Jordan River Water Use Plan

Monitoring Programs and Physical Works
Annual Report: 2012

Implementation Period: December 2011 to November 2012

- **JORMON-1 Lower Jordan River Inflow Monitoring**
- **JORMON-2 Fish Index: Lower Jordan River**
- **JORMON-3 Lower Jordan River Salmon Spawning Assessment and Enumeration**
- **JORMON-4 Diversion Reservoir Fish Indexing**
- **JORMON-5 Monitoring Surfing Quality below the Jordan River Generating Station**
- **JORWORKS-1 Water Release Mechanism at Elliot Dam**

For Water Licences FL117999, FL118000, FL118001, FL118004 and FL 118005

December 31, 2012

BC Hydro Jordan River Project Water Use Plan Monitoring Programs and Physical Work Annual Report: 2012

1 Introduction

This document represents a summary of the status and the results of the Jordan River Water Use Plan (WUP) monitoring programs and physical work to November 30, 2012, as per the Jordan River Order under the *Water Act*, dated July 20, 2004. There are five monitoring programs and one physical work:

- JORMON-1 Lower Jordan River Inflow Monitoring
- JORMON-2 Fish Index: Lower Jordan River
- JORMON-3 Lower Jordan River Salmon Spawning Assessment and Enumeration
- JORMON-4 Diversion Reservoir Fish Indexing
- JORMON-5 Monitoring Surfing Quality below the Jordan River Generating Station
- JORWORKS-1 Water Release Mechanism at Elliot Dam

2 Background

The water use planning process for BC Hydro's Jordan River project was initiated in April 2000 and completed in November 2001. The conditions proposed in the WUP for the operation of the project reflect the February 2002 recommendations of the Jordan River WUP Consultative Committee.

In February 2002, the Jordan River WUP was submitted to the Comptroller of Water Rights (Comptroller).

On July 20, 2004, BC Hydro was ordered to implement the conditions proposed in the Jordan River WUP and prepare the monitoring programs and physical work terms of reference (TOR).

On June 10, 2005, the Jordan River WUP monitoring programs TOR were submitted to the Comptroller for review and approval. Revised TOR costs were submitted on June 28, 2005. On June 30, 2005, the monitoring programs TOR were accepted by the Comptroller.

On May 31, 2006, BC Hydro sent a letter to the Comptroller requesting a one year delay in the commencement of minimum flow until June 30, 2007 in order to collect two years of pre-flow release field data. On July 20, 2006, the Comptroller approved the delay.

On May 31, 2006, the Jordan River WUP physical work TOR was submitted to the Comptroller for review and approval. On July 14, 2006, the revised TOR was submitted to the Comptroller as the construction schedule would be delayed one year until spring 2007. On September 18, 2006, the revised TOR for the water release mechanism at Elliott Dam were accepted by the Comptroller.

On May 28, 2007, revised TOR for the Lower Jordan River Inflow Monitoring was approved for a study cost increase.

On July 16, 2007, a TOR revision for a cost increase and completion date change to the water release mechanism at Elliott Dam was submitted to the Comptroller. On July 24, 2007, approval was received for the cost increase and for the delay in minimum flow commencement until October 15, 2007.

On October 2, 2007, a letter was sent to the Comptroller to inform of a delay in construction completion of the water release mechanism at Elliott Dam and to request approval for a delay in commencement of minimum flow. Approval was received October 29, 2007 for minimum flow commencement delay until January 30, 2008.

On December 21, 2007, a TOR revision for a cost increase for the Lower Jordan River Inflow Monitoring Study was submitted to the Comptroller. On April 24, 2008, approval was received for the cost increase.

On May 20, 2010, a TOR revision for a cost increase for the Lower Jordan River Inflow Monitoring Study was submitted to the Comptroller. On July 8, 2010, approval was received for the cost increase.

As outlined in the Jordan River WUP, the Jordan River Consultative Committee recommended a review of this WUP after six years of its implementation. A review may be triggered sooner if scientific data or significant new risks are identified that could result in a change to operations.

A WUP review is planned for 2013 once all final reports have been received and a synthesis of the reviewed data has been completed.

3 Schedule

The following table outlines the status and schedule for the Jordan River WUP monitoring programs and physical work.

