COURSIER DAM
DECOMMISSIONING PROJECT

ANNUAL REPORT 2008

Prepared for: **BC Environmental Assessment Office**

BC hydro

ENGINEERING

Report No. E737
September 2009

COURSIER DAM
DECOMMISSIONING PROJECT

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WPR-2728

COURSIER DAM
DECOMMISSIONING PROJECT

ANNUAL REPORT 2008

Prepared by: _____

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Submitted by: _____

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BC hydro

ENGINEERING

Report No. E737
September 2009
WPR-2728

ACKNOWLEDGEMENTS

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COURSIER DAM
DECOMMISSIONING PROJECT

ANNUAL REPORT 2008

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COURSIER DAM DECOMMISSIONING PROJECT

ANNUAL REPORT 2008

1.0 INTRODUCTION

On 8 May 2003, the Minister of Sustainable Resource Management, with the concurrence of the Minister of Water, Land and Air Protection and the Minister of Energy and Mines approved the Coursier Dam Decommissioning Project (the Project) and issued Environmental Assessment Certificate E03-02 (the Certificate).

The Certificate contained a number of conditions. The current status of compliance with these conditions is tabulated in Status Report No. 7, dated June 2009 in Appendix A. In addition, BC Hydro's Director of Dam Safety committed to an annual inspection of the decommissioning works after freshet, and the completed 2008 report appears at the end of Appendix A.

The Certificate also directed BC Hydro to present an Annual Report, commencing in 2003, with an update on the status of the Project and compliance with the conditions of the Certificate and the Environmental Management Plan (BC Hydro, 2003).

This report is BC Hydro's 2008 Annual Report, year five (5) of a five year commitment to produce an annual report for the BC Environmental Assessment Office. BC Hydro plans to continue to monitor and assess the site per the schedule of activities listed in Table 1 until 2013. Table 1 is shown in Section 4.3.

2.0 BACKGROUND

The Coursier Dam, located in an isolated mountain valley 30 km south of Revelstoke, formerly impounded a 2 km^2 reservoir along Cranberry Creek. The

earthfill dam provided storage for the 8 MW Walter Hardman generating facility fed by Cranberry Creek and located on the west side of Upper Arrow Lakes Reservoir 20 km downstream of the dam.

The City of Revelstoke built Coursier Dam in 1963. In 1969, the dam crest was raised. In 1972, the dam was purchased by BC Hydro. Coursier Dam has had approximately 30 years of dam safety incidents, and various dam safety remedial repairs.

BC Hydro considered a full range of options to address the future of this dam, ranging from a comprehensive rebuild to decommissioning. Decommissioning the dam was chosen as the preferable option.

Decommissioning of the Coursier Dam was carried out over the summer and fall of 2003.

The work involved the following sequence of activities:

- recover rip rap from the face of the dam, obtain rock materials and store in a stockpile area near the dam;
- drawdown and maintain reservoir levels by discharging water through the low level outlet and pumping flows over the spillway;
- start excavation of the notch through the dam gradually moving through the dam towards the reservoir, leaving an upstream plug;
- build a cofferdam upstream of the plug and dewater the area to allow restoration of the lake outlet channel in dry work conditions, monitor and conduct a fish salvage as required,
- remove the plug and the low level outlet;
- restore the channel below the cofferdam;
- remove the cofferdam in the dry, stop pumping, and allow the lake water to slowly fill and flow into the new channel;
- demolish and bury the spillway; and,
- clean up and rehabilitate the site.

Excavation of the notch through the dam required disposal of approximately 105,000 m^3 of material. The finer fraction spoils were disposed in spoil areas near the existing dam. The remainder of the material, sand and gravel was returned to the gravel pit from where it was originally sourced approximately 1.5 km west of the dam.

3.0 2008 ACTIVITIES

3.1 Revegetation Activities

Completion of the Coursier Dam decommissioning and the start of the revegetation of the former Coursier Reservoir occurred in 2004. Figure 1 shows the revegetation prescription; planting activities were completed in 2005.

No revegetation activities were completed in 2008. The 2008 scheduled formal survey of the entire basin was attempted in October 2008 but was deferred due to early snowfall. The survey will be completed in the summer of 2009 (Wilson, 2009).

3.2 Fish and Aquatic Monitoring

The objectives of the fish and aquatic monitoring component are:

- To monitor and assess bank stability, lateral movement, and erosion in the previously inundated drawdown zone and to recommend any physical interventions that may be required to achieve channel equilibrium.
- To monitor and assess the biophysical, fish and aquatic habitat in Upper South Cranberry Creek, Westside Creek, and other Coursier Lake tributaries.
- To monitor and assess the restored outlet channel to evaluate channel performance and integrity.
- To monitor and assess Coursier Lake limnology to detect biotic and physical responses to dam decommissioning.

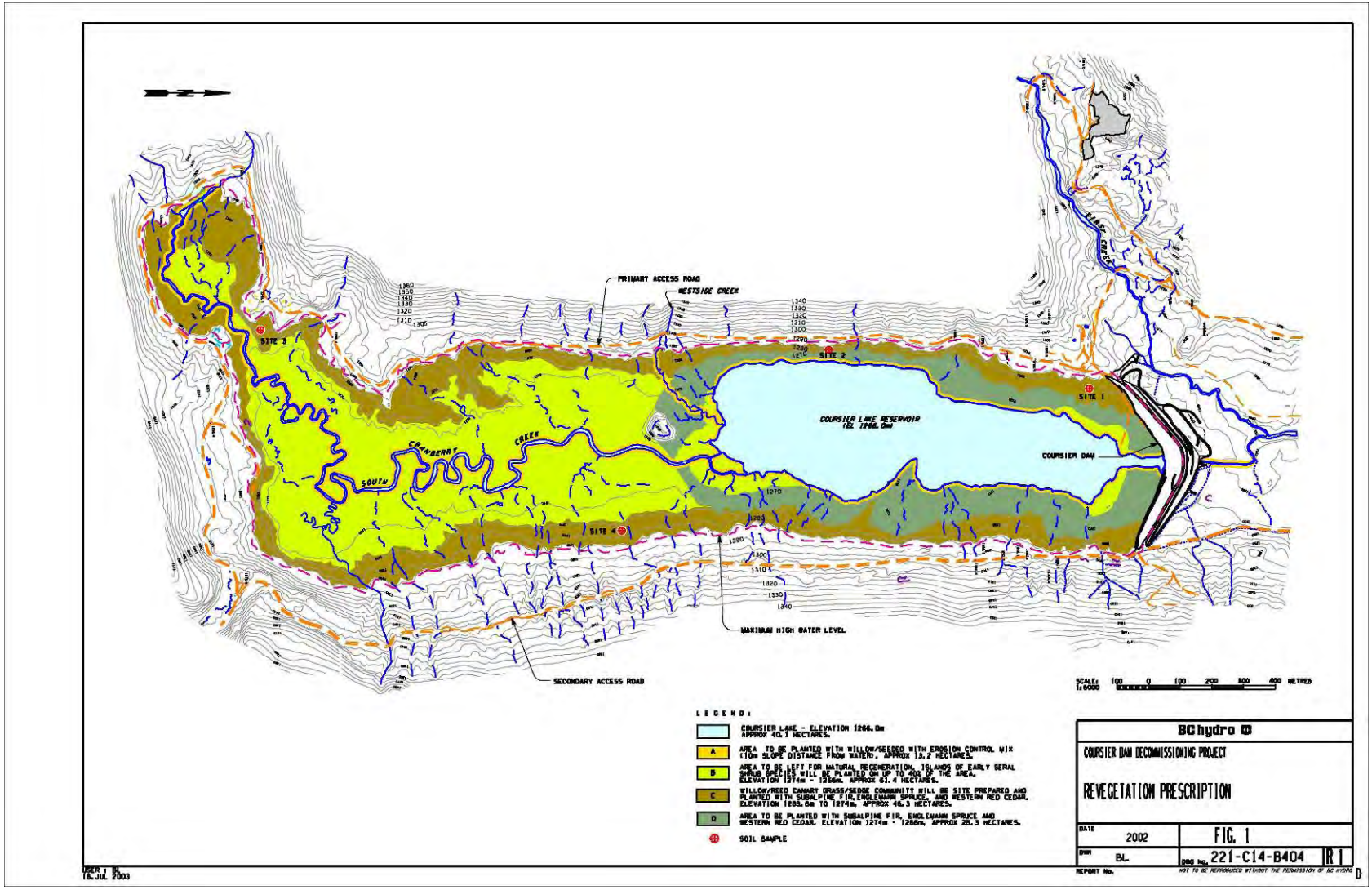


Figure 1: Revegetation Prescription

These objectives have been achieved by establishing baseline biophysical information in 2003 and completing subsequent 2004, 2005, 2006 and 2008 biophysical assessments.

Fish and fish habitat monitoring and assessment were initiated by collecting baseline data during August 2003 (Ramsay and Associates, 2003). This work involved documenting the biophysical, fish and aquatic habitats in the outlet channel, Upper South Cranberry Creek, Westside Creek, and other Coursier Lake tributaries. Water quality and limnological data were also collected and analysed. Fish were sampled and species and morphometric data were obtained. This data has served as a baseline for future assessments of fish and fish habitat and specifically, bank stability, lateral movement, and erosion in the mainstream channels and their tributaries.

In 2003, most areas surveyed were found to be suitable for fish utilization. Fish were observed rearing in the outlet channel, Coursier Lake, Upper South Cranberry Creek and its tributaries and lower Westside Creek. Downcutting has resulted in potential fish access barriers to the upper reaches of Westside Creek, however, other barriers (e.g. culverts, steep gradients) also exist upstream. No fish were observed upstream of these barriers, and the downcutting has not resulted in a significant incremental fish access impact.

Fish and fish habitat monitoring and assessments were replicated in September 2004, 2005, 2006, and 2008 (I.C. Ramsay and Associates, 2009). The location of morphological changes in the South Cranberry Creek Watershed are shown in Figure 2.

As per the specifications of the monitoring report outlined in the Environmental Management Plan (BC Hydro 2003), a subset of the physical aquatic parameters of each stream segment were collected in 2003. In addition, crown closure, stream bank characteristics, stream

morphology and lateral channel movement were also recorded in the 2003 baseline assessment and re-assessments in 2004, 2005, 2006, and 2008.

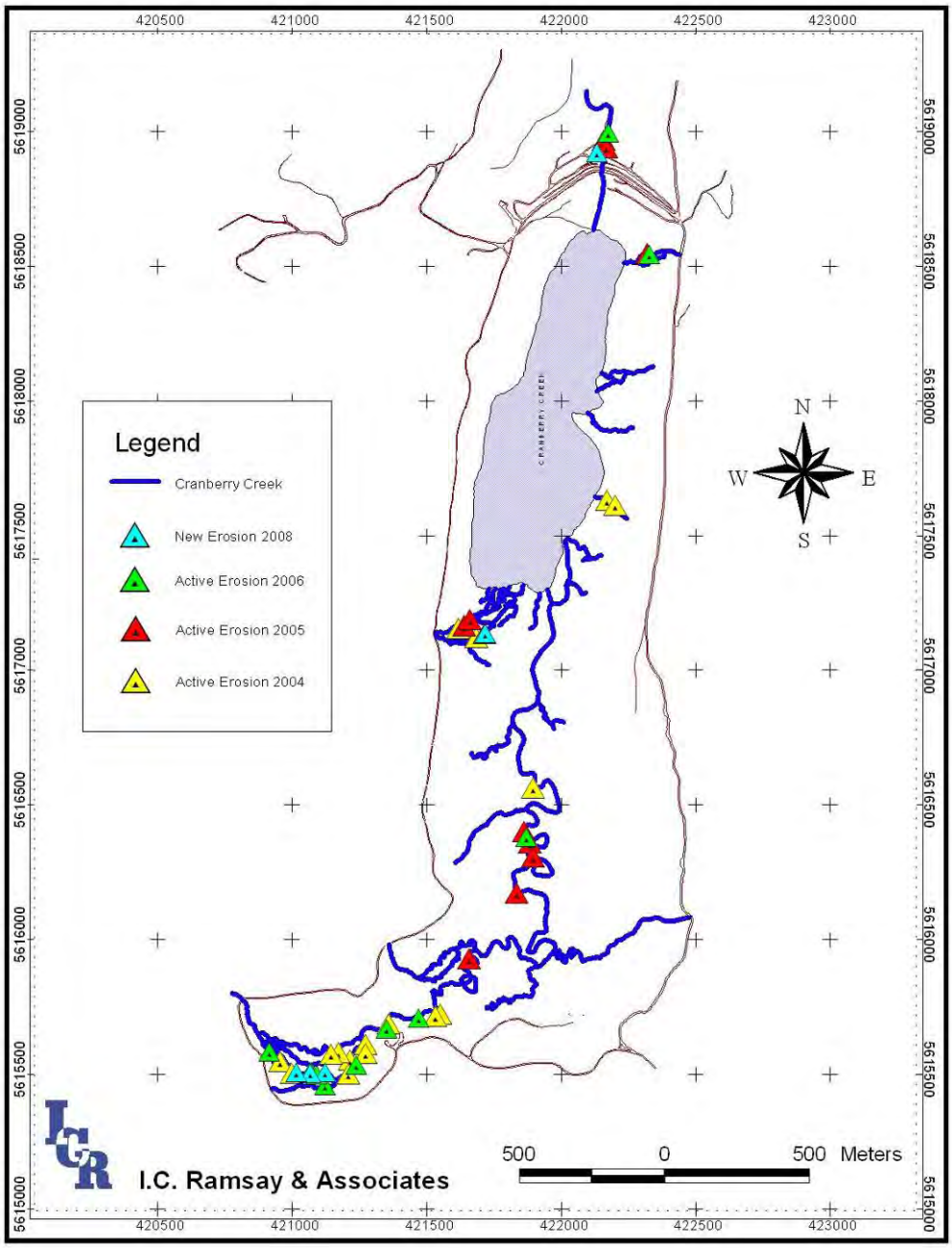


Figure 2: Location of Morphological Changes in the South Cranberry Creek Watershed since 2003

In 2008, the aquatic monitoring tasks scheduled were:

1. The evaluation of the restored outlet channel to determine channel performance and integrity.
2. To monitor the slide (unrelated to BC Hydro) on the west side of Coursier Lake (Photograph 1).

The outlet channel was assessed in September 2008 and was found to be very stable, and continues to be suitable for fish utilization. The Coursier Lake foreshore was also stable, as historic gravel and cobble beaches were evident. The slide (unrelated to the Coursier Dam decommissioning) on the west side of Coursier Lake was reassessed and has not significantly changed. We believe the origin of the slide was historic logging activity. The slide did not change significantly over the 2007/08 winter (Photograph 1). The slide will be monitored during future assessments.

Photograph 1: A slide on the west side of Coursier Lake recorded in 2006. No significant changes or additional erosion were recorded in 2008.

Lower Westside Creek was braided and aggrading, but was adequate for rainbow trout rearing. This creek section will likely form dominant channels in a few years. Upper Westside creek is not fish bearing and remains isolated by the fish access barriers documented previously. In Upper South Cranberry Creek, 13 instances of bank scour, erosion and downcutting were noted in 2004, and five additional instances of bank scour and erosion were recorded in 2005. In 2006 four additional erosion sites, two downcutting sites and general sediment deposition (in Segment 1) were recorded. In 2008 minor erosion was identified between riffle #3 and riffle #4. In Westside Creek we identified a debris jam below the road culvert that was likely in place in previous years. We also identified two new erosion sites in Segment 4 and ongoing minor erosion in previously identified sites (Photograph 2). These areas will likely stabilize over time. Other instances of channel degradation, aggradation, undercutting, downcutting and minor erosion were noted in the smaller tributaries.

Photograph 2: Active erosion at a previously recorded (in 2006) right bank erosion site in Upper South Cranberry Creek (USCC) Segment 4 just upstream of Segment 3. The photo was taken facing downstream.

The 2003 assessment, compared with 2008 observations, indicates that there are relatively minor morphological changes to date. Therefore, no physical interventions are recommended at this time.

The riparian zone of Coursier Lake and the tributaries continues to re-vegetate with grasses, and recorded recently planted and natural establishment of woody vegetation (Photographs 3 and 4).

Photograph 3: Westside Creek Segment 2 facing downstream. Notice the natural and recently planted riparian vegetation.

Photograph 4: Upper South Cranberry Creek Segment 5 facing downstream. Notice the height of the deciduous vegetation (e.g. Alder).

Winter measurements of dissolved oxygen were obtained in 2004 (I.C. Ramsay and Associates 2004), 2005 (I.C. Ramsay and Associates 2005), and 2006 (I.C. Ramsay and Associates 2006). Additional winter dissolved oxygen measurements were collected in March 2008 (I.C. Ramsay and Associates 2008, Appendix D). Measurements were taken beneath the Coursier Lake ice at two locations on each occasion. Dissolved oxygen concentrations suitable to sustain rainbow trout were found at each location in all years.

Spawning surveys were attempted in June 2004, June 2005 and June 2006. However, due to elevated turbidity and streamflows, visual observations of spawners and redds was not possible. These surveys were not repeated past 2006 due to ongoing poor visibility.

4.0 PLANNED 2009 ACTIVITIES

4.1 Revegetation

The following revegetation works are scheduled for 2009:

- Formal regeneration survey of all Strata to determine if stocking requirements are being met.
- Walkthrough of Stratum C to determine if the area brushed in 2007 requires further treatment.
- Assess objectives and recommendations for Stratum B based on results of the 2009 regeneration survey.

4.2 Aquatic Biophysical Assessment

The fisheries and biophysical assessment planned for 2009 is restricted to an evaluation of the restored outlet channel for performance and integrity.

4.3 Schedule of Activities

The schedule of completed activities and future monitoring and assessments are shown in Table 1.

Table 1: Schedule of Activities

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Fish and Fish Habitat Assessment	**C**	**C**	**C**	**C**		**C**		**x**			**x**
Spawning and Redd Counts		**C***	**C***	**C***	**C***						
Winter dissolved oxygen sampling		**C**	**C**	**C**		**C**		**x**			
Limnology and temperature		**C**	**C**	**C**		**C**		**x**			**x**
Outlet channel evaluation		**C**	**C**	**C**	**C**	**C**	**x**	**x**	**x**	**x**	**x**
Vegetation surveys			**C**		**D**	**D**		**x**			
Annual Report to EAO		**C**	**C**	**C**	**C**	**x**					

C = complete
D = deferred
***** = Due to turbid stream conditions this was attempted but not successfully completed
x = Future activity

5.0 REFERENCES

1. BC Hydro. July 2003. Coursier Dam Decommissioning Project, Environmental Management Plan, Engineering Report E139.

2. Ramsay, I.C. and Associates, 2004. Fish Habitat Assessment 2003 Following the Coursier Dam Decommissioning Project. March 2004.

