CONSULTANT REPORT

ANALYSIS OF REGULATORY REQUIREMENTS FOR INCLUDING BRITISH COLUMBIA RUN-OF-RIVER FACILITIES IN THE CALIFORNIA RENEWABLES PORTFOLIO STANDARD

Prepared for: California Energy Commission
Prepared by: Suzanne Phinney and Emily Capello
Aspen Environmental Group
KEMA Technical Assistance Contract Number: 400-07-030,
Work Authorization #24

MARCH 2013
CEC-300-2013-006

Prepared by:

Primary Author(s):
Suzanne Phinney, D. Env.
Emily Capello

Aspen Environmental Group
8801 Folsom Blvd., Suite 290
Sacramento, CA 95826

Contract Number: 400-07-030

Prepared for:

California Energy Commission

Otto Tang
Contract Manager

Brian McCollough
Project Manager

Tony Gonçalves
Office Manager
Renewable Energy Office

Dave Ashuckian, P.E.
Deputy Director
EFFICIENCY AND RENEWABLE ENERGY DIVISION

Robert P. Oglesby
Executive Director

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission. It does not necessarily represent the views of the Energy Commission, its employees or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the California Energy Commission nor has the California Energy Commission passed upon the accuracy or adequacy of the information in this report.

ABSTRACT

This analysis examines the status and potential for considering run-of-river hydroelectric projects in British Columbia, Canada, eligible for California's Renewables Portfolio Standard (RPS) Program. Since renewable projects located outside the United States must be as protective of the environment as a project located in California, the study also compares regulatory requirements in British Columbia and California. The report describes the possible effects of including British Columbia run-of-river resources as eligibile for California's RPS. The report concludes that additional requirements are necessary if California is to allow British Columbia run-of-river hydroelectric resources to be RPS-eligible.

Keywords: British Columbia, run-of river, hydroelectric, Renewables Portfolio Standard, RPS, environmental, permitting

Please use the following citation for this report:

Phinney, Suzanne, Emily Capello. (Aspen Environmental Group). 2013. ***Analysis of Regulatory Requrements for Incuding British Columbia Run-of-River Facilities in the California Renewables Portfolio Standard.*** California Energy Commission. Publication Number: CEC-300-2013-006.

TABLE OF CONTENTS

CHAPTER 1: Introduction **1**

Run-of-River Hydro 5

Existing Run-of-River Projects 7

Proposed Run-of-River Projects 9

Run-of River Project Operations 10

CHAPTER 2: Stakeholder Issues **15**

CHAPTER 3: Run-of-River Project Permitting **18**

Canadian Laws, Ordinances, Regulations, and Standards 18

British Columbia Run-of-River Hydro Project Permitting 22

Water License 23

Land Tenure 24

Other Permits 25

Laws, Ordinances, Regulations, and Standards for Permitting Hydroelectric Facilities in California 30

California Run-of-River Hydro Permitting 34

Federal Energy Regulatory Commission 34

California 36

Comparison of LORS in Canada and California 37

CHAPTER 4: Comparison of B.C. Project Environmental Documentation With California Project Environmental Documentation **39**

Upper Harrison Water Project 40

Pre-Application 40

Application Review 41

Completed/Certified 45

Monitoring and Compliance 45

Bear Hydro Project 46
Water License Application 47
Monitoring and Compliance 48
Land Tenure Agreement 48
El Dorado Hydroelectric Project 49
Environmental Impact Statement 49
Monitoring and Compliance 50
Comparison of Projects 56
CHAPTER 5: Effect of Inclusion of B.C. Run-of-River Projects in RPS Program 57
CO_2 and GHG Emissions 57
Air Pollutants 59
Water Quality and Fisheries 59
Water Quality 60
Fisheries 60
Mitigation Measures 61
Recreation 62
Cumulative Effects 62
CHAPTER 6: Conclusions 65
References……...69

LIST OF FIGURES

Figure 1. A Run-of-River Hydro Project 6
Figure 2. IPP Supply in British Columbia 11
Figure 3. IPP Supply in Lower Mainland and Vancouver Island 12
Figure 4. Potential Run-of-River Hydro Sites in British Columbia 13
Figure 5. Normalized Monthly Run-of-River Energy Profiles by Transmission Region 14
Figure 6. Upper Harrison Water Project Location 41
Figure 7. Predicted Baseflows in Stave River 43
Figure 8. Predicted Operations Flows in Stave River 44
Figure 9. Bear Creek Hydro Project Location 47
Figure 10. El Dorado Hydroelectric Project 49
Figure 11. Life-Cycle Assessment of Greenhouse Gas Emissions 58
Figure 12. Water Power Licenses and Applications 63
Figure 13. Holmes Hydro IPP Project Location 64

LIST OF TABLES

Table 1. Existing Run-of-River Hydro Projects in British Columbia 7

Table 2. Run-of-River Hydro Projects in British Columbia Currently in Development 9

Table 3. Summary of Run-of-River Potential in British Columbia 12

Table 4. British Columbia Environmental Laws, Ordinances, Regulations, and Statutes Regulating Run-of-River Hydroelectric Projects 19

Table 5. Canadian Federal Environmental Laws, Ordinances, Regulations, and Statutes Regulating Run-of-River Hydroelectric Projects 21

Table 6. EcoLogo Requirements 28

Table 7. 30 MW or Less Run-of-River Projects With EcoLogo Certification 30

Table 8. United States Federal Laws, Ordinances, Regulations, and Standards for Hydroelectric Power 32

Table 9. California State Laws, Ordinances, Regulations, and Standards for Hydroelectric Power 33

Table 10. Comparison of LORS Regulating Run-of-River Hydro in Canada and California 38

Table 11. Overview of the Environmental Review for the Upper Harrison Water Project, Bear Creek Hydro Project, and El Dorado Project 52

EXECUTIVE SUMMARY

Introduction

The California Renewable Energy Resources Act (Senate Bill X1 2, Simitian, Chapter 1, Statutes of 2011-12) requires the California Energy Commission to report to the Legislature on run-of-river hydroelectric resources in British Columbia and on whether those facilities are or should be included as eligible facilities for California's Renewables Portfolio Standard. Run-of-river facilities divert flowing water to generate electricity, but without the dam and reservoir used by conventional hydroelectric projects.

Stakeholder Issues

This section lists some of the issues raised by stakeholders at an Energy Commission WebEx workshop, which helped frame this analysis. The issues included concerns with public outreach, impact analysis, cumulative effects analysis, fish and other habitat, fish migration, water levels and flow, and monitoring.

Run-of-River Project Permitting

This section describes the Canadian laws, ordinances, regulations, and standards for permitting run-of-river hydro projects, as well as the requirements for a hydroelectric facility in California.

Comparison of Project Environmental Documentation in British Columbia and California

This summary compares the environmental documentation prepared for two projects in British Columbia (the Upper Harrison Water Project and the Bear Hydro Project) with a project in California (the El Dorado Hydroelectric Project). The Upper Harrison Water Project is a group of five projects with a total capacity of 103 megawatts (MW) that followed the environmental assessment process, which entailed review by multiple provinicial and federal agencies. This process required the applicant to comply with a table of commitments, such as mitigation measures and ongoing monitoring requirements. The Bear Hydro Project is a 20 MW run-of-river project that was reviewed through the separate license applications for a water license, which governs the water usage, and land tenure, which governs the right to use public lands. The El Dorado Hydroelectric Project is a 21 MW project in California with four storage reservoirs that prepared an environmental impact statement as part of the Federal Energy Regulatory Commission relicensing process.

The environmental reviews of the three projects were comparable in many ways, including how they considered endangered species, fish habitat and migration, and water quality and flows. However, there were differences in the level of public outreach, impact analysis, mitigation, cumulative effects analysis, and monitoring.

Effect of Including British Columbia Run-of-River Projects in the Renewables Portfolio Standard Program

This section considers the effect of run-of-river projects on the following:

- Emissions of carbon dioxide and other greenhouse gases
    - The estimated greenhouse gas emissions from run-of-river projects per kilowatt hour (kWh) of electricity varies but is lower than the majority of energy projects currently permitted in California.
- Emissions of air pollutants
    - Run-of-river projects should have low levels of air pollutant emissions except for those emissions associated with project construction.
- Water quality, recreation, and fisheries
    - Impacts to water quality and fisheries are a major concern with run-of-river hydroelectric projects. Mitigation measures, including steps taken during siting, design, construction, and operation of a facility, can reduce the severity of these impacts.
- Any other environmental impact caused by run-of-river hydro
    - Impacts on recreation and aesthetics can result from run-of-river projects.
    - Cumulative effects of run-of-river projects can occur at the watershed and regional levels.

Conclusions

Run-of-river hydroelectric facilities in California and British Columbia are required to comply with an array of laws and regulations that result in environmental assessments or permits. To be considered eligible for California's Renewables Portfolio Standard, projects located outside the United States must be developed and operated in a manner that is as protective of the environment as a similar facility located in California. Facilities going through the full environmental assessment in British Columbia must adhere to similar regulatory requirements as those in California; however, a run-of-river hydroelectric project would have to meet additional requirements to be considered eligible for California's Renewables Portfolio Standard.

Run-of-river hydroelectric facilities in British Columbia may have the potential to bring additional environmental benefits to California; however, those benefits do not warrant changing existing statutory requirements to categorically allow all run-of-river hydroelectric projects in British Columbia to become eligible for California's Renewables Portfolio Standard.

The Energy Commission is considering the following requirements for a British Columbia run-of-river project requesting eligibility:

- The project must be less than 30 MW.

- The project must complete an environmental assessment or development plan with a cumulative impact assessment based on the Canadian Environmental Assessment Agency's *Cumulative Effects Assessment Practitioners Guide*.
- Instream flow requirements must be sufficient to not compromise the river ecosystem based on volume or timing of streamflow.
- The project should obtain an EcoLogo certification. EcoLogo is a Canadian third-party certifier of environmentally preferable products.
- Documentation (which may or may not be EcoLogo) must be provided to show the project was analyzed, constructed, and operated to protect the environment in a similar manner as a California project.
- Transparency during the environmental review and monitoring process should be comparable with Federal Energy Regulatory Commission standards.

CHAPTER 1: Introduction

Senate Bill X1 2 (Simitian, Chapter 1, Statutes of 2011) requires the California Energy Commission to report to the Legislature on its analysis of run-of-river[1] hydroelectric generating facilities (hereafter called *run-of-river hydro*) in British Columbia (B.C.). The analysis includes whether these facilities should be considered renewable electrical generating facilities under the California Renewables Portfolio Standard Program. SB X1 2 also required the Energy Commission to consider the effects of including run-of-river hydro on:

- Emissions of carbon dioxide (CO_2) and other greenhouse gases.
- Emissions of air pollutants.
- Water quality, recreation, and fisheries.
- Any other environmental impact caused by run-of-river hydro.

This report addresses the requirements of SB X1 2, Section 25741.5, and focuses on run-of-river facilities of less than 30 megawatts (MW). The report is structured as follows:

- Chapter 1 defines run-of-river hydro facilities, identifies pertinent eligibility requirements, and describes the status of (and potential for) run-of-river facilities in British Columbia.
- Chapter 2 identifies stakeholder issues and comments.
- Chapter 3 provides an overview of run-of-river hydro permitting in British Columbia and hydroelectric facility permitting in California.
- Chapter 4 compares environmental review and documentation for run-of-river hydro projects in British Columbia and California.
- Chapter 5 describes the effects on emissions of CO_2, other greenhouse gases and air pollutants, water quality, recreation and resources; and any other environmental impacts if British Columbia run-of-river projects are considered eligible renewable energy resources.
- Chapter 6 provides report conclusions.

Run-of-River Hydro

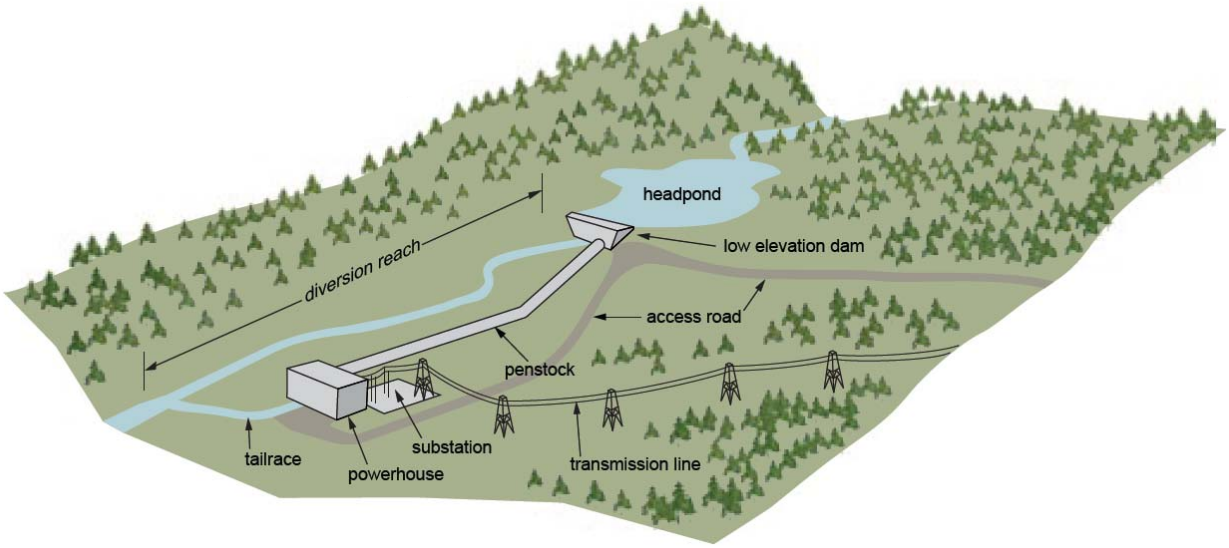
For this study, run-of-river hydro is defined as facilities where a portion of a river's water is diverted to a channel, pipeline, or pressurized pipeline (penstock) that delivers it to a waterwheel or turbine (U.S. Department of Energy [DOE] 2001). Run-of-river hydro typically returns the water to the channel downstream of the turbine (Energy Commission 2011). A run-of-river hydro project is generally, but not always, less than 30 MW.

Figure 1 shows a typical run-of-river project. A run-of-river hydro project includes (Watershed Watch Salmon Society [WWSS] 2007a and DOE 2001) the following elements:

1 Also called "river diversion."

- A small dam that creates a headpond. The headpond floods an area to ensure that the intake to the penstock is under water.
- A water conveyance system (penstock) that delivers water from the headpond to the lower elevation turbines. The conveyance may be three to four kilometers (1.8 to 2.5 miles) in length.
- A powerhouse building that contains at least one turbine or waterwheel that transforms the energy of flowing water into rotational energy.
- An alternator or generator that transforms the rotational energy into electricity.
- A tailrace channel to divert the water to the river of origin.
- Access roads to the headpond and powerhouse.
- Transmission lines from the powerhouse to the nearest larger transmission line (gen-tie line).

Figure 1: A Run-of-River Hydro Project



Source: WWSS 2007.

A run-of-river hydro project would be eligible as a renewable facility pursuant to Section 25741 of the Public Resources Code if it is a small hydroelectric generation of 30 MW[2] or less or under Article 16 (commencing with Section 399.11) of Chapter 2.3 of the Public Utilities Code. Article 16 states that a new hydroelectric facility is not an eligible renewable energy resource if it would cause an adverse impact on instream beneficial uses or cause a change in the volume or timing of streamflow. Additionally, a facility outside the United States must be developed and

2 Under SBX1 2 , an eligible renewable energy resource can include a hydroelectric generation unit with a nameplate capacity not exceeding 40 megawatts that is operated as part of a water supply or conveyance systems if the retail seller or local publicly owned electric utility procured the electricity from the facility as of December 31, 2005.

operated in a manner that is as protective of the environment as a similar facility located in California.

British Columbia Hydro and Power Authority

British Columbia Hydro and Power Authority (BC Hydro) is a Crown corporation serving 95 percent of the population in the province of British Columbia. BC Hydro operates 30 hydroelectric facilities and 3 natural gas-fueled thermal power plants and generates about 80 percent of the province's electricity from major hydroelectric generating stations on the Columbia and Peace rivers. The 2002 *B.C. Energy Plan* prohibited BC Hydro from generating additional power and requires BC Hydro to purchase any additional energy needed from independent power producers (IPPs).

Existing Run-of-River Projects

As of 2011, 42 run-of-river hydro projects provide energy to BC Hydro, totaling 822 MW of capacity and representing between 5 percent and 7 percent of BC Hydro's generation portfolio. Run-of-river projects of 30 MW or less represent between 1 percent and 2 percent of BC Hydro's generation portfolio (BC Hydro 2011b and BC Hydro 2011c). Of the 42 projects, 35 are less than 30 MW in size (representing 33 percent of the run-of-river hydro power capacity in B.C.), and 7 projects are greater than 30 MW (representing 67 percent of the run-of-river hydro power capacity in B.C.). Table 1 shows project name, location, and capacity.

Table 1: Run-of-River Hydro Projects in British Columbia

Projects less than 30 MW		
Project Name	Location	Capacity (MW)
Coats IPP	Gabriola Island	<0.5
Ocean Falls	Bella Bella	15
Akolkolex	Revelstoke	8
Boston Bar Hydro (Scuzzy Creek)	Boston Bar	6
Doran Taylor	Port Alberni	6
East Twin Creek Hydro	McBride	2
McDonald Ranch	Grasmere	<0.5
Morehead Creek	Williams Lake	<0.5
Robson Valley (Ptarmigan Creek- RBV)	McBride	4
Salmon Inlet (Sechelt Creek SCG)	Sechelt	17
Seaton Creek Hydro (Homestead)	New Denver	<0.5
Soo River	Whistler	13
Walden North	Lillooet	18
Hluey Lake Project (SNP)	Dease Lake	3
Hystad Creek Hydro	Valemount	6
Miller Creek Power	Pemberton	30
Upper Mamquam Hydro	Squamish	25

Projects less than 30 MW		
Project Name	Location	Capacity (MW)
Brandywine Creek Small Hydro	Whistler	8
Eagle Lake C2 Micro Hydro	West Vancouver	<0.5
Furry Creek	Lions Bay	10
Hauer Creek (aka Tete)	Valemount	2
Marion 3 Creek	Port Alberni	5
McNair Creek Hydro	Sechelt	10
Mears Creek	Gold River	4
South Sutton Creek	Port Alberni	5
China Creek Small Hydroelectric	Port Alberni	6
South Cranberry Creek	Revelstoke	9
Bone Creek Hydro	Kamloops	20
Lower Clowhom	Sechelt	11
Upper Clowhom	Sechelt	11
Canoe Creek Hydro	Ucluelet	6
Cypress Creek	Gold River	3
Fitzsimmons Creek	Whistler	8
Pine Creek	Atlin	2
South Cranberry Creek 2	Revelstoke	<0.5
Subtotal		273
Percentage of existing run-of-river hydro		33%
Projects greater than 30 MW		
Project Name	Location	Capacity (MW)
Mamquam Hydro	Squamish	58
Pingston Creek	Revelstoke	45
Rutherford Creek Hydro Project	Pemberton	50
Ashlu Creek Water Power	Squamish	50
East Toba and Montrose	Powell River	196
Kwalsa Energy	Mission	90
Upper Stave energy	Mission	60
Subtotal		549
Percentage of existing run-of-river hydro		67%

Source: BC Hydro 2011a.

Proposed Run-of-River Projects

There are 35 run-of-river hydro projects under development in British Columbia. Of those, 25 projects would be less than 30 MW in size, and 10 would be greater than 30 MW in size. Table 2 shows project name, location, and capacity.

Table 2: Run-of-River Hydro Projects in British Columbia in Development (2011)

Projects less than 30 MW		
Project Name	Location	Capacity (MW)
Cranberry Creek Power	Revelstoke	3
Barr Creek	Tahsis	4
Corrigan Creek	Port Alberni	7
Sakwi Creek Run of River	Agassiz	5
Maroon Creek Hydro	Terrace	5
Clint Creek Hydro	Woss	6
Raging River 2	Port Alice	8
Log Creek Hydroelectric	Boston Bar	10
Kookipi Creek Hydroelectric	Boston Bar	10
Victoria Lake Hydroelectric	Port Alice	10
Fries Creek	Squamish	9
Lower Bear Hydro	Sechelt	10
Upper Bear Hydro	Sechelt	10
Castle Creek (formerly Benjamin Creek)	McBride	6
Box Canyon	Port Mellon	15
North Creek Hydroelectric	Pemberton	16
Northwest Stave River	Mission	18
Culliton Creek	Squamish	15
Jamie Creek	Gold Bridge	19
Dasque-Middle	Terrace	20
Tretheway Creek	Mission	21
Boulder Creek	Pemberton	23
Skookum Power (aka Mamquam Skookum)	Squamish	25
Subtotal		275
Percentage of planned run-of-river capacity		22%
Projects greater than 30 MW		
Project Name	Location	Capacity (MW)
Kwoiek Creek Hydroelectric	Lytton	50
Beaver River (Ventego, Cupola)	Golden	44
Big Silver- Shovel Creek	Harrison Hot Springs	37
Kokish River	Port McNeil	45
Bremmer-Trio	Harrison Hot Springs (Doublas IR)	45

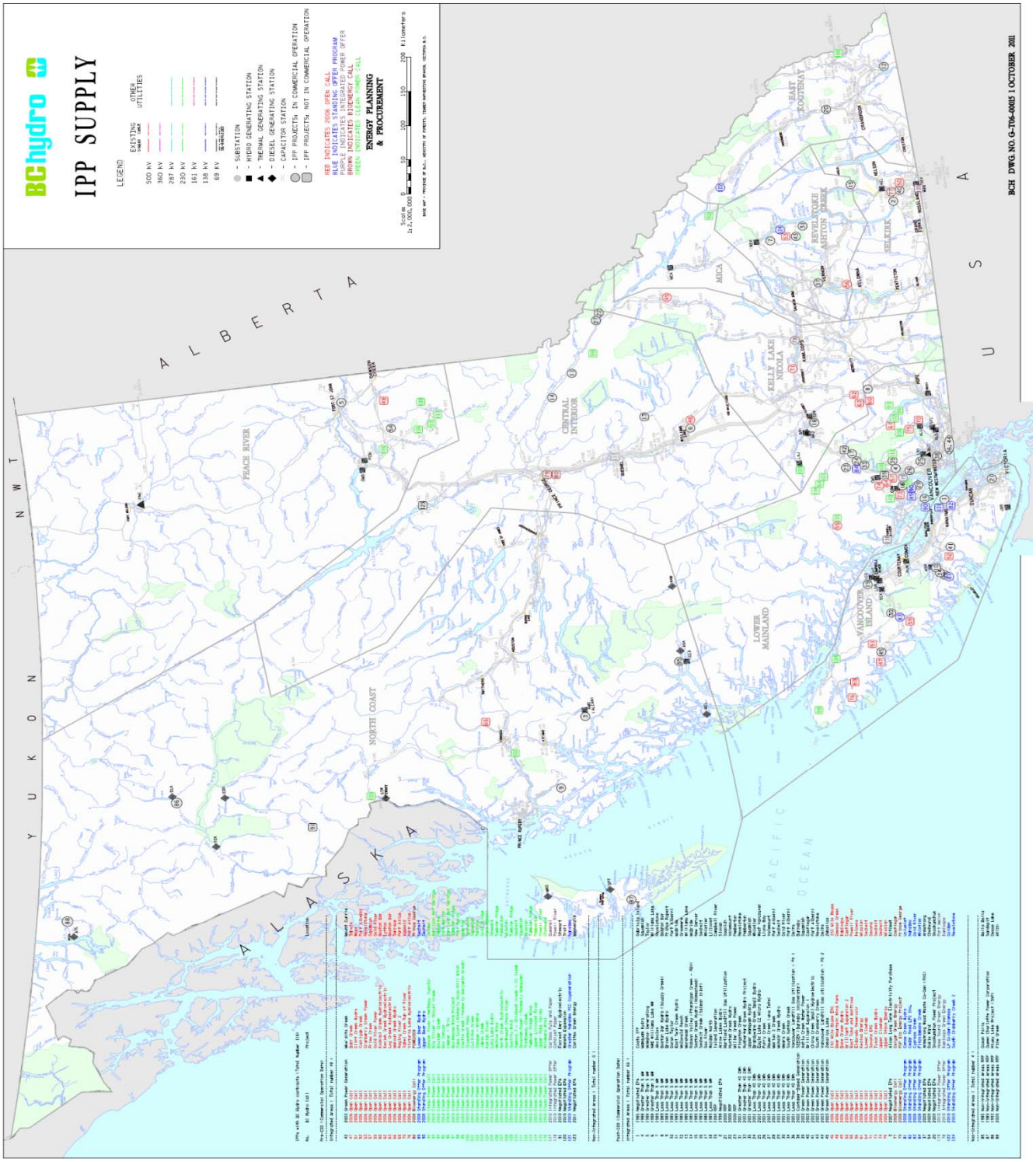
Projects less than 30 MW		
Project Name	Location	Capacity (MW)
Ramonas-CC Creek-Chickwat	Sechelt	45
Upper Lillooet River	Pemberton	74
Upper Toba Valley	Powell River	124
Waneta Expansion	Trail	335
Forrest Kerr Hydroelectric	Stewart	195
Subtotal		994
Percentage of planned run-of-river capacity		78%

Source: BC Hydro 2011b.

