></td>
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<tr>
<td><strong>COQMON#7 LOWER COQUITLAM FISH PRODUCTIVITY INDEX</strong></td>
<td></td>
<td>2,316,721</td>
<td>2,316,738</td>
<td>($17)</td>
<td></td>
<td></td>
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<tr>
<td>Direct Management 001</td>
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<td>116,253</td>
<td>116,419</td>
<td>($166)</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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<tr>
<td>Implementation 002</td>
<td></td>
<td>2,200,468</td>
<td>2,200,319</td>
<td>$149</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
<td></td>
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<tr>
<td><strong>COQMON#8 LOWER COQUITLAM RIVER SUBSTRATE QUALITY ASSESSMENT</strong></td>
<td></td>
<td>416,664</td>
<td>416,523</td>
<td>$141</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct Management 001</td>
<td></td>
<td>80,392</td>
<td>80,380</td>
<td>$12</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
<td></td>
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<tr>
<td>Implementation 002</td>
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<td>336,272</td>
<td>336,143</td>
<td>$129</td>
<td>Minor variance acknowledged and will endeavourer to manage to zero over project duration.</td>
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<tr>
<td><strong>COQWORKS#1 MODIFICATION OF COQUITLAM DAM RELEASE FACILITIES</strong></td>
<td></td>
<td>1,308,208</td>
<td>868,189</td>
<td>$440,019</td>
<td>Works installation completed under forecast in fall 2008 based on efficiencies of construction crew and no requirement for use of 15% contingency.</td>
<td>Resubmit to CWR</td>
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<tr>
<td>Direct Management 001</td>
<td></td>
<td>9,508</td>
<td>57,397</td>
<td>($47,889)</td>
<td>Works installation completed under forecast in fall 2008 based on efficiencies of construction crew and no requirement for use of 15% contingency.</td>
<td>Resubmit to CWR</td>
</tr>
<tr>
<td>Implementation 002</td>
<td></td>
<td>1,298,700</td>
<td>810,792</td>
<td>$487,908</td>
<td>Works installation completed under forecast in fall 2008 based on efficiencies of construction crew and no requirement for use of 15% contingency.</td>
<td>Resubmit to CWR</td>
</tr>
</tbody>
</table>