3. Ramsay, I.C. and Associates, 2004. Coursier Lake Winter Dissolved Oxygen Reading 2004, Letter from March 2004.

4. Ramsay, I.C. and Associates, 2005. Coursier Lake Winter Dissolved Oxygen Reading 2005, letter from March 2005.

5. Ramsay, I.C. and Associates, 2006. Coursier Lake Winter Dissolved Oxygen Reading 2006, Letter from March 2006.

6. Ramsay, I.C. and Associates, 2007. South Cranberry Creek Summary of the 2006 Biophysical Assessment Following the Coursier Dam Decommissioning Report. April 2007.

7. Ramsay, I.C. and Associates, 2008. Coursier Lake Winter Dissolved Oxygen Reading 2008, Letter from March 2008.

8. Ramsay, I.C. and Associates, 2009. Draft South Cranberry Creek Watershed Summary of the 2008 Biophysical Assessment Following the Coursier Dam Decommissioning Report. March 2009.

9. Wilson, Brent, 2009. Coursier 2008 Revegetation Activities, Inter-office memo, June 2009.

APPENDIX A: PROJECT APPROVAL CERTIFICATE

1. Coursier Dam Decommissioning Project Status Report No. 7 to Environmental Assessment Office, updated to June 2009

2. Coursier Lake Inspection Checklist (completed July 27, 2008)

COURSIER DAM DECOMMISSIONING PROJECT
STATUS REPORT #7

ENVIRONMENTAL ASSESSMENT OFFICE
JUNE 2009

1. Status of Activities Required by Project Approval Certificate:

Condition	Status
5	Completed - Post-commissioning works monitoring and reporting program submitted to the CWR on April 28, 2005
8	Completed
9	Completed - Traditional Use Species planting plan is in place and implemented during summer 2004.
10	Completed

2. Permits, Licenses and Authorizations:

Authority	Permit/Licence/Authorization	Status
Natural Resources Canada	Explosives licence	
DFO	Harmful alteration	Received 30 July 2003 -#5300-10-067
Coast Guard	Navigable Waters Act	Exemption received 22 Sept 2003 - NWP File 8200-03-8095
MOT	Oversize/Overweight vehicles permit	N/A
	Storage and dispensing fuels	N/A
MOF	Licence to cut	Obtained
L&WBC	Licences of occupation	Obtained
ME&M	Quarry permit	Obtained
BCUC	Order	Received 8 July 2003 - Order #G-41-03
CWR	Permit/Order to decommission	Received - July 2003 - Order D360000 01
L&WBC	Changes about stream	Received 2 July 2003 - File A4-1771
WL&AP	Fish salvage	Received 18 July 2003 - Permit #03-4-0986

3. BC Hydro Commitments and Assurances:

a) Environmental Management Plan

		Status
1	BC Hydro will provide copies of the final draft of the EMP to the SFC, the ONA and interested government agencies who may then direct any additional comments to DFO and the Comptroller of Water Rights for consideration as part of the permit authorisation process.	Completed, Final EMP issued in July 2003
2	All contractors and on-site personnel will be required to comply with the EMP.	Complete
3	BCH will retain an Environmental Monitor who will be responsible for ensuring that the environmental requirements of the EMP are adhered to, and will report to agencies as required by the EMP.	Complete - Mr. Ian Ramsay (I.C. Ramsay & Associates) was retained
4	The Environmental Monitor survey for bird nests within the work area immediately prior to starting construction work and report results to Canadian Wildlife Service. Trees slated for removal will be removed as early in the construction period as possible, to avoid effects on established nests.	Complete
5	Issues with regard to blasting and work around nesting birds will be addressed.	Complete
6	All instream work will be conducted in the dry, and fish will be salvaged and isolated from the work areas.	Complete - all instream work was completed in the dry
7	BC Hydro will complete a Fish and Fish Habitat Mitigation and Compensation Plan as part of its Environmental Management Program and to implement the plan to achieve No Net Loss of the productive capacity of fish habitat for the south Cranberry Creek/Coursier Lake system relative to pre-dam conditions.	Complete
8	If excavated dam material (spoilage) is deposited in Spoil Area A, the berm of the existing dyke of Spoil Area will be raised as necessary to mitigate risk of sediment releases into First Creek.	Complete - Spoil Area A was not used
9	Channel rewatering will be done slowly to minimize the sedimentation potential.	Complete - channel rewatering was completed over 4 days after removal of the cofferdam on 20 Sept and cessation of pumping on 21 Sept. 2003

b) Dam Safety

10	BC Hydro will develop a post-decommissioning works monitoring and reporting program; submit the program to the comptroller of Water Rights ("CWR") for review and approval; implement the monitoring and reporting program to the satisfaction of the CWR; and where instructed by the CWR, remediate any future structural defects, insufficiencies or failures of the decommissioning works.	2008 Post-decommissioning works monitoring report is attached to this appendix.

c) Archaeology

11	BC Hydro will, following the drawdown of the reservoir and prior to the start of revegetation activities within the reservoir, complete an Archaeological Impact Assessment of the land area within the reservoir between elevations 1274 metres and 1266 metres to the satisfaction of the Archaeology Planning and Assessment Branch of the Ministry of Sustainable Resource Management and implement any further measures identified by the Archaeology Planning and Assessment Branch.	Complete. AOA sent to Archaeological Branch on March 31, 2004. There was no recommendation for an AIA in the AOA.
12	If traditional use information indicates aboriginal use of areas, beyond the land area within the reservoir between elevations 1274 metres and 1266 metres, that will be disturbed BC Hydro will, where required, expand the scope of the Archaeological Impact Assessment.	Complete. No areas have been identified outside of the drawdown area by the TUS.

d) Revegetation Plan

13	BCH will adjust the boundaries of the revegetation plan to accurately reflect the previous forest and wetland areas. Wetland habitats are being retained and will be left to recover naturally.	Complete. Final report on Post-Decommissioning Revegetation strategy was issued on December 30, 2003.
14	Grass areas will be mechanically treated to facilitate the establishment of conifers in areas targeted for forestry.	Complete summer 2004
15	With regard to willow plantings, elevation, aspect and environmental considerations to harvesting willows will be considered when selecting a source and willow planting survival will be maximized by planting willow whips appropriately. Willow planting will include cottonwood and will be extended to include Westside Creek.	Complete summer 2004
16	Vegetation surveys will be conducted to determine survival success, and fill planting will be considered if required.	Survey conducted in summer 2007. Findings reported in 2007 EAO Annual Report. Vegetation survey planned for 2008 but deferred to 2009 due to early snowfall. .

d) Revegetation Plan - (Cont'd)

17	BCH will extend conifer planting to microsites along Cranberry Creek upstream of Coursier Dam; large planting stock will be used and 2+0 stock will be grown.	Completed in 2005
18	The entire drawdown zone will be revegetated including both the RRZ and RMA.	Complete summer 2004.
19	Grass seed in general will only be used when erosion is considered to be a problem. Erosion will not be a problem if prompt development of indigenous vegetative communities occurs. If this development does not occur, then grass seedlings will be done as prescribed.	Complete post-consideration 2003.
20	Post-decommissioning vegetation monitoring will be conducted according to measurable targets and objectives for the revegetation program.	Included in the revised revegetation plan (see #13) Ongoing
21	BC Hydro and its contractors will inspect and clean all equipment and vehicles before entry to the project area. The revegetation program will include monitoring for project site weed infestations and BC Hydro will recommend and implement management control options where necessary.	Ongoing

e) Cumulative Effects

22	Should the AES hydroelectric project proposal proceed on Lower Cranberry Creek, BCH will be referred to in the review process as a permit holder in the vicinity of the project. BC Hydro will review the material provided and discuss appropriate direction (e.g. environmental management planning) with the appropriate referring agencies.	No activity

f) First Nations

23	BC Hydro will provide copies of the detailed design for the restoration channel to the SFC and the ONA who may then direct any additional comments to DFO and the Comptroller of Water Rights for consideration as part of the permit/authorization process.	Complete. Comments on final design received form SFC.
24	A traditional use reforestation species identification and sourcing study will be commissioned to identify appropriate species/sources and costs of material. BC Hydro will consider the planting of traditional species subject to costs and availability of appropriate species.	Traditional Use Studies have completed. SFC have completed a TUS planting plan and implemented Phase 1 and 2 in July 2004. Part of Phase 2 planting was done in summer 2005. Phase 2 planting complete summer 2006.

g) Navigation

25	BCH will submit an application for exemption under Section 5 (2) of the NWPA at the permitting stage of the project.	N/A
26	BCH will address risk to public safety for potential boaters on the decommissioned campsite located at the upstream end of the reservoir.	Complete

h) Monitoring

27	BC Hydro will monitor and report on the revegetation program, restoration channel and other works for up to ten years upon completion of the dam decommissioning. [EAO Note: Timeframes for ongoing project monitoring by BC Hydro may be adjusted where the appropriate federal or provincial permitting authority considers necessary.]	Annual Reports submitted to EAO for 2004, 2005, 2006, 2007 and 2008.
28	A monitoring program will be conducted for determining whether natural stream flows have succeeded in re-establishing habitat and determining the stability of tributary stream channels.	Baseline field survey complete September 2003. Field surveys complete 2004, 2005, 2006, 2007 and 2008.
29	BC Hydro will monitor lateral bank stability; conduct fish habitat and spawning habitat assessments, provide monitoring reports to interested agency and First Nations representatives implement remedial measures where long term problems are identified.	Lateral bank stability and fish habitat assessments completed in 2003, 2004, 2005, 2006 and 2008. No long term problems have been identified. .
30	BC Hydro will submit written reports on the status of the Project and compliance with the Conditions of the Environmental Assessment Certificate to EAO; • two weeks prior to the start of excavation of the notice in the dam; • one month after completion of the restoration channel; • one months prior to the start of revegetation activities in 2004; and • annually, for five years beginning in 2004 or until relieved of the obligation by the EAO.	Annual Reports submitted and accepted by EAO in 2005, 2006, 2007 and 2008. Fifth Annual Report submitted with this table.

INSPECTION CHECKLIST

INSTRUCTIONS

Record the condition of each item as follows:

S = Satisfactory. No significant defects observed.

F = Fair. Will fulfil intended purpose. Maintenance may be required.

P = Poor. May not fulfil intended purpose. Repair or maintenance required.

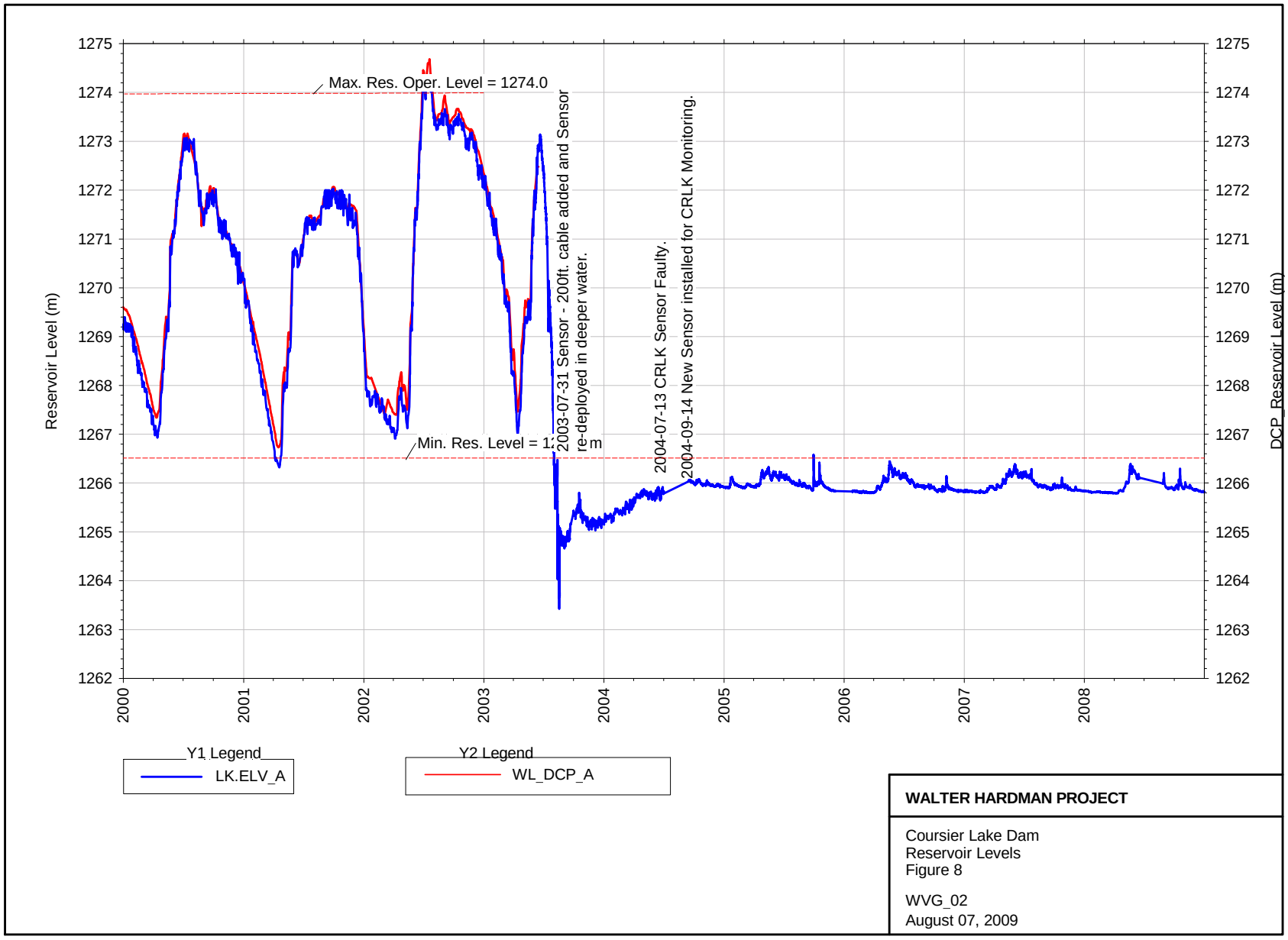
U = Unsatisfactory. Will not fulfil intended purpose. Repair or maintenance required.

\- = Not inspected. Give reasons under "Remarks/Recommendations".

Project:	Coursier Lake Decommissioned Works
Date of Inspection:	27 July 2008
Reservoir W/L Elev.:	Coursier Lake, 1266.0 m (ADAS rdg.)
Weather:	Cloudy, 22^{o}C
Inspected by:	Wim Van Gassen
Date of Last Inspection:	23 June 2007

Feature/Instrumentation	*Condition*	*Remarks/Recommendations*
1.0 <u>DECOMMISSIONED DAM</u>		Dam decommissioned in 2003. A channel was excavated through the centre of the dam. This excavation re-established the pre-dam lake elevation of approximately 1265.3 m. Details are documented in the Project Completion Report prepared by Engineering.
(a) Crest	S	No erosion or instability noted.
(b) Upstream slope	S	No erosion or instability noted.
(c) Downstream Slope	S	No erosion or instability noted.
(d) Instrumentation	-	All instrumentation decommissioned or destroyed during the project, with the exception of the lake level sensor
(e) Reservoir Level	S	The original lake level sensors connected to ADAS and to the PI system were

Feature/Instrumentation	*Condition*	*Remarks/Recommendations*
		decommissioned in 2003, along with removal of the dam crest instrumentation shack. A new lake level sensor was installed by the UCG Civil Crew in 2003, and is currently connected to ADAS.
2.0 RESTORED CHANNEL		
(a) Outlet Structure	S	Channel reconnected to lake via constructed section through centre of dam. This reconstructed channel satisfactorily passed a significant flood event in October 2003, estimated at a 100 year return period event.
(b) Riffles	S	No erosion noted.
(c) Pools	S	No erosion noted.
(d) Flood Plain	S	
3.0 DECOMISSIONED SPILLWAY	S	Spillway chute removed and area re-contoured.
4.0 SPOIL AREAS		
(a) Spoil Area A	S	
(b) Spoil Area B	S	Minor erosion at the northern edge of Spoil Area B
5.0 ACCESS ROADS	F	Access via Hall Mountain and Dry Creek Roads. Roads in fair condition.



WALTER HARDMAN PROJECT

Coursier Lake Dam
Reservoir Levels
Figure 8

WVG_02
August 07, 2009

APPENDIX B: COURSIER LAKE POST-DECOMMISSIONING 2008 SUMMARY OF REVEGETATION ACTIVITIES

BC hydro

ENGINEERING

Report No. E737
August 2009
WPR-2728

BC hydro
FOR GENERATIONS

Inter-office memo

To: Carol Lamont

From: Brent Wilson

CC: Adam Croxall

Subject: Coursier 2008 Revegetation Activities

---

27 June 2009

Management of the Coursier revegetation commitments has been transferred to the Upper Columbia Generation Area. Adam Croxall (Sr. Environmental Coordinator) based out of the Revelstoke Office will assume responsibility for activities starting in 2009.

Ian Ramsey (I.C. Ramsay and Associates Consulting) has been compiling the 2008 Coursier Dam Decommissioning Report for the British Columbia Environmental Assessment Office and has requested a summary of revegetation activities. They are as follows:

2008 ACTIVITIES

Revegetation Activities

Completion of the Coursier Dam decommissioning and the start of the revegetation of the former Coursier Reservoir occurred in 2004 (Coursier Dam Decommissioning Annual Report, 2004). Planting activities were completed in 2005.

No revegetation activities were completed in 2008. The 2008 scheduled formal survey of the entire basin was attempted in October 2008 but was deferred due to early snowfall and will be completed in the summer of 2009.

Scheduled Revegetation Acitivities

The following revegetation works should be scheduled for 2009:

- Formal regeneration survey of all Strata.
- Walkthrough of Strata C to determine if area brushed in 2007 requires further treatment.
- Assess objectives and recommendations for Strata B based on results of 2009 regeneration survey.

APPENDIX C: SOUTH CRANBERRY CREEK BIOPHYSICAL ASSESSMENT 2008

BC hydro

ENGINEERING

Report No. E737
August 2009
WPR-2728

South Cranberry Creek
Biophysical Assessment 2008

Following the Coursier Dam Decommissioning Project

Prepared for

BC hydro

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March 2009

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Arc Environmental Ltd

EXECUTIVE SUMMARY

Watershed Information

Watershed Code:	300-735400-63000
Waterbody Identifier:	00313UARL
UTM at Lake Outlet:	11.0422087E.5618554N
Order at Lake Outlet:	2
Number of Tributaries:	2 main tributaries, 8 ephemeral
Elevation:	1264.5m
TRIM Map:	082L09
BEC Zone:	Transitional between ICH and ESSF

Lake Sampling Summary

Lake Survey Type:	Reconnaissance
Water Surface Area:	47 hectares
Max. Depth:	8m
Secchi Depth:	0.9m
Shoreline Perimeter:	3.23 kilometers
Lake Length:	1.25 kilometers
Number of Islands:	0
Fish Species Present in Lake:	RB

Changes in Channel Morphology Following the Coursier Dam Decommissioning.