Table 3-1: Status and Schedule of Jordan River WUP Monitoring Programs and Physical Work Implementation

Monitoring Programs	2005 WLR YR1	2006 WLR YR2	2007 WLR YR3	2008 WLR YR4	2009 WLR YR5	2010 WLR YR6	2011 WLR YR7
Lower Jordan River Inflow Monitoring	✓	✓	×	✓	✓	✓	
Fish Index: Lower Jordan River	✓	✓	✓	✓	✓	✓	
Lower Jordan River Salmon Spawning Assessment and Enumeration	✓	✓	✓	✓	✓	✓	
Diversion Reservoir Fish Indexing	✓	✓	✓	✓	✓	✓	
Monitoring Surfing Quality below the Jordan River Generating Station		✓	✓	✓	✓	✓	u/w
Physical Works							
Water Release Mechanism	✓	✓	✓	✓			

Legend:			
	■	=	Program to be undertaken/initiated in identified year
	u/w	=	Project is underway
	✓	=	Program completed for the year
	×	=	Program started, but encountered operational or hydrological delays

4 Summary of Monitoring Program

The following section outlines the status of the Jordan River WUP monitoring programs as per the Jordan River order under the *Water Act*, dated July 20, 2005. Table 4-1 summarizes the monitoring program results according to the key monitoring indicators for each program.

Table 4-1: Summary of Jordan River WUP Monitoring Programs Results

Study	Monitoring Indicator	Bio-Standard or Base-Line	2005 WLR YR1	2006 WLR YR2	2007 WLR YR3	2008 WLR YR4	2009 WLR YR5	2010 WLR YR6	2011 WLR YR7
Lower Jordan River Inflow Monitoring	% Diff from WUP MAD (1.51cms) [3]	0						Analysis deferred to 2012	
Lower Jordan River Fish Indexing	Rainbow Fry Density (fish/100m^2)	N/A	3.7 [9]	4.9	6.4	7.0	3.3	9.5	
	Rainbow Parr Density (fish/100m^2)	N/A	1.4 [8]	1.6	0.7	2.0	4.8	3.1	
	Rainbow Trout Condition Factor	1.05 [2]	1.07	1.13	1.08	1.06	1.06	1.08	
Lower Jordan River Salmon Spawning Assessment and Enumeration	Salmon (coho and/or chum) escapement	N/A	4 CO	13 CM 1 CO	0 CM 0 CO	0 CM 0 CO	0 CM 4 CO	0 CM 2 CO	
	Egg to fry survival (%)	80% [1]	76% (97%) [6]	0% [7] (95%) [6]	96% (99%) [6]	96% (97%) [6]	98% (98%) [6]	98%[9] (97%) [6]	
Diversion Reservoir Fish Indexing	Rainbow CPUE[11] (Floating and Sinking)	N/A	6.5	6.95	18.55	26.75	21	26.25	
	Rainbow Trout Condition Factor	1.05 [2]	1.10	1.10	1.07	1.08	1.03	1.07	
Monitoring Surfing Quality Below the Jordan River Generating Station	% Surfers Not Affected by Operations	< 50% [4]	Not studied	82%	66% [5]	77%	75%	66%[10]	61%

1. Salmonid Enhancement Program biostandards for Vancouver Island (Quinsam River) transplanted eggs (March 1997)
2. R. Ptolemy, Ministry of Environment, Victoria, personal communication.
3. Water Use Plan hydrology summary - see Taylor, 2001
4. Drafted as a threshold below which it may be determined that further operational constraints are required.
5. Based on a single survey not necessarily representative of typical surfers. To be reviewed at end of review period.
6. Hatch Stage Assessment normally completed at 350-450 ATUs. Note that 2005 data did not include Site 3 data (potential water quality issues).
7. Incubation cassettes were all lost due to extreme inflows to Jordan River March 2007
8. Reported densities in 2005 (10.2fry/unit 1.9parr/unit) were incorrectly summarized - geometric means are being used from now on.
9. Four of five sites/cassettes lost due to extreme inflows.
10. Correction. In 2010 Annual Report incorrectly reported as 60%.
11. Mean CPUE of all floating and sinking nets combined.

5 Jordan River WUP Monitoring Programs

This section outlines the status of the Jordan River WUP monitoring program as per the Order under the *Water Act,* dated July 20, 2004.

