Brookfield

Brookfield Renewable Energy Group
Brookfield White Pine Hydro LLC
150 Main Street
Lewiston ME 04240

Tel 207.755.5600
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www.brookfieldrenewable.com

December 30, 2015
VIA E-FILING

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N. E.
Washington, DC 20426

Ellsworth Hydroelectric Project FERC No. 2727-086
Application for New License for Major Water Power Project – Existing Dam

Dear Secretary Bose:

In accordance with 18 CFR § 5.18, the Licensee for the Ellsworth Hydroelectric Project, Black Bear Hydro Partners LLC (Black Bear or Licensee), respectfully submits for filing the *Application for New License for Major Water Power Project –Existing Dam for the Ellsworth Hydroelectric Project* (Application). The Application contains the information and Exhibits required by the pertinent Federal Energy Regulatory Commission (FERC) regulations and, with particular emphasis on the results from the Integrated Licensing Process (ILP), reflects the Licensee's strong commitment to maintain the developmental values of the Project, in particular the benefits provided to electric generation, while preserving and enhancing the non-developmental resources associated with the Project and its immediate surroundings for the foreseeable future. Notification via email that the application has been filed and a link to download associated electronic files through FERC's elibrary are being provided to entities listed on the attached Service List.

Black Bear filed a Notice of Intent (NOI) and Pre-Application Document (PAD) for the relicensing of the Project on October 24, 2012 pursuant to the Commission's ILP rules, 18 CFR Part 5. A Proposed Study Plan (PSP) was filed with FERC on April 8, 2013. A Revised Study Plan (RSP) was filed with FERC on August 5, 2013 that contained modifications intended to address written comments provided by stakeholders. The Study Plan was approved with specific revisions by FERC in its Study Plan Determination (SPD) issued on September 4, 2013. An Initial Study Report (ISR) was filed with FERC on September 4, 2014. A Draft License Application (DLA) was filed on July 10, 2015. The Updated Study Report (USR) was filed with FERC on August 21, 2015. Stakeholder comments on the DLA were received by October 8, 2015. The responses to comments filed regarding the DLA are included in the Application.

The Ellsworth Project is located on the Union River, in Hancock County, Maine. The four turbine-generator units contained in the Ellsworth powerhouse have a total FERC-authorized nameplate capacity of 8.9 megawatt (MW). By definition, under FERC's regulations the project is an existing dam that has a total installed capacity of more than 5 megawatts (18 CFR § 4.50). Accordingly, the accompanying application has been prepared in conformance with 18 CFR § 4.51. The contents of the Application include the following:

Initial Statement
Exhibit A – Project Description
Exhibit B – Project Operation and Resource Utilization
Exhibit C – Construction History and Proposed Construction Schedule
Exhibit D – Statement of Costs and Financing
Exhibit E – Environmental Report and Appendices
Exhibit F – General Design Drawings and Supporting Design Report
Exhibit G – Project Map
Exhibit H – Description of Project Management and Need for Project Power

As part of the National Historic Preservation Act Section 106 consultation process and in accordance with 18 CFR § 4.32(b)(3)(ii), Black Bear is filing with the Commission under separate cover, the report *Phase II Archaeological Investigations of Precontact Period Sites: 58.29, 58.30 and 58.31 Leonard Lake - Ellsworth, Hancock County, Maine*, and a Draft Historic Properties Management Plan, which contain privileged cultural resources information and are only being provided to the Maine Historic Preservation Commission, representatives of the area Native American Tribes, and FERC.

In accordance with the Commission's Order No. 630 (68 FR 9857), Exhibit F, including the Supporting Design Report, contains Critical Energy Information (CEII) and is being submitted under separate cover for the Commission's non-public file. Exhibit F contains sensitive and detailed engineering information that, if used incorrectly, may compromise the safety of the Project and those responsible for its proper operation. Members of the public requesting CEII information for the Ellsworth Project must comply with the Commission's procedures for obtaining access to CEII as required under CFR § 388.113. All public requests for CEII should be made to the Commission's CEII Coordinator.

Also it should be noted that the Commission, over the course of reviewing and commenting on the study plans, ISR, USR, and DLA, and in its Determination on Requested Study Modifications (December 8, 2015) has either authorized, or required the continuance of, several studies into 2016. These studies include:

- Atlantic Salmon Smolt Downstream Passage Study, to be conducted in the spring of 2016;
- Graham Lake, Lake Leonard, and Union River Tributary Access Study, to be conducted in the summer/fall of 2016;
- Adult American Eel Downstream Passage Study (year two), to be conducted in the fall of 2016.

The Study Reports for the above studies are to be submitted to FERC by December 31, 2016.

If you have any questions regarding this filing, please contact me by phone at (207) 755-5603 or by email at Frank.Dunlap@BrookfieldRenewable.com.

Sincerely,

Frank H. Dunlap
Licensing Specialist

Attachment: Application for New License for the Ellsworth Hydroelectric Project No. 2727

cc: Distribution List
K. Maloney, Brookfield Renewable Energy Group
T. Wynn, Brookfield Renewable Energy Group

CERTIFICATE OF SERVICE
Ellsworth Hydroelectric Project (FERC No. 2727)
Final License Application

I, Frank H. Dunlap, Licensing Specialist, Brookfield Renewable Energy Group, hereby certify that a link to the foregoing document on the Commission website has been transmitted to the following parties on December 30, 2015.

Frank H. Dunlap

One copy, via e-filing to:
Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street N.E., Dockets Room
Washington DC 20426

Via email, or one copy on compact disk,
Regular mail, postage paid to:

Federal Agencies

John T. Eddins
Advisory Council on Historic Preservation
The Old Post Office
1100 Pennsylvania Ave NW Ste 809
Washington, DC 20004-2501

Gerald Cross
Regional Engineer
Federal Energy Regulatory Commission
New York Regional Office
19 W. 34th St., Room 400
New York, NY 10001-3006

Sean McDermott
National Oceanic & Atmospheric Administration
New England Regional Office
55 Great Republic Drive
Gloucester, MA 01930

Jeffery Murphy
Fisheries Biologist
National Oceanic & Atmospheric Administration
Maine Field Office
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Orono, ME 04473

Donald A. Dow III, PE
Hydro/Fish Passage Engineer
National Oceanic and Atmospheric Administration
Maine Field Station
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Director
Bureau of Indian Affairs
U.S. Dept. of the Interior Headquarters
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Washington, DC 20240

Harold Peterson
Bureau of Indian Affairs
Eastern Regional Office
545 Marriott Drive, Suite 700
Nashville, TN 37214

Greg Stewart
Data Section Chief
United States Geological Survey
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Augusta, ME 04333

Nicholas Palso
Federal Energy Regulatory Commission
888 First Street, NE
Room 62-30
Washington, DC 20426

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Manchester, ME 04351

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Director
Water Quality Control Branch (WQB)
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Maine Hydro Licensing Coordinator
U.S. Fish and Wildlife Service
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Fish Passage Engineering
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Region 5, Fisheries
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Hadley, MA 01035

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NER Hydro Program Coordinator
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15 State Street, 10th Floor
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Ecological Services
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Hadley, MA 01035

State Agencies

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Maine Historic Preservation Commission
65 State House Station
55 Capitol Street
Augusta, ME 04333

Robin Reed
Maine Historic Preservation Commission
65 State House Station
55 Capitol Street
Augusta, ME 04333

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– Region C
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Jonesboro, ME 04648

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Augusta, ME 04333-0021

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Hydro Coordinator
Maine Dept. of Environmental Protection
17 State House Station
Ray Building – AMHI Complex
Augusta, ME 04330-0017

Kathleen Leyden
Director
Maine Coastal Program
Bureau of Geology
Maine Dept. of Agriculture, Conservation and Forestry
93 State House Station
Augusta, ME 04333-0093

Gail Wippelhauser
Maine Department of Marine Resources
21 State House Station
Augusta, ME 04333

Randy Spencer
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Maine Dept. of Inland Fisheries & Wildlife
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State House Station 41
Augusta, ME 04333

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Senior Planner
Division of Parks and Public Lands
Maine Dept. of Agriculture, Conservation and Forestry
18 Elkins Lane, Harlow Building
22 State House Station
Augusta, ME 04333-0022

Nicholas Livesay
Executive Director
Maine Land Use Planning Commission
Maine Dept. of Agriculture, Conservation and Forestry
22 State House Station
Augusta, ME 04333-0022

Tribes

Chief
Penobscot Indian Nation
12 Wabanaki Way
Indian Island, ME 04468

Chris Sockalexis
THPO
Cultural and Historic Preservation Program
Natural Resources Department
Penobscot Indian Nation
12 Wabanaki Drive
Indian Island, ME 04468

Chief
Aroostook Band of Micmacs
8 Northern Road
Presque Isle, ME 04769

Chief
Houlton Band of Maliseet Indians
88 Bell Road
Littleton, ME 04730

Tribal Governor
Passamaquoddy Tribe
Pleasant Point Reservation
P.O. Box 343
Route 190
Perry, ME 04667

Donald Soctomah
Tribal Historic Preservation Officer
Passamaquoddy Tribe
Indian Township Reservation
P.O. Box 343
Route 190
Perry, ME 04667

Non-Governmental Agencies

Ken Cline
Union River Watershed Coalition
105 Eden Street
Bar Harbor, ME 04609

Barb Witham
Union Salmon Association
61 Birch Lawn Drive
Lamoine, ME 04605

Atlantic Salmon Federation
Atlantic Office
P.O. Box 807
Calais, ME 04619-0807

Gary Arsenault
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Bangor, ME 04401

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P.O. Box 201
Columbia Falls, ME 04623

George Leinbaugh
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P.O. Box 201
Columbia Falls, ME 04263

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P.O. Box 201
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Stonington, ME 04681

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P.O. Box 27
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Aaron Dority
Downeast Groundfish Initiative Director
Penobscot East Resource Center
13 Atlantic Avenue
PO Box 27
Stonington, ME 04681

Local Governments

Penny Weinstein
Administrative Assistant
City of Ellsworth
1 City Hall Plaza
Ellsworth, ME 04605

Town Clerk
Town of Mariaville
1686 Mariaville Road
Mariaville, ME 04605

Town Clerk
Town of Waltham
1520 Waltham Road
Waltham, ME 04605

Individuals

Doug Watts
131 Cony Street
Augusta, ME 04330

Mark Whiting
145 Gary Moore Road
Ellsworth, ME 04605

Joseph Minutolo
77 Whitmore Road
Mariaville, ME 04605

Licensee

Frank Dunlap
Brookfield Renewable Energy Group
Black Bear Hydro Partners LLC
150 Main Street
Lewiston, ME 04240

Kelly Maloney
Brookfield Renewable Energy Group
Black Bear Hydro Partners LLC
150 Main Street
Lewiston, ME 04240

Dave Dominie
TRC
14 Gabriel Drive
Augusta, ME 04330

Black Bear Hydro Partners LLC

Before the
Federal Energy Regulatory Commission

Application for New License
for Major Water Power Project – Existing Dam

Ellsworth Hydroelectric Project
(FERC No. 2727)

Initial Statement and Exhibits A, B, C, D, E, F, G, and H

Submitted by:

Black Bear Hydro Partners LLC
150 Main Street
Lewiston, ME 04240

December 2015

Brookfield

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

CONTENTS

This Application for New License for the Ellsworth Hydroelectric Project (FERC No. 2727) consists of the following exhibits:

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INITIAL STATEMENT

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BEFORE THE
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Black Bear Hydro Partners, LLC	**)**	**Project No. 2727**
	)	**Ellsworth Hydroelectric Project**
	)	

APPLICATION FOR NEW LICENSE FOR MAJOR WATER POWER PROJECT – EXISTING DAM

INITIAL STATEMENT

1. Black Bear Hydro Partners, LLC (hereinafter "Applicant", "Licensee" or "Black Bear") applies to the Federal Energy Regulatory Commission (hereinafter FERC) for a New License for the Ellsworth Hydroelectric Project (FERC No. 2727) (Project), an existing licensed major project, as described in the attached exhibits. The current license for the Ellsworth Project was issued by order dated December 28, 1987. The license was for a period effective January 1, 1988 and has a termination date of December 31, 2017. The Applicant is the only entity that has or intends to obtain and will maintain any proprietary right or interest to construct, operate, or maintain the Project.

2. The location of the Project is:

State or territory:	Maine
County:	Hancock County
Townships or nearby towns:	Ellsworth, Waltham, Mariaville, Fletchers Landing Township
Stream or other body of water:	Union River

3. The exact name, business address, and telephone number of the Applicant are:

Black Bear Hydro Partners, LLC
150 Main Street
Lewiston, Maine 04347
ATTN: C. Todd Wynn, Vice President
Telephone: (857) 755-5622

The exact name and address of each person authorized to act as agent for the Applicant in this application are:

Kelly Maloney, Manager of Licensing and Compliance
Brookfield Renewable Energy Group
150 Main Street
Lewiston, Maine 04240
Telephone: (207) 755-5606

The Applicant requests that copies of all correspondence pertaining to this application be provided to:

Frank Dunlap
Brookfield Renewable Energy Group
150 Main Street
Lewiston, Maine 04240
E-mail: Frank.Dunlap@BrookfieldRenewable.com
Telephone: (207) 775-5603

It is requested that copies of all correspondence pertaining to this application also be provided to:

David Dominie
TRC Companies, Inc.
14 Gabriel Drive
Augusta, Maine 04330
E-mail: ddominie@trcsolutions.com
Telephone: (207) 620-3835

4. The Applicant is:

   Black Bear Hydro Partners, LLC, a Delaware limited liability company, is Licensee for the water power project designated as Project No. 2727 in the records of the Federal Energy Regulatory Commission[1]. The Licensee is not claiming preference under section 7(a) of the Federal Power Act. See 16 U.S.C. 796.

5. (i) The statutory or regulatory requirements of the State of Maine, in which the project is located, which would, assuming jurisdiction and applicability, affect the project as proposed with respect to bed and banks and the appropriation, diversion, and use of water for power purposes, and with respect to the right to engage in the business of developing,

[1] Black Bear Hydro Partners LLC, a Delaware limited liability company, is a member of Brookfield Renewable Energy Group.

transmitting, and distributing power and in any other business necessary to accomplish the purposes of the license under the Federal Power Act are:

(1) Maine Waterway Development and Conservation Act, 38 M.R.S.A. §§ 630 *et. seq*.

(2) Mill and Dam Act, M.R.S.A. Title 38 § 651 et. seq.

(ii) The steps which the Applicant has taken or plans to take, to comply with each of the laws cited above are:

(1) The Maine Waterway Development and Conservation Act (MWDCA), enacted in 1983, regulates certain construction or reconstruction of hydropower projects which change water levels or flows above or below a dam. The Applicant is not proposing as part of the relicensing any construction or changes in water levels that would require approval under the MWDCA.

(2) The Mill Act, essentially enacted in 1821, allows riparian owners to maintain dams and raise water. The statute does not require any permits and has been interpreted by the Maine Supreme Judicial Court to apply to hydroelectric generating plants. See Veazie v. Dwinel, 50 Me. 479 (1862). Maine case law has also held that owners of the riverbed have the right to the natural flow of a stream as it passes through their land, Wilson & Son v. Harrisburg, 107 Me. 207 (1910). Licensee either owns or has an easement or flowage rights to all Project lands and waters.

6. The Ellsworth Hydroelectric Project is located on the lower reach of the Union River in the City of Ellsworth, and the towns of Waltham and Mariaville and Fletchers Landing Township in Hancock County, Maine. The Project consists of a lower dam with a small (90–acre) impoundment (Lake Leonard) and an upper dam with a large (10,000-acre) storage reservoir (Graham Lake). Integral to the lower dam, known as Ellsworth Dam is a powerhouse and appurtenant facilities. The powerhouse contains four (4) turbine-generator units with a total FERC-authorized capacity of 8.9 MW. A transmission line of approximately 320 feet conducts generator voltage to the Project's step-up transformers located in Emera Maine's adjacent substation (non-Project). See Exhibit A, Project Description and Exhibit F, General Design Drawings for a complete description of the Project.

7. No lands of the United States are affected by the Project.

8. This is an existing Project and no new generating facility construction is planned in association with this relicensing.

9. Black Bear Hydro Partners LLC owns, and, as Licensee for the project, will maintain any proprietary right necessary to construct, operate, and maintain the Project.

10. The names and mailing addresses of:

(i) *Every county in which any part of the project, and in which any Federal facility that is used or to be used by the project, is located;*

The Project is located entirely within Hancock County.

Hancock County Government
50 State Street, Suite 7
Ellsworth, Maine 04605

There are no Federal facilities used by the Project.

(ii) *Every city, town, or similar local political subdivision in which the project is located, and in which any Federal facility that is used by the project is located, or that is within 15 miles of the project dam and has a population of 5,000 or more people is:*

The Project is located in municipalities of Ellsworth, Mariaville, and Waltham:

Ellsworth City Hall
1 City Hall Plaza
Ellsworth, Maine 04605

Mariaville Town Office
1686 Mariaville Road
Mariaville, Maine 04605

Waltham Town Office
1520 Waltham Road
Waltham, Maine 04605

The Project impoundment is also partially located in the unorganized territory of Fletchers Landing Township, which falls under the jurisdiction of the Maine Land Use Planning Commission, which was created by the Maine Legislature in 1971 and is defined as an agency which serves "as the planning and zoning authority for areas of the state that do not have the capacity to administer land use controls (principally, townships and plantations) (LURC, 2012[2])."

Maine Land Use Planning Commission
22 State House Station
Augusta, Maine 04333

[2] Land Use Regulation Commission (LURC). 2012.

The Town of Bar Harbor, Maine is located within 15 miles of the Project and has a population greater than 5,000 residents

Bar Harbor Town Office
93 Cottage Street
Suite 1
Bar Harbor, Maine 04609

(iii) *Every irrigation district, drainage district or similar special purpose political subdivision in which any part of the project is located, and in which any Federal facility that is used by the project is located, or that owns, operates, maintains or uses any project facility:*

There are no irrigation, drainage or special purpose political subdivisions associated with the Project.

(iv) *Every other political subdivision in the general area of the project that there is some reason to believe would be likely to be interested in, or affected by, the notification:*

There are no other political districts or subdivisions that are likely to be interested in or affected by the notification.

(v) *All Indian tribes that may be affected by the project:*

There are no Native American tribes affected by the Project. The following Native American tribes may have some level of interest in the region surrounding the Project and have been included in the distribution list for the Project; Aroostook Band of Micmacs, Passamaquoddy Tribe, Houlton Band of Maliseet Indians, Penobscot Indian Nation.

Chief
Penobscot Indian Nation
12 Wabanaki Way
Indian Island, ME 04468
(207) 817-7350

Chris Sockalexis
THPO
Cultural and Historic Preservation Program
Natural Resources Department
Penobscot Indian Nation
12 Wabanaki Drive
Indian Island, ME 04468
(207) 827-7471

Chief
Aroostook Band of Micmacs
8 Northern Road
Presque Isle, ME 04769
(207)764-1972

Tribal Governor
Passamaquoddy Tribe
Pleasant Point Reservation
P.O. Box 343
Route 190
Perry, ME 04667
(207) 853-2600

Donald Soctomah
Tribal Historic Preservation Officer
Passamaquoddy Tribe
Indian Township Reservation
P.O. Box 343
Route 190
Perry, ME 04667
(207) 796-2301

Chief
Houlton Band of Maliseet Indians
88 Bell Road
Littleton, ME 04730
(207) 532-4273 ext. 218

11. The Applicant has in accordance with 18 CFR Section 5.18 (a)(3)(i) made a good faith effort to notify, by certified mail, the following entities of the filing of this application:

(i) *Every property owner of record of any interest in the property within the bounds of the project; and*

(ii) *The entities identified in paragraph (10) above, as well as other Federal, state, municipal or other local government agencies that would likely be interested in or affected by the application.*

A Certificate of Service is attached to the transmittal letter for this Application for New License.

12. In accordance with 18 CFR Sections 4.51 and 16.10 of the Commission's regulations, the following Exhibits are attached to and made a part of this application:

Exhibit A – Project Description

Exhibit B – Project Operation and Resource Utilization

Exhibit C – Construction History and Proposed Construction Schedule

Exhibit D – Statement of Costs and Financing

Exhibit E – Environmental Report

Exhibit F – General Design Drawings and Supporting Design Report
(CEII; filed under separate cover)

Exhibit G – Project Maps

Exhibit H – Description of Project Management and Need for Project Power

SUBSCRIPTION

This Application for New License for the Ellsworth Hydroelectric Project, FERC No. 2727 is executed in the State of Maine, County of Androscoggin, by C. Todd Wynn, Vice President, Black Bear Hydro Partners, LLC, 150 Main Street, Lewiston, Maine 04240, who, being duly sworn, deposes and says that the contents of this application are true to the best of his knowledge or belief and that he is authorized to execute this application on behalf of Black Bear Hydro Partners LLC. The undersigned has signed this application this 30th day of December, 2015.

BLACK BEAR HYDRO PARTNERS LLC

By ______________________
C. Todd Wynn
Vice President
Black Bear Hydro Partners LLC

VERIFICATION

Subscribed and sworn to before me, a Notary Public of the State of Maine this 30th day of December, 2015.

____
(Notary Public)

(My Commission Expires Dec 21, 2019)/seal

TONYA ROBERT
Notary Public-Maine
My Commission Expires
December 21, 2019

EXHIBIT A

PROJECT DESCRIPTION

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT A

PROJECT DESCRIPTION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PHOTOS

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT A
PROJECT DESCRIPTION

1.0 INTRODUCTION

The Ellsworth Hydroelectric Project (Project) is owned and operated by Black Bear Hydro Partners, LLC (Black Bear) and is located on the lower reach of the Union River in the City of Ellsworth, the Towns of Waltham and Mariaville, and the Township of Fletchers Landing, an unincorporated township, in Hancock County, Maine. The Project consists of two developments, the Ellsworth Development and the Graham Lake Development.

The Ellsworth Development consists of the Ellsworth Dam, which forms the 90-acre Lake Leonard, and the associated generating facilities. The Ellsworth Dam forms the upper limit of tidal influence of the Union River. The Graham Lake Development consists of a dam with a large storage reservoir (Graham Lake). There are no generating facilities at the Graham Lake Development.

The Project is operated for water storage and power generation. Operationally, the Project is typically run as a peaking facility, with water being released from the Graham Lake reservoir and then used to generate electricity at the downstream Ellsworth powerhouse. Black Bear is not proposing any changes to operations.

2.0 PROJECT DESCRIPTION

The Ellsworth Project is located in Downeast Maine on the Union River, approximately 3 miles upstream of the Union River Bay, which flows into the Atlantic Ocean. The Project includes Graham Lake, Graham Lake Dam, a 3-mile stretch of the Union River, Lake Leonard, and Ellsworth Dam and powerhouse.

2.1 Project Facilities

Ellsworth Development

Construction of the Ellsworth Dam was completed in 1907. The Ellsworth Dam is an Ambursen-style dam that was filled in part with concrete in the early 1990s. The non-overflow section includes a gatehouse; turbine-generator Unit No. 1 is served by a 10-foot diameter vertical penstock contained in the gatehouse. The non-overflow section is connected to an intake structure containing three additional penstocks: two 8-foot diameter penstocks serving turbine-generator Units No. 2 and 3, and one 12-foot diameter penstock serving turbine-generator Unit No. 4. The four units contained in the Ellsworth powerhouse have a total FERC-authorized nameplate capacity of 8.9 megawatts (MW) and an average annual generation of 30,511 megawatt hours (MWh).

Graham Lake Development

The Graham Lake Dam was completed in 1924. Graham Lake Dam is a non-generating facility located about four miles upstream from the Ellsworth Dam. Graham Lake Dam consists of an earthen dike and concrete gate structure. There is a flood control structure immediately downstream of Graham Lake Dam. No powerhouse is associated with the Graham Lake Dam and reservoir. A summary of Project structures and features associated with the Ellsworth Project is provided in Table A-1.

Table A-1: Ellsworth Project Specifications

GENERAL INFORMATION
Owner and Operator: Black Bear Hydro Partners, LLC
FERC Project Number: 2727
Current License Term: January 1, 1998 to December 31, 2017
County: Hancock County
Nearest Town: Ellsworth, Maine
Watershed: Union River
River: Union River
Drainage Area: 547 square miles at the Ellsworth Dam

Ellsworth Development	**Graham Lake Development**
Normal Maximum Water Surface Elevation	
Lake Leonard	**Graham Lake**
66.7’[1] (includes 1.7 foot flashboards)	104.2’
Normal Tailwater Elevation	
Varies with tidal fluctuations	80.5’
Reservoir Length	
1 mile	10 miles
Shoreline Length	
4.4 miles	80 miles (not including islands)

[1] All elevations are relative to National Geodetic Vertical Datum 1929.

Surface Area at Maximum Water Surface	
Lake Leonard	**Graham Lake**
90 acres	Approximately 10,000 acres
Gross Storage Lake Leonard 0.107 billion cubic feet	Useable Storage Graham Lake – 5.4 billion cubic feet between elevations 104.2' and 93.4'
Structures	
Ellsworth Dam	**Graham Lake Dam**
Concrete buttress dam	Earth fill dam with concrete core walls
Total Length 377 feet	Total Length 750 feet
Penstock: 10-foot diameter vertical penstock serving Unit 1; two 8-foot diameter penstocks serving powerhouse Units No. 2 and 3, and a 12-foot diameter penstock serving Unit No. 4	N/A
Dam height 60 feet	Dam height 58 feet
Unit 2 – 4 Powerhouse: reinforced concrete and concrete block masonry structure 52.5 feet x 68 feet with an attached 15 feet x 30 feet switch house annex Unit 1 Powerhouse: approximately 26 feet by 28 feet integral to the concrete non-overflow section of the dam.	N/A
Turbine Rated Capacity:* Unit 1 – 3,800 hp (2,850kW) (vertical shaft propeller) Unit 2 – 2,900 hp (2,175 kW) (Kaplan) Unit 3 – 2,900 hp (2,175 kW) (Kaplan) Unit 4 – 3,800 hp (2,850 kW) (vertical shaft propeller)	N/A
Generator Rated Capacity:** Unit 1 – 3,125 kVA @ power factor 0.8; 2,500 kW Unit 2 – 2,500 kVA @ power factor 0.8; 2,000 kW Unit 3 – 2,500 kVA @ power factor 0.8; 2,000 kW Unit 4 – 3,000 kVA @ power factor 0.8; 2,400 kW	N/A

*The total combined maximum hydraulic capacity of the turbines is estimated to be 2,460 cfs.
**The total FERC authorized nameplate capacity of the facility, based on the limiting unit components, is 8.9 MW.

Table A-2: Additional Ellsworth Project Specifications

Additional Facility Data (Note: Dimensions are estimated using best available information through scaling from Exhibit F drawings.)	
Respective Heights and Lengths of Project Structures	
Ellsworth Dam	
Right Retaining Wall (Abutment)	26 feet high
Intake	
Units 2 – 4 Intake Structure	32 feet high; 88 feet – 4 ¾ inches long
Units 2 – 4 Trashracks	1 inch clear spacing for first 14 feed of depth, then 2.37 inch clear spacing
Unit 2 Penstock	164 feet long; 8 foot diameter
Unit 3 Penstock	195 feet long; 8 foot diameter
Unit 4 Penstock	225 feet long; 12 foot diameter
Non-Overflow Wall (Between Units 2 through 4 Intake Section and Bulkhead Section)	71 feet high; 85 feet long
Unit 1 Trashracks	2.44 inch clear spacing
Intake (Unit 1) Penstock	74 feet long; 10 foot diameter
Bulkhead Section	62 feet – 9 inches high; 102 feet long
Spillway Section	57 feet high; 275 feet long
Graham Lake Dam	
Earthen Embankment and Concrete and Sheet Pile Core Wall	45 feet high; 550 feet long
Gated Spillway	58 feet high; 80 feet long
Concrete Gravity Flood Control Structure	58 feet high; 720 feet long
Stone-filled Sheet Pile Cell	55 feet high; 65 feet diameter
Southwest Wingwall (Between Cell and Gate Structure)	36 feet – 6 inches high; 71 feet long
Tainter Gates	22 feet – 6 inches high; 20 feet wide

2.1.1 Dams

Ellsworth Development

The Ellsworth Dam is a concrete structure with a maximum height of 60-feet (the majority of it being 57 feet high) and 377 feet long including a 275-foot spillway. The overflow spillway and non-overflow section are comprised of a reinforced concrete buttress dam with 22 bays. These were partially filled in 1993 to create a concrete gravity dam. The overflow spillway has a flashboard crest elevation of 66.7’. A fish passage facility consisting of a vertical slot fishway and trap is operated at the Ellsworth Dam providing for upstream fish passage and the commercial harvest of river herring by the City of Ellsworth under a cooperative management agreement with the Maine Department of Marine Resources.

Photo A-1: Ellsworth Dam Spillway and Powerhouse

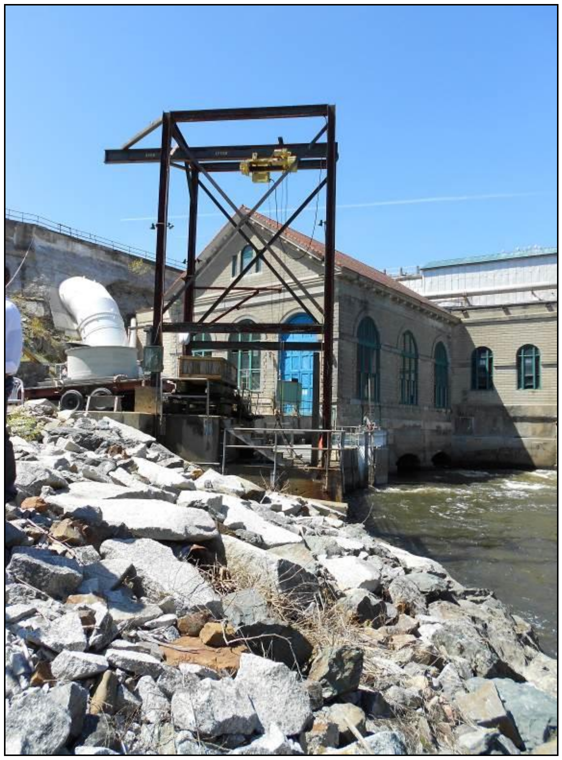

Photo A-2: Ellsworth Dam Powerhouse and Fish Lift

Photo A-3: Ellsworth Development - Lake Leonard

Graham Lake Development

The Graham Lake Dam is 58 feet high and consists of 670-foot-long earth dike and an 80-foot-long concrete gate structure plus abutments. The concrete gate structure contains three 20-foot-wide radial gates and an eight-foot wide sluice that is used for downstream fish passage. There is a concrete flood control structure associated with the Graham Lake Dam. The flood control structure consists of a concrete flood wall approximately 720 feet long, a 65-foot diameter steel cell (formerly part of the construction coffer dam) and a 71-foot-long wing wall extension that connects to the gate structure and serves as an emergency overflow spillway.

Photo A-4: Graham Lake Dam Gate Structure

Photo A-5: Graham Lake Dam Flood Control Structure

2.1.2 Impoundments

The Ellsworth Project has a drainage area of approximately 547 square miles at the Ellsworth Dam. The lake impounded by the Ellsworth Dam, Lake Leonard, has a surface area of 90 acres at its normal maximum elevation of 66.7’ and a length of one mile. Normal water levels in Lake Leonard vary between 65.7’ and 66.7’ over the course of the year. The upper reservoir, Graham Lake, has a normal maximum surface area of approximately 10,000 acres and a maximum length of approximately 10 miles. Annual water levels in Graham Lake are managed between elevations 93.4’ and 104.2’. Drawdown of Graham Lake in the summer/fall and more extensively at the beginning of the year provides significant downstream flood control benefits. The ability to store a large water volume when the lake is drawn down is a particularly valuable asset given the location of downtown Ellsworth just below the Ellsworth Dam. Drawdown of Graham Lake also can provide important flow augmentation during dry periods so that minimum flows can be maintained in the Union River below Graham Lake Dam.

2.1.3 Transmission

A transmission line of approximately 320 feet conducts generator voltage to the Project step-up transformers located in the adjacent non-Project substation owned by the local utility.

2.1.4 Appurtenant Equipment

The Project also has appurtenant facilities such as cranes, trash racks, and other equipment necessary for day-to-day operations and maintenance.

3.0 LANDS OF THE UNITED STATES

There are no federal lands within the Project boundary.

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EXHIBIT B

PROJECT OPERATION AND RESOURCE UTILIZATION

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT B
PROJECT OPERATION AND RESOURCE UTILIZATION

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT B
PROJECT OPERATION AND RESOURCE UTILIZATION

1.0 PROJECT OPERATION

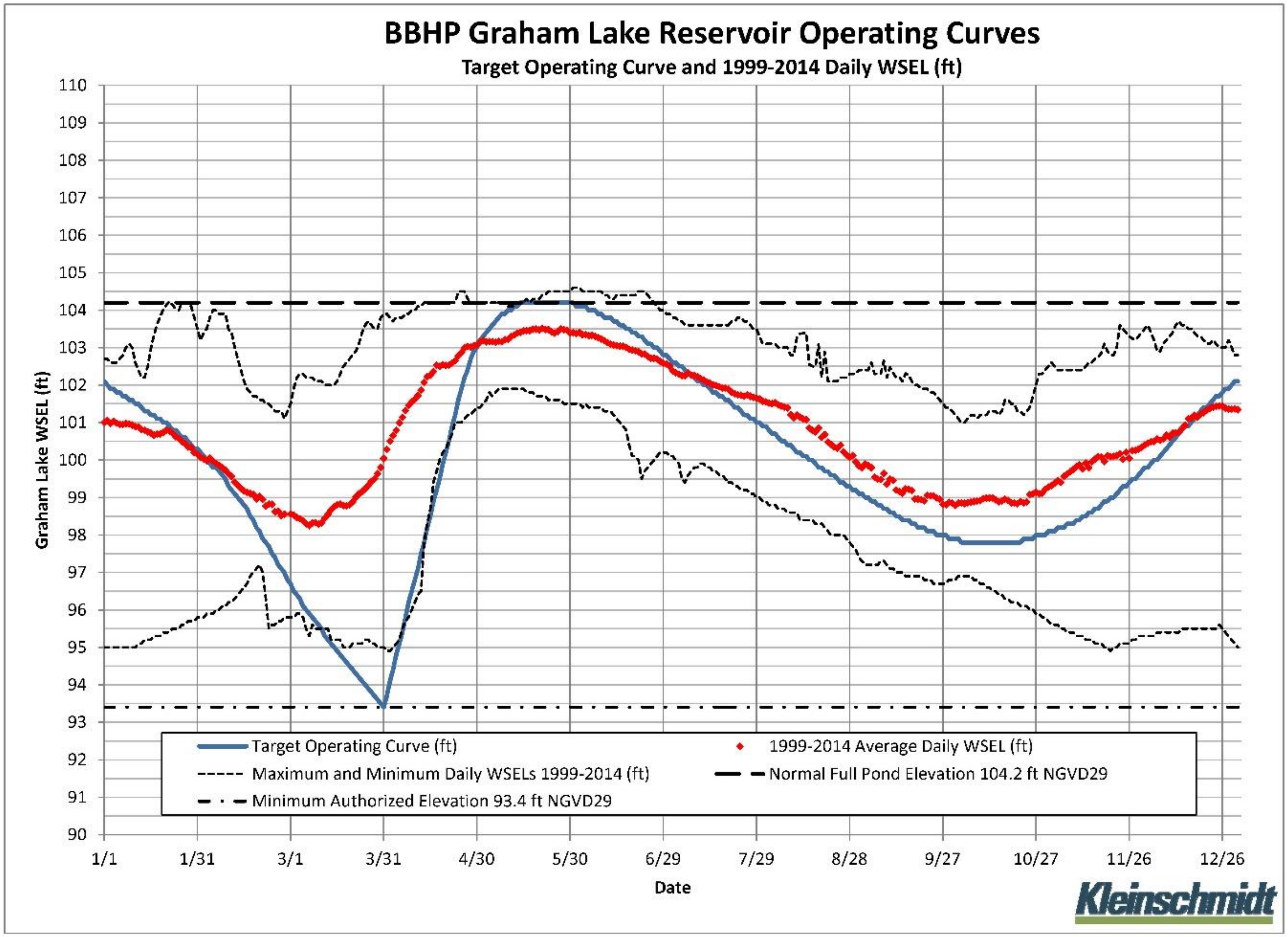
The Ellsworth Hydroelectric Project (Project or Ellsworth Project) consists of a lower dam with a small impoundment (Leonard Lake) and an upper dam with a large storage reservoir (Graham Lake) separated by a 3-mile stretch of the Union River. The FERC-authorized nameplate rated capacity of the Ellsworth Project is 8.9 MW. The Project generated an average of 30,511, MWh per year for the period 1994-2014. The rated dependable capacity for ISO-New England is 9.050 MW, based on the ISO-NE Winter Claimed Capacity as of December 7, 2015.

1.1 Existing Operating Mode

The Ellsworth Project operates both as a water storage facility and as a peaking generation facility, depending on available inflows and storage, while maintaining minimum flows. The Project is comprised of two developments: the Graham Lake Development and the Ellsworth Development. The Graham Lake Development consists of a dam (the development has no power generations facilities) and the approximately 10,000 acre storage reservoir, Graham Lake. The allowable annual operating range of Graham Lake is 10.8 feet, between the elevations of 104.2’ and 93.4’. The operation of Graham Lake generally follows the historic operating curves included as Figure B-1. The Ellsworth Development operates in a run-of-river mode automatically via pond level control. Timed releases at Graham Lake are used at Ellsworth Dam for power production and may result in minor (up to approximately 1 foot) surface elevation changes (65.7’ – 66.7’) in Lake Leonard.

The Union River has an average annual flow of 958 cubic feet per second (cfs). As part of the current license requirements the Licensee is required to release a continuous minimum flow of 105 cfs from the Graham Lake Development and the Ellsworth Development from July 1 through April 30 and 250 cfs from May 1 through June 30 (FERC 1987b). Black Bear is proposing no changes to the current minimum flow requirements. The ability to store and release water at Graham Lake allows the Ellsworth plant to operate in a peaking mode during periods of high electric demand.

Figure B-1: Graham Lake Historic Operating Curves



1.1.1 Normal Operations

The Ellsworth Project is operated automatically via a Programmable Logic Controller (PLC) system. This system monitors and controls project operations including headpond levels at each development. The Project is monitored by Black Bear on a 24-hour basis and is typically visited at least 3-5 times each week by a roving operator. Daily logs of elevation and flow data, as well as any outages are maintained for the Project.

1.1.2 Adverse and High Water Condition Operations

Low Flow

Under the current license the Ellsworth Project is required to release a continuous minimum flow of 105 cfs from July 1 through April 30 and 250 cfs from May 1 through June 30. The minimum flow requirements from the Project developments have been developed to maintain fish habitat, to facilitate fish migration, and to protect downstream water quality. Drawdown of Graham Lake provides important flow augmentation during dry inflow periods so that minimum flows can be maintained in the Union River below Graham Lake Dam. This capacity benefits both water quality and aquatic habitat and organisms in the river.