The original objectives of the fish and aquatic monitoring component were:

- To monitor and assess bank stability, lateral movement, and erosion in the previously innundated drawdown zone and to recommend any physical interventions that may be required to achieve channel equilibrium.
- To monitor and assess the biophysical, fish and aquatic habitat in Upper South Cranberry Creek, Westside Creek, and other Coursier Lake tributaries.
- To monitor and assess the restored outlet channel to evaluate channel performance and integrity.
- To monitor and assess Coursier Lake limnology to detect biotic and physical responses to dam decommissioning.

These objectives have been achieved by establishing 2003 baseline biophysical information and completing subsequent 2004, 2005, 2006, and 2008 biophysical assessments.

During the Decommissioning Project in the summer/fall 2003, Coursier Lake was returned to its' historic elevation of 1264.5m. A baseline assessment was conducted following the decommissioning in 2003 (I.C. Ramsay and Associates 2004). A 2008 assessment was completed in August and September 2008 to provide qualitative and quantitative changes in the fish habitat and channel stability that has occurred since the 2003 decommissioning. Assessments were conducted on the restored outlet channel, Upper South Cranberry Creek, Westside Creek, and associated tributaries. SHIM mapping was used and MWLAP Level 1 Stream Survey methodologies provided in *Lake*

and Stream Inventory: Standards and Procedures (RIC 2001)[1]. The inventory was tailored to focus on the GPS position of specific features, namely reservoir downcutting and erosion due to the reduction in reservoir levels from 1274m down to 1264.5m above sea level.

The Upper South Cranberry Creek watershed was divided into segments of uniform habitat, gradient, substrate and riparian conditions. Global Positioning System (GPS) coordinates of stream features were captured using a Trimble Geo-XT GPS unit capable of sub-meter post-processing accuracy.

SOUTH CRANBERRY CREEK OUTLET CHANNEL

The Coursier Outlet Channel was created in the footprint of the Coursier Dam during the Coursier Dam Decommissioning Project in 2003. The sinuous channel is approximately 170m long with 6 pool/riffle complexes that enable upstream and downstream fish migration between Cranberry Creek and Coursier Lake. Instream rearing habitat, potential overwintering habitat, and potential velocity refuge exists in the pools. Instream habitat was enhanced by the addition of large woody debris salvaged from the construction site during the dam decommissioning.

In 2008 no changes in channel morphology were detected downstream of the outlet channel. In addition, the outlet channel morphology was not significantly altered following the 2008 freshet; the channel appears very stable.

We recorded minor right bank scour between riffle #3 and riffle #4 (Photo 1, Appendix 1).

Panoramic photographs of the outlet channel illustrate the stability of the channel and the incremental increase in riparian vegetation over time (Photos 31&32, Appendix 1).

Tables 1&2 summarize the morphology of the Upper South Cranberry Creek basin and summarize the morphological changes since 2003. Figure 3 provides the location of active erosion and morphological changes that have been recorded in the South Cranberry Creek Watershed since 2003.

COURSIER LAKE

No significant morphological changes were recorded along the Coursier Lake shoreline in 2008. The historic shoreline, evident as gravel and cobble substrate in areas, is stable at the current lake elevation of 1264.5m above sea level. We did not record significant changes or erosion from the slide that was previously recorded on the West side of the lake (Photo 4, Appendix 1).

We also did not record significant additional sediment deposition from 2006 to 2008 at the outlet of Upper South Cranberry Creek into the lake (Photo 5, Appendix 1). We will continue to monitor this deposition in the future.

WESTSIDE CREEK

[1] For more detailed information on the standards utilized refer to: http://srmwww.gov.bc.ca/risc/pubs/aquatic/recon/index.htm).

In the former Coursier Reservoir drawdown zone between 1265-1284m above sea level, Westside Creek consists of two distinct segments (reaches). The Westside Creek segment 1 channel is an aggrading, low gradient, alluvial fan adjacent to Courser Lake. In 2008 Westside Creek continued to remain dynamic downstream of the logging road culvert within the previously inundated Coursier floodplain.

Approximately 20m downstream of the road culvert a debris jam splits the channel into two main channels: a northern channel and a southern channel. The predominant flow was in the southern channel during our assessment, however, at high flow both channels would be flowing. In 2008 we recorded some minor new erosion in the southern channel, continued yet slowed channel degradation in segment 2 and bed load deposition in segment 1. The extent of gravel deposition continues to migrate downstream from segment 2 into segment 1, however, the rate of gravel movement appears to have slowed and the creek is beginning to channelize and abandon some of the secondary stream channels in segment 1 (see the Watershed Channel Assessment Map, Appendix 4) (Photo 6, Appendix 1).

UPPER SOUTH CRANBERRY CREEK

No significant morphological changes were recorded in Segments 1, 2 and 6 of Upper South Cranberry Creek. Two previously recorded erosion sites were still active in Segment 2.

We recorded active erosion of two previously recorded erosion sites within Upper South Cranberry Creek Segment 3. The two sites were recorded as a separate upstream site in 2004 and a separate downstream site in 2006. The two sites are now one continuous right bank scour (Photo 7, Appendix 1).

Five previously identified erosion sites were active in Upper South Cranberry Creek Segment 4 (Photo 8, Appendix 1). We recorded two new minor bank erosion sites within the segment in 2008 (Photos 9 & 10, Appendix 1). As previously identified, the left stream channel within the segment continues to receive significantly less flow and may be isolated in the future.

In general Upper South Cranberry Creek Segment 5 continues to degrade and channelize becoming more stable. The segment still contains significant small and large woody debris in secondary channels that are gradually becoming isolated.

UPPER SOUTH CRANBERRY CREEK TRIBUTARIES AND COURSIER LAKE TRIBUTARIES

Twelve tributaries to Coursier Lake and Upper South Cranberry Creek over 0.5m channel width were identified. No significant morphological changes were recorded in Upper South Cranberry Creek Tributaries in 2006. These tributaries are numbered 1- 5, 11& 12.

We recorded continued channel degradation in segment 2 and deposition (aggradation) within the Coursier Lake Tributaries 6 & 7 in 2006. These events were not significant and unstable, however, the degradation and aggradation will gradually continue in the coming years.

No significant morphological changes were recorded in the other Coursier Lake Tributaries identified as tributaries 8-10.

Tributary (channel) level morphologcal changes based on instream parameters will be more evident over time. Detectible morphological changes thus far appear mainly as localized events (i.e. downcutting, bank scour) and we have not detected significant changes in habitat unit level parameters (i.e. Channel Width, Bankfull Width). We plan to continue to compare video, GPS, photographic monitoring stations, and instream parameters in the coming assessments to assess channel level changes.

Fish Distribution and Sampling

The August 2008 surveys indicated the presence of rainbow trout in all the tributaries surveyed, as well as, the lake. The size and age of rainbow trout captured in the streams suggests a dominance of young age-classes (0+ and 1+). The fish captured in Coursier Lake were larger and reflected a greater range and older age-classes (1+ to 5+) than those captured from the streams (0+ to 2+).

The confirmed presence of young-of-the-year in each of the tributaries suggests that rainbow trout had likely spawned in each of streams surveyed. The presence of multiple age-classes (0+ to 5+) of rainbow trout captured from the streams and the lake suggest that currently the habitat requisites for population maintenance are present.

Limnological Assessment

Lake limnological information suggests that Coursier Lake may be oligotrophic based on possible phosphorous limitations and Chlorophyll ‘a’ concentrations (Nordin 1985 and Appendix 3).

Stream Temperature

Two data loggers were stationed in tributaries into Coursier Lake, one logger at the in the outlet channel and one logger in First Creek in 2003. To date, temperature data has been collected from December 2003 to September 2008. All temperatures recorded within Upper South Cranberry Creek above the lake, Westside Creek, the Coursier Lake outlet channel and First Creek remain between 0-2 ^{o}C during the winter months (November to April). In May the water temperatures gradually increased to maximums in July and August. The outlet channel reaches the highest maximum yearly temperatures above 20^{o}C (July 2005), followed by maximum temperatures of 16.4 ^{o}C in Westside Creek (July 2004), 14.5 ^{o}C in Upper South Cranberry Creek (August 2005), and 13 ^{o}C in First Creek (August 2004 and 2005).

Scheduled Monitoring and Recommendations for 2010

A schedule of future monitoring and reporting activities is noted in the table below.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Fish and Fish Habitat Assessment	**C**	**C**	**C**	**C**		**C**		**x**			**x**
Spawning and Redd Counts		**C***	**C***	**C***							
Winter dissolved oxygen sampling		**C**	**C**	**C**		**C**		**x**			
Limnology and temperature		**C**	**C**	**C**		**C**		**x**			**x**
Outlet channel evaluation		**C**	**C**	**C**	**C**	**C**	**x**	**x**	**x**	**x**	**x**
Vegetation surveys (by others)			**C**		**C**		**x**				
Annual Report to EAO		**C**	**C**	**C**	**C**	**x**					

C = complete
C* - Due to turbid stream conditions this was attempted but not successfully completed

The surveys at Coursier Lake and the stream sites have been designed to develop a practical and cost-effective monitoring program post-decommissioning of the BC Hydro dam.

Following the 2008 assessment we recommend:

- That the outlet channel is assessed to ensure channel stability and identify any issues following the 2009 freshet.
- That the temperature probes are downloaded in June 2009 to avoid omission of data.
- Based on the results from August 2008, the summer sampling period (mid-August) appears sufficient to identify young-of-the-year (0+) rainbow trout in the stream sites and hence infer their use by spawning fish. Although total captures are low in the stream sites it is anticipated the determination of CPUE, in stream sites and Coursier Lake, may be sufficient to monitor relative abundance over time. In addition the morphometric characteristics will be used to identify trends over time; for example, fork length, weight, condition factor (K), and morphometric characteristic-at-age.
- The summer limnological survey in combination with a winter one to determine temperature and dissolved oxygen profiles would likely be sufficient to characterize the lake's trophic status and the risk from winter-kill.
- It is also possible to continue with the option of a September sampling period if after the completion of an August survey the results appear inadequate to describe the fisheries resources and/or trophic status of the lake.

Acknowledgements

Brent Magnan assisted with instream geomorphological assessment, GPS data capture and GIS metadata compilation. The assessment could not be completed without the assistance of Brent.

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APPENDICES

1.0 INTRODUCTION

1.1 Project Scope

Coursier Dam was constructed on South Cranberry Creek in 1963 to provide upstream storage for the Walter Hardman Generating Station. The dam had a long history of safety incidents and deficiencies and BC Hydro chose to decommission the dam during the summer of 2003.

The decommissioning project resulted in the following changes to the aquatic habitat at Coursier Lake:

- The reservoir elevation was reduced from the maximum operational level of 1274m to the historic lake level of 1264.5m.
- The inlet tributaries now cross previously inundated reservoir soils and flow into Coursier Lake.
- The outlet channel was constructed to pass Coursier Lake outflows and to provide fish habitat at the site of the dam excavation.

This document summarizes the biophysical, fish and aquatic monitoring and assessment that was conducted in the 2008 calendar year and represents the ***fifth monitoring phase*** *following the completion of the Coursier Dam Decommissioning Project in 2003*. The monitoring and assessment will be conducted for a period spanning ten years until 2013 as specified in the BC Hydro Environmental Management Plan (BCH 2003).

1.2 Objectives

The objectives of this monitoring project are to:

- To monitor and assess the bank stability, lateral movement and erosion in the previously inundated draw-down zone.
- To monitor and assess the biophysical, fish and aquatic habitat of Cranberry Creek, Westside Creek and the other tributaries of Coursier Lake.
- To monitor and assess the restored outlet channel to evaluate channel performance and effectiveness.
- To monitor and assess the water quality of Cranberry Lake (formerly Coursier Reservoir), the inlet tributaries, and the outlet channel.

1.3 Location and Access

Coursier Lake is located approximately 30 km south of Revelstoke, British Columbia (Figure 1). The site is located in the transition zone between the 'Interior Cedar – Hemlock' and the 'Engelmann Spruce – Subalpine Fir' Biogeoclimatic Zones. Access is off Highway 23 on existing logging roads; 'Dry Creek Road' and 'Cranberry Road'.

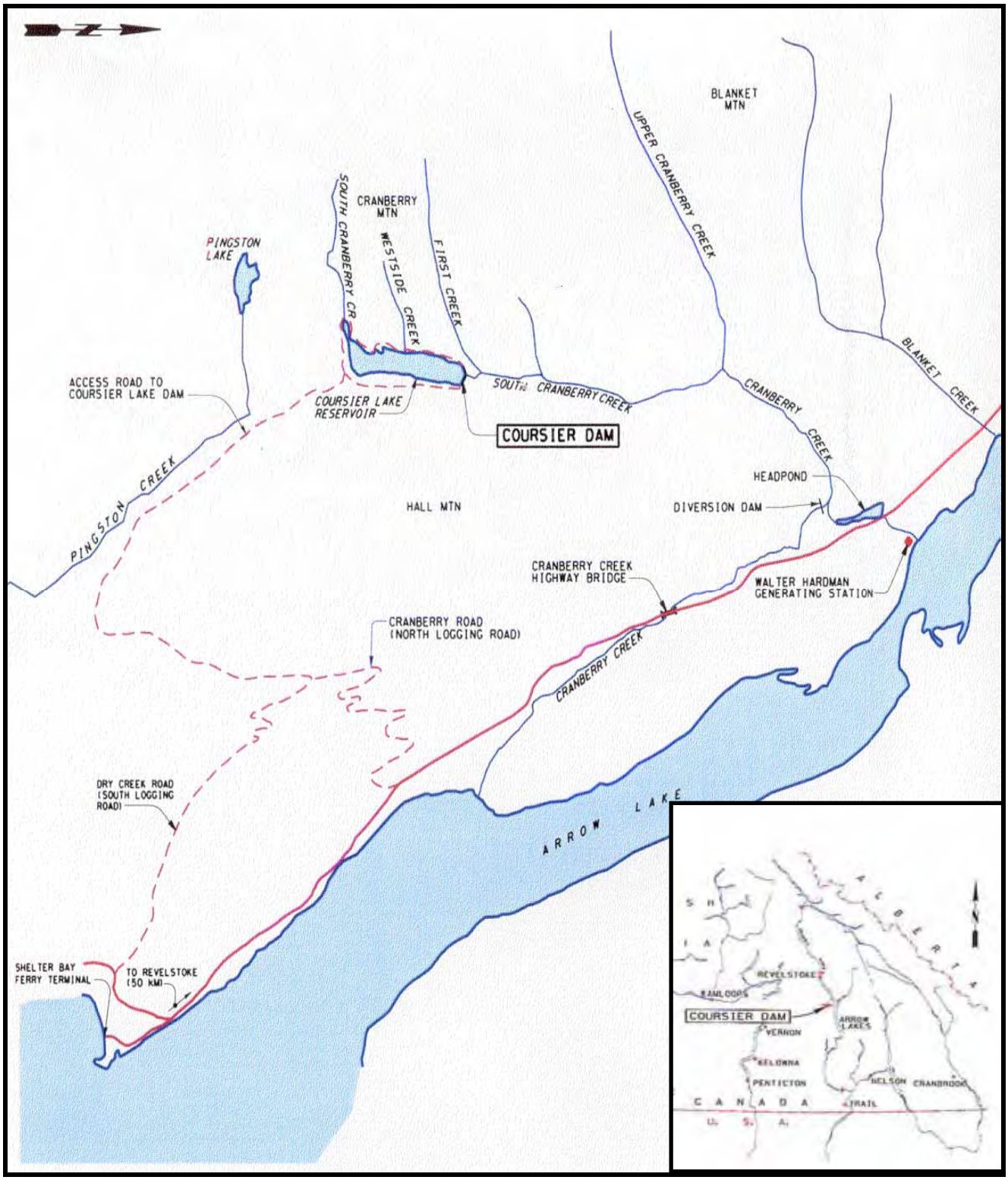

FIGURE 1: Location of the Coursier Dam

2.0 RESOURCE INFORMATION

A detailed description of all local resources can be found in the Coursier Dam Decommissioning Project Environmental Management Plan (BCH 2003) and the application to the Environmental Assessment Office (BCH 2002). Below is a brief summary of the local resources.

2.1 Fisheries Resources

Rainbow trout (*Oncorhynchus mykiss*) are the only fish observed in Cranberry Creek upstream of the Walter Hardman diversion structure. The Ministry of Environment, Lands, and Parks (now known as the Ministry of Sustainable Resource Management) stocked Coursier Lake with 4000 rainbow trout in 1986 and 1987. These fish have propagated in the lake and a self sustaining population exists (BCH 2003, Ministry of Water Land and Air Protection, 2003).

2.2 Vegetation Resources

The Coursier Lake Reservoir is transitional between two biogeoclimatic zones: the Engelmann Spruce – Subalpine Fir Columbia Wet Cold Variant (ESSFwc1) and the Interior Cedar – Hemlock Wells Gray Wet Cool Variant (ICHwk1). Subalpine fir is the dominant climax species in the area, however, western red cedar is not uncommon and an indicator of the ICH influences (BCH 2003).

The reservoir drawdown area has been influenced by reservoir operations and predominantly contains sedge and reed canary grass as well as willow stems planted during drawdown operations in 1993.

2.3 Wildlife Resources

The forested area (Sub-Alpine Fir with Western Red Cedar) surrounding the reservoir contains mature and replanted conifers (less than 5 years old). Ungulate species inhabiting the area include moose, mountain caribou, elk, mule deer, and white-tailed deer. Ungulates likely utilize the Coursier Lake Reservoir area in the summer and overwinter at lower elevations (BCH 2003, Meidinger and Pojar 1991).

In addition, black bear, wolverine, lynx, pine martin, and river otter have been confirmed at the reservoir. Within the nearby Pinkston Creek watershed grizzly bear, coyote, wolf, cougar, and bobcat have been confirmed or are suspected to occur.

Field studies indicate that 27 bird species including waterfowl, shorebirds, osprey, hawks, owls, woodpeckers and several passerine species inhabit the area. Amphibian species documented in the nearby Pingston Creek watershed include adult and tadpole Boreal Toad and Spotted Frog, the Pacific Tree Frog, and potentially the Long-toed Salamander. No rare or endangered amphibian species are expected to occur in the Project Area (BCH 2002).

3.0 SAMPLING METHODS

All sampling occurred when the lake elevation was at approximately 1264.5m above sea level. This report summaries sampling completed in the 2008 calendar year following the completion of the Coursier Dam Decommissioning Project in 2003.