Run-of River Project Operations

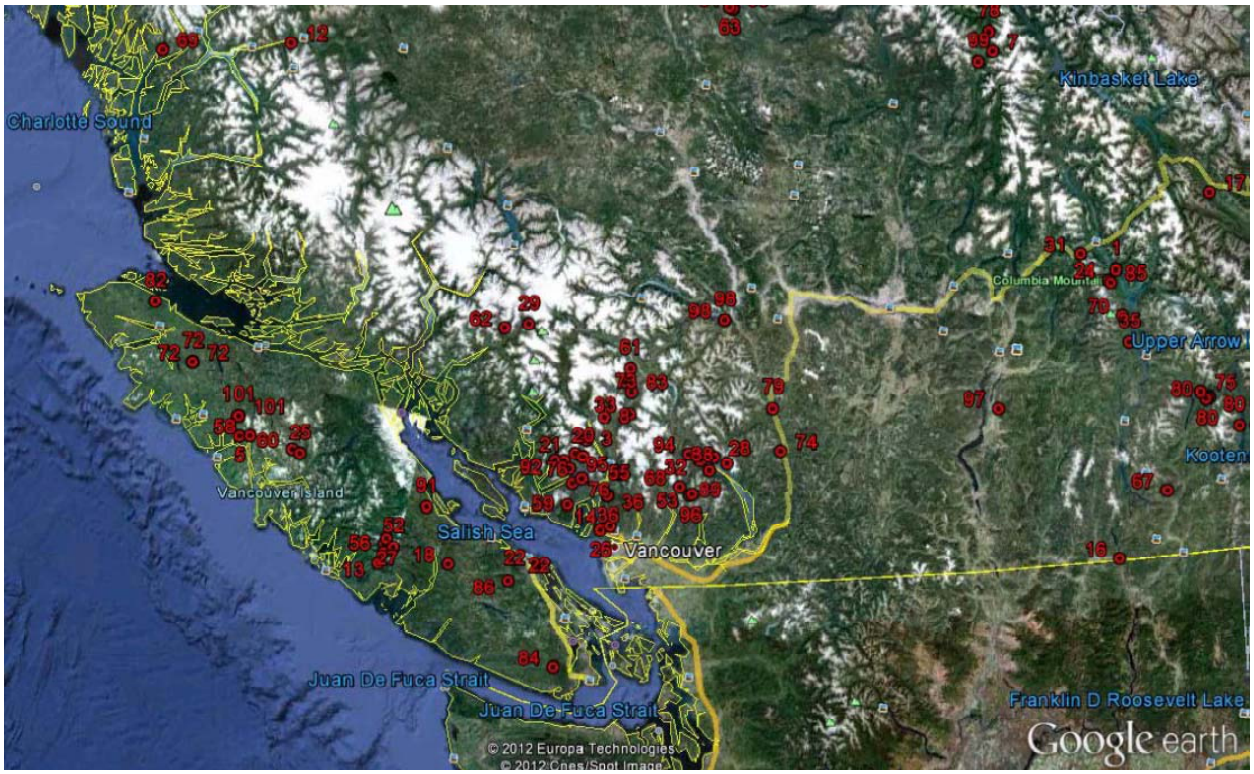
Existing and proposed run-of-river projects are located throughout British Columbia. Figure 2 shows the locations of run-of-river facilities within the province. As shown in Figure 3, the majority of existing facilities less than 30 MW are located in the Lower Mainland and Vancouver Island.

Figure 2: IPP Supply in British Columbia



Source: BC Hydro 2011d.

Figure 3: IPP Supply in Lower Mainland and Vancouver Island



Source: MEM 2011.

BC Hydro carried out a hydrology analysis to estimate the annual energy potential from run-of-river hydro (BC Hydro 2010) using data from a statistical analysis of Water Survey of Canada. The analysis looked at annual energy, firm energy, and dependable capacity. Table 3 provides a summary of run-of-river potential, and Figure 4 illustrates the locations for potential run-of-river hydro in British Columbia. The hydrology analysis also considered the seasonality and intermittent nature of run-of-river hydro projects. Figure 5 illustrates the normalized monthly run-of-river profiles by transmission region and indicates that run-of-river resource options have seasonal characteristics; much of the power generation occurs in the freshet period, a flood of a river from heavy rain or melted snow. As shown in Table 3 and Figure 4, the largest potential for run-of-river hydro projects is in the North Coast, Vancouver Island, and the Lower Mainland; however, as noted in the report, the results of this study are subject to change. The cost of the run-of-river electricity potential varies greatly – $66 to $600 per megawatt hour (in 2011 Canadian dollars). Table 3 does not distinguish what is economically viable to build (BC Hydro 2011e).

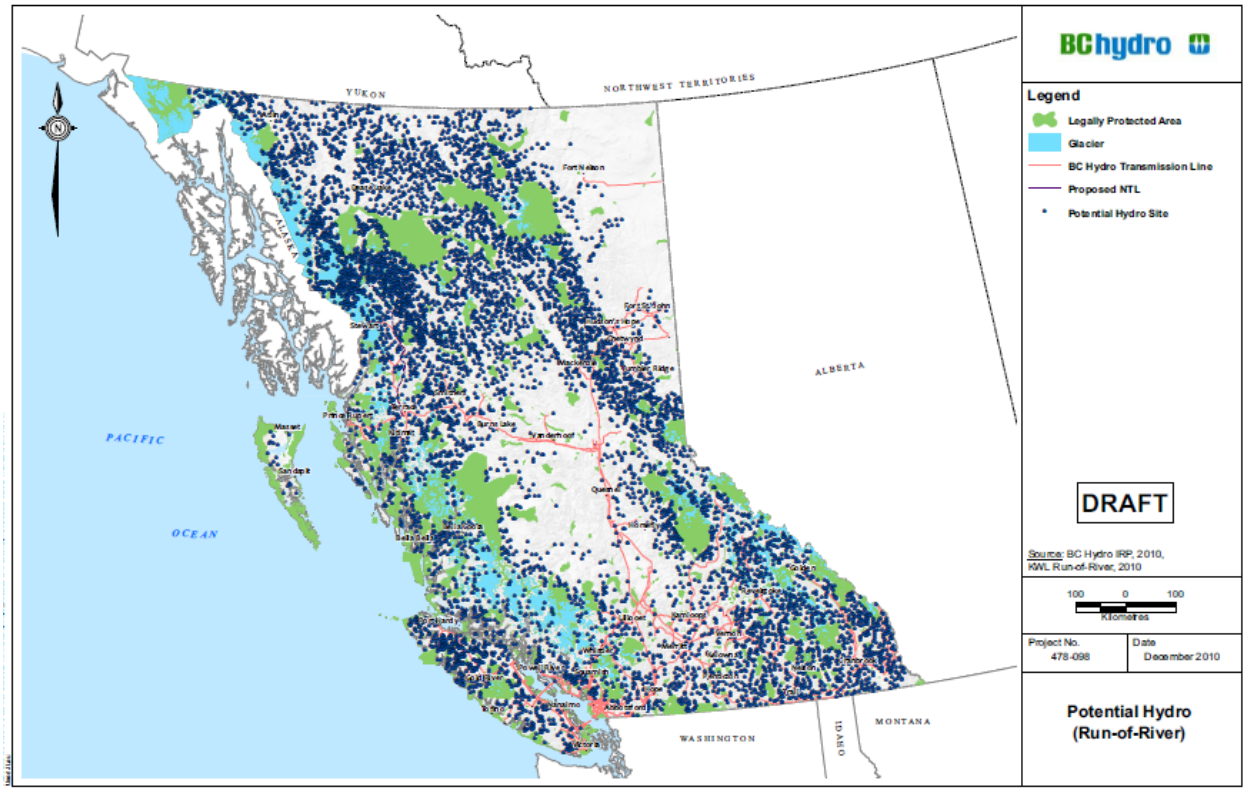
Table 3: Summary of Run-of-River Potential in British Columbia

Transmission Region	Number of Projects	Installed Capacity (MW)	Annual Energy (GWh/yr)
Peace River	32	115	342
North Coast	434	2,778	10,140
Central Interior	122	849	3,089
Kelly Nicola	179	978	3,588
Mica	128	808	2,802
Revelstoke	192	972	3,428
Vancouver Island	320	2,274	9,248

Transmission Region	Number of Projects	Installed Capacity (MW)	Annual Energy (GWh/yr)
Lower Mainland	206	1,684	7,174
Serlkirk	90	525	1,718
East Kootenay	213	970	3,173
Total	1,916	11,950	44,703

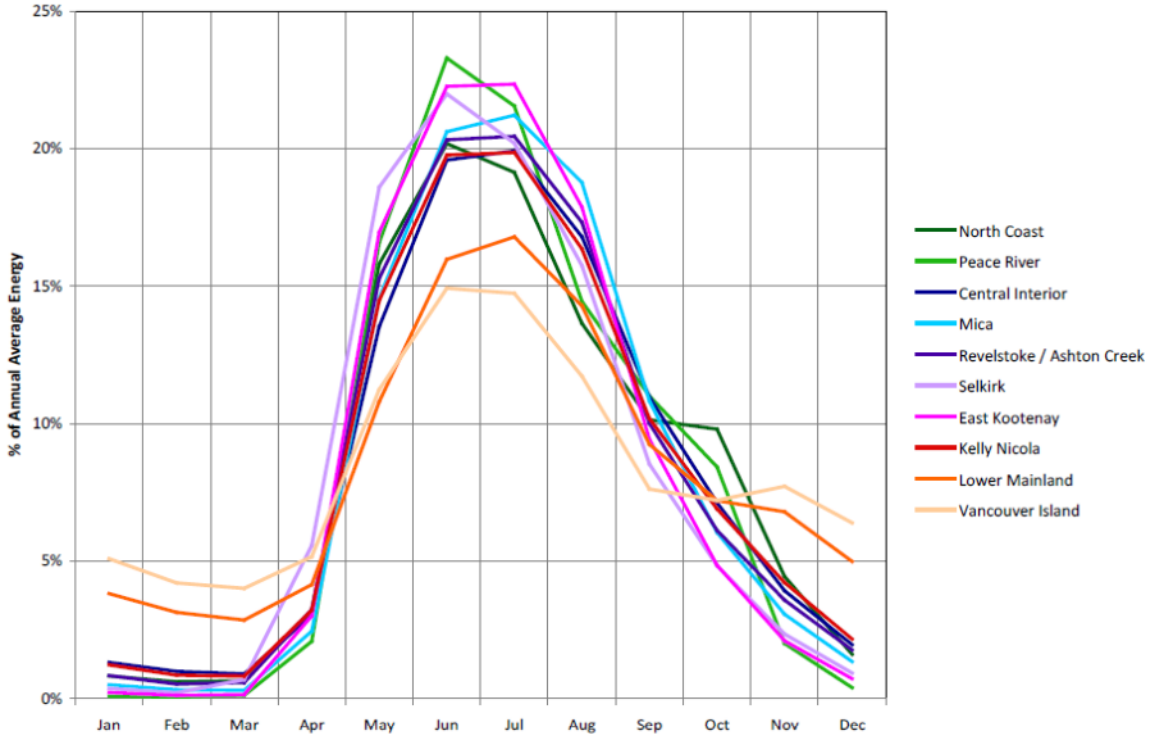
Source: BC Hydro 2011e.

Figure 4: Potential Run-of-River Hydro Sites in British Columbia



Source: *BC Hydro 2010*, Appendix 2j.

Figure 5: Normalized Monthly Run-of-River Energy Profiles by Transmission Region



Source: *BC Hydro 2010*.

CHAPTER 2:
Stakeholder Issues

Senate Bill X1 2 also required this study to provide opportunities for public comment, including at least one public workshop and consultation with interested governmental entities. The Energy Commission held a workshop via WebEx on February 24, 2012, with about 30 participating parties. The following governmental, nongovernmental, and private parties provided written and oral information during the WebEx and through consultation:

- B.C. Ministry of Energy and Mines
- B.C. Ministry of Environment Water Stewardship Division
- B.C. Ministry of Forests, Lands, and Natural Resource Operations (BC MFLNRO)
- B.C. Environmental Assessment Office
- BC Hydro Regeneration
- Powerex, wholly owned subsidiary of BC Hydro
- B.C. Creek Protection Society
- California Hydropower Reform Coalition
- Clean Energy Association of British Columbia
- Friends of Bute Inlet
- Wilderness Committee
- Watershed Watch Salmon Society (WWSS)
- TerraChoice
- Private individuals

Numerous studies and articles were reviewed for the report, including:

- Senate Bill X1 2, Enacted by Governor Jerry Brown, April 12, 2011.
- *2011 Integrated Resource Plan: Planning for a Clean Energy Future Consultation Workbook*, March 1 – April 30, 2011, BC Hydro.
- *Final Report 2010 BC Hydro Resource Options Update Review and Update of Environmental Attributes*, Kerr Wood Leidal Associates Ltd., Hemmera, HB Lanarc, April 2011.
- *2011 Integrated Resource Plan: BC Hydro Draft 2010 Resource Options Report*.
- *EcoLogo™-Environmental Standard – Certification Criteria Document*. CCD-003: Renewable Low-Impact Electricity Products, November 2010.
- *The B.C. Energy Plan: A Vision for Clean Energy Leadership: Electricity*
- *Province of British Columbia: Clean Energy Project Development Plan Information Requirements*, November 2011.
- *Clean Energy Production in B.C.: An Inter-agency Guidebook for Proponents*, 2011.
- *Independent Power Producers Association of British Columbia: Economic Impact Analysis of Independent Power Projects in British Columbia*, December 2009.
- *Best Practices in Small Hydro Development – A Perspective from British Columbia, Canada*, Matt Hammond.

- *Run-of-River Hydropower in B.C.: A Citizen's Guide to Understanding Approvals, Impacts and Sustainability on Independent Power Projects*, Watershed Watch Salmon Society, August 2007.
- *"Green" Hydro Power: Understanding Impacts, Approvals, and Sustainability of Run-of-River Independent Power Projects in British Columbia*, Watershed Watch Salmon Society, August 2007.
- *Independent Power Production, Run-of-River, Small Hydro and the Pitt River Power Cluster*, University of British Columbia Faculty of Law(No date).
- *Testing the Waters: A Review of Environmental Regulation of Run of River Power Projects in British Columbia*, April 2010, Prepared for Wilderness Committee and B.C. Creek Protection Society.
- *Upper Harrison Water Power Project Environmental Assessment,* including compliance documents, Wilderness Committee.
- *Bear Creek Water License Technical Report*, September 2008.
- *Bear Creek Construction Environmental Management Plan*, March 2007.
- *Review of BC Hydro*, June 2011.
- Independent Power Producers Association of British Columbia, Run-of-River Hydro Power Fact Sheet.
- *Final Environmental Impact Statement for Hydropower License: El Dorado Project No. 184-065*, July 2003.
- *An Overview of U.S. Reservoir GHG Emissions Studies and Preliminary Automated Sampling Results for Lake Oroville*, September 2009.
- *Ontario Power Authority, Supply Mix Advice Report, Volume 2 – Analysis Report*, December 2005.
- *Battle Creek Salmon and Steelhead Restoration Project Draft EIS/EIS,*. Consultation and Coordination Chapter, July 2003.
- *Preparing Environmental Documents: Guidelines for Applicants, Contractors, and Staff*, Federal Energy Regulatory Commission: Office of Energy Projects Division of Hydropower Licensing, September 2008.
- *Tamed Rivers: Hydropower in British Columbia: A Guide to Impacts and Opportunities*. Watershed Water Salmon Society, in Preparation May 2012 (IN PUBLICATION).
- Development of instream flow thresholds as guidelines for reviewing proposed water uses, March 2003.

The categories below present issues concerning run-of-river hydro, which helped frame the report analysis. Later report sections discuss information regarding the issues provided in comments by nongovernmental and governmental agencies and in the resources noted above. Comments relating to projects greater than 30 MW are outside the scope of this study.

Regulations

- Environmental standards for run-of-river projects in B.C. are less stringent than for other industrial projects, even if the impact is comparable.
- Environmental assessments are required only for projects that are greater than 50 MW (although some applicants have and do opt in even when they do not trigger such a review).
- Local agency involvement/approval may be limited.
- British Columbia Strategic Land and Resource Plans and Land and Resource Management Plans for Crown land were originally meant for managing forest and have been less effective for run-of-river projects.

Public Outreach

- Environmental review may not provide for adequate public involvement.
- Projects may lack information sharing.
- Projects provide a process during agency review for collaboration.
- Projects may provide benefits to First Nations communities through partnerships, support for businesses, employment opportunities, training, and capacity building.

Impact Analysis

- Construction activities emit air pollutants and greenhouse gases.
- Construction activities may directly harm species and affect habitat.
- Construction activities may cause erosion and spread invasive species.
- Projects may impact recreation, such as kayaking or fly fishing, aesthetic values, and tourism.
- Penstocks, powerhouses, access roads, and transmission lines may affect terrestrial environments and wildlife movement/mortality.
- Fine sediment accumulation and sediment movement may cause downstream effects.
- Projects have low life-cycle, greenhouse gas unit emissions as compared to other generation technologies.
- Projects incorporate best management practices to minimize terrestrial impacts.

Cumulative Effects Analysis

- Cumulative impacts may arise and may not be sufficiently addressed.
- Cumulative effects may impact a river system if more than one tributary is diverted.
- Development of linear/ancillary facilities such as roads and transmission lines may result in future development of previously undisturbed areas.

Fish and Other Habitat

- Projects are increasingly proposed in sensitive wildlife habitat and in fish habitat.
- Effects of river diversions on fish populations have not been well studied.
- Projects may impact fish and fish habitat/migration and other aquatic organisms.
- Projects may affect streamside (riparian) vegetation and surrounding habitat.
- Mitigation is included in the environmental assessment or water license for a run-of-river hydro project to minimize impacts to fish populations.
- Impacts on fish and fish habitat are regulated provincially through British Columbia's Fish Protection Act.

Fish Migration

- Projects may impact fish habitat/migration.

Water Levels/Flow

- Projects may result in diversion of more than 90 percent of river flow.
- Lack of high flows may affect channel maintenance.

Monitoring

- There is no capacity within the Ministry of Environment or any other government agency to monitor these projects effectively during construction, and when in operation, agencies have a lack of field presence.
- Field monitoring (audit) information is not shared with the public.
- Certificate commitments are not measurable and enforceable.
- Project proponents are generally required to do their own monitoring and reporting, and compliance with instream flow requirements is not very good.

CHAPTER 3: Run-of-River Project Permitting

This chapter outlines the basic provincial and federal laws for run-of-river hydro projects in B.C., Canada, for projects that generate 30 MW of electricity or less. It then describes the environmental regulations and review process for hydroelectric projects in British Columbia. Finally, it outlines the laws, ordinances, regulations, and statutes for hydroelectric power in California and explains the small-hydroelectric project exemption processes.

Canadian Laws, Ordinances, Regulations, and Standards

Under Canadian law, an IPP that proposes a run-of-river hydro project must obtain approvals from provincial and federal resource ministries. The legislative framework that governs run-of-river hydro projects is the same for all industrial projects. Local zoning approval of an IPP run-of-river hydro project was required until the spring of 2006. Passage of Bill 30, Miscellaneous Statutes Amendment Act, in May 2006 amended Section 121 of the *Utilities Commission Act* so that local government land use decisions (for example, local zoning) cannot prevent public utilities from constructing a run-of-river facility. The amendment set out the following criteria to determine whether a clean energy project should be considered a "facility": (1) It must be entirely located on provincial Crown land; (2) has an electricity purchase agreement with BC Hydro, Powerex, or FortisBC; and (3) has obtained necessary federal and provincial authorizations. Local governments retain the ability to participate in project reviews and provide information and feedback during the project permitting process. The Ministry of Energy and Mines has produced a guide titled *Opportunities for Local Government and the Public Participation in Provincial Regulatory Processes for Independent Power Producers' Projects.*

A run-of-river hydro project is subject to provincial and federal legislation. Table 4 summarizes the primary and secondary provincial legislation that governs the approval of a run-of-river hydro project. Not all of the laws in the table are applicable to every run-of-river hydro project; many would be triggered only if the project impacted a resource protected under the law.

Table 4: British Columbia Environmental Laws, Ordinances, Regulations, and Statutes Regulating Run-of-River Hydroelectric Projects

Primary Regulations	Description	Regulating Agency
Comply with Regulations		
Clean Energy Act	The Clean Energy Act establishes a long-term vision for British Columbia to become a clean-energy powerhouse. It sets out 16 specific energy objectives that focus on three areas: ensuring electricity self-sufficiency at low rates, harnessing B.C.'s clean power potential to create jobs, and strengthening environmental stewardship and reducing greenhouse gases.	Ministry of Energy, Mines and Petroleum Resources
Environmental Management Act	The Environmental Management Act regulates the discharge of waste into the environment. The aim of the act is to protect human health and the quality of water, land, and air in British Columbia. The act enables the use of administrative penalties, informational orders, and economic instruments to assist in achieving compliance.	Ministry of Environment
Environmental Assessment Act	The Environmental Assessment Act requires that certain major project proposals obtain an environmental assessment certificate before they can proceed. Energy projects may be subject to the act if the size of the project meets or exceeds a threshold established in the Reviewable Projects Regulation. A project that completes an environmental assessment must get an environmental assessment certificate to proceed with other provincial approvals.	Ministry of Environment
Land Act	B.C.'s Land Act is used by the government to allocate Crown land to the public for various uses including the granting of land, and issuance of Crown land tenure in the form of permits, licenses, leases and rights-of-way.	Ministry of Forests, Lands and Natural Resource Operations
Endangered Species		
Wildlife Act	The Wildlife Act vests ownership of wildlife in B.C. in the government unless a permit or license is issued under the act and is administered by Wildlife Management Programs. The Wildlife Act allows the minister to designate a wildlife management area where conservation and management of wildlife, fish, and their habitats are the priority for management and where a person is prohibited from using land or resources without written permission. The act allows the Lieutenant Governor to designate endangered and threatened species.	Ministry of Environment
Fish Habitat		
Fish Protection Act	The Fish Protection Act enables the protection of fish and fish habitats. The main objectives of the act are to ensure sufficient water for fish; enable fish habitat to be protected and restored; improve riparian habitat protection and enhancement; and, give local governments greater powers of environmental planning. The act allows for designation of sensitive streams and recovery plans that may have restrictions placed on new water licenses or approvals, or amendments to existing ones.	Ministry of Environment

Water Quality		
Water Act	The Water Act vests ownership of the water in streams in B.C. in the provincial government. The Water Act regulates the diversion, use, and storage of water from streams, as well as changes (works and activities) in and about streams for which an approval is required unless otherwise covered by the Water Regulation. A water license provides for the diversion and use or storage of a designated quantity of water for a specific purpose and permission to construct associated project components such as a powerhouse, penstock, intake structures, transmission lines, roadways and construction staging areas and to undertake changes in a stream. Approval is required if the project would cause changes in or about a stream.	Ministry of Forests, Lands and Natural Resource Operations
Water Protection Act	The Water Protection Act reconfirms that surface water and groundwater are, and always have been, vested in the Crown, except in so far as private rights have been established. A comprehensive registration system is established under the legislation to define and limit the quantity of bulk water being removed from British Columbia. The legislation protects the province's water supplies by prohibiting persons from removing water from the province except under specific conditions.	Ministry of Environment
Secondary Legislation Regulating Run-of-River Hydro Projects		
Impact Analysis		
Forest Act	The Forest Act provides the authority to grant various licenses to access or harvest Crown timber. It stipulates license requirements for road use. The act also establishes the “provincial forest” and certain activities (such as a power station) have not been identified as compatible use within the provincial forest, and the area of use may need to be deleted from the provincial forest.	Ministry of Forests, Lands and Natural Resource Operations
Forest and Range Practices Act	The Forest and Range Practices Act outlines requirements regarding the acquisition of authority to use forest service roads for industrial purposes. The act identifies range planning requirements and protection of forest resource.	Ministry of Forests, Lands and Natural Resource Operations
Heritage Conservation Act	The purpose of the Heritage Conservation Act is to encourage and facilitate the protection and conservation of heritage property in British Columbia.	Ministry of Forests, Lands and Natural Resource Operations
Highway Act	This act deals with the establishment, maintenance, alteration and regulation of public highways in the province, including bridges and tunnels.	Ministry of Transportation and Infrastructure
Industrial Roads Act	The Industrial Roads Act includes provisions governing the use and linkage to public roads.	Ministry of Transportation and Infrastructure
Park Act	The Park Act is designed to protect parks, nature conservancies, ecological reserves, recreation areas, and other designated areas. Parks and protected areas are managed for important conservation values and are dedicated to the preservation of natural environments. The Park Act prohibits hydroelectric power generation within these areas.	Ministry of Environment
Transportation Act	The Transportation Act includes provisions governing the use and linkage to public roads.	Ministry of Transportation and Infrastructure

Source: BC MFLNRO 2011a.