High Flow

The Ellsworth Project is normally operated as a peaking plant, with water being released from the Graham Lake reservoir and then used to generate electricity at the downstream Ellsworth powerhouse. During periods of high inflows, primarily in the spring and fall, the project may generate at full load up to 24 hours a day.

The ability to store large volumes of inflow in the spring is also valuable given the location of downtown Ellsworth just below the Ellsworth Dam. In a potential flood situation, Black Bear dam operators manage water levels along the Union River in order to minimize risk and flood damage.

1.1.3 Annual Plant Factor

The nameplate rated capacity of the Ellsworth Project is 8.9 MW. The Ellsworth Dam generates an average annual energy output of 30,511 MWh at a plant factor of 39 percent.

1.2 Proposed Operating Mode

The Licensee plans to continue the current licensed mode of operation and proposes that the following operating conditions with respect to minimum flows and impoundment levels be included as articles in the new license:

- Minimum Flows

Except as temporarily modified by (1) approved maintenance activities, (2) extreme hydrologic conditions, as defined below, (3) emergency electrical system conditions, as defined below, or (4) agreement between the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies, the Licensee shall release a continuous minimum flow of 105 cubic feet per second (cfs) from the Graham Lake development and the Ellsworth development from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30, for the protection of fishery resources.

- Impoundment Levels

Except as temporarily modified by (1) approved maintenance activities, (2) extreme hydrologic conditions, as defined below, (3) emergency electrical system conditions, as defined below, or (4) agreement between the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies, the Licensee shall operate the project so that water levels in Lake Leonard are maintained between the elevations of 65.7' and 66.7' (flashboard crest) during normal operation, and water levels in Graham Lake are maintained between 104.2' and 93.4'.

"Extreme Hydrologic Conditions" means the occurrence of events beyond the Licensee's control such as, but not limited to, abnormal precipitation, extreme runoff, flood conditions, ice conditions or other hydrologic conditions such that the operational restrictions and requirements contained herein are impossible to achieve or are inconsistent with the safe operation of the Project.

"Emergency Electrical System Conditions" means operating emergencies beyond the Licensee's control which require changes in flow regimes to eliminate such emergencies which may in some circumstances include, but are not limited to, equipment failure or other temporary abnormal operating conditions, generating unit operation or third-party mandated interruptions under power supply emergencies, and orders from local, state, or federal law enforcement or public safety authorities.

2.0 DEPENDABLE CAPACITY AND AVERAGE ANNUAL ENERGY PRODUCTION

The rated dependable capacity for ISO-New England is 9.050 MW, based on the ISO-NE Winter Claimed Capacity as of December 7, 2015.

The ISO- NE determines the monthly capacity values for the developments. The values are called "seasonal claim capacity" (SCC) and are divided in to the summer (June 1 through

September 30) and winter (October 1 through May 31) periods. The current claimed values are presented in Table B-1.

Table B-1: Seasonal Claimed Capacity Values at Ellsworth Dam

Summer SCC (MW)	Winter SCC (MW)
9.044	9.050

2.1 Summary of Project Generation Records

The Ellsworth Project generated an average annual energy output of 30,511 MWh for the period 1994-2014. Table B-2 shows historical monthly generation at the Project for the period January 1994 through December 2014.

Table B-2: Summary of Project Generation

ELLSWORTH PROJECT GENERATION 1994 - 2014 (MWh)													
YEAR	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	
1994	4,022	4,064	4,521	5,031	3,370	1,730	644	649	519	757	585	1,744	
1995	2,941	3,517	4,870	1,733	3,252	2,193	134	447	465	538	4,295	3,601	
1996	2,737	4,836	3,275	4,876	5,095	2,261	4,321	2,257	1,775	1,092	834	4,258	
1997	4,768	2,464	2,364	3,549	5,051	2,033	2,100	999	811	707	626	845	
1998	1,156	4,035	5,576	2,863	2,091	2,206	2,976	968	442	1,186	647	480	
1999	2,984	4,697	6,011	4,083	1,358	1,072	516	347	981	2,626	2,646	4,398	
2000	3,702	2,839	4,891	5,412	3,342	1,838	710	1,037	981	1,125	563	986	
2001	1,644	2,177	1,776	2,525	1,613	1,049	511	600	496	500	281	203	
2002	237	604	4,737	5,555	3,036	1,301	1,343	918	577	417	1,548	3,993	
2003	3,873	1,443	3,342	5,215	3,093	2,256	440	554	1,488	2,193	6,050	5,616	
2004	3,380	948	2,130	2,350	2,618	1,440	679	1,917	2,025	768	654	3,145	
2005	4,070	1,538	4,306	5,058	6,175	3,604	1,304	1,275	607	4,550	4,241	4,171	
2006	5,324	4,992	1,678	1,059	3,510	4,330	680	DNA	DNA	2,761	4,120	4,000	
2007	4,202	1,426	3,841	5,397	3,169	2,177	664	735	DNA	215	2,991	3,270	
2008	4,161	4,597	6,335	4,856	2,921	1,290	1,011	2,296	2,614	3,959	2,880	6,436	
2009	2,949	2,888	2,775	5,540	2,322	3,680	3,771	1,084	1,175	2,892	4,235	3,364	
2010	3,326	4,127	3,261	3,303	1,483	1,284	1,040	1,121	619	736	4,893	5,225	
2011	2,638	2,979	4,903	4,805	3,820	1,091	858	1,826	1,724	2,116	1,680	3,034	
2012	2,958	1,144	1,550	2,563	4,976	2,736	1,356	696	1,803	3,621	4,421	1,805	
2013	2,864	3,405	3,451	2,247	2,376	3,300	1,928	1,887	4,422	1,305	625	1,908	**Average Annual Generation**
2014	5,341	3,481	2,486	5,141	2,802	2,642	2,961	1,881	857	676	2,418	5,021	
Average	**3,299**	**2,962**	**3,718**	**3,960**	**3,213**	**2,167**	**1,426**	**1,175**	**1,283**	**1,654**	**2,440**	**3,214**	**30,511**

DNA – data not available

2.2 Flow Data

Flow statistics for the Project area were calculated from generation data for Ellsworth Dam collected at the facility, as there is no USGS Gage associated with the project area. Generation data is recorded in megawatts which is converted to flow using a 1 kW/3.62 cfs relationship for the project (i.e., 8900 kW with a hydraulic capacity of 2,460 cfs). Hourly plant generation records for the period 2001-2012 were reduced to daily flow values using a time weighted average analysis for each day. These data were trended into an annual flow duration curve for the project. In addition, the mean daily flow data from the Narraguagus River at Cherryfield (USGS Gage 01022500) were pro-rated to the site based on the ratio of the respective drainage areas (gage vs. site). The annual flow duration curve developed from the 2001-2012 trended plant generation records data aligns closely with the pro-rated annual curve for the Narraguagus River gage data. Because this comparison shows that the 2001-2012 trended Generation Log Data provides a reasonable approximation of flow at the site, these data were used to derive the monthly flow duration curves for the Project.

Table B-3 provides the monthly minimum, average and maximum out flows from Ellsworth Dam based upon the plant data. Annual and monthly outflow duration curves for the Project are presented in Appendix B-1.

Table B-3: Annual and Monthly Maximum, Average and Minimum Flow (cfs) for the Ellsworth Dam

Ellsworth Dam Monthly Minimum, Average, and Maximum Flows - 1994-2014 (cfs)												
	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Maximum	1984	2053	2353	2132	2294	1662	1605	853	1698	1690	2323	2391
Average	1226	1209	1377	1520	1194	832	530	416	446	615	937	1194
Minimum	88	248	576	407	504	403	50	129	170	80	108	76

Table B-4: Monthly Average River Flow

CALCULATED DAILY RIVER FLOW - 1994 - 2014 (cfs)													
YEAR	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Average (Year)**
1994	1494	1672	1680	1931	1252	664	239	241	199	281	225	648	**877**
1995	1093	1447	1809	665	1208	842	50	166	179	200	1649	1338	**887**
1996	1017	1921	1217	1872	1893	868	1605	838	681	406	320	1582	**1185**
1997	1771	1013	878	1363	1876	781	780	371	311	263	240	314	**830**
1998	430	1660	2072	1099	777	847	1105	359	170	441	248	178	**782**
1999	1109	1932	2233	1568	504	412	192	129	377	976	1016	1634	**1007**
2000	1376	1127	1817	2078	1242	706	264	385	377	418	216	366	**864**
2001	611	896	660	969	599	403	190	223	191	186	108	76	**426**
2002	88	248	1760	2132	1128	500	499	341	221	155	594	1483	**762**
2003	1439	594	1241	2002	1149	866	163	206	571	815	2323	2086	**1121**
2004	1256	376	791	902	973	553	252	712	777	285	251	1168	**691**
2005	1512	633	1510	1942	2294	1384	485	474	233	1690	1628	1550	**1278**
2006	1978	2053	623	407	1304	1662	253	DNA	DNA	1026	1582	1486	**1031**
2007	1561	587	1427	2072	1177	836	247	273	DNA	80	1148	1215	**885**
2008	1546	1826	2353	1864	1085	495	376	853	1003	1471	1106	2391	**1364**
2009	1096	1188	1031	2127	863	1417	1401	403	451	1074	1626	1250	**1161**
2010	1236	1697	1211	1268	551	493	386	416	238	273	1878	1941	**966**
2011	980	1226	1822	1845	1419	419	319	678	662	786	645	1127	**994**
2012	1099	454	576	984	1849	1050	504	259	692	1345	1697	671	**932**
2013	1064	1400	1282	863	883	1267	716	701	1698	485	240	709	**942**
2014	1984	1432	924	1973	1041	1014	1100	699	329	251	928	1865	**1128**
Average (month)	**1226**	**1209**	**1377**	**1520**	**1194**	**832**	**530**	**416**	**446**	**615**	**937**	**1194**	**958**

DNA – data not available
Installed generator capacity: 8.9 MW
Installed Hydraulic capacity: 2460 cfs
kW/cfs = 3.618

2.3 Project Storage

The usable storage capacity of Graham Lake is 5.4 billion cubic-feet.

2.4 Hydraulic Capacity of the Project

The Ellsworth turbine units have a combined estimated maximum hydraulic capacity of 2,460 cfs.

The Graham Lake Dam contains no generating equipment.

2.5 Tailwater Rating Curve

Tailwater rating curves for the Ellsworth Dam are provided in Appendix B-2.

2.6 Power Plant Capability versus Head

A capacity versus head curve for the Ellsworth plant is provided in Appendix B-3. The curve is based upon a total station capacity versus gross head curve developed in 1940 for Units 1-4 of the Ellsworth development. Several major maintenance projects have occurred since that time, including unit rebuilds, generator rewinds, and intake replacement/penstock extensions. The major maintenance projects may have influenced capacity versus gross head values, however it is likely that any difference would be nominal. The curve provided in Appendix B-3 is based upon best available information and is a reasonable representation of the Project capability.

3.0 UTILIZATION OF POWER PROJECT

The Licensee is an independent power producer and, as such, does not provide electric service to any particular group or class of customers, or prepare and submit load and capability forecasts or resource plans to any regulatory body.

The Project generates renewable power for Maine and the regional power pool administered by ISO New England. Currently, output is sold on the open market through bidding into the New England Power Pool (NEPOOL) market administered by ISO New England, the non-profit independent system operator for New England. ISO New England administers all significant aspects of the NEPOOL power market.

4.0 PLANS FOR FUTURE DEVELOPMENT

Black Bear has not proposed any new generating development as part of the application for a new license.

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APPENDIX B-1

ANNUAL and MONTHLY FLOW DURATION CURVES

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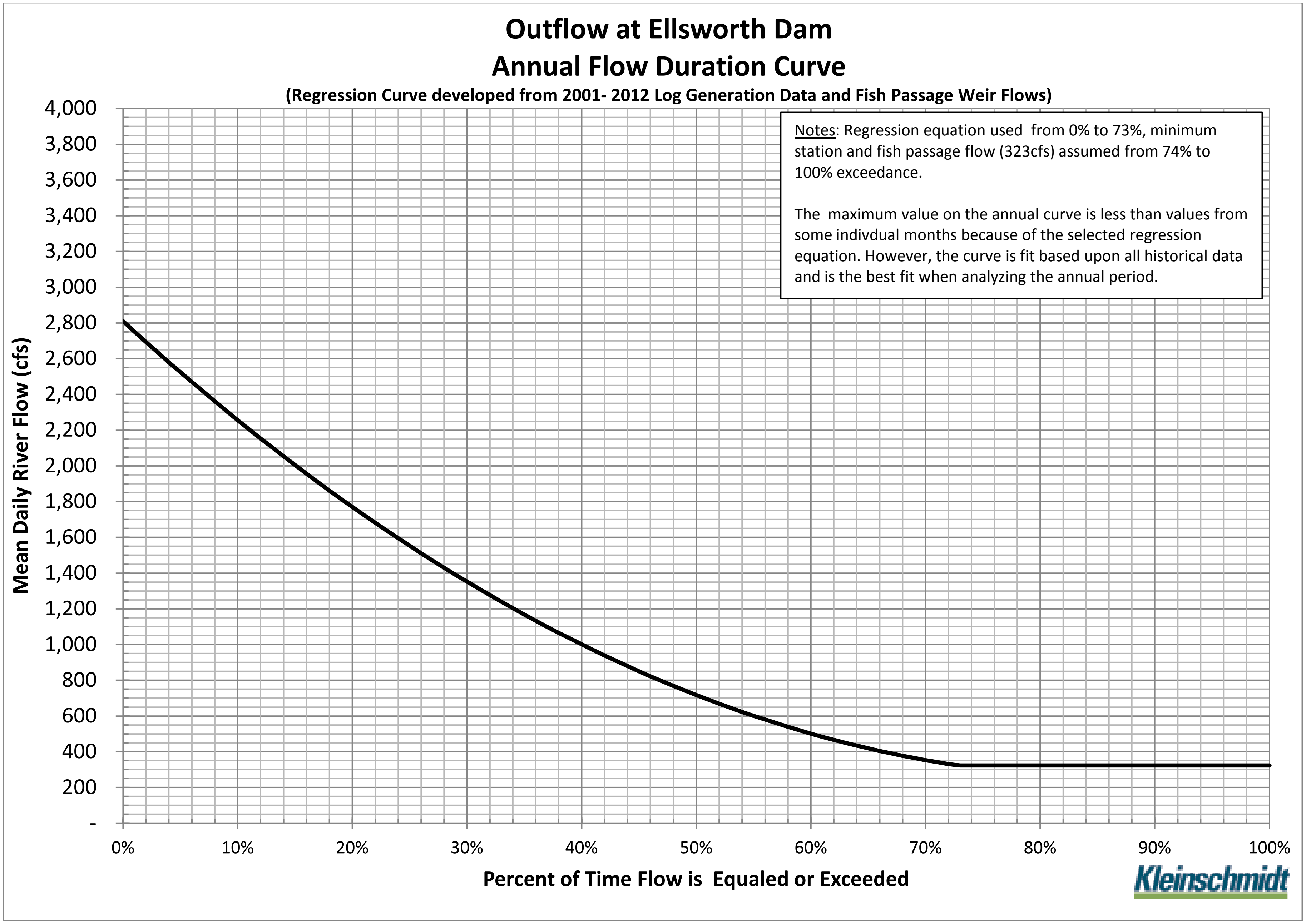
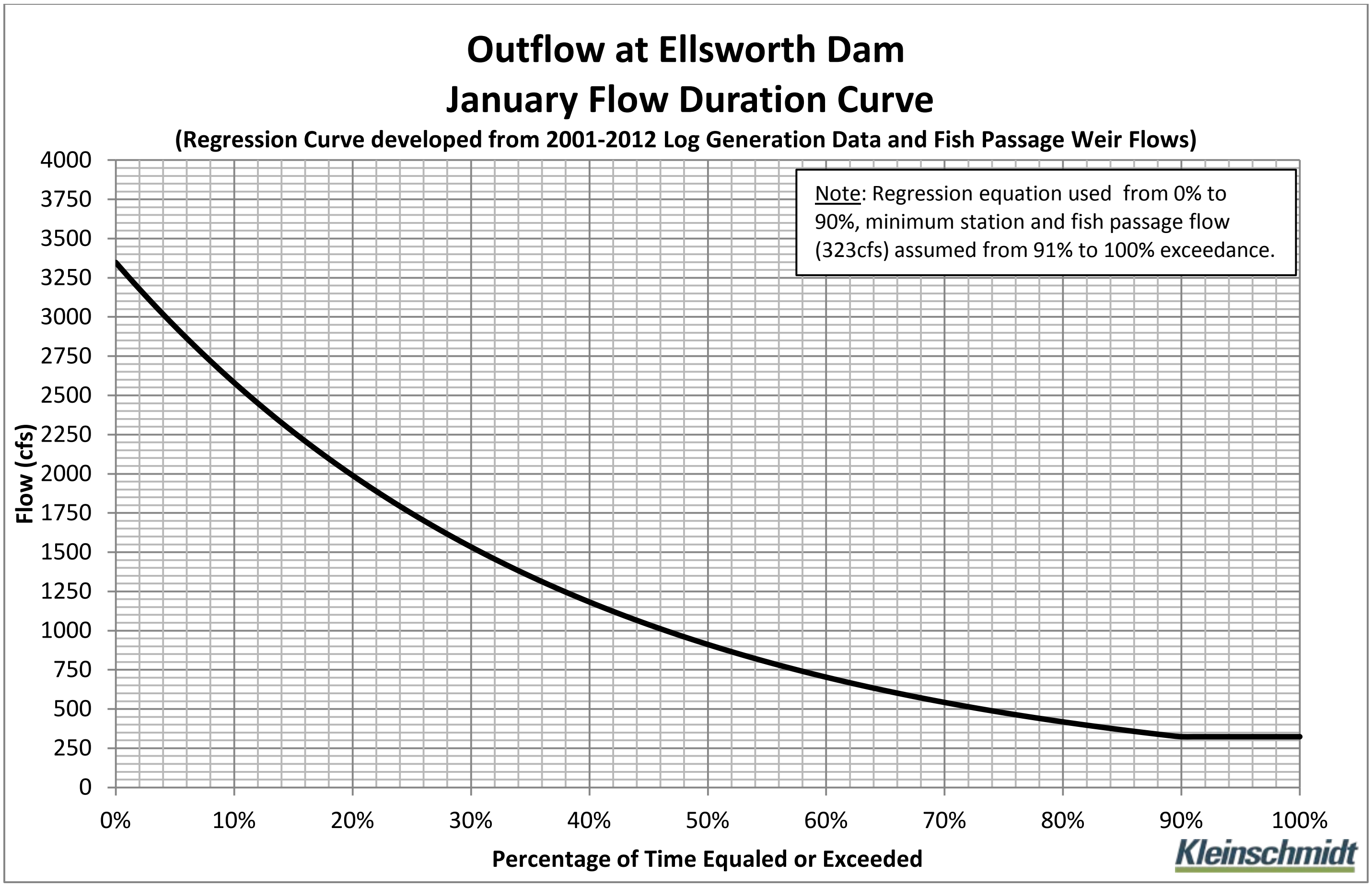
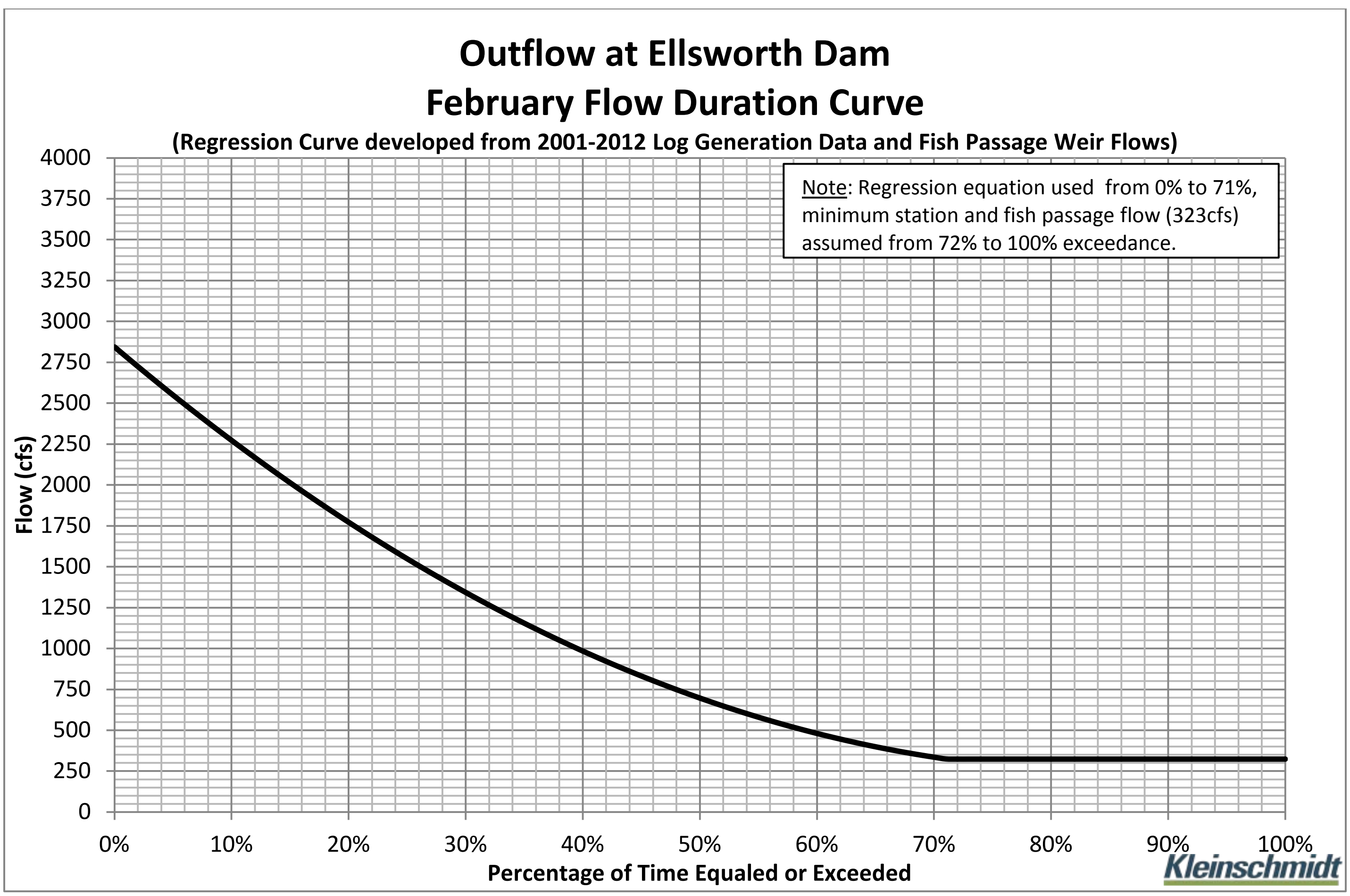
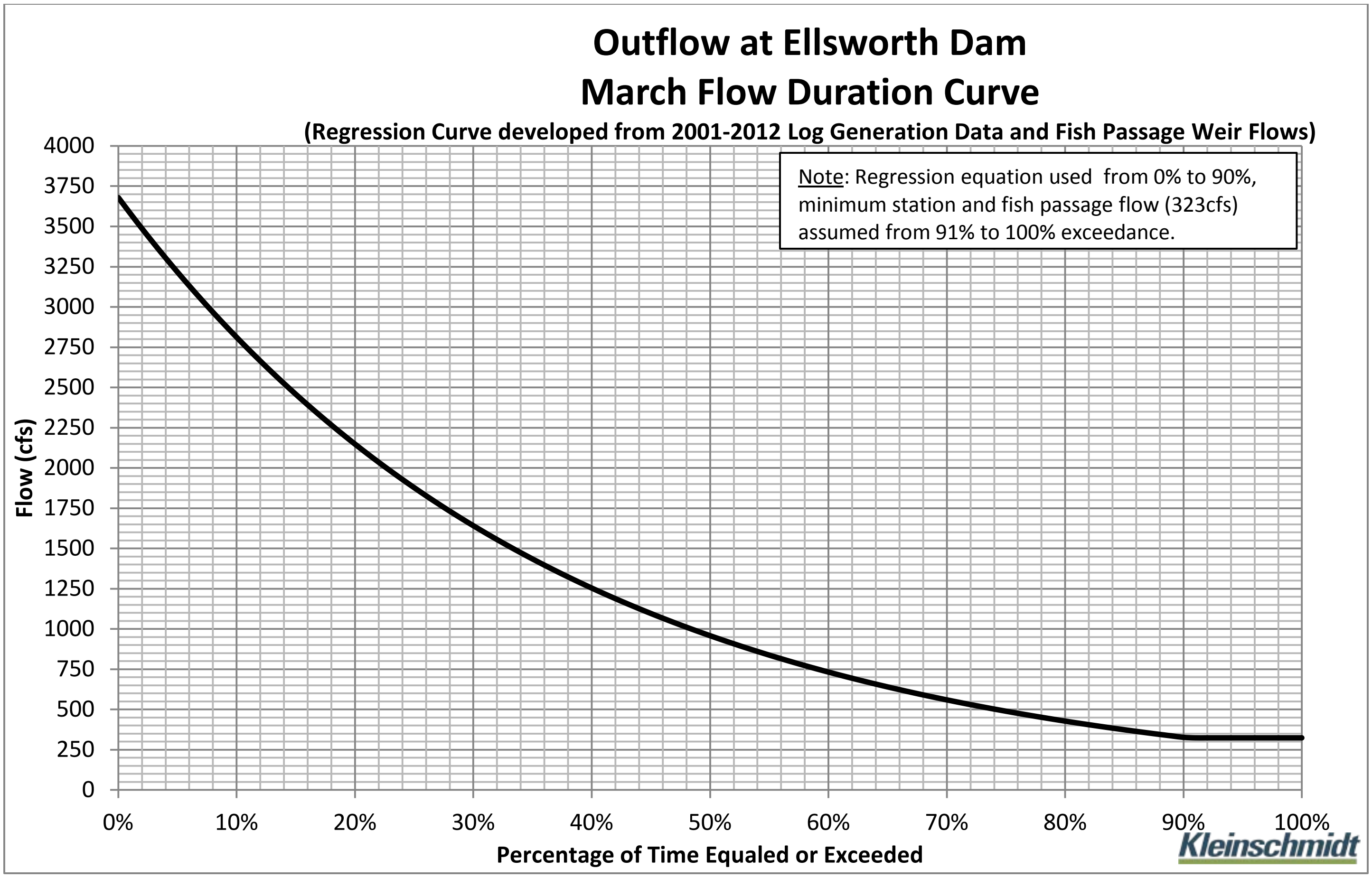
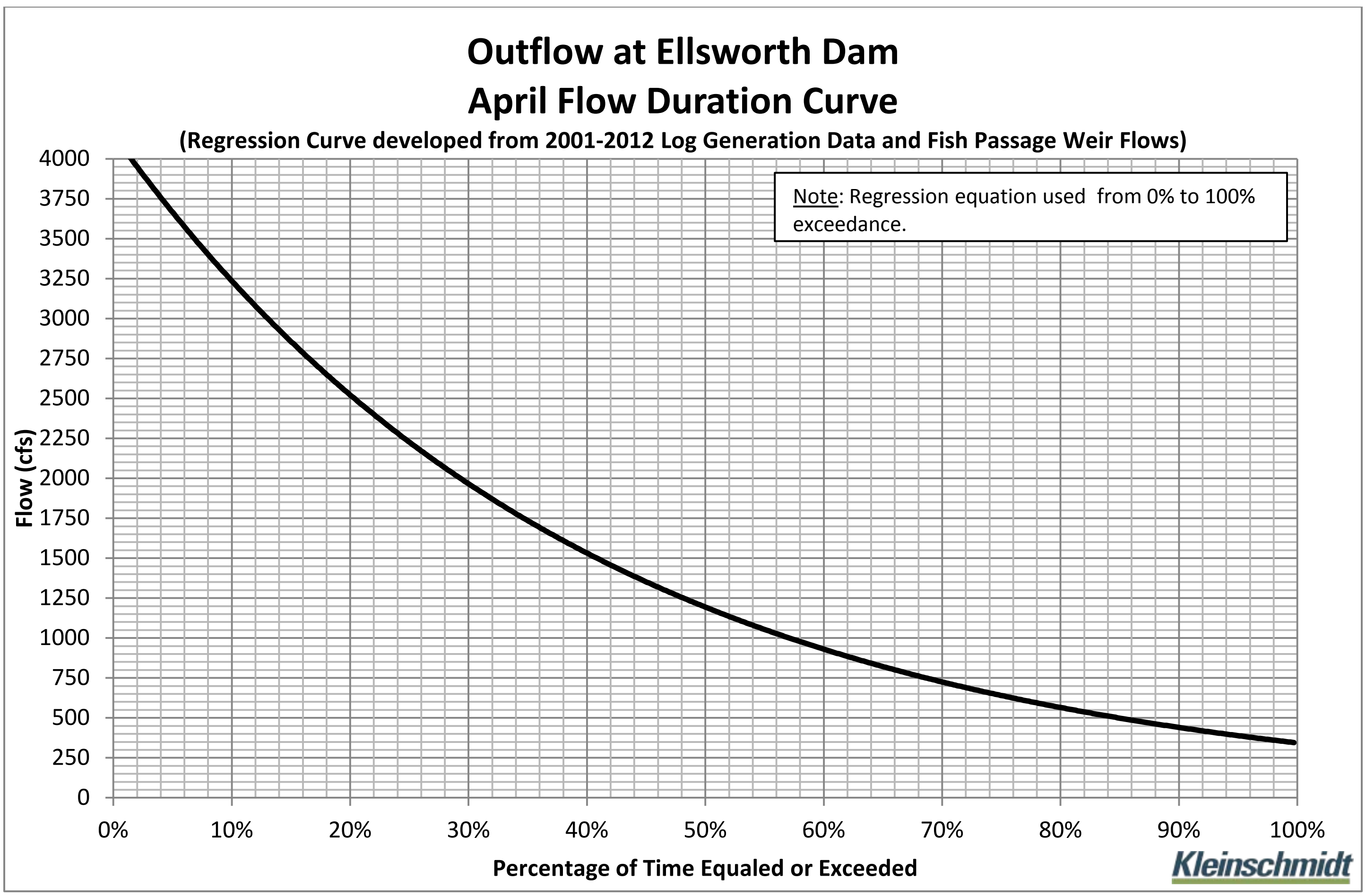

Outflow at Ellsworth Dam
Annual Flow Duration Curve
(Regression Curve developed from 2001- 2012 Log Generation Data and Fish Passage Weir Flows)
Notes: Regression equation used from 0% to 73%, minimum station and fish passage flow (323cfs) assumed from 74% to 100% exceedance.
The maximum value on the annual curve is less than values from some indivdual months because of the selected regression equation. However, the curve is fit based upon all historical data and is the best fit when analyzing the annual period.
Mean Daily River Flow (cfs)
4,000
3,800
3,600
3,400
3,200
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
-
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Flow is Equaled or Exceeded
Kleinschmidt


Outflow at Ellsworth Dam
January Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 90%, minimum station and fish passage flow (323cfs) assumed from 91% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Equaled or Exceeded
Kleinschmidt

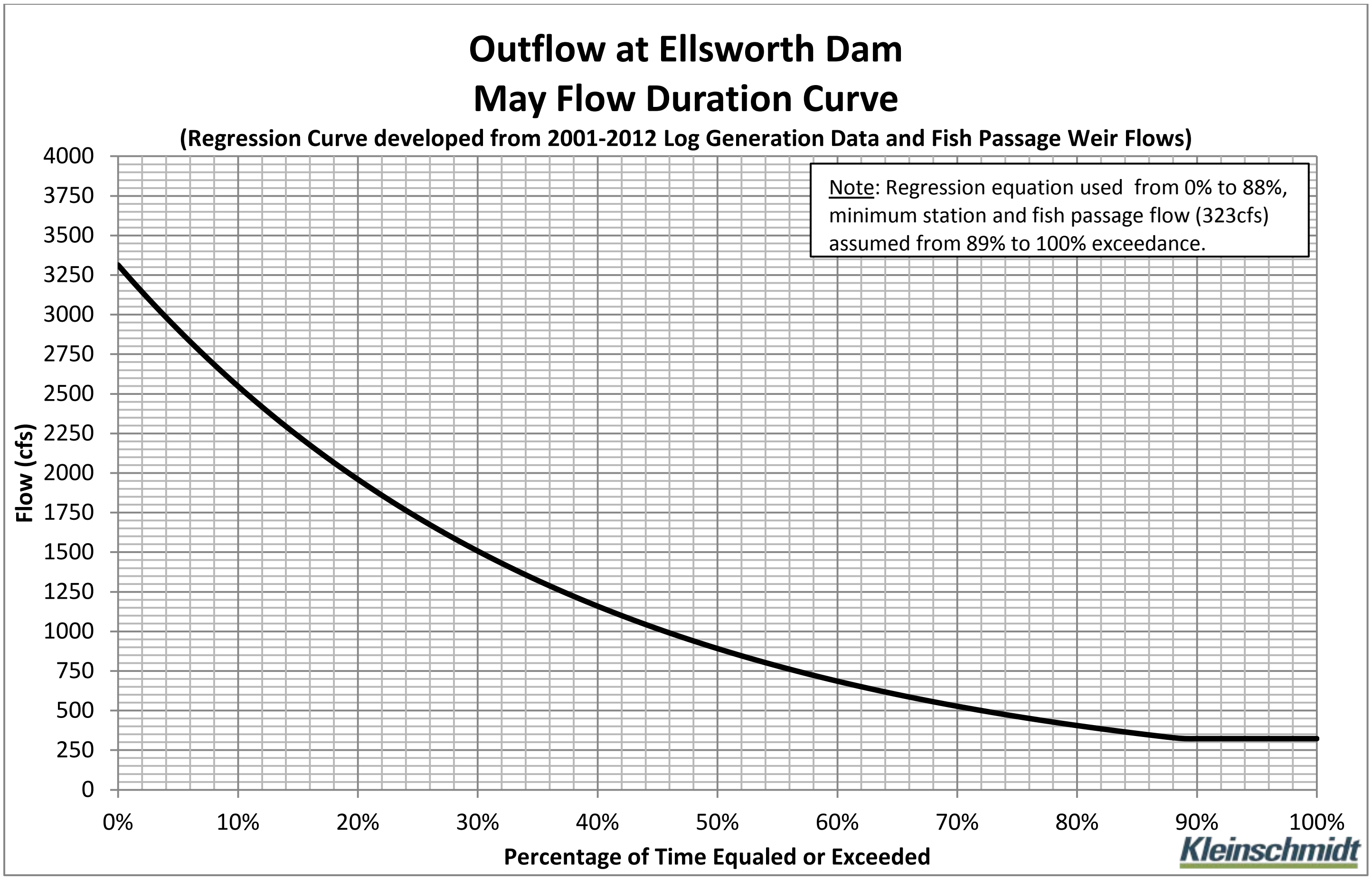

Outflow at Ellsworth Dam
February Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 71%, minimum station and fish passage flow (323cfs) assumed from 72% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Equaled or Exceeded
Kleinschmidt



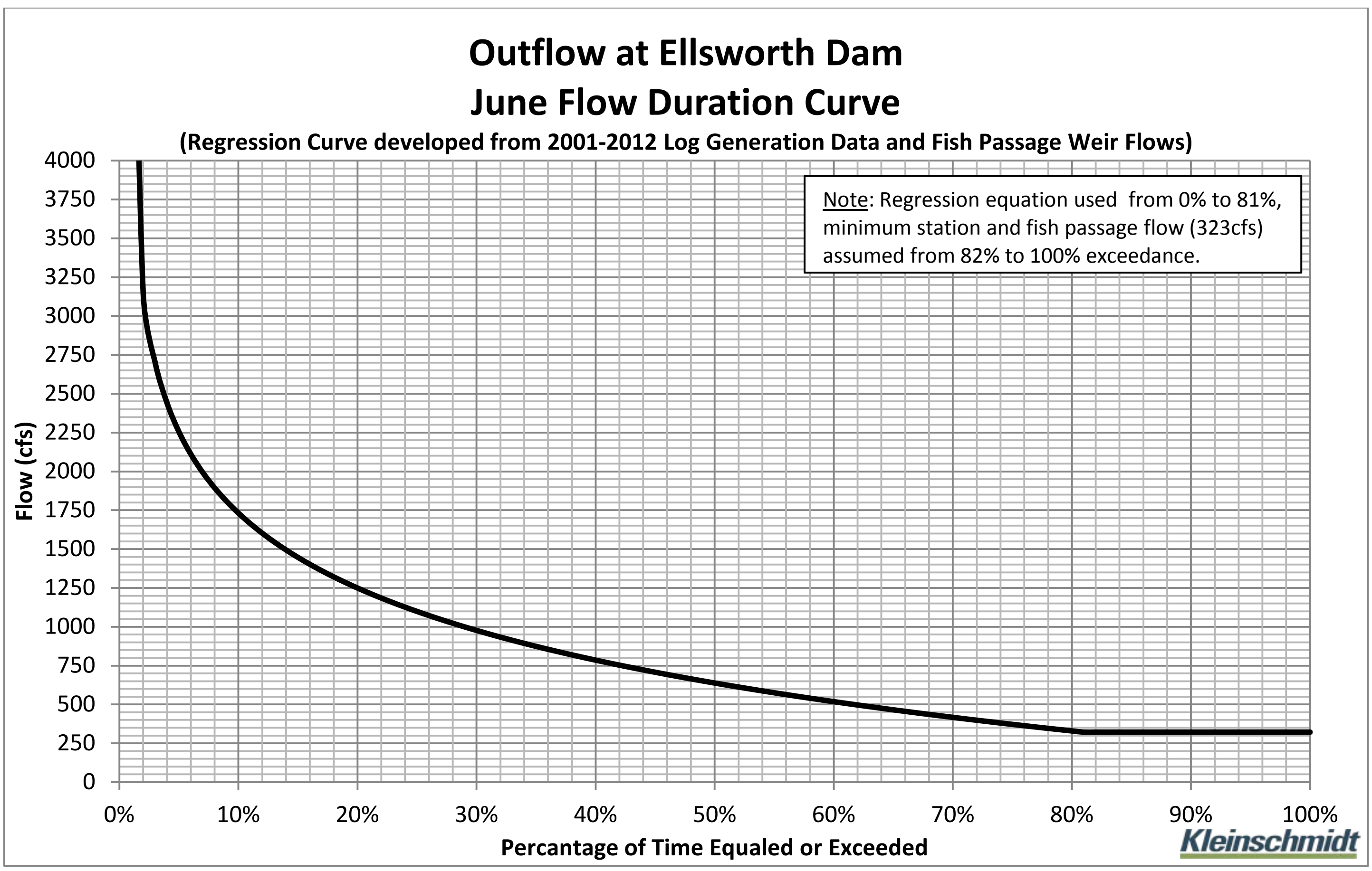
Outflow at Ellsworth Dam
March Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 90%, minimum station and fish passage flow (323cfs) assumed from 91% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Equaled or Exceeded
Kleinschmidt