3.1 Fish Habitat Assessment

During the Decommissioning Project in the summer/fall 2003, Coursier Lake was returned to its' historic elevation of 1264.5m. A baseline biophysical assessment was conducted following the decommissioning in 2003 (I.C. Ramsay and Associates 2004). The 2008 biophysical assessment was completed on September 20th and 21st, 2008 to provide qualitative and quantitative changes in the fish habitat and channel stability that has occurred since the 2003 decommissioning. Assessments were conducted on the restored outlet channel, Upper South Cranberry Creek, Westside Creek, and associated tributaries. SHIM mapping was used and MWLAP Level 1 Stream Survey methodologies provided in *Lake and Stream Inventory: Standards and Procedures* (RIC 2001)[2]. The inventory was tailored to focus on the GPS position of specific features, namely reservoir downcutting and erosion due to the reduction in reservoir levels from 1274m down to 1264.5m above sea level.

The Upper South Cranberry Creek watershed was divided into segments of uniform habitat, gradient, substrate and riparian conditions. Global Positioning System (GPS) coordinates of stream features were captured using a Trimble Geo-XT GPS unit capable of sub-meter post-processing accuracy.

Stream Parameters measured during the physical fish habitat assessment included but were not limited to:

- Mean Channel Width – the channel width is the width of the bankfull flood stage of the stream channel. This is often denoted by a change in vegetation from bare ground, with no trees, moss or grasses, to vegetated ground with trees, moss, or grasses. Channel width was taken at a minimum of six locations per segments and averaged to represent the channel width of the entire segment.
- Mean Wetted Width – the wetted width is the width of the wetted portion of the stream channel at the time of the inventory. Wetted width was obtained at a minimum of six locations per segment and averaged to represent the channel width of the entire segment.
- Mean Pool Depth – the residual pool depth is the difference between the maximum pool depth and the pool outlet. A minimum sampling of six representative pools per stream segment were recorded.
- Gradient – gradient or the slope of the channel bed is measured using an Abbney level. At least one measurement was obtained per stream segment over a length of at least 60m along the stream to provide gradient in % (e.g. 15% gradient).
- Cover – cover is any structure in the wetted channel that provides hiding, resting, or feeding places for fish. Cover can be provided by woody debris, boulders, undercut

[2] For more detailed information on the standards utilized refer to: http://srmwww.gov.bc.ca/risc/pubs/aquatic/recon/index.htm).

stream banks, deep pools, and vegetation. Stream cover was visually estimated and recorded.

- Large woody debris distribution – large woody debris cover estimates include the presence and the amount of functional large woody debris within the stream channel. Functional LWD is defined as woody debris greater than 10cm in diameter and attached or embedded in the stream or bank (i.e root wads). The abundance of LWD and distribution within the stream channel was recorded for each segment.
- Stream Bank Characteristics – the left and right bank refer to the stream bank being described when the observer is facing downstream. Each stream bank was described in terms of the shape of the stream bank (i.e. v-shaped, sloping, overhanging or undercut bank) and the bank texture or material comprising the stream bank. In addition, the dominant riparian vegetation (e.g. coniferous forest), and vegetation stage (e.g. mature forest) on each stream bank were recorded.
- Stream Morphology – the stream morphology or stream form can be characterized by evaluating bed material, classifying the channel morphology, and recording disturbance, channel pattern, islands, bars, coupling, and confinement.
  In this portion of the assessment, the survey crew focused on channel stability by evaluating within-channel sediment storage patterns (islands and gravel bars), lateral instability, channel meander wavelength, and sinuosity (CAP 1996)[3].
- Fish Habitat Comments – any observations regarding fish habitat such as distinct spawning sites, rearing habitat, over-wintering, and potential barriers to fish migration were recorded and GPS located.
- Channel Lateral Movement – the centerline of each stream segment was GPS recorded during the entire inventory. In addition, significant point features such as erosion and migration barriers.

The GPS data was differentially corrected to provide sub-meter location accuracy and was overlain on an existing 1:5,000 BC Hydro database. The positional data and digital mapping accompany this report and can be viewed using Arcview Software. *(Arcview version 3.2 was used to create and summarize the positional data, data tables, video stream segments, and photos).*

[3] For more detail refer to: http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/channel/chan-toc.htm

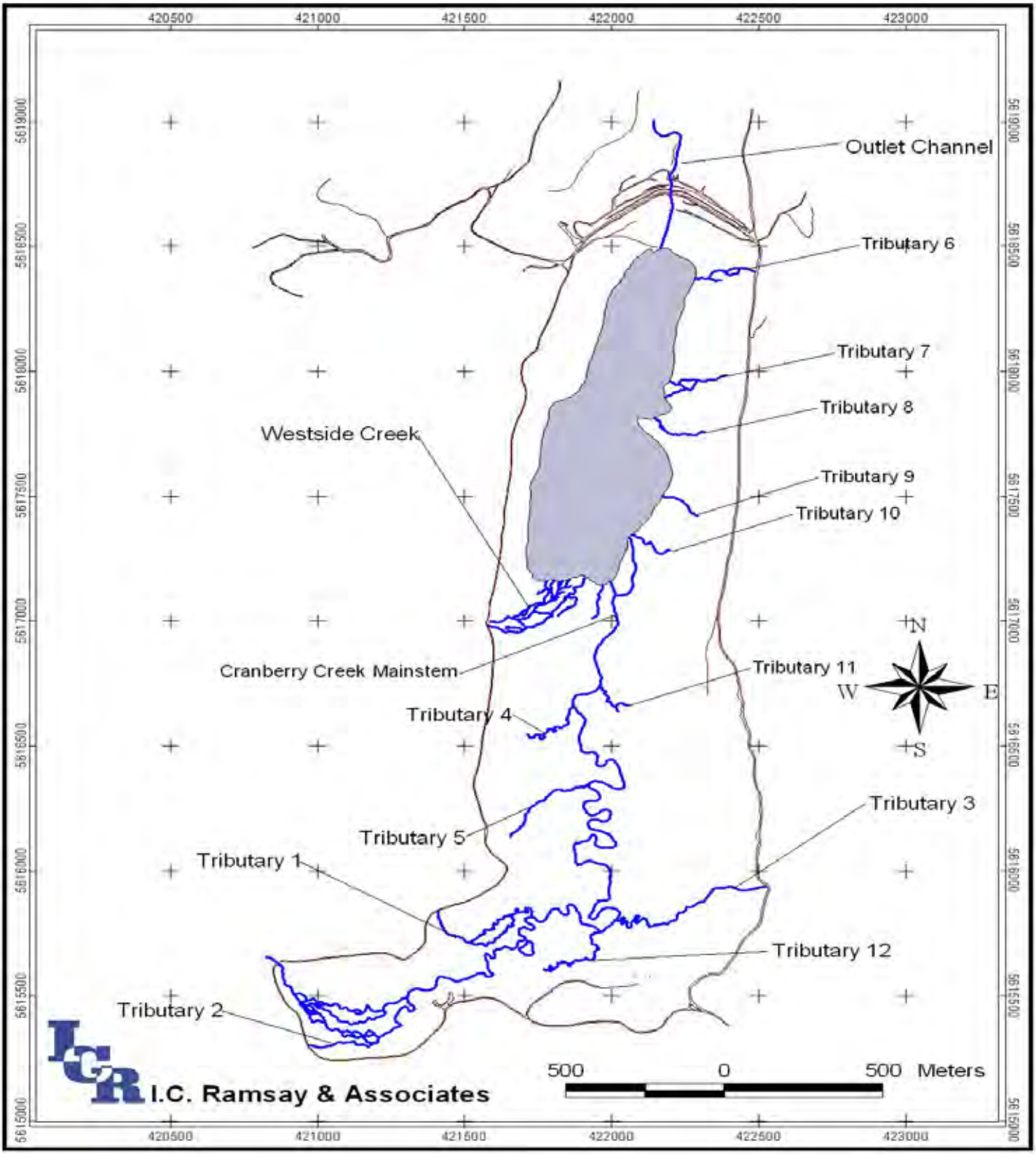

Figure 2: Location of inlet tributaries in relation to Coursier Lake and the Outlet Channel.

3.2 Fisheries Resources

The fisheries resources were assessed in Coursier Lake's two (2) significant tributary inlets, as well as in its only outlet, a total of 4 sites were assessed (Sites 1-4) in August 2008 (Table 1). The site identified as 'Site 2b' was surveyed and sampled again this year, however, 'Site 2' was not. The sites assessed in the streams and in the lake were geo-referenced (UTM). For stream sites, the coordinates indicate the downstream end. For lake sites, the coordinates indicate the location of the limnological stations, the deepest location of the gillnets, and the location of the minnow traps. Fish sampling (Ministry of Environment Permit No. CB08-47069) within the stream sites involved electrofishing and in Coursier Lake fish sampling was undertaken with gillnets (floating and sunken) and minnow traps.

Stream surveys

Electrofishing effort was standardized to a 100m long channel section and 200 electrofishing seconds (s). Electrofishing was conducted in a downstream to upstream direction. Salt was added to the stream site to increase conductivity from *in situ* measurements of <10 uS/cm and in turn improve fish capture efficiency, if necessary. The total fish enumerated was the sum of both the number captured as well as those observed (i.e. flipped) but not captured. Catch per Unit Effort (CPUE) was expressed as the total number enumerated per second (No. fish/s), per m of channel length (No. fish/m) and per area (No. fish/m2, area = wetted width * 100m section length). The fish captured and observed were identified to species, and those captured were sampled for weight (g) and fork length (FL-mm), and for those observed an estimate of FL was recorded. In addition, Fulton's condition factor (K) was determined (Ricker 1975). Scales were taken from a sub-sample of the fish captured and aged by Hamaguchi Fish Ageing Services of Kamloops.

Table 1. Summary of the location of stream and Coursier lake fish sampling and limnology sites, August 2008.

Activity	Waterbody Name	Site	Location: UTM		
Fish sampling	Cranberry Creek Outlet	Site 1	Zone 11	421982	5618710
	Westside Creek Inlet	Site 2 (***not sampled in 2008)***	Zone 11	421671	5617203
	Westside Creek Inlet*	Site 2b	Zone 11	421731	5617244
	South Cranberry Inlet	Site 3	Zone 11	421103	5615645
	South Cranberry Inlet	Site 4	Zone 11	421894	5616270
Limnology	Coursier Lake	Station 1	Zone 11	421996	5618080
		Station 2	Zone 11	421867	5617608
Fish sampling	Coursier Lake*	Floating gill net (shore)	Zone 11	421827	5617599
		Sinking gill net	Zone 11	421783	5617473
		Minnow trap 1	Zone 11	422096	5618558
		Minnow trap 2	Zone 11	421950	5618382
		Minnow trap 3	Zone 11	421677	5617493
		Minnow trap 4	Zone 11	421887	5617320
		Minnow trap 5	Zone 11	422067	5617599
		Minnow trap 6	Zone 11	422122	5618120

In addition to the fish sampling, sample sites were photographed and characterized by assessments of;

- Water temperature,
- Turbidity,
- Channel width,
- Wetted width,
- Gradient,
- Dominant and sub-dominant substrate characteristics, and
- Dominant cover characteristics.

Lake survey

Fish sampling in Coursier Lake involved the deployment of standard 6 panel multiple mesh (25 mm, 76 mm, 51 mm, 89 mm, 38 mm, 64 mm) gillnets, 2.5m deep and 90m in length. Both a floating and sinking gillnet were deployed (Table 1). In addition to gillnets, 6 minnow traps were deployed around the lake (Table 1). Sinking and floating gillnets were allowed to soak for 16.35h and 17.10h; respectively, and minnow traps for approximately 16h. CPUE was determined as the number of fish captured per hour. The fish captured were identified to species, and a sub-sample of the fish was weighed (g) and measured [fork length (FL - mm]. In addition, Fulton's condition factor (K) was determined (Ricker 1975). Scales were taken from a sub-sample of fish captured in August, and aged by Hamaguchi Fish Ageing Services of Kamloops.

3.3 Lake Limnology

Limnological samples were obtained from the following two geo-referenced (UTM) sampling stations in Coursier Lake August 20, 2008:

- Sample Station #1 (UTM: 11.421996.5618080) located in the northern section of the lake.
- Sample Station #2 (UTM: 11.421867.5617608) in the southern section of the lake.

The sample stations were chosen in the summer using a depth sounder with the intent to establish sampling points at the deepest portion of the water column in the northern and southern portions of Coursier Lake. The information collected at the limnological stations included; photographs, secchi depth (m), depth (m), dissolved oxygen and temperature profiles, and water sampling. Two water samples were collected from each of the 2 stations; surface (0.5m below the surface) and deep water (0.5 m off the bottom) samples. The water samples were analyzed by ECO Tech Laboratoyry Ltd. of Kamloops for:

- Chlorophyll a (µg/L)
- pH
- Conductivity (µS/cm)
- Acidity (as CaCO3 – pH 8.3) (mg/L)
- Total Alkalinity (as CaCO3 – pH 4.5) (mg/L)
- Nitrate (as N) (mg/L)
- Nitrite (as N) (mg/L)
- Ammonia (as N) (mg/L)
- Total Phosphorous (mg/L)
- Total Dissolved Phosphorous (mg/L)
- TKN (mg/L)
- Total Dissolved Solids (m/L)
- Total Suspended Solids (mg/L)

3.4 Stream Temperature

Remote ‘Hobo H8’ data loggers were installed in the late fall 2003 in the upper South Cranberry Creek above Coursier Lake, in Westside Creek, at the lake outlet channel created during the Coursier Dam Decommissioning project, and in First Creek. The loggers record temperature on the hour and were downloaded September 21st, 2008.

The upper South Cranberry Creek and Outlet Channel loggers were flooded likely as a result of human tampering. Both flooded loggers were sent to the manufacturer for data download. The Westside Creek and First Creek loggers were successfully downloaded in 2008.

4.0 RESULTS

4.1 Fish Habitat Assessment

Table 2 summarizes the habitat features of the Upper South Cranberry Creek watershed and Table 3 summarizes the morphological changes that have been recorded since the Coursier Dam Decommissioning project in 2003. Figure 3 illustrates the active erosion recorded following the Coursier Dam decommissioning within the South Cranberry Creek watershed.

SOUTH CRANBERRY CREEK OUTLET CHANNEL

The Coursier Outlet Channel was created in the footprint of the Coursier Dam during the Coursier Dam Decommissioning Project in 2003. The sinuous channel is approximately 170m long with 6 pool/riffle complexes that enable upstream and downstream fish migration between Cranberry Creek and Coursier Lake. Instream rearing habitat, potential overwintering habitat, and potential velocity refuge exists in the pools. Instream habitat was enhanced by the addition of large woody debris salvaged from the construction site during the dam decommissioning.

In 2008 no changes in channel morphology were detected downstream of the outlet channel. In addition, the outlet channel morphology was not significantly altered following the 2008 freshet; the channel appears very stable.

We recorded minor right bank scour between riffle #3 and riffle #4 (Photo 1, Appendix 1).

In previous years we recorded minor right bank scour between riffle #4 and riffle #5 at the mouth of a small tributary on the right bank. This area appears to have stabilized (Photo 2, Appendix 1).

The bank scour previously detected on the left bank at riffle #5 also appears to have stabilized (Photo 3, Appendix 1).

COURSIER LAKE

No significant morphological changes were recorded along the Coursier Lake shoreline in 2008. The historic shoreline, evident as gravel and cobble substrate in areas, is stable at the current lake elevation of 1264.5m above sea level. We did not record significant changes or erosion from the slide that was previously recorded on the West side of the lake (Photo 4, Appendix 1).

We also did not record significant additional sediment deposition from 2006 and 2008 at the outlet of Upper South Cranberry Creek into the lake (Photo 5, Appendix 1). We will continue to monitor this deposition in the future.

WESTSIDE CREEK

In the former Coursier Reservoir drawdown zone between 1265-1284m above sea level, Westside Creek consists of two distinct segments (reaches). The Westside Creek segment

1 channel is an aggrading, low gradient, alluvial fan adjacent to Courser Lake. In 2008 Westside Creek continued to remain dynamic downstream of the logging road culvert within the previously inundated Coursier floodplain.

Approximately 20m downstream of the road culvert a debris jam splits the channel into two main channels: a northern channel and a southern channel. The predominant flow was in the southern channel during our assessment, however, at high flow both channels would be flowing. In 2008 we recorded some minor new erosion in the southern channel, continued yet slowed channel degradation in segment 2 and bed load deposition in segment 1. The extent of gravel deposition continues to migrate downstream from segment 2 into segment 1, however, the rate of gravel movement appears to have slowed and the creek is beginning to channelize and abandon some of the secondary stream channels in segment 1 (see the Watershed Channel Assessment Map, Appendix 4) (Photo 6, Appendix 1).

UPPER SOUTH CRANBERRY CREEK

No significant morphological changes were recorded in Segments 1, 2 and 6 of Upper South Cranberry Creek. Two previously recorded erosion sites were still active in Segment 2.

We recorded active erosion of two previously recorded erosion sites within Upper South Cranberry Creek Segment 3. The two sites were recorded as a separate upstream site in 2004 and a separate downstream site in 2006. The two sites are now one continuous right bank scour (Photo 7, Appendix 1).

Five previously identified erosion sites were active in Upper South Cranberry Creek Segment 4 (Photo 8, Appendix 1). We recorded two new minor bank erosion sites within the segment in 2008 (Photos 9 & 10, Appendix 1). As previously identified, the left stream channel within the segment continues to receive significantly less flow and may be isolated in the future.

In general Upper South Cranberry Creek Segment 5 continues to degrade and channelize becoming more stable. The segment still contains significant small and large woody debris in secondary channels that are gradually becoming isolated.

UPPER SOUTH CRANBERRY CREEK TRIBUTARIES AND COURSIER LAKE TRIBUTARIES

Twelve tributaries to Coursier Lake and Upper South Cranberry Creek over 0.5m channel width were identified. No significant morphological changes were recorded in Upper South Cranberry Creek Tributaries in 2006. These tributaries are numbered 1- 5, 11& 12.

We recorded continued channel degradation in segment 2 and deposition (aggradation) within the Coursier Lake Tributaries 6 & 7 in 2006. These events were not significant and unstable, however, the degradation and aggradation will gradually continue in the coming years.

No significant morphological changes were recorded in the other Coursier Lake Tributaries identified as tributaries 8-10.