In addition to provincial laws, federal laws govern the approvals of some run-of-river hydro projects. Table 5 lists federal laws that are applicable to run-of-river hydro projects.

Table 5: Canadian Federal Environmental Laws, Ordinances, Regulations, and Statutes Regulating Run-of-River Hydroelectric Projects

Regulations	Description	Agency
Comply with Regulations		
Canadian Environmental Assessment Act (CEAA)	The Canadian Environmental Assessment Act ensures that the environmental effects of projects are carefully reviewed before federal authorities take action so that projects do not cause significant adverse environmental effects; encourages federal authorities to take actions that promote sustainable development; promotes cooperation and coordinated action between federal and provincial governments on environmental assessments; promotes communication and coordination between federal authorities and Aboriginal peoples; ensures that development in Canada or on federal lands does not cause significant adverse environmental effects in areas surrounding the project; ensures that there is an opportunity for public participation in the environmental assessment process.	Environment Canada
National Energy Board Act	The Board regulates the construction and operation of international and designated interprovincial power lines and the export of oil and electricity. It also provides energy advice to the Minister of Natural Resources in areas where the Board has expertise.	National Energy Board
Navigable Waters Protection Act	The Navigable Waters Protection Act's primary purpose is the protection of the public right of navigation. NWPA approval is required for any works placed on, over, under, through or across navigable waters that may result in a substantial interference to navigation. The potential to affect navigation on waterways can occur through changes to water flow along diversion reaches that are sited in navigable waters. Bridge crossings along access roads and transmission line crossings also have the potential to affect navigation.	Transport Canada
Endangered Species		
Migratory Birds Convention Act	The Migratory Birds Convention Act prohibits the unauthorized taking or killing of migratory birds, their nests and eggs, and the deposition of harmful substances in areas frequented by migratory birds. Project-related impacts have the potential to occur during construction, operation, and/or decommissioning.	Environment Canada

Regulations	Description	Agency
Species at Risk Act (SARA)	The Species at Risk Act is designed to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened. Under SARA, habitat requirements and anticipated level of harm to species at risk must be considered before authorization to construct and operate a clean energy project can be granted.	Environment Canada
Fish Habitat		
Fisheries Act	The Fisheries Act is administered jointly by Fisheries and Oceans Canada (DFO) and Environment Canada (EC). The purpose of this act is to conserve and protect Canada's fisheries resources, including fish habitat. The act establishes four overarching requirements and prohibitions: • Prohibits the killing of fish by means other than fishing. • Prohibits the harmful alteration, disruption, or destruction of fish habitat. • Prohibits the deposit of substances into waters frequented by fish.; • Requires the provision of sufficient flows below obstructions for the descent and safety of fish. An authorization under the Fisheries Act from Fisheries and Oceans Canada is required if the project or works would result in the harmful alteration, disruption, or destruction of fish habitat.	Fisheries and Oceans Canada, Environment Canada

Source: BC MFLNRO 2011a.

A proponent of a run-of-river hydro project must also consult with the First Nations (Canada's Aboriginal Peoples). Federal and provincial environmental assessment processes, as well as federal and provincial decision-makers on operational permitting, are constitutionally required to consult the First Nations and, if appropriate, accommodate them for potential impacts on aboriginal or treaty rights (Ministry of Energy and Mines 2012). The clean energy industry reports that more than 125 First Nations are part owner/operators in run-of-river projects or looking at commercial opportunities with developers.

British Columbia Run-of-River Hydro Project Permitting

British Columbia requires an environmental assessment for hydroelectricity projects that are 50 MW or greater under the Environmental Assessment Act. Projects that are under 50 MW (including all projects that would be potentially eligible for Renewables Portfolio Standard [RPS] compliance in California) may require an environmental assessment but only by one of these:

- Ministerial Designation by the Minister of Environment, who has the authority to direct the review of projects that are not automatically reviewable under the Reviewable Projects Regulation
- Proponent "opt-in" whereby a proponent may request that the Environmental Assessment Office (EAO) consider designating its project (that otherwise would not be reviewable) as a reviewable project, and the EAO agrees with and orders such a designation.

Run-of-river hydro projects that generate less than 30 MW of electricity and do not require an environmental assessment apply for provincial and federal environmental, land, and resource approvals. Run-of-river hydro projects must also consult with First Nations and other holders of water licenses on the water system. The applicant must enter into an agreement with BC Hydro for an electricity purchase agreement.

The Province of British Columbia published the *Clean Energy Project Development Plan Information Requirements (Development Plan Requirements)* in July 2011 (updated November 2011) to provide guidelines on the types of information required in the decision-making process for clean energy projects, including run-of-river hydro. These guidelines provide pertinent information on the clean energy project plan as well as for the environmental assessment of the project. The *Development Plan Requirements* mandate the following types of information:

- Project description, including the environmental setting
- Environmental assessment, including the aquatic environment, fish and fish habitat, water quality, hydrology and hydrogeology, and other terrestrial environment data
- Socioeconomic assessment, including regional economy, land-use plans, wildfire protection, transportation and access, water rights, and human health and safety concerns
- Project engagement activities (public participation)
- First Nation information requirements including consultation
- Monitoring programs
- Any federal requirements.

This information is used to obtain all provincial and federal approvals and licenses required for a clean energy project. The *Development Plan Requirements* requests detailed information that, if appropriately compiled, is sufficient to assess any potential impacts of the clean energy projects. A regional project team would review a project's development plan template and work with the applicant to determine whether it meets the information requirements. While some of this information is publicly available, many of the more detailed technical reports are not.

The provincial and federal permits required for a run-of-river project would depend on the resources impacted by the project. The two primary licenses required are a water license and land tenure. A water license is required because the Water Act vests ownership of water in streams in B.C. in the provincial government. Since 94 percent of the land in B.C. is provincial Crown land, most run-of-river hydro projects would require land tenure for use of Crown land. Both these permits are addressed in detail below.

In 2010, British Columbia initiated an interagency project, the cumulative effects assessment and management framework, to develop a consistent approach for considering the cumulative effects in natural resource decision-making. Three demonstration projects are being used as learning opportunities for developing this framework and for testing tools to support the cumulative effects assessment (Ministry of Energy and Mines 2012).

Water License

The Water Stewardship Division of the Ministry of the Environment requires a water license for run-of-river hydro projects. A project proponent would apply for the water license and land tenure at the same time. If a run-of-river hydro project proponent opts into the environmental assessment, all of the license applications

would be completed at the same time. This allows the agencies to review the applications simultaneously and reduce redundancy.

A water license application requires a detailed series of project maps, watershed maps, identification of stream and tributaries affected by the project, project linkages (application areas that are linked together by one transmission line), and a project scope. The project scope requires data on the run-of-river hydro project construction and operation details, measures taken to protect environmental values, and discussion of any planned involvement with First Nations (BC Ministry of Environment 2009a). The project scope must also identify any assessment studies required to preserve fish, wildlife, or aquatic habitat and any base water flows needed to protect aquatic resources (BC Ministry of Environment 2009a). The Water Stewardship Division would consider all projects along the water system that impact water inflow (Davidson 2011).

The Water Stewardship Division would work with the federal Department of Fisheries and Oceans (DFO) and the applicant biologists to assess impacts to fisheries and reduce any impacts to fish species (Davidson, 2011). However, the Water Act has no clear legal obligation to consider regional or local land-use plans, stream health, cumulative effects, or other environmental factors (Thielmann, 2010). If monitoring of stream inflow is required, the applicant would provide the information to the division, which periodically audits the project (Davidson, 2011).

A water license would authorize the proponent to construct the hydroelectric project's components, such as a powerhouse, penstock, intake structures, transmission lines, roadways, and construction staging areas. However, a water license does not authorize use of Crown land to build the components. This requires a land tenure agreement. Land tenure applications would be processed only in conjunction with an application for a water license, or if the applicant has proof of an existing or pending water license (BC MFLNRO 2011c).

Land Tenure

A run-of-river hydro project being built on or using Crown land requires tenure under the Land Act. The type of land tenure depends on how the land is being used.

- A temporary permit authorizes short-term use of six months to two years and is limited to low-impact use such as site investigations, which require no construction.
- A license allows the holder to carry out specified activities and may result in some improvements to the land such as trails and some buildings; a license gives the holder nonexclusive access to the site.
- A lease gives the tenure holder exclusive right to use a parcel of Crown land and allows for substantial improvements or investments in and on the land for long-term facilities and requires specific boundaries. A statutory right-of-way is used to authorize linear uses of Crown land, such as pipelines or transmission lines.

A project proponent applying for land tenure must submit a development plan as part of the application package. The development plan describes the types of impacts the project could have on the land, natural resources, and other users or interested groups. It also explains any measures proposed to eliminate or minimize conflicts with other users, protect environmental integrity, respond to First Nations' concerns, and ensure public access if appropriate (BC MFLNRO 2011b). All energy projects must inform the public of the project and request they submit comments regarding the Crown land application (BC MFLNRO 2011b).

The Ministry of Forests, Lands, and Natural Resource Operations, created in the fall of 2010 by merging the Natural Resource Operations with Forests and Land, reviews any application for land tenure and solicits written comments, known as referrals, on an application from recognized agencies and groups that make up

the Regional Project Team. The referral agencies, organizations, and identified special interest groups provide their responses to the authorizing agency within 30 days (45 days for First Nations) (BC MFLNRO 2011c).

The project proponent must engage with the community regarding the project by providing public notice, allowing a public comment period, and hosting open houses or public meetings. The project proponent needs to obtain written consent from owners of waterfront property and, in certain cases, from owners of adjacent properties.

After reviewing and revising the development plan, the project proponent provides all information regarding the project, including public comments, to the decision maker for consideration. If the project is approved, the Ministry of Forests, Lands, and Natural Resource Operations staff must inspect and monitor the work sites and operations to ensure compliance with stipulated terms and conditions. The Independent Environmental Monitor and Independent Engineer provide reports to the Ministry of Forests, Lands, and Natural Resource Operations on a regular schedule (Ministry of Energy and Mines 2012).

Permits and Approvals

A run-of-river hydro project less than 30 MW may require more than 50 permits, licenses, approvals, and reviews from 14 regulatory bodies, including federal, provincial, local, and Aboriginal or First Nations peoples. However, many of these laws and permits do not address environmental impacts and mitigation for a run-of-river project (Thielmann 2010). Potential permits and the environmental issues addressed for a run-of-river hydro project include:

- A federal environmental assessment is required for a regulatory decision such as issuance of a Fisheries Act authorization or Navigable Waters Protection Act approval. The Canadian Environmental Assessment Agency would review this assessment. The assessment is likely to be a screening to document the environmental effects of a project and determine the need to eliminate or minimize adverse effects. A report is prepared that summarizes the findings of a screening and includes a cumulative effects assessment under the Canadian Environmental Assessment Act. Proponents wanting to build projects in or near fish-bearing streams must work with the DFO to prevent or mitigate impacts. The DFO would consider any harmful alteration, disruption, or destruction of fish habitat. Where fish habitat exists, the project must be designed to return diverted water to the stream upstream of anadromous salmonid, critical trout, or endangered species habitat. DFO would only authorize harmful alteration, disruption, or destruction of fish habitat after exhausting all other options and after proponents develop appropriate compensatory habitat as per the no-net-loss guiding principle under the DFO's Habitat Management Policy.
- An approval from Transport Canada for works built or placed in, on, over, under, through, or across navigable water.
- An occupant license to cut if the project involves cutting timber on Crown land (including clearing a road). However, some run-of-river applications are exempt from considering a broad scope of potential environmental impacts because an occupant's license to cut is defined as a minor tenure.
- A works permit from the Ministry of Forests and Range for carrying out works within a Forest Service road right-of-way (70 m), such as clearing for transmission lines, installation of penstocks for water power projects or road realignment, and widening for safety reasons.
- A highway access permit from the Ministry of Transportation if roadways or driveways required to access IPP works connect to provincial highways or other secondary roads.

- A right-of-way from the Minister of Natural Resources Operations for transmission lines that cross Crown land.

Public Outreach

- Approval from Indian and Northern Affairs Canada for construction of any works on or over an Indian reserve.
- Written permission from a First Nation to avoid or minimize infringements on or impacts related to aboriginal rights, title, land claims, or treaty negotiations.

Impact Analysis

- A heritage inspection permit for an archaeological impact assessment from the Ministry of Forests, Lands and Natural Resource Operations if a project is located at or near an archaeological or historic site to identify site locations, evaluate site significance, and determine the magnitude of development-related impacts.
- An archaeological overview assessment if aboriginal rights or title issues exist at or near the proposed project.

Fish Habitat

- Authorization is required under the Fisheries Act if the project will result in the harmful alternation, disruption, or destruction of fish habitat or fish.

Monitoring

- Monitoring of the site as per agency requirements to verify the impacts are expected during the environmental reviews. Monitoring of projects falls to the applicant, who provides reports to the respective agencies. The agencies audit the projects but are limited by funds and the numbers of projects.
- Ministry of Forests, Lands, and Natural Resource Operations has technical staff and compliance specialists who audit the projects in the field during construction and operations. The number of compliance and enforcement staff under the Ministry of Forests, Lands, and Natural Resource Operations has increased since 2010, and clean energy projects are a priority for inspections.

Environmental Assessment

As noted above, if a project is 50 MW or greater or under certain circumstances, the British Columbia Environmental Assessment Office reviews the project. The environmental assessment ensures review and vetting of major projects that have the potential for significant adverse impacts. Environmental nongovernmental groups, industry, and First Nations conduct the review. The environmental analysis provided for an environmental assessment can be used, where applicable, to support the issuance of other required permits, including the water license and land tenure.

An environmental assessment includes four primary elements (BC MFLNRO 2011a):

- Opportunities for all interested parties, including First Nations and neighboring jurisdictions, to identify issues and provide input
- Technical studies of the relevant environmental, economic, social, heritage, and health effects of the proposed project
- Identification of ways to prevent or minimize undesirable effects and enhance desirable effects

- Consideration of the input of all interested parties in compiling the assessment findings and making recommendations about project acceptability.

During the environmental assessment process for a run-of-river hydro project, a technical working group reviews the project submissions and makes recommendations for the project. The proponent must complete the following steps to obtain regulatory approval:

- Application submission and acknowledgement to state the proponent's intent to develop a clean energy project at a specific site and start the regulatory process
- Dialogue with the Ministry of Forests, Lands and Natural Resource Operations (BC MFLNRO) project lead to discuss the project and confirm regulatory requirements, meet with First Nations and stakeholders to understand specific issues and opportunities, and improve the project definition as needed
- Submission of a development plan template to get feedback from agencies regarding technical aspects of the project with respect to regulatory expectations
- Development plan submission, based on the development plan template, to fulfill regulatory requirements and expectations, including a cumulative effects review
- Initial approvals based on the development plan, which provide requirements and guidance for final design of the project
- Final approvals based on final design, which allows the project and construction to proceed
- Final approvals that include applicant commitments that are designed to reduce impacts of project
- Approval to operate following the construction, testing, and commissioning of the project
- Monitoring of the site as per agency requirements to verify the impacts are as identified during the environmental reviews.

In July 2011, the Office of the Auditor General of British Columbia reviewed the postcertification stage (monitoring) of the environmental assessment process. The Auditor General concluded that the oversight of certified projects was not sufficient to avoid or mitigate potential adverse effects and recommended ways to improve this process (OAGBC 2011). The recommendations included:

- Ensure the mitigation is measureable and enforceable.
- Work with the Ministry of Environment to finalize a policy framework to provide provincial guidance on environmental mitigation.
- Clarify postcertification monitoring responsibilities and compliance mechanisms.
- Develop and implement a compliance and enforcement program.
- Conduct postcertificate evaluations to evaluate if environmental assessments are avoiding or mitigating potentially significant adverse effects.
- Provide appropriate accountability information.

The EAO accepted all the recommendations and has been actively working with the Ministry of Environment to improve EAO's postcertification process and provide input to the policy initiative for the provincial guidance on environmental mitigation (OAGBC 2011). The policy initiative aims to improve mitigation monitoring on all types of environmental reviews. The audit noted that commitments of the applicant for environmental mitigation were less likely to succeed because there is no provincial law requiring, or policy guiding, actions to mitigate adverse environmental effects. In response, the Ministry of Environment is developing a provincial environmental mitigation policy. Specifically, the EAO has been enhancing its

compliance management programs to improve communications, build on existing information systems, and identify more cohesive methods to monitor and track project environmental certificate conditions (Ministry of Energy and Mines 2012).

EcoLogo® Certification

BC Hydro has a goal to add "green energy" to B.C.'s electricity mix. To do so, BC Hydro purchases power from IPPs that meet green criteria. BC Hydro entered into an agreement with TerraChoice Environmental Services Inc. to certify existing and new green energy supply contracted from IPPs. Facilities that meet the Environmental Choice™ Program requirements receive the program's symbol of certification, or EcoLogo.

The EcoLogo Program is a third-party certifier of environmentally preferable products that operates under the ISO 14024 requirements and is a member of (and audited by) the Global EcoLabelling Network. EcoLogo certifies two products: 1) bundled renewable low-impact electricity and 2) renewable energy certificates (REC). EcoLogo considers these renewable products as likely to impose relatively low impacts on the environment. Potential benefits cited by the program include low net greenhouse gas emissions, limited depletion of nonrenewable resources, reduced emissions of other pollutants, and reduced impacts on aquatic, riparian, and terrestrial ecosystems and species. A REC and a bundled renewable low-impact electricity product must initially be derived from renewable low-impact electricity (EcoLogo, 2010). A run-of-river project would have to demonstrate that the general and technology-specific environmental requirements identified in Table 6 have been met to receive the EcoLogo certification. EcoLogo certification has received recent scrutiny, as water-flow fluctuations downstream of EcoLogo-certified hydro projects resulted in repeated juvenile fish deaths (Pynn 2012). EcoLogo initiated a comprehensive revision to its low-impact hydro renewable electricity standards in 2011 and expects to release the more comprehensive standards in December 2012 (EcoLogo 2012).

Table 6: EcoLogo Requirements

Environmental Issue	Requirement
Comply With Regulations	The project meets or exceeds all applicable governmental, industrial safety, and performance standards. Operates in compliance with all regulatory licenses and requirements, and/or other authorizations pertaining to fisheries (including, for facilities located in Canada, the Fisheries Act), without regard to waivers or variances that may be granted or authorized.
Public Outreach	Appropriate consultation with communities and stakeholders has occurred, and issues of concern have been reasonably addressed.
Impact Analysis	Prior or conflicting land use, biodiversity losses, and scenic, recreational, and cultural values have been addressed during project planning and development.
Mitigation	Reasonable mitigation of negative social impacts and environmental impacts, where applicable, has been carried out, and that unmitigated or immitigable social and environmental impacts, if they exist, are of limited scale and scope.
Cumulative Effects Analysis	A Cumulative Effects Assessment in Canada or a Cumulative Effects Analysis in the United States has been performed, or that such an assessment has been considered and if not performed, reasons why are provided.
Endangered Species	The project would not jeopardize the survival or recovery of any species designated as endangered or threatened.
Fish Habitat	Operating conditions do not allow the harmful alteration, disruption, or destruction of fish habitat unless i) such harmful alteration, disruption or destruction is not affecting the limiting factor controlling productive capacity; and ii) habitat compensation is implemented such that loss of the affected habitat is replaced by the creation of similar habitat, supporting the same stock, at or near the

Environmental Issue	Requirement
	development site within the same ecological unit such that the created habitat replaces lost productive capacity, within an approved safety factor; For facilities located in Canada, these conditional authorizations include those issued under Section 35(2) of the Fisheries Act, by the Minister of Fisheries and Oceans or under regulations made by Governor in Council under the Fisheries Act.
Fish Migration	The project provides fish passage when necessary for maintaining preexisting migration patterns for fish communities both upstream and downstream where a human-made structure is placed across a waterway where no natural barriers exist. The project provides any measures (including, among other things, trash racks, oversized intake structures designed to slow intake velocities, underwater strobe and sound, fish screens) necessary to minimize fish mortality that would occur through impingement and entrainment.
Water Levels/Flow	Within practical limits and subject to regulatory direction and approval, plant operations are coordinated with any other water-control facilities that influence water levels and/or flows operating on the same waterway, to mitigate impacts and protect indigenous species and the habitat upon which they depend. As a maximum, the project causes as much water to flow out of the head pond as is received in any 48-hour period. In cases where this particular criterion cannot be met, EcoLogo would consider certification if the applicant submits evidence that indicates those hydrological and ecological components key to sustainability of the surrounding watershed are maintained. As a minimum, this evidence must include environmental impact assessments and documentation from a formal public consultation process. In cases where neither of the above conditions is met, the applicant can opt to apply to a multistakeholder and public electricity review process to demonstrate equal or lower adverse environmental impacts. The project operates such that reduced water flows in the bypassed reach and reaches downstream of diversion dams and/or dykes are not detrimental to indigenous aquatic and riparian species; operates such that instream flows downstream of the tailrace are adequate to support downstream indigenous aquatic and riparian species at pre project ranges.
Water Quality	The project operates such that water quality in a head pond, a bypassed reach, reaches downstream of the tailrace and reaches downstream of any diversion dams and/or dykes remains comparable to preproject quality in unaltered bodies of water or waterways within the local watershed.
Water Temperature	The project operates such that any changes in water temperature caused by the facility in the head pond or in reaches downstream of the tailrace or downstream of any diversion dams and/or dykes are not detrimental to indigenous aquatic species.
Water Management	An appropriate waste management plan is in place for the proper waste. minimization, reuse, sorted recycling, and/or safe disposal of all solid waste resulting from the construction, generation, and end-of-life phases of the electricity generation. Water is generated in a manner such that all steps of the process, including the disposal of waste products arising therefrom, would meet the requirements of all applicable governmental acts, by laws and regulations including the Fisheries Act and the Canadian Environmental Protection Act for facilities located in Canada
Monitoring	A monitoring plan has been considered to monitor all of the stressors of potential environmental impacts addressed by this standard such that: there is proof that a monitoring plan is in place that monitors these stressors; or if no monitoring plan is in place or if the monitoring plan is incomplete, there is proof that such a plan

Environmental Issue	Requirement
	has been considered and if it was not pursued, reason why are provided

Source: EcoLogo 2010.