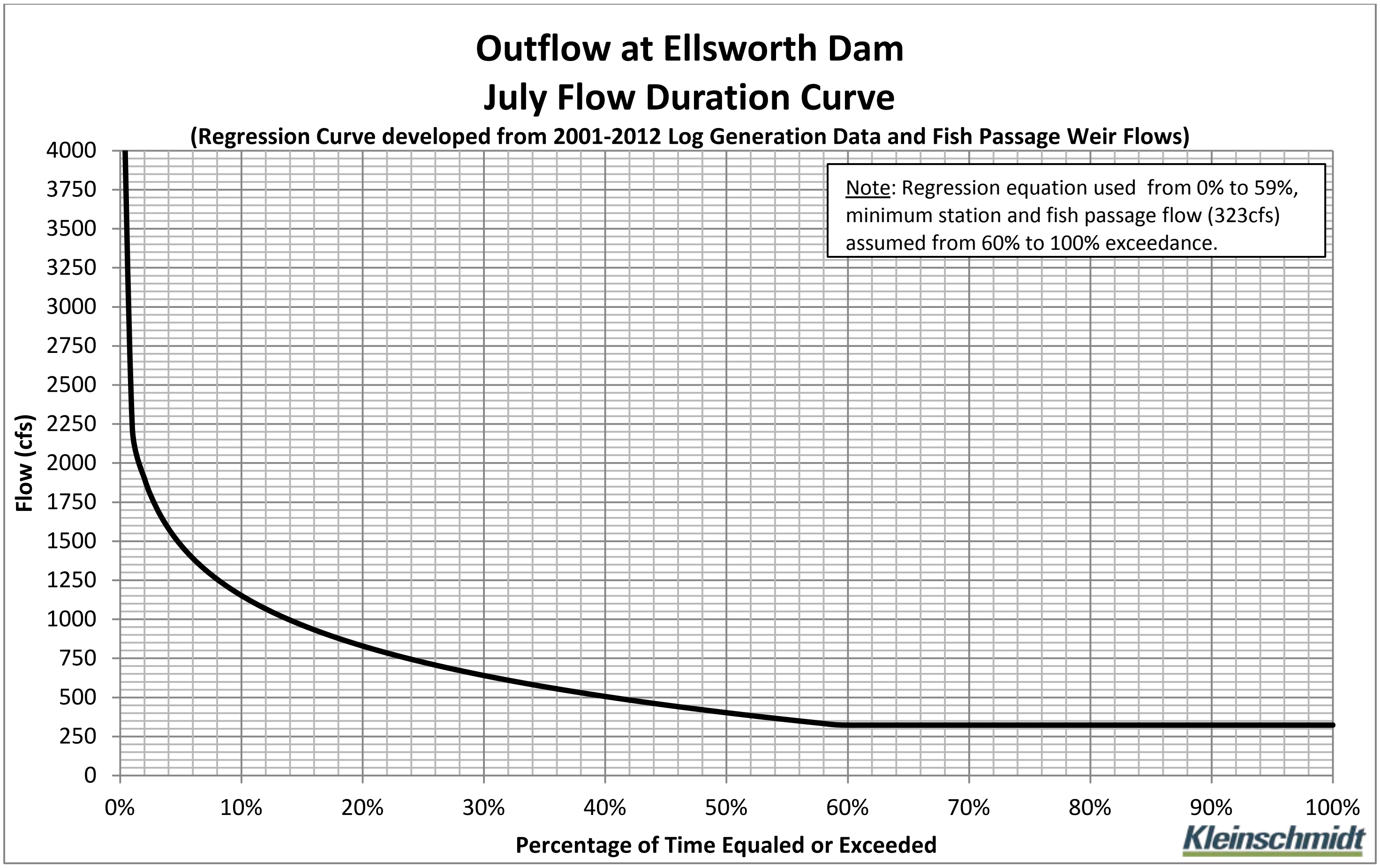
Outflow at Ellsworth Dam
April Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Equaled or Exceeded
Kleinschmidt

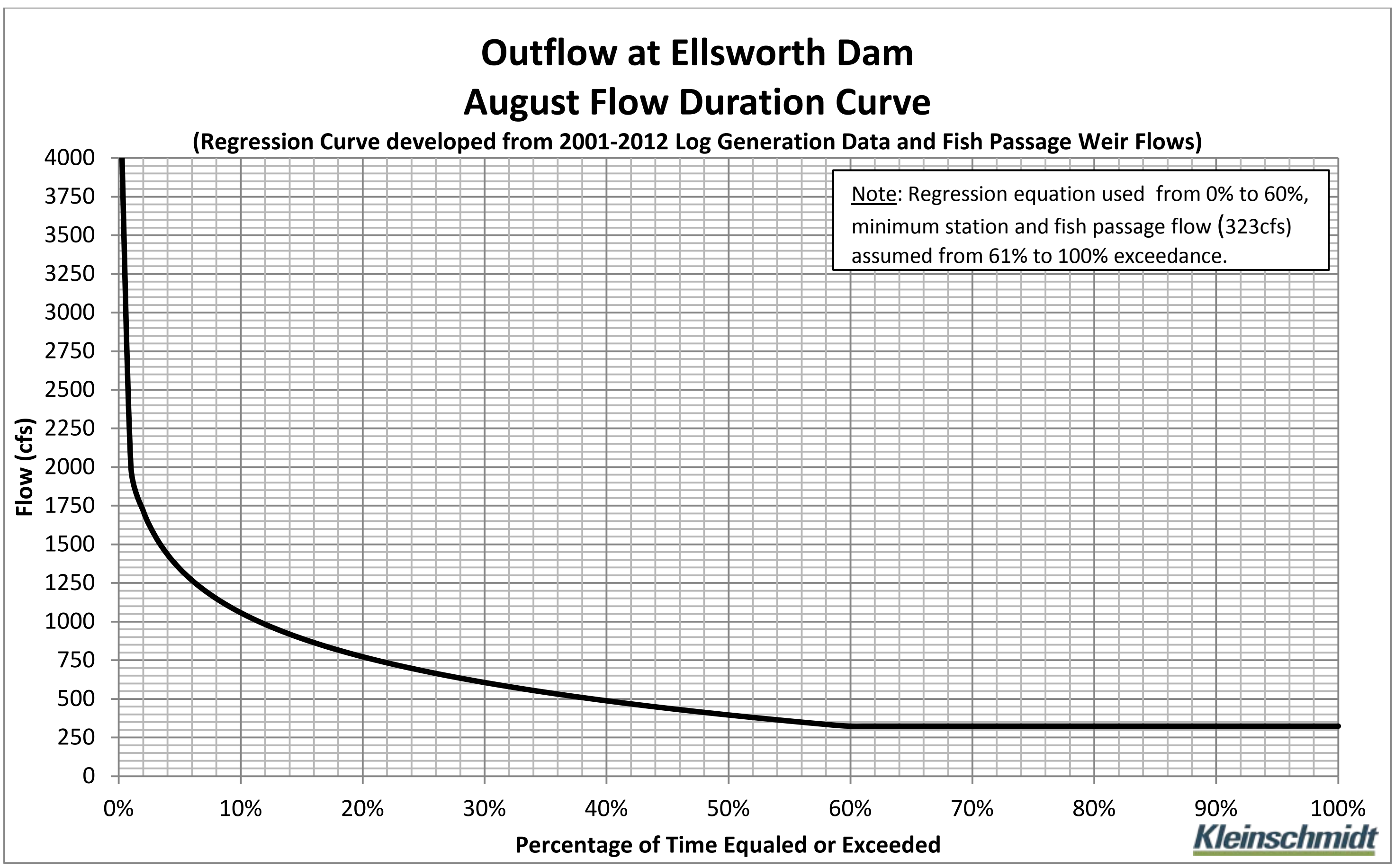


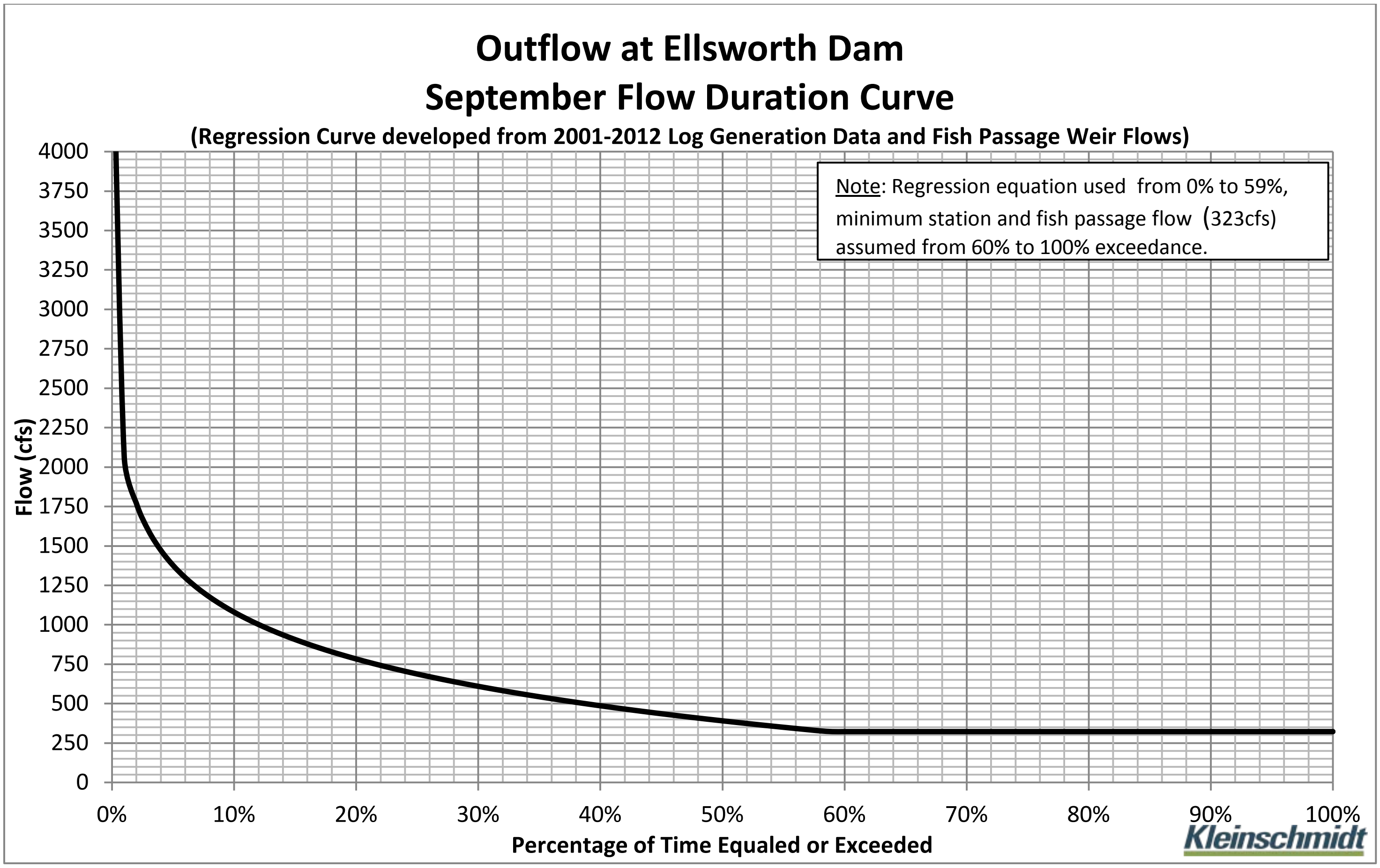
Outflow at Ellsworth Dam
May Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 88%, minimum station and fish passage flow (323cfs) assumed from 89% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Equaled or Exceeded
Kleinschmidt



Outflow at Ellsworth Dam
June Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 81%, minimum station and fish passage flow (323cfs) assumed from 82% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percantage of Time Equaled or Exceeded
Kleinschmidt


Outflow at Ellsworth Dam
July Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 59%, minimum station and fish passage flow (323cfs) assumed from 60% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Equaled or Exceeded
Kleinschmidt


Outflow at Ellsworth Dam
August Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 60%, minimum station and fish passage flow (323cfs) assumed from 61% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Equaled or Exceeded
Kleinschmidt


Outflow at Ellsworth Dam
September Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 59%, minimum station and fish passage flow (323cfs) assumed from 60% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
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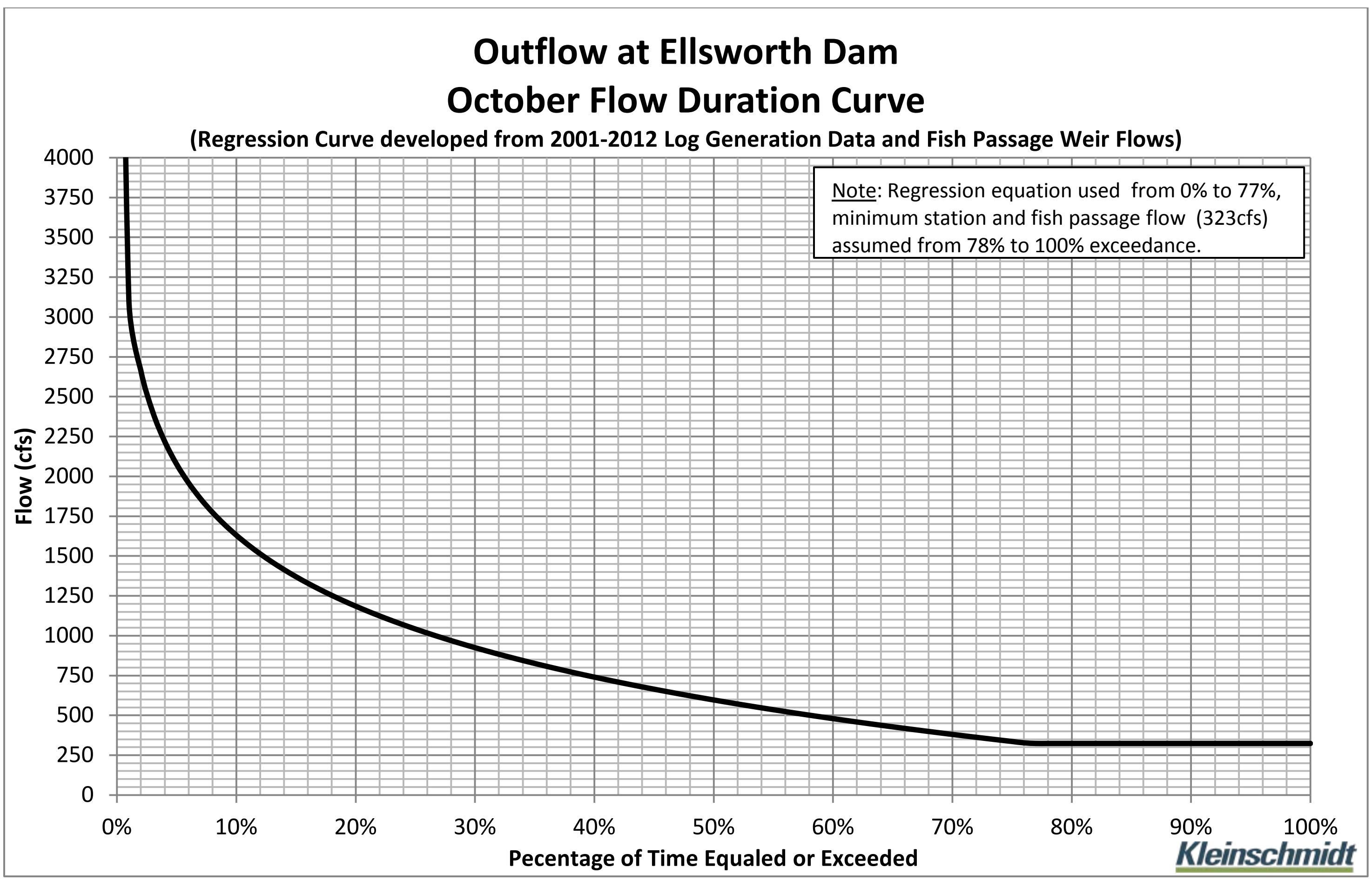
Percentage of Time Equaled or Exceeded
Kleinschmidt


Outflow at Ellsworth Dam
October Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 77%, minimum station and fish passage flow (323cfs) assumed from 78% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
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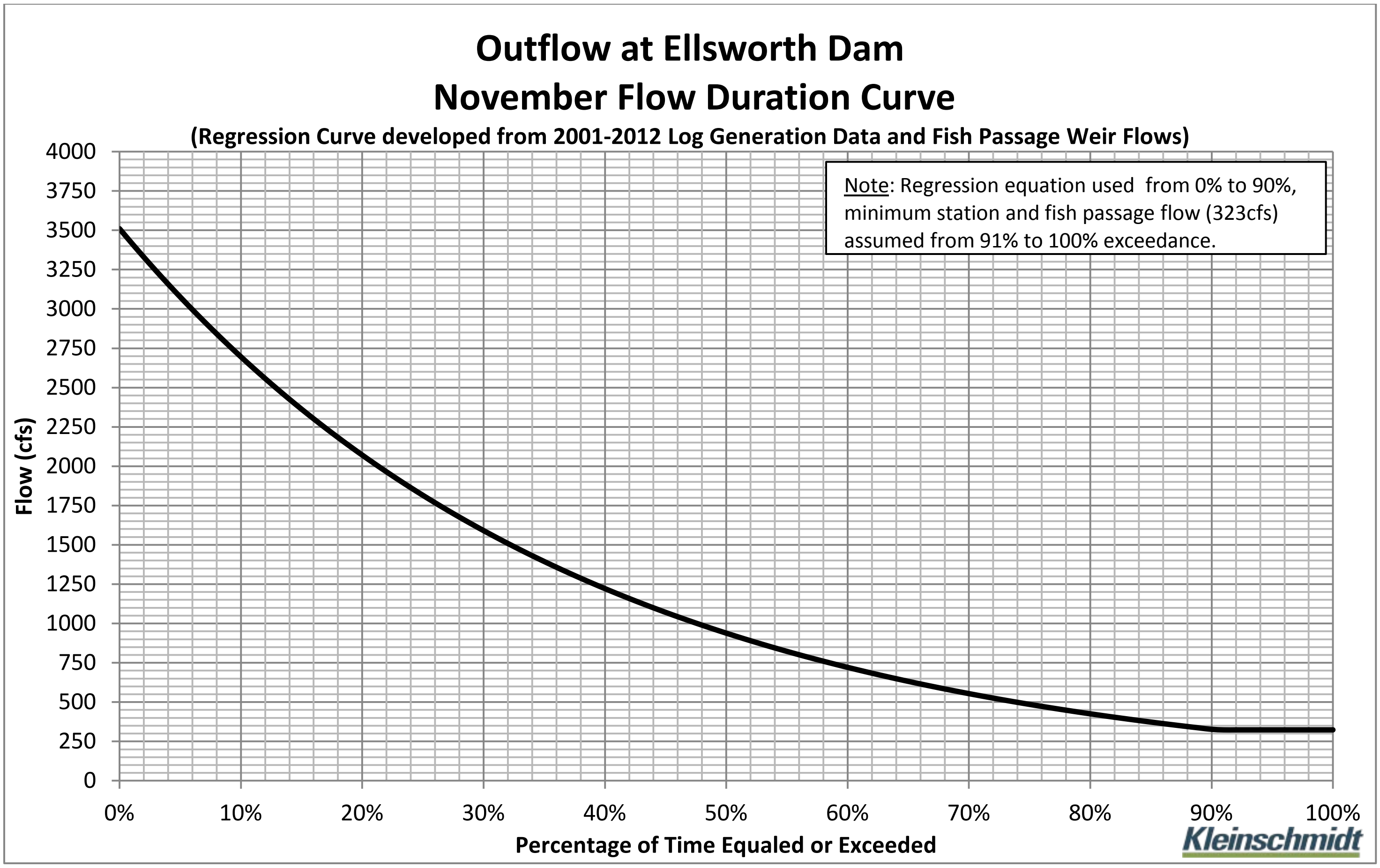
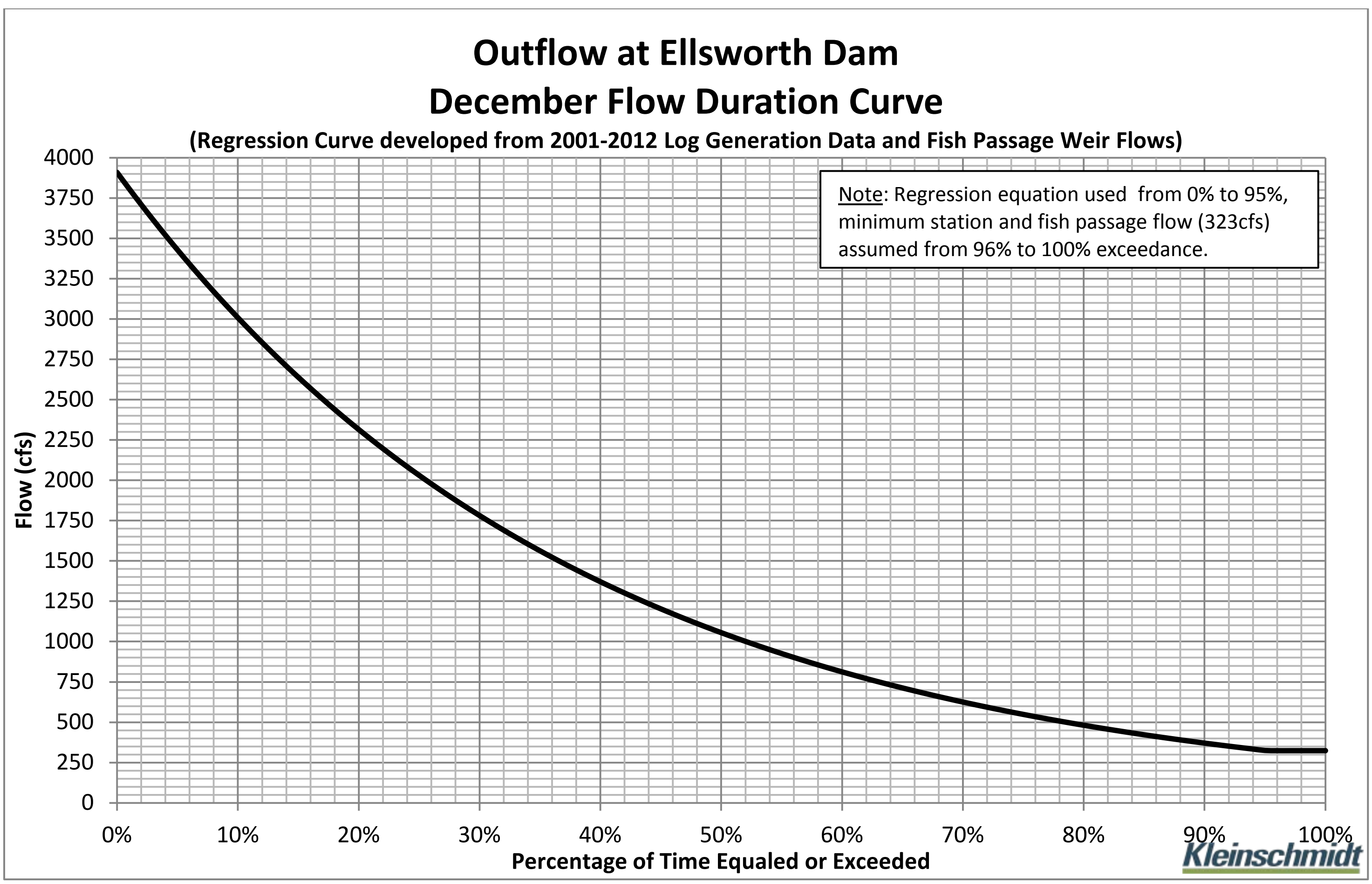
Pecentage of Time Equaled or Exceeded
Kleinschmidt


Outflow at Ellsworth Dam
November Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 90%, minimum station and fish passage flow (323cfs) assumed from 91% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Equaled or Exceeded
Kleinschmidt


Outflow at Ellsworth Dam
December Flow Duration Curve
(Regression Curve developed from 2001-2012 Log Generation Data and Fish Passage Weir Flows)
Note: Regression equation used from 0% to 95%, minimum station and fish passage flow (323cfs) assumed from 96% to 100% exceedance.
Flow (cfs)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0%
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30%
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Percentage of Time Equaled or Exceeded
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APPENDIX B-2

TAILWATER RATING CURVES

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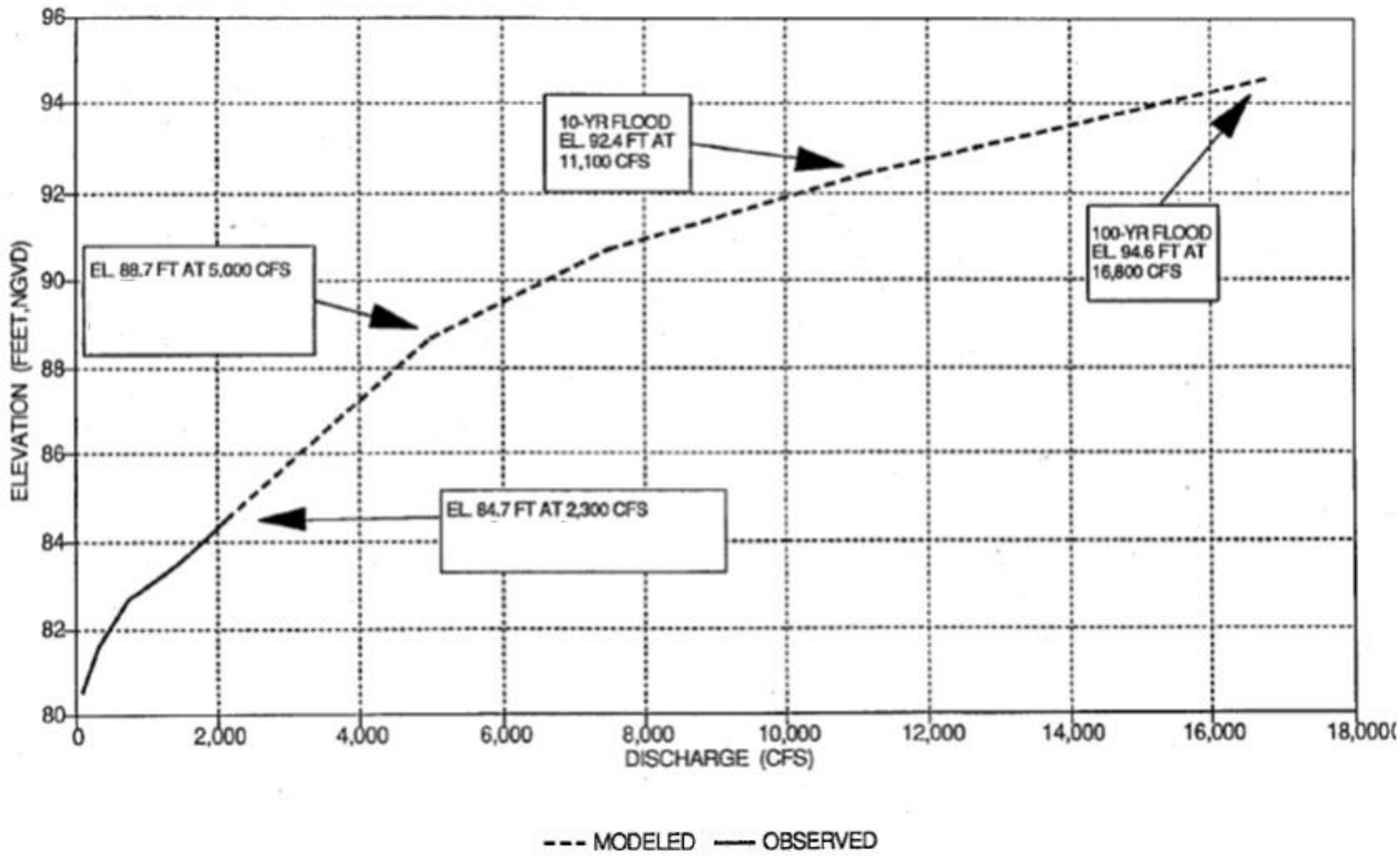
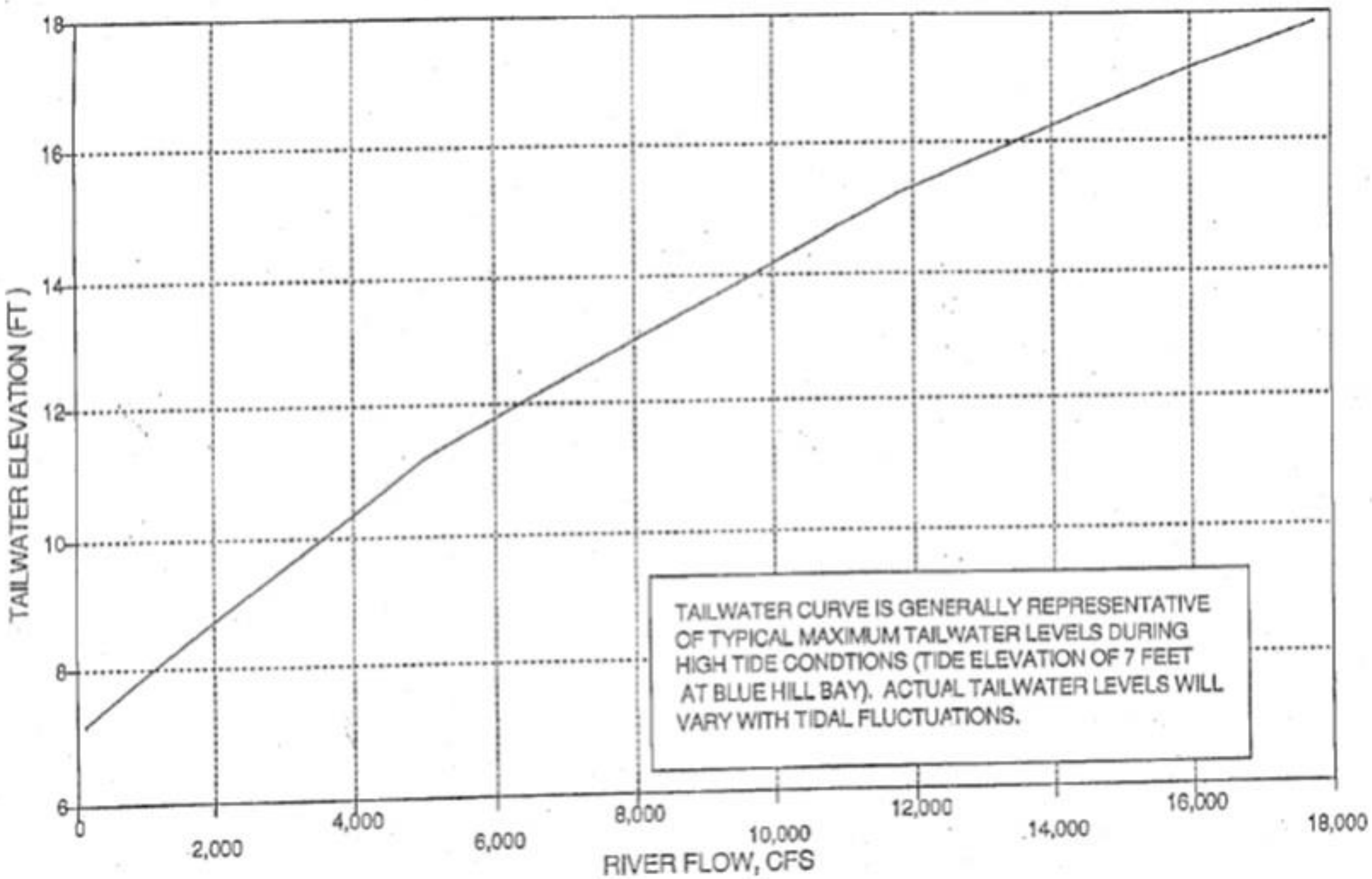


Graham Lake Dam Tailwater Rating Curve (Source: *Graham Lake Dam Remedial Measures Project Geotechnical Report* Northrop, Devine & Tarbell, Inc. 1992)



Ellsworth Dam Tailwater Rating Curve (Source: Ellsworth Project EAP – Appendix B. 1994)

APPENDIX B-3

CAPACITY VS. HEAD CURVE

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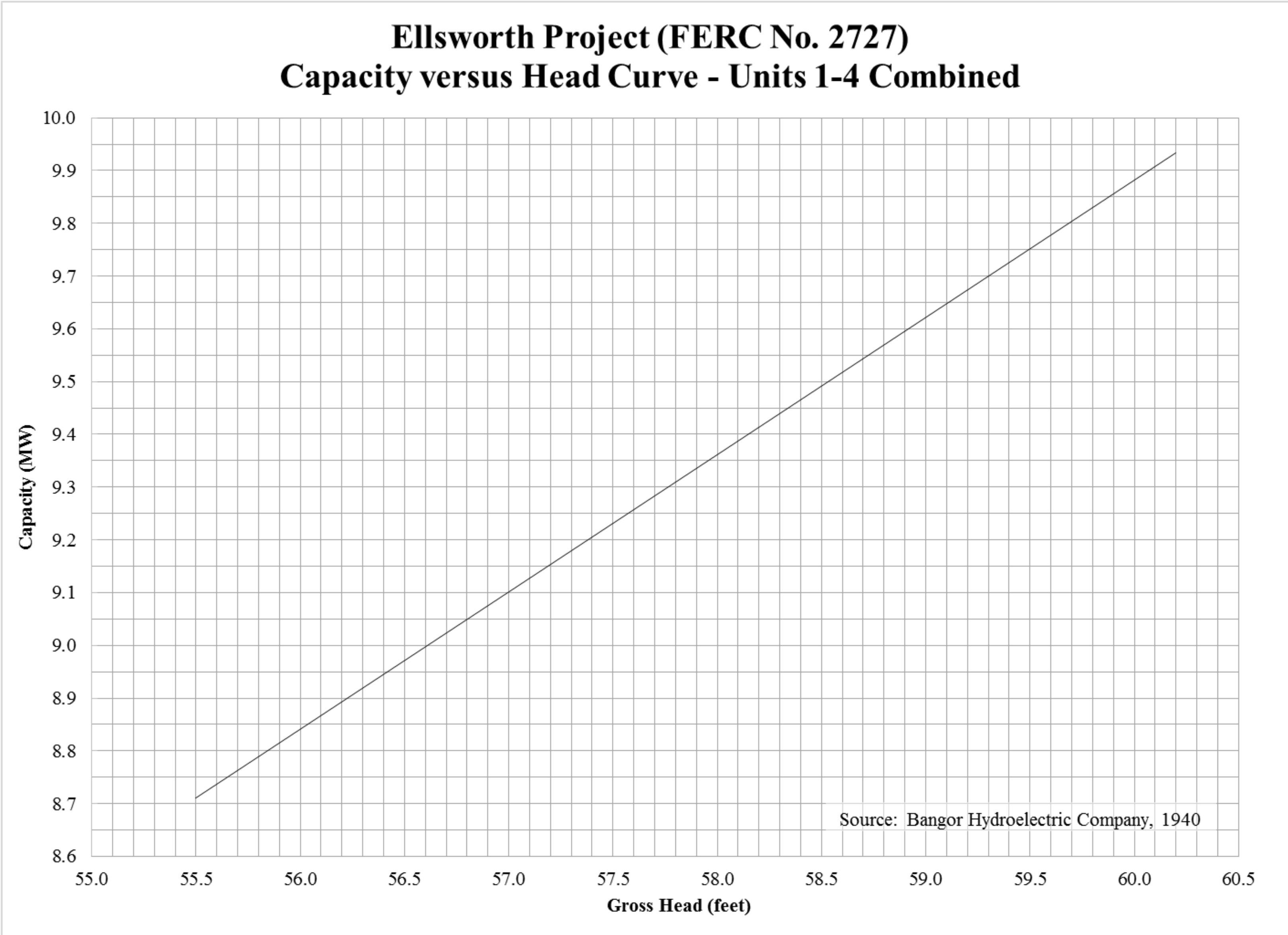
Ellsworth Project (FERC No. 2727)
Capacity versus Head Curve - Units 1-4 Combined
Capacity (MW)
10.0
9.9
9.8
9.7
9.6
9.5
9.4
9.3
9.2
9.1
9.0
8.9
8.8
8.7
8.6
55.0
55.5
56.0
56.5
57.0
57.5
58.0
58.5
59.0
59.5
60.0
60.5
Gross Head (feet)
Source: Bangor Hydroelectric Company, 1940

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EXHIBIT C

CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION SCHEDULE

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT C
CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION SCHEDULE

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT C
CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION SCHEDULE

1.0 INTRODUCTION

Black Bear Hydro Partners, LLC (Black Bear) is filing an application with the Federal Energy Regulatory Commission (FERC) for a new license for the Ellsworth Hydroelectric Project (Project or Ellsworth Project) located on the Union River in Hancock County, Maine. The following provides construction history information for the Project required under 18 CFR § 4.51(d).

2.0 CONSTRUCTION HISTORY

Bar Harbor and Union River Power Company constructed the Ellsworth Dam in 1907. The Graham Lake Dam, and the resulting Graham Lake reservoir were completed in 1924. Maintenance and repair activities at each of the developments has continued since their origination with major activities noted below.

The original facilities of the Ellsworth Dam consisted of two generation units (now termed Units No. 2 and 3). A third generation unit (now termed Unit No. 1) was added in 1919 and a fourth unit (Unit No. 4) was added in 1923 at the same time as construction of Graham Lake Dam. The horizontal turbines for Units No. 2 and 3 were replaced with vertical turbines in 1938, and the majority of the associated penstocks were also replaced at that time. In 1990 the open forebay was replaced with a new intake structure and longer penstocks.

Graham Lake Dam was constructed between 1922 and 1923. The original gate structure was found to have been constructed on soil and failed during a flood at the time of the initial filling of the reservoir. The gate structure was replaced with a structure founded on bedrock, and the dam was put into service in 1924. In response to the 1984 FERC Safety Inspection and subsequent studies, the site was dewatered from 1993-1994 and extensive remedial measures (including the construction of a downstream flood control structure) were implemented to address the high hazard potential and embankment stability of the structure.