Table 2: Upper South Cranberry Creek Fish Habitat Assessment, Coursier Lake 2008

Area	Seg.	Fish Present	Habitat	Mean Bankfull Width (m)	Mean Wetted Width (m)	Mean Bankfull Depth (m)	Substrate (%)				Gradient (%)	Cover (%)	Pool Freq. (Ch.width/ pool)(%)	LWD Pieces/ Ch.Width	Comments
							Fines	Gravel	Cobble	Boulder					
South Cranberry Creek below Outlet Channel	1	Yes	Riffle/ Pool	5.2	2.9	1.1	50	20	30	--	3	80	<2 (45%)	<1	Stable channel
South Cranberry Creek (Outlet Channel)	2	Yes	Riffle/ Pool	12.6	8.7	0.95	70	10	10	10	3	60	<1 (70%)	>2	Anthropogenic channel and habitat
Coursier Lake	---	Yes	Lake	---	---	---	100	--	--	--	---	---	---	---	---
Westside Creek	1	Yes	Run/ Riffle	1.5	0.85	0.05	100	--	--	--	3	20	>4 (<30%)	1-2	Braided Channel
	2	Not Likely	Cascade/ pool	2.9	1.1	0.04	35	25	25	15	8	20	>4 (<20%)	1-2	Potential upstream barriers
Upper South Cranberry Creek	1	Yes	Run	7.9	6.0	0.8	100	--	--	--	0.5	80	<1 (60%)	2-4	Grass/shurb layer evident
	2	Yes	Riffle/ Pool	7.0	6.0	0.2	60	40	--	--	1.0	70	1-2 (40%)	2-3	Spawning habitat throughout
	3	Yes	Riffle/ Pool	5.8	5.2	0.25	10	50	20	10	2	70	1-2 (30%)	2-4	Good Spawning habitat
	4	Yes	Riffle/ Pool	8.1	5.45	0.25	40	60	--	--	3	60	1-2 (35%)	2-3	Active erosion
	5	Yes	Cascade/ Pool	~20	7.5	0.18	10	60	30	--	5	80	1-2 (30%)	2-4	Braided areas Channelizing
	6	Yes	Cascade/ Pool	8.0	6.2	0.35	--	--	30	70	6	80	<2 (30%)	2	Single Channel
Upper South Cranberry Creek Tributary 1	1	Yes	Run	1.8	0.9	0.05	100	--	--	--	1	60	2-4 (<10%)	<1	No changes. Rearing habitat.
Upper South Cranberry Creek Tributary 2	1	Yes	Riffle/ Pool	2.1	1.4	0.12	40	60	--	--	6	60	2-4 (<10%)	3-5	No changes. Rearing habitat.
Upper South Cranberry Creek Tributary 3	1	Yes	Run	4.3	2.6	0.22	100	--	--	--	0.5	80	2-4 (10-20%)	<1	No changes. Rearing habitat.

Table 2 (cont'd): Upper South Cranberry Creek Fish Habitat Assessment, Coursier Lake 2008

Area	Seg.	Fish Present	Habitat	Mean Bankfull Width (m)	Mean Wetted Width (m)	Mean Bankfull Depth (m)	Substrate (%)				Gradient (%)	Cover (%)	Pool Freq. (Ch.width/ pool)(%)	LWD Pieces/ Ch.Width	Comments
							Fines	Gravel	Cobble	Boulder					
Upper South Cranberry Creek Tributary 3	2	Possible	Cascade/ Pool	4.9	3.2	0.15	30	70	--	--	4	80	2-4 (<10%)	>2	Rearing habitat
Upper South Cranberry Creek Tributary 4	1	Yes	Run	3.1	2.6	0.08	100	--	--	--	1	80	>4 (<30%)	1-2	Ephemeral
Upper South Cranberry Creek Tributary 5	1	Yes	Run	1.1	0.8	0.11	100	--	--	--	1	80	>4 (<30%)	<1	Ephemeral
	2	Yes	wetland	15	12	0.25	100	--	--	--	1	80	<1 (<60%)	<1	Peat bog
Coursier Lake Tributary 6	1	Yes	Riffle/ Pool	3.5	1.1	0.04	70	30	--	--	1	20	>4 (<30%)	<1	Ephemeral; unstable channel
	2	Yes	Cascade/ Pool	3.4	0.9	0.04	30	60	10	--	22	40	>4 (<30%)	<1	Ephemeral; unstable channel
Coursier Lake Tributary 7	1	Yes	Riffle/ Pool	12	5.5	0.06	100	--	--	--	6	30	>4 (<30%)	<1	Ephemeral; unstable channel
	2	Yes	Cascade/ Pool	1.6	1.3	0.08	100	--	--	--	6	50	>4 (<30%)	<1	Ephemeral; unstable channel
Coursier Lake Tributary 8	1	Yes	Riffle/ Pool	1.3	1.1	0.09	100	--	--	--	2	40	>4 (<30%)	<1	Ephemeral
Coursier Lake Tributary 9	1	Yes	Riffle/ Pool	1.1	0.7	0.05	80	15	5	--	8	30	>4 (<30%)	<1	Ephemeral
Coursier Lake Tributary 10	1	Yes	Riffle/ Pool	0.9	0.6	0.05	100	--	--	--	3	30	>4 (<30%)	<1	L. Channel abandoned
Upper South Cranberry Creek Tributary 11	1	Yes	Riffle/ Pool	0.9	0.6	0.07	100	--	--	--	1	40	>4 (<30%)	<1	Ephemeral
Upper South Cranberry Creek Tributary 12	1	Yes	Riffle/ Pool	1.3	0.9	0.05	100	--	--	--	1	40	>4 (<30%)	<1	Ephemeral

Table 3: Summary of Upper South Cranberry Creek morphological changes

Area	Segment	2004 Morphological Changes	2005 Morphological Changes	2006 Morphological Changes	2008 Morphological Changes	Remedial Action Required
S. Cranberry Creek below Outlet Channel	1	N/C	N/C	N/C	N/C	No
S. Cranberry Creek (Outlet Channel)	2	Right bank scour and 2 stumps overturned (still stable)	Continued right bank scour, left bank scour, deposition, stump (stable) overturned	N/C in right bank scour, left bank scour longer but appears stable	Minor right bank scour between riffle #3 and riffle #4	No
Coursier Lake	1	N/C	N/C	Slide on Westside of Lake, sediment deposition at Cranberry Creek confluence	N/C	No
Westside Creek	1	Continued lower reach channel aggradation	Continued lower reach channel aggradation	Continued lower reach channel aggradation	Slowed aggradation, channelization evident in areas	No
	2	Continued Degradation downstream of access road; 2 new and 1 previous down cutting events recorded	Continued Degradation downstream of access road; 1 new and 2 previous down cutting events recorded	Continued Degradation downstream of access road; no new down cutting events recorded	Continued yet slowed degradation downstream of access road. Minor new erosion recorded	No
Upper S. Cranberry Creek	1	Linear Fractures and undercutting recorded	2 undercutting events and 3 future potential oxbow sites. Large+small woody debris jams	Sediment deposition where channel splits just upstream of Coursier Lake. General channel degradation – no significant morphological changes.	N/C	No
	2	Minor undercutting	N/C	N/C	Two previously recorded erosion sites still active	No
	3	1 new bank erosion	N/C	2 new erosion events; continued erosion of the 2004 site	Continued erosion of previously recorded sites	No
	4	Seven erosion sites including new down cutting, linear fractures in bank, and bank erosion/undercutting	N/C 2004 erosion sites still evident	2 new downcutting sites; 2 new erosion sites. 2 previously identified erosion sites active	Five previous erosion sites were still active; two new minor bank erosion sites were identified.	No
	5	New undercut bank and previous down cutting	Channelization occurring	Channelization occurring	Channelization occurring	No
	6	N/C	N/C	N/C	N/C	No
Upper S. Cranberry Creek Tributary 1	1	N/C	N/C	N/C	N/C	No
Upper S. Cranberry Creek Tributary 2	1	N/C	N/C	N/C	N/C	No

N/C – denotes no significant morphological changes within the past 12 months

Table 3 (cont'd): Summary of Upper South Cranberry Creek morphological changes

Area	Segment	2004 Morphological Changes	2005 Morphological Changes	2006 Morphological Changes	2008 Morphological Changes	Remedial Action Required
Upper S. Cranberry Creek Tributary 3	1	N/C	N/C	N/C	N/C	No
	2	N/C	N/C	N/C	N/C	No
Upper S. Cranberry Creek Tributary 4	1	N/C	N/C	N/C	N/C	No
Upper S. Cranberry Creek Tributary 5	1	N/C	N/C	N/C	N/C	No
	2	Banks likely impacted by reservoir re-vegetation crews	N/C	N/C	N/C	No
Coursier Lake Tributary 6	1	Channel aggradation adjacent to Coursier Lake	Continued channel aggradation	Continued channel aggradation	Continued channel aggradation	Not at this time
	2	Channel degradation	Continued channel degradation	Continued channel degradation	Continued channel degradation	Not at this time
Coursier Lake Tributary 7	1	Braided channel and aggradation	Continued channel aggradation	Continued channel aggradation	Continued channel aggradation	Not at this time
	2	Channel degradation	Continued channel degradation	Continued channel degradation	Continued channel degradation	Not at this time
Coursier Lake Tributary 8	1	Undercutting on right bank	N/C	N/C	N/C	No
Coursier Lake Tributary 9	1	2 down cutting sites recorded	N/C	N/C	N/C	No
Coursier Lake Tributary 10	1	N/C	Abandoned channel and subsurface flow	N/C - Abandoned channel and subsurface flow still evident	N/C	No
Upper S. Cranberry Creek Tributary 11	1	N/C	N/C	N/C	N/C	No
Upper S. Cranberry Creek Tributary 12	1	N/C	N/C	N/C	N/C	No

N/C – denotes no significant morphological changes within the past 12 months

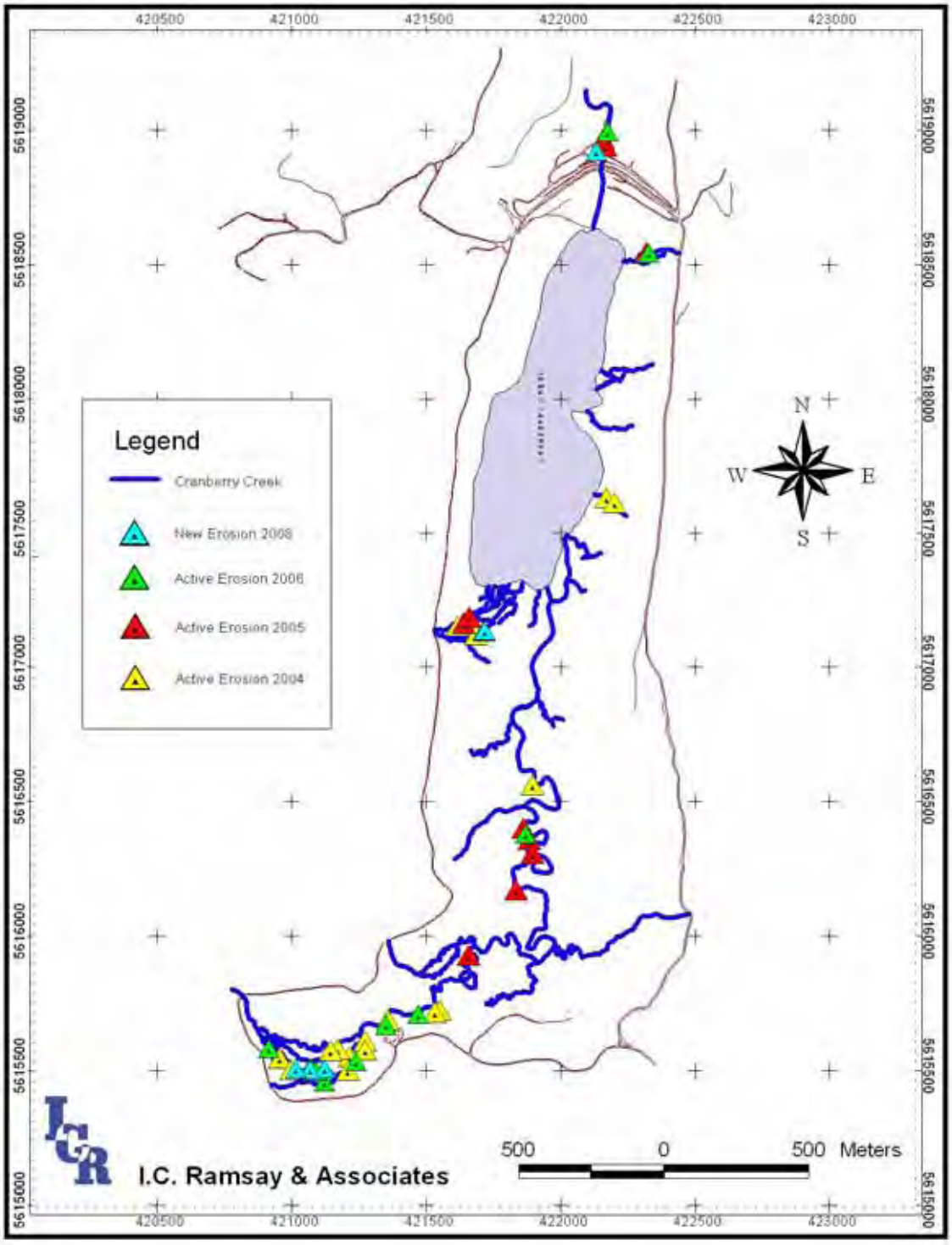

Figure 3: Active erosion by year recorded within the South Cranberry Creek (Coursier Lake) watershed**.**

4.2 Fisheries Resources

Rainbow trout were the only fish captured and enumerated from the streams and lake. The presence of rainbow trout in this area of the watershed upstream of the Walter Hardman diversion structure, are likely the result of past stocking efforts by private individuals and provincial programs. These stocked fish have likely propagated in the lake and tributaries where a self sustaining population now resides (I.C. Ramsay and Associates 2005).

Stream habitat characteristics

A summary of the stream site habitat characteristics are provided in Table 4 and photographs in Appendix 1. A common trait of the stream sites was a lack of significant crown closure, specifically the inlet stream sites which were located within the area previously inundated by the lake. The riparian zones along these inlet streams consist of initial seral stages of re-vegetation. Crown closure associated with the outlet stream site was estimated as <20%, the riparian area consists of vegetation typical of mature forests. Site 4 located in the lower section of South Cranberry Creek was characterized by substrate conditions composed of fines and as such offered no spawning habitat. All other stream sites offered gravels suitable for spawning.

Table 4. Summary of tributary site habitat characteristics, August 19-20, 2008.

Site	Site	Temp (C)	Substrate		Turb.	Average Width (m)		Gradient	Instream Cover
			Dom	Sub-dom		Channel	Wetted		(Amount - Dom. type
Cranberry Creek	1	15.0	B	C	M	7.7	7.5	4.0	Abundant – B
Westside Creek isolated pools	2b	14.0	G	F	C	3.5	2.8	3.8	Moderate - SWD
South Cranberry	3	10.0	B	C	M	7.9	7.9	3.0	Abundant – B
South Cranberry	4	10.0	F	F	M	10.4	10.4	0.0	Trace - LWD

Substrate: B – Boulder, C – Cobble, G – Gravel, F – Fines,
Turbidity (Turb.): M – Moderately Turbid, L – Lightly Turbid, C – Clear;
Cover: B – Boulder, LWD – Large Woody Debris
Dom – Dominant, Sub-dom – Sub-dominant

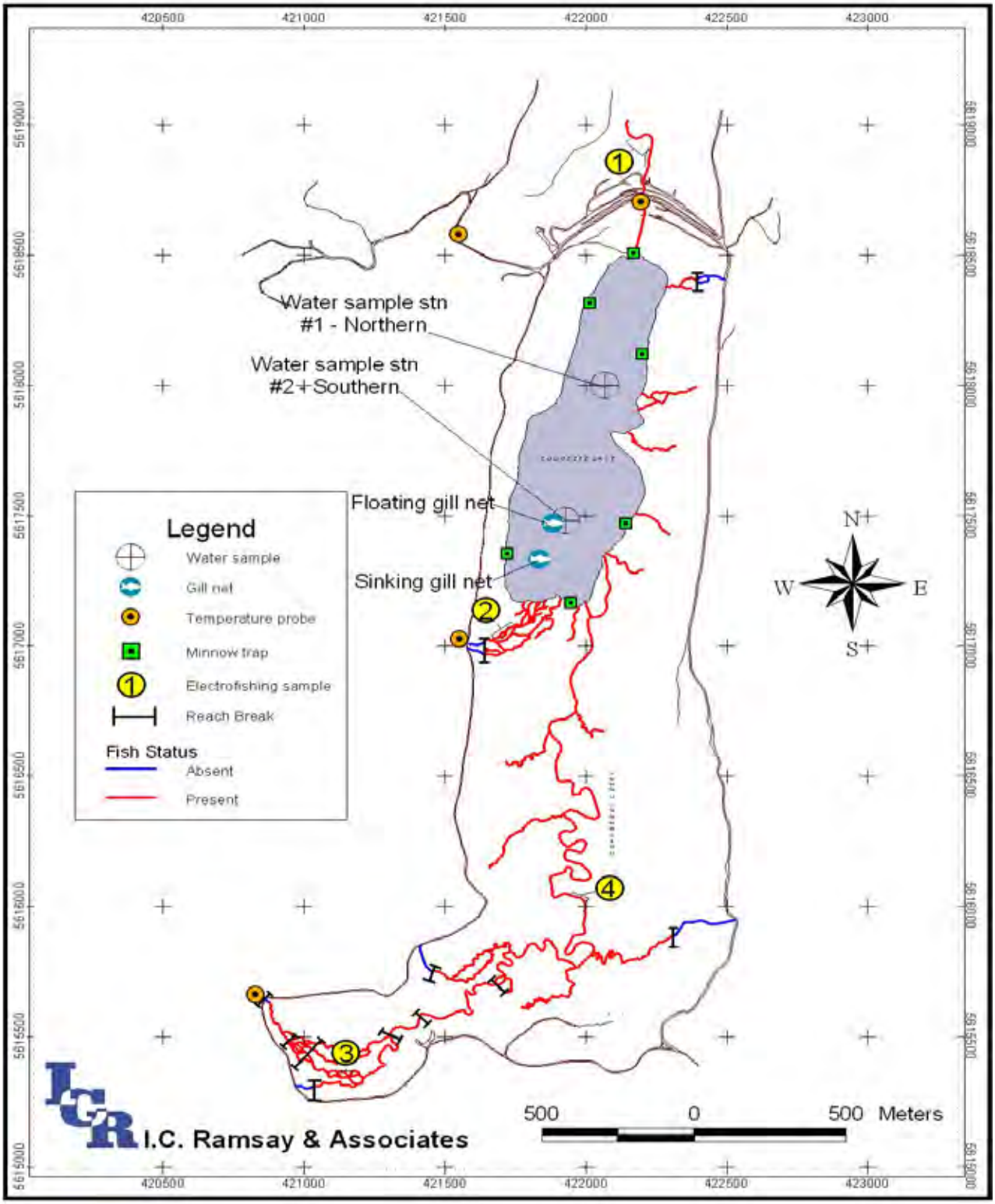

Figure 4: Location of the limnological water sample sites, fish sample sites, temperature probes, and fish status**.**

Fish captures

The CPUE for rainbow trout from the stream sites ranged from 0.0 to 0.109 Fish/s in August (Table 5). Although no fish were captured from Site 4 on South Cranberry, they were captured from Site 3, another site on South Cranberry.

Table 5. Summary of the Catch per Unit Effort (CPUE) of rainbow trout enumerated from tributary sites, August 19 -20, 2008.