5.1 JORMON-1 Lower Jordan River Inflow Monitoring

5.1.1 Management Questions

The primary management questions discussed regarding the natural inflows below Elliott Dam are:

1) How accurate were the assumptions of local inflows used for WUP recommendations?

2) What implications, if any, are there on the WUP recommendations based on revised inflow data?

3) What are the reasons for the differences, if any, between the monitored and assumed inflows?

5.1.2 Overview

The objective of this monitoring program is to assess the performance of the key WUP decision to increase flows in the lower Jordan River from leakage/local inflows to ≥ 0.25 m^3s^{-1} using instream flow measurements as the performance measure.

The Jordan River Consultative Committee's recommendation to release a base flow was based, in part, on estimates of weighted usable rearing area. The Jordan River Consultative Committee has recommended that more accurate river discharge and local inflow contributions be assessed.

Monitoring Indicator a): Percentage difference from assumed (Jordan River WUP, Taylor, 2001[1]) mean annual discharge.

This monitoring program involves monitoring instream flow at three locations in Lower Jordan River through the combination of water level monitoring and rating curve (flow-water surface elevation relationship) development.

5.1.3 Status

This monitoring program was initiated in November 2005, and will be carried out over six years. The first year program report was received in November 2006. A storm event in November 2006 resulted in major flooding which compromised all of the hydrometric stations. New more robust stations were installed in 2007. During 2007 the implementing contractor could not complete the project due to health reasons. A new contractor was retained to complete the remainder of the six year program. In 2009 hydrometric equipment was replaced as a result of damage caused by large spill events, and climbing equipment and training was acquired to improve safe access into the steep canyon. Due to the challenges identified above BC Hydro has submitted three revisions between 2007 and 2010 notifying the Comptroller of cost increases and changes to the terms of reference. The fourth year program report was completed in 2010. All field work is now complete. The fifth year program final report as well as the sixth year draft report will be submitted at the end of December 2012.

5.1.4 Interpretation of Data

At the time of reporting, there was inadequate data to report on the monitoring indicator above. Due to program delays and issues with data collection, an update on this measure will be provided in the upcoming sixth year program report.

[1] Taylor, Lara, 2001. Inter-office memo: Jordan River Projects – basin hydrology. Prepared for Eric Wiess, BC Hydro Operations, Burnaby, BC.

The monitoring indicator will provide both the context of the Jordan River Water Use Plan recommendations and the flow response of the water release, for consideration in future planning processes.

5.2 JORMON-2 Fish Index: Lower Jordan River

5.2.1 Management Questions

The primary management questions discussed regarding the effects of flow increases on Lower Jordan River habitat and fauna were:

1) Does the flow release restore habitat continuity (i.e. are all habitat units connected by flowing water)?
2) How will the planned flow releases affect the standing stock of the rainbow trout population?
3) How will the planned flow releases affect the distribution of fish condition (weight to length) by age within the rainbow trout population?

5.2.2 Overview

The objective of this monitoring program is to assess the biological benefits of the key WUP decision to increase flows in the lower Jordan River from leakage/local inflows to ≥ 0.25 m^3s^{-1} using stock abundance and fish condition as performance measures.

The Jordan River WUP Consultative Committee recommendation to release a 0.25 m^3s^{-1} flow was based, in part, on estimates of increased weighted usable area for rearing rainbow trout. To address this decision, the Jordan River Consultative Committee recommended a monitoring program to detect an increase in the standing stock of rainbow trout.

Monitoring Indicators a): Rainbow trout (juvenile) density.

b): Rainbow trout (juvenile) condition factor.

This monitoring program involves three components:

- Establish sampling protocol expected to provide statistical power to detect changes in standing stock (expected change ≥ 100%);
- Collect initial estimates of standing stock, physical habitat changes and fish size and condition for rainbow trout, and;
- Analyse data to compare increases in size, condition and standing stock between pre and post 0.25 m^3s^{-1} flow release.

5.2.3 Status

This monitoring program was initiated in September 2005 and will be carried out over six years. All field work is now complete. The sixth year program final report will be submitted at the end of December 2012.