Year	Ellsworth Dam	Graham Lake Dam
1907	Construction of dam and a two unit powerhouse completed and made operational	
1919	Third unit added	
1922		Dam construct initiated
1923	Fourth unit added	Dam failed during initial filling
1924		Dam rebuilt and put into service
1938	Units No. 2 and 3 replaced with vertical turbines and penstocks replaced	
1939	Crane trolley replaced with a motorized geared trolley	
1950	Spillway and non-overflow structures refaced with shotcrete	
1957	Rebuilt section of enclosure between buttresses four and six	
1982	All four turbines rebuilt and the generators rewound	
1985	Brake systems and cooling waters systems on Units No. 2 and 3 upgraded	
1986	Rip rap installed on downstream river bank to prevent erosion	
1986	Gatehouse replaced; fish passage facility installed	
1989		Temporary seepage control measures installed in one area of the downstream toe
1990	New intake structure constructed and penstock bays extended to the intake structure and buried	
1991	Headgate hoist installed	
1993	The buttress sections of the spillway and non-overflow structure partially filled with mass concrete and post-tensioned anchors installed	Site dewatered and site underwent extensive remedial repairs including construction of flood control structure, permanent cell, and southwest wingwall
1994		Major rehabilitation of radial gates.
1995	Repair of undermining of Unit No. 4 piers	
1995	Video cameras and high water alarms installed, the powerhouse automated	Video cameras and high water alarms installed

Year	Ellsworth Dam	Graham Lake Dam
2004	Sluice gate replaced with a stop log system used for downstream passage of migratory fish	
2005	Unit 4 rewound	
2006	Repairs completed on the downstream wall and tailrace flume piers of the powerhouse	
2007	No. 4 penstock replaced between the old forebay wall and powerhouse	

3.0 CONSTRUCTION SCHEDULE FOR NEW DEVELOPMENT

Black Bear proposes to install new upstream eel passage facilities at both the Ellsworth and Graham Lake dams within two years of the effective date of a new license. Black Bear also proposes to relocate the Graham Lake canoe portage within two years of the effective date of a new license.

Black Bear is not proposing any new capacity-related developments to the Ellsworth Project at this time.

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EXHIBIT D

STATEMENT OF COSTS AND FINANCING

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT D
STATEMENT OF COSTS AND FINANCING

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT D
STATEMENT OF COSTS AND FINANCING

1.0 ORIGINAL COST OF EXISTING UNLICENSED FACILITIES

This section is not applicable to the Ellsworth Hydroelectric Project (Project or Ellsworth Project) because Black Bear Hydro Partners, LLC (Black Bear) is not applying for an initial (original) license.

2.0 ESTIMATED AMOUNT PAYABLE UPON TAKEOVER PURSUANT TO SECTION 14 OF THE FEDERAL POWER ACT

Under Section 14(a) of the Federal Power Act (FPA), the Federal government may take over any project licensed by the FERC upon the expiration of the original license. FERC may also issue a new license in accordance with Section 15(a) of the FPA. If such a takeover were to occur upon expiration of the current license, Black Bear would have to be reimbursed for the net investment, not to exceed fair value, of the property taken, plus severance damages. To date, no agency or interested party has recommended a federal takeover of the Project pursuant to Section 14 of the Federal Power Act.

2.1 Fair Value

The fair value of the Project is dependent on prevailing power values and license conditions, both of which are subject to change. The best approximation of fair value would likely be the cost to construct and operate a comparable power generating facility. Because of the high capital costs involved with constructing new facilities and the increase in fuel costs associated with operation of such new facilities (assuming a fossil fueled replacement), the fair value would be considerably higher than the net investment amount. If a takeover were to be proposed, Black Bear would calculate fair value based on then-current conditions.

2.2 Net Investment

The net book investment for the Project was approximately $50,591,000 as of the end of 2014[1]. Table D-1 shows original costs, accumulated depreciation, cost of relicensing[2] and net investment, under the Commission's Uniform System of Accounts.

Table D-1: Data Used to Determine the Net Book Investment of the Project

FERC	Production Plant	Original Cost ($)	Accumulated Depreciation	Net Investment
330	Land and Water Rights	16,500	800	15,800
331	Structures and Improvements	5,016,200	107,100	4,909,100
332	Reservoirs, Dams and Waterways	41,743,200	745,000	40,998,200
333	Waterwheels, Turbines and Generators	3,874,000	136,700	3,737,300
334	Accessory Electrical Equipment	894,600	73,300	821,300
335	Misc. Power Plant Equipment	94,800	3,600	91,200
336	Roads, Railroads and Bridges	18,600	600	18,000
	Totals	**51,657,900**	**1,067,100**	**50,590,900**
302	Relicensing Costs	1,394,000	0	1,394,000
	Total Including Relicense Costs	**53,051,900**	**1,067,100**	**51,984,900**

2.3 Severance Damages

Severance damages are determined either by the cost of replacing (retiring) equipment that is "dependent for its usefulness upon the continuance of the License" (Section 14, Federal Power Act), or the cost of obtaining an amount of power equivalent to that generated by the Project from the least expensive alternative source, plus the capital cost of constructing any facilities that would be needed to transmit the power to the grid, minus the cost savings that would be realized from not operating the Project. As discussed above, these values would need to be calculated based on power values and license conditions at the time of project takeover.

[1] Black Bear's fiscal year is the calendar year; therefore, 2015 financial information is not yet available. 2014 information is considered a reasonable representation

[2] The cost of relicensing presented is the total cost to date through November 2015.

3.0 ESTIMATED COST OF NEW DEVELOPMENT

3.1 Land and Water Rights

Black Bear is not proposing to expand land or water rights as a consequence of this license application.

3.2 Cost of New Facilities

Black Bear is not proposing any capacity-related developments at the Project. Black Bear proposes to install new upstream eel passage facilities at both the Ellsworth and Graham Lake dams within two years of the effective date of a new license. Black Bear also proposes to relocate the Graham Lake canoe portage within two years of the effective date of a new license. The cost to construct and maintain these facilities is provided in Exhibit E – Section 4.5.

4.0 ESTIMATED AVERAGE ANNUAL COST OF THE PROJECT

This section describes the annual costs of the Project as proposed. The estimated average cost of the total Project is approximately $813,000 per year, based on a full 2014 year period of record[3]. This estimate includes costs associated with existing and projected project operations and maintenance[4], as well as local property and real estate taxes, but excludes income taxes, depreciation, and costs of financing.

4.1 Capital Costs

Black Bear uses a 12% rate to approximate its average cost of capital. Actual capital costs are based on a combination of funding mechanisms that includes stock issues, debt issues, revolving credit lines, and cash from operations.

4.2 Taxes

Property taxes for the 2014 fiscal year were approximately $161,000. Income taxes for the Project are incorporated into costs of Black Bear's consolidated business and are not separated out for the Project.

4.3 Depreciation and Amortization

The annualized composite rate of depreciation for the Project is approximately 2.25%.

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[3] Full 2014 year period of record has been determined to be representative of the Annual Cost of the Project.
[4] Including major maintenance costs. Costs for individual PME measures are provided in Exhibit E- Section 4.5.

4.4 Operation and Maintenance Expenses

The estimated annual operation and maintenance expense at the Project was approximately $652,000 including corporate support costs, but excludes property and real estate taxes.

4.5 Costs to Develop License Application

The approximate cost through November 2015 to prepare the application for a new license for the Project is approximately $1,394,000.

4.6 Costs of Proposed Environmental Measure

Black Bear is proposing the following environmental measures in this application:

- implement erosion controls at the Graham Lake boat launch facility;
- develop a new portage trail at the west end of Graham Lake Dam;
- improve a fisherman's downstream access trail on the east side of Graham Lake Dam;
- develop and install in consultation with fisheries agencies, upstream eel passage at both the Ellsworth and Graham Lake Dams;
- implement the final Historic Properties Management Plan to provide for management of historic properties throughout the term of the license;
- implement the final Recreation Management Plan to provide for the management of recreation facilities throughout the term of the license.

The costs to develop and maintain the proposed measures is discussed in Exhibit E – Section 4.5.

5.0 ESTIMATED ANNUAL VALUE OF PROJECT POWER

Power generated by the project is sold through the Independent System Operator of New England (ISO NE) at prevailing market rates. Black Bear estimates gross annual energy production of about 30,511 megawatt-hour (MWh). The average market clearing price for energy can be estimated based on the ISO NE web site.

6.0 SOURCES AND EXTENT OF FINANCING

Black Bear's current financing needs are generated from internal funds. Financing of major enhancements will likely be made through earnings retention, equity contributions and/or loans made by the corporate parent.

EXHIBIT E

ENVIRONMENTAL REPORT

ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT E
ENVIRONMENTAL REPORT

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LIST OF ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effects
BA	Biological Assessment
Black Bear	Black Bear Hydro Partners, LLC
CEII	Critical Energy Infrastructure Information
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWA	Clean Water Act (Federal)
CZMA	Coastal Zone Management Act (Federal)
DLA	Draft License Application
DO	dissolved oxygen
DPS	Distinct Population Segment
DWA	Deer Wintering Area
EFH	Essential Fish Habitat
EP	Ephemeroptera, Plecoptera
EPT	Ephemeroptera, Plecoptera, Trichoptera
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FLA	Final License Application (for new FERC license)
FPA	Federal Power Act
FT	Federal Threatened
GIS	Geographic Information System
GOM	Gulf of Maine
GPS	Global Positioning System
HBN	Hilsenhoff’s Biotic Index
HPMP	Historic Properties Management Plan
ILP	Integrated Licensing Process
ISR	Initial Study Report
IWWH	Inland Waterfowl and Wading-bird Habitat
kW	kilowatt
KWh	Kilowatt hour
LAA	likely to adversely affect (in reference to federal endangered species)
Licensee	Black Bear Hydro Partners, LLC
LUPC	Land Use Planning Commission (Maine)
LURC	Land Use Regulation Commission (Maine)
Maine DEP	Maine Department of Environmental Protection
Maine DIFW	Maine Department of Inland Fisheries and Wildlife

Maine DMR	Maine Department of Marine Resources
mg/l	Milligrams per liter
Maine HPC	Maine Historic Preservation Commission
Maine NAP	Maine Natural Areas Program
MOA	Memorandum of Agreement
Maine SPO	Maine State Planning Office
MWDCA	Maine Waterway Development and Conservation Act
MW	megawatt
MWh	megawatt hours
NEPA	National Environmental Policy Act
NGO	non-governmental organization
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NLAA	not likely to adversely affect (in reference to federal endangered species)
NMFS	United States National Marine Fisheries Service (Part of NOAA)
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NRPA	Natural Resources Protection Act
NWI	National Wetlands Inventory
PAB	Palustrine Aquatic Bed
PAD	Pre-Application Document
PCE	primary constituent elements
PEM	Palustrine Emergent Wetland
PFO	Palustrine Forested Wetland
PLP	Preliminary Licensing Proposal
PME	protection, mitigation, and enhancement
PPM	parts per million
PSP	Proposed Study Plan
PSS	Palustrine Scrub-Shrub Wetland
PUB	Palustrine Unconsolidated Bottom
REA	Ready for Environmental Analysis
RMP	Recreation Facilities Management Plan
RPS	Renewable Portfolio Standards
RSP	Revised Study Plan
RTE	rare, threatened, or endangered
SD1	Scoping Document 1

SHPO	State Historic Preservation Officer
SPD	Study Plan Determination
SPP	Species Protection Plan
ST	State Threatened
SVP	Significant Vernal Pool
µg/l	micrograms per liter
URFCC	Union River Fisheries Coordinating Committee
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USR	Updated Study Report

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT E
ENVIRONMENTAL REPORT

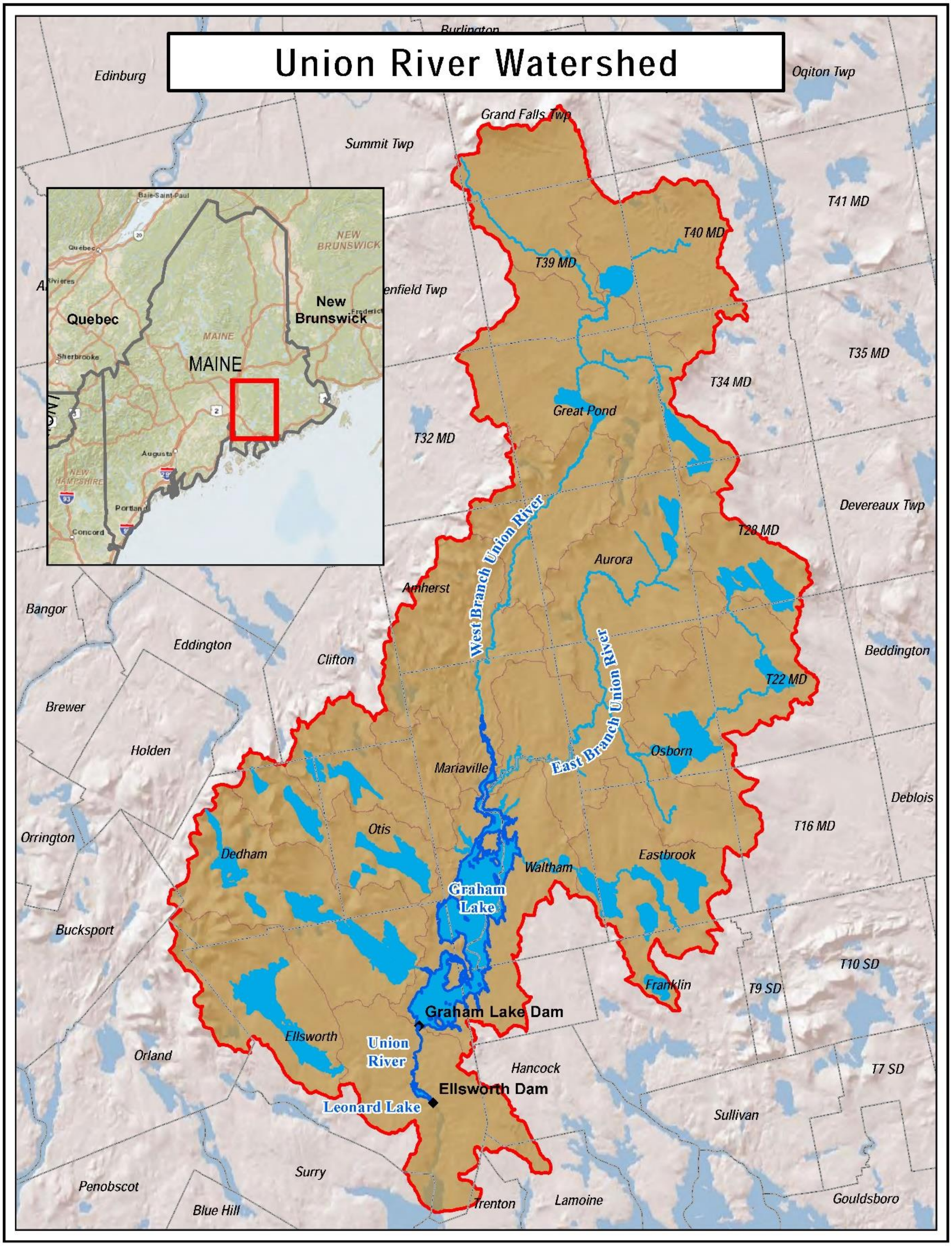
1.0 INTRODUCTION

Black Bear Hydro Partners, LLC (Black Bear) is the owner, operator, and licensee of the Ellsworth Hydroelectric Project (FERC No. 2727) (Project). The Project is located on the lower reach of the Union River in the City of Ellsworth, the towns of Waltham and Mariaville, and the township of Fletchers Landing in Hancock County, Maine (Figure E-1). Black Bear is using the Federal Energy Regulatory Commission's (FERC) Integrated Licensing Process (ILP) for the relicensing of the Project. Pursuant to the process and schedule requirements of the ILP (CFR Part 5), Black Bear is filing with FERC its Final License Application (FLA) for a new license for the Project. The FLA is being provided to participating agencies, tribes, non-governmental organizations (NGOs), local governments and the public.

The Project consists of two developments, the Ellsworth Development and the Graham Lake Development. The Ellsworth Development consists of the Ellsworth Dam, which forms the 90-acre Lake Leonard, and the associated generating facilities having an authorized installed nameplate capacity of 8.9 MW. The Ellsworth Dam forms the upper limit of tidal influence of the Union River; below Ellsworth Dam the Union River flows into the Union River Bay approximately three miles downstream from the Project. The Graham Lake Development consists of a dam with an approximately 10,000-acre storage reservoir (Graham Lake). There are no generating facilities at the Graham Lake Development.

Construction of the Ellsworth Dam was completed in 1907 and the Graham Lake Dam was completed in 1924. The current license was issued by FERC in 1987. The license has been amended three times since then; in 1992, 1999, and 2002. In 1992, the project boundary was modified to include an additional 2 acres of land located downstream of the existing Graham Lake Dam. In 1999; the project description was corrected, Exhibit A was revised and the project boundary was changed to exclude land underlying a substation not a part of the project. In 2002, the approval of an upstream fish passage plan filed pursuant to Article 406 in 1994 was rescinded and the Comprehensive Fishery Management Plan for the Union River was filed in its stead. The license was transferred to Black Bear Hydro Partners, LLC by FERC Order Approving Transfer of License dated September 17, 2009 (128 FERC ¶ 62,212).

Figure E-1: Project Location



The lower impoundment, Lake Leonard impounded by the Ellsworth Dam, has a surface area of 90 acres at its normal maximum elevation of 66.7’ and a length of one mile. Graham Lake, the upper reservoir of the Project, has a normal maximum surface area of approximately 10,000 acres and a maximum length of approximately 10 miles. Graham Lake holds approximately 5.4 billion cubic feet of useable storage. Water levels in Graham Lake are typically managed between elevations of 93.4’ and 104.2’ (NGVD 1929).

The Project Developments are collectively operated as a peaking project utilizing stored water released at Graham Lake for power production at Ellsworth Dam. The Graham Lake Development provides storage and has no power facilities. The Ellsworth development is operated in a run-of-river mode, where water levels at Lake Leonard (Ellsworth Dam) are kept within a one foot fluctuation range during normal project operations (i.e. inflows to Lake Leonard are passed through equally at Ellsworth Dam). As part of the current license requirements the Licensee is required to release a continuous minimum flow of 105 cfs from the Graham Lake Dam and the Ellsworth Dam from July 1 through April 30 and 250 cfs from May 1 through June 30. The Union River has an average flow of 958 cubic feet per second (cfs) at the Ellsworth Development.

1.1 Purpose of Exhibit E

The purpose of Exhibit E, as defined in 18 CFR § 5.18, is to describe the following: 1) the existing and proposed project facilities, including project lands and waters; 2) the existing and proposed project operation and maintenance, to include measures for protection, mitigation and enhancement (PME), if appropriate, with respect to each resource affected by the Project proposal; and 3) the effects of issuing a new license for the continued operation and maintenance of the Project, including direct, indirect, and cumulative impacts based on information generated during relicensing studies.

The environmental analysis in this Exhibit E (Section 4.4) presents the assessment of effects associated with proposed Project operations and facilities and the expected benefits of proposed PME measures. This analysis is based in large part on the results of studies conducted by Black Bear in consultation with participating agencies, Tribes, and public and under the FERC approved and revised Study Plans. As discussed herein, there are several relicensing studies that will continue in 2016, and be reported in December 2016, as approved by the Commission.

The results of the continuing studies, as well as the resource analyses contained in this Exhibit E will provide the foundation for FERC’s National Environmental Policy Act (NEPA) analysis.

1.2 Document Organization

In organizing this Exhibit E, Black Bear relied on FERC's Revised Scoping Document for the Project, FERC's regulations for Exhibit E – Environmental Report (18 CFR § 5.18[b]), and FERC's guidance document, *Preparing Environmental Documents, Guideline for Applicants, Contractors, and Staff* (FERC, 2008).

This Exhibit E is divided into four sections: 1) Introduction, 2) Consultation (a summary of consultation is provided in Appendix E-1), 3) Proposed Action and Alternatives and 4) Environmental Analysis. Following a general description of the basin, Section 4 describes each of the following for each resource area: Affected Environment (brief description of the existing environment based on information from the Pre-Application Document (PAD) and study reports included in the ISR and USR), Environmental Analysis (description of the effects of the Project under proposed operations), Proposed PMEs (description of Black Bears proposed PME measures), Cumulative Effects (for those resources identified in the Scoping Document as ones that could be cumulatively affected, a description of whether the Proposed Action would contribute to such cumulative effects), and Unavoidable Adverse Impacts (description of any adverse impacts that will occur despite the implementation of proposed PMEs).

2.0 CONSULTATION

Black Bear initiated consultation with federal and state agencies, tribes, NGOs and other interested parties in October 2012, with the issuance of the Notice of Intent (NOI) and PAD. The NOI and PAD for the Ellsworth Project were issued to stakeholders and filed with FERC on October 24, 2012. FERC subsequently issued Scoping Document 1 (SD1) on December 20, 2012. Public scoping meetings were held January 15/16, 2013. Black Bear developed study plans, filed with FERC on April 8, 2013, that addressed written comments provided by stakeholders, as well as study scope changes resulting from comments and discussions that occurred at the public scoping meetings. After FERC conducted the Proposed Study Plan meetings and Agency Meetings in the spring of 2013, a Revised Study Plan was filed with FERC on August 5, 2013.

The Study Plan was approved with specific revisions by FERC in its Study Plan Determination issued on September 4, 2013. Study results were filed with FERC on September 4, 2014 in an Initial Study Report and shared with stakeholders at an Initial Study Report Meeting held on September 18, 2014. A Modified Study Plan was approved with specific revisions by FERC in a Determination on Requests for Study Modifications and New Studies letter dated December 30, 2014. The Updated Study Report, with additional study results from the second year of studies was filed with FERC on August 21, 2015. The USR public review meeting was conducted on September 3, 2015. The USR Meeting Summary was filed on September 9, 2015. FERC issued its Determination on Requested Study Modifications on December 8, 2015.

Stakeholders contacted as part of the ongoing consultation process are included in Table E-1. Appendix E-1 provides a summary of consultation over the course of the relicensing process.

Table E-1: List of Consulted Parties

Federal Agencies	
ACHP	Advisory Council on Historic Preservation
USACE	U.S. Army Corps of Engineers
FERC	Federal Energy Regulatory Commission
NMFS	U.S. National Marine Fisheries Service
NOAA	U.S. National Oceanic & Atmospheric Administration
NPS	U.S. Department of the Interior National Park Service
BIA	U.S. Department of the Interior Bureau of Indian Affairs
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
State Agencies	
Maine DMR	Maine Department of Marine Resources
Maine DIFW	Maine Department of Inland Fisheries & Wildlife
Maine DEP	Maine Department of Environmental Protection
Maine BPL	Maine Bureau of Parks and Lands (Department of Agriculture, Conservation and Forestry)
Maine HPC	Maine Historic Preservation Commission
Maine LUPC	Maine Land Use Planning Commission
Maine NAP	Maine Natural Areas Program
Maine DACF	Maine Department of Agriculture, Conservation, and Forestry
Local Governments	
Ellsworth	
Waltham	
Mariaville	
Non-Governmental Agencies	
ASF	Atlantic Salmon Federation
URWC	Union River Watershed Coalition
USA	Union Salmon Association
PERC	Penobscot East Resource Center
DSF	Downeast Salmon Federation
FBC	Frenchman’s Bay Conservancy
FTB	Friends of Taunton Bay
COA	College of the Atlantic
SC	Sierra Club
Tribes	
	Aroostook Band of Micmacs

Federal Agencies	
	Houlton Band of Maliseet Indians
	Passamaquoddy Tribe
	Penobscot Indian Nation
Individuals	
	Doug Watts
	Andrea Perry
	Toby Stephenson
	Peter Laplant
	Terry Carlisle
	Tom Folsem
	Peter Ober
	Anne Clarke
	Todd Little-Siebold
	Joe Minutolo
	Alan Atherton
	Jennifer Fortier

2.1 Response to Draft License Application Comments

Black Bear filed the Draft License Application (DLA) with FERC and stakeholders on July 10, 2015. Written comments on the DLA are summarized in Appendix E-2, with an explanation of how comments are addressed in the FLA.

2.2 REA Notice

This Environmental Report summarizes the results of studies conducted and reported to date. The FERC, over the course of reviewing and commenting on the study plans, ISR, USR and DLA, and in its Determination on Requested Study Modifications (December 8, 2015) has either authorized or required the continuance of several studies into 2016. These studies include:

- Atlantic Salmon Smolt Downstream Passage Study, to be conducted in the spring of 2016;
- Graham Lake, Lake Leonard, and Union River Tributary Access Study, to be conducted in the summer/fall of 2016;
- Adult American Eel Downstream Passage Study (year two), to be conducted in the fall of 2016.

The Study Reports for the above studies are to be submitted to FERC by December 31, 2016.

Once FERC has determined that Black Bear's FLA and additional study reports meet all filing requirements, any deficiencies with the application have been resolved, and no additional information is required, FERC will issue the Notice of Acceptance and Ready for Environmental Analysis (REA). When the application is accepted, FERC issues the public notice in the Federal Register, local newspapers, and directly to resource agencies and Indian tribes.

The Acceptance/REA notice solicits comments, protests, and interventions- along with recommendations, preliminary terms and conditions, and preliminary fishway prescriptions by mandatory conditioning agencies- including all supporting documentation. Comments, protests, and interventions must be filed within 60 days of notice. Black Bear will then have 45 days to respond to submitted comments (105 days from the REA notice).

3.0 PROPOSED ACTION AND ALTERNATIVES

FERC issued a new license for the Project by order dated December 28, 1987. The license was for a term effective January 1, 1988 and terminating December 31, 2017. On September 17, 2009, the Commission issued an order approving the transfer of the Project license from PPL Maine, LLC, to Black Bear Hydro Partners LLC (Black Bear). The proposed action consists of the issuance of a new FERC license to Black Bear for the continued operation and maintenance of the Project with appropriate PME measures as described in Section 3.3.4 below.

3.1 No Action Alternative

No action means that the Project would continue to operate as authorized by the current license. Existing facilities would remain in place and existing resource measures would continue, but there would be no additional protection or enhancement of resources. If the Project were to operate as currently authorized, Black Bear would continue to produce energy in the present manner and the environmental effects of its operation would remain unchanged. Any ongoing effects of the Project would continue. The no action alternative represents the baseline Project energy production and environmental conditions for comparison with other alternatives.

3.1.1 Existing Project Facilities

The Project consists of two developments with associated dams and impoundments. The Ellsworth Development has a concrete dam 65 feet high and 377 feet long (with a 275-foot long section of spillway) and a powerhouse with four generation units having a total authorized installed nameplate capacity of 8.9 MW. The overflow spillway has a flashboard crest elevation of 66.7’. Unit No. 1 is served by a 10-foot diameter vertical penstock contained in the non-overflow section of the dam. The non-overflow section is connected to an intake structure containing three penstocks; two 8-foot diameter penstocks serving powerhouse units No. 2 and 3 and one 12-foot diameter penstock serving powerhouse unit No. 4. A fish passage facility is operated at the Ellsworth Dam providing for upstream fish passage, and the commercial harvest of river herring by the City of Ellsworth, under a cooperative management agreement with the Maine Department of Marine Resources (Maine DMR).

The Graham Lake Dam is a non-generating facility located about four miles upstream from the Ellsworth Dam. The structure is 30 feet high and consists of a 670-foot long earth dike and an 80 foot long concrete gate structure. The concrete gate structure contains three 20-foot-wide radial gates and an eight-foot-wide sluice that is used for downstream fish passage. There is a concrete flood control structure associated with the Graham Lake Dam. The flood control structure consists of an approximately 720-foot long flood wall, which is connected to the existing Graham Lake Dam gate structure by a wing wall extension and a permanent cofferdam cell.

The Ellsworth Project has a drainage area of approximately 547 square miles. The reservoir impounded by the Ellsworth Dam, Lake Leonard, has a surface area of 90 acres at its normal maximum elevation of 66.7’ and a reservoir length of one mile. Water levels in Lake Leonard vary between 65.7’ and 66.7’ during normal project operations.[1] The upper reservoir, Graham Lake, has a full pond surface area of approximately 10,000 acres and a maximum length of approximately 10 miles.

Table E-2: Ellsworth Project Specifications

GENERAL INFORMATION
Owner and Operator: Black Bear Hydro Partners LLC
FERC Project Number: 2727
Current License Term: January 1, 1998 to December 31, 2017
County: Hancock County
Nearest Town: Ellsworth, Maine
Watershed: Union River
River: Union River
Drainage Area: 547 square miles

Ellsworth Development	**Graham Lake Development**
Normal Maximum Water Surface Elevation	
Lake Leonard	**Graham Lake**
66.7’ (includes 1.7 foot flashboards)	104.2’
Normal Tailwater Elevation	
Varies with tidal fluctuations	80.5’
Reservoir Length	
1 mile	10 miles
Shoreline Length	
4.4 miles	80 miles (not including islands)
Surface Area at Maximum Water Surface	
Lake Leonard	**Graham Lake**
90 acres	Approximately 10,000 acres
Gross Storage Lake Leonard 0.107 billion cubic feet	Useable Storage Graham Lake – 5.4 billion cubic feet between elevations 104.2’ and 93.4’
Structures	
Ellsworth Dam	**Graham Lake Dam**
Concrete buttress dam	Earth fill dam with concrete core walls
Total Length 377 feet	Total Length 750 feet

[1] All elevations are in reference to NGVD 1929.

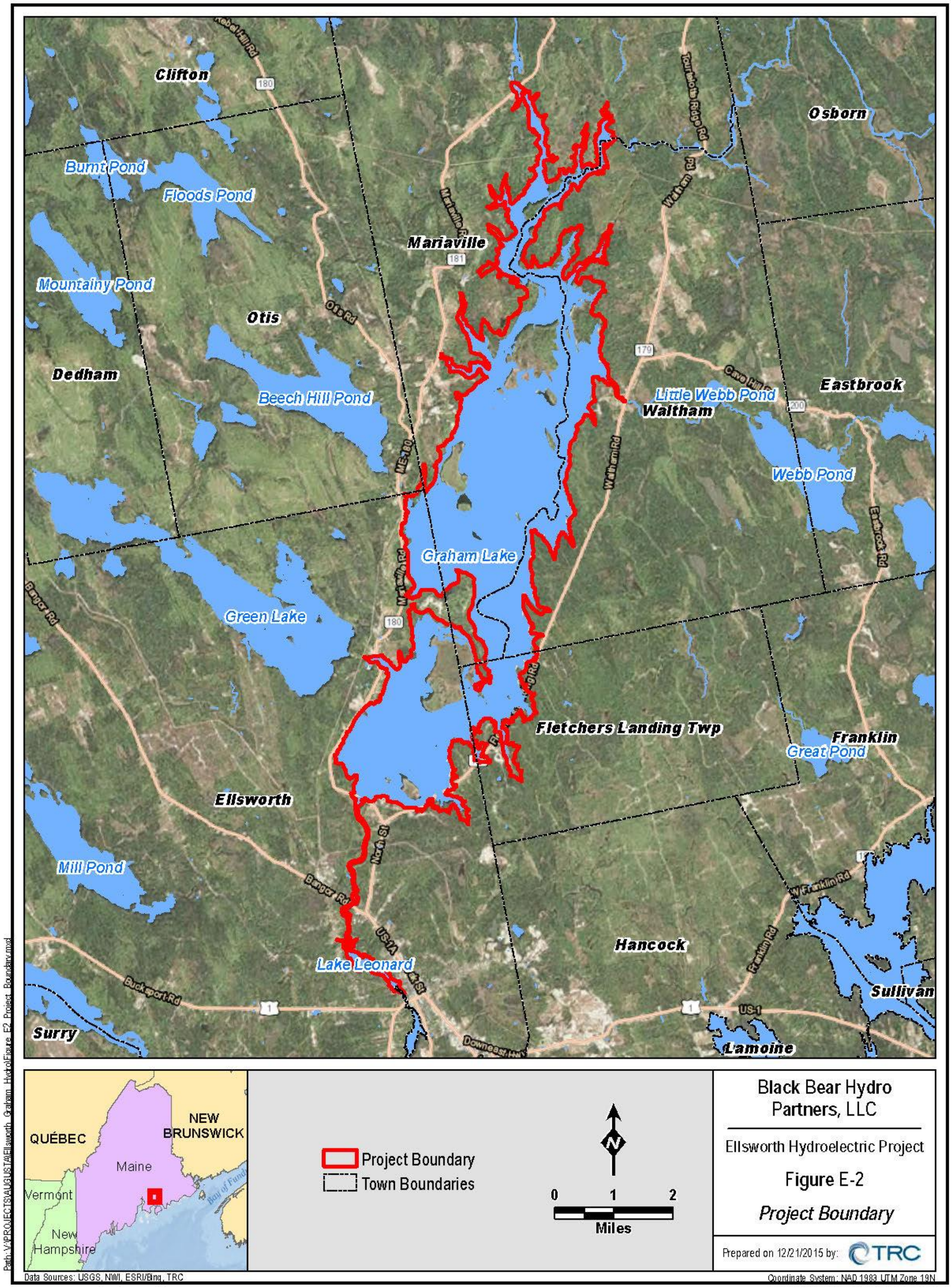
Structures (continued)	
Ellsworth Dam	**Graham Lake Dam**
Penstocks: 10-foot diameter vertical penstock serving Unit 1; two 8-foot diameter penstocks serving powerhouse Units No. 2 and 3, and a 12-foot diameter penstock serving Unit No. 4	N/A
Dam height 65 feet	Dam height 30 feet
Powerhouse: reinforced concrete and concrete block masonry structure 52.5 feet x 68 feet with an attached 15 feet x 30 feet switch house annex	N/A
Turbine Rated Capacity:* Unit 1 – 3,800 hp (2,850 kW) (vertical shaft propeller); minimum generating capacity unknown, approximately 685 cfs maximum hydraulic capacity Unit 2 – 2,900 hp (2,175 kW) (Kaplan); approximately 87 cfs minimum generating capacity and 545 cfs maximum hydraulic capacity Unit 3 – 2,900 hp (2,175 kW) (Kaplan); approximately 87 cfs minimum generating capacity and 545 cfs maximum hydraulic capacity Unit 4 – 3,800 hp (2,850 kW) (vertical shaft propeller); minimum generating capacity unknown, approximately 685 cfs maximum hydraulic capacity	N/A
Generator Rated Capacity:** Unit 1 – 3,125 kVA @ power factor 0.8; 2,500 kW Unit 2 – 2,500 kVA @ power factor 0.8; 2,000 kW Unit 3 – 2,500 kVA @ power factor 0.8; 2,000 kW Unit 4 – 3,000 kVA @ power factor 0.8; 2,400 kW	N/A

*The total combined maximum hydraulic capacity of the turbines is estimated to be 2,460 cfs.
**The total FERC authorized nameplate capacity of the facility, based on the limiting unit components, is 8.9MW.

3.1.2 Existing Project Boundary

The Project boundary generally follows elevation 66.7’ on Lake Leonard and elevation 107’ on Graham Lake. The Project boundary extends downstream from Ellsworth Dam approximately 800 feet. The project boundary also follows metes and bounds delineations surrounding the project facilities as shown on Exhibit G. There are no federal lands within the Project boundary.

Figure E-2: Project Boundary



3.1.3 Project Safety

The Project is classified as a high hazard dam and is subject to the Commission's Emergency Action Plan requirements. The Licensee's engineering or operations staff conducts an inspection annually, and routine repairs are performed as needed. Exhibit H, *Description of Project Management and Need for Power*, provides additional detail regarding the Licensee's safety programs.

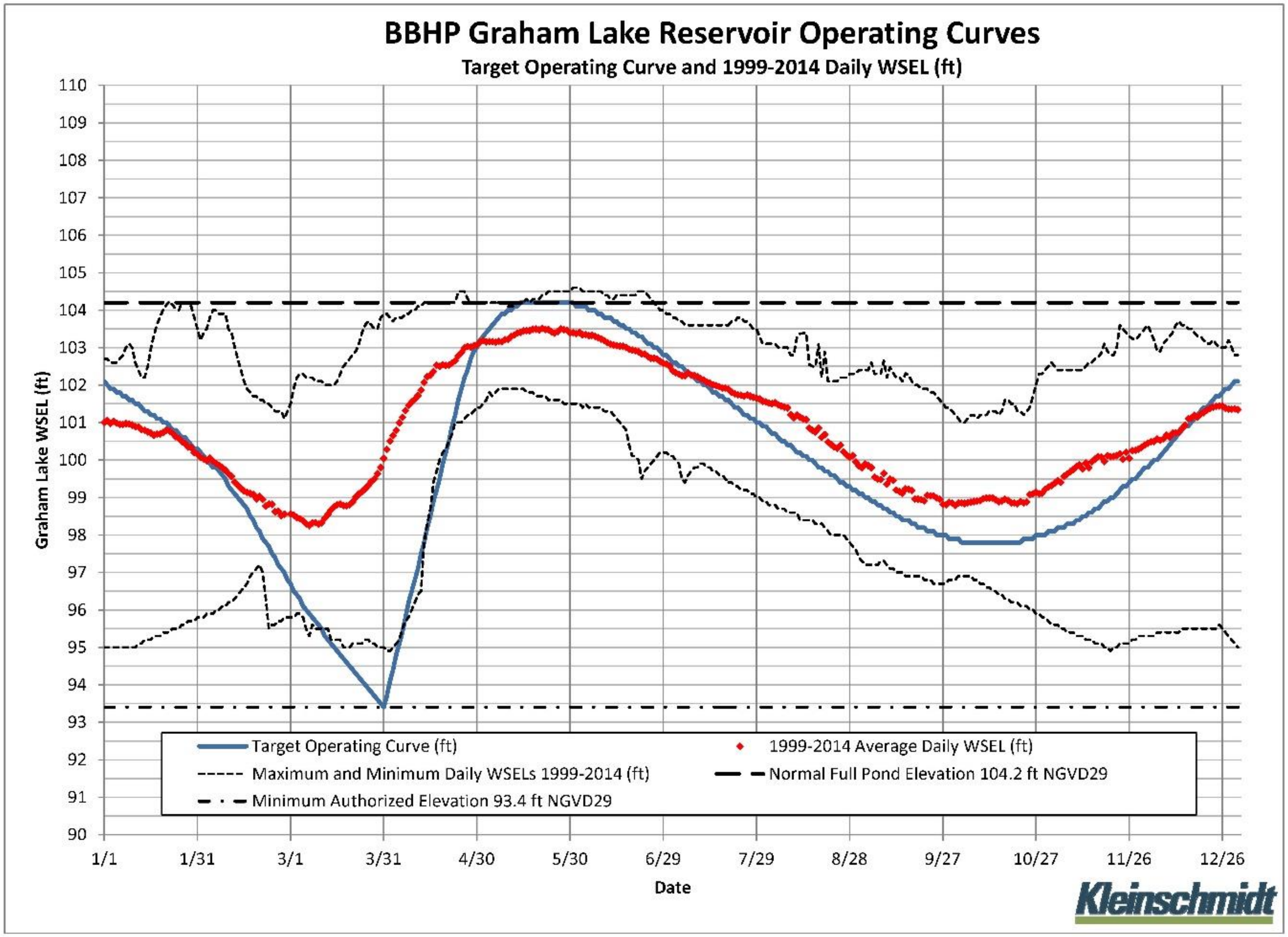
3.1.4 Existing Project Operations

The Project Developments are collectively operated as a peaking project utilizing stored water released at Graham Lake for power production at Ellsworth Dam. The four units contained in the Ellsworth powerhouse have a total FERC-authorized capacity of 8.9 megawatts (MW) with an estimated total hydraulic capacity of approximately 2,460 cubic feet per second (cfs). The Project generated an annual average of 30,511 MWh during the period 1994 – 2014.