Site		Fish Capture			Time	Site Length	Site area	CPUE		
		Captured	Observed	Total	(s)	(m)	(m^2)	Fish/s	Fish/m	Fish/m^2
Cranberry Creek	1	5	4	9	200	100	750	0.045	0.09	0.012
Westside Creek	2b	8	7	15	201	100	280	0.109	0.15	0.054
South Cranberry	3	5	2	7	200	100	790	0.035	0.07	0.009
South Cranberry	4	0	0	0	200	100	1040	0	0	0

The majority of lake fish were captured in the sinking gillnet (n=39). Only 13 were captured with the floating gillnet. No fish was captured in the 6 minnow traps (Table 6).

Table 6. Summary of the Catch per Unit Effort (CPUE) of rainbow trout enumerated from Coursier Lake, August 19 -20, 2008.

Site	Method	Total Fish Capture	Time (h)	CPUE Fish/h
Coursier Lake	Sinking Net	39	16.35	2.39
	Floating Net	13	17.10	0.76
	Minnow Traps	0	16	0.0

Table 7 summarizes the morphometric characteristics of the rainbow captured from the stream sites and Coursier Lake. Data for individual fish is provided in Appendix 2. On average the rainbow trout captured appeared larger in the lake than in the streams (Table 7 and Figure 5). Mean fork length of 86.3 mm (SD 26.5) for fish caught in the streams in August is less than half the mean fork length of fish caught from the lake (173.7 mm, SD 33.3). While it is expected that larger fish would reside in the lake through most of the year, these results are in part biased because fish were only captured in gillnets and not in the minnow traps. While the minnow traps are capable of capturing rainbow trout as small as young-of-the-year, the smallest mesh (25mm) of the gillnet panels used in lake sampling would likely not capture fish <110mm FL, whereas electrofishing is capable of capturing all sizes that may be present in the streams.

Table 7. Summary of the fork length (mm), weight (g) and condition factor (K) of rainbow trout captured in the streams and Coursier Lake, August 19-20, 2008.

Site	Date	Length (mm)				Weight (g)				Condition Factor (K)				n
		MN	SD	Max	Min	MN	SD	Max	Min	MN	SD	Max	Min	
Strm	Aug.	86.3	26.5	144.0	53.0	9.0	8.9	32.0	2.0	1.1	0.1	1.3	0.9	18
Lake	Aug.	173.7	33.3	241.0	112.0	57.8	33.3	153.9	16.0	1.2	0.1	1.4	1.0	52

Strm – Stream sites, MN - Mean, SD – Standard Deviation, Max – Maximum, Min - Minimum

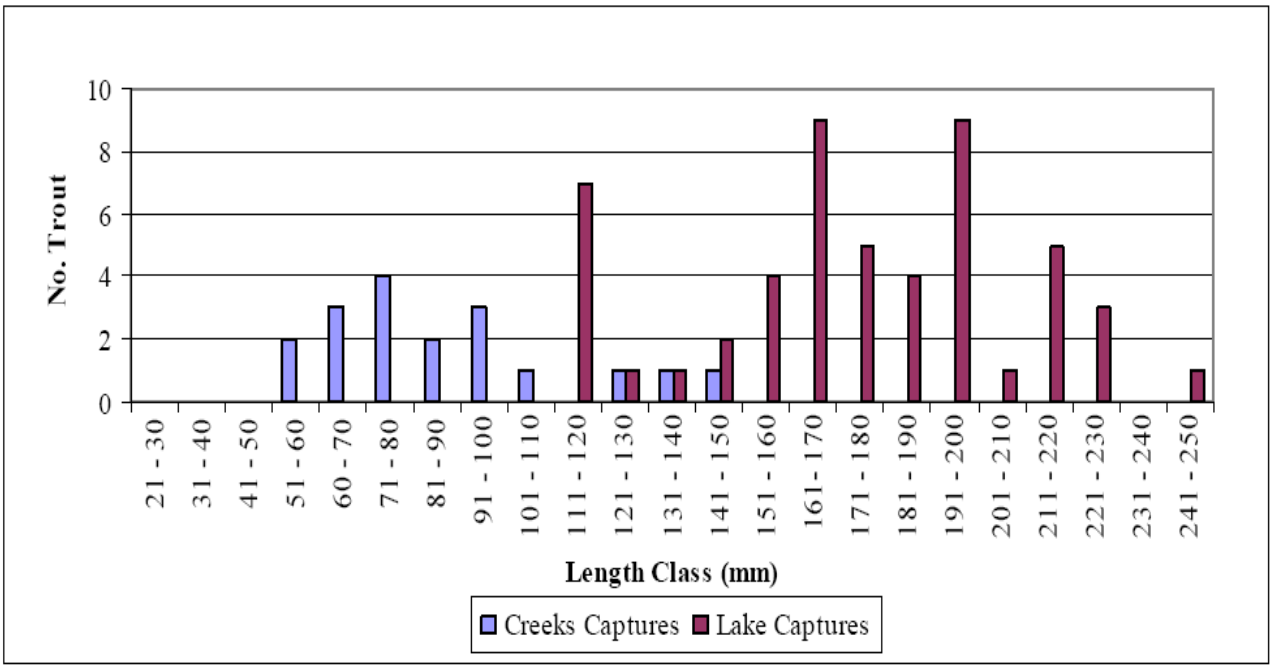

Figure 5. A length frequency histogram of the rainbow trout captured in the streams and lake, August 19-20 2008.

Mean Condition factors (K) ranged from 1.1 to 1.2 (Table 7). The condition factor (K) is influenced by such variables as age, sex, stage of maturation, fullness of gut, amount of fat reserve, and degree of muscular development. Based on lengths (approximate 10mm increments) and weights provided for rainbow trout ranging in size from 28mm to 249mm (Leitritz and lewis 1980) the mean condition factor for hatchery cultured rainbow trout is approximately 1.3. The mean Condition factors (K) determined from the streams and lake are above 1.0, closer to the 1.3 K value suggesting that optimal food rations were available, which may be suspect given the low productivity of the systems.

Table 8 summaries the morphometric characteristics of the rainbow trout captured as a function of age. Early age classed (0+ and 1+) rainbow trout were captured at all the tributaries, although not at both sites in Upper South Cranberry Creek. And 2+ rainbow trout were also captured at Site 1 and 2b, and potentially at Site 3, although the scale

analysis for the largest rainbow trout captured at Site 3 was not conducted. A greater range of age-classes (1+ to 5+) were captured in the lake.

Table 8. Summary of the length, weight and condition factor – at – age of rainbow trout captured from the streams and lake, August 19 -20, 2008.

Site	Age	Length (mm)		Weight (g)		Condition Factor (K)		n
		Mean	SD	Mean	SD	Mean	SD	
Creeks	0+	65.5	12.6	3.0	1.4	1.04	0.21	4
	1+	87.5	10.4	7.8	2.2	1.16	0.13	4
	2+	119.5	14.8	18.8	6.4	1.08	0.03	2
Lake	0+	-	-	-	-	-	-	0
	1+	115.0	-	19.6	-	1.29	-	1
	2+	147.7	23.2	40.6	18.3	1.20	0.11	8
	3+	185.7	23.1	78.2	28.5	1.18	0.08	7
	4+	206.4	28.0	103.5	32.1	1.13	0.08	5
	5+	228.0	-	136.8	-	1.15	-	1

4.3 Spawner Survey

We attempted to view spawning redds in June/July of 2005, however, due to elevated turbidity and stream flows we experienced difficulty identifying redds. We have previously noted that Upper South Cranberry Creek (above the lake) at the upper end of Segment 1, throughout Segment 2, 3 & 4 appear to provide suitable spawning habitat and the presence of multiple age-classes suggest that population maintenance is occurring. We did not attempt to complete a spawner survey in 2008 due to stream conditions.

4.4 Limnological Assessment

The August 2008 oxygen and temperature profiles from each of the two limnological stations are provided in Figures 6 and 7. In August the temperature range at the 2 stations was similar, ranging from approximately 15ºC at the surface to 10ºC at depth. Although both stations indicated summer temperature stratification, the thermoclines differed; Station 2 had a shallower (1m) epilimnion than Station 1 (2m). The thermocline at Station 2 began at approximately 1m depth and extended to 6.5m depth, and the thermocline at Station 1 was more abrupt and located approximately at 2-4m depth.

Dissolved oxygen profiles from August did not reflect the stratified conditions of the lake, oxygen concentrations were approximately 7-8mg/L throughout the water column sampled. Dissolved oxygen concentrations of greater than 5mg/L are considered suitable for rainbow trout (Ministry of Environment Environmental Protection Division 2006).

Table 9 summarizes the results of the water quality sampling conducted at each of the limnological stations. The results, specifically those for; pH, Conductivity, Ammonia, Nitrate and Nitrite are within preferred ranges (Ministry of Environment Lands and Parks 1998 and Appendix 3). Although the Total Nitrogen (surface and bottom sample – Station 1 and 2) concentrations suggest meso-trophic conditions (TN 0.01-0.5 mg/L), the Chlorophyll 'a' concentrations (0.9 – 1.1 µg/L surface sample – Station 1 and 2) and the Total Phosphorous concentrations (below detection limits i.e. <0.003 mg/L) suggest oligotrophic conditions (Nordin 1985 and Appendix 3). The shallow Secchi depths at each of the 2 stations reflect the influence of glacial till and not the trophic status.

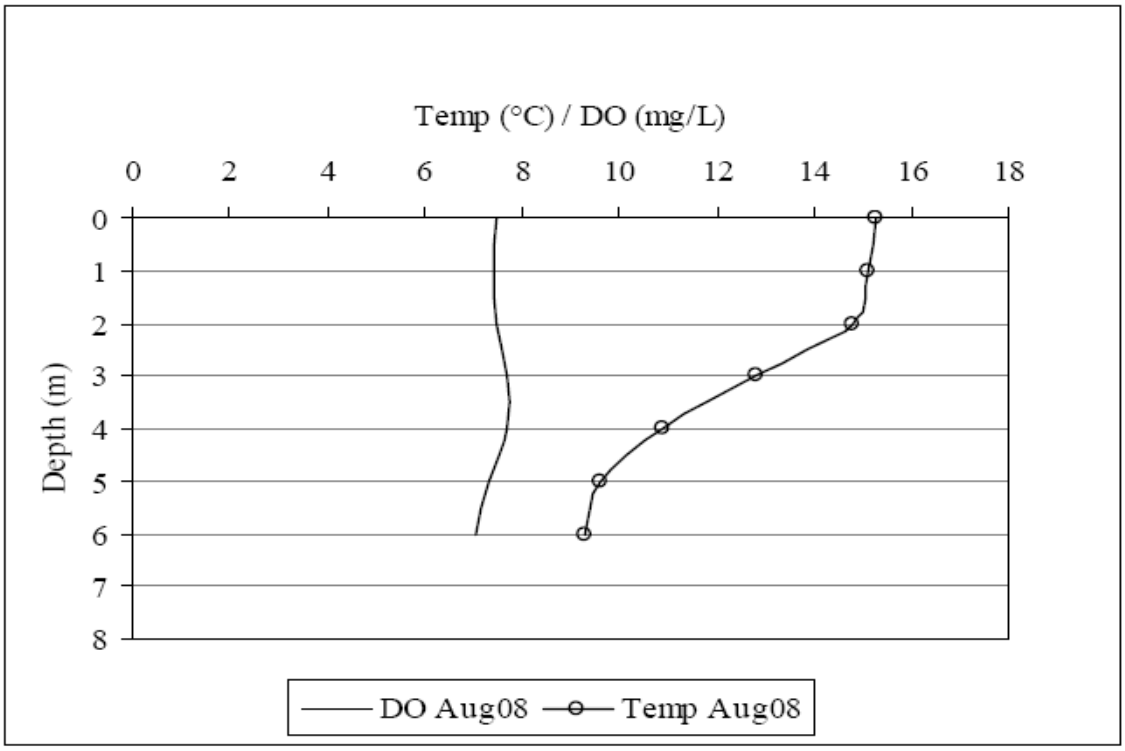

Figure 6. Coursier Lake - Station 1: Temperature and dissolved oxygen profiles, August 20 2008

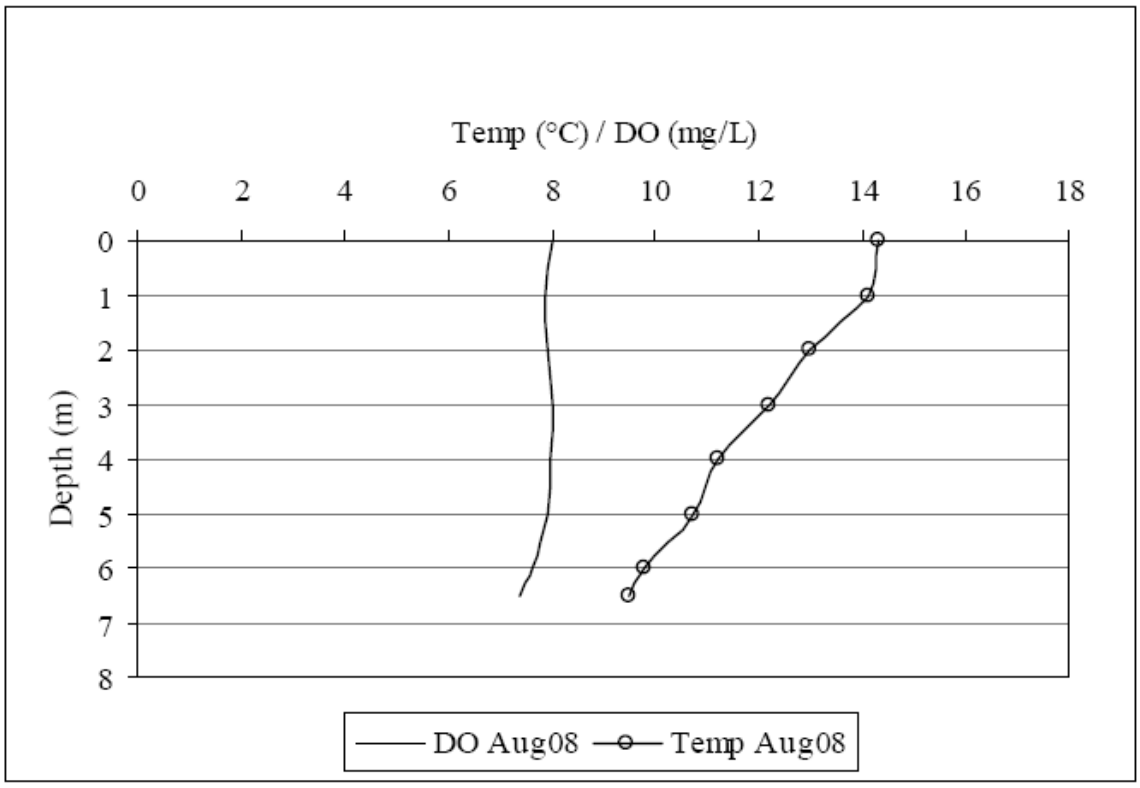

Figure 7. Coursier Lake - Station 2: Temperature and dissolved oxygen profiles, August 20 2008

Table 9. Coursier Lake Station 1 and 2: Analytical results, August 20, 2008.

Parameter	Station 1 - Surface	Station 1 - Bottom	Station 2- Surface	Station 2 - Bottom
pH (unit)	7.24	7.01	7.23	6.99
Conductivity (µs/cm)	22	21	22	21
Acidity	<1	<1	<1	<1
Total Alkalinity (as $CaCO_3$)	10	8	9	8
Nitrate (as N; mg/L)	0.008	0.032	0.008	0.035
Nitrite (as N; mg/L)	<0.003	<0.003	<0.003	<0.003
TKN (mg/L)	0.07	0.06	0.06	0.05
Total Nitrogen (mg/L)	~0.077	~0.093	~0.069	~0.086
Ammonia (as N; mg/L)	0.013	0.007	0.011	<0.005
Total Phosphorous (mg/L)	<0.003	<0.003	<0.003	<0.003
Total Dissolved Phosphorous (mg/L)	<0.003	<0.003	<0.003	<0.003
Total Dissolved Solids (mg/L)	17	14	16	15
Total Suspended Solids (mg/L)	4	4	4	3
Chlorophyll 'a' (µg/L)	0.9		1.1	
Depth (m)		6		6.5
Secchi depth (m)	0.55		0.55	

4.5 Stream Temperature

Two data loggers were stationed in tributaries into Coursier Lake, one logger at the in the outlet channel and one logger in First Creek in 2003. To date, temperature data has been collected from December 2003 to September 2008. All temperatures recorded within Upper South Cranberry Creek above the lake, Westside Creek, the Coursier Lake outlet channel and First Creek remain between 0-2 ^{o}C during the winter months (November to April). In May the water temperatures gradually increased to maximums in July and August. The outlet channel reaches the highest maximum yearly temperatures above 20^{o}C (July 2005), followed by maximum temperatures of 16.4 ^{o}C in Westside Creek (July 2004), 14.5 ^{o}C in Upper South Cranberry Creek (August 2005), and 13 ^{o}C in First Creek (August 2004 and 2005).

4.6 Discussion

In general the streams within the Coursier Lake drawdown zone and outlet channel appear to be quite stable. Minor bank scour/eroson and gravel movement continue and were evident in our 2008 assessment, however, these events appear to be but quite minor in magnitude.

During our 2008 assessment we recorded active erosion in three areas: the outlet channel, Westside creek and Upper South Cranberry Creek Segments 2, 3 and 4. The outlet channel appears quite stable overall and the minor right bank scour and gravel movement in areas should not be of concern in the future.

Westside Creek is still quite unstable. A debris jam 20m downstream of the access road culvert may provide future instability should the debris jam fail. The channel degradation and aggradation in the former floodplain appears to be slowing in recent years. A southern channel carried the predominant flow during our assessment and a northern channel appears to be abandoned at this time.

Upper South Cranberry Creek Segment 4 contains the most active erosion sites and two new active erosion sites. This segment will continue to channelize as the main channel becomes more defined. This area should stabilize over time and fish habitat will increase in quality as riparian vegetation develops.

The August 2008 surveys indicated the presence of rainbow trout in all the tributaries surveyed, as well as, the lake. The size and age of rainbow trout captured in the streams suggests a dominance of young age-classes (0+ and 1+). The fish captured in Coursier Lake were larger and reflected a greater range and older age-classes (1+ to 5+) than those captured from the streams (0+ to 2+).

The confirmed presence of young-of-the-year in each of the tributaries suggests that rainbow trout had likely spawned in each of streams surveyed. The presence of multiple age-classes (0+ to 5+) of rainbow trout captured from the streams and the lake suggest that currently the habitat requisites for population maintenance are present.

Lake limnological information suggests that Coursier Lake may be oligotrophic based on possible phosphorous limitations and Chlorophyll ‘a’ concentrations (Nordin 1985 and Appendix 3).