5.2.4 Interpretation of Data

Nested ANOVA's were used to assess performance measure 1 (rainbow trout density) and performance measure 2 (rainbow trout condition factor) before and after the flow release (i.e., study year as the subgroup nested within pre and post treatment groups). In the case of fish density, a noticeable increase was observed for age 1+ and age 2/3+ rainbow, however, only the increase in 2/3+ fish was significant. For rainbow condition factor, there was no significant difference before and after the flow release.

In terms of habitat continuity, obvious benefits were noted. The reach immediately downstream of Elliott Dam (Reach 7) was mostly dry before the flow release, but exhibited continuous flows after the release. In fact, no subsurface flows were found in any of the habitat survey sections after the flow release. In addition, prior to the flow release, riffle habitats often had only seepage flows which were felt to inhibit the upstream/downstream dispersal of trout except during higher winter flows.

After the flow release riffle habitats were well wetted and no longer an impediment to fish dispersal. In terms of quantifiable habitat changes, the flow release increased wetted stream length by 771 m, while wetted area increased by an average of 85%. Riffle habitats, which are typically the main zones of aquatic invertebrate production, increased from an average of 6.1% of wetted area before the flow release to 15.5% after the flow release.

5.3 JORMON-3 Lower Jordan River Salmon Spawning Assessment and Enumeration

5.3.1 Management Questions

The primary management questions discussed regarding the effects of flow increases on Lower Jordan River habitat and fauna were:

1) Will the planned flow releases improve spawning habitat for spawning salmon and steelhead in the anadromous reaches of the Lower Jordan River?
2) Will the planned flow releases improve effective incubation habitat for spawning salmon and steelhead?
3) What effects, if any, do the planned flow releases have on chronic toxicity of rearing and incubating salmonids?

5.3.2 Overview

The objective of this monitoring program is to assess the performance of the key WUP decision to increase flows in the lower Jordan River from leakage/local inflows to ≥ 0.25 m^3s^{-1} using spawning success (number of returns to outmigrants) as the performance measure. Effective spawning and incubation habitat will also be measured.

Spawning success in lower Jordan River is limited by the cumulative impacts of flow reductions, mine operations, and log sort operations in the Lower Jordan River.

Fisheries and Ocean Canada and some members of the Consultative Committee, however, hypothesised that improvements to the base flow in the lower reaches may be adequate to A) improve effective incubation habitat and B) dilute dissolved metal levels (Cu) sufficiently to reduce chronic toxicity. To address this hypothesis the Jordan River Consultative Committee recommended a program to monitor for successful signs of spawning and rearing in the Lower Jordan River following the base flow release.

Monitoring Indicators a): Salmon escapement (coho + chum).

b): Spawning success (egg to fry survival).

This monitoring program involves repeated snorkel surveys, incubation tests where observations of significant spawning warrant follow-up and analysis of flow information.

5.3.3 Status

This monitoring program was initiated in October 2005 and will be carried out over six years. All field work is now complete. The fifth and sixth year program final reports will be submitted in early 2013.

5.3.4 Interpretation of Data

Results to date show potential limits to spawning success in the Lower Jordan River remain consistent over all six years of this study. The results show an absence of adequate spawning habitat (flow, gravel quality and quantity) as well as potential water quality issues from historic mine abandonment. Other potentially limiting factors to spawning success include predation in the lower reaches by eagles and a seal, a lack of freshwater attraction flows from the Lower Jordan River and confounding effects of generation which may attract fish to the tailrace rather than to the Lower Jordan River mainstem. As monitoring predation and attraction flow issues are not part of this study scope, it is recommended that future studies review these issues if salmon spawning success becomes an objective for fisheries management in the watershed.

The effect of the initiation of the 0.25 cms minimum flow release on spawning success was not measurable in terms of providing additional access to spawning habitat, or providing more stable incubation habitat. It may, however, have improved the water quality adjacent to Site 3 as egg survival was higher in Year 5 and Year 6 (after the initiation of the 0.25 cms flows) than in all previous assessments. The distribution and abundance of Rainbow trout also appears to have increased in conjunction with the release of 0.25 cms as the frequency of sightings and overall numbers of fish observed have increase dramatically over the last three years.

5.4 JORMON-4 Diversion Reservoir Fish Indexing

5.4.1 Management Questions

The primary management questions discussed regarding the operations of Diversion Reservoir were:

1) What are the benefits to rainbow trout condition associated with a reduced allowable drawdown?
2) What are the impacts on rainbow trout condition associated with a prolonged extensive drawdown?