The Union River has an average annual flow of 958 cubic feet per second (cfs). Minimum flows and water levels are maintained as per Articles 401 and 402 of the 1987 License. Article 401 specifies a continuous minimum flow release of 105 cfs from the Ellsworth Dam and Graham Dam from July 1 through April 30 and a continuous minimum flow release of 250 cfs from May 1 through June 30 for the protection of fishery resources (FERC 1987). The flows can be temporarily modified if required by operating emergencies beyond the control of Licensee, and for short periods upon on agreement among Licensee, USFWS and Maine DEP.

Article 402 of the current FERC license requires Licensee to operate the Project so that water levels in Lake Leonard are maintained between the elevations of 65.7' and 66.7' during normal project operations, and water levels in Graham Lake are maintained between elevations 104.2' and 93.4'. The requirements can be temporarily modified if required by operating emergencies beyond the control of Licensee, and for short periods upon agreement among Licensee, USFWS and Maine DEP. Timed releases at Graham Lake are used at Ellsworth Dam for power production. Graham Lake generally follows an operating curve that has historically resulted in fluctuations approaching 11 feet over the course of a year (Figure E-3). The normal operation of the Ellsworth facility maintains Lake Leonard to within a foot of normal full pond (i.e. normal variation between elevation 65.7' and 66.7'). Drawdown of Graham Lake in the fall and more extensively at the beginning of the year provides significant downstream flood control benefits. The ability to store large inflows when the lake is drawn down is a particularly valuable asset given the location of downtown Ellsworth just below the Ellsworth Dam. Drawdown of Graham Lake also provides important flow augmentation during dry periods so that minimum flows can be maintained in the Union River below Graham Lake Dam.

Figure E-3: Graham Lake Historic Operating Curves



3.1.5 Existing Environmental Measures

The Licensee currently provides the following PME measures for recreational and aquatic resources:

- Black Bear maintains a continuous minimum flow release of 105 cfs from the Ellsworth Dam and Graham Dam from July 1 through April 30 and a continuous minimum flow release of 250 cfs from May 1 through June 30 for the protection of fishery resources.
- Black Bear operates the Project so that water levels in Lake Leonard are maintained between the elevations of 65.7’ and 66.7’ during normal project operations, and water levels in Graham Lake are maintained between elevations 104.2’ and 93.4’.
- Black Bear maintains a boat launch facility at Graham Lake;
- Black Bear maintains a portage/fisherman’s access trail at Graham Lake
- Black Bear maintains a carry-in boat launch facility at Lake Leonard;
- Black Bear cooperatively manages an upstream fish passage facility at the Ellsworth Dam and provides downstream passage facilities at both Graham and Ellsworth dams.

3.2 Alternatives Considered but Eliminated from Detailed Study

3.2.1 Federal Government Takeover of the Project

No party has suggested that federal takeover of the Project would be appropriate and no federal agency has expressed an interest in operating the Project. The federal takeover of the Project would require congressional approval. Moreover, there is no evidence that indicates a federal takeover should be recommended to Congress. Thus, the federal takeover of the Project is not a reasonable alternative and has not been considered in detail in this analysis.

3.2.2 Issuance of Non-Power License

No party has sought a non-power license and there is no basis for concluding that the Project should no longer be used to produce power. Thus, a non-power license is not a reasonable alternative to a new license with PME measures and has not been considered in detail in this analysis.

3.2.3 Project Decommissioning

Decommissioning of the Project could be accomplished with or without dam removal. Either alternative would require denying the request for a new power license and surrender or termination of the existing license with appropriate conditions.

The Project provides a viable, safe, and clean renewable source of power to the region; therefore, replacement power would need to be identified. The Project contributes to flood control and seasonal water storage in the Union River basin and provides the public with recreational access. If the Project were decommissioned, its contribution to flood control and seasonal water storage in the Union River basin would end and the public would no longer have access to the Project's recreation facilities. In addition, dam removal would lead to the loss of a significant amount of alewife habitat upstream of Graham Lake Dam. The cost of decommissioning as an alternative means of providing for fish passage was generally considered in the Upstream Fish Passage Alternatives Study. However, Project decommissioning is not a reasonable alternative to relicensing the Project with appropriate PME measures and has not been considered in detail in this analysis.

3.3 Proposed Action

3.3.1 Proposed Project Facilities

Black Bear is proposing no power-related modifications of the existing Ellsworth Project facilities. The existing dams, powerhouse, spill gates, and appurtenant features are all well maintained and in good working order. No changes of these facilities that are outside normal maintenance practices or the Commission's safety requirements are required or proposed. Black Bear is, however, proposing to consult with the agencies on appropriate fish passage facilities or measures as described below.

3.3.2 Proposed Project Boundary

Black Bear is proposing no changes to the existing Project boundary, which encloses the project works and impoundments and lands necessary for Project purposes.

3.3.3 Proposed Project Operation

Black Bear is proposing no changes in the way the Ellsworth Project is currently operated. The Project will continue to operate to generate electricity. Black Bear is proposing to maintain the current flow regime, whereby it will provide a seasonally variant minimum flow of 105 cfs or inflow, whichever is less, and 250 cfs or inflow, whichever is less, from the Project. Black Bear is also proposing to operate the impoundments within existing pond level limits. Periodically, the Licensee may be required to modify Project operations, including flows and impoundment levels in order to maintain or repair the Project, consistent with FERC requirements. However, any such planned changes in Project operation would be conducted in accordance with FERC's requirements for notification and consultation, consistent with the new Project license and the final Operations Monitoring Plan (OMP). The draft OMP is attached as Appendix E-11.

The Licensee proposes that the following operating conditions with respect to minimum flows and impoundment levels be included as articles in the new license:

- Minimum Flows

Except as temporarily modified by (1) approved maintenance activities, (2) extreme hydrologic conditions, as defined below, (3) emergency electrical system conditions, as defined below, or (4) agreement between the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies, the Licensee shall release a continuous minimum flow of 105 cubic feet per second (cfs) from the Graham Lake Development and the Ellsworth Development from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30, for the protection of fishery resources.

- Impoundment Levels

Except as temporarily modified by (1) approved maintenance activities, (2) extreme hydrologic conditions, as defined below, (3) emergency electrical system conditions, as defined below, or (4) agreement between the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies, the Licensee shall operate the project so that water levels in Lake Leonard are maintained between the elevations of 65.7’ and 66.7’ (flashboard crest) during normal operation, and water levels in Graham Lake are maintained between 104.2’ and 93.4’.

"Extreme Hydrologic Conditions" means the occurrence of events beyond the Licensee's control such as, but not limited to, abnormal precipitation, extreme runoff, flood conditions, ice conditions or other hydrologic conditions such that the operational restrictions and requirements contained herein are impossible to achieve or are inconsistent with the safe operation of the Project.

"Emergency Electrical System Conditions" means operating emergencies beyond the Licensee's control which require changes in flow regimes to eliminate such emergencies which may in some circumstances include, but are not limited to, equipment failure or other temporary abnormal operating conditions, generating unit operation or third-party mandated interruptions under power supply emergencies, and orders from local, state, or federal law enforcement or public safety authorities.

3.3.4 Proposed Environmental Measures

Black Bear is proposing the following PME measures for the management of resources:

- Implement the following recreation proposals:
    - Implement erosion control measures at the existing Graham Lake boat launch facility;
    - Develop a new portage trail at the west end of Graham Lake Dam;
    - Improve a fisherman's downstream access trail on the east side of Graham Lake Dam;
    - Implement a Recreation Facilities Management Plan (RMP) to include the above measures and management of recreational facilities at the Project;
- Develop, in consultation with fisheries management agencies, plans for upstream eel passage at Ellsworth and Graham Lake Dams;
- Consult with the fisheries management agencies on the need for and, if necessary, the design of downstream eel passage measures pending the results of downstream eel passage studies;
- Consult with the agencies on the need for and, if necessary, the design of upstream and downstream anadromous fish passage improvements pending the results of ongoing studies;
- Finalize and implement a Historic Properties Management Plan to provide for management of historic resources throughout the term of the license;
- Finalize and implement an Operations Monitoring Plan (OMP) specifying the methods the Licensee will use to monitor and report the provision of minimum flows and pond levels, to confirm that the Project is operated in compliance with the new FERC license.

4.0 ENVIRONMENTAL ANALYSIS

4.1 General Description of the River Basin

The Union River Watershed—located in Hancock and Penobscot Counties, in eastern Maine—has a drainage area of approximately 547 square miles above the Ellsworth Dam. The Union River is composed of three main tributaries: the East, West, and Middle Branches. The total length of these branches includes 484 miles of streams and 81 miles of lakes and ponds (URSG 2000).

The river forms at the north end of Graham Lake at the confluence of the river's East and West branches, on the border of the towns of Mariaville and Waltham. It runs south 10 miles through Graham Lake to the dam at the lake's outlet, then continues south through Ellsworth, flowing through Leonard Lake and passing over its outlet dam just above the downtown. The Ellsworth Dam, built in 1907, spans the Union River and forms Lake Leonard. It houses a powerhouse with four generating units that combined produce 30,511 MWh per year, enough to power about 3,000 households. At downtown Ellsworth, the river reaches tidewater, and flows south as an estuary (Union River Bay) for 5 miles (8 km) to the Atlantic Ocean.

4.1.1 Hydrology

The calculated mean annual flow for the Project at the Ellsworth Dam is 958 cfs. Annual and monthly flow duration curves are provided in Appendix A of Exhibit B. These curves were calculated based on daily generation records at the Project.

4.1.2 Topography

The Union River basin is characterized by numerous flat or gently rolling plains, a few high bedrock ridges and monadnocks, and a variety of lakes, ponds, and streams. The basin topography has been shaped primarily by glaciation and marine invasion. Elevations throughout the basin range from sea level to a maximum of 1,300 feet.

The bedrock of the basin consists of highly altered metamorphic rock in the northern portion, and a wide zone of schist and gneiss intruded by great masses of granite along the southern section near the coast. The overburden throughout the basin consists of glacial till aqueo-glacial outwash, and marine sediments. While the glacial till covers most of the bedrock in the region, extensive areas of till have, in turn, been buried by subsequent glacial outwash and marine materials. These materials, consisting of sand and gravel, form numerous and extensive outwash plains, deltas, kames, and eskers. Many of the flat, swampy areas in the basin are largely the result from graded material washed out by the retreating glacier (Bangor Hydro-Electric Company 1984).

4.1.3 Climate

The Ellsworth Project is located in Maine's coastal climatological division, which extends for about twenty miles inland along the length of the coast. The coastal division is tempered by the ocean, resulting in lower summer and higher winter temperatures than are typical of interior zones. In the Ellsworth Project area, the average daily temperature maximum in July is 78^{o} F (26^{o}C) and the average daily minimum is 58^{o} F (14^{o}C). In January the average daily maximum is 30^{o} F (-1^{o}C) and the average daily minimum is 11^{o} F (-12^{o}C). The average annual precipitation in the Project area is 46.8 inches which is typically distributed evenly throughout the year (3-4 inches/month), although some flooding may occur in late winter/early spring due to rain/snowmelt events. Annual snowfall averages approximately 63 inches in the Project area.

4.1.4 Land Uses and Economic Activity

The Ellsworth Project is located in Hancock County, the seventh largest county in terms of land area. Hancock County is rural and sparsely populated, ranking eighth out of 16 in population. Hancock County's population is density is 34.3 persons per square mile, which is lower than the state of Maine average of 43.1 persons per square mile (U.S. Census Bureau, 2015h).

Approximately 90.2 percent of Hancock County is comprised of forested land (USDA, 2005). The City of Ellsworth, Towns of Mariaville and Waltham, and Fletchers Landing Township are in the Northeast Maine nonmetropolitan area (BLS, 2013). While lands within the Project vicinity are predominately undeveloped forest lands and wetlands, the city of Ellsworth is an area of relatively dense population (7,741 in 2010) within the County. Forestry is a common land use in the area, while agricultural uses include apple orchards and blueberry barrens (Ellsworth Comprehensive Planning Committee, 2004, Mariaville Comprehensive Planning Committee, 2006).

There were an estimated 24,355 households in Hancock County, which was approximately 4.4 percent of the state's households based upon the Census 2009-2013 American Community Survey Estimate values. The median household income in Hancock County was $47,460. Approximately 14.0 percent of the population of Hancock County was below the poverty level, while the percent of the state's population living below poverty level was lower at 13.6 percent (US Census Bureau, 2015h). Hancock County had a higher unemployment rate (7.8 percent) as compared to the overall state (5.5 percent) in December 2014 based upon the data derived from the Local Area Unemployment Statistics (LAUS) program (Maine CRWI, 2015).

In Hancock County, as well as the entire state of Maine, the top two sources of employment are in education and health services (7,336 people employed) and in the retail trade industry (3,286 people employed) (US Census, 2015b and 2015c). The largest employer in Hancock County is Jackson Laboratory, which employed over 1,000 people in 2014 (MDOL, 2014).

4.1.5 Dams and Diversions

Other than the Ellsworth and Graham Lake Dams, there are no other dams or diversions on the main stem Union River[2]. The Ellsworth Dam is at the head-of-tide of the Union River which empties into Union River Bay in the Atlantic Ocean approximately three miles downstream from the Project.

4.2 Cumulative Effects

4.2.1 Resources that could be Cumulatively Affected

In SD1, the Commission identified migratory fish (i.e., alewife, American eel, American shad, Atlantic salmon, Atlantic sturgeon, blueback herring, and striped bass) and water quality as resources that could be cumulatively affected by the proposed continued operation and maintenance of the Ellsworth Project in combination with other hydroelectric projects and other activities in the Union River Basin. The effects analyses for the resources identified as having the potential to be cumulatively affected appear in the applicable resource area sections.

4.2.2 Geographic Scope of Cumulative Effects Analysis

The geographic scope of the analysis for cumulatively affected resources is defined by the physical limits or boundaries of (1) the proposed action's effect on the resources, and (2) contributing effects from other hydropower and non-hydropower activities within the Union River Basin. In SD1 the Commission identified the geographic scope for migratory fish species to include the Union River Basin from Union River Bay upstream to Great Pond on the West Branch Union River, to Alligator Lake on the Middle Branch Union River, and to Rocky Pond on the East Branch Union River. The Commission chose this geographic scope because operation and maintenance of the Ellsworth Project, in combination with other hydroelectric projects and activities in the Union River Basin, may directly affect migratory fish species or affect access to and quantity of migratory fish habitat.

4.2.3 Temporal Scope of Cumulative Effects Analysis

The temporal scope of the environmental analysis includes the past, present, and reasonably foreseeable future actions and their effects on migratory fish and water quality. Based on the potential term of the new license for the Ellsworth Project, the temporal scope will look 30 to 50 years into the future, concentrating on the effect on resources of reasonably foreseeable actions. The historical discussion will, by necessity, be limited to the amount of available information for each resource.

[2] The Green Lake Project, FERC No. 7189 is located on Reeds Brook, a tributary of Graham Lake.

4.3 Applicable Laws

4.3.1 Section 401 of the Clean Water Act

Pursuant to Section 401 of the Federal Water Pollution Act, Public Law 92-500 as amended, Black Bear is required to apply for Water Quality Certification for the federal licensing of the continued operation of the Project.

As part of the ILP, Black Bear consulted with the Maine Department of Environmental Protection (Maine DEP) throughout the relicensing process. Black Bear will file an Application for Water Quality Certification with Maine DEP subsequent to the FERC notice of Ready for Environmental Analysis (REA).

4.3.2 Endangered Species Act

The federal Endangered Species Act (ESA) (16 U.S.C. 1531-1544 – Public Law 93-205) provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The lead federal agencies for implementing the ESA are the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS). The USFWS maintains a nationwide list of endangered species. The law requires federal agencies, in consultation with the USFWS or NOAA to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. Section 9 of the ESA prohibits taking endangered species of fish and wildlife. The regulations implementing ESA define “take” as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct.

As part of the ILP, Black Bear consulted with the USFWS and the NOAA throughout the relicensing process to assess potential Project effects on federally listed threatened and endangered species in the Project area. Rare, threatened and endangered species at the Project are listed in Section 4.4.6 of this Exhibit E and described in detail in relevant sections of this Exhibit E. The federally listed Atlantic salmon is documented in the project area. A draft Biological Assessment for Atlantic salmon is included in Appendix E-12.

4.3.3 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Steven Fishery Conservation and Management Reauthorization Act of 2006 mandated that habitats essential to federally managed commercial fish species be identified, and that measures be taken to conserve and enhance habitat. In the amended Act, Congress defined essential fish habitat (EFH) for federally managed fish species as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". The designation and conservation of EFH seeks to minimize adverse effects on habitat caused by fishing and non-fishing activities.

Before a Federal agency proceeds with an activity that may adversely affect a designated EFH (e.g., relicensing of a hydro project), the agency must: 1) consult with NOAA Fisheries and, if requested, the appropriate Council for the recommended measures to conserve EFH and 2) reply within thirty days of receiving EFH recommendations. The agency response must include proposed measures to avoid or minimize adverse impacts on the habitat, or alternatively an explanation if the agency cannot adhere to the recommendation from NOAA Fisheries.

Essential fish habitat for Atlantic salmon is described as all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut (NEFMC 1998). The EFH designated habitat for all life stages of Atlantic salmon (eggs, larvae, juveniles, and adults) in Maine includes the Union River and Union River Bay, including the Project area. Black Bear provides its EFH assessment in Section 4.5

4.3.4 Coastal Zone Management Act

Under section 307(c) (3) (A) of the Coastal Zone Management Act (CZMA), the Commission cannot issue a license for a project within or affecting a states' coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the states' CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

The Ellsworth Project is located in the City of Ellsworth at the head of tide of the Union River, within the Maine Coastal Zone. Black Bear will, subsequent to the FERC issuance of the REA, submit a certificate of consistency to the Maine Coastal Program in the Maine Department of Agriculture, Conservation and Forestry for their review and concurrence.

4.3.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, requires FERC to take into account the effect of its undertakings on historic properties. In this case the undertaking includes the issuance of a federal license for the continued operation of the Ellsworth Project. Section 106 of the NHPA is implemented through the Advisory Council on Historic Preservation (Council regulations "Protection of Historic Properties" (36 CFR Part 800). For hydropower licensing actions, FERC typically completes Section 106 by entering into a Programmatic Agreement or Memorandum of Agreement (MOA) with the licensee, the Advisory Council on Historic Preservation (ACHP), and the state and tribal historic preservation office. FERC typically requires the licensee to develop and implement a Historic Properties Management Plan (HPMP) as a license condition. Through an approved HPMP, FERC can require consideration and management of effects on historic properties for the license term; thus, meeting the requirements of Section 106 for its undertakings.

As part of the relicensing process, Black Bear consulted with the State Historic Preservation Officer (SHPO) and the Tribes that may have an interest in the Project, as appropriate, regarding the Phase I archaeological survey, Phase II archaeological testing and the historic architectural survey of the Project area. A draft HPMP is attached as Appendix E-10 and proposes the process and measures to be taken by Black Bear to protect and preserve the historic properties identified at the Project over the term of the new license. With the implementation of an approved HPMP, the continued operation of the Project as proposed by Black Bear will have no significant adverse impacts on cultural resources at the Project.

4.3.6 Wild and Scenic Rivers and Wilderness Acts

The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law 90-542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. Rivers are classified as wild, scenic, or recreational.

The Wilderness Act of 1964 [Public Law 88-577 (16 U.S.C. 1131-1136)] was enacted to establish a National Wilderness Preservation System for the permanent good of the whole people, and for other purposes.

There are no nationally designated wild and scenic rivers or wilderness areas within the Project boundary or in the vicinity of the Project.

4.4 Proposed Action

4.4.1 Geology and Soils

4.4.1.1 Affected Environment

The Ellsworth Project is located within the eastern coast of Hancock County in an area of the State that was modified heavily by glacial activity. The majority of the landscape in the vicinity of the Project is gently sloping valleys draining into the coastal lowlands of the southern portion of the county. Elevations throughout the basin range from sea level to a maximum of 1300 feet.

Geological Features

The Project area is contained within three biophysical regions in the State of Maine: Central Interior, the Eastern Lowlands, and Penobscot Bay regions (Figure E-4). The Central Interior biophysical region is characterized by sedimentary and metamorphic bedrock overlain by deep, well to moderately drained, coarse sandy loam soils. The Penobscot Bay Region is distinguished by granitic plutons and granite. The Eastern Lowlands Biophysical Region is comprised of mineral soils that are generally wet and dense with glaciolacustrine deposits and glaciomarine clays. Depressions within this region are commonly filled with organic soils, mucks, clays, and silts (Maine DIF&W, 2005).

The underlying bedrock within the region is complex with alternating bands of metasedimentary and metavolcanic rocks (Maine DIF&W, 2005). Geologic formations dating from the Ordovician and Cambrian periods consist of stratified rocks including Penobscot formation of schist and pelitic slate and unnamed volcanic rocks and the Ellsworth Schist, a type of quartz-feldspar-muscovite-chlorite schist (MGS, 2008).

Soils

Soils within the Union River Basin consist mainly of marine clays in the low-lying areas, and glacial tills above. The tills are of a coarse sandy or stony nature, are well to excessively drained, and contain hardpan about two to three feet below the surface. The soils in the Project area fall into four dominate soil association units: Lamoine-Lyman-Dixfield; Hermon-Dixfield-Lyman; Colton-Sheepscot-Adams; and Dixfield-Marlow-Brayton. Table E-3 lists the soil series known to occur in the Project area.

The majority of the Project lies within the Lamoine-Lyman-Dixfield unit, which is comprised of loamy and clayey soils deposited over bedrock (Ferwerda, 1997). Drainage ranges from the somewhat excessively drained Lyman soil to the somewhat poorly drained Lamoine soil (NRCS, 1988).

The second general soil group within the Project area is the Hermon-Dixfield-Lyman unit, located on the west side of Graham Lake. These soils are characterized by sandy loams that are very stony to extremely bouldery on upland till ridges surrounding lakes, ponds, and valleys. Drainage classes within the general unit range from somewhat excessively drained to moderately well drained Dixfield soil (NRCS, 1988).

The third general soil group is the Colton-Sheepscot-Adams unit, located on the west side of Graham Lake. Soils here are very deep and range from steep slope to relatively flat with moderately well drained to excessively drained soils formed in glaciofluvial sand and gravel. These soils are poorly to very poorly drained.

Figure E-4: Biophysical Regions

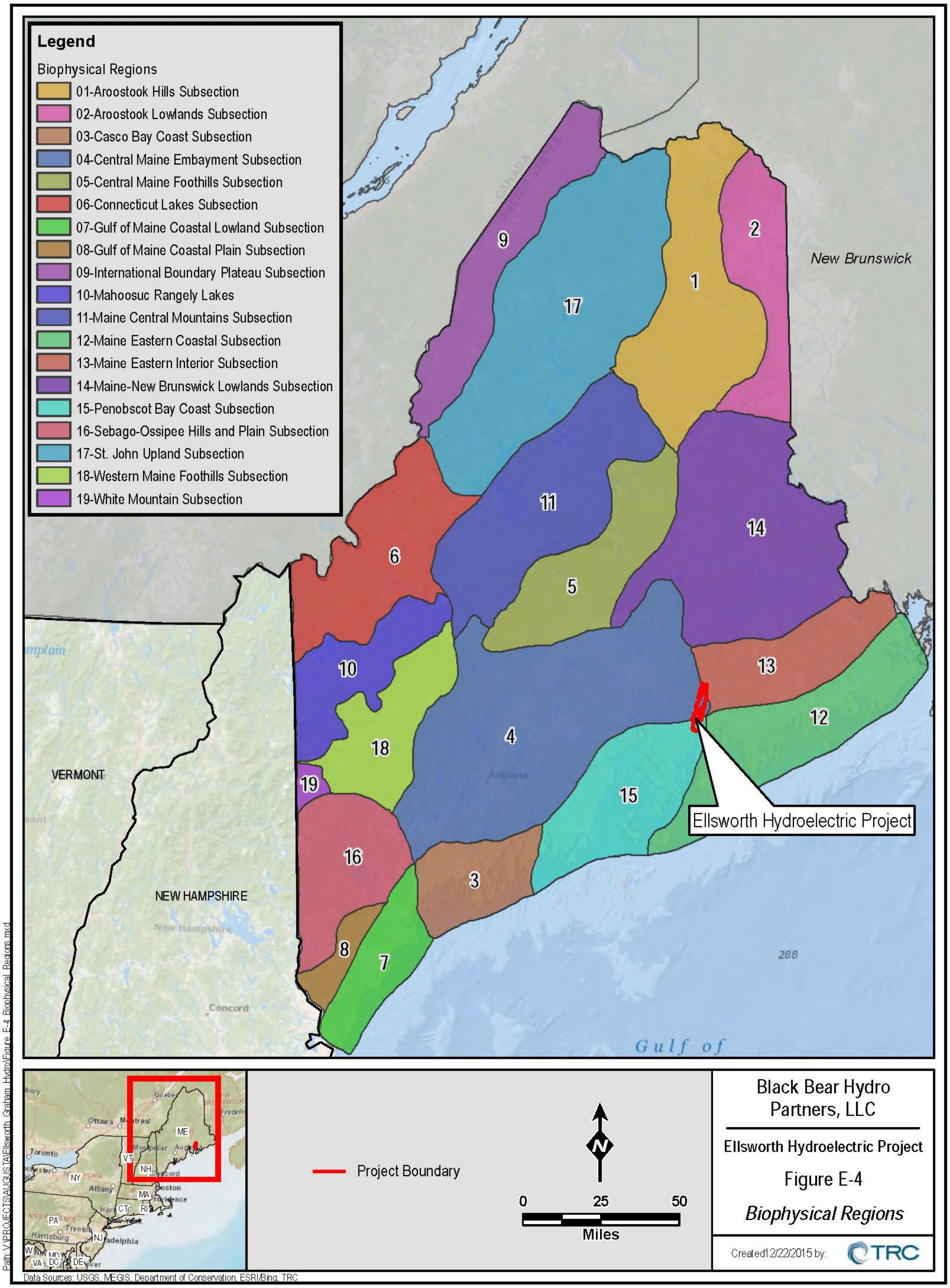


Figure E-5: Hancock County General Soil Map

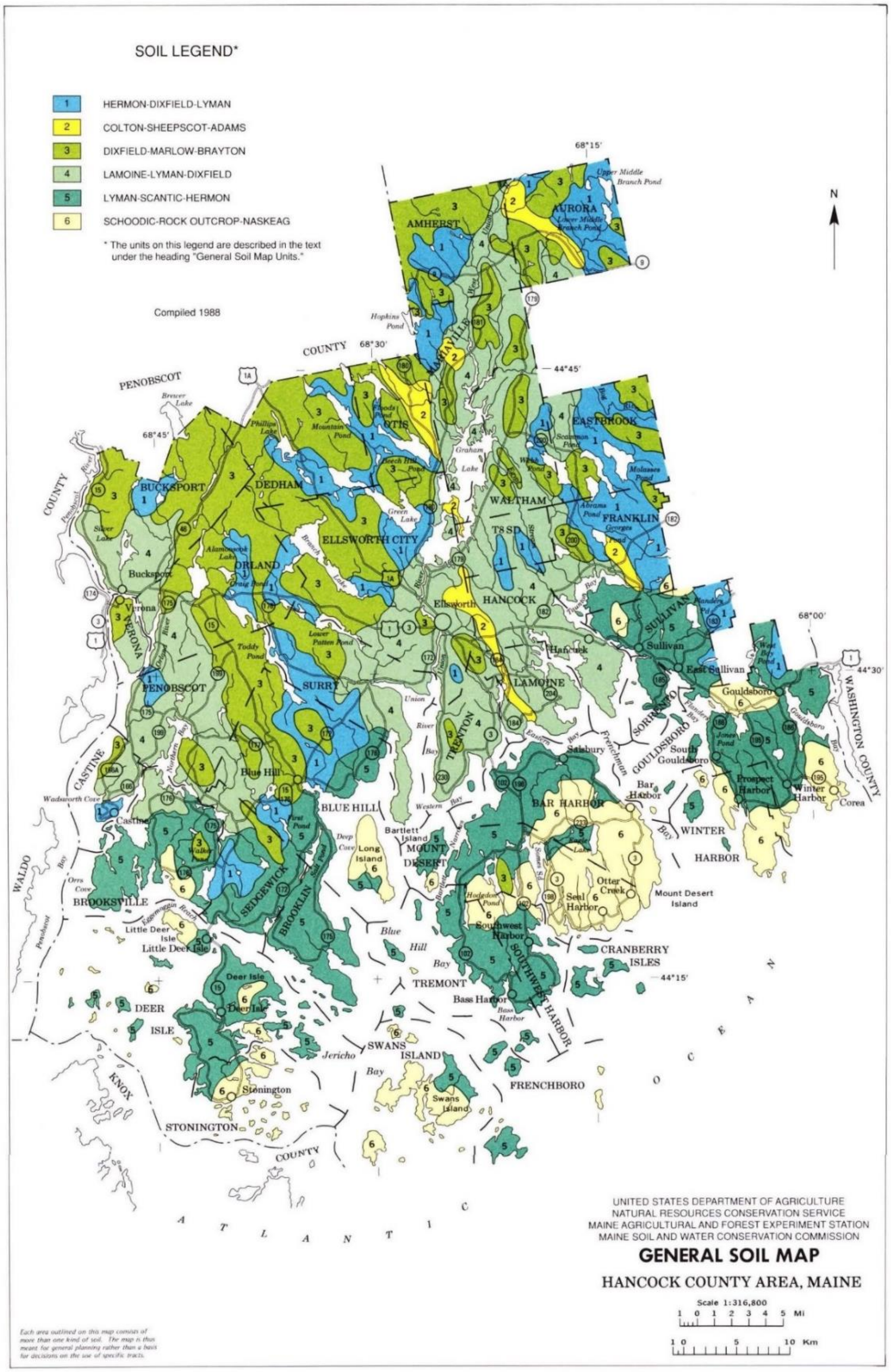


Figure E-6: Project Area Soils

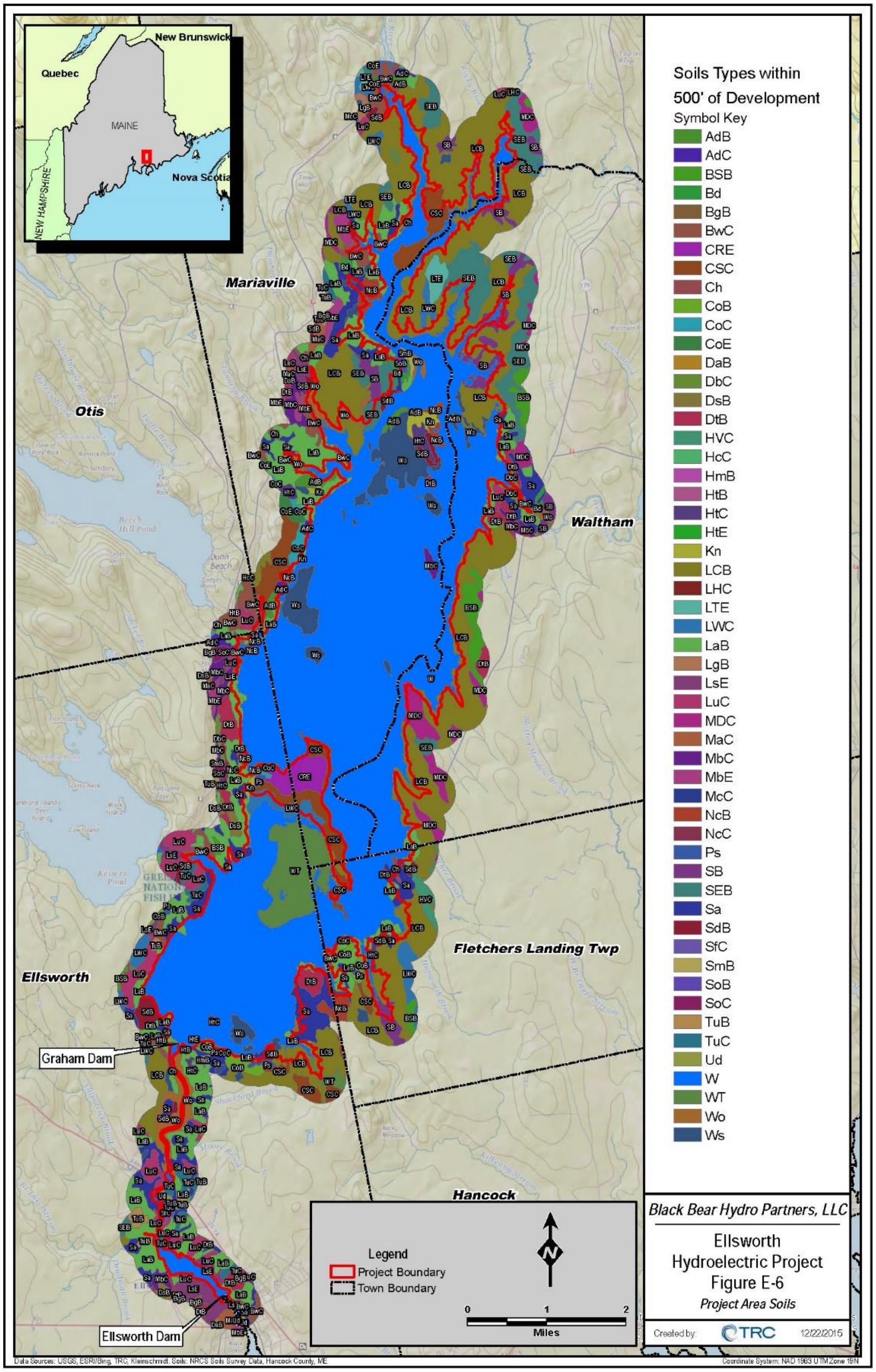


Table E-3: Soils Series Occurring within the Ellsworth Project Area

Soils Unit Symbol	Soils Unit Name
AdB	Adams loamy sand, 0 to 8 percent slopes
AdC	Adams loamy sand, 8 to 15 percent slopes
Bd	Biddeford mucky peat, 0 to 3 percent slopes
BgB	Brayton fine sandy loam, 0 to 8 percent slopes, very stony
BSB	Brayton-Colonel association, gently sloping, very stony
BwC	Buxton silt loam, 8 to 15 percent slopes
Ch	Charles silt loam, 0 to 2 percent slopes, occasionally flooded
CoB	Colton gravelly sandy loam, 0 to 8 percent slopes
CoC	Colton gravelly sandy loam, 8 to 15 percent slopes
CoE	Colton gravelly sandy loam, 15 to 45 percent slopes
CRE	Colton-Adams association, steep
CSC	Colton-Adams-Sheepscot association, strongly sloping
DaB	Dixfield fine sandy loam, 3 to 8 percent slopes
DbC	Dixfield fine sandy loam, 8 to 15 percent slopes, very stony
DsB	Dixfield-Colonel complex, 3 to 8 percent slopes
DtB	Dixfield-Colonel complex, 3 to 8 percent slopes, very stony
HcC	Hermon-Colton-Rock outcrop complex, 3 to 15 percent slopes, very stony
HmB	Hermon-Monadnock complex, 3 to 8 percent slopes
HtB	Hermon-Monadnock complex, 3 to 8 percent slopes, very stony
HtC	Hermon-Monadnock complex, 8 to 15 percent slopes, very stony
HtE	Hermon-Monadnock complex, 15 to 45 percent slopes, very stony
HVC	Hermon-Monadnock-Dixfield complex, strongly sloping, very stony
Kn	Kinsman loamy sand
LaB	Lamoine silt loam, 3 to 8 percent slopes
LCB	Lamoine-Scantic-Buxton association, gently sloping
LgB	Lyman-Brayton complex, 3 to 15 percent slopes, very stony
LHC	Lyman-Brayton-Schoodic complex, 3 to 15 percent slopes , rocky
LsE	Lyman-Schoodic complex, 15 to 35 percent slopes, rocky
LTE	Lyman-Schoodic-Rock outcrop complex, 15 to 35 percent slopes, very stony
LuC	Lyman-Tunbridge complex, 0 to 15 percent slopes, very stony
LWC	Lyman-Tunbridge-Schoodic complex, 8 to 15 percent slopes, very stony
MaC	Marlow fine sandy loam, 8 to 15 percent slopes
MbC	Marlow fine sandy loam, 8 to 15 percent slopes, very stony

Soils Unit Symbol	Soils Unit Name
MbE	Marlow fine sandy loam, 15 to 45 percent slopes, very stony
McC	Marlow fine sandy loam, 3 to 15 percent slopes, extremely bouldery
MDC	Marlow-Dixfield association, strongly sloping, very stony
NcB	Nicholville very fine sandy loam, 3 to 8 percent slopes
NcC	Nicholville very fine sandy loam, 8 to 15 percent slopes
Ps	Pits, gravel and sand
Sa	Scantic silt loam, 0 to 3 percent slopes
SB	Scantic-Biddeford complex, 0 to 3 percent slopes
SdB	Scantic-Lamoine complex, 0 to 8 percent slopes, very stony
SEB	Scantic-Lamoine-Dixfield complex, gently sloping, very stony
SfC	Schoodic-Rock outcrop complex, 0 to 15 percent slopes
SmB	Sheepscot sandy loam, 0 to 8 percent slopes
SoB	Sheepscot sandy loam, 3 to 8 percent slopes, very stony
SoC	Sheepscot sandy loam, 8 to 15 percent slopes, very stony
TuB	Tunbridge-Lyman complex, 3 to 8 percent slopes, rocky
TuC	Tunbridge-Lyman complex, 8 to 15 percent slopes, rocky
Ud	Udorthents-Urban land complex
W	Water bodies
Wo	Wonsqueak muck, flooded
Ws	Wonsqueak and Bucksport mucks
WT	Wonsqueak, Bucksport, and Sebago soils

Source: NRCS 2015

The final general soil group is the Dixfield-Marlow-Brayton unit, located west of Lake Leonard. These soils consist of very deep compact upland glacial till that is poorly to well drained with steep to nearly flat topography.

Exposed boulder/ledge substrate is limited in, and around, Graham Lake. Boulder/cobble substrate mixed with sand and gravel is the most common substrate along the east shore of Graham Lake and the islands. The western shore of Graham Lake is made up of varying ratios of clay and finer sands as well as medium to coarse sands and some fine gravel. Some small areas (predominantly in the southwest area of Graham Lake) have boulder and cobble areas. A combination of clay, sand, gravel, and organic substrates are present where the Union River enters the northern portion of Graham Lake (Northrop, Devine & Tarbell, Inc., 1990).