4.7 Scheduled Monitoring and Recommendations for 2010.

A schedule of future monitoring and reporting activities is noted in the table below.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Fish and Fish Habitat Assessment	**C**	**C**	**C**	**C**		**C**		**x**			**x**
Spawning and Redd Counts		**C***	**C***	**C***							
Winter dissolved oxygen sampling		**C**	**C**	**C**		**C**		**x**			
Limnology and temperature		**C**	**C**	**C**		**C**		**x**			**x**
Outlet channel evaluation		**C**	**C**	**C**	**C**	**C**	**x**	**x**	**x**	**x**	**x**
Vegetation surveys (by others)			**C**		**C**		**x**				
Annual Report to EAO		**C**	**C**	**C**	**C**	**x**					

C = complete
C* - Due to turbid stream conditions this was attempted but not successfully completed

The surveys at Coursier Lake and the stream sites have been designed to develop a practical and cost-effective monitoring program post-decommissioning of the BC Hydro dam.

Following the 2008 assessment we recommend:

- That the outlet channel is assessed to ensure channel stability and identify any issues following the 2009 freshet.
- That the temperature probes are downloaded in June 2009 to avoid deletion of data.
- Based on the results from August 2008, this summer sampling period (mid-August) appears sufficient to identify young-of-the-year (0+) rainbow trout in the stream sites and hence infer their use by spawning fish. Although total captures are low in the stream sites it is anticipated the determination of CPUE, in stream sites and Coursier Lake, may be sufficient to monitor relative abundance over time. In addition the morphometric characteristics will be used to identify trends over time; for example, fork length, weight, condition factor (K), and morphometric characteristic-at-age.
- The summer limnological survey in combination with a winter one to determine temperature and dissolved oxygen profiles would likely be sufficient to characterize the lake's trophic status and the risk from winter-kill.
- It is also possible to continue with the option of a September sampling period if after the completion of an August survey the results appear inadequate to describe the fisheries resources and/or trophic status of the lake.

5.0 Literature Cited

ARC Environmental 2008. Coursier Fisheries and Limnological Assessment 2008. Prepared for BC Hydro. Arc Environmental, Kamloops, BC.

BCH 2002. Coursier Dam Decommissioning Project Application to the British Columbia Environmental Assessment Office, December 2002. Report E72. BC Hydro, Burnaby, BC.

BCH 2003. Coursier Dam Decommissioning Project Environmental Management Plan. Engineering Report E139, July 2003. BC Hydro, Burnaby, BC.

Ford, B.S., P.S. Higgins, A.F.Lewis, K.L. Cooper, T.A. Watson, C.M. Gee, G.L. Ennis and R.L. Sweeting 1995. Literature reviews of the life history, habitat requirements and mitigation/compensation strategies for thirteen sport fish species in the Peace, Liard and Columbia River drainages of British Columbia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2321

I.C. Ramsay and Associates 2007. South Cranberry Creek biophysical assessment 2006. prepared for BC Hydro. I.C. Ramsay and Associates, Kelowna, BC.

Leitritz, E. and R.C. Lewis 1980. Trout and salmon culture: hatchery methods. California Fish Bulletin Number 164

Meidinger, D and J. Pojar (editors). 1991. *Ecosystems of British Columbia*. B.C. Ministry of Forests, Victoria, BC. Special Report No. 6. 330 pp.

Ministry of Forests (MOF). 2001.Coursier Lake and Pingston Lake (Online). Available: http://www.for.gov.bc.ca/dco/trails/pingston.htm

MWLAP 2003. Fish Inventory Web Site: **http://srmapps.gov.bc.ca/apps/fidq/**. Accessed December 15th, 2003, 16:30 pm.

Ministry of the Environment Lands and Parks 1998. Guidelines for Interpreting Water Quality Data. Prepared by Ministry of Environment, Lands and Parks, Land Data BC, Geographic Data BC for the Land Use Task Force Resources Inventory Committee.

Ministry of Environment Environmental Protection Division. 2006 Water quality website. http://www.env.gov.bc.ca/wat/wq/. accessed October 27, 2006.

Nordin, R. 1985. Water quality criteria for nutrients and algae. Prepared for the Ministry of Environment.

Ricker, W.E 1975. Computation and interpretation of biological statistics of fish populations. Bulletin 191 Department of the Environment Fisheries and marine Service.

Wetzel 2001. Limnology: Lake and River Ecosystems 3rd Edition. Academic Press, San Diego California, 2001.

Appendix 1:

Photos

Photo 1: The outlet channel facing minor right bank scour just upstream of riffle #4.

Photo 2: Stabilized right bank scour between riffle #4 and riffle #5.

Photo 3: Stabilized left bank scour previously recorded at riffle #5 of the outlet channel.

Photo 4: A Slide on the Westside of Coursier Lake recorded in 2006. No significant changes or additional erosion were recorded in 2008.

Photograph 5: Coursier Lake sediment deposition at the outlet of Upper South Cranberry Creek. No significant additional deposition was recorded in 2008.

Photo 6: Westside Creek Segment 1 abandoned channel.

Photo 7: Erosion within Segment 3 identified as a separate upstream site in 2004 and a separate downstream site in 2006. The two sites are now one continuous right bank scour.

Photo 8: Active erosion at a previously recorded (2006) right bank erosion site in USCC Segment 4 just upstream of Segment 3. The photo was taken facing downstream.

Photo 9: New bank erosion recorded on the left bank of USCC 4.

Photo 10: New bank erosion recorded on the right bank of USCC 4.

Photo 11: A previously identified downcutting event in USCC Segment 5. This photo was taken facing upstream in 2003.

Photo 12: The same downcutting event recorded in USCC Segment 5 in 2008. Notice vegetation growth and decrease in flow.

Photo 13: Cranberry Creek Site 1: View of two size classes of Rainbow trout, August 19, 2008.

Photo 14: Coursier Lake: View of Rainbow trout captured with floating gill net, August 20, 2008.

Photo 15: Westside Creek Site 2b: View of young-of-the year (0+) Rainbow trout from Westside Creek, August 19, 2008.

Photo 16: Cranberry Creek Site 3: View of young-of-the-year (0+) Rainbow trout from Cranberry Creek, August 20, 2008.

MONITORING STATIONS

Six areas within the watershed were photo-documented to help record changes in geomorphology over time. These include sites at Segments 2, 3, 4, and 5 of Upper South Cranberry Creek, Westside Creek, and the Outlet Channel.

Monitoring Station 1

Photo 17: Monitoring Station 1 - USCC Segment 5 facing downstream (Sept.11th, 2004).

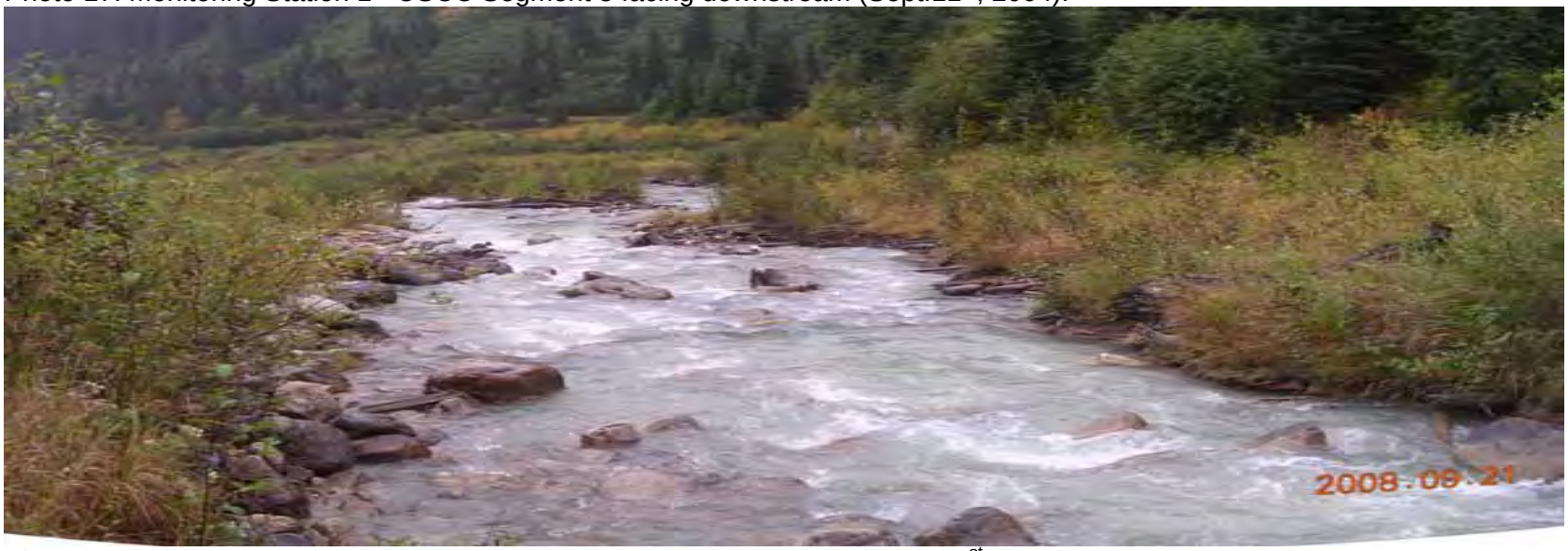

Photo 18: Monitoring Station 1 - USCC Segment 5 facing downstream (Sept. 21st, 2008).

Monitoring Station 2

Photo 19: Monitoring Station 2 - USCC Segment 4 facing upstream (Sept 11th, 2004).

Photo 20: Monitoring Station 2 - USCC Segment 4 facing upstream (Sept 21st, 2008).

Photo 21: Monitoring Station 2 - USCC Segment 4 facing downstream (Sept 11th, 2004).

Photo 22: Monitoring Station 2 - USCC Segment 4 facing downstream (Sept 21st, 2008).

Monitoring Station 3

Photo 23: Monitoring Station 3 - USCC Segment 3&4 facing upstream (Sept. 11th, 2004).

Photo 24: Monitoring Station 3 - USCC Segment 3&4 facing upstream (Sept 21st, 2008). Notice the debris jam forming along the right bank of the main channel (mid point on the bend).

Photo 25: Monitoring Station 3 - USCC Segment 3 facing downstream (Sept. 11th, 2004).

Photo 26: Monitoring Station 3 - USCC Segment 3 facing downstream (Sept 21st, 2008).

Monitoring Station 4

Photo 27: Monitoring Station 4 - USCC Segment 2 facing downstream (Sept. 11th, 2004)

Photo 28: Monitoring Station 4 - USCC Segment 2 facing downstream (Sept 21st, 2008).

Monitoring Station 5

Photo 29: Monitoring Station 5 - Westside Creek facing upstream (Sept. 11th, 2004).

Photo 30: Monitoring Station 5 - Westside Creek facing upstream (Sept 20th, 2008).

Monitoring Station 6

Photo 31: Monitoring Station 6 – Outlet Channel (Oct. 1st, 2005).

Photo 32: Monitoring Station 6 – Outlet Channel (Sept 20h, 2008).

Appendix 2:

Coursier Fish Sampling Data, August, 2008.

Table 2a: Length, weight and condition factor of rainbow trout captured from the tributary and Coursier lake sites, August 19-20, 2008.

No	Date (yy-mm-dd)	Site	Method	Species	Length (mm)	Weight (g)	Condition Factor (K)	Age	Comments
1	08-08-19	1	EF	RB	144	32.0	1.07	Un	scale #1
2	08-08-19	1	EF	RB	130	23.3	1.06	2+	scale #2
3	08-08-19	1	EF	RB	87	6.8	1.03	1+	scale #3
4	08-08-19	1	EF	RB	73	5.2	1.34	1+	scale #4
5	08-08-19	1	EF	RB	53	2.0	1.34	0+	scale #5
6	08-08-19	1	EF	RB	60-80	-	-		
7	08-08-19	1	EF/VO	RB	60-80	-	-		
8	08-08-19	1	EF/VO	RB	60-80	-	-		
9	08-08-19	1	EF/VO	RB	60-80	-	-		
10	08-08-19	2b	EF	RB	96	9.6	1.09	1+	scale #6
11	08-08-19	2b	EF	RB	109	14.3	1.10	2+	scale #7
12	08-08-19	2b	EF	RB	94	9.8	1.18	1+	scale #8
13	08-08-19	2b	EF	RB	72	3.4	0.91		
14	08-08-19	2b	EF	RB	71	3.3	0.92		
15	08-08-19	2b	EF	RB	58	2.0	1.03	0+	scale #9
16	08-08-19	2b	EF	RB	69	3.4	1.03		
17	08-08-19	2b	EF	RB	60	2.5	1.16		
18	08-08-19	2b	EF/VO	RB	60-80	-	-		
19	08-08-19	2b	EF/VO	RB	60-80	-	-		
20	08-08-19	2b	EF/VO	RB	60-80	-	-		
21	08-08-19	2b	EF/VO	RB	60-80	-	-		
22	08-08-19	2b	EF/VO	RB	60-80	-	-		
23	08-08-19	2b	EF/VO	RB	60-80	-	-		
24	08-08-19	2b	EF/VO	RB	60-80	-	-		
25	08-08-20	3	EF	RB	133	26.3	1.12		
26	08-08-20	3	EF	RB	94	8.0	0.96		
27	08-08-20	3	EF	RB	81	4.9	0.92	0+	Scale #32
28	08-08-20	3	EF	RB	60	2.2	1.02		
29	08-08-20	3	EF	RB	70	3.0	0.87	0+	scale #33
30	08-08-20	3	EF/VO	RB	60-80	-	-		
31	08-08-20	3	EF/VO	RB	60-80	-	-		
NA	08-08-20	4	EF	NFC		-	-		No fish captured
33	08-08-20	Coursier Lake	GN (Sink)	RB	214	104.2	1.06	4+	scale #10
34	08-08-20	Coursier Lake	GN (Sink)	RB	191	87.5	1.26	3+	scale #11
35	08-08-20	Coursier Lake	GN (Sink)	RB	182	76.5	1.27	2+	scale #12
36	08-08-20	Coursier Lake	GN (Sink)	RB	222	125.9	1.15	4+	scale #13
37	08-08-20	Coursier Lake	GN (Sink)	RB	166	53.2	1.16	2+	scale #14
38	08-08-20	Coursier Lake	GN (Sink)	RB	177	63.2	1.14	3+	scale #15
39	08-08-20	Coursier Lake	GN (Sink)	RB	177	66	1.19	3+	scale #16
40	08-08-20	Coursier Lake	GN (Sink)	RB	218	127.6	1.23	3+	scale #17
41	08-08-20	Coursier Lake	GN (Sink)	RB	196	82.8	1.10	4+	scale #18

No	Date (yy-mm-dd)	Site	Method	Species	Length (mm)	Weight (g)	Condition Factor (K)	Age	Comments
42	08-08-20	Coursier Lake	GN (Sink)	RB	214	110.2	1.12		
43	08-08-20	Coursier Lake	GN (Sink)	RB	171	57.4	1.15		
44	08-08-20	Coursier Lake	GN (Sink)	RB	228	136.8	1.15	5+	scale # 19
45	08-08-20	Coursier Lake	GN (Sink)	RB	222	123.2	1.13		
46	08-08-20	Coursier Lake	GN (Sink)	RB	165	47.4	1.06	2+	scale # 20
47	08-08-20	Coursier Lake	GN (Sink)	RB	163	57.7	1.33		
48	08-08-20	Coursier Lake	GN (Sink)	RB	200	91	1.14		
49	08-08-20	Coursier Lake	GN (Sink)	RB	163	51.7	1.19		
50	08-08-20	Coursier Lake	GN (Sink)	RB	185	67.9	1.07	3+	scale #21
51	08-08-20	Coursier Lake	GN (Sink)	RB	169	51.4	1.06		
52	08-08-20	Coursier Lake	GN (Sink)	RB	189	72	1.07		
53	08-08-20	Coursier Lake	GN (Sink)	RB	206	96.2	1.10	3+	scale # 22
54	08-08-20	Coursier Lake	GN (Sink)	RB	135	29.3	1.19	2+	scale # 23
55	08-08-20	Coursier Lake	GN (Sink)	RB	200	79.4	0.99		
56	08-08-20	Coursier Lake	GN (Sink)	RB	163	52.6	1.21		
57	08-08-20	Coursier Lake	GN (Sink)	RB	200	92.7	1.16		
58	08-08-20	Coursier Lake	GN (Sink)	RB	140	30.8	1.12	2+	scale # 24
59	08-08-20	Coursier Lake	GN (Sink)	RB	193	77.7	1.08		
60	08-08-20	Coursier Lake	GN (Sink)	RB	159	50.5	1.26	4+	scale # 25
61	08-08-20	Coursier Lake	GN (Sink)	RB	192	82.6	1.17		
62	08-08-20	Coursier Lake	GN (Sink)	RB	181	69.5	1.17		
63	08-08-20	Coursier Lake	GN (Sink)	RB	175	63.9	1.19		
64	08-08-20	Coursier Lake	GN (Sink)	RB	166	50	1.09		
65	08-08-20	Coursier Lake	GN (Sink)	RB	146	39.1	1.26	3+	scale # 26
66	08-08-20	Coursier Lake	GN (Sink)	RB	199	82.8	1.05		
67	08-08-20	Coursier Lake	GN (Sink)	RB	167	65.9	1.41		
68	08-08-20	Coursier Lake	GN (Sink)	RB	177	75.4	1.36		
69	08-08-20	Coursier Lake	GN (Sink)	RB	156	42.3	1.11	2+	scale # 27
70	08-08-20	Coursier Lake	GN (Sink)	RB	163	51.4	1.19		
71	08-08-20	Coursier Lake	GN (Sink)	RB	192	82.5	1.17		

No	Date (yy-mm-dd)	Site	Method	Species	Length (mm)	Weight (g)	Condition Factor (K)	Age	Comments
72	08-08-20	Coursier Lake	GN (Float)	RB	241	153.9	1.10	4+	scale # 28
73	08-08-20	Coursier Lake	GN (Float)	RB	213	107.2	1.11		
74	08-08-20	Coursier Lake	GN (Float)	RB	153	44.8	1.25		
75	08-08-20	Coursier Lake	GN (Float)	RB	157	46.5	1.20		
76	08-08-20	Coursier Lake	GN (Float)	RB	117	22.2	1.39	2+	scale # 29
77	08-08-20	Coursier Lake	GN (Float)	RB	115	19.6	1.29	1+	scale # 30
78	08-08-20	Coursier Lake	GN (Float)	RB	118	20.4	1.24		
79	08-08-20	Coursier Lake	GN (Float)	RB	121	23.5	1.33	2+	scale # 31
80	08-08-20	Coursier Lake	GN (Float)	RB	115	16	1.05		
81	08-08-20	Coursier Lake	GN (Float)	RB	119	23.1	1.37		
82	08-08-20	Coursier Lake	GN (Float)	RB	112	18.7	1.33		
83	08-08-20	Coursier Lake	GN (Float)	RB	211	105	1.12		
84	08-08-20	Coursier Lake	GN (Float)	RB	119	21	1.25		

Appendix 3: Limnological Sampling Objectives

Limnological sampling objectives to monitor lake water quality and trophic status over time

Category	Parameter	Ranges		
		Low	Preferred	High
Profiles	Temperature (°C)	-	10 - 18°C	>20
	Dissolved Oxygen (mg/L)	<8 (<5)	≥8 - 100% saturation	>100% saturation
Water chemistry (Surface and Bottom)	pH	<6.5	6.5-9.0	>9.0
	Total Alkalinity		>20	
	Nitrate - Nitrogen (mg/L)		mean ≤40, max < 200	
	Nitrite-Nitrogen (mg/L)		mean ≤0.02, max <0.06	
	Conductivity (uS/cm)		<700	
	Ammonium-N (mg/L) (30 d mean)		<1.84	≥1.84
Trophic Status		**Oligotrophic**	**Meso-trophic**	**Eutrophic**
Nutrients	Total Phosphorus (mg/L)	0.001 - 0.010	0.010 - 0.030	>0.030
	Total Nitrogen (mg/L)	<0.01	0.01-0.5	0.5 - 1.0
Productivity	Chlorophyll a (µg/L)	0 - 2	2 - 7	>7
Physical	Secchi Depth (m)	>6	3 - 6	<3

References: Ford et al 1995, Nordin 1985, Ministry of the Environment Lands and Parks 1998, and Ministry of Environment Environmental Protection Division 2006.