Table 7 identifies run-of-river projects in B.C. that have received EcoLogo certification. These facilities total 173 MW and represent 63 percent of the 273 MW provided by existing 30 MW or less run-or-river projects.

Table 7: 30 MW or Less Run-of-River Projects With EcoLogo Certification

Project Name	Location	MW
Akolkolex	Revelstoke	8
Salmon Inlet (Schelt Creek SCG)	Sechelt	17
Hluey Lake Project (SNP)	Dease Lake	3
Hystad Creek Hydro	Valemount	6
Miller Creek Hydro	Pemberton	30
Upper Mamquam Hydro	Squamish	25
Brandywine Creek Small Hydro	Whistler	8
Eagle Lake C2 Micro Hydro	West Vancouver	<0.5
Hauer Creek (aka Tete)	Valemount	2
Marion 3 Creek	Port Alverni	5
McNair Creek Hydro	Sechelt	10
Bone Creek Hydro	Kamloops	20
Lower Clowhom	Sechelt	11
Upper Clowhom	Sechelt	11
Canoe Creek Hydro	Ucluelet	6
Cypress Creek	Gold River	3
Fitzsimmons Creek	Whistler	8

Additionally, the following run-of-river projects greater than 30 MW have also received EcoLogo certification: Pingston Creek – 45 MW; Ashlu Creek Water Power – 50 MW; East Toba and Montrose – 196 MW. Run-of-river projects less than 30 MW represent 37 percent of the energy projects that have received EcoLogo certification. Source: EcoLogo 2010.

.

Laws, Ordinances, Regulations, and Standards for Permitting Hydroelectric Facilities In California

This study used federal, state, and local laws, ordinances, regulations, and standards (LORS) that apply to hydroelectric facilities in California as a baseline for comparison with the Canadian environmental regulation and permit requirements. Under California's current rules, small hydroelectric or conduit hydroelectric facilities less than 30 MW can be eligible for RPS certification. (see Section 12, Public Utilities Code 399.12, page 21).

Table 8 lists the federal LORS applicable to hydroelectric power in California. Because the Federal Energy Regulatory Commission (FERC) issues licenses for new and relicensed hydropower project, projects are subject to the National Environmental Policy Act (NEPA) unless otherwise exempt. Under NEPA, either an environmental assessment (EA) or an environmental impact statement (EIS) is prepared. An EIS is required for a major federal action significantly affecting the quality of the human environment. Additionally, if the project requires a state permit, it is also subject to the California Environmental Quality Act (CEQA). CEQA review is most likely to be triggered by the federal Clean Water Act Section 401 permits or the California Department of Fish and Wildlife Streambed Alternative Agreement (§1602 Fish and Game Code). CEQA encourages state and local agencies to use existing NEPA documents to avoid duplication and costs if the NEPA document is to be prepared before a CEQA document and the NEPA document, in the judgment of the state agency, meets the requirements of CEQA (Cal. Code Regs., tit. 14, § 15221.) For this reason, it is likely that the CEQA

documentation would be limited in scope, that is, a supplemental environmental impact report (EIR) or mitigated negative declaration (MND).

Table 8: United States Federal Laws, Ordinances, Regulations, and Standards for Hydroelectric Power

Primary Regulations	Description	Regulating Agency
Regulations		
Federal Power Act	Pursuant to Section 23(b)(1) of the Federal Power Act (FPA), hydropower projects must be licensed, or granted an exemption from licensing, pursuant to the FPA (unless the applicant has a valid pre-1920 federal permit). Each hydroelectric license issued by FERC must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation of damage to, and enhancement of fish and wildlife resources.	Federal Energy Regulatory Commission (FERC)
Federal Power Act Section 4(e)	If a project occupies public lands or reservations, the license must not interfere with the purpose for which such reservation was created or acquired and would be subject to conditions that the department under whose supervision such reservation falls deems necessary for the protection and utilization of such reservation.	Responsible federal land management agency
Federal Power Act Section 10(a)	Requires that each licensed project be best adapted to a comprehensive plan for improving or developing a waterway for, among others, beneficial public uses including recreational purposes.	Responsible federal agency
Coastal Zone Management Act	Section 307(c)(3) requires that all federally licensed and permitted activities be consistent with approved state Coastal Zone Management Programs.	San Francisco Bay Conservation and Development Commission and the California Coastal Commission
Federal Power Act Section 10(j)	Allows state and federal agencies to file recommendations pursuant to section 10(j) of the FPA and the date of their filings.	FERC, state and federal agencies to file recommendations
Federal Power Act Section 18	States that the U.S. Fish and Wildlife Service (U.S. FWS) and the National Marine Fisheries Service (NMFS) have the authority to prescribe fishways at projects.	U.S. Fish and Wildlife Service and the National Marine Fisheries Service
Impact Analysis/Mitigation/Cumulative Effects Analysis		
National Environmental Policy Act (NEPA) of 1969, as amended, 42 U.S.C. §§ 4321-4347	The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment (Sec. 1500.1). NEPA mandates the preparation of an EA or EIS for all federal actions significantly affecting the quality of the human environment.	FERC
National Historic Preservation Act (NHPA) Section 106	Licensing or relicensing is considered an undertaking within Section 106 of the NHPA of 1966, as amended (P.L.89-665; 16 U.S.C.470). Section 106 requires that every federal agency "take into account" effects to historic properties including districts, sites, buildings, structures, traditional cultural properties, and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the National Register.	Responsible federal agency
Wild and Scenic Rivers Act	Section 7(a) of the Wild and Scenic Rivers Act bars FERC from licensing the construction of any dam, water conduit, or other project works on or directly affecting any river that is designated a component of the national Wild and Scenic Rivers System.	FERC

Endangered Species		
Federal Endangered Species Act (Title 16, United States Code, section 1531 et seq., and Title 50, Code of Federal Regulations, part 17.1 et seq.)	The Endangered Species Act (ESA) designates and provides for protection of threatened and endangered plant and animal species, and their critical habitat. Section 7 of the ESA requires federal agencies to consult with the U.S. Fish and Wildlife Service to ensure that their actions are not likely to jeopardize the continued existence of a threatened and endangered species or impact designated critical habitat. U.S. FWS is responsible for freshwater and terrestrial species and the NMFS is responsible for marine and anadromous species.	U.S. Fish and Wildlife Service and National Marine Fisheries Service
Fish Habitat		
Fish and Wildlife Coordination Act §661 et seq.	If a stream or other body of water would be impounded, diverted, or the stream or other body of water otherwise controlled or modified for any purpose whatever, by any department or agency of the U.S., or by any public or private agency under Federal permit or license, such department or agency first shall consult with the USFWS, DOI, and with the head of the agency exercising administration over the wildlife resources of the particular state. This would be designed to conserve wildlife resources by preventing loss of and damage to such resources.	U.S. Fish and Wildlife Service, Department of Interior, and California Department of Fish and Wildlife
Magnuson-Stevens Fishery Conservation and Management Act	The consultation requirements of §305(b)(2) of the Magnuson-Stevens Act provide that federal agencies must consult with the Secretary of Commerce on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect essential fish habitat.	Responsible federal agency
Water Quality		
Clean Water Act (33 U.S.C. Section 401 et seq.)	The Clean Water Act establishes protection of navigable waters through Section 401. Section 401 Water Quality Certification through the Army Corps of Engineers (and Regional Water Quality Control Board [RWQCB] for California) is required if there are potential impacts to surface waters of the state and/or waters of the United States. Section 401 requires impacts to these waters to be quantified and mitigated.	Army Corps of Engineers and RWQCB

In addition, California requirements govern the approvals of run-of-river hydro projects. Table 9 lists the state LORS that are applicable to run-of-river hydro projects.

Table 9: California State Laws, Ordinances, Regulations, and Standards for Hydroelectric Power

Primary Regulations	Description	Regulating Agency
Impact Analysis/Mitigation/Cumulative Effects Analysis		
California Environmental Quality Act (CEQA), (Public Resources Code 21000 et seq.)	CEQA requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible.	RWQCB (most likely)
California Clean Air Act (CCAA) (Stats 1988, ch 1568)	The CCAA protects and enhances the quality of California's air resources by reducing air pollutants. During construction, an applicant may be required to consult with the California Air Resources Board (ARB) or appropriate air quality management district to ensure that construction conforms to regulations contained in the federal Clean Air Act and California Clean Air Acts and their implementing regulations.	ARB and the regional air quality management districts

Primary Regulations	Description	Regulating Agency
County Permits	Zoning, administrative, and user permits may be required and obtained from the Department of Planning. Encroachment, transportation, and floodplain development permits may be required and would be obtained from the Department of Public Works. Grading and hazardous material permits may be required and would be obtained from the Department of Environmental Health.	Counties
Endangered Species		
California Endangered Species Act (CESA) (Fish and Game Code §§2050–2068)	CESA parallels the main provisions of the federal ESA (16 USC 1531–1544). A state lead agency is required to consult with the California Department of Fish and Wildlife (CDFW) to ensure that any action it undertakes is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of essential habitat.	CDFW
Water Quality		
Clean Water Act (33 U.S.C. Section 401 et seq.)	The Clean Water Act establishes protection of navigable waters through Section 401. Section 401 Water Quality Certification through the Regional Water Quality Control Board (RWQCB) is required if there are potential impacts to surface waters of the state and/or waters of the United States. Section 401 requires impacts to these waters to be quantified and mitigated.	RWQCB
Clean Water Act (Section 402)	National Pollutant Discharge Elimination System (NPDES) permit. The NPDES program controls direct discharges into navigable waters. NPDES permits, which are issued by the state, contain industry-specific, technology-based, and/or water quality–based limits and establish pollutant monitoring and reporting requirements.	RWQCB
Streambed Alteration Agreement (SAA) (Fish and Game Code Sections 1600 et seq.)	The SAA regulates activities that may divert, obstruct, or change the natural flow or the bed, channel, or bank of any river, stream, or lake in California designated by CDFW in which there is at any time an existing fish or wildlife resource or from which these resources derive benefit. Impacts to vegetation and wildlife resulting from disturbances to waterways are also reviewed and regulated during the permitting process.	CDFW

California Run-of-River Hydro Permitting

Federal Energy Regulatory Commission

Under the Federal Power Act (FPA), FERC regulates the nation's nonfederal hydropower resources. FERC issues three types of development authorizations: 5-MW exemptions, licenses, and conduit exemptions (FERC 2010a). Although FERC may issue an exemption of NEPA review for a run-of-river hydroelectric facility, the exemption is not specifically dictated by the size of the facility, but rather by the environmental considerations. For example, FERC required an EIS for the El Dorado Project No. 184-065, a 21 MW hydroelectric facility. Although FERC issues conduit[3] exemptions and 5-MW exemptions, only the 5-MW exemption is addressed below. This report did not consider conduit hydroelectricity projects as run-of-river projects of interest to this study. Exempted projects are subject to mandatory terms and conditions set by federal and state fish and

3 *Conduit* is defined as any tunnel, canal, pipeline, aqueduct, flume, ditch, or similar manmade water conveyance that is operated for the distribution of water for agricultural, municipal, or industrial consumption and not primarily for the generation of electricity (CFR § 4.30[b])[2]).

wildlife agencies and by the FERC. However, an exemption would not convey the right of eminent domain for the project.

The required federal authorization for hydropower resources may require certain steps and oversight from FERC, as follows.

- **5-MW Exemptions.** A hydroelectric project of 5 MW or less may be eligible for a 5-MW exemption. The applicant must propose to install a project located at an existing dam or at a natural water feature or add capacity to an existing project. The project can be located on federal lands but cannot be located at a federal dam. The applicant must obtain all the real property interests or an option to obtain the interests in any nonfederal lands. The 5-MW exemption must include an environmental report as an exhibit.
- **Licenses.** A license from FERC is required to construct, operate, and maintain a nonfederal hydroelectric project that would (a) be located on navigable waters of the United States; (b) occupy U.S. lands; (c) use surplus water or water power from a U.S. government dam; or (d) be located on a stream over which Congress has Commerce Clause jurisdiction, where project construction or expansion occurred on or after August 26, 1935, and the project affects the interests of interstate or foreign commerce. Licenses may be issued for up to 50-year terms and must be renewed at the end of each term. A license gives the licensee the power of "eminent domain" to obtain lands or other rights needed to construct, operate, and maintain the hydroelectric project.
- If applying for a license, there are three processes available: Integrated Licensing Process (ILP), Traditional Licensing Process (TLP), and the Alternative Licensing Process (ALP). Regardless of the process used, environmental review is required.
- **Preliminary filing information.** Applicants for a license must file with FERC a Notice of Intent (NOI), Pre-Application Document (PAD), and a request to use the TLP or ALP. Applicants must provide public notice of the filing no later than the filing date of the NOI in a daily or weekly newspaper in each county in which the project would be located. Applicants must also provide a copy of the TLP request to all stakeholders likely to be interested in the project and must ask for comments on the request to be filed with the Energy Commission within 30 days of the filing date of the request. (FERC 2010b)
- The PAD includes:
    - A description of the existing environment.
    - Summaries of existing data or studies.
    - Existing or proposed resource protection and mitigation measures.
    - Any known and potential project effects on specific resources including geology and soils; water resources; fish and aquatic resources; wildlife and botanical resources; wetlands, riparian, and littoral habitats; rare, threatened, and endangered species; recreation and land use; aesthetic resources; cultural resources; socioeconomic resources; tribal resources; and a description of the river basin.
    - Preliminary issues and studies list for each resource area.
    - Summary of contacts used to prepare the PAD.
- **Consult Stakeholders.** The applicant must identify all relevant federal and state agencies, Indian tribes, nongovernmental organizations, and interested parties of the proposal. Consultation also provides the

agencies and the public an opportunity to voice concerns or request studies that may be relevant to the proposed project. The applicant must document that the consultation process required in 18 C.F.R. § 4.38 (original licenses and exemptions) was fully satisfied. An applicant must hold at least one joint meeting with stakeholders to explain the project (for example, its facilities and operation), review existing information, discuss the project's potential environmental effects, and find out if there are any needed studies to fill information gaps (FERC 2011c).

- **Prepare Application.** All applications for a hydroelectric project require general information, a description of the project and the proposed mode of operations, an environmental report, general design drawings, and project maps. FERC staff must be able to determine the location of the project and the extent of land area impacted by the project works and the proposed design of all power producing structures and equipment. The environmental report must include a general description of the locale and reports on the following: water use and quality, fish, wildlife, and botanical resources, historical and archaeological resources, socioeconomic impacts, geological and soil resources, recreational resources, aesthetic resources, land use, and alternative locations, designs, and energy sources (Federal Regulations 2011a).

FERC must prepare an environmental evaluation of a hydroelectric project under NEPA. FERC has issued *Preparing Environmental Documents: Guidelines for Applicant, Contractors, and Staff* (September 2008) for FERC staff as well as applicants who plan on preparing Exhibit E, Environmental Report. The guidelines reflect NEPA standards and include portions of NEPA or the Council on Environmental Quality's (CEQ) NEPA regulations that are found at 40 CFR, Parts 1500-1508. The CEQ NEPA regulations identify mitigation in the NEPA process as measures to avoid, minimize, rectify, reduce, or compensate for environmental impacts (40 CFR 1508.20).

The environmental document would likely include a description of mandatory conditions provided under Sections 18, 4(e), or 30(c) of the Federal Power Act and under Section 401 of the Clean Water Act (FERC 2008). Resource management and monitoring plans may be required to address environmental issues and additional monitoring may be required by the USFWS in a biological opinion. The environmental review should describe the need for monitoring including methods, schedule, contingency measures, and reporting (FERC 2008). In some cases mitigation would require funds for additional monitoring by specific agencies such as in the *El Dorado Final EIS*.

California's State-Level Permitting Process

As noted above, if the project requires a state permit, it is subject to CEQA review, which would most likely be triggered by the federal Clean Water Act Section 401 permits or the California Department of Fish and Wildlife Streambed Alternative Agreement (§1602 Fish and Game Code). Under CEQA, the project needs an environmental review unless the NEPA document meets the CEQA requirements. CEQA review is similar in scope to the NEPA review and requires public consultation, an environmental impact analysis, and potential mitigation to minimize significant adverse impacts.

In addition to CEQA review, the following permits are potentially required for a hydroelectric project in California:

- **Water Quality Certification.** To receive a new FERC operating license, an applicant is required to request and obtain a water quality certification (WQC) under Section 401 of the federal Clean Water Act from the State Water Resources Control Board (SWRCB). The SWRCB is the lead agency

- **National Pollution Discharge Elimination System.** The SWRCB would also issue a National Pollution Discharge Elimination System (NPDES) General Permit for storm water discharges associated with construction activities for a hydroelectric project. An NPDES permit application must describe the wastes to be discharged, the setting for the discharge, and the method of treatment or containment. The State or Regional Water Board staff reviews the application for completeness and may request additional information. Once the application is deemed complete, the State or Regional Water Board staff would draft a permit, which must be adopted by the State or Regional Water Board before any discharge can occur.
- **Streambed Alteration Agreement.** Fish and Game Code Section 1602 requires an entity to notify CDFW of any proposed activity that may substantially modify a river, stream, or lake. If the CDFW determines that the activity may substantially adversely affect fish and wildlife resources, a Lake or Streambed Alteration Agreement would be prepared. The agreement includes reasonable conditions necessary to protect those resources and must comply with CEQA. The entity may proceed with the activity in accordance with the final agreement. The Notification of Lake or Streambed Alteration form would describe the project; any modifications to a river, stream, or lake; any vegetation or special status species that would be impacted; and the measures proposed to protect fish, wildlife, and plant resources.
- **Incidental Take Permit.** Section 2080 of the Fish and Game Code prohibits "take" of any species that the commission determines to be an endangered species or a threatened species. *Take* is defined in Section 86 of the Fish and Game Code as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." The Incidental Take Permit process is normally initiated in the region where the permitted activity would take place by contacting the appropriate regional office and submitting an Incidental Take Permit Application. The application must include the species that would be covered by the permit, a description of the project or activity, an analysis of the impacts of the proposed taking on the species, proposed measures to minimize and mitigate impacts of the proposed taking, a proposed plan to monitor compliance with the minimization and mitigation measures and the effectiveness of the measures including a funding source and the level of funding for implementation of the minimization and mitigation measures.

Comparison of LORS In Canada and California

Hydroelectric generation projects in Canada and California are governed by federal and local laws. Table 10 shows the similarities and differences between the LORS governing permitting hydroelectric projects in Canada and California.

Run-of-river hydro projects in B.C. are regulated at the provincial level. Federal review is triggered only if the project impacts federally regulated resources. In California, FERC regulates hydroelectric generation projects at the federal level. State-level regulation is triggered by the need for permits under the Clean Water Act.

Table 10: Comparison of LORS Regulating Run-of-River Hydro in Canada and California

Environmental Issues	B.C. and Canada	U.S. and California
Regulations	Comparable: • Up to 50 permits required at the provincial and federal level • British Columbia does not have a provincial endangered species legislation and relies on the federal legislation.	Comparable: • Multiple permits required at federal and state level • California has an Endangered Species Act that is considered in addition to the federal Endangered Species Act.
Public Outreach	Less Stringent: • Environmental assessment has specific guidelines for public outreach including outreach to agencies and the general public. • Individual licenses require outreach to agencies and other water license holders, but scope of outreach is narrower and does not require consultation with the general public. • Required to consult with First Nations	More Stringent: • Required under NEPA and CEQA; public consultation period is dictated by level of environmental impacts and occurs prior to and after publication of the environmental review document. • Agency consultation required depending on resources impacted • Native American consultation required
Impact Analysis	Comparable: • Environmental Assessment Act (for certain projects) and CEAA if project would impact resources under federal jurisdiction. • Water license requires studies of fish, wildlife, or aquatic habitat; no clear legal obligation to consider regional or local land-use plans, stream health, cumulative effects, or other environmental factors.	Comparable: • Required under both NEPA and CEQA at a level corresponding with the level of impact to the environment • The 5-MW exempt projects do not require NEPA but must provide an environmental assessment as part of the application.
Mitigation	Less Stringent: • EA must identify ways to prevent or minimize undesirable effects and enhance desirable effects, but there is no provincial law requiring restoration of terrestrial ecosystems or offsets for impacts. • The instream flow requirement are included in the water license.	More Stringent: • Environmental document includes mandatory conditions to address environmental issues including considering recommendations for resource agencies. • NEPA requires mitigation that rectify, reduce, or compensate for environmental impacts. • CEQA requires the environmental review document to describe feasible measures that could minimize significant adverse impacts.
Cumulative Effects Analysis	Less Stringent: • A cumulative effects assessment is required under the provincial and federal EA process; projects that do not trigger the EA process do not require a cumulative assessment.	More Stringent: • Required under both NEPA and CEQA

Environmental Issues	B.C. and Canada	U.S. and California
Endangered Species	Less Stringent: • In Canada, the SARA is designed to protect wildlife species and to provide for the recovery of wildlife species that are endangered or threatened; however, habitat protection is mandatory only for aquatic species and migratory birds, and on federal land. Protection is not required for species located on provincial Crown land. • BC has no provincial species at risk legislation.	More Stringent: • In the United States, both the Federal Endangered Species Act and the California Endangered Species Act designate and protect threatened and endangered plant and animal species and their critical habitat. • CESA prohibits the taking of listed species except as otherwise provided in state law and applies these prohibitions to state candidate species as well.
Fish Habitat/ Migration	Comparable: • Considered under the EA or the water license	Comparable: • Considered under NEPA or CEQA review and under the Endangered Species Act if fish species are endangered.
Water Levels/Quality /Temperature/ Management	Comparable: • Considered under the EA or the Water license	Comparable: • Considered under NEPA and under the Clean Water Act permit requirements that may trigger CEQA assessment
Monitoring	Comparable but Mitigation Plans and Reports Are Not Made Publicly Available: • The different licenses required for run-of-river hydro projects in British Columbia require monitoring. • A construction environmental management plan would be submitted to the appropriate agencies during the environmental review process. • Monitoring is conducted primarily by environmental monitors hired by the proponent of the project with visits from the permitting agencies. • Ministry of Environment is developing a provincial environmental mitigation policy that includes consideration of monitoring	Comparable but Mitigation Plans and Reports Are All Publicly Available: • Monitoring of projects is required under FERC. • The majority of the monitoring is conducted by environmental monitors hired by the proponent. • Individual mitigation plans must be reviewed and approved by regulating agencies and monitoring may require monthly or annual meetings to review reports provided by the applicant. Plans are posted on FERCs website. • Monitoring may require funding of agencies to provide site visits.

The comparison in Table 10 does not include the requirements outlined above by EcoLogo, as they are not Canadian LORS but rather a third-party certifier of environmentally preferable products. The environmental requirements identified in Table 6 consider some of the topics not specifically addressed by Canadian LORS such as cumulative effects.

CHAPTER 4:
Comparison of B.C. Project Environmental Documentation With California Project Environmental Documentation

This chapter compares the documentation and process for permitting run-of-river projects in B.C. and in California. In B.C., the Upper Harrison Water Project is an example of a project that opted into the environmental assessment process while the Bear Hydro Project is one that received individual licenses from various agencies. The Upper Harrison Water Project is composed of five individual projects between 6 MW and 35 MW, and the Bear Hydro Project is a 20 MW project. The Upper Harrison Water Project proponent opted into the environmental assessment process rather than having each project reviewed independently.

In California, a comparable run-of-river project was not available. The run-of-river hydroelectric projects in California that have undergone relicensing in the last 10 years are either above 30 MW, less than 1 MW, or are part of an aqueduct system (Energy Commission 2011). Instead, the study considered the El Dorado Hydroelectric Project's (21 MW) relicensing EIS for comparison. Table 11 provides an overview of the environmental reviews of the three projects, including the topics addressed in the environmental review documents, data collection methods, agency reviews, and mitigation required.