Portions of the shoreline along Graham Lake are comprised of highly erodible soils, including sand and gravel. Erosion has been observed in select areas along the shoreline of Graham Lake, including bank slumps located primarily along the western shore of the impoundment. The shoreline of Lake Leonard is composed of ledge and stony glacial soils with gentle to moderate slopes. The Ellsworth Dam is located in a gorge of solid bedrock.

4.4.1.2 Environmental Effects

Potential Project effects to geology and soil resources are limited to the possibility that water level fluctuations may impact soils and geologic resources through shoreline erosion. Shoreline erosion is present along portions of Graham Lake. The combination of wave and ice action, erodible soils, and water level fluctuations may contribute to this erosion within Graham Lake (FERC, 1987). Much of the shoreline is heavily vegetated with forest and wetland habitats, which reduce the potential for erosion along the shoreline.

During prior relicensing proceedings, the Maine DEP was cited as stating that the existing full pond elevation limit of 104.2 feet appears adequate for managing shoreline erosion, and recommended that the Graham Lake surface elevation be maintained between elevation 104.2 feet and 93.4 feet (FERC 1987). To minimize shoreline erosion and turbidity in Lake Leonard, DEP recommended that the lake level of Lake Leonard be maintained within 1 foot of the crest of the Ellsworth Dam flashboards; that is, 65.7 feet and 66.7 feet (FERC 1987). FERC's 1987 Environmental Assessment indicated that an unavoidable adverse impact of the Project, "…would be some increase in suspended sediment from wave and ice action on shoreline areas."

The Licensee developed a study plan in 1990 to determine the effectiveness of the water elevation management plan in controlling shoreline erosion, protecting water quality, and providing for enhancement of fish and wildlife resources in response to Article 403 of the 1987 FERC license. This study, conducted by Northrup, Devine and Tarbell, Inc. 1990, concluded that, "The observations made as part of the study of the effectiveness of the present water elevation management plan confirmed that a majority of the shoreline at Graham Lake has been subject to erosion forces since the establishment of the original impoundment. The majority of the soils that exist at the Graham Lake site are silt, sand, and clay and tills which are all susceptible to erosion forces. Observations confirm that the present operating rule curve has reduced the erosion conditions and reduced the risk of erosion damage to camp owners bordering the lake. Minor erosion continues to take place along some sections of the shoreline. These shoreline areas are predominantly effected by wave action under the maximum water levels that occur in the spring."

Stakeholders did not express concerns, provide comments, or submit study plan requests to address soil erosion or suspended sediments during the scoping phase of this current relicensing process. However, during relicensing studies the Licensee noted that the Graham Lake boat launch site is sloped such that runoff from the site concentrates along the east side of the launch ramp. During periods of high runoff erosion has occurred along the edge of the launch. Black Bear proposes to regrade the parking area such that runoff is more evenly dispersed off the site thereby reducing the erosive capacity in the area of the ramp.

Black Bear is proposing no changes of operations; therefore, Black Bear anticipates that continued operation of the Ellsworth Project will not significantly affect geological and soil resources.

4.4.1.3 Proposed Environmental Measures

Black Bear is proposing to continue operating the Project under the current operating regime. Black Bear is proposing remedial measures to address erosion occurring at the public boat launch. These measures are discussed in Section 4.4.1.2.

4.4.1.5 Unavoidable Adverse Effects

Some small amounts of erosion and sedimentation may occur within the Project boundary as a result of continued Project operation. However, Black Bear has demonstrated that operation of the Ellsworth Project has a limited effect on geological resources and soil; therefore, PME measures are not warranted.

4.4.2 Water Resources

4.4.2.1 Affected Environment

Water Resources Overview

The Project area is located within the Union River watershed and encompasses portions of the Union River, Lake Leonard, and Graham Lake. The Union River watershed encompasses approximately 547 square miles in Hancock and Penobscot Counties in Maine (Maine DEP, MDIF&W, and MEGIS, 2010) and includes 484 miles of streams and 81 miles of lakes and ponds) (College of the Atlantic, 2004). The Union River watershed is bordered by coastal rivers and by the Gulf of Maine to the south, the Penobscot River basin to the west and north, and the Narraguagus River basin to the east (FERC, 1987a).

The Project creates two impoundments on the Union River, Lake Leonard which is a small impoundment, and Graham Lake which is a larger storage reservoir. Ellsworth Dam, the lower dam, is located at the upper limit of tidal influence of the Union River, impounds Lake Leonard, and is the site of power generation. Lake Leonard has a surface area of approximately 90 acres at its normal maximum elevation of 66.7’, a width of up to 0.3 miles and a maximum length of approximately 1.0 mile. Lake Leonard has a volume of 751 acre-feet (Mohler, 2012a).

Graham Lake is the storage reservoir formed by the Graham Lake Dam. The Graham Lake Dam is located approximately four miles upstream of the Ellsworth Dam. Graham Lake has a surface area of approximately 10,000 acres at a normal full pond surface elevation of 104.2’; a maximum width of 2.75 miles; and a maximum length of approximately 10 miles. Graham Lake has a volume of approximately 124,000 acre-feet.

Drainage Area

The Union River at the Ellsworth Dam has an average annual flow of approximately 958 cfs from a drainage area of approximately 547 square miles (Maine DEP, 1987 and Maine DEP, MDIF&W, and MEGIS, 2010). The total drainage area at Graham Dam is approximately 499 square miles (Maine DEP, MDIF&W, and MEGIS, 2010).

The Union River originates from the following sources: Great Pond (West Branch) in Great Pond Township approximately 18 miles north of Graham Lake; Upper Middle Branch Pond (Alligator Lake) (Middle Branch) approximately 14 miles northeast of Graham Lake; and Rocky Pond (East Branch) approximately 24 miles northeast of Graham Lake. The Union River is approximately 65 miles long. Topographically, the watershed is hilly, but also has numerous flat or gently rolling plains, a few high bedrock ridges and monadnocks, and a variety of lakes, ponds, and streams with associated marshes, bogs and forested wetlands (FERC 1987b, College of the Atlantic 2004). The Union River flows into Union River Bay in the Atlantic Ocean, approximately three miles downstream from the Project (FERC, 1987a).

In addition to the East and West Branches of the Union River, Graham Lake receives flow from the outlets of Beech Hill Pond, Webb Pond (Webb Brook), and Green Lake (Reed’s Brook) (USFWS, 2005). Other tributaries to Graham Lake include Little Meadow Brook, Rocky Brook, Jordan Brook, Dumb Brook, Tannery Brook, Rankin Brook, Day Brook, Hapworth Brook, Archer Brook, Cyreno Brook, and several unnamed tributaries.

Lake Leonard receives flow from the outlet of Branch Lake (Branch Lake Stream) and two unnamed tributaries. Furthermore, Grey, Shackford, Moore and Gilpatrick Brooks and some unnamed tributaries, flow into the Union River downstream of Graham Lake and upstream of Lake Leonard.

Streamflow, Gage Data and Flow Statistics

Black Bear uses the waters of the Union River for water storage at the Graham Lake Dam and for power generation at the Ellsworth Dam. Operationally the Project is typically run as a peaking project, with water being released from the Graham Lake reservoir and then used to generate electricity at the downstream Ellsworth powerhouse. Water levels in Lake Leonard vary very little over the course of the year. Water levels in Graham Lake are managed between elevations 93.4’ (end of March in order to provide storage capacity for spring rains and snow melt runoff) and 104.2’ (typically in late May after spring runoff). This provides significant downstream flood control benefits. Water levels then gradually decline over the summer months down to approximately 98’ in mid-October after which the lake is partially refilled at the first of the year.

Black Bear operates the Project as a peaking facility, depending on available inflows. Under Article 401 of the FERC license, Licensee is required to release a continuous minimum flow of 105 cubic feet per second (cfs) from the Ellsworth Dam and the Graham Lake Dam from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30, for the protection of fishery resources (FERC 1987b). Timed releases from Graham Lake storage are used at the Ellsworth Dam for power production. Figure E-7 depicts the historic Graham Lake Reservoir Operating Curves.

Table E-4: Annual and Monthly Maximum, Average and Minimum Flow (cfs) for the Ellsworth Dam

Ellsworth Dam Monthly Minimum, Average, and Maximum Flows - 1994-2014 (cfs)												
	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Maximum	1984	2053	2353	2132	2294	1662	1605	853	1698	1690	2323	2391
Average	1226	1209	1377	1520	1194	832	530	416	446	615	937	1194
Minimum	88	248	576	407	504	403	50	129	170	80	108	76

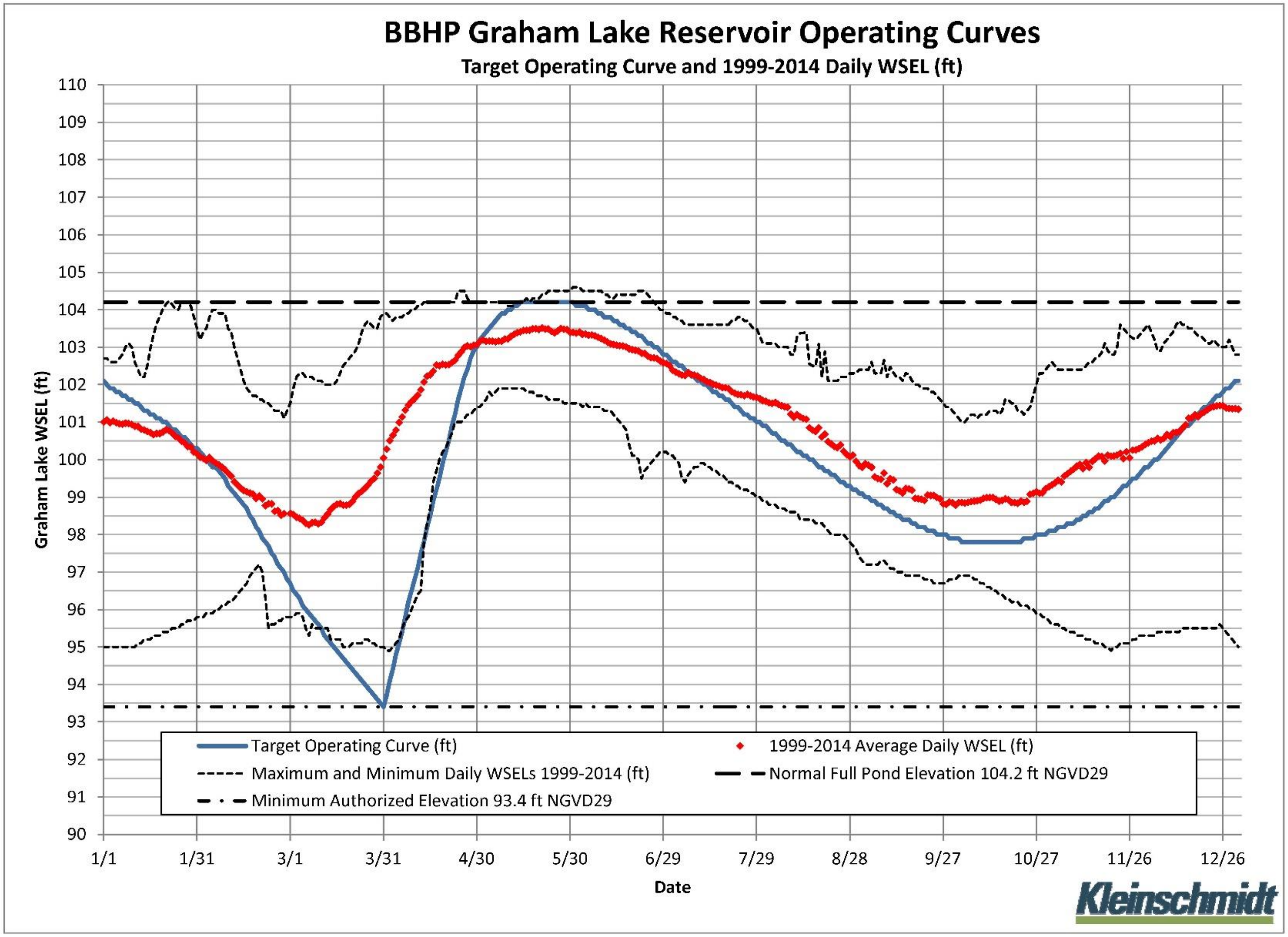
Existing and Proposed Uses of Water

Water within the Project area is not used for major consumption, irrigation, municipal water supply, or industrial purposes, although some seasonal residential use does occur. There are no known major withdrawals of water from the Project impoundments.

Potential sources of non-point source discharge into the Union River watershed include agricultural run-off, road salt, and sediment inputs due to land use activities. Permitted point source discharges to the Project impoundment include effluent from the U.S. Fish and Wildlife Service’s Green Lake National Fish Hatchery, which discharges to Reed’s Brook, the outlet stream of Green Lake and a tributary to Graham Lake (USFWS, 2005).

Black Bear currently proposes to continue the operational pattern of the Project and does not propose to modify the existing uses of water at the Project.

Figure E-7: Graham Lake Historic Operating Curves



Existing Instream Flow Uses

The primary developmental uses of inflows to the Project are water storage and hydroelectric generation, and to a limited extent recreation. Recreational uses include boating and fishing.

Upstream from the Project, there are five retired, unlicensed hydroelectric projects and one operating, licensed project (the Green Lake Dam). Branch Lake, which is an impoundment of Branch Lake Stream, a tributary of Lake Leonard, provides water to the Ellsworth Water Company for domestic use (Bangor Hydro-Electric Company, 1984).

The City of Ellsworth's municipal waste water treatment plant discharges into the Union River estuary approximately 0.5 miles downstream from the Ellsworth Dam (Maine DEP, 1987).

Existing Water Rights

Currently, no major withdrawals are made from Graham Lake, Lake Leonard, or the Union River within the Project boundary. Black Bear has all the ownership or flowage easements necessary to operate the Project. There is no commercial development and there are no residences within the Project boundary along Lake Leonard or the Union River. There is existing residential development within the Project boundary on Graham Lake, most of which are seasonal dwellings.

Impoundment Bathymetry

Graham Lake is oriented in a north-south direction and flow is from north to south. The lake is divided into two large basins (a north and a south basin) by a peninsula that originates from the western shore (USFWS, 2005). The lake is irregular in shape with numerous coves and inlets. The mean depth of Graham Lake is 17 feet, and the maximum depth is 47 feet. Figure E-8 depicts the bathymetry of Graham Lake. This figure was developed from ortho-photo based shape files of the Graham Lake shoreline at known dates (August 22, 2007, and May 19, 2004) and lake elevations (99.0’ and 103.9’ respectively). A third elevation, 102.5’ was interpolated between the 99.0’ and 103.9 elevations. Figure E-9 is a sounding map of Graham Lake developed by the Maine Department of Inland Fisheries and Wildlife (revised 1980). Lake Leonard runs northwest to southeast with flow in the same direction, has a mean depth of 25 feet and a maximum depth of 55 feet. Figure E-10 is a sounding map of Lake Leonard developed by the Maine Department of Inland Fisheries and Wildlife (1960). Morphometric information for Lake Leonard and Graham Lake is presented in Table E-5 below.

Figure E-8: Graham Lake Bathymetry Map

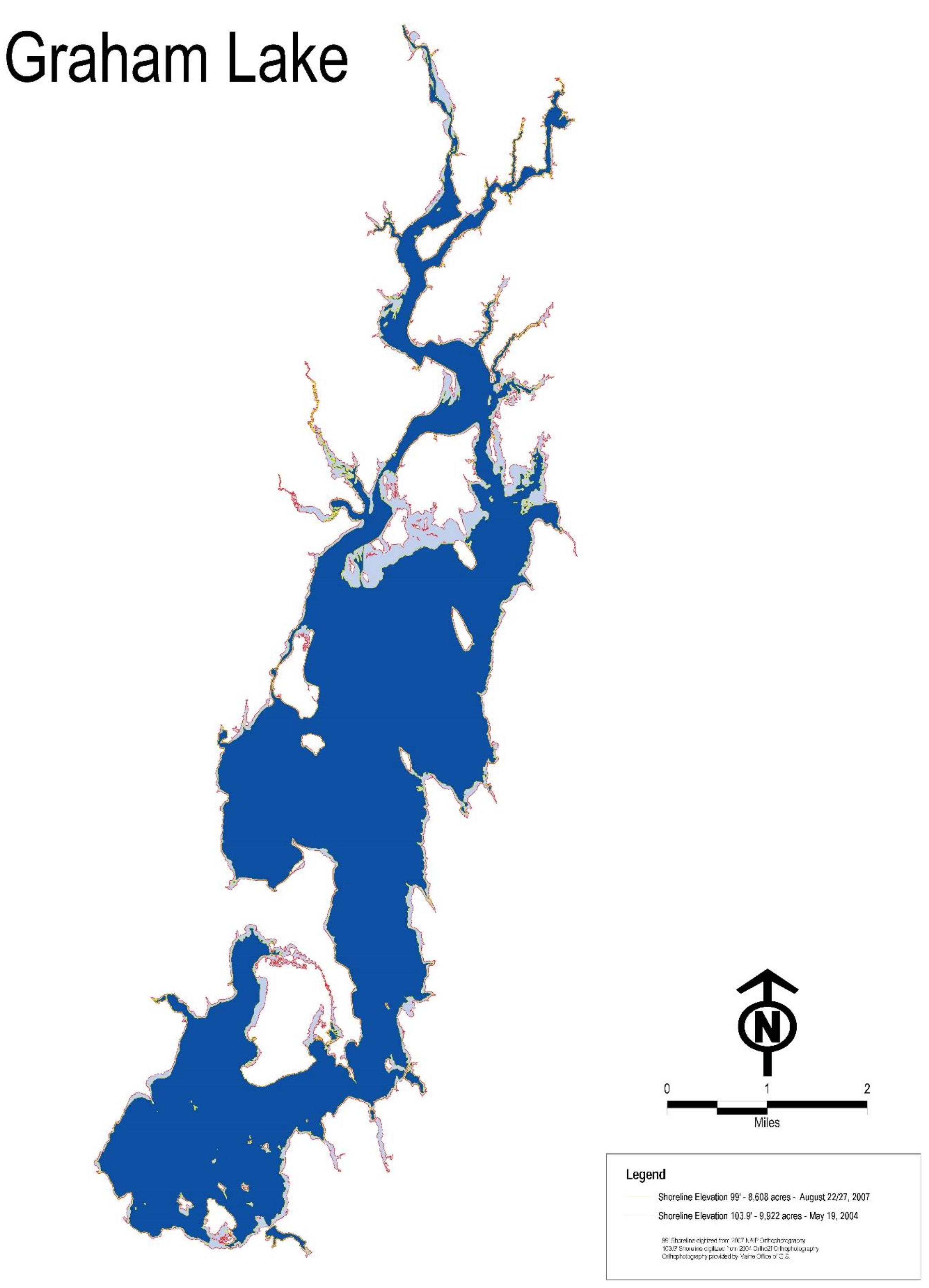


Figure E-9: Graham Lake Maine DIFW Bathymetry Map

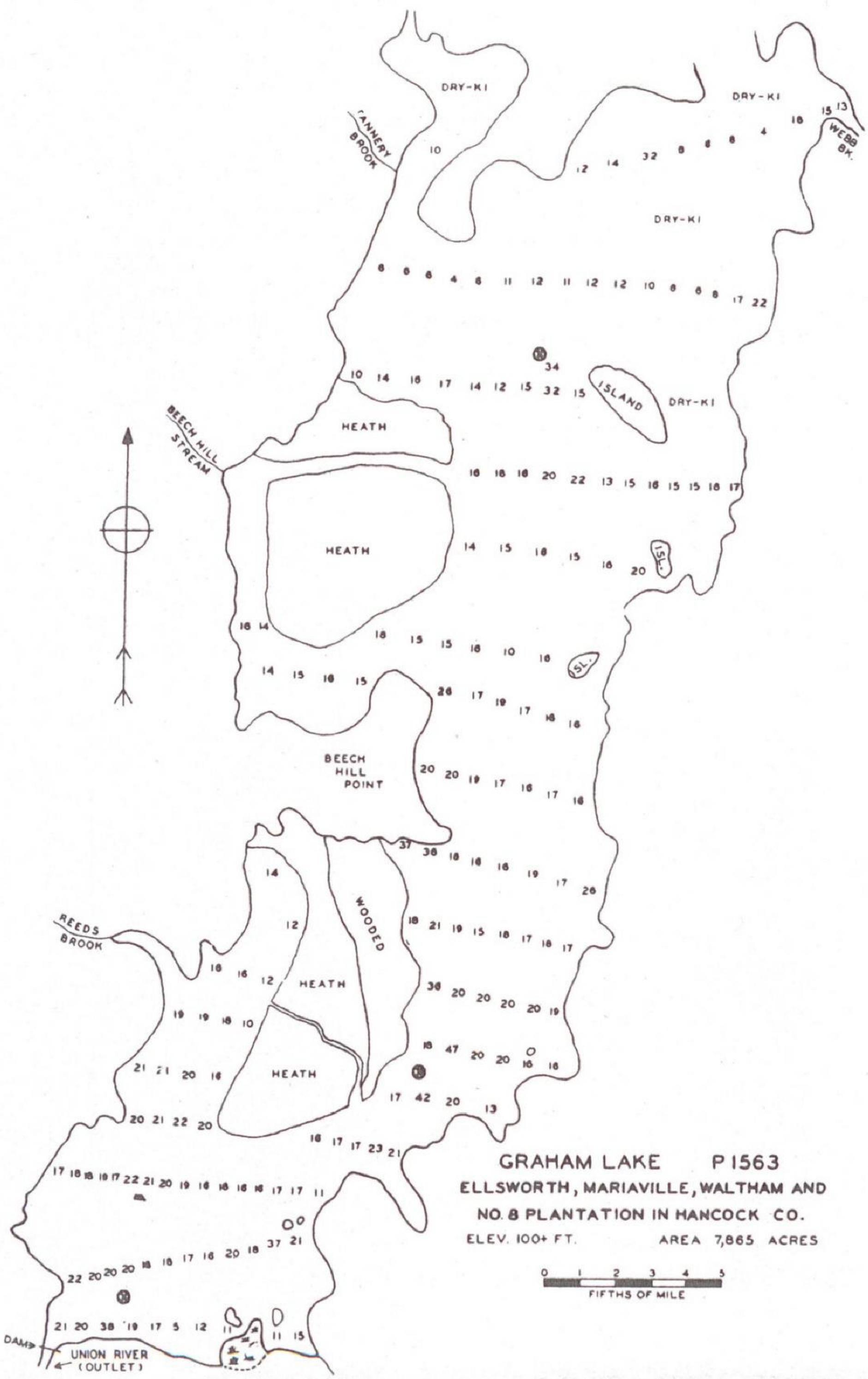


Figure E-10: Leonard Lake Bathymetry Map

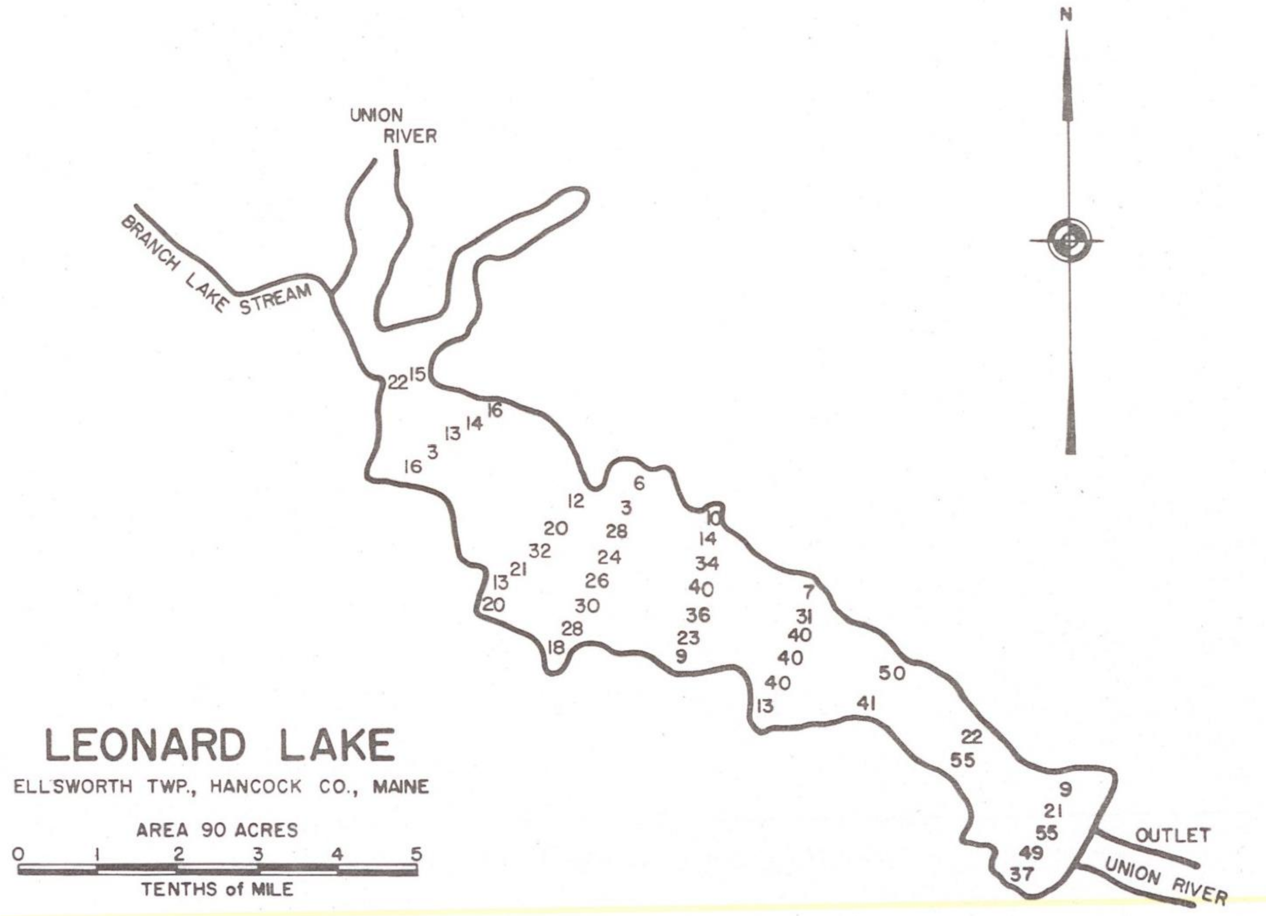


Table E-5: Morphometric Information for the Lake Leonard and Graham Lake Impoundments

	Lake Leonard	Graham Lake
Area (ac)	90	10,000
Perimeter (miles)	4.4	80
Mean Depth (ft)	25	17
Maximum Depth (ft)	55	47
Flushing Rate (flushes per year)	288	4.06
Total Volume (ac-ft)	751	124,000
Direct Drainage Area (sq. mi)	12	48.56
Total Drainage Area (sq. mi)	547	499
Elevation at full pond (ft)	66.7	104.2

Gradient of Downstream Reaches

The Project is located in the southern portion of the Union River watershed; the Union River flows into the Union River Bay approximately three miles downstream from the Project. The Ellsworth Dam is located at the upper limit of tidal influence of the Union River.

Water Quality Standards

Maine statute 38 MRSA (§464-470) establishes the basis for the State's classification system of surface waters. The State has one water quality standard for lakes and great ponds (GPA) which includes inland bodies of water artificially formed or increased that have a surface area greater than 30 acres. Graham Lake is included in this classification The Maine DEP currently interprets the water quality statutes to classify Lake Leonard as a GPA water (K. Howatt, Maine DEP personal communication, June 16, 2015). There are four standards for the classification of fresh surface waters which are not classified as great ponds: Class AA, A, B, and C waters. With the exception of Lake Leonard impoundment, which is classified as GPA, the Union River from the outlet of Graham Lake to tidewater is classified as Class B (Maine Revised Statute, 2012a).

Designated uses for Class GPA water include: drinking water supply after disinfection; recreation in and on the water; fishing; agriculture, industrial process and cooling water supply; hydroelectric power generation; navigation; and habitat for fish and aquatic life. The habitat must be characterized as natural (Maine Revised Statute, 2012c).

Maine's water quality standards provide that, with certain exceptions, "all hydropower projects with impoundments in existence on June 30, 1992 that remain classified under Section 465-A after June 30, 1992 and that do not attain the habitat and aquatic life criteria of that section must, at a minimum, satisfy the aquatic life criteria contained in section 465, subsection 4, paragraph C." 38 M.R.S.A. § 464(9-1)(D). In other words, if the impoundment habitat is not characterized as natural, then the impoundment must meet Class C habitat and aquatic life criteria.

The Class C habitat and aquatic life criteria provide that: "[d]ischarges to Class C waters may cause some change to aquatic life, except that the receiving waters must be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community." 38 M.R.S.A. § 465(4)(C). The term "resident biological community" is defined to mean "aquatic life expected to exist in a habitat which is free from the influence of the discharge of any pollutant." 38 M.R.S.A. § 466(10). Because Graham Lake was in existence on June 30, 1992 and remains classified as GPA, the applicable aquatic life standard for Graham Lake is that the receiving waters be of sufficient quality to support all species of fish indigenous to the receiving water and maintain the structure and function of the resident biological community.

Designated uses for Class B waters are the same as those for Class GPA waters and are described above, except in outstanding river segments (as defined under Title 12, section 403) where hydroelectric power generation is prohibited. The Union River is not designated as an outstanding river segment. The habitat in Class B waters must be characterized as unimpaired (Maine Revised Statute, 2012b).

The water quality standard for Class B waters (Table E-6) requires that dissolved oxygen (DO) concentrations be maintained at not less than 7 parts per million (ppm) or 75 percent saturation whichever is higher.

Table E-6: Maine Water Quality Standards for Select Parameters for Class B and GPA Waters

Parameter	Standard Class B	Standard GPA
DO (mg/L)	7 ppm or 75% of saturation, whichever is higher, except from Oct. 1st to May 14th, the 7-day mean DO concentration may not be less than 9.5 ppm and the 1-day minimum DO concentration may not be less than 8.0 ppm in identified fish spawning areas	No Numeric Standard
pH (su)	6.0 to 8.5	6.0 to 8.5
E. coli	Between May 15th and Sept, 30th, not to exceed a geometric mean of 64 per 100 milliliters or an instantaneous level of 236 per 100 milliliters	Not to exceed a geometric mean of 29 per 100 mL or an instantaneous level of 194 per 100 mL
Aquatic Life Habitat	Unimpaired	Maintain the structure and function of the resident biological community

Sources: Maine Revised Statute, 2012b and 2012c

The State of Maine Department of Environmental Protection 2012 Integrated Water Quality Monitoring and Assessment Report, approved by the US Environmental Protection Agency, classified Graham Lake as Category 4c: aquatic life drawdown (impairment not caused by a pollutant, but impaired by habitat modification). The Union River main stem in Ellsworth is classified as having insufficient data or information to determine if designated uses are attained; one or more uses may be impaired (Maine DEP, 2012). In communications with the Maine DEP, staff stated that historically the main stem of the Union River, outside of the Project area had some transient isolated pockets of marginal dissolved oxygen non-attainment associated with discharge from the Ellsworth municipal wastewater treatment plant more than a mile below the Ellsworth Dam. New construction at the plant, including a new discharge location more than a mile below the previous discharge point, has recently been implemented. Maine DEP feels that these changes have satisfactorily resolved the downstream dissolved oxygen issue (R. Mohler, personal communication February 2015).

Existing Water Quality

Impoundment Sampling

Impoundment water quality sampling was conducted in accordance with Maine DEP's Lake Trophic State Sampling Protocol for Hydropower Studies on a bi-weekly basis in Graham Lake from April 23 through October 24, 2013, and in Lake Leonard from June 13 through October 24, 2013.

Graham Lake

Graham Lake is a large (approximately 10,000 acres), shallow lake (average depth 17 feet; maximum depth 47 feet). Sampling on Graham Lake was conducted at the three historic sampling locations (north, central, and south). In general there was little variation in sampling results between the three locations. Water in the lake is turbid (average 3.3 NTU) and colored (average 75.2 PCU) resulting in low visibility. The average Secchi disk transparency is less than two meters (average 1.7 meters). Algal production, as indicated by chlorophyll *a* levels, (average 2.3 µg/l) is low.

Graham Lake weakly stratifies during the summer months, but due to the shallowness of the lake and long fetch from multiple directions, the stratification often breaks down during windy periods that prevail on the lake. Thermal stratification was first documented on June 27 and occurred at all three of the sampling stations in Graham Lake. This was the only date on which thermal stratification was documented at Station 1 (central). Thermal stratification was documented one other time (July 18) at sampling Station 3 (north) when the top of the thermocline was at 3 meters. At sampling Station 2 (south), thermal stratification was also documented on July 2, July 18, August 1, and August 28. The top of the thermocline on June 27 and July 18 was at 3 and 4 meters respectively. The top of the thermocline on July 2 and for two dates in August was at 10 to 11 meters

The results of the 2013 sampling for Graham Lake are consistent with previous sampling efforts dating back to the 1970's.

Lake Leonard

Lake Leonard is a small (approximately 90 acres), though moderately deep lake (average depth 25 feet; maximum depth 55 feet) for its size. Sampling on Lake Leonard was conducted at the deep hole, a mid-channel location, slightly north of the buoy barriers at the Ellsworth Dam. Water quality in Lake Leonard is similar to Graham Lake, though slightly less turbid (average 2.59 NTU) and less colored (average 67.8 PCU). These differences are reflected in a slightly higher Secchi disk transparency (average 2.1 meters) in Lake Leonard. The improvements in Lake Leonard water quality over Graham lake water quality is likely in part due to intervening tributary inputs between the two developments, especially from Branch Lake Stream which enters toward the upper end of Lake Leonard. Algal production, as indicated by chlorophyll *a* levels, (average 2.4 µg/l) is low.

Riverine Sampling

River water quality sampling was conducted in the Union River in the tailwater area of Graham Lake Dam in accordance with Maine DEP's River Sampling Protocol on a weekly basis from July 2 through September 12, 2013 in both the early morning (before 7:00 AM) and afternoon (after 1:00 PM) on each sampling day. Sampling was not conducted in the Ellsworth Dam tailwater as the Union River is subject to tidal fluctuations at that point.

The Union River sampling was conducted mid-channel, approximately 450 feet downstream of the Graham Lake Dam. Water depth was 3-4+ meters on each sampling day. Sampling results showed only minor variation in vertical profile, and between the morning and afternoon periods on individual sampling days. Over the course of the 11 week sampling period, temperatures ranged from 19.1 – 26.6°C and DO levels ranged from 8.3 and 10.4 mg/l (96 – 114% saturation).

Secchi disk transparency and chlorophyll *a* levels averaged 2.1 meters and 3.3µg/l respectively. These values are similar to the sampling results for both Graham Lake and Lake Leonard.

As per the approved study plan, benthic macroinvertebrate sampling was conducted at one location in the Union River approximately 450 feet downstream of Graham Lake Dam in 2014. Moody Mountain Environmental conducted the field sampling and laboratory procedures in accordance with the Maine DEP's Methods for Biological Sampling and Analysis of Maine's Inland Waters (Davies and Tsomides 2002). The samplers were placed in the Union River on July 24, 2014 and were retrieved on August 22, 2014.

The macroinvertebrate community sampled below the Graham Lake Dam was abundant and rich in taxa (Leeper 2014). The community was populated with 29 different taxa with a Mean Total Abundance of 640. The community was dominated by filter-feeding caddisflies which represented more than 79% of Total Abundance. The Diversity value for the community was correspondingly low at 1.75.

Indices measuring the tolerance to poor water quality conditions revealed that sensitive caddisflies dominated the community. The EPT richness index showed that sensitive mayfly and caddisfly taxa represented 41% of the taxa identified. No stoneflies were collected. Of those 3 orders, the stoneflies and mayflies are generally more sensitive to environmental stressors. Two (2) mayfly taxa were found representing 7% of the taxa richness. In terms of numbers (Tot. Abundance), mayflies made up 1% of the community. Hilsenhoff's Biotic Index value, 4.91, indicated good water quality (Hilsenhoff 1987).

The community structure and function found in the tailwater section of the Graham Lake Dam on the Union River shows evidence of organic enrichment and filter-feeder dominance which is a common phenomenon below lake outlets and impoundments (Hynes 1970, Spence and Hynes 1970, Parker and Voshell 1983).

Following consultation with Maine DEP, additional macroinvertebrate sampling was conducted in the summer of 2015. Three sites in the Union River were sampled. Site 1 was located at the downstream end of the "pool" below the Graham Lake Dam. This site was approximately 950 ft downstream of the dam. Site 2 was located was located approximately 1750 ft downstream of the dam. Site 3 was located approximately 1.92 miles downstream of the dam, approximately 850 ft upstream of the railroad crossing. Site 3 was just downstream of a bedrock hydraulic constriction that changed the character of the river from slow moving meandering flat water to rapids. The samplers were placed in the Union River on July 15, 2015 and were retrieved on August 11, 2015.

The sampler at Site 1 was disturbed and was not analyzed. For sites 2 and 3 the macroinvertebrate communities sampled downstream of the Graham Lake Dam were abundant but not very rich in taxa. The community at Site 2 was populated with 26 different taxa with a Mean Total Abundance of 355. The Site 3 community was much more numerous (Total Abundance of 2430), but was less rich with 15 taxa. Both communities were dominated by filter-feeding caddisflies, representing over 67% of Total Abundance at Site 2 and over 93% at Site 3. The Diversity values were correspondingly low at 1.70 (Site 2) and 1.76 (Site 3).

Indices measuring the tolerance to poor water quality conditions revealed that sensitive caddisflies dominated the community. The EP index of sensitive mayflies and stoneflies showed 3 and 2 taxa respectively. These insect orders represented less than 4% of the communities. No stoneflies were collected at either sampling site. The Hilsenhoff Biotic Index values, 4.30 (Site 2) and 4.36 (Site 3), indicated good water quality.

The community structure and function found in the tailwater section of the Graham Lake Dam on the Union River shows evidence of organic enrichment and filter-feeder dominance which is a common phenomenon below lake outlets and impoundments (Hynes 1970, Spence and Hynes 1970, Parker and Voshell 1983). The communities sampled are influenced by the food suspended in the water. This resource allows the aquatic caddisfly filter feeders to flourish. However, the lack of stoneflies in the community, and the small proportion of mayflies, indicates changes to the resident biological community. Based on the Maine DEP linear discriminant model used to assess attainment with state water quality standards, the Union River downstream of Graham Lake Dam achieves a Class C aquatic life standard.

The 2015 Macroinvertebrate Sampling Study is presented in Appendix E-3.

Impoundment Aquatic Habitat

Graham Lake, the upper reservoir of the Project, has a full pond surface area of approximately 10,000 acres and a maximum length of approximately 10 miles. In accordance with Article 402 of the current FERC license, water levels in Graham Lake are managed between elevations of 93.4' and 104.2'. Generally Graham Lake is filled in the spring reaching full pond in mid-April following spring snow melt and runoff. The lake is gradually drawn down over the summer into the early fall as reservoir storage is used to augment downstream river flows. There is a partial refill during the late fall followed by a winter drawdown under the ice, typically reaching its lowest levels in late winter. Refill then re-occurs during the spring. Figure E-7 shows the historic operating curve for Graham Lake.