Appendix 4:

Post Project Biophysical Assessment Outline

Post Project Biophysical Assessment Outline

1.0 Introduction

Coursier Dam was constructed on south Cranberry Creek in 1963 to provide upstream storage for the Walter Hardman Generating Station. The dam has a long history of dam safety incidents and deficiencies and B.C. Hydro is planning to decommission it in the summer and fall of 2003.

The decommissioning of the Coursier Dam will result in the following changes to the aquatic habitat at Coursier Lake:

- The reservoir elevation will be reduced from its current maximum operational elevation of 1274m to its historic lake level, elevation 1266m.
- The inlet tributaries will cross previously inundated reservoir soils and flow into Coursier Lake.
- An outlet channel will be constructed to pass Coursier Lake outflows and provide fish habitat at the site of the dam excavation.

This document outlines the biophysical, fish, and aquatic monitoring and assessment that will be conducted following the Coursier Dam Decommissioning Project. The monitoring and assessment will be conducted for a period of 10 years following dam decommissioning.

2.0 Objectives:

- To monitor and assess bank stability, lateral movement, and erosion in the previously innundated drawdown zone and to recommend any physical interventions that may be required to achieve channel equilibrium.

- To monitor and assess the biophysical, fish and aquatic habitat in Upper South Cranberry Creek, Westside Creek, and other Coursier Lake tributaries.

- To monitor and assess the restored outlet channel to evaluate channel performance and integrity.

3.0 Methodology:

3.1 Overview Assessment

Existing reports and information have been compiled as part of the environmental review process. This includes aerial photographs and existing maps, water quality and fisheries information. This information will be combined with data collected in the 2003 field season to establish a baseline maps and inventory information.

3.2 Fish Habitat Assessment

In the summer 2003 the Coursier Lake will reach return to elevation 1266m. For the lowest reaches of each inlet stream, the restored outlet channel, and First Creek, a reconnaissance level stream inventory will be conducted to provide qualitative and quantitative descriptions of the fish habitat and channel stability. Each stream reach will be evaluated using the FOC/MWLAP Stream Survey Form, Fish Collection Data Form, and Photo-documentation Forms 1 and 2.

Methodologies will follow those provided in; Lake and Stream Inventory: Standards and Procedures (RIC 2001, http://srmwww.gov.bc.ca/risc/pubs/aquatic/recon/index.htm) and A Guide to Photo-documentation (RIC 1996, http://srmwww.gov.bc.ca/risc/pubs/aquatic/photodoc/index.htm).

The stream inventory will provide detailed channel and habitat unit level physical information and specifically identify disturbance indicators and potential obstructions to fish migration within the drawdown zone. The areas immediately above the high water mark of the reservoir (elevation 1283m) will also be included.

Specific Stream Parameters measured during the physical fish habitat assessment will include but not be limited to:

- **Channel Width** – the channel width is the width of the bankfull flood stage of the stream channel. This is often denoted by a change in vegetation from bare ground, with no trees, moss or grasses, to vegetated ground with trees, moss, or grasses. Channel width will be taken at a minimum of six locations per sample site and averaged to represent the channel width of the entire reach.

- **Wetted Width** – the wetted width is the width of the wetted portion of the stream channel at the time of the inventory. Wetted width will be taken at a minimum of six locations per sample site and averaged to represent the channel width of the entire reach.

- **Residual Pool Depth** – the residual pool depth is the difference between the maximum pool depth and the pool outlet. A minimum sampling of six representative pools per stream reach will be recorded.

- **Gradient** – gradient or the slope of the channel bed will be measured using an Abbney level. At least one measurement will be taken per stream reach over a length of at least 60m along the stream to provide gradient in % (e.g. 15% gradient).

- **Depth at Channel Bankfull** – depth at channel bankfull is the depth of the stream channel when the flows are bankfull. The depth will be measured in at least three locations within the sampling area at a riffle-pool crest or step-pool break.

- **Cover** – cover is any structure in the wetted channel that provides hiding, resting, or feeding places for fish. Cover can be provided by woody debris, boulders, undercut stream banks, deep pools, and vegetation. Stream cover will be visually estimated and recorded.

- **Crown Closure** – the crown closure consists of the stream-side riparian vegetation that projects over the stream channel. The percentage of channel area covered by crown closure will be visually estimated and recorded.

- **Large woody debris distribution** – large woody debris cover estimates include the presence and the amount of functional large woody debris within the stream channel. Functional LWD is defined as woody debris greater than 10cm in diameter and attached or embedded in the stream or bank (i.e root wads). The abundance of LWD and distribution within the stream channel will be recorded.

In the restored outlet channel periodic inspections will be performed to ensure that debris jams do not occur. Debris jams may reduce the flow that the channel can pass and result in bank and

bed scour. In particular, debris jams that may form at the lake outflow are of specific concern and will be monitored closely.

- **Stream Bank Characteristics** – the left and right bank refer to the stream bank being described when the observer is facing downstream. Each stream bank will be described in terms of the shape of the stream bank (i.e. v-shaped, sloping, overhanging or undercut bank) and the bank texture or material comprising the stream bank. In addition, the dominant riparian vegetation (e.g. coniferous forest), and vegetation stage (e.g. mature forest) on each stream bank will be recorded.

- **Stream Morphology** – the stream morphology or stream form can be characterized by evaluating bed material, classifying the channel morphology, and recording disturbance, channel pattern, islands, bars, coupling, and confinement.

  In this portion of the assessment, the survey crew will focus on channel stability by evaluating within-channel sediment storage patterns (islands and gravel bars), lateral instability, channel meander wavelength, and sinuosity (CAP 1996, http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/channel/chan-toc.htm).

- **Fish Habitat Comments** – any observations regarding fish habitat such as distinct spawning sites, rearing habitat, overwintering, and potential barriers to fish migration will be recorded and GPS located.

- **Channel Lateral Movement** – during each fish habitat assessment a GPS unit will be used to record the location of the thalweg of the stream channel (as a line feature) and record significant point features such as erosion and migration barriers. The GPS data will be differentially corrected to provide sub-meter location accuracy and will be overlain on the 1:20,000 Provincial TRIM database. Larger 1:5000 scale maps may be produced for each inlet stream and the outlet stream to monitor lateral movement.

3.3 Fish Sampling/Assessment

Fish sampling will be conducted in the lowest reaches of each inlet stream and the outlet channel to determine fish presence and use. Fish sampling will focus on defining the overall distribution of all fish species in the study area through presence/absence sampling using electrofishing in minimum sample areas of at least 100 m^2 and overnight minnow trap sets. Fish sampling will follow methodologies outlined in Fish Collection Methods and Standards (RIC 1997, http://srmwww.gov.bc.ca/risc/pubs/aquatic/fishcol/index.htm).

Fish catches obtained at each site will be sampled such that:

- All species will be identified and enumerated
- Life stage and fork length (mm) and wet weight (g) measure; and
- Non-destructive aging structures (i.e. scales and fin rays) will be taken from samples of Freshwater Game Species (FPC definition) captured over a representative range of lengths.

Spawning Surveys

Separate surveys will be completed to document rainbow trout spawning and redds. These will be completed using walk-through and visual assessments of existing rainbow trout spawning, rearing and overwintering habitat.

3.4 Water Quality and Other Measurements

Water temperature (^oC) will be remotely recorded in the lower Cranberry Creek (above Coursier Lake), in Coursier Lake, and below the Coursier Dam at First Creek using optic logger temperature probes.

Winterkill may be a limiting factor to resident fish populations within Coursier Lake. Factors influencing winterkill conditions may not manifest in the winters immediately following dam decommissioning. As such, vertical dissolved oxygen (DO) and temperature profiles will be taken below the ice cover in the late winter in 2006, 2008, and 2010.

Limnological sampling to detect the biotic and physical response to dam decommissioning will be done in year 1, 3, and 5 following dam decommissioning. This will include water nutrient parameters and plankton species composition, size, and densities.

3.5 Schedule of Fish and Fish Habitat Assessment:

Fish habitat assessments, fish sampling and water temperature measurements will commence in the summer of 2003 and continue yearly following freshet until the summer of 2006. Assessments will subsequently be completed bi-annually in 2008 and 2010 and a final assessment will be completed in 2013.

Disturbance and migration barriers that are recorded during stream inventories will continue to be monitored in subsequent years. If the disturbance, instability or barrier persists after the 2nd or 3rd spring freshet after dam decommissioning, the requirement for the development and possible implementation of prescriptive measures may be developed.

In summary, stream inventory monitoring will include:

- Summer 2003 - Overview and Fish and Fish Habitat Assessment
- Spring 2004 - Spawning and Redd Counts
- Summer 2004 - Fish and Fish Habitat Assessment (after 1st freshet), Limnology, and temperature.
- Spring 2005 - Spawning and Redds Counts
- Summer 2005 - Fish and Fish Habitat Assessment (after 2nd freshet), Limnology, and temperature.
- Winter 2006 - Winterkill Assessment
- Spring 2006 - Spawning and Redds Counts
- Summer 2006 - Fish and Fish Habitat Assessment (after 3rd freshet), Limnology, and temperature. Channel prescription if necessary
- Winter 2008 - Winterkill Assessment
- Summer 2008 - Fish and Fish Habitat Assessment, Limnology, and temperature.
- Winter 2010 - Winterkill Assessment
- Summer 2010 - Fish and Fish Habitat Assessment, Limnology, and temperature.
- Summer 2013 - Fish and Fish Habitat Assessment, Limnology, and temperature.

3.6 Reporting

Interim summary reporting will be completed at the end of each monitoring year. Each report will include a data summary, assessment of finding, recommendations, and a 1:20, 000 Fisheries Interpretive map of Coursier Lake, the Inlet Streams, and the Outlet Channel with new information collected in each calendar year.

In addition to the 1:20,000 map, a larger scale 1:5,000 map may be produced to illustrate the GPS position of inlet streams within the drawdown zone. The maps will be produced according to the Fish and Fish Habitat Assessment Procedures (RIC 2001).

4.0 References

Resource Inventory Committee. April 2001. *Reconnaissance (1:20, 000) Fish and Fish Habitat Inventory Standards and Procedures*. Fisheries Branch, BC Ministry of Sustainable Resource Management.

Resource Inventory Committee. January 1997. *Fish Collection Methods and Standards*. Fisheries Branch, BC Ministry of Sustainable Resource Management.

Resource Inventory Committee. March 1996. *A Guide to Photodocumentation for Aquatic Inventory*. Fisheries Branch, BC Ministry of Sustainable Resource Management.

Ministry of Forests. December 1996. *Channel Assessment Procedure Guidebook*. Forest Practices Code, BC Ministry of Forests.

Appendix 5:

Maps and GIS

APPENDIX D: COURSIER LAKE WINTER DISSOLVED OXYGEN READINGS 2008

- Letter from I.C. Ramsay and Associates to Carol Lamont dated 7 March 2008
  Re: Coursier Lake Winter Dissolved Oxygen Readings 2008

Ian Ramsay
1041 Skeena Drive
Kelowna, B.C.
V1V 2B2

Date: March 7th, 2008

Carol Lamont
BC Hydro
6911 Southpoint Drive (E-05),
Burnaby, BC
V3N 4X8

Re: Coursier Lake Winter Dissolved Oxygen Readings 2008

Carol,

On March 7th, 2008 winter vertical dissolved oxygen measurements were obtained from Coursier Lake beneath the ice. A standard ice auger was used to create a hole in the ice and measurements were obtained every meter below the lake surface with a YSI dissolved oxygen meter. We accessed the site using Kokanee helicopters from Kelowna, BC due to avalanche concerns.

SNOW AND ICE DEPTH

It was estimated that the snow cover was approximately 0.76m (2.5 ft) in depth over approximately 1.0m (3.3 ft) of ice/slush/ice. The inflow tributaries were mainly covered in ice, however, we detected flow in upper South Cranberry Creek. The outlet channel water elevation was very low, however, we detected flow around and beneath the ice that had formed across sections of the channel.

SAMPLE SITES (LAKE BATHYMETRY)

Vertical dissolved oxygen measurements were obtained at two sample sites: Northern Sample Site #1 (UTM: 11.0421996E.56180880N), and Southern Sample Site #2 (UTM: 11.0421867E.5617608N). These sites were the same sites utilized in the previous water sampling programs in 2004, 2005, 2006 (Figure 1). The sample sites were identified in the summer/fall using a depth sounder to identify the deepest area of the water column in the northern and southern portion of the lake. The lake elevation in the fall following the Coursier Dam Decommissioning project was 1264.5m above sea level.

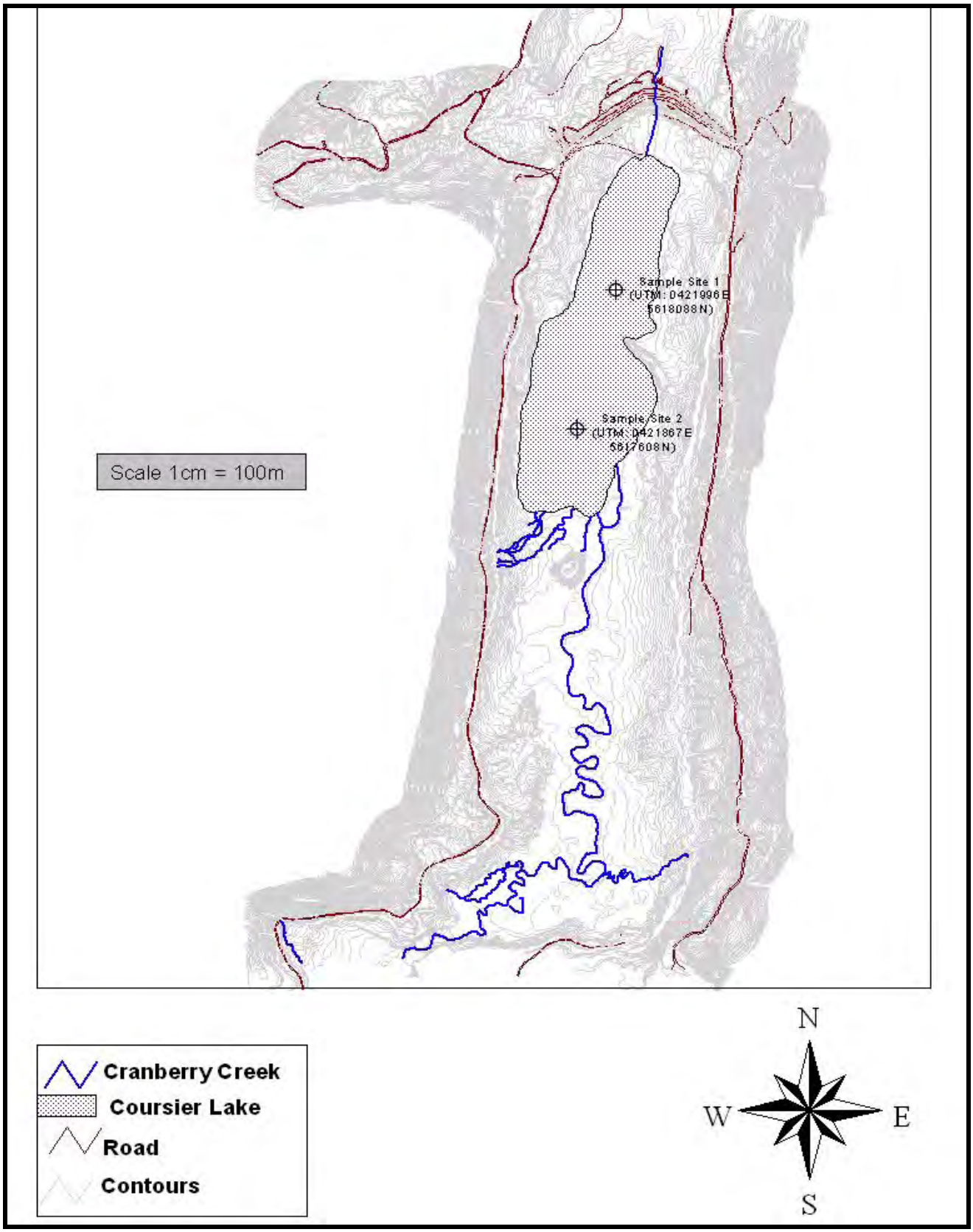

Figure 1: Location of Coursier Lake Dissolved Oxygen Sample Sites.

RESULTS

Table 1: Vertical dissolved oxygen profile for Coursier Lake (March 7th, 2008).

Date Measured: March 7th, 2008
Equipment: YSI DO Meter
Crew: Ian Ramsay &
Greg Brown

Site	Depth (m)	Temp. (oC)	D.O. (mg/L)
Site 1: Northern Site	Bottom of Ice 1.0	0.8	10.51
	2.0	1.8	9.84
	3.0	3.0	9.37
	4.0	3.5	9.18
	5.0	3.7	8.37
Site	**Depth (m)**	**Temp. (oC)**	**D.O. (mg/L)**
Site 2: Southern Site	Bottom of Ice 1.0	0.7	11.09
	2.0	2.2	9.95
	3.0	3.1	9.58
	4.0	3.7	8.68
	5.0	3.7	8.07

Please contact me if you have any questions.

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Photo 1: Coursier Lake facing north over Upper South Cranberry Creek.

Photo 2: Upper South Cranberry Creek.

Photo 3: Obtaining the dissolved oxygen/temperature profile at Site 1 – the Northern Site.


Photo 4: Obtaining pH and confirming temperature at Site 1.