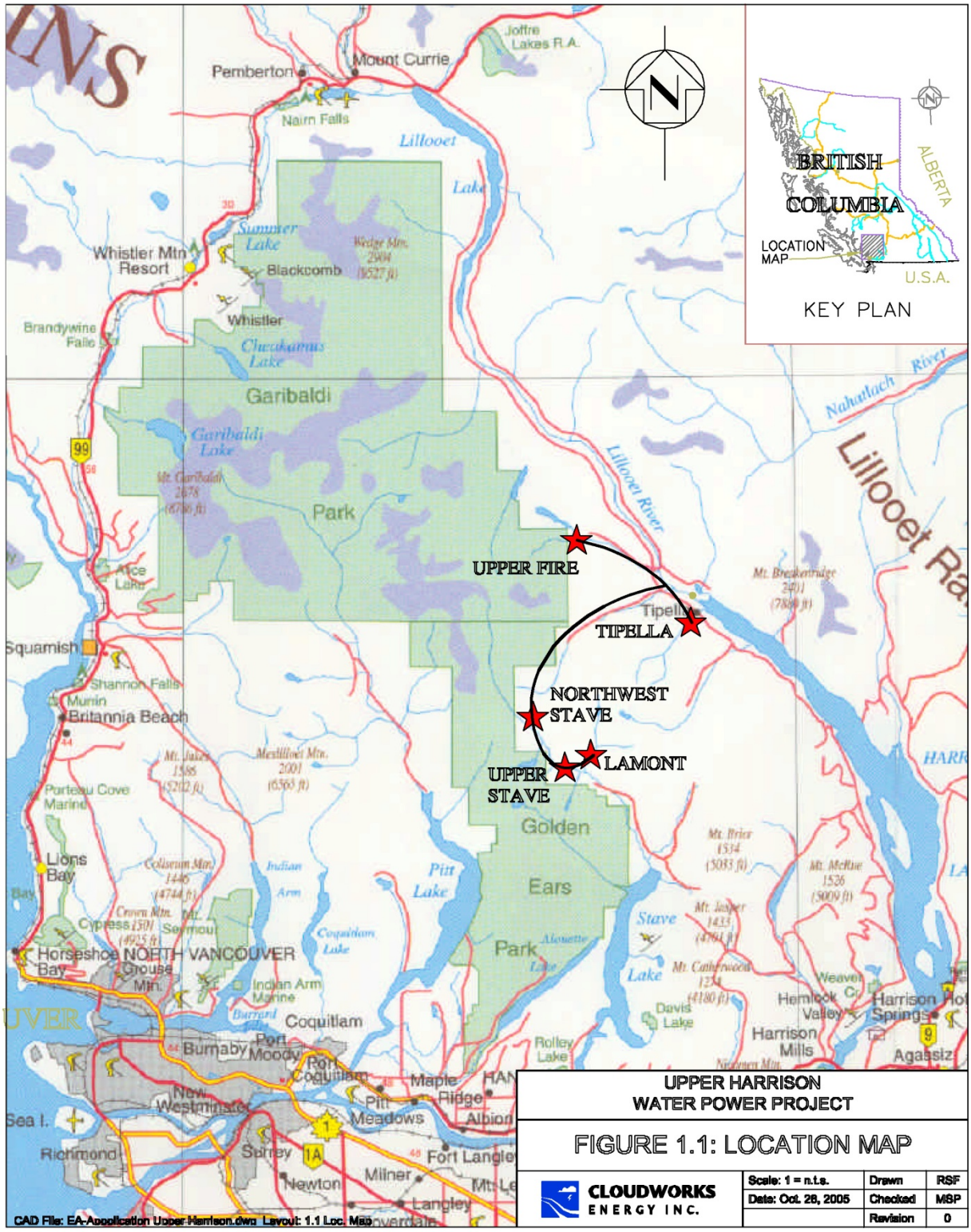
Upper Harrison Water Project

The Upper Harrison Water Project began the environmental assessment pre-application process in December 2004. It is a cluster of five run-of-river hydro projects with a combined capacity of up to 103 MW. Because each project is less than 50 MW, the proponent (Cloudworks Energy, Inc.) was not required, but rather opted, to complete the environmental assessment process. The Upper Harrison Water Project was reviewed under the B.C. Environmental Assessment Act and the Canadian Environmental Assessment Act (screening level) (Cloudworks, 2005). The environmental assessment as conducted during three stages: pre-application, review of application, and completion/certification. An amendment to the environmental assessment certificate was also requested. These stages are described below.

Pre-Application

During this stage, the EAO reviewed the proponent's project description and figures showing the location of the five hydro projects (see Figure 6). The EAO determined that the project was reviewable under the Environmental Assessment Act and filed an order to require an environmental assessment certificate. During 2005, Cloudworks Energy, Inc., held discussion with the Douglas First Nation and with federal, provincial, and local government agencies regarding the project. At the end of 2005, the terms of reference for preparation of an application were provided to the EAO. The terms of reference included the project description, a description of any consultation between the applicant and stakeholders, the project location, construction and operational schedules, and a description of baseline information to be collected for the project. The baseline information included any effects on the environment and the cumulative effects of any residual effects identified in the analysis (Cloudworks, 2005).

Figure 6: Upper Harrison Water Project Location



Source: Cloudworks 2005.

Application Review

In the spring of 2006, Cloudworks Energy, Inc., submitted an application for an environmental assessment certificate to the EAO, including figures of the run-of-river projects and appendices. The application described the five projects as the "Upper Harrison Water Project" and included the project setting and characteristics, an

analysis of project impacts, mitigation and residual effects, and a discussion regarding cumulative effects. The appendices included project-specific technical information such as geotechnical assessments, a hydrology report, fish and fish habitat suitability reports, predicted baseflows at intake locations, predicted operation flows, and water quality data.

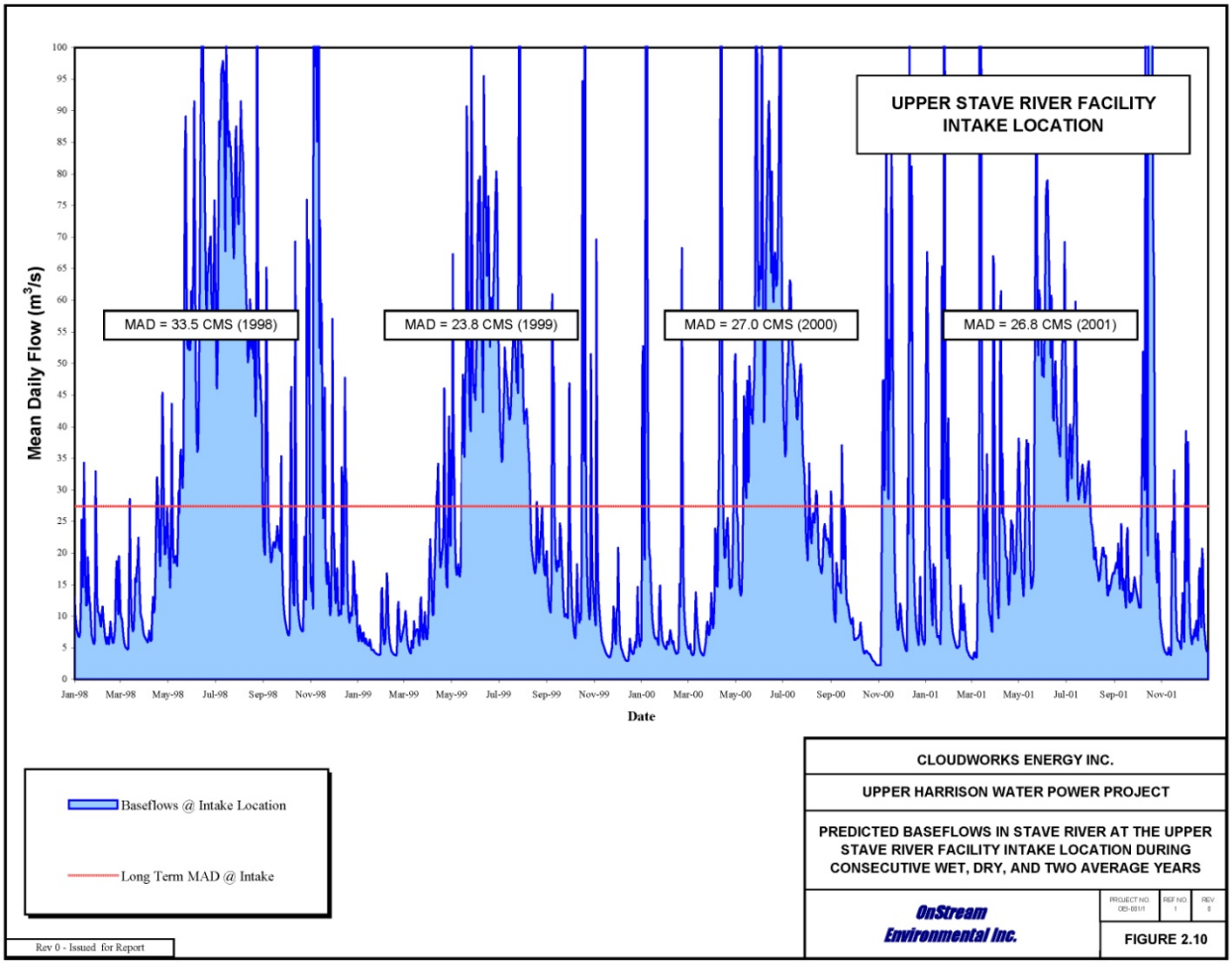
To define baseflows at intake locations, the applicant must estimate the mean annual discharge (MAD), or the mean amount of water that annually flows through the river system, including both low and high seasonal flows.[4] Applicants use the MAD to design the intake flow (amount of water diverted) at the diversion point. The applicant must propose a set amount of instream flow (amount of water remaining in the river) such that the river flow meets agency requirements; however, the method for determining adequate flow may not be readily apparent. The instream flow may be adjusted seasonally based on potential impacts to water quality or fish.

For the Upper Stave River Facility, the designed intake flow was 43.8 cubic meters per second (m^3/s) of water. The MAD for 1998 to 2001 fluctuated between 23.8 m^3/s and 33.5 m^3/s. The Upper Harrison Water Project designed intake flow was consistently greater than 100 percent of the MAD for each of the five rivers making up the project. The Upper Harrison Creek winter intake flows would reduce the instream flows to between 6.6 percent and 10 percent of the MAD, except for the Upper Stave River, which would cease operations during winter and late summer dry periods (EAO 2006). The instream flows were set at 30 percent of MAD or above predicted optimal levels during fish spawning and rearing times. In addition to setting instream flow requirements based on the critical periods in the life cycle of the fish, additional mitigation measures were incorporated into the project such as screens to reduce sediment, regular flushing to reduce large-scale sediment releases, and screens to exclude fish.

Figure 7 illustrates the predicted baseflows in Stave River, or the predicted baseline operations of the river without the project. Figure 8 illustrates the predicted instream flow with the facility in place. As shown in Figure 8, during the summer months, the predicted instream flow is above 100 percent of the MAD, as is the intake flow. As shown previously in Figure 5, run-of-river hydro projects typically generate almost all electricity during April through October.

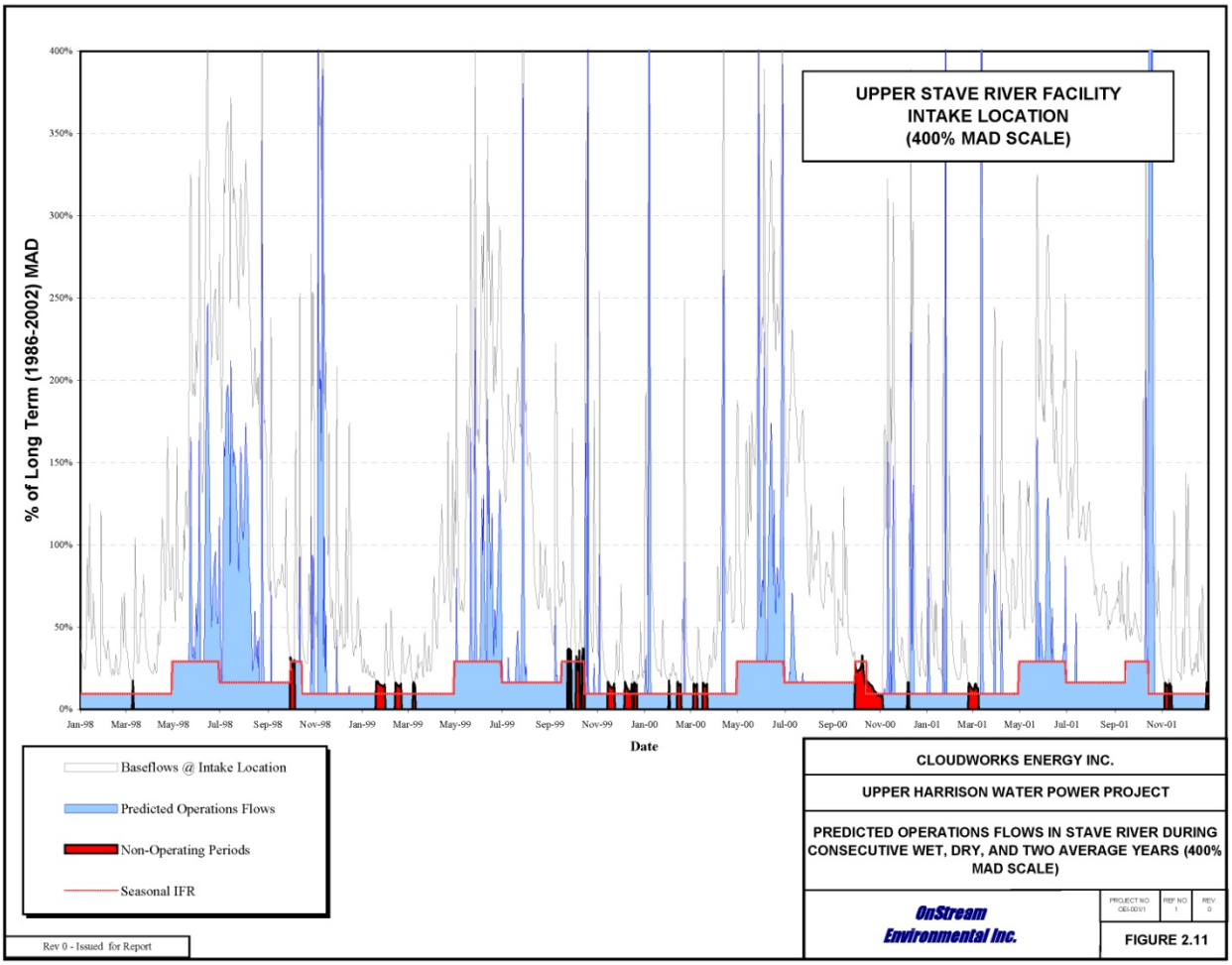
4 B.C. provides guidance documents to use for estimating MAD. See for example *Guidelines for the Collection and Analysis of Fish and Fish Habitat Data for the Purpose of Assessing Impacts From Small Hydropower Projects in British Columbia* (March 2007) and *Assessment Methods for Aquatic Habitat and Instream Flow Characteristics in Support of Applications to Dam, Divert, or Extract Water from Streams in British Columbia* (March 2004).

Figure 7: Predicted Baseflows in Stave River



Source: Cloudworks 2005.

Figure 8: Predicted Operations Flows in Stave River



Source: Cloudworks 2005.

The EAO held open houses to review the proposal and invited the public to comment on the application during the formal comment period (about 30 days).

The EAO reviewed the information provided by the applicant. Additionally, a number of local and federal agencies reviewed the application and provided feedback. Feedback from federal agencies included requests from Environment Canada for a copy of postconstruction monitoring surveys for sensitive species (harlequin ducks) and monitoring of vegetation clearance outside of breeding bird season. Other agencies requested additional baseline data because of concerns regarding proposed flow withdrawals and fish sampling standards (Fisheries and Oceans) and a lack of detail in the studies provided (Canadian Environmental Assessment Agency). Comments from Health Canada, Indian and Northern Affairs Canada, and Transport Canada requested additional information or suggested additional mitigation.

The application received provincial agency feedback from the Ministry of Environment, Environmental Stewardship, regarding survey standards and the use of the surveys in the assessment of the project for harlequin duck, the need for a discussion of the northern goshawk, a species at risk, the need for additional mitigation for mountain goats, and concerns regarding impacts to the grizzly bear population. The Ministry of Environment Regional Hydrologist provided comments regarding additional discussion of proposed ramping rates, sediment, instream flow guidelines. The comments noted that specific standards or guidelines were not specified for data collection, water data, or water temperature data.

Comments were received from the Stewardship Forester regarding impacts to logging and timber; the Integrated Land Management Bureau regarding roads and access areas, First Nations consultation, and communication lines; Water Stewardship Division regarding items pertaining to the water license; and the Ministry of Energy, Mines, and Petroleum Resources: Electricity Policy Branch regarding the province's energy plan.

Cloudworks Energy, Inc., provided responses to the comments from federal, provincial, and local governments, as well and private citizens, and provided some additional information regarding data collection and some additional mitigation.

Completion/Certification

The EAO published an *Assessment Report and Screening Report for the Upper Harrison Water Project* in August 2006. The environmental assessment report found the following (EAO 2006):

- The process and documentation generated as part of the environmental assessment review identified and addressed potential effects of the projects.
- Consultation with the public and First Nations was adequate.
- Cloudworks Energy, Inc., adequately addressed the issues identified during the review period by the public, First Nations, and agencies.
- The *Assessment Report* included an analysis of cumulative effects as required under the CEAA and concluded the projects were unlikely to have significant adverse effects.
- Practical methods to prevent or reduce adverse effects had been identified.

The proponent's table of commitments (mitigation measures) was included as an appendix and required the applicant to commit to items such as appropriate design criteria for access roads, archaeological impact assessments, blasting avoidance, wildlife protection, fish habitat monitoring, and work with First Nations, among others. Cloudworks Energy, Inc., also made operational plan commitments.

At this same time, the Minister of Environment and the Minister of Energy, Mines and Petroleum Resources issued a certificate for the project thatincluded a condition requiring the applicant to comply with the table of commitments.

Monitoring and Compliance

The EAO published the *Environmental Assessment Certificate Tracking for the Upper Harrison Water Project,* which noted the status of compliance for the project. The tracking reports noted where the commitments had been met and provided an explanation for the public regarding any additional commitments that were required and any additional monitoring. As noted in the tracking reports, the commitments were either ongoing or had been met. However, during construction, agencies monitoring the Upper Harrison Water Project noted instances during construction of the project where the applicant did not comply with the mitigation commitments (MOE COS *et al.* 2007-2009). The applicant responded to the agency observations in an e-mail and a letter to the Ministry of Environment (Cloudworks 2009a; Cloudworks 2009b). The concerns noted by agencies are briefly listed followed by the response from the applicant:

- Slope failures occurred at the construction sites, depositing sediment and debris into the nearby creeks. Additional mitigation was recommended to avoid such events in the future. The applicant responded to the agency observations in a letter to the Ministry of Environment, noting that additional measures had

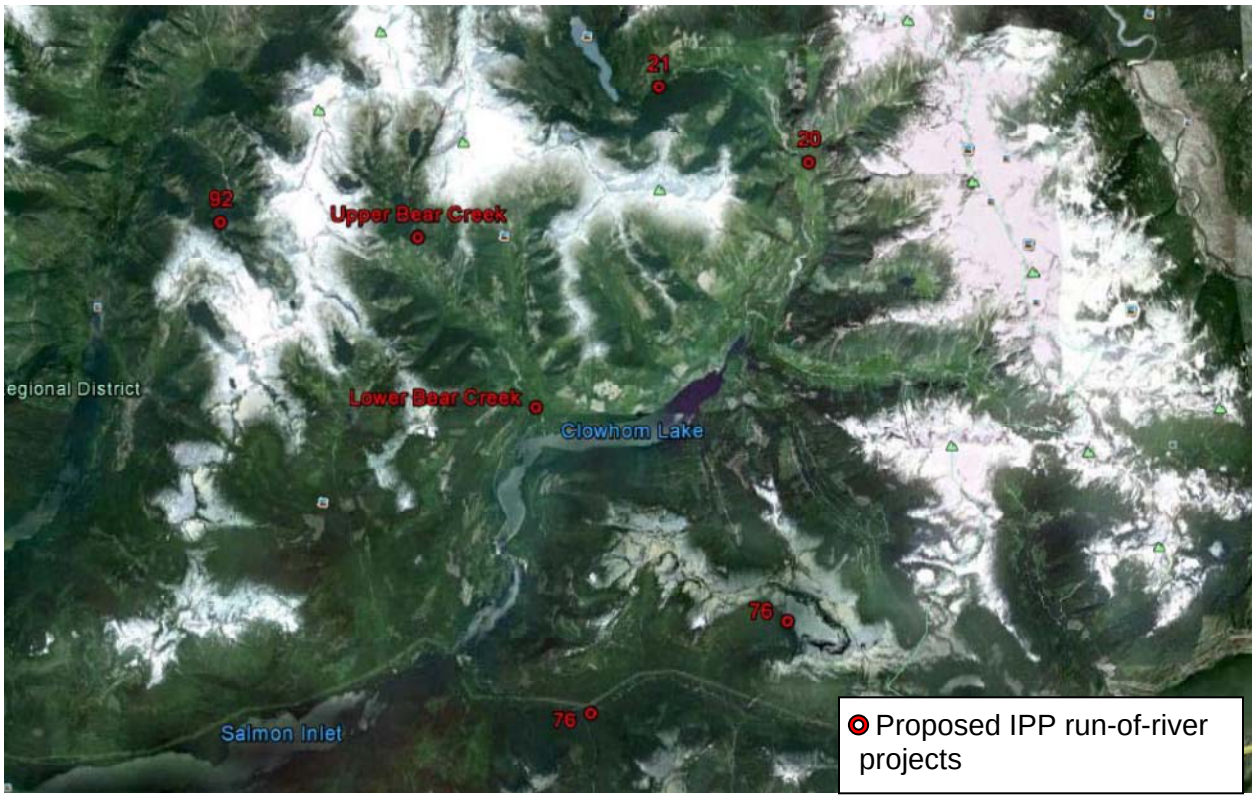
been implemented to avoid slope failures in the future, including additional training and independent environmental audits.

- A stop work order was issued due to an unauthorized bridge installation over a creek and felling of timber near a wetland and outside the License to Cut area. The applicant's response noted that use of the bridge was temporary while reactivating a forestry road and that both the Water License and the Fisheries Act Authorization review process allows for access construction along access roads.
- A road was reconstructed on a Wilderness Forest Service Road without a road use permit. The applicant responded that it was operating under an approved road use permit and it had submitted a works permit for construction and installation of the permanent infrastructure, which had since been approved. Roads that were not Forest Service roads did not require a road use permit.
- Impacts to forest old growth management areas were not considered under the permit legislation for the project because a run-of-river project may apply for an occupation leave to cut permit, which is considered a minor permit and does not address impacts to old growth management areas. As such, impacts to these areas may not be mitigated unless specified in the permit. The applicant noted that the monitoring commitments allowed variation in right-of-way width and therefore the construction had not contravened the commitments. The applicant noted that the clearing limits were established to allow for constructability and safety to workers.
- Timber was placed in creeks with confirmed fish presence and suitable fish habitat, which could result in altered and/or disrupted fish habitat. The applicant noted that the projects by their nature are partly in streams and some fish habitat exists in almost all streams. This is recognized in the project reviews by all agencies. Cloudworks is authorized by the Fisheries Act to damage a very limited amount of fish habitat during construction but must compensate more than double for any damage.

Bear Hydro Project

The Bear Hydro Project began the water license application process in February 2004 by submitting the project's development plan to the Water Stewardship Division of the Ministry of Environment. The Bear Hydro Project is a run-of-river hydro project with two points of diversion. Storage of water would occur within Bear Lake, and water would be returned to Bear Creek. The project has a capacity of 20 MW. The Bear Hydro Project, proposed by REGIONAL Power, Inc., was reviewed under separate license applications including a water license application and a land tenure application. Figure 9 shows the location of the project as well as run-of-river projects within a 10-mile radius .