The lower impoundment, Lake Leonard is impounded by the Ellsworth Dam, has a surface area of 90 acres and a length of one mile. Water levels in Lake Leonard are normally maintained between the elevations of 65.7' and 66.7' as per the current FERC license.

Impoundment Tributary Connectivity

An assessment of impoundment tributary connectivity for the single Lake Leonard and seven Graham Lake tributaries (Figure E-11) designated in FERC's Study Plan Determination was based on field observations and photo documentation during low water conditions on October 5 and 6, 2014 when Graham Lake water level elevations were at 97.9', and on October 6, 2014 when Lake Leonard was between elevations 65.7' and 66.7'.

In accordance with the FERC's Study Plan Determination (September 4, 2013), the impoundment Connectivity Study was conducted in October 2014. The target normal fall drawdown for Graham Lake is elevation 97.8 and occurs in mid-October. The Graham Lake elevation during the study was 98.0' only 0.2 feet above the normal target elevation and 1.1 foot below the 1999-2014 long term average of 98.9'.

At the Graham Lake water levels investigated, the surface area of the lake was reduced from a full pond area of approximately 10,000 acres to approximately 8,340 acres. This change in lake surface area resulted in areas of dewatered shoreline around the lake. These areas were investigated to determine the effect of drawdown on lake access to the seven designated tributaries.

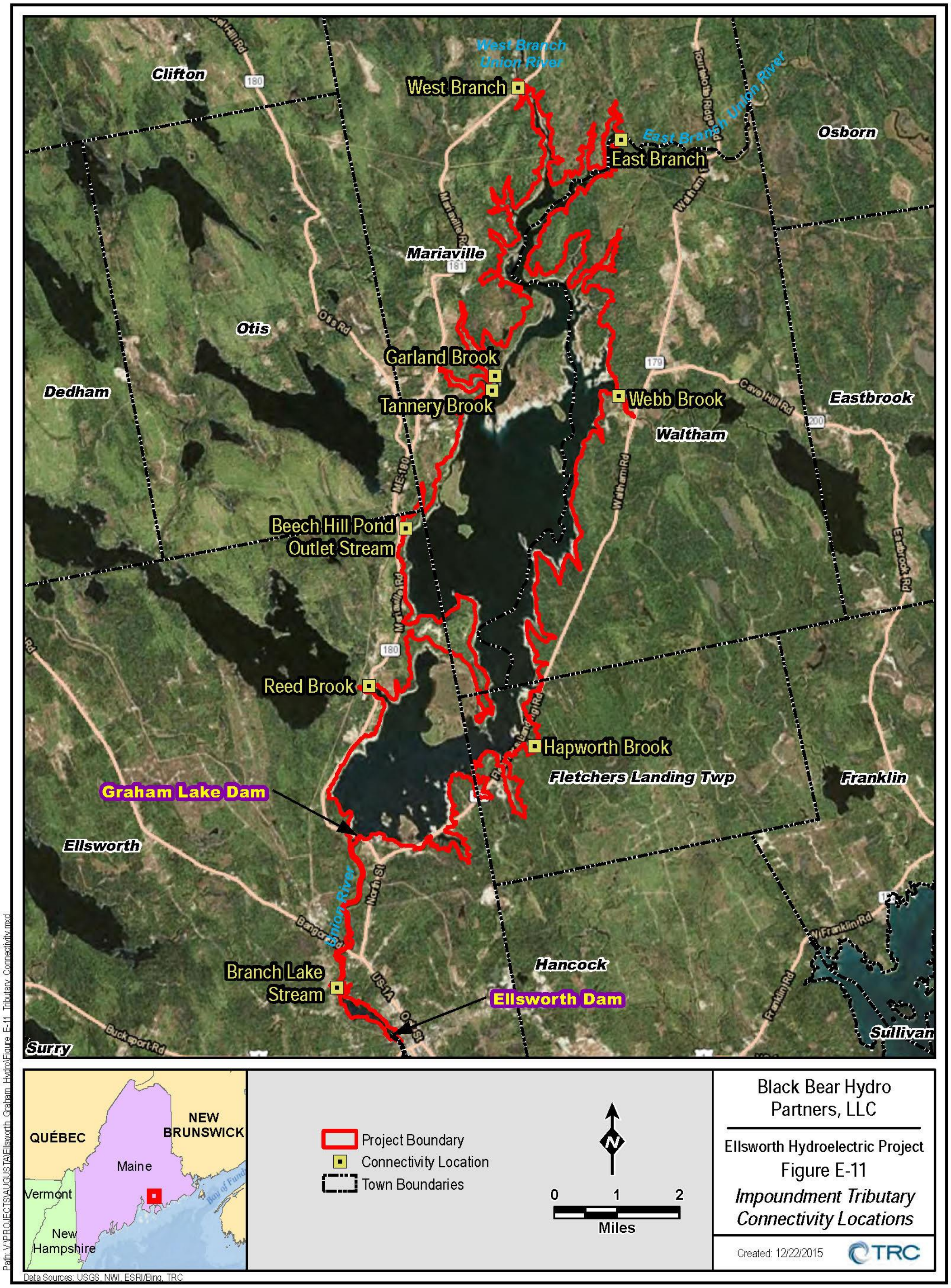
1. Hapworth Brook flows into Graham Lake via two culverts under Route 179, which are located adjacent to the lake's eastern shore. One of the culverts was completely dry, but the second culvert was fully submerged with a water depth in excess of 5 feet connecting Hapworth Brook and the lake.
2. Webb Brook entered Graham Lake via a 20-50 foot wide quick-flowing stream. Slightly upstream of the lake two beaver dams created runs and pools in the stream. Water depths

ranged from a few inches to a few feet in the quick-flowing sections and up to several feet deep behind the beaver dams.

3. The East Branch of the Union River is a large, quick-flowing boulder strewn stream that ranged in depth from a few inches to a few feet deep across its 50-100 foot width where it enters the lake.
4. The West Branch of the Union River entering Graham Lake is a broad (100+ feet) run that is several feet deep at its center.
5. Garland Brook enters Graham Lake via a long (0.7 miles), broad inlet with a well-defined channel. The gradient is very flat and the brook flows in wide meanders. The brook channel is 30-75 feet wide through most of its length, is quick-flowing, and is as much as 5+ feet deep.
6. Tannery Brook is somewhat smaller, but otherwise very similar to Garland Brook, and the two brooks are located in close proximity to one another. The brook channel is 25-50 feet wide through most of its length, is quick-flowing and is 0.5 to 2+ feet deep.
7. Beech Hill Stream enters Graham Lake by an approximately 1,600-foot long, broad, flat inlet. Just upstream of the inlet area is a small beaver dam and approximately 200 feet upstream of the beaver dam is a cascade with a vertical drop of about 8 feet. The stream is quick-flowing in the inlet area and is 0.5 to 2+ feet deep. At the water levels observed, tributary connectivity exists through the dewatered shoreline areas of Graham Lake for all of the tributaries investigated.
8. Only one tributary to Lake Leonard, Branch Lake Stream was investigated. Branch Lake Stream is dammed by a small concrete dam at its confluence with Lake Leonard. The dam has two approximately 4-foot wide stop log sections. It was difficult to determine if there were any engaged stop logs, though the openings were clogged with logs, sticks, and debris.

The results of the 2014 investigation were reported in the 2015 USR. Stakeholder comments received in response to the USR stated that the tributary connectivity investigation should have included 1) evaluation of tributary connectivity at full drawdown conditions at Graham Lake, 2) consideration of more specific zone-of-passage criteria, and 3) more specific gradient information for the tributaries. The Commission considered the stakeholder comments on the study, and Licensee's November 9, 2015 response and issued a December 8, 2015 Determination on Requested Study Modifications finding that additional information is required for the study. As required in the December 8, 2015 Determination, Licensee will conduct additional field work in 2016 to provide gradient profiles above el. 97.8' for the Graham Lake tributaries and will assess zone of passage based on more detailed criteria at tributaries selected in consultation with the fisheries agencies. Black Bear will collect this information and file it with FERC by December 31, 2016 as additional information to the FLA.

Figure E-11: Impoundment Tributary Connectivity Locations



Riverine Aquatic Habitat

The outlet stream (Union River) downstream of the Graham Lake Dam was evaluated regarding the adequacy of habitat for aquatic organisms under current instream flow releases.

Article 401 of the current FERC license requires a continuous minimum flow release of 105 cfs from the Graham Lake Dam from July 1 through April 30 and 250 cfs from May 1 through June 30. Measurements were obtained of the wetted width and bankfull width on the Union River approximately 1,000 feet downstream of Graham Lake Dam under low flow conditions estimated to be 150 cfs based upon the actual gate setting at the time of the field study.

The Union River at the point of measurement is the beginning of a long run stretch of river. The bankfull width of the river is 242 feet at this point. At 150 cfs the wetted width was 203 feet or 83% of the bankfull width. The water depth at this transect was 12+ feet. The wetted width at a flow of 105 cfs was extrapolated for this transect based on measured data for four observed flows at additional downstream transects for the Instream Flow and Union River Tributary Access Study. There is very little difference in wetted width percent bankfull between the observed 150 cfs and the extrapolated minimum flow of 105 cfs (Appendix E-4).

As noted in the USR, the additional transect data collected further downstream as part of the Instream Flow and Tributary Access Study also indicated wetted width, and, coupled with the depth at the flow release at Graham Lake Dam of 150 cfs, provided adequate wetted zone of passage and habitat for aquatic organisms in the Union River, as discussed in detail for river herring and Atlantic salmon in the Habitat Suitability section of the Instream Flow and Tributary Access Study. For these seven transects, the wetted width was extrapolated for the target minimum flow of 105 cfs and is presented in Table E-7. This data demonstrates the wetted width under the minimum flow was near or exceeded ¾ of the bankfull width.

Table E-7: Minimum Flow Wetted Width for Instream Flow and Tributary Access Study Transects

Transect		Graham Dam Release Discharge (cfs)	Wetted Width (ft)	Wetted Width % Bankfull
Sub-Reach	Type			
Upper Reach	Riffle/ Run	105[1]	304.0	83
		150	310.0	85
		Bankfull	366.0	NA
	Pool	105[1]	191.0	83
		150	191.0	83
		Bankfull	231.0	NA
Middle Reach	Riffle	105[1]	178.8	74
		150	180.5	75
		Bankfull	240.6	NA
	Pool	105[1]	172.0	73
		150	176.8	75
		Bankfull	236.1	NA
	Run	105[1]	128.1	68
		150	134.3	71
		Bankfull	188.9	NA
Lower Reach	Riffle	105[1]	173.1	73
		150	173.5	74
		Bankfull	235.9	NA
	Pool/ Run	105[1]	139.3	74
		150	139.4	74
		Bankfull	189.2	NA

Note: [1] The wetted width and wetted width percent bankfull values for the minimum flow of 105 cfs were extrapolated from the field collected data from four flow observations of surveyed transects measured for and discussed in the *Instream Flow and Tributary Access Study* in Section 3.2.3.

4.4.2.2 Environmental Analysis

Effects of continued project operation on water quality

Impoundment Water Quality

As described above, impoundment water quality sampling was conducted in accordance with Maine DEP's Lake Trophic State Sampling Protocol for Hydropower Studies on a bi-weekly basis in Graham Lake from April 23 through October 24, 2013, and in Lake Leonard from June 13 through October 24, 2013. Results of the sampling indicate that Graham Lake meets the applicable Class GPA trophic state standards and is free of culturally induced algal blooms which might impair its use or enjoyment. Lake Leonard, to which Maine DEP has indicated the GPA standards apply, also meets the standards applicable to that classification. The water quality parameters typically sampled for Class B waters (riverine) were included in the Lake Leonard trophic state sampling conducted in 2013 as requested by the Maine DEP. Maine DEP has requested no additional sampling of Lake Leonard.

Riverine Water Quality

Tailwater water quality sampling downstream of Graham Lake Dam was conducted in accordance with Maine DEP's River Sampling Protocol on weekly basis from July 2 through September 12, 2013 in both the early morning (before 7:00 AM) and afternoon (after 1:00 PM) on each sampling day. Tailrace sampling was not conducted in the Ellsworth Dam tailrace as the Union River is subject to tidal fluctuations at that point. Results of the sampling indicate that Class B physical and chemical water quality standards were met in the tailwater downstream of Graham Lake Dam.

Effects of continued project operation on aquatic habitat

Impoundment Aquatic Habitat

Maine DEP considers aquatic life and habitat standards in determining whether a water body is meeting water quality standards. It is Maine DEP's position that there must be both sufficient quality and quantity of habitat for aquatic organisms to meet aquatic life and habitat standards. The Maine DEP has a hydropower policy which states that, generally, water levels providing wetted conditions for ¾ of the littoral zone of a lake or pond, as measure from full pond conditions, are sufficient to meet aquatic life and habitat standards.

Using a depth of twice the mean 2013 summer sampling Secchi disk transparency (1.77 meters or 5.8 feet) as a measure of the bottom of the littoral zone, the littoral zone depth at Graham Lake was approximately 11.6 feet during the sampling period. This calculates to an elevation of 92.6'. Extrapolating, at its deepest the littoral zone of Graham Lake at elevation 92.6' has an area of approximately 7,232 acres. Similarly extrapolating from known bathymetric data, Graham Lake at full pond elevation of 104.2 has a surface area of 10,042 acres. Thus the approximate area of the littoral zone is: 10,042 acres – 7,232 acres =2,810 acres.

Lake Leonard is operated with a maximum normal pond fluctuation of one foot. As such Lake Leonard essentially maintains a fully wetted littoral zone.

Riverine Aquatic Habitat

Macroinvertebrate sampling in 2014 showed a hyperdominance of net spinning caddisflies in the Graham Lake tailwater, a phenomenon commonly seen in rivers below lakes and reservoirs. Following consultation with Maine DEP, additional macroinvertebrate sampling was conducted in the summer of 2015. The results of the additional sampling are similar to the sampling results from the 2014 sampling i.e., there was a hyperdominance of certain species that is common below both reservoirs and natural lakes. The 2015 Macroinvertebrate Sampling Study is presented in Appendix E-3. Based on the Maine DEP linear discriminant model used to assess attainment with state water quality standards, the Union River downstream of Graham Lake Dam achieves a Class C aquatic life standard. Regardless of how the Project is operated, it is likely that the riverine reach below Graham Lake will continue to support a macroinvertebrate community dominated by species that are responsive to the abundant food source provided downstream of a large lake.

The wetted width of the riverine reach below Graham Lake, coupled with the depth at the flow release of 150 cfs, provided adequate wetted habitat for aquatic organisms in the Union River. The estimated wetted width at a flow of 105 cfs demonstrates there is very little difference in wetted width compared to the observed 150 cfs and minimum flow (Appendix E-4). Given that 105 cfs flow is the minimum flow out of Graham Lake (July 1- April 30) and 250 cfs at other times, and that Black Bear is not proposing any operational changes, the wetted zone of passage and habitat for aquatic organisms will remain adequate in the future.

4.4.2.3 Proposed Environmental Measures

Black Bear proposes to continue to operate and maintain the Project generally under the existing licensed regime. Under the propose operation of the Project, there will be no significant changes to the magnitude or timing of seasonal minimum flow releases, or of Graham Lake or Leonard Lake water levels, from what currently occurs. As a result, the continued operation of the Project will have no impacts on existing water quality in Graham Lake, the Union River or Lake Leonard.

4.4.2.4 Cumulative Effects

In Scoping Document 1, the effects of continued Project operation on dissolved oxygen and water temperature in Lake Leonard, Graham Lake, and the Union River downstream of the Project were identified as an issue to be analyzed for both cumulative and site specific effects. Black Bear is proposing to continue to operate the Project with the same flow and water level restrictions that are in the current license. No new project effects and no other significant changes in the Union River watershed were identified, so no cumulative water quality effects are anticipated.

4.4.2.5 Unavoidable Adverse Impacts

The continued operation of the Ellsworth Project as proposed will result in no new impacts to Project water quality. The annual drawdown of Graham Lake for the purposes of enhanced generation at the Ellsworth Dam is managed within the licensed impoundment elevations of 104.2’ and 93.4’ while at the same time maintaining the seasonal minimum flow license conditions of 105 cfs (July 1 through April 30) and 250 cfs (May 1 through June 30). The drawdown results in portions of the littoral zone being dewatered. The greatest extent of the drawdown occurs early in the year under ice cover conditions.

4.4.3 Fish and Aquatic Resources

4.4.3.1 Affected Environment

The Union River watershed is inhabited by a diversity of coldwater and warmwater fish species (Baum 1982). Approximately 36 species of fish are known to occur in the Project area (Table E-8).

Long-term fishery management goals have been identified for reaches of the Union River in the *Comprehensive Fishery Management Plan for the Union River Drainage* (CFMP [URFCC 2015]). The river reach between Ellsworth Dam and Graham Lake Dam is managed for sustained production of brook trout and as a migratory pathway for Atlantic salmon, American shad, river herring and American eels. Graham Lake is managed for existing resident species including smallmouth bass, white perch and pickerel, as well as alewives and eels (URFCC 2015).

American shad, river herring and American eels, along with striped bass, are managed in accordance with the Atlantic States Marine Fisheries Commission’s Interstate Fisheries Management Plans from the mouth of the Union River to Ellsworth Dam. This reach of the river is also managed for sustained production of resident and diadromous species.

Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon are species listed under the Endangered Species Act (ESA) as discussed in the following sections.

Resident Species

Warmwater species such as smallmouth bass, chain pickerel, and white perch are resident species in Graham Lake and Lake Leonard (Black Bear 2012). Largemouth bass were introduced illegally into Graham Lake about five years ago, and are expanding rapidly (Greg Burr, Maine DIFW, personal communication July 3, 2014). Data collected at a bass tournament in Graham Lake showed the largest bass caught (species was not specified) weighed 5.2 pounds, and the average weight of the bass caught by each team ranged from 1.7 to 3.9 pounds, Table E-9 (USA Bassin 2014).

Table E-8: Fish Species Known to Occur in the Union River Watershed

Scientific Name	Common Name
Acipenseridae	
Acipenser oxyrinchus	Atlantic sturgeon
Acipenser brevirostrum	Shortnose sturgeon
Anguillidae	
Anguilla rostrata	American eel
Catostomidae	
Catostomus commersoni	White sucker
Clupeidae	
Alosa aestivalis	Blueback herring
Alosa pseudoharengus	Alewife
Alosa sapidissima	American shad
Centrachidae	
Lepomis gibbosus	Pumpkinseed
Lepomis auritus	Redbreast sunfish
Micropterus dolomieu	Smallmouth bass
Micropterus salmoides	Largemouth bass
Cyprinidae	
Luxilus cornutus	Common shiner
Notemigonus crysoleucas	Golden shiner
Notropis heterolepis	Blacknose shiner
Phoxinus eos	Northern redbelly dace
Semotilus atromaculatus	Creek chub
Semotilus corporalis	Fallfish
Cyprinodontiformes	
Fundulus diaphanus	Banded killifish
Fundulus heteroclitus	Mummichog
Esocidae	
Esox niger	Chain pickerel
Gadidae	
Microgadus tomcod	Tomcod
Gasterosteidae	
Gasterosteus oculeatus	Threespine stickleback
Pungitius pungitius	Ninespine stickleback
Ictaluridae	
Ameiurus nebulosus	Brown bullhead (hornpout)
Osmeridae	
Oxmerus mordax	Rainbow smelt
Percichthyidae	
Morone americana	White perch
Morone saxatilis	Striped bass

Scientific Name	Common Name
Percidae	
Perca flavescens	Yellow perch
Petromyzontidae	
Petromyzon marinus	Sea lamprey
Salmonidae	
Salvelinus alpinus	Landlocked arctic char
Salvelinus fontinalis	Brook trout
Savelinus namaycush	Lake trout (togue)
Salvelinus namaycush x S. fontinalis	Splake
Salmo salar	Atlantic salmon
Salmo salar sebago	Landlocked salmon
Salmo trutta	Brown trout

Source: Black Bear 2012; Maine DIFW 2013a and 2013b; Baum 1982

Table E-9: Bass Tournament Results, Graham Lake, May 18, 2014

Group	No. of Bass	Total Weight (lbs)	Avg. Weight (lbs)*	Largest Fish Weight (lbs)
1	5	19.3	3.9	5.2
2	5	18.5	3.7	5.1
3	5	13.9	2.8	4.3
4	5	13.1	2.6	3.4
5	5	12.7	2.5	3.5
6	5	11.1	2.2	2.3
7	3	5.2	1.7	0
8	2	4.2	2.1	0

*Calculated. Source: USA Bassin 2014.

As reported in the Fish Community Study, contained in the September 4, 2014 Initial Study Report, the Maine DIFW started a study in 1997 to evaluate the effects of stocking alewives in Graham Lake on the smallmouth bass population in Graham Lake. Maine DIFW sampled the smallmouth bass population by angling for two years during two successive five year periods to monitor proportional stock density (PSD) and relative stock density (RSD)[3] values (Table E-10)(URFCC 2010).

[3] Proportional stock density is the percentage of a sample of "stock-length" fish that also are greater than or equal to "quality length". Relative stock density is the percentage of "stock-length" fish that also are in a defined length interval of larger fish (larger length-classes are "quality", "preferred", "memorable", and "trophy"). These length categories are species specific (Murphy and Willis 1996).

Table E-10: Proportional Stock Density (PSD) and Relative Stock Density (RSD) Values for Smallmouth Bass Collected in Graham Lake, 1997-1998, 2002-2003

Year	Proportional Stock Density	Relative Stock Density
1997	74	17
1998	41	<1
2002	68	7
2003	82	9

Source: URFCC 2010.

Maine DIFW concluded, using values from 1997 and 1998 as the baseline for comparative purposes, that neither PSD nor RSD values from 2002 and 2003 suggested any detrimental impact from the increased stocking rate of alewives to smallmouth bass (URFCC 2010).

White perch fishing exists at Graham Lake, which also has a productive pickerel (URFCC 2015) and brown bullhead fishery (Dick Fennelly, personal communication July 23, 2014). Given the connections and proximity between other adjacent lakes and ponds to Graham Lake and Lake Leonard, species likely drop down to the Project area; for example, in the spring, lake trout, brook trout, brown trout, and landlocked salmon are caught below Graham Lake Dam, but not in great numbers (Burr, G. Maine DIFW, personal communication, July 23, 2014). Fish that occur in Graham Lake and the Union River upstream of Lake Leonard would be expected to occur in Lake Leonard as well.

Stocking of brown trout still occurs at some lakes and ponds in the drainage, and wild brown trout still occur in the Union River (Greg Burr, Maine DIFW, personal communication July 23, 2014). Maine DIFW stocked brook trout in the riverine reach of the Union River between Graham Lake Dam and the Ellsworth Dam from approximately 2004 to 2007 (Burr, G. Maine DIFW, personal communication, March 7, 2013 and July 18, 2013), however, stockings were not successful and the efforts were cancelled (Burr, G. Maine DIFW, personal communication, July 3, 2014).

Diadromous Species

River Herring (Alewives and Blueback Herring)

Alewives are common in the Union River in May and June (Baum 1982). Alewives spawn about two or three weeks earlier in the spring than blueback herring. They migrate upstream entering rivers from the ocean in April and May, spawning in quiet areas with slow current or in still pools (Jenkins and Burkhead 1993). Similar to other herring species, they are fractional broadcast spawners, randomly releasing their small adhesive eggs over cobble, gravel, or other bottom material on their way upstream. After spawning, alewives return to the river mouth and may live in the shallow estuary until fall before heading out to sea for the winter (Jenkins and Burkhead 1993). Juveniles remain in primary nursery areas until October and then begin migrating to shallow, high salinity estuaries for over-wintering (Jenkins and Burkhead 1993).

A small remnant stock of blueback herring is believed to exist in the Union River below the Ellsworth Dam. Blueback herring closely resemble alewives, but spawn in free-flowing rivers and streams rather than in lakes and ponds. The peak spawning period for blueback herring is also slightly later than that of alewives. The existence of blueback herring in the Union River is based on the river herring trapping data at Ellsworth Dam (URFCC 2015).

Alewives and blueback herring, collectively referred to as river herring, are managed by the Maine DMR in cooperation with the City of Ellsworth. The City of Ellsworth holds the commercial fishing rights for river herring on the Union River, and historically assumed responsibility for stocking adult fish in upstream spawning habitat under a cooperative agreement with the Maine DMR. The annual commercial harvest, which occurs at the trapping facility at the Ellsworth Dam, has ranged from 5,000 to 1,066,297 fish since 1974 (URFCC 2010, 2015), with the catch being sold as bait in the lobster fishery.

Black Bear operates the upstream passage facility at Ellsworth Dam, where river herring are trapped and transported to Lake Leonard and Graham Lake[4]. Lake Leonard and Graham Lake are the primary stocking locations for river herring in the Union River drainage, and contain the majority of potential spawning habitat. Based on the upstream fishway operations data, the alewife migration and trap and transport activity typically runs from early May to early/mid-June. For 2014, the upstream trap and transport started capturing alewives on May 8 and extended to June 11, with one additional trap and transport to Lake Leonard on June 14. For 2015, the operation of the trap began on May 1 and extended to October 31. The upstream trap and transport started capturing alewives on May 10th and extended into July. According to the fishway operator, the presence of river herring in the river near the fishway is typically sporadic after early June as the migration slows to an end. Table E-11 shows returns of river herring to the fishway since 1986.

[4] The existing fish trap is owned by the Maine Department of Inland Fisheries and Wildlife and/or Atlantic Sea-Run Salmon Commission. However, the trap and truck facility is contained within the project boundary and is integral to the FERC approved Union River Comprehensive Fishery Management Plan. The Licensee’s roles and responsibilities for the trap and truck facility are clearly laid out in the Plan and codified in the September 27, 2002 FERC Order Amending License Article 406 requiring compliance with the FERC approved Plan.

Table E-11: River Herring Fishway Counts, Union River at Ellsworth Dam

Year	Number	Year	Number
1986	1,038,920	2001	446,850
1987	473,840	2002	666,967
1988	526,911	2003	326,497
1989	559,676	2004	193,523
1990	368,400	2005	195,277
1991	192,720	2006	693,360
1992	390,210	2007	227,070
1993	111,139	2008	515,160
1994	117,158	2009	452,250
1995	183,634	2010	450,090
1996	301,253	2011	415,125
1997	279,145	2012	1,219,927
1998	441,923	2013	709,097
1999	277,425	2014	769,635
2000	389,610	2015	555,015

Source: URFCC 2015.

Efforts to restore river hearing populations to the Union River drainage began in 1972 (UFCC 2015). Initially, brood stock were trapped in a nearby river and released in Graham Lake (UFCC 2015). Once the fish trapping facility at the Ellsworth dam was completed in 1974, fish were collected in the Union River trap and transported upstream of the dam (UFCC 2015). Annual trap and transport of adult spawners ranged from 600 to 63,585 fish from 1972 through 1999 (no fish were transported upstream in 1978 - 1980). Licensee had transported over 100,000 river herring (11.6 fish/acre) upstream annually since 2000, until increasing the spawning escapement to 125,000 in 2010 and 150,000 (18 fish/acre) in 2011. In addition, 1,600 river herring are transported to Lake Leonard after June 10 if available. This late season stocking is to enhance and expand the small population of blueback herring thought to consist primarily of the late run (URFCC 2015). The overall goal is to reach an annual alewife run size that would allow for harvest of two million fish plus the spawning escapement numbers (URFCC 2015). Starting in 2015, the planned river herring stocking number has been raised from 150,000 to 315,000. Another change included in the updated CFMP consists of stocking river herring in five additional lakes/ponds in the Union River drainage. Based on the target 35 fish/acre and a harvest of 2 million river herring, the calculated spawning escapement for all seven lakes is 357,151 alewives. Thus, Black Bear transported a sufficient number of river herring in 2015 to meet a minimum of 88 percent of the calculated spawning escapement for the watershed (final stocking numbers were 329,160, exceeding the target 315,000).

Black Bear operates downstream passage facilities at both the Ellsworth and Graham Lake Dams. The downstream fishways are operated from April 1 to December 31 annually, as river conditions allow. Fish passage facilities were designed and are operated in consultation with the agencies through the CFMP (URFCC 2015).

Atlantic Salmon

The Gulf of Maine (GOM) Distinct Population Segment (DPS) of Atlantic salmon was first listed as endangered under the ESA by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (the Services) on November 17, 2000 (USFWS and NMFS 2000). The GOM DPS designation in 2000 included all naturally reproducing Atlantic salmon populations occurring in an area from the Kennebec River downstream of the former Edwards Dam site extending north to the international border between Canada and the United States at the mouth of the St. Croix River. This range includes the Union River. The GOM DPS also included river-specific hatchery fish that were being propagated at the Craig Brook Hatchery for release into the wild.

The Ellsworth Project falls within the designated critical habitat of the Downeast Coastal Salmon Habitat Recovery Unit for Atlantic salmon (NMFS 2009; Sean McDermott, NMFS, personal communication July 2, 2014). Black Bear has developed a draft Biological Assessment (BA) for Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon (Appendix E-12), and more detailed information about these species is included in the draft BA.

Historically, hatchery raised salmonids have been stocked in most of the lakes and ponds of the Union River (Baum 1982). Annual releases of hatchery-reared Atlantic salmon smolts (one- and two-year old fish) began in the Union River in 1971, and were continued until 1991, when stocking was suspended due to funding reductions and a redirected focus on wild salmon rivers and the Penobscot River (USASAC 1992). Since 1993, there has been sporadic stocking of salmon parr, and annual stocking of fry since 2001, in the Union River (Table E-12).

In 2011, 282 excess captive-reared brood stock (pre-spawn) salmon were released into the West Branch, Union River. During a subsequent survey Maine DMR biologists documented over 200 completed redds produced by these salmon several miles upstream of the Project. Maine DMR expected that smolts produced from the captive-reared excess brood stock would migrate to the sea in 2014-2015 (Maine DMR letter to FERC, dated July 1, 2013).

Table E-12: Union River Atlantic Salmon Stocking History 1970-2014

Year	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Adult
1971-2001	425,000	371,400	0	0	379,700	251,000	0
2002	5,000	0	0	0	0	0	0
2003	3,000	0	0	0	0	0	0
2004	3,000	0	0	0	0	0	0
2005	2,000	0	0	0	0	0	0
2006	2,000	0	0	0	0	0	0
2007	22,000	0	0	0	0	0	0
2008	23,000	0	0	0	0	0	0
2009	28,000	0	0	0	0	0	0
2010	19,000	0	0	0	0	0	0
2011	19,000	0	0	0	0	0	282
2012	Natural recruitment from 282 adult spawners stocked in September, 2011 – no fry stocking						
2013	Natural recruitment from 282 adult spawners stocked in September, 2011 – no fry stocking						
2014	23,000	0	0	0	0	0	0

Source: URFCC 2015.

Since 1999, the resource agencies have examined scale samples from each adult salmon returning to the Union River to determine origin. The assessments of salmon origin show that returns to the Union River since 1993 (i.e., following cessation of the broodstock program) consist of a few hatchery origin strays and a few wild or fry stocked salmon. The latter include salmon that originated from fry stocking, natural reproduction or wild/fry stocked strays from other rivers. Having a few strays into the Union River that originated from the Penobscot River, or from the other eastern Maine rivers, is consistent with the homing and straying behavior of Atlantic salmon and the typical rate of straying described in the Status Review (i.e., 2% [Fay et al. 2006]). Between 2006 and 2011, no salmon returned to the Union River. Since then, three aquaculture escapees returned in 2012, one salmon (wild) returned in 2013, and two (one wild and one hatchery) in 2014 (Table E-13) (URFCC 2015). The 2014 suspected hatchery stray was released downstream of the Project. In 2015, the upstream fishway was checked four times per day for an extended period from May 1 to October 31. As per the Maine DMR fishway protocols, the upstream fishway was not operated when temperatures exceeded 23°C (73°F), which occurred intermittently in July and September and throughout most of August. However, observations of the fishway entrance area and tailwaters continued on a routine basis; no Atlantic salmon were observed. Maine DMR noted in a letter to FERC dated July 1, 2013 that the lack of returning Atlantic salmon to the Union River is not unexpected given the recent stocking history and lack of spawning escapement.

Table E-13: Union River Atlantic Salmon Returns by Origin

Year	Aquaculture	Hatchery	Wild	Total
1973 - 1986	0	1892	4	1896
1987	undetermined	63	0	63
1988	undetermined	45	2	47
1989	undetermined	30	0	30
1990	undetermined	21	0	21
1991	undetermined	2	6	8
1992	undetermined	4	0	4
1993	undetermined	0	0	0
1994	undetermined	0	0	0
1995	undetermined	0	0	0
1996	undetermined	68	1	69
1997	undetermined	8	0	8
1998	undetermined	13	0	13
1999	63	6	3	72
2000	3	2	0	5
2001	2	0	0	2
2002	6	5	0	11
2003	0	1	0	1
2004	0	1	1	2
2005	4	0	0	4
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	3	0	0	3
2013	0	0	1	1
2014	0	1	1	2
2015	0	0	0	0
TOTAL 1995 - 2015	81	105	7	193

Source: URFCC 2015; Maine DMR 2015
Note: Salmon returns before 2000 included rod and trap captures.

NMFS and the University of Maine maintain an array of acoustic telemetry receivers along the coast of Maine. This array is used to detect passing fish that have been tagged by the University with acoustic tags. Species tagged include Atlantic salmon, as well as shortnose and Atlantic sturgeon (Gayle Zydlewski, University of Maine, personal communication July 22, 2013). Acoustic receivers have been deployed in the Union River annually since 2008 (G. Zydlewski, University of Maine, personal communication July 9, 2014). One receiver is deployed about 0.7 km downstream of the boat launch in Ellsworth and the second, about 1.7 km downstream of the boat launch, close to Blue Hill Bay. The receivers are typically deployed in mid- or late-May and retrieved in late October or early November. No fish from the Union River have been captured and tagged for monitoring. One acoustically tagged shortnose sturgeon was detected in the Union on June 23 and 24, 2014. Otherwise, no acoustic tags have been detected in the Union River from fish tagged in other Maine rivers (G. Zydlewski, University of Maine, personal communication July 9, 2014 and August 25, 2015).

<u>Essential Fish Habitat</u> - The Magnuson-Steven Fishery Conservation and Management Reauthorization Act of 2006 mandated that habitats essential to federally managed commercial fish species be identified, and that measures be taken to conserve and enhance habitat. In the amended Act, Congress defined essential fish habitat (EFH) for federally managed fish species as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". Essential fish habitat for Atlantic salmon is described as all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut (NEFMC 1998). The EFH designated habitat for all life stages of Atlantic salmon (eggs, larvae, juveniles, and adults) in Maine includes the Union River and Union River Bay, including the Project area.

The Project protects EFH for Atlantic salmon by providing upstream and downstream fish passage and migratory pathways to habitat, and ensuring suitable habitat downstream of each development through minimum flows.

Atlantic Sturgeon and Shortnose Sturgeon

On February 6, 2012, NOAA published notice in the Federal Register listing the Atlantic sturgeon as endangered in the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs, and as threatened in the Gulf of Maine DPS (77 FR 5880 and 77 FR 5914). The Atlantic sturgeon is a long-lived, late maturing, estuarine dependent, anadromous species. Information in the following subsections is taken from the 2007 Atlantic sturgeon status review (Atlantic Sturgeon Status Review Team 2007), unless otherwise noted. The species' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida. Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer. Critical habitat has not been designated for the Atlantic sturgeon.

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada; Maine; Massachusetts; Connecticut; New York; New Jersey/Delaware; Maryland and Virginia; North Carolina; South Carolina; Georgia; and Florida.

The shortnose sturgeon occurs in large coastal rivers of eastern North America. In the northern part of its range, the species is considered to be "freshwater amphidromous," and it spawns in freshwater, but regularly enters seawater during various stages of its life (NMFS 1998). Shortnose sturgeon are occasionally found near the mouths of rivers, and coastal migrations between the lower Penobscot River and the Androscoggin/Kennebec estuary (i.e., Merrymeeting Bay) have been documented (Zydlewski 2011, Fernandes et al. 2010). Juveniles typically move upstream in rivers in spring and summer, and downstream in fall and winter, but inhabit reaches above the freshwater - saltwater interface. Adults may move into higher salinity areas on a more regular basis (NMFS 1998). Critical habitat has not been designated for the shortnose sturgeon.

According to state fishery personnel, Atlantic sturgeon have been observed in the Union River below Ellsworth Dam (URFCC 2015). The status of the population of Atlantic sturgeon and shortnose sturgeon, which may also occur in the river, is unknown at this time (URFCC 2015). In the Status Review of Atlantic sturgeon, it was noted that "The geomorphology of most small coastal rivers in Maine is not sufficient to support Atlantic sturgeon spawning populations, except for the Penobscot and the estuarial complex of the Kennebec, Androscoggin, and Sheepscot Rivers" though subadults may use the estuaries of smaller coastal drainages during the summer months (Atlantic Sturgeon Status Review Team 2007). Zydlewski et al. (2011) found that shortnose sturgeon use small coastal rivers as they migrate between the Kennebec and Penobscot Rivers. However, as noted above, only one shortnose sturgeon and no Atlantic sturgeon tagged at other locations have been detected by the acoustic receivers deployed in the lower Union River (G. Zydlewski, University of Maine, personal communication July 9, 2014 and August 20, 2015). From review of the limited bathymetry data of the original river channel that has been inundated by Lake Leonard there may be steep gradient reaches that would have historically kept Atlantic and shortnose sturgeon from accessing the Union River above the site of the Ellsworth Dam.

Black Bear has developed a draft Biological Assessment (BA) for Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon (Appendix E-12), and more detailed information about these species is included in the draft BA.

American eel

American eel are present in the Union River estuary, and some are known to occur in inland waters above the Ellsworth Project dams. The USFWS recently reviewed a petition to list the American eel as a protected species under the ESA and determined that listing was not warranted (USFWS 2015). Specifically, the finding stated that "While sources of individual mortality still exist, there are no stressors (natural or human induced negative pressures affecting individuals or subpopulations of a species), individually or cumulatively, that rise to the level of threats (natural or human induced pressure affecting a species as a whole) to the American eel's panmictic population". The Atlantic States Marine Fisheries Commission's (ASMFC) 2012 Benchmark Stock Assessment determined the stock is depleted (ASMFC 2012), while the most recent status review considered the eel abundance to be stable (Shepard 2015).