5.4.2 Overview

The objective of this monitoring program is to evaluate the effects of extensive drawdown on Diversion Reservoir, using rainbow trout fish condition as the performance measure.

The Jordan River WUP Consultative Committee recommended an operational change that was hypothesised to elicit biologically significant measurable responses in the resident fish populations in Diversion Reservoir. It was hypothesised that the decrease in seasonal and daily reservoir fluctuation and bulk decrease in pelagic volume would increase both the establishment of an effective littoral zone and mitigate against reducing rainbow trout condition factors.

Monitoring Indicators a): Rainbow trout catch per unit effort (CPUE; sinking + floating gillnet).

b): Rainbow trout condition factor.

This monitoring program involves repeated gill-net and gee-trap surveys set at index sites in the reservoir in late-August/early-September every year, coinciding with typical low-reservoir operations.

5.4.3 Status

This monitoring program was initiated in September 2005, and will be carried out over six years. All field work is now complete. The sixth year program report will be submitted with the 2012 Annual Report.

5.4.4 Interpretation of Data

The six years of data will be compiled with a final assessment of whether constrained Diversion Reservoir drawdown conditions improve fish productivity and health as defined by the monitoring indicators above.

The physical condition of the rainbow trout remained remarkably stable during the six years of sampling with no significant differences between the six years of sampling. Analysis of pooled data found a slightly decreasing trend in condition over the study period.

Study results indicate that the rainbow trout population appears to be limited by the limited food and space for the rapidly growing 2 year old fish during their period of rapid growth during the critical summer period in the reservoir. It was concluded that the abundance of trout increased over the study period but that the larger population continued to be constrained by limited food and space resources, albeit at a level of greater abundance.

5.5 JORMON-5 Monitoring Surfing Quality below the Jordan River Generating Station

5.5.1 Management Question

The primary management question discussed regarding the effects of generation constraints on Jordan River surfing quality is:

- How do constraints on generation benefit surfing quality at Jordan River?

5.5.2 Overview

The objective of this monitoring program is to assess the performance of the WUP decision to constrain maximum discharge opportunistically during the surfing season, using surf quality as the performance measure.

Jordan River is one of the most popular surf locations on Vancouver Island. A surfing survey conducted over the WUP indicated that surf conditions are also affected by Jordan River Generating Station discharge. In some conditions high discharges may flatten waves and make it more difficult for surfers to catch waves against the current.

Monitoring Indicators a): Surfers not affected by operations.

This monitoring program involves on-site observations of surfing use proximal to the mouth of the Jordan River under constrained and unconstrained conditions, and a surfing survey of Jordan River recreationalists under constrained and unconstrained conditions.

5.5.3 Status

This monitoring program was initiated in March 2006 and will be carried out over six years. All field work is now complete. The sixth year program report is currently under review.

5.5.4 Interpretation of Data

The six year survey results show that 90% of surf users are board users, 76% are male 24% are female. Most surf users spend between $10-$25 each day. The most used surf area is Points Right, which is located to the east side of the point at Jordan River.

The key purpose of the survey has been to determine whether restraint on flows from the Jordan River generating facility are necessary to improve surf conditions for surf users at Jordan River.

The surveys indicate that while some surf users, particularly those that are experienced observe a benefit, overall, regardless of flow volume, an increasing proportion of surf users at Jordan River report having a good to excellent experience. Over the six-year period, 67% of surf users had a good to excellent experience regardless of flow conditions or ocean conditions.

Over the six year period, 32% of surfs noticed the river flow, 68% did not, indicating that the majority of surf users do not notice river flows, regardless of their level of experience and regardless of the interactions between river flows and ocean conditions.

When aspects of the surf condition are looked at over the six years, specifically conditions for catching waves, wave heights and the wave break, there is an increasing satisfaction level in each aspect, again regardless of flow volume or sea condition.

Taken collectively, the data suggests that while there is some benefit of constraints to some surf users, the majority of surf users do not benefit from constraint of flow volumes from the Jordan River generating facility.

6 Summary of Jordan River WUP Physical Work

This section outlines the status of the Jordan River WUP physical works as per the Jordan River Order under the *Water Act,* dated July 20, 2004.