Figure 9: Bear Creek Hydro Project Location



Source: Google Earth 2011 and MEM 2011.

Water License Application

REGIONAL Power, Inc., applied for a water license in 2004 and provided a project hydrology report in February 2005. The application included a number of plans and reports providing additional information regarding the project as listed (MOE WSD 2008):

- *Mitigation and Compensation Plan for Fish and Fish Habitat*
- *Potential Impacts on Fish of Hydroelectric Power Generation at Bear Creek on Clowhom Lake*
- *Fish and Fish Habitat Assessments of Bear Creek in Relation to Proposed Hydropower*
- *Fisheries Studies on Bear Creek in Relation to Proposed Hydropower Development*
- *Aquatic Habitat and Instream Flow Impact Assessment Summary*
- *Professional Opinion on the In-Stream Flow Requirements (IFRs) for the Proposed Bear Hydro Projects and Impacts of the Proposed Bear Hydro Project on the Dolly Varden of Bear Creek*

The Bear Creek project established an instream flow requirement of 3 percent of the MAD during the dry, cold period of the year and 10 percent of the MAD during the summer months. The increased instream flow requirement value coincides with the rainbow trout and cutthroat spawning/fry emergence period (MOE WSD 2008).

A number of provincial and federal agencies reviewed the application and required additional permits. The agencies completed the following reviews and reports (MOE WSD 2008):

- Canadian Environmental Assessment Act screening report completed by Transport Canada and Fisheries and Oceans Canada concluded that the project was unlikely to cause significant adverse environmental

effects. Transport Canada would provide a Navigable Water Protection Act approval. Fisheries and Oceans completed the Authorization for Works or Undertakings Affecting Fish and Fish Habitat, which included a maximum flow and minimum release flow.

- Fisheries and Oceans reviewed the project and completed an Authorization for Works or Undertakings Affecting Fish and Fish Habitat that included the maximum flow that could be diverted, the minimum instream flow requirements, and the ramping rates.
- Environment Canada reviewed the project under the CEAA screening.
- Ministry of Environment – Environmental Stewardship Division reviewed the project regarding the instream flow requirements and noted concerns about the requirements. The division also reviewed the Bear Hydro Project Monitoring Program (February 2007).
- Ministry of Forests indicated support for the project, provided some requirements were met, including acquiring appropriate permits.
- The Sechelt Indian Band First Nation was consulted and signed a participation agreement with REGIONAL; however, correspondence from the Sechelt Indian Band (June 2007) noted concerns with the application and requested additional consultation. The land use tenure agreement (June 2007) was for a smaller area than originally proposed due to a commitment made by the Ministry of Sustainable Resource Management to the Sechelt Nation.

The Canadian Environmental Assessment Act screening report also includes summary information regarding the watershed characteristics, the water balance and monthly summary of flows, instream flow requirements, a justification for the license and quantity, and a list of special clauses for the license. The special clauses include the maximum quantity of water that may be held in live storage and the maximum quantity of water that may be diverted and used for power. The proposed minimum IFRs are required to increase between July and September during rainbow trout, cutthroat, and Dolly Varden spawning (MOE WSD 2008).

Monitoring and Compliance

The Bear Hydro Project Construction Environmental Management Plan was published in March 2007 (Canadian Projects Limited 2007). The plan includes general project requirements such as low-impact principles and socially responsible principles in addition to compensation for remnant effects to fish habitat, instream requirements, and vegetation removal requirements. Project-specific requirements include monitoring water quality before, during, and after construction and reducing impacts to the resident fish in Bear Creek and other visiting species. Construction began in July 2010, which included monitoring.

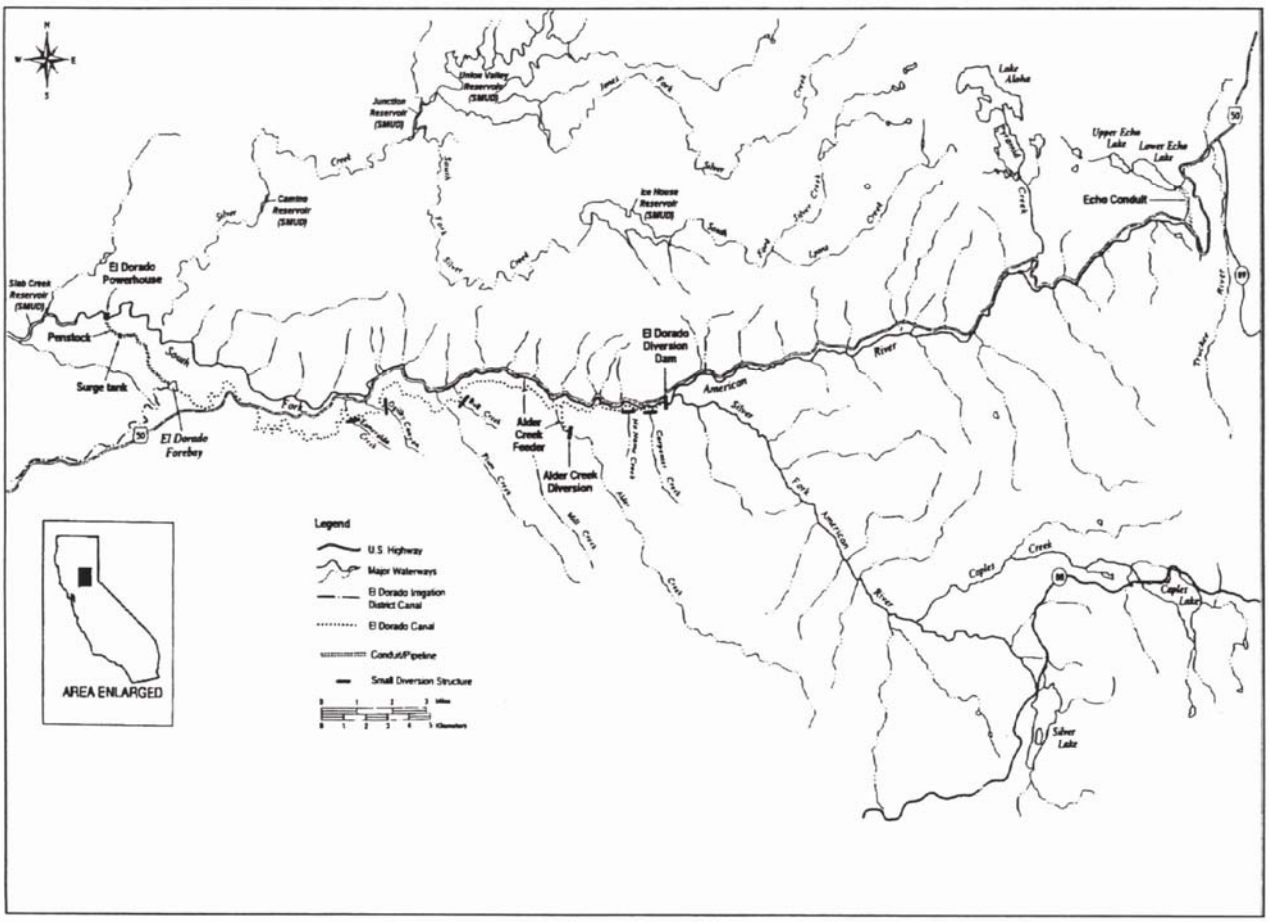
Land Tenure Agreement

A land-use report was issued for the Bear Creek Hydro Project in 2007. The land-use report followed the environmental standards of other agencies to form recommendations for a decision on the land application. In this instance, the report provided a brief summary of the analysis and any concerns raised by Transport Canada, Fisheries and Oceans Canada, the Forest District, Ministry of Environment, Ministry of Energy and Mines, and the Shishalh Nation. The report noted that the Clowhom Project and the Bear Project would use a shared transmission line to reduce environmental concerns. Additionally, land tenure area was reduced due to commitments made to the Sechelt Nation. The land tenure agreement relies on other agencies for the environmental review and environmental monitoring of the project. However, since 2011, the environmental review practice has included new environmental standards for B.C., which are not reflected in the land reports for the Bear Creek Hydro Project.

El Dorado Hydroelectric Project

The 21-MW El Dorado Hydroelectric Project is located in California – on the South Fork of the American River and its tributaries, and on Echo Creek, a tributary to the Upper Truckee River – in El Dorado, Alpine, and Amador counties (see Figure 10). The project includes four storage reservoirs (Lake Aloha, Echo Lake, Silver Lake, and Caples Lake), the El Dorado Diversion Dam on the South Fork of the American River, and several smaller diversions on tributaries. The El Dorado Diversion Dam diverts water into the 22.3-mile-long El Dorado Canal, which terminates at the El Dorado Forebay.

Figure 10: El Dorado Hydroelectric Project



Source: FERC 2006.

The Federal Energy Regulatory Commission (FERC) issued Pacific Gas and Electric (PG&E) the first and second hydroelectric licenses for the project, which were valid from 1922 to 1972 and 1972 to 2002, respectively. PG&E transferred the project to the El Dorado Irrigation District (EID) in 1999, and EID began the FERC relicensing process in 2000 (EID, 2012a).

Environmental Impact Statement

On February 22, 2000, EID filed an application for the continued operation and maintenance of the project, and FERC issued a notice on August 17, 2000, of its intention to prepare a scoping document and environmental impact statement (EIS).

On July 31, 2002, FERC issued a Ready for Environmental Analysis Notice, requesting comments, recommendations, and terms and conditions with a filing deadline of October 31, 2002. FERC released the draft EIS on March 7, 2003, and the final EIS on August 6, 2003. Issues specifically addressed in the EIS

included the potential effects of relicensing on water quality and quantity; aquatic biota; terrestrial resources; threatened and endangered species; recreational resources; land use and aesthetic resources; and cultural resources. FERC also analyzed the cumulative effects of the project on water quality, water quantity, and coldwater fishery resources (primarily rainbow trout). FERC recommended its alternative (which included additional measures to those proposed by EID to further protect, enhance, or mitigate adverse effects to the environment) and that a new license be issued for continued operation of the El Dorado Hydroelectric Project (FERC, 2003).

The EIS analysis relied on the results of studies, surveys, and reports that studied the following environmental resources (EID 2012b; Floch 2002):

- Hydrology including water quality, lake depth, and temperature modeling
- Aquatic biota including benthic macroinvertebrates, fisheries, and amphibians
- Terrestrial biota including bats, birds, mammals, and the Valley elderberry longhorn beetle
- Vegetation including noxious weeds and riparian habitat
- Recreation
- Cultural resources
- Geotechnical resources and local landforms
- Visual resources
- Access roads

Collaborative/Settlement Process. On June 26, 2001, the El Dorado Irrigation District, along with other interested stakeholders agreed to engage in a public, collaborative process with the goal of executing a multiple-party settlement agreement that would resolve outstanding issues regarding recreation, lake levels, and monitoring aquatic and fish habitat conditions for the project's relicensing. On April 29, 2003, EID filed the El Dorado Relicensing Settlement Agreement with FERC; it contains recommended protection, mitigation, and enhancement (PM&E) measures as proposed by the settlement parties. The agreement was signed by the U.S. Forest Service, National Park Service, California Department of Fish and Wildlife, County of Alpine, Citizens for Water, County of Amador, Friends of the River, the American Whitewater Affiliation, and several individuals (EID, 2001; EID, 2003).

Monitoring and Compliance

On October 18, 2006, FERC issued a new 40-year license for the project that expires October 1, 2046. The license contains operating requirements, including provisions for maintaining year-round minimum flows and existing recreation, regulating lake levels, monitoring of aquatic conditions, enhancing fish habitat, adding a boat launch facility at Caples Lake, and other actions. These requirements are estimated to cost EID roughly $40 million over 40 years (EID 2012a).

The license for the project includes various plans and recommendations that must be filed with the State Water Resources Control Board (SWRCB), the U.S. Forest Service, and FERC. Additionally, a visual resources plan developed in consultation with the Forest Service and a Programmatic Agreement and Historic Properties Management Plan were required. The project is subject to the inspection and supervision of the regional engineer for FERC in the region where the project is located.

The Forest Service conditions required for the project include minimum streamflow schedules, which are divided into five water year types: wet, above normal, below normal, dry, and critically dry. The applicant is

required to use the forecast of unimpaired inflow as set forth by the California Department of Water Resources to determine the year type.

The applicant provides an annual monitoring program report that describes any monitoring incidents that occurred throughout the previous year. Incidents must be immediately reported to the appropriate agency and mitigated as appropriate. Typical incidents and responses include:

- Debris resulting in underreleases and minimum streamflow reported by the applicant to FERC. Applicant report indicates the time and duration of the under release and the cause. Depending on the cause, the applicant is required to mitigate the underrelease and report the underrelease to FERC, who would determine if the deviations violate the license requirement.
- Accidental releases of water causing impacts in fish or amphibian habitat. The applicant is required to notify the Forest Service, California Department of Fish and Wildlife, and the SWRCB of any spills and detail the methods used to mitigate the spills, including surveying for fish species and removing the species from the ponds.
- Yearly monitoring reports. The applicant is required to provide FERC and other appropriate agencies with monitoring reports. Incidents regarding the reports include failure to file the report by the appropriate date. FERC provides warnings if the reports are not filed at the appropriate time with the understanding that the late filing would become part of the compliance history for the project.
- Water quality monitoring for any project construction, operation, or maintenance. The applicant proposed a spillway study and noted that it did not intend to conduct turbidity monitoring. When directed to do so by FERC, the applicant attempted to comply with the study but was unable to do so. FERC reviewed the case and noted that the applicant was in violation of the permit and ordered the applicant to develop a monitoring plan and that the applicant consult with FERC and other agencies early in the development of any plans to construct, operate, or maintain a project.

Incident reports are posted on the FERC website.

Table 11: Overview of the Environmental Review for the Upper Harrison Water Project, Bear Creek Hydro Project, and El Dorado Project

Environmental Review Attribute	Upper Harrison Water Project (Environmental Assessment)	Bear Creek and Bear Lake (Licenses)	El Dorado Relicensing (Federal Environmental Impact Statement)
Regulations	• Environmental assessment • Screening level review under CEAA • Water license • Crown land tenure	• Water license • Crown land tenure • Screening level review under CEAA	• Environmental impact statement • Supplemental information to the final EIS for CEQA
Project Size	• Five interconnected run-of-river facilities with a combined capacity of approximately 102 MW (each project would generate between 6 and 34 MW) • Connected to the BCTC 360-kV transmission line via 52 km gen-tie of between 13.8 to 69 kV	• 20 MW • 13.7 km of new 138 kV, single wood pole transmission line	• Relicensing an existing 21 MW hydro project. • No new transmission required.
Public Outreach	• EAO held open houses and formal comment period of 30 days. • EAO request feedback from federal and provincial agencies:	• Public notice published by applicant in local newspapers • Federal and provincial agencies were asked for feedback on the project.	• Held scoping meetings and scoping period for 30 • Released the EIS for public review • Requested agency review
Data collected for Impact Analysis	• Design flood frequencies • Seasonal flow values • Fish species, habitat, and biological requirements	• Hydrological conditions • Fish status at Bear Creek on Clowhom Lake • Fisheries Studies on Bear Creek	• Discharge data • Simulated creek flow for dry, normal, and wet water year • Water temperature data • Existing ramping rates • Instream flow study (using instream flow incremental methodology)

Environmental Review Attribute	Upper Harrison Water Project (Environmental Assessment)	Bear Creek and Bear Lake (Licenses)	El Dorado Relicensing (Federal Environmental Impact Statement)
Impact Analysis Considerations	• Effects on instream flow requirements, fish and fish habitat, wildlife, and navigation • Public health and safety effects related to noise, air quality, and water quality • Socioeconomic concerns related to construction and employment • First Nations interests raised related to fish and wildlife, vegetation, and historical trails • CEAA considered alternative means of undertaking the project, accidents and malfunctions, cumulative environmental effects, residual effects.	• Watershed characteristics and water balance • Instream flow requirements • intake and diversion structure • Operational environmental monitoring plan	• Effects on water quantity and quality, aquatic biota, terrestrial resources, and threatened and endangered species • Effects on recreational resources, land use and aesthetic resources, and cultural resources • Cumulative effects on water quality, water quantity, and coldwater fishery resources • Evaluated effects of four alternatives including project as proposed; project with modified measures to protect, enhance, or mitigate effects on environmental resources; project decommissioning; and project with no changes

Environmental Review Attribute	Upper Harrison Water Project (Environmental Assessment)	Bear Creek and Bear Lake (Licenses)	El Dorado Relicensing (Federal Environmental Impact Statement)
Mitigation	Minister of Environment (MOE) reasonable degree of confidence that instream flows are mitigable but requires operational monitoring to allow adaptive management • Compensate for habitat loss through creation of wetted areas • Maintain and manage instream flow requirements for fish • Minimizing damage to riparian zones • Clear headpond areas to maximize fish habitat values • Manage headpond operations to maintain water levels for habitat benefits • Best management plans for surface water quality, product spills, and blasting • Assess metal leaching and acid rock drainage • Include additional mitigation for specific facilities including working with recreational facilities, First Nations, and safety and security controls	Construction environmental management plan – submitted to Fisheries and Oceans Canada, Transport Canada, Ministry of Environment and Integrated Land Management Bureau, Regional District and First Nation • Monitor water quality before, during, and after construction • Reduce work windows for Dolly Varden fish during appropriate times • Maintain instream flow requirements • Be aware of Coastal Tailed Frogs and report sightings • If possible, avoid land clearing activities during sensitive nesting periods for birds • No blasting and limited helicopter flights in the Ungulate Winter Range (mountain goats)	• Maintain minimum streamflows according to month and water year • Maintain ramping rates • Survey and monitor pools and ponds for trout and if present implement removal program • Provide flow release specifications • Survey and develop plan for stabilization of channels • Implement a monitoring program in coordination including monitoring fish habitat, macroinvertebrates, and yellow-legged frog • Monitor riparian vegetation, channel properties, water temperature, water quality, flow fluctuations • Implement ecological resources adaptive management program • Prepare biological evaluation prior to new construction or maintenance • Develop recreation implementation plan and recreation monitoring plan • Implement visual resources protection plan • Develop public information plan
Cumulative Effects Analysis	• Required under CEAA • Considered logging, mineral exploration, and other independent power producers • Concluded that cumulative impact was negligible and not significant	None	• Included in analysis for each resource that could be potentially impacted • Concluded that could be potentially cumulative impacts to water quality and impact trout habitat. • Recommended mitigation should minimize effect
Endangered Species	• Potential Harlequin duck habitat	• Coastal Tailed Frogs should be noted	• Three federally listed species could potentially occur in project area • U.S. FWS consulted

Environmental Review Attribute	Upper Harrison Water Project (Environmental Assessment)	Bear Creek and Bear Lake (Licenses)	El Dorado Relicensing (Federal Environmental Impact Statement)
Fish Habitat/Migration	• Fish were present above the barriers for two of the projects and below the barriers for all of the projects • MOE reasonable degree of confidence impacts to in-stream biota are mitigable	• Project would impact fish habitat, required an Authorization for Works or Undertakings Affecting Fish and Fish Habitat from the DFO • Additional mitigation required	• Multiple native and nonnative fish species located in the project area • Instream flow requirements for normal, dry, and wet years
Water Levels/ Flow/ Quality/ Temperature/ Management	• Potential for icing on some of the creeks, overwintering flow increased to protect against icing • Flow expected to remain the same	• Water report included information regarding the watershed characteristics, water balance including mean annual flows	• Analyzed impacts to water resources including simulated creek flows for dry, normal, and wet years • Water quality impacts were analyzed
Monitoring	• Applicant commitments reviewed by the agencies • Incidents require formal explanation by the applicant • Incident reports and responses are not made publicly available • Environmental monitor hired by Cloudworks (Proponent)	• Operational Environmental Monitoring Program (OEMP) submitted and approved by MOE prior to construction. Initiated prior to construction and continued for a period not less than 5 years. • OEMP should include preconstruction period and baseline monitoring • After completion of monitoring program, prepare report that identifies nature of any impacts to fish habitat and wildlife and implement appropriate mitigation	• Mitigation measures proposed by applicant and FERC during relicensing process • Mitigation reports posted on FERC website including incident reports • Primary monitors hired by the applicant • Additional Forest Service monitors funded by applicant

Source: EAO 2006a. EAO 2006b. MOE WSD 2008. FERC 2003.

Comparison of Projects

As shown in Table 11, many aspects of the environmental reviews for each of the three projects – the Upper Harrison Water Project, the Bear Creek Hydro Project, and the El Dorado Relicensing Project – were comparable. Specifically, the projects all complied with the appropriate regulations and required similar data collection, consideration of endangered species, fish habitat and migration, and analysis of water levels, flow, and quality. The differences between the projects' review process are described below.

- **Public Outreach.** Public outreach efforts for the Upper Harrison Water Project and the El Dorado Project were of a similar scope and duration. Although information about the Bear Creek Hydro Project was published in a local newspaper, public outreach for the Bear Creek Hydro Project did not include public meetings.
- **Impact Analysis Considerations.** The Upper Harrison Water Project and El Dorado Project included lengthy reports that reviewed and analyzed the impacts of the projects. The Bear Creek Hydro Project included a brief summary of the environmental reviews that the applicant provided for the project and any concerns highlighted by other B.C. agencies. The land use tenure report for the Bear Creek Hydro Project did not include an environmental review but instead relied on the environmental review completed by other agencies. The Upper Harrison Water Project and El Dorado Project environmental review considered alternatives to the project as proposed. The Bear Creek Hydro Project did not consider alternatives to the project.
- **Mitigation.** All projects required mitigation that specified a minimum instream flow. The El Dorado Project included an adaptive instream flow that depended on the amount of rainfall expected for that year. Additionally, the El Dorado Project included a public information plan as a mitigation measure.
- **Cumulative Effects Analysis.** The Upper Harrison Water Project and El Dorado Project included a cumulative analysis. The El Dorado Project considered cumulative impacts to each resource that could potentially be impacted independently while the Upper Harrison Water Project considered cumulative impacts more generally. The Bear Creek Hydro Project did not consider cumulative impacts but did consider any reserves and restrictions on Bear Creek and other licenses on Bear Creek.
- **Monitoring.** Monitoring was required for each of the projects considered. Monitoring concerns were raised for the Upper Harrison Water Project and the applicant responded to each of the concerns raised. These reports were not published on the Environmental Assessment Office website. Monitoring reports, including incident reports, for the El Dorado Relicensing project were published on the FERC website and publicly available. Monitors were primarily hired by the applicants for all three projects; however, the El Dorado Project mitigation required some funds for independent Forest Service monitoring.

CHAPTER 5:
Effect of Inclusion of B.C. Run-of-River Projects in RPS Program

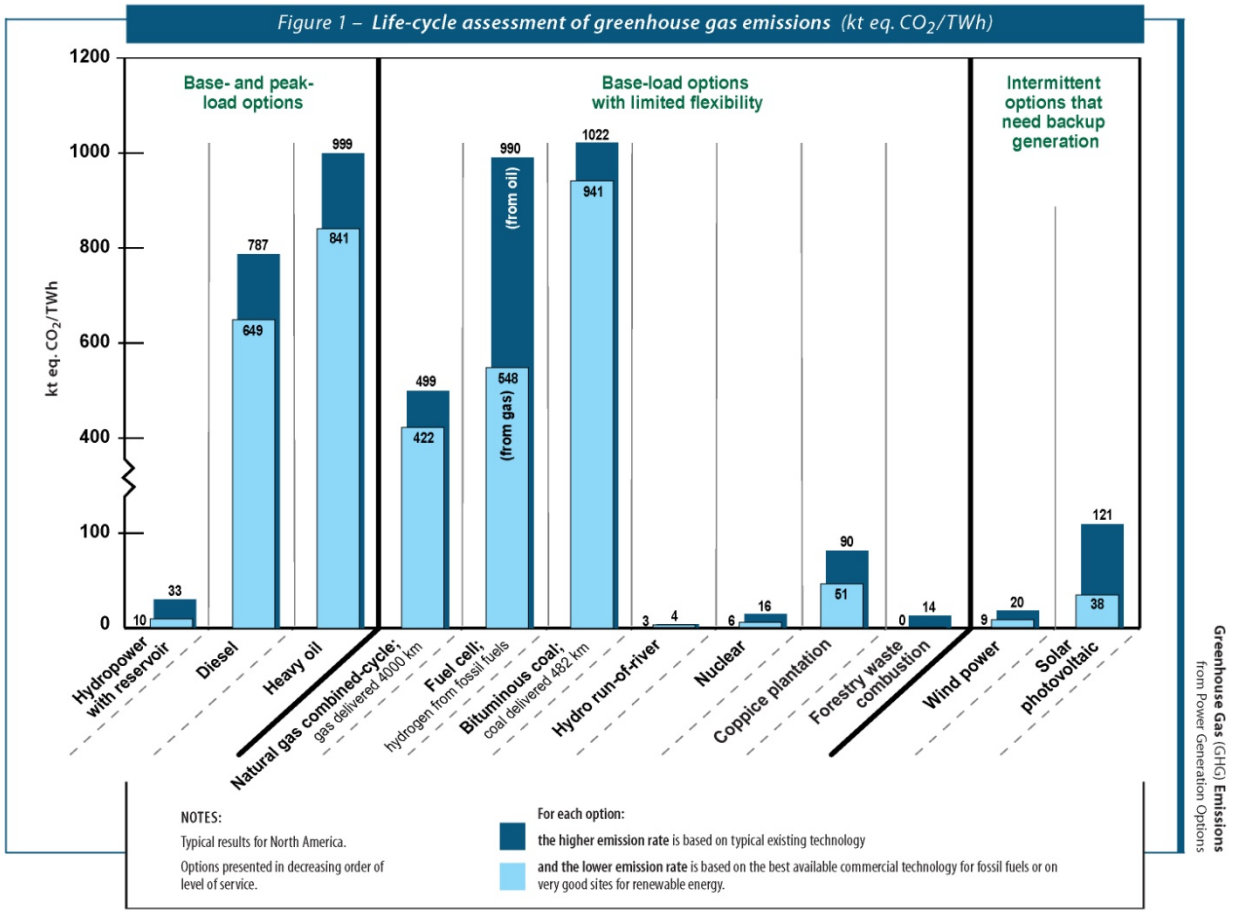
The Energy Commission was charged with considering the effect of run-of-river hydro projects on the following:

- Emissions of carbon dioxide and other greenhouse gases
- Emissions of air pollutants
- Water quality, recreation, and fisheries
- Any other environmental impact caused by run-of-river hydro

Carbon Dioxide and Greenhouse Gas Emissions

Run-of-river systems generate minimal carbon dioxide (CO_2)and greenhouse gas emissions. The California Department of Water Resources (2008) cites North American hydropower emissions in the range of 4 to 33 grams (g) CO_2-equivalent per kilowatt-hour (kWh). Based on a comparison by Hydro Quebec (2006), a rate of 4 g CO_2-equivalent per kWh is less than 1 percent of the emissions from fossil fuel technologies and is the lowest compared to nuclear, wind, solar, and forestry waste combustion technologies (see Figure 11). Similarly, a life-cycle analysis of run-of-river (as well as storage) hydropower plants in the Swiss Alps found greenhouse gas emissions on the order of 4 g CO_2-equivalent per kWh, mostly from construction (Dones 1998). A life-cycle estimate for electricity generators in *Energy Policy Journal* estimated a run-of-river facility at 13 g CO_2-equivalent per kWh, which was shown as greater than wind and biogas and tied with solar thermal electricity (Sovacool, 2008).

Figure 11: Life-Cycle Assessment of Greenhouse Gas Emissions



Source: Hydro Quebec, 2006

Smaller run-of-river projects, however, have greater per unit emissions due to a higher ratio of construction materials and transportation energy. Access roads and transmission line connections often use or reactivate existing infrastructure but can sometimes require construction of extensive new rights-of-way and clearing of forested terrain, which would affect carbon storage. Pacific and montane cordillera forests store an estimated 375 and 324 metric tons of carbon per hectare, respectively (Henschel and Gray 2007; Natural Resources Canada 2012; Watershed Watch 2012b).

According to the Independent Power Producers Association of British Columbia, a typical 26 MW run-of-river power plant producing 80 gigawatt hours (GWh) of green energy annually would displace roughly 47,000 metric tons of carbon dioxide (IPPBC 2008). FERC, meanwhile, projected that the 21 MW (106 GWh) El Dorado Project in California would displace 14,082 metric tons of carbon dioxide per year (FERC 2003).

As noted above, the estimated CO_2-equivalent per kWh for run-of-river hydroelectricity varies. Despite this, run-of-river hydroelectricity generates fewer CO_2-equivalent emissions per kWh than the majority of energy projects currently permitted in California.

Air Pollutants

Hydroelectricity is generally considered to have negligible air quality impacts because it does not burn fuel (U.S. EPA 2007). Project construction and travel on unimproved roads could generate air pollutants, however. Although the land impact of the hydroelectric system – which includes a small dam, headpond, penstocks, and powerhouse – is relatively small, the land disturbance could be significant for extensive rights-of-way. Run-of-river projects less than 30 MW would be expected to have relatively short transmission lines since transmission line costs would be greater per MW generated. If multiple under-30 MW facilities were constructed along the same river system, the facilities may require a longer transmission interconnection. The Holmes Hydro Project consists of 11 projects under 30 MW that would generate a total of 85 MW and require a 70-km (43-mile), 138-kV interconnection line (British Columbia Transmission Corporation 2007). The Bear Creek Hydro Project would require an estimated 13.7-km (8.5 mile) interconnection to reach the existing BC Hydro system. The transmission interconnections for the Upper Harrison Water Project facilities ranged from 0 to 35 km (0-22 miles).

The majority of the existing run-of-river facilities are located in the Lower Mainland and Vancouver Island area near existing BC Hydro transmission lines. As shown in Figure 3, much of the run-of-river hydro potential in British Columbia is located in the North Coast, requiring long transmission interconnection lines. The actual sizes and locations, and whether this development is economically feasible, are not known at this time. Overall, run-of-river hydroelectricity projects would have minimal air quality impacts except during project construction and when associated with the construction of the ancillary facilities such as transmission interconnection.

Water Quality and Fisheries

Impacts to fisheries and aquatic habitat are major environmental concerns with run-of-river projects (Watershed Watch 2007). The amount of flow diverted would affect potential impacts to water quality and fisheries. British Columbia regulations provide guidelines for the development of instream flow thresholds or requirements. As noted in the Upper Harrison Water Project Application, instream flow evaluation considers multiple criteria including location of project components, design parameters, economic feasibility, baseflows at the intake location, fish species presence, physical habitat, and biological habitat. Although a project may divert more than 90 percent of the streamflow at certain times of the year and more than 100 percent of the MAD, rivers may still have streamflows above the MAD during portions of the year. As shown in Figure 8, the Upper Harrison Water Project Stave River Facility modeled operations instream flow (in other words, flow with a run-of-river project in operation) is above the MAD during some summer and some winter months even during dry years (Cloudworks 2007. Appendix 7). Such periods would be limited compared to the baseline flows.

A low elevation dam creates a headpond deep enough to ensure that the intake to the penstock (pipe to the powerhouse) is underwater. The size of the headpond can vary, depending on stream channel characteristics. The application for the 25 MW Cascade Heritage Power Project specified a headpond that would extend 1.7 km upstream and would have an approximate volume of 300,000 m^3 (Powerhouse Energy Corp 1999), while the application for the 30 MW

Dalgleish Creek Hydroelectric Facility (part of the 124 MW Upper Toba Valley Hydroelectric Project) proposed a smaller headpond of about 2,000 square meters in area and an approximate volume of 5,000 m^3(Knight Piesold 2008). The Cascade Heritage Power Project was located downstream of speckled dace and rainbow trout fry habitat. Portions of the Dalgleish Creek provide fish habitat, including salmon habitat. For this reason, the ramping rates calculated by the applicant were determined to seasonally reflect salmonid life history and were reduced during sensitive periods to avoid downstream channel processes, as suggested by DFO guidelines (EAO 2009).

The flow diverted into the penstock continues through the powerhouse and turbines, and back into the river via a tailrace channel. The diversion reach is often 3 to 4 km long (Watershed Watch 2012a) but can vary. For example, a diversion reach of 1.4 km is proposed for the 10 MW Upper Bear Creek project (MOE WSD 2008), and a reach of 11 km is proposed for the five Upper Harrison Water Power Projects totaling up to 102 MW (EOA 2006).

Water Quality

Unlike a reservoir behind a major dam, water temporarily stored in a small run-of-river headpond would undergo very little or no deterioration (International Rivers 2012). Headpond dams can block passage of instream sediment, woody debris, and other channel-forming elements. In addition, the reduced flows do not allow for channel-maintaining floods that flush out and move fine sediments downstream. Fine sediments could accumulate in pool areas, clogging the space between gravel and larger substrates.

Reduced instream flows throughout the diversion reach have potential impacts to the creek's temperature regime. Higher water temperatures in the summer and colder water temperatures in the winter could result. As noted in Figure 5, run-of-river projects generate a majority of their electricity between the months of May and September, which correlate with the periods when the instream flows are predicted to be above the MAD (See Figure 8). Mitigation can be included to reduce the impact to water temperature as with the Upper Harrison Water Project where overwintering instream flow was increased to protect the river against icing.

Although run-of-river projects less than 30 MW have fewer water quality and water temperature impacts than larger hydroelectric projects, impacts to both the water quality and temperature occur. Mitigation can be required to reduce such impacts.

Fisheries

Run-of-river instream infrastructure can block or delay passage of fish migrating both upstream and downstream. The tailrace and upstream water intake, as well as reduced flows in the diversion reach, could interfere with upstream migration. Juveniles migrating downstream could become entrained (or drawn in), blocked, or delayed in intake valves (for example, Bech 2011).

For salmon and steelhead that travel upstream to spawn, females excavate depressions called redds in the gravel river bottom to lay their eggs. The greater sedimentation resulting from reduced flows could clog the air spaces between gravel and prevent a sufficient supply of

dissolved oxygen for the eggs. The interrupted supply of woody debris and gravel can lead to a lack of quality spawning material and impact the bottom-dwelling insects that live in the debris and gravel and provide food for juvenile fish (Watershed Watch 2012b). Instream diversion would result in greater impacts to fish species in smaller streams than in larger ones. Studies have shown that small streams are more sensitive to water withdrawals than larger streams, and the recommended flow for spawning salmonids in B.C. streams indicates that smaller channels require higher relative flows than do larger streams (Hatfield, *et al.* 2003). Discharges and sudden upramping could scour the river beds, disturbing nests and increasing mortality of eggs and juvenile fish, as well as amphibians.

Reduced instream flow in fishless streams can also impact fish-bearing streams. Seventy-two percent of run-of-river projects are located in known or suspected fish habitat (Watershed Watch 2012b). Fishless streams contribute to downstream fish productivity through the export of invertebrates (food for fish) and detritus (food for aquatic invertebrates) (Hatfield, *et al*. 2003).

Changes to water temperatures can affect fish growth and physiology. Warmer water temperatures associated with smaller flows can lead to faster egg development and hatching and, in turn, emergence of smaller, more susceptible fry. Warmer temperatures also increase metabolic demands for cold-blooded fish. Higher metabolic demands on growing fish could further decrease their growth rates, as well as increase their susceptibility to pathogens and parasites. Summer temperatures could be lethal. Conversely, colder water temperatures in winter could lead to harmful ice formation. Frazil ice – which forms in supercooled water in turbulent, high-gradient streams – directly affects the respiratory system of trout, as well as aggregates on woody debris and substrate, forcing fish out of protective habitats (Brown 1993).

Mitigation Measures

Water quality and fisheries mitigation measures, as discussed in environmental reviews of various run-of-river projects, may include the following, for example (FERC 2008; Sound Energy, Inc., 2011; BC EAO 2006):

- Penstock intakes or sluice gates designed to pass mobile substrates and woody debris
- Overtopping low dams once a year to allow sediments downstream
- Outages, upramping, downramping, and other changes to instream flows adjusted for species-specific and site-specific factors, including drought years where instream flows would be expected to be low
- Instream flow monitoring
- Water velocities low enough so that fish are not pinned against intake screens
- Consideration of seasonal life history and habitat requirements of fish and amphibian species using the diversion reach
- Siting of projects (for example, upstream of headwaters) to minimize disturbance to spawning salmon
- Fish habitat compensation
- Sediment control measures during construction

- Construction activities carried out within the "fisheries window."

With effective mitigation, impacts to water quality and fisheries can be minimized.

Recreation

Due to the mountainous terrain often required of run-of-river projects, they are frequently proposed in areas where recreation activities take place. The two activities on which run-of-river projects would likely have the greatest direct effect are whitewater rafting/kayaking and fishing. For instance, concerns have been voiced by whitewater users regarding proposed run-of-river projects at Big Silver Creek (16 MW), Tretheway Creek (21 MW), Shovel Creek (36 MW), and Statlu Creek (11 MW) near Harrison Lake (Fraser Valley Whitewater 2012; *Vancouver Sun* 2010). For the Fitzsimmons Creek project (8 MW) near Whistler, conditions of project approval included working with kayak groups and maintaining higher flows in the stream for two weekends (total of four days) per year (BC Ministry of Environment 2001). Impacts to recreational fishing are closely tied to fisheries, as discussed above, as well as aesthetic and wilderness values.

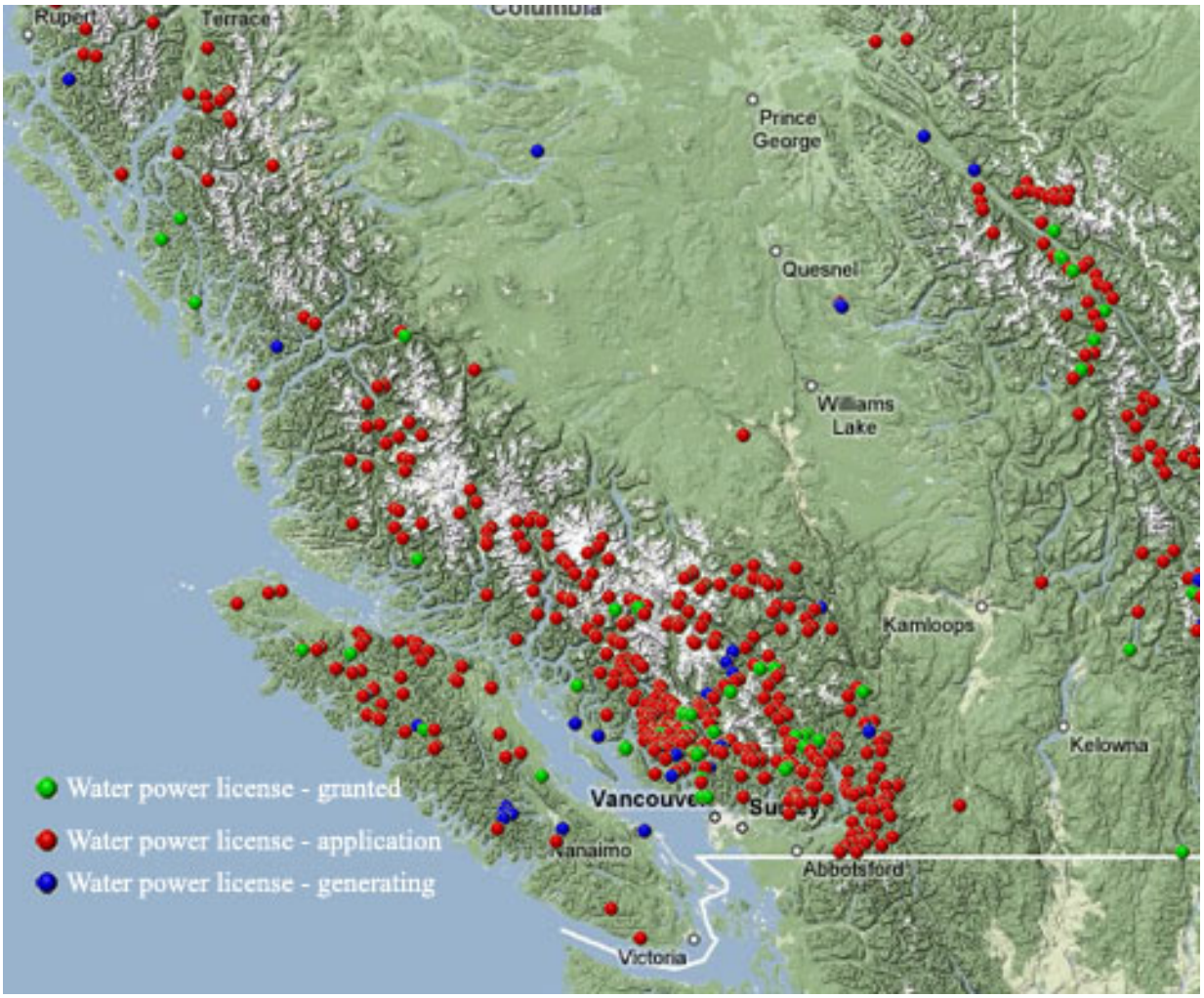
Run-of-river projects could also have aesthetic effects on other recreational activities, including camping, hiking, hunting, sightseeing, off-highway vehicle use, and bouldering. A ziplining operation near the Fitzsimmons project (500 meters upstream of the powerhouse) had concerns about the aesthetic values of low flows (BC Ministry of Environment 2001). Run-of-river projects could also enhance tourism in an area by maintaining infrastructure used for recreation, such as roads or walking paths.

Impacts to recreation and aesthetics could result from run-of-river hydro projects. Mitigation, such as that described above requiring higher flows in the stream during certain periods of the year, would reduce such impacts. As with all energy production infrastructure, mitigation for aesthetic impacts can be challenging. Powerhouse structures could be designed to blend with the surrounding environment.

Cumulative Effects

As of October 1, 2011, BC Hydro reported 42 existing run-of-river projects supplying up to 822 MW of power (BC Hydro 2011a). Another 35 run-of-river projects (1,269 MW) are in development, and as noted in Figure 12, the technical potential for run-of-river hydro projects in B.C. is widespread throughout the province (BC Hydro 2011b). Figure 12 below includes existing water power projects, projects that have water licenses, and projects where an application has been filed. As of September 2010, British Columbia had received 627 applications for water power licenses (PPW 2010). The cumulative effects of these projects could occur at the watershed and at regional levels.

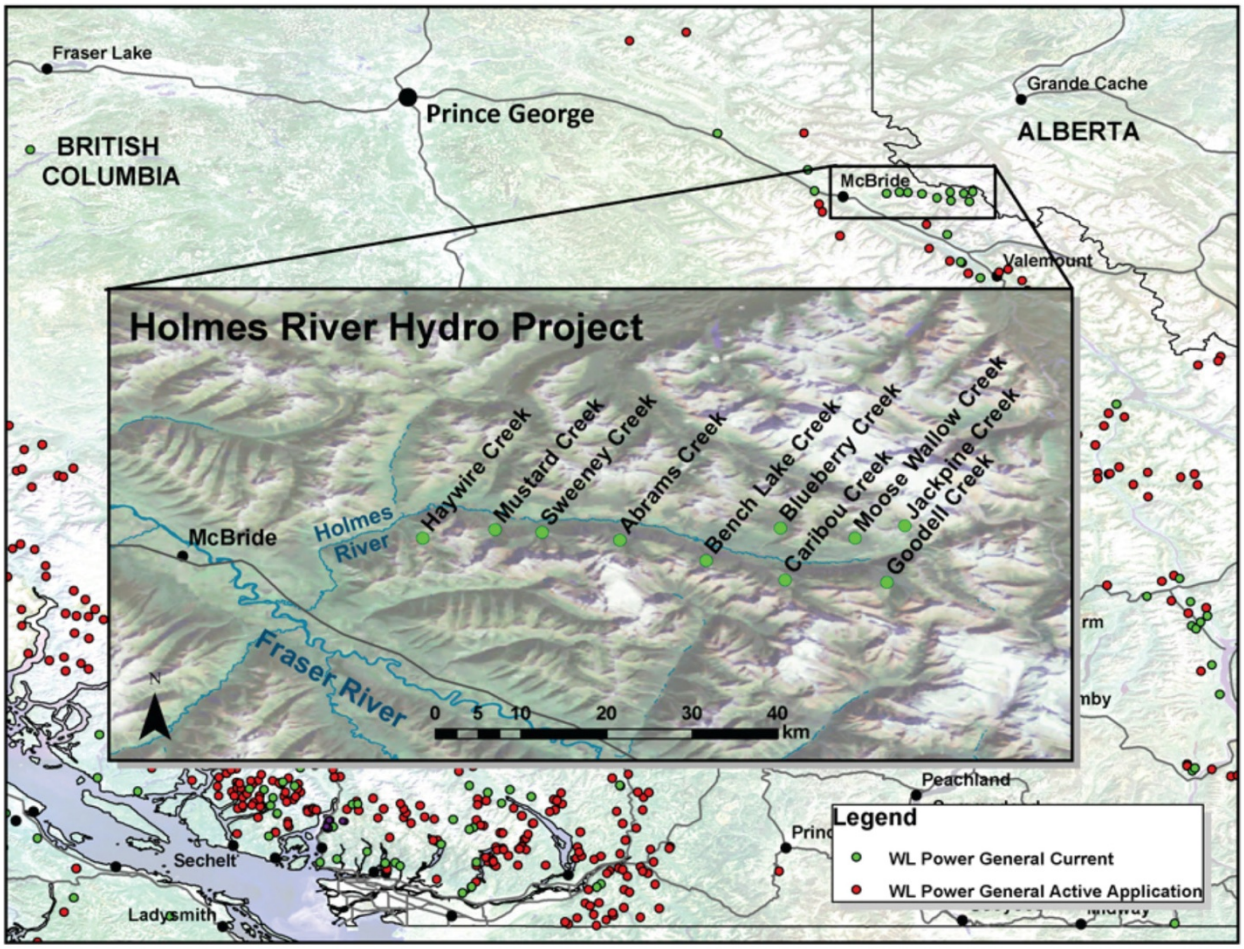
Figure 12: Water Power Licenses and Applications



Source: PPW 2010.

Cumulative effects could occur when there are multiple projects in the same watershed. For example, the Pitt River Power cluster in the Upper Pitt River consists of a proposal by Northwest Cascade Power Ltd. to develop eight run-of-river projects (ranging from 10 MW to 30 MW) with a total capacity of 161 MW. The cluster affects all eight major tributaries located within 12.5 km of each other (BC EAO 2012; ROR Inc. 2011). Projects entailing diversions of multiple adjacent streams or rivers within a single watershed are sometimes addressed individually instead of being reviewed as a whole under B.C.'s Environmental Assessment Act. Holmes Hydro, Inc., proposed 11 projects, each under 15 MW, on a tributary of the Holmes River (see Figure 13). Each project applied for a water license and land tenure independently; however, the *British Columbia Transmission Corporation Feasibility Study* was for the cluster of Holmes River projects (British Columbia Transmission Corporation 2007), suggesting that the projects were not independent. For such projects, there are potential impacts to aquatic health if joint impacts are not considered (Douglas 2007).

Figure 13: Holmes Hydro IPP Project Location



Source: Comment Letter from Watershed Watch Salmon Society (March 2012).

Cumulative effects can also occur at the regional level, particularly with the construction of roads and transmission corridors associated with the run-of-river projects. Consequences can include habitat fragmentation, increased human entry to wilderness areas, harm to wildlife, and other wide-ranging effects (Douglas 2007). The vast majority of existing and proposed projects are located in southern B.C., in the province's Vancouver Island-Coast, Lower Mainland Southwest, Kootenay, Thompson-Okanagan, and Cariboo Prince George regions. There can be further concentration of run-of-river projects within these regions. For instance, since the early 1990s, seven run-of-river projects have been constructed in the Sea-to-Sky (Highway 99) corridor on B.C.'s south coast , with additional applications underway (Douglas 2007). Concern regarding the cumulative impacts to tourism and recreation were expressed by local communities in the region. Cumulative effects are considered in the environmental assessment review and must be considered if a project applies for the EcoLogo certification. The cumulative effects assessment must follow the *Cumulative Effects Assessment Practitioners Guide,* which includes (CEAA 2010):

- Assessing the effects of a project over a larger (regional) area that may cross jurisdictional boundaries.