6.1 JORWORKS-1 Water Release Mechanism at Elliot Dam

6.1.1 Overview

The objective of this physical work includes the design and construction of a water release mechanism at Elliott Dam in order to ensure a minimum base flow of 0.25 m^3s^{-1} from the dam.

During the Consultative Committee process the committee agreed to an objective to maximize fish populations in the Lower Jordan River below Elliott Dam. Currently no base flows are provided below the dam and therefore the committee considered a number of alternatives for releasing base flows. It was agreed to release a base target flow of 0.25 m^3s^{-1} year-round through the dam. It is expected that the increased base flow will result in improved ecosystem condition and an increase in habitat for fish from the mouth of the river, up to and including the river 300 m below Elliott Dam.

6.1.2 Status

The implementation phase of the physical works was initiated in October 2006 and was completed in 2008. The physical works completion report was finalized in December 2008.

Phase I of the Water Release Mechanism was completed in 2004, prior to the receipt of the Order. Phase II of this physical work was scheduled to be completed by July 2007 but was delayed for the following reasons: 1) the access road to the site was damaged and impassable as a result of winter storms; 2) specialized drilling equipment was unavailable; and 3) construction procedures were altered where the drilling through the dam occurred from the inside of the gallery out to the dam face. Costs increased as a result of changes in the detailed designs and construction.

Construction of Phase II began in October 2007 and completed in 2008. The final testing and commissioning of the mechanism was completed in January 2008. The 0.25 m^3s^{-1} minimum flow release from Elliott Dam commenced in January 2008 prior to the ordered date of January 30, 2008.

7 Jordan River WUP Monitoring Programs and Physical Work Costs

The following table summarizes the Jordan River WUP monitoring programs and physical works costs approved by the Comptroller and the actual costs to November 30, 2012.

Table 7-1: Jordan River WUP Monitoring Programs and Physical Work Costs

Monitoring Programs	Activity	Costs approved by CWR	Total Forecast (Life to Date Actuals and Forecast)	Variance Total to Approved	Explanation	Corrective Action
Jordan River Annual Report	OR	$13,274	$11,200	$2,074		
JORMON#1 LOWER JORDAN RIVER INFLOW MONITORING	OR	$178,412	$167,158	$11,254	Efficiencies found during project implementation.	
JORMON#1 Direct Management 001	OR	$29,533	$18,694	$10,839		
JORMON#1 Implementation 002	OR	$148,879	$148,465	$414		
JORMON#2 FISH INDEX: LOWER JORDAN RIVER	OR	$175,923	$137,837	$38,086	Efficiencies found during project implementation.	
JORMON#2 Direct Management 001	OR	$51,935	$18,282	$33,653		
JORMON#2 Implementation 002	OR	$123,988	$119,556	$4,432		
JORMON#3 LOWER JORDAN RIVER SALMON SPAWNING ASSESSMENT AND ENUMERATION	OR	$144,894	$120,829	$24,065	Efficiencies found during project implementation.	
JORMON#3 Direct Management 001	OR	$57,454	$30,460	$26,994		
JORMON#3 Implementation 002	OR	$87,440	$90,368	($2,928)		
JORMON#4 DIVERSION RESERVOIR FISH INDEXING	OR	$121,543	$80,162	$41,381	Efficiencies found during project implementation.	
JORMON#4 Direct Management 001	OR	$60,028	$13,800	$46,228		
JORMON#4 Implementation 002	OR	$61,515	$66,362	($4,847)		
JORMON#5 MONITORING SURFING QUALITY BELOW THE JORDAN RIVER GENERATING STATION	OR	$65,362	$34,115	$31,247	Efficiencies found during project implementation.	
JORMON#5 Direct Management 001	OR	$45,734	$16,877	$28,857		
JORMON#5 Implementation 002	OR	$19,628	$17,237	$2,391		
JORWORKS#1 WATER RELEASE MECHANISM	OR	$675,982	$670,068	$5,914	Project completed.	
JORWORKS#1 Direct Management 001	OR	$20,461	$22,542	($2,081)		
JORWORKS#1 Implementation 002	OR	$655,521	$647,526	$7,995		

OR - Ordered Remissible
ONR - Ordered Non-Remissible

* Red values in parentheses denote overage.