- Assessing effects during a longer period.
- Considering effects on ecosystem components including interactions with other past, existing, and future actions.
- Evaluating significance considering more than just local, direct effects.

Evaluation of cumulative impacts as described above would reduce the likelihood of impacts and be comparable to cumulative impact assessments conducted for California projects.

CHAPTER 6: Conclusions

This study addresses the requirements of Senate Bill X1 2, Section 25741.5, and focuses on run-of-river facilities less than 30 MW in British Columbia. Run-of-river facilities divert a portion of the river's water into a channel, deliver it to a waterwheel or turbine, and return the water to the channel downstream. Run-of-river projects 30 MW or less represent between 1 and 2 percent of BC Hydro's generation portfolio and are primarily located in the Lower Mainland and Vancouver Island. Although there is a large technical potential for run-of-river projects in British Columbia, the cost of run-of-river electricity potential varies greatly.

SB X1 2 requires an opportunity for public comment including holding a public workshop and consultation with interested governmental entities. A workshop was held on February 24, 2012; about 30 parties participated in the workshop. In addition, governmental and nongovernmental entities in B.C. were contacted. The following concerns were noted: concern about the environmental standards for run-of-river projects, a lack of public outreach, impacts due to construction of the projects including to terrestrial and aquatic species, cumulative impacts of the projects, and a lack of appropriate mitigation and monitoring of the projects. It was also noted that run-of-river projects have low air quality and greenhouse gas emissions per kWh and the industry has been working with the First Nations such that First Nations are part owner/operators of a number of projects.

Multiple laws, ordinances, regulations, and statutes regulate run-of-river hydro projects in both British Columbia and in California. Run-of-river permitting in British Columbia occurs primarily at the provincial level and can either require an environmental assessment, for projects above 50 MW and for projects that opt into the process, or can require a suite of permits, the two most common being a water license and land tenure. British Columbia published the *Clean Energy Project Development Plan Information Requirements* in 2011 to streamline the permitting of clean energy projects, including run-of-river hydro, and to provide pertinent environmental information to the decision makers. In addition to the governmental review, run-of-river hydro projects in B.C. can apply for EcoLogo certification. EcoLogo is a third-party certifier of environmentally preferable projects. Seventeen 30 MW or less run-on-river projects totaling 173 MW have EcoLogo certification. In California, hydroelectric projects are permitted by FERC, which is required to do a NEPA review. Hydroelectric projects would likely require permitting by the SWRCB and possibly by the CDFW, which, in addition to the

permit, would trigger the need for a CEQA environmental review unless the NEPA document meets the CEQA requirements.

The environmental review process for three hydroelectric projects was compared, two run-of-river projects in British Columbia and one small hydroelectric project in California. One of the run-of-river projects in British Columbia had undergone the environmental assessment process and the other had applied for appropriate licenses. Many aspects of the environmental reviews for the projects were similar. The project in British Columbia that underwent an environmental assessment, and the project that was reviewed in California required similar public outreach, considered alternatives to the proposed projects, and included analysis of cumulative effects. The project in British Columbia that applied for individual licenses did not. All three projects considered impacts to water quality and aquatic species and included mitigation and adjusted instream flow requirements to address environmental impacts. The mitigation and monitoring plans and any incident reports for the project in California were publicly available on the FERC website. Final compliance summary reports were publicly available for the project in B.C. that had an environmental assessment; however, the reports were summaries, and individual monitoring plans were not publicly available.

Senate Bill X1 2 requires the Energy Commission to consider the environmental effects of run-of-river hydro projects. Run-of-river hydro projects generate fewer CO_2-equivalent emissions per kWh than the majority of energy projects currently permitted in California and have minimal air quality impacts except during project construction. Run-of-river hydro projects can impact water quality and result in water temperature changes during summer and winter. Impacts to water quality and water temperature can affect fish spawning, growth, and physiology, and the run-of-river hydro project in-stream infrastructure can block or delay passage of fish migration. For impacts to water quality, water temperature, and fisheries, mitigation can be required to reduce the effects. Impacts to recreation, aesthetics, and wilderness values can also occur due to project infrastructure and to the decrease in river flow. Concerns regarding impacts to recreational activities such as rafting and kayaking have been noted, and mitigation such as increasing river flow during certain times of the year has been incorporated into project licenses. A primary concern regarding environmental impacts caused by run-of-river hydro projects was cumulative impacts. Cumulative effects of the 627 applications for run-of-river water licenses could occur at the watershed and at regional levels. Cumulative effects are considered in the environmental assessment review and for EcoLogo certification.

As noted above, British Columbia run-of-river projects would be subject to several conditions prior to granting of RPS eligibility. These include the following: The project is less than 30 MW; it must not cause an adverse impact on instream beneficial uses or cause a change in the volume or timing of streamflow; and it must be developed and operated in a manner that is as protective of the environment as a similar facility located in California.

To meet these requirements, the Energy Commission is considering the following requirements for a B.C. run-of-river project requesting RPS eligibility:

- The project must be less than 30 MW.
- An environmental assessment or development plan with a cumulative impact assessment based on the *Cumulative Effects Assessment Practitioners Guide* must be completed.
- Instream flow requirements must be sufficient to not compromise the river ecosystem based on volume or timing of streamflow.
- EcoLogo certification should be obtained.
- Documentation (which may or may not be EcoLogo) must be provided that indicates the project was analyzed, constructed, and operated to protect the environment in a similar manner as a California project.
- Transparency during the environmental review and monitoring process should be comparable with FERC standards.

Acronyms

ALP	Alternative Licensing Process
ARB	California Air Resources Board
B.C.	British Columbia
BC Hydro	British Columbia Hydro and Power Authority
BC MFLNRO	British Columbia Ministry of Forests, Lands, and Natural Resource Operations
CCAA	California Clean Air Act
CDFW	California Department of Fish and Wildlife
CEAA	Canadian Environmental Assessment Act
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
DFO	Fisheries and Oceans Canada
DOE	U.S. Department of Energy
EAO	Environmental Assessment Office
EC	Environment Canada
EID	El Dorado Irrigation District
EIR	environmental impact report
EIS	environmental impact statement
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
GHG	greenhouse gas
GWh/yr	gigawatt-hour/ year
ILP	Integrated Licensing Process

IPP	independent power producer
kWh	kilowatt-hour
LORS	laws, ordinances, regulations and standards
MAD	mean annual discharge
MW	megawatts
MND	mitigated negative declaration
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NWPA	Navigable Waters Protection Act
OAGBC	Office of the Auditor General of British Columbia
NPDES	National Pollution Discharge Elimination System
PAD	pre-application document
RPS	Renewables Portfolio Standard
RWQCB	Regional Water Quality Control Board
SARA	Species at Risk Act
SBX1-2	Senate Bill X1-2 (Simitian, Chapter 1, Statutes of 2011)
SWRCB	State Water Resources Control Board
TLP	Traditional Licensing Process
WQC	Water Quality Certification
WWSS	Watershed Watch Salmon Society

References

BC Hydro. 2011a. Independent Power Producers (IPPs) currently supplying power to BC Hydro.

http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/acquiring_power/2011q4/20111001_ipp_supply1.Par.0001.File.20111001-IPP-Supply-List-In-Operation.pdf. Accessed January, 2012.

BC Hydro. 2011b. Independent Power Producers (IPPs) with projects currently in development. http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/acquiring_power/2011q4/20111001_ipp_supply0.Par.0001.File.20111001-IPP-Supply-List-In-Development.pdf. Accessed January, 2012.

BC Hydro. 2011c. Who we are. http://www.bchydro.com/about/. Accessed January, 2012.

BC Hydro. 2011d. IPP Supply Map October 2011. http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/acquiring_power/2011q4/20111001_ipp_supply.Par.0001.File.20111001-IPP-Supply-Map.pdf. Accessed January, 2012.

BC Hydro. 2011e. 2010 Resource Options Report. http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/iep_ltap/2012q1/2010_resource_options.Par.0001.File.2010ResourceOptionsReport.pdf Accessed February, 2012.

BC Ministry of Environment 2009a. Templates for a Waterpower Project July 2009. http://www.env.gov.bc.ca/wsd/water_rights/waterpower/cabinet/project_scope_template2.pdf. Accessed November, 2011.

BC Ministry of Environment. 2001. Report for Water Licence Application: Fitzsimmons Creek.

BC MFLNRO (British Columbia Ministry of Forests, Lands, and Natural Resources Operations). 2011a. Clean Energy Production in B.C.: An Inter-agency Guidebook for Proponents. http://www.agf.gov.bc.ca/clad/IPP_guidebook.pdf. Accessed November, 2011.

_____. 2011b. Land procedure: Allocation Procedures – Applications. May. http://www.agf.gov.bc.ca/clad/Documents/LPSB/Procedures/ap_applications.pdf. Accessed November, 2011.

_____.2011c. Land Use Operational Policy: Waterpower. http://www.env.gov.bc.ca/wsd/water_rights/waterpower/cabinet/land_use_waterpower.pdf. Accessed December, 2011.

Bech, P. 2011. Hydro project approval threatens steelhead and salmon habitat. Vancouver Sun, special to the Sun. December 16, 2011. http://www.vancouversun.com/Hydro+project+approval+threatens+steelhead+salmon+habitat/5874644/story.html. Accessed January 13, 2012.

British Columbia Environmental Assessment Office (BC EAO). 2006. Cascade Heritage Power Project Assessment Report and Screening Report. http://a100.gov.bc.ca/appsdata/epic/documents/p55/1154642088660_0a7c400c73194e7eb6fceb2d5b6bde9f.pdf. Accessed January 12, 2012.

British Columbia Environmental Assessment Office (BC EAO). 2012. Project Information Centre (e-PIC): Upper Pitt River Water Power Project. http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_291.html. Accessed January 16, 2012.

British Columbia Transmission Corporation. 2007. Feasibility Study for the Homes Hydro IPP Project. July. http://transmission.bchydro.com/nr/rdonlyres/a9cdb091-1d91-40ad-8c79-ea8de63ad304/0/holmes_hydro_feasibility_study.pdf. Accessed March 3, 2012.

Brookfield Renewable Power Inc. 2012. Kokish River Hydroelectric Project. http://www.kokishriver.com/content/about_the_project/overview-607.html. Accessed January 12, 2012.

Brown, R.S., S.S. Stanislawski, and W.C. Mackay. 1993. Effects of Frazil Ice on Fish. Proceedings of the Workshop on Environmental Aspects of River Ice, T.D. Prowse (Editor), National Hydrology Research Institute, Saskatoon, Saskatchewan, 1993, NHRI Symposium Series No. 12, p. 261-278. http://cripe.civil.ualberta.ca/Downloads/07th_Workshop/Brown_et_al_1993.pdf

California Department of Water Resources. 2008. Compilation of Published Reservoir and Lake GHG Emission Studies and Preliminary Assessment of Potential Annual GHG Emissions from the Oroville Facilities. Presented at NWHA Annual Conference, February 2008. www.nwhydro.org/...Annual.../NWHA_GHG_emissions_21808.ppt

Canadian Projects Limited. 2007. *Bear Hydro Project Construction Environmental Management Plan.* http://www.westernversatile.com/content/uploads/editor/downloads/Bear_Hydro_Project/Construction_Environmental_Management_Plan.pdf. Accessed January, 2012.

Canadian Environmental Assessment Agency. 2011. East Toba River & Montrose Creek Hydroelectric Project. http://www.ceaa.gc.ca/052/details-eng.cfm?pid=46101. Accessed December 19, 2011.

CEAA (Canadian Environmental Assessment Agency). 2010. *Cumulative Effects Assessment Practitioners' Guide.* http://www.ceaa.gc.ca/default.asp?lang=En&n=43952694-1&offset=6&toc=show. Accessed January, 2012.

California Energy Commission. 2011. List of Hydroelectric Power Plants in California. http://energyalmanac.ca.gov/renewables/hydro/index.html. Accessed February, 2012.

Cloudworks (Cloudworks Energy, Inc.) 2005. Upper Harrison Water Power Project: Terms of Reference for Preparation of an Application Under the BC Environmental Assessment Act. http://a100.gov.bc.ca/appsdata/epic/documents/p251/d20954/1131401526151_ec460705e25947e7977af2c4b3ef81a2.pdf. Accessed December, 2011.

Cloudworks. 2006. Application for an Environmental Assessment Certificate for the Upper Harrison Water Power Project. February. http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_251_21322.html. Accessed March, 2012.

Cloudworks. 2009a. Cloudworks Reponse to Western Canada Wilderness Committee FOI excerpts. E-mail dated June 6.

Cloudworks. 2009b. Cloudworks Formal Response to IPP Inspection Team Findings for Inspections of Stave, Lamont, Stokke, Tipella Hydroelectric Projects (MOE File: 43255-20/LMR31-02-IPP/INSP01). Dated April 9.

Department of Energy (DOE). 2001. *Small Hydropower Systems.* http://www.nrel.gov/docs/fy01osti/29065.pdf. Accessed January, 2012.

Dones, R, U. Gantner, and S. Hirschber. 1998. *Greenhouse Gas Total Emissions From Current and Future Electricity and Heat Supply System.* http://gabe.web.psi.ch/pdfs/lca/GHGT4_Interlaken_1998.pdf.

Douglas, T. 2007. *"Green" Hydro Power Understanding Impacts, Approvals, and Sustainability of Run-of-River Independent Power Projects in British Columbia.* Watershed Watch Salmon Society. http://www.watershed-watch.org/publications/files/Run-of-River-long.pdf

EcoLogo 2010. EcoLogo® Environmental Standard – Certification Criteria Document: CCD-003 Renewable Low-Impact Electricity Products. November.

EcoLogo 2012. Renewable Low-Impact Electricity Products - Hydro Review Process. http://www.ecologo.org/en/criteria/subpage.asp?page_id=239. Accessed July 6, 2012.

El Dorado Irrigation District (EID). 2001. El Dorado Hydroelectric Project, FERC No. 184

Request for FERC to Delay Processing Application and Conditions of El Dorado Project Collaborative. http://www.project184.org/doc_lib/documents/2001/1101/EID_letter_10-25_01.pdf. Accessed January 23, 2012.

El Dorado Irrigation District (EID). 2003. *El Dorado Relicensing Final Settlement Agreement.* http://www.project184.org/doc_lib/documents/2003/Final_Agreement/Final_Settlement.pdf. Accessed January 23, 2012.

El Dorado Irrigation District (EID). 2012a. FERC Project 184: About. http://www.project184.org/about/about.html. Accessed January 23, 2012.

El Dorado Irrigation District (EID). 2012b. FERC Project 184: Document Library- Relicensing Studies. http://www.project184.org/doc_lib/doc_lib.html. Accessed January 23, 2012.

Energy Commission. 2011. Hydroelectric Power in California. http://www.energy.ca.gov/hydroelectric/index.html. Accessed December 2011.

Environmental Assessment Office (EAO). 2009. *Upper Toba Valley Hydroelectric Project Assessment Report*. March 20, 2009. http://a100.gov.bc.ca/appsdata/epic/documents/p302/d29402/1239043500069_afd8d0ff6013d93592b154723050a6d3fefed17aa28b2f508a424456b26289c6.pdf. Accessed January 2012.

_____. 2006. *Upper Harrison Water Power Project Assessment Report and Screening Report.* http://a100.gov.bc.ca/appsdata/epic/documents/p251/1164048354779_b68c2372b04547abae7fe22123b103a1.pdf. Accessed December 2011.

_____.2006b. *Environmental Assessment Certificate E0605.* http://a100.gov.bc.ca/appsdata/epic/documents/p251/1158854959637_3f6a4a63985d417fb8f8945bc04e377e.pdf. Accessed December 2011.

Glen Davidson. 2011. Personal conversation between Glen Davidson, Comptroller of Water Rights, Ministry of Environment, British Columbia and Emily Capello, Aspen Environmental Group. December 7, 2011.

Federal Regulations. 2011. Title 18: Conservation of Power and Water Resources. § 4.41 Contents of application. http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=9b50aa1588db90dcf33d35e67de4b500&rgn=div5&view=text&node=18:1.0.1.2.9&idno=18#18:1.0.1.2.9.7.20.2. Accessed November 2011.

FERC (Federal Energy Regulatory Commission). 2010a. Small/Low-Impact Hydropower Projects. http://www.ferc.gov/industries/hydropower/gen-info/licensing/small-low-impact/get-started/exemp-licens.asp. Accessed November 2011.

FERC (Federal Energy Regulatory Commission). 2010b. Small/Low-Impact Hydropower Projects: File Preliminary Information. http://www.ferc.gov/industries/hydropower/gen-info/licensing/small-low-impact/prepare-application/process-overview/file-preliminary-info.asp. Accessed November 2011.

FERC (Federal Energy Regulatory Commission). 2010c. Small/Low-Impact Hydropower Projects: Consult Stakeholders. http://www.ferc.gov/industries/hydropower/gen-info/licensing/small-low-impact/prepare-application/process-overview/consult-stakeholders.asp. Accessed November 2011.

FERC (Federal Energy Regulatory Commission). 2010d. Small/Low-Impact Hydropower Projects: Prepare Application. http://www.ferc.gov/industries/hydropower/gen-info/licensing/small-low-impact/prepare-application/process-overview/application-preparation.asp. Accessed November 2011.

FERC (Federal Energy Regulatory Commission). 2008. *Preparing Environmental Documents: Guidelines for Applicants, Contractors, and Staff*. Federal Energy Regulatory Commission, Office of Energy Projects, Division of Hydropower Licensing. September 2008.

Federal Energy Regulatory Commission. 2008. *Environmental Assessment for Minor-Part Hydropower License: DeSabla-Centerville Hydroelectric Project, FERC Project No. 803-087*.

FERC (Federal Energy Regulatory Commission). 2006. *Order Issuing New License.* October 18. http://www.project184.org/doc_lib/documents/2007/OrderIssuingLicense.pdf. Accessed February 2012.

FERC (Federal Energy Regulatory Commission). 2003. *Final Environmental Impact Statement For Hydropower License: El Dorado Project No. 184-065*. July.

Fisheries and Oceans Canada (DFO). 2009. Proposal is likely to result in significant impacts to fish and fish habitat. Request relocation or redesign. http://a100.gov.bc.ca/appsdata/epic/documents/p302/d29258/1237924657711_fffaa875616f20deba31778be90c3b9cf7216634b0dc43c73e830ac8d967bbc5.pdf. Accessed January 2012.

Floch. 2002. Anticipated Schedule- Relicensing Studies. http://www.project184.org/doc_lib/documents/2002/0509/CPM%2020020509.pdf. Accessed January 23, 2012.

Fraser Valley Whitewater. 2012. BC Creeks Need Your Help! http://fraservalleywhitewater.com/creeks/bc-creeks-need-your-help/. Accessed January 16, 2012.

Hatfield, T., Lewis, A., Ohlson, D., and M. Bradford. 2003. Development of instream flow thresholds as guidelines for reviewing proposed water uses. Prepared for the BC Ministry of Sustainable Resource Management, and the BC Ministry of Water, Land and Air Protection. http://www.elp.gov.bc.ca/wld/documents/bmp/phase2_instreamflow_thresholds_guidelines.pdf

Henschel, C. and T. Gray. 2007. Forest Carbon Sequestration and Avoided Emissions. Background paper for the Canadian Boreal Initiative/Ivey Foundation Forests and Climate Change Forum- October 15th to 17th, 2007, Kananaskis, Alberta. http://www.forestsandclimate.org/background.pdf. Accessed January 16, 2012.

Independent Power Producers Association of British Columba (IPPBC). 2008. Fact Sheet: Run-of-River. http://www.bcenergyblog.com/uploads/file/IPPBC_Fact_Sheet_runofriver.pdf.

International Rivers. 2012. Dams and Water Quality. http://www.internationalrivers.org/node/1638. Accessed January 12, 2012.

Knight Piesold Ltd. 2008. Upper Toba Valley Hydroelectric Project: Application for an Environmental Assessment Certificate. MEM (Ministry of Energy and Mines). 2011. Independent Power Projects kml. November.

Ministry of Energy and Mines. 2012. Comment letter provided on Docket #11-RPS-01, Elegibility of British Columbia Run-of-River Projects under California's Renewable Portfolio Standard. Dated March 16.

MOE COS *et al.* (Ministry of Environment – Conservation Officer Service, *et al*). 2007-2009. E-mails released at a FOI to Wilderness Committee. http://wildernesscommittee.org/sites/all/files/Upper_Harrison_FOI_CTV_Gwen1.pdf. Accessed January, 2012.

MOE WSD (Ministry of Environment Water Stewardship Division). 2008. Report for Water License Application File 2001939 (Upper Bear). November.

Natural Resources Canada. 2012. Spatial Framework: National Reporting Zones. http://cfs.nrcan.gc.ca/pages/100. Accessed January 16, 2012.

Powerhouse Energy Corp. 1999. Cascade Heritage Power Park: Project Approval Certificate Application.

PPW (Private Power Watch). 2010. Water Licences. http://www.ippwatch.info/w/. Accessed February, 2010.

Pynn, Larry. Ecologo plans to get tougher on run-of-river projects. May 27, 2012. http://www.vancouversun.com/technology/EcoLogo+plans+tougher+river+projects/6636104/story.html Accessed June 6, 2012.

Run of River Power Inc. (ROR Power). 2011. Management Discussion and Analysis: Quarter Ended March 31, 2011. http://www.runofriverpower.com/media/financials/ROR%20Q1%202011%20MDA%20FINAL.pdf. Accessed January 16, 2012.

Sound Energy Inc. and Box Canyon Hydro Corp. 2011. *Waterpower Project Development Plan: Box Canyon Hydroelectric Project*. http://www.scrd.ca/files/File/Community/Planning/RR_Box%20Canyon%20Revised%20WPDP%202011%20Final.pdf.

Sovacool, Benjamin K. *Valuing the greenhouse gas emissions from nuclear power: A critical survey*. http://www.nirs.org/climate/background/sovacool_nuclear_ghg.pdf. Accessed February 2012.

U.S. Environmental Protection Agency (EPA). 2007. Hydroelectricity. http://www.epa.gov/cleanenergy/energy-and-you/affect/hydro.html. Accessed December 20, 2011.

Vancouver Sun. 2010. "Run-of-river projects rile whitewater kayakers." December 10, 2010. http://www.canada.com/vancouversun/news/westcoastnews/story.html?id=ec97c82e-016f-44a4-85f4-d22b2b08bb53. Accessed January 16, 2012.

Watershed Watch Salmon Society. 2012a. What is "run-of-river" hydropower? http://www.watershed-watch.org/issues/hydropower/bcs-liquid-gold-rush/river-diversion/. Accessed January 12, 2012.

Watershed Watch Salmon Society. 2012b Tamed Rivers: Hydropower in British Columbia – a guide to impacts and opportunities. October 2012. http://www.watershed-watch.org/wordpress/wp-content/uploads/2012/10/TamedRivers-Web.pdf. Accessed October 2012.

WWSS (Watershed Watch Salmon Society). 2007a. Run-of-River Hydropower in BC: A Citizen's Guide to Understanding Approvals, Impacts and Sustainability of Independent Power Projects. http://www.watershed-watch.org/publications/files/RoR-CitizensGuide.pdf. Accessed January 2012.

WWSS (Watershed Watch Salmon Society). 2007b. *"Green" Hydro Power: Understanding Impacts, Approvals, and Sustainability of Run-of-River Independent Power Projects in British Columbia*. http://www.watershed-watch.org/resources/green-hydro-power-understanding-impacts-approvals-and-sustainability-of-run-of-river-independent-power-projects-in-british-columbia/. Accessed November 2011.