The American eel is a widely spread, catadromous fish that spends most of its life in fresh or estuarine water before migrating to the Sargasso Sea to spawn. Juvenile eel (elvers) enter river systems in the spring, migrating upstream. They are habitat generalists and may stay in the lower coastal river habitat or continue moving upstream to distant inland waters. American eel have multiple lifestages, including a larval stage (leptocephalus) that typically occurs offshore; young juvenile forms (glass eel and elver) that enter rivers; and older juveniles (yellow eel), and adult (silver eel). Research suggests that eels that migrate to headwater habitat are more likely to be female, while those that remain in downstream habitat are more likely to be male (Shepard 2015). Shepard (2015) also described males as maturing faster than females and are more abundant in the southern portion of their range while females tend to be larger, take longer to mature, and are more abundant in the northern range. They may take from as few as 8 to more than 20 years to mature, before migrating back out to sea to spawn. Spawning likely occurs from February through April, although spawning has never been observed (Boschung and Mayden 2004).

Maine manages three different eel fisheries, glass eel/elver fishery, yellow eel fishery, and mature adult silver eel fishery. There is an active elver fishery downstream of Ellsworth Dam. Maine DMR regulates the elver fishing industry in Maine with dip net and fyke net permits. Records of elver fishing from 2007 to 2014 in the Union River and the percent of the landing in comparison to total elver statewide landings are shown in Table E-14. During this period, landings of elvers in the Union River ranged from 173 to 1,501 pounds, and represented 6 to 10 percent of the state's total elver catch (G. Wippelhauser, Maine DMR, personal communication July 15, 2014). Based on the 2012 benchmark assessment, ASMFC recommended eel conservation and management measures for states to reduce landings. In response to ASMFC discussions of quota management for glass eel fisheries, Maine voluntarily implemented a 2014 harvest management plan that included a quota of 11,749 pounds, which was a 35 percent reduction from 2012 levels (ASMFC 2014). Maine instituted a glass eel quota of 9,688 pounds for the 2015-2017 commercial glass eel fishing seasons. This quota will be re-evaluated after three years (prior to the start of the 2018 fishing season). Additional ASMFC conservation measures include limits on yellow eel fishery and closure of silver eel fishery from September 1st through December 31st (ASMFC 2013).

Table E-14: 2007 to 2014, Union River Elver Landings

Year	Union River Elver Landing (Total Pounds)	Percent of Statewide Elver Landing
2007	306	10
2008	494	8
2009	424	9
2010	173	7
2011	436	6
2012	1,183	8
2013	1,501	10
2014	570	6

During the 2014 upstream eel migration season, Black Bear conducted nighttime eel surveys at Ellsworth Dam and Graham Lake Dam (Black Bear 2014). Eel observation surveys were conducted once per week from June to August. Each site was surveyed for approximately 1 hour between 21:00 hours and midnight. At the Ellsworth Dam, the number of eel observed during each night's survey ranged from approximately 10 to more than 700 (Table E-15). At Graham Lake Dam, the total number of eels observed per survey ranged from approximately 40 to more than 600. The highest eel densities were observed during the July 8th survey. Eel ranged from 2 to 5 inches in length at the Ellsworth Dam. At Graham Lake Dam, the length of eel generally ranged from approximately 3 to 6 inches long, but there were a few longer eel that ranged up to approximately 8 to 10 inches in length. The study, based on visual observations coupled with the known presence of the species in the Union River above Graham Lake, concluded that eel are able to migrate upstream through Project waters and facilities under existing conditions.

Table E-15: Summary of 2014 Nighttime Juvenile Eel Survey Results at Ellsworth Dam and Graham Lake Dam

Date	Ellsworth Dam		Graham Lake Dam	
	Number of Eel	Size Class (inches)	Number of Eel	Size Class (inches)
06/10/2014	0	-	40 to 50	3 to 6
06/18/2014	0	-	200+	3 to 6
06/25/2014	10	-	70+	3 to 6
07/01/2014	100+	2 to 4	100+	3 to 6
07/08/2014	700+	2 to 4	20+	3 to 6
			600+	<3 to 10
07/22/2014	400+	2 to 5	150+	3 to 8
08/05/2014	200 to 300	3 to 4	50	3 to 6

Black Bear 2014

Other Diadromous Fish

Based on past incidental occurrence in the commercial river herring harvest, occasional catch by anglers, and historic reports by agency personnel that used to tend the fishway and trap, a residual population of American shad together with strays from other river systems is believed to exist in the Union River estuary below Ellsworth Dam. Based on a statewide assessment of habitat information, including historic distribution, the Union River contains 4.9 miles of potential habitat for American shad, compared to the total of 1,607 miles statewide (Maine DMR 2014). Of the total 4.9 miles of shad habitat within the Union river, only two miles occur above Ellsworth Dam. The major known American shad spawning and young-of-year rivers consist of the Saco, Androscoggin, Kennebec, and Penobscot rivers (Maine DMR 2014). Due to the lack of an available source of brood stock, there currently are no plans for active restoration of shad to the Union River (URFCC 2015). The Maine DMR plans to focus its shad restoration efforts on rivers other than the Union River from 2015 to 2017 as identified in the CFMP (URFCC 2015). Given the small amount of shad habitat mapped by Maine DMR (2014) in the Union River, restoration efforts are unlikely in this river any time in the foreseeable future.

Striped bass use the Union River estuary for feeding during the spring, summer and fall, and are attracted into the river by the presence of migrating river herring and eel. They are not known to spawn in the Union River, but originate from other coastal migratory populations at major spawning rivers outside of the Gulf of Maine, including the Hudson and Delaware Rivers, and the tributaries to Chesapeake Bay. Striped bass are a popular sport fish in the lower Union River estuary downstream of Ellsworth Dam and are currently protected through the use of regulated size and creel limits (URFCC 2015).

Rainbow smelt occur in the Union River estuary downstream of Ellsworth Dam and continue to be managed in the Union River in accordance with statewide regulations governing recreational and commercial harvest (URFCC 2015). They support a small recreational fishery at the head of tide, which is limited to harvest by hook and line or dip net from March 15 to June 15 (URFCC 2015, Baum 1982). Anadromous rainbow smelt typically migrate a short distance into rivers and streams during their annual spawning migrations and cannot negotiate rapids or other significant natural barriers. It is unknown how far smelt migrated upstream in the Union River prior to the existence of the Ellsworth Dam (URFCC 2015), but it is unlikely that they ascended the steeper rock ledges at the Ellsworth Dam location.

Freshwater Mussels

Per the study request of the Maine DIFW, Black Bear performed a survey for the Brook Floater (*Alasmidonta varicosa*) freshwater mussel in the Union River downstream of the Graham Lake Dam in 2014 to provide more detailed information on the occurrences in Project waters. The Brook Floater freshwater mussel is listed as Threatened under Maine's Endangered Species Act. Black Bear performed surveys on July 24, August 22, and September 22, 2014, using a combination of widely used methodologies for determining presence/absence of freshwater mussels. The primary reference for the methodologies used was "A Guide to Sampling Freshwater Mussel Populations" (Strayer and Smith 2003).

Black Bear used aerial photography, coupled with the biologists' investigation of the Project's riverine areas and shoreline, to identify distinct river reaches in which to locate survey transects. The first field component of the survey effort consisted of a reconnaissance review around the perimeter of the river. This was conducted by boat using view tubes and on foot for shoreline investigations. Nineteen survey transect locations were selected based on observations made during the perimeter reconnaissance. Divers then swam bank-to-bank transects in each of the identified reaches of the river. In the lower part of the investigation area river rapids made it unsafe for SCUBA or snorkel investigations. In this reach investigators used view tubes and face masks and investigated wadeable portions of the reach.

In addition to in-water searches, Black Bear surveyed the shoreline for shell middens by boat and on foot. All surveys were performed in summer months, during low water levels and warm water conditions. The water temperature was between 22ºC and 24ºC during the surveys. These parameters favor times when mussels are more likely to be visible at the substrate surface.

No Brook Floater mussels were observed in either the upper or lower survey reaches. Shell middens observed on the shore revealed no Brook Floater shells.

Fish Passage

Ellsworth Dam is equipped with a vertical slot upstream fishway and trap, which is managed in consultation with the agencies through the management plan. The upstream fishway and fish trapping facility were constructed at the Ellsworth Dam (Lake Leonard) in 1974, originally to provide a supplemental source of Atlantic salmon broodstock for use in the restoration of populations to the Penobscot and other rivers (Baum 1982). Atlantic salmon broodstock collection was discontinued and the upstream fishway has been used primarily during the river herring migration, but also to collect any salmon that might use the facility for potential upriver transport (depending on origin of fish) in the Union River. Maine DMR has annually directed Black Bear whether to transport any returning adult Atlantic salmon upstream of the Project. The trapping facility is also used for the commercial harvest of river herring by the City of Ellsworth under a cooperative management agreement with the Maine DMR. In 2014, the upstream fishway was operated for alewife stocking and harvesting beginning in early May through mid-June. Black Bear then continued to operate the fishway through November 4 for Atlantic salmon (URFCC 2015). In 2015, the upstream fishway was operated from May 1 through October 31 as part of an upstream salmon passage effectiveness study.

Black Bear operates downstream passage facilities at both the Ellsworth and Graham Lake Dams. Downstream measures at the Ellsworth Dam consist of two stop-log controlled surface weirs above Units 2 through 4 and a transport pipe leading to a plunge pool immediately downstream of the dam, as well as a third surface weir adjacent to the Unit 1 intake that discharges directly to the same plunge pool.

Black Bear operates a surface weir (within a former log sluice bay) to provide downstream passage of out-migrating Atlantic salmon and river herring on the west end of the Graham Lake Dam gate structure. The development of this passage route was completed in 2003, coinciding with increased upstream stocking of alewives. The weir is very similar to the downstream passage system at the Ellsworth Dam in that it is a surface weir that contains stoplogs, which enable Black Bear to adjust the opening to match the changes in water elevation of Graham Lake. The opening empties into a downstream plunge pool and provides migrants with another route of passage in addition to the existing Tainter gates, which are operated to pass minimum flows and for flows used for generation purposes at the Ellsworth Dam. The downstream fishways are operated from April 1 to December 31 annually, as river conditions allow.

The Project's upstream and downstream fish passage facilities are managed in consultation with the agencies through the CFMP (URFCC 2015). Black Bear developed a site specific operation and maintenance plan for the fishways in 2015. The plan, which is consistent with the original design criteria for the fishways, includes a daily checklist that was instituted at the beginning of the 2015 season, and will be employed in future seasons, to ensure that the upstream and downstream fishways are operating properly. The plan also includes both a list of spare parts critical to fishway operation and a checklist of proper fishway operating characteristics. In 2015, Black Bear hired dedicated staff to operate the project fish passage facilities; these staff were dedicated to fishway operations, oversight, fish trap tending, and transporting the fish upriver. These dedicated fishway staff completed the daily checklists and prepared weekly reports on fishway operations, which were provided to the fisheries management agencies throughout the fishway operational season.

Reservoir Fisheries Habitat

The diverse habitat within the vicinity of the Ellsworth Project provides for an abundant variety of fish. Water quality throughout the basin is considered high, and is for the most part suitable for fish and wildlife resources and recreational uses. Lake Leonard is about one mile long with a surface area of 90 acres at normal water surface elevation. Lake Leonard has a maximum depth of 55 feet and a mean depth of 25 feet. Graham Lake is about 10 miles long with a surface area of approximately 10,000 acres at normal water surface. Graham Lake is divided into two basins (a north and a south basin) by a large peninsula that originates from the western shore (USFWS 2005). The lake is irregular in shape with numerous coves and inlets. The maximum depth of Graham Lake is 47 feet, while the mean depth is 17 feet. The bathymetry of Graham Lake is described in Section 4.4.2.

Exposed boulder/ledge substrate is limited in and around Graham Lake. Boulder/cobble substrate mixed with sand and gravel is the most common substrate along the east shore and the islands in the lake. In general, these substrate types are present from the shoreline to at least 4 to 5 feet depths. The western shore of Graham Lake is made up of varying ratios of clay and finer sands as well as medium to coarse sands and some fine gravel. Some localized areas have boulder and cobble mixed in with the sand/gravel. The north end of the lake, where the Union River enters the lake also has clay/sand/gravel substrates with some organic substrate. This area tends to have somewhat coarser material than the lower west shore. Substrates surrounding the heath areas within Graham Lake are dominated by clay and fine sand (Northrop, Devine & Tarbell, Inc. 1990).

Lake Leonard and Graham Lake are the primary stocking locations for river herring in the Union River drainage, with Graham Lake containing the majority of potential spawning habitat in the watershed.

In Graham Lake, data were collected on fish habitat around the perimeter of the lake to determine if conditions were appropriate for spawning, and providing juvenile and adult habitat of primarily smallmouth bass and chain pickerel (Black Bear 2012). The eastern shore of the lake and around the islands was observed to provide suitable habitat for smallmouth bass. The riprap area along the shore offers juvenile and spawning habitat for the bass. It has previously been concluded that chain pickerel would utilize the heath areas where aquatic vegetation is present, though habitat for spawning pickerel has been documented as somewhat scarce (Northrop, Devine & Tarbell, Inc. 1990).

Riverine Fisheries Habitat

In order to assure water quality and to protect fishery resources in the lower river, a continuous minimum flow release of 105 cfs is maintained from the Graham Lake Dam and Ellsworth Dam from July 1 through April 30 and a continuous minimum flow release of 250 cfs is maintained from May 1 through June 30.

Black Bear conducted an Instream Flow and Union River Tributary Access Study in 2014 and evaluated habitat within the Union River between Graham Lake Dam and Lake Leonard at various flows (Black Bear 2015). Habitat in the Union River between Graham Lake and Lake Leonard primarily consists of runs with periodic pools and riffles upstream of Route 1A (Figure E-12). The section of the Union River between Graham Lake Dam and Lake Leonard was divided into three representative reaches (upper, middle, and lower); the upper reach was just downstream of Graham Lake Dam, the lower reach was just upstream of Lake Leonard, and the middle reach was located in between these reaches. Habitat parameters (depth, velocity, wetted width and substrate) were measured during a set flow to help characterize the habitat available at low flows. The lowest gate setting provided at the time of the field study was estimated to provide a flow of 150 cfs. The wetted width for a flow of 105 cfs (lowest required minimum flow) was extrapolated for each transect based on measured data for four observed flows at multiple transects established throughout the reach. The difference in wetted width and depth between the observed 150 cfs and the extrapolated minimum flow of 105 cfs is insignificant as illustrated by the profiles presented in Appendix E-4. The calculations used to extrapolate to 105 cfs, and all field data collected at each transect are provided in Appendix E-4 in tabular form.

Portions of the upper reach of the Union River were relatively wide and consisted of deeper pool/run, which is uncharacteristic of this reach. Most of this reach consisted of deep run habitat and instream cover was abundant, which included submerged woody debris, snags and vegetation. Substrate consisted of fine sediment, gravel, cobble, and bedrock. There is also a wetted remnant oxbow, which transitions into a shallower run/riffle habitat. Further downstream, the river deepens into a slower pool-type habitat with fish cover including submerged large woody debris and large boulders.

The middle reach of the study reach had distinct riffle, pool and run habitats. Riffle substrate consisted of gravel, cobble and large boulders. The pool substrate included silt, gravel and large boulders with submerged woody debris collecting along the left bank of the pool. The run substrate consisted of silt, gravel, and large boulders. All habitats had instream cover.

The lower reach was located at the upper extent of Lake Leonard. The lower reach had numerous large bedrock outcrops defining the channel where large boulders and woody debris provide instream cover. The habitat near Gilpatrick Brook (Figure E-12, Figure E-13) was a deep, run-type habitat with a large vegetated island located just downstream. Both sides of the island consisted of riffle habitat. Collectively, habitat information indicated the wetted width and depth at the estimated low flow release of 150 cfs, and extrapolated for the minimum flow of 105 cfs, provides an adequate wetted zone of passage for migratory fish and other aquatic species.

The Union River below the Ellsworth Dam is tidal water and as such the characteristics of the habitat changes with the tidal cycle and river flows. A large riffle area dominated by cobble and boulder substrates occurs downstream of the Project tailrace and is bound on one shore by large bedrock cliff.

Figure E-12: Habitat and Flow Study Transects, Union River between Graham Lake and Lake Leonard

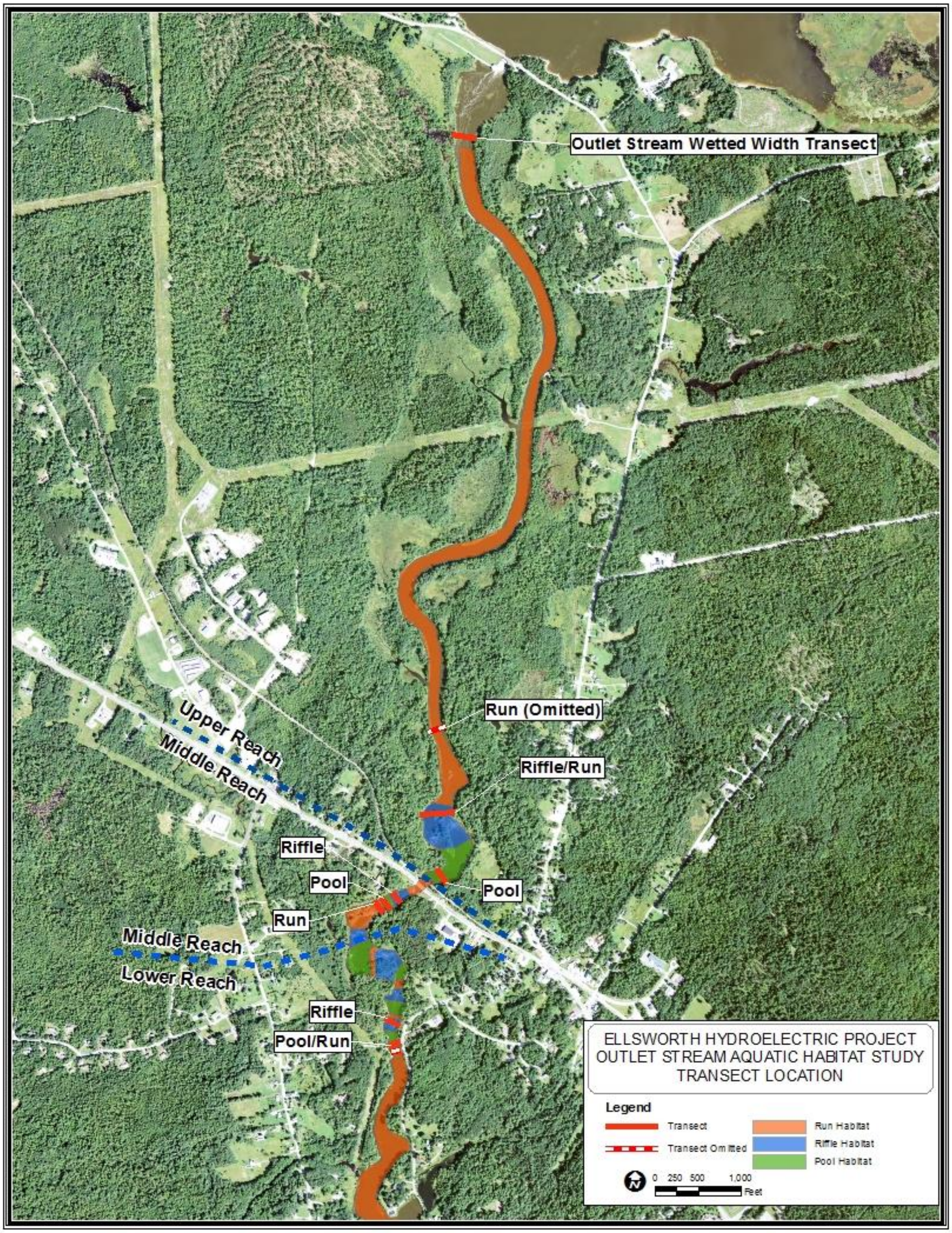
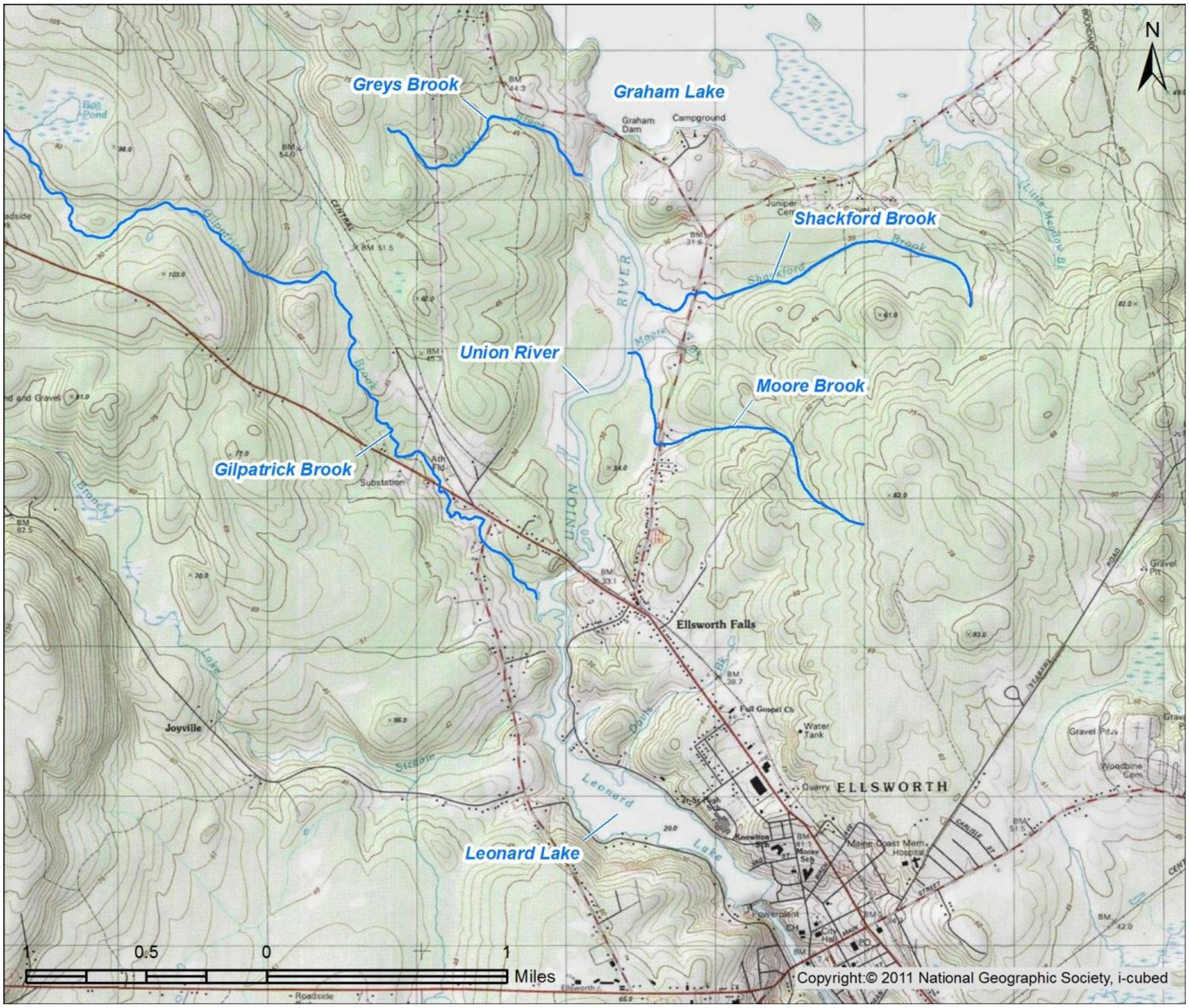


Figure E-13: Union River from Graham Lake Dam to Lake Leonard



4.4.3.2 Environmental Analysis

Water Level Fluctuations

An interest was identified by stakeholders during project scoping and study plan development regarding the effect of Project operations on the existing fish community and tributary connectivity. The Ellsworth Project currently operates with releases from Graham Lake development used to generate electricity at the Ellsworth development powerhouse. Water levels in Graham Lake are typically managed consistent with the target operating curve depicted in Figure E-7, though elevations vary annually. Graham Lake water levels are maintained between elevations 93.4' (late winter in order to provide storage capacity for spring rains and snow melt) and the normal full pond elevation of 104.2' (typically in late May after spring runoff). This provides the ability to store and release water seasonally and also provides significant downstream flood control benefits. The Ellsworth development is operated such that nearly all inflows into the Ellsworth headpond are passed through the generating units, while the impoundment is maintained in a very stable state (i.e. within 1-foot of full pond during normal operations).

Warmwater species such as smallmouth bass, chain pickerel, and white perch provide sport fishing opportunities in Graham Lake (Black Bear 2012). Largemouth bass have been expanding rapidly (Burr, G. Maine DIFW, personal communication, July 3, 2014). A Project area resident and former Maine Guide who has fished Graham Lake extensively for many years, and who kept extensive catch records, which he submitted to Maine DIFW, noted that originally, largemouth bass were being caught primarily in the north part of the lake, and could reach two to three pounds; they are now found throughout the lake and in much higher abundance, and can reach five pounds. He noted that he had caught 80 bass on Graham Lake in a day (Fennelly, D. personal communication July 23, 2014). Bass fishing tournaments are hosted in Graham Lake, also indicating that there are abundant bass, and Maine DIFW (2015) reports that Graham Lake has good action for medium size bass. Good white perch fishing exists at Graham Lake, which also has a productive pickerel fishery (URFCC 2010), as well as a brown bullhead fishery (Fennelly, D. personal communication July 23, 2014).

Graham Lake provides a majority of the spawning and rearing habitat for river herring in the Union River watershed, and Black Bear's trap and transport efforts have allowed for development of one of the largest alewife runs in the country.

Instream Flows

Minimum flow releases from the Project dams have been developed to maintain fish habitat, to facilitate anadromous fish migration, and to protect downstream water quality. Resource agencies requested Black Bear evaluate the relationship between existing minimum flows, aquatic habitat and migratory fish behavior in the Union River below the Graham Lake Dam. Black Bear subsequently conducted an instream flow study (Black Bear 2014). Flows analyzed included two low flows (150 and 300 cfs), a mid-range flow (1,230 cfs) and a high level (2,460 cfs) generating capacity flow.

The study found aquatic habitat for river herring and Atlantic salmon is sufficient at all flows analyzed. In addition, a zone of passage for these species is provided throughout the Union River during the observed low flows. Tributaries to the Union River between Graham Lake and Lake Leonard (Greys, Shackford, Moore, and Gilpatrick brooks [Figure E-13]) maintained adequate connectivity for Atlantic salmon, river herring and other aquatic species during the flows observed. Appendix E-4 contains the photographs of tributary connections under the minimum observed study flow of 150 cfs.

Mode of Operation

Comments provided on the DLA expressed concern for peaking flow effects to aquatic resources downstream of Graham Lake Dam specifically that studies conducted at other rivers suggest benthic macroinvertebrates may be adversely affected by peaking flows, and that any impact to macroinvertebrates may affect feeding by juvenile alosids and Atlantic salmon. Lake and impoundment outlet waters are known to provide abundant food sources, and typically exhibit hyperdominance by hydropsychids (Spence and Hynes 1971) and filter feeding caddisflies (Parker and Voshell 1983). The Union River macroinvertebrate data collected downstream of Graham Lake Dam was described as abundant (Black Bear 2015). Juvenile alosids feed primarily on zooplankton, fish eggs and larvae, crustaceans, and insects (Bozeman and Van Den Avyle 1989, USFWS 2001, Riley 2012), and juvenile Atlantic salmon feed primarily on drift items (Keeley and Grant 1997, Orlov et al. 2006). The productive impoundment outlet waters provide ample prey items to support feeding by juvenile alosids and salmon.

Comments on the DLA also expressed a concern regarding whether peaking flows affect aquatic habitat and upstream passage effectiveness downstream of the Ellsworth Dam. In regards to upstream passage effectiveness, the one consistent observation made throughout the upstream fish passage study (Black Bear 2014 and 2015) was that fish (river herring) occurrence and densities were higher in the afternoon and evening hours (prior to sunset), and on incoming tides. A review of project operations/ river flow data did not suggest the fish migration or fishway numbers responded to changes in flow from the Project. Because river herring can access the river below Ellsworth Dam, it is expected that turbine discharge would not affect other diadromous fish from accessing Ellsworth Dam. Observations below the dam indicate the river bed remains watered under minimum flow conditions with no evidence of areas of potential stranding.

There is very little, if any, adverse impact to the resident fish or diadromous fish from the current or proposed operating regime for the Ellsworth Project.

Fish Access to Tributaries

In October 2014, impoundment tributary connectivity was assessed for tributaries during low water conditions in Graham Lake (97.9’) and in Lake Leonard (65.7’ to 66.7’). Observations in Graham Lake indicated tributaries maintained connectivity at this elevation. Based on the Graham Lake historic operating curves (Figure E-7), the conditions of connectivity observed at 97.9’ in Graham Lake were only 2 inches above the target elevation for October (target elevation increases late October through November), and one foot below the long term (1999-2014) average elevation for October. Therefore, connectivity is expected to be maintained through the fall seasonal drawdown (Black Bear 2014). To address stakeholder comments on the USR, and in accord with FERC's December 8, 2015 Determination on Requested Study Modifications, Black Bear will provide gradient profiles for the Graham Lake and Lake Leonard tributaries as indicated in the Study Plan Determination and will collect zone of passage information from tributaries selected in consultation with the fisheries agencies. Black Bear will collect this information and file it with FERC by December 31, 2016 as additional information to the FLA.

A similar evaluation of tributary access for the streams entering the Union River between Graham Lake and Lake Leonard (Greys Brook, Shackford Brook, Moore Brook, and Gilpatrick Brook) was conducted in September 2014 during managed low flow conditions. All tributary confluences had adequate depths (> 6 inches) during the observed low flows that would allow Atlantic salmon access, see photographs provided in the USR and Appendix E-4 of each tributary confluence during the low flow observations. In addition, the tributary confluences had low velocities that would not preclude access by Atlantic salmon or river herring. Therefore, the confluence at each of the tributaries provide a zone of passage into the tributaries for Atlantic salmon to access any suitable spawning habitat that may be present upstream in these tributaries[5]. Natural low flows within the tributaries themselves were observed during the study, suggesting that low flows within the tributaries could potentially be a limiting factor for migratory fish accessibility further up in the tributaries.

It should be noted that migratory species typically migrate upstream into tributaries during instances of high runoff following rain events, rather than during the low flow period observed in this study. This further suggests that accessibility to these tributaries is available during the Atlantic salmon migratory season.

Stakeholder comments on the USR suggested that the evaluation of accessibility to tributaries should be based upon more detailed criteria. To further address stakeholder comments on the USR, and in accord with FERC's December 8, 2015 Determination on Requested Study Modifications, Black Bear will consult with agencies and collect additional zone of passage information in 2016 for select tributaries to the Union River between Graham Lake and Lake Leonard. Black Bear will file the results of this study with FERC by December 31, 2016 as additional information to the FLA.

[5] This portion of the instream flow study (evaluation of tributary access) was conducted as required in the approved study plan: "To evaluate tributary access for diadromous fish, the confluence of the tributaries (pending accessibility) of Union River and Moore Brook, Gilpatrick Brook, Shackford Brook and Greys Brook will be observed during the various flow conditions to document with photographs there is reach connectivity to allow diadromous fish accesses to each of the tributaries."

Upstream Passage

Anadromous Species

The upstream fish passage facility at the Project is designed to trap Atlantic salmon and river herring, and to transport fish to suitable upstream habitat located above the Project dams. Resource agencies and stakeholders expressed interest regarding the effectiveness of the upstream fishway at Ellsworth Dam and the potential for migration delay for diadromous species.

In 2014, Black Bear conducted an upstream fish passage study to evaluate the effectiveness of the existing upstream trap and transport operations (Black Bear 2014). Black Bear evaluated the route and behavior of river herring approaching the fishway and trap, and the extent of any injury, stress or mortality during and after handling at the fishway and trap and release sites.

To evaluate the route and behavior of river herring approaching the fishway, Black Bear viewed the Union River from several stations at the base of the dam and powerhouse several times a day and prior to checking the fishway, as conditions allowed, to determine whether river herring were present and the approximate abundance. The 2014 alewife migration and trap and transport activity started on May 8 and extended to June 7 for Graham Lake, with an additional trap and transport to Lake Leonard on June 14. Observations of river herring presence and behavior as they approached the fishway indicated they use both sides of the river and occasionally, the middle of the river. The primary factor affecting alewife presence and abundance was the time of day, where the number of fish in the river as well as entering the fishway increased substantially during afternoon hours. There was no apparent pattern associated with river flows, Project operations, or weather conditions.[6]

To assess the extent of any injury, stress or mortality during and after handling at the fishway and trap and release sites, a total of 857 fish were held for 24 hours and evaluated during 4 net pen trials. The net pen trials resulted in a total of 21 mortalities (<2.5%), all of which resulted from net entanglement and did not appear to be related to delayed mortality from transport. Observations noted during the truck transport and release into Graham Lake and the results of

[6] An Upstream Atlantic Salmon Passage Study was conducted in 2015 to evaluate whether operations at the trapping facility may affect the capture of adult Atlantic salmon. The study observations, including observations of river herring passage (intended to inform the potential for the presence of herring to affect the passage of salmon) are included in Appendix E-6. During observations of the river, it was noted that the river herring tended to run strongest in the evenings and moved stronger during an incoming tide. Increasing river temperature was also noted to increase river herring densities during warm sunny days. It was also noted that, on most evenings, river herring stopped entering the fishway and began dropping downriver around sunset. River flows did not seem to have as strong of a correlation to river herring densities as the previously mentioned environmental factors. During all flows, the river herring tended to migrate upstream on the fishway side of the river (deeper water is present here) and hold in front of the fishway entrance. During spill events, the river herring did not appear to migrate towards the dam face.

the net pen trials indicated that the transport and release does not result in observed or measured immediate or delayed mortality, injury or stress.

The upstream fish passage study also evaluated the trap and transport capacity for adult river herring. Observations during the study showed that when fish are abundant, the fish trap fills rapidly, transport trucks leave immediately, and fish are released into Graham Lake in 14 minutes or less 90 percent of the time. With two transport trucks running, as many as 25,920 (5,200 fish per hour) river herring were trapped and transported to Graham Lake during afternoon daylight hours in a single day.

In 2015, the Union River target alewife stocking number was increased from 150,000 to 315,000 fish. The trap and transport study concluded that the current fishway operation is more than sufficient to provide the 2015 to 2017 target management spawning escapement goal of 315,000. An increase in the annual river herring runs to two million fish is anticipated to occur 4 to 5 years after the 2015 escapement increase is implemented (URFCC 2015).

The full spawning escapement that would utilize additional habitat in five other pond/lakes targeted for alewife stocking is calculated at 357,151 (35/acre). Black Bear transported a sufficient number of river herring in 2015 to meet the minimum target of 88 percent[7] of the calculated future spawning escapement for the watershed (315,000 stocked in 2015/357,151 revised spawning escapement), which represents a considerable increase over transporting 47 percent of the spawning escapement in prior years (150,000 stocked/315,000 spawning escapement calculated prior to 2015).

Collectively, these data indicate the operation of the current Ellsworth fish trap and transport facility has successfully developed and maintained a self-sustaining river herring population and commercial fishery. The Union River herring run has developed to be among the largest in the country. Further, the Atlantic States Marine Fisheries Commission (ASMFC) assessed the status of populations of river herring along the Atlantic Coast, and concluded that the population of alewife in the Union River had increased between 1975 to the early 2000s. The ASMFC also concluded that the Union River has exhibited a stable population of alewife for the past 10 years (ASMFC 2012 *cited in* FERC's September 4, 2013 Study Plan Determination).

Comments on the DLA requested that American shad upstream passage be evaluated. An analysis of upstream fish passage alternatives was conducted by Black Bear in 2015 and the initial report was presented in the USR (Black Bear 2015). The initial study report was revised to address several stakeholder comments, including a request to evaluate shad passage, and is included as Appendix E-7. As discussed previously, only a short reach of river above Ellsworth

[7] The final 2015 numbers of river herring transported was 329,160, which equates to 92 % of the calculated future spawning escapement for the watershed.

Dam (to the top of Lake Leonard) is currently suitable for American shad. There is no information available on historical use of the river by shad and this species is not a conservation priority for the Maine DMR on the Union River (Maine DMR 2013). However, the upstream passage and alternatives analysis concluded the existing fishway should function with low to moderate effectiveness for shad. The fishway has the potential to be modified in the future for improved shad passage effectiveness if shad numbers and management goal priorities change.

The vertical slot upstream fish passage and trapping facility at the Project has a positive effect on the Atlantic salmon GOM DPS, as it increases habitat connectivity in the event migrating adults seek to enter the Union River searching for access to suitable spawning habitats. Some potentially negative effects from the trapping and transporting of adult Atlantic salmon include migration delay/interruption, and handling and holding stress or injury. While empirical studies of the upstream passage effectiveness for adult Atlantic salmon have not been specifically conducted at the site (primarily due to a lack of available study fish), an Upstream Atlantic Salmon Passage Study was conducted in 2015 to evaluate whether operations at the trapping facility may affect the capture of adult Atlantic salmon. The trap was operated from sunrise to sunset from May 1 to October 31 in 2015, checked at least four times a day, and observations made regarding the potential effects of fishway operations on salmon. As per the Maine DMR fishway protocols, the upstream fishway was not operated when temperatures exceeded 23°C (73°F), which occurred intermittently in July and September and throughout most of August. However, observations of the fishway entrance area and tailwaters continued on a routine basis. No Atlantic salmon were observed in the river or collected in the fishway in 2015. The study observations, including observations of river herring passage (intended to inform the potential for the presence of herring to affect the passage of salmon) are included in Appendix E-6.

Hydroelectric facilities may result in delays of both upstream and downstream migration of Atlantic salmon. Several studies on the Penobscot River have evaluated upstream passage behavior including the time needed for individual adult salmon to pass upstream of various dams once detected in the vicinity of a spillway or tailrace. These studies documented certain migratory behaviors that may contribute to migration delays, including frequent upstream and downstream movement, periods of holding in fast water, seeking thermal refuge in tributaries, attraction to spillage at dams, reduced migratory behavior in late summer, and inhibited movement at temperatures above 23°C (Power and McCleave 1980, Shepard 1995). However, upstream passage is site specific and passage studies conducted in the Penobscot River or other rivers may not be applicable to the Ellsworth Project.

As part of the ongoing relicensing of the Project, Black Bear reviewed historic information related to operations and environmental conditions during historic captures of Atlantic salmon to assist in evaluating the efficacy of the trap and transport facility and operations (Black Bear 2014). Recorded data on fishway operations when salmon were captured was available for years

2002 to 2005. There were no apparent trends in salmon captures and flow conditions as salmon were collected over a wide range of river flows, from summer flows as low as 48 cfs to the higher June flow of 937 cfs. Salmon were also captured over a range in temperatures up to 74°F. The fish trap was not operated when water temperatures were at or exceeded 77°F as per direction from Atlantic Sea-Run Salmon Commission and Maine DMR protocol. Temperatures in the upper seventies are more typical of late summer when salmon are not expected to be entering the river, or would be expected to be holding in thermal refugia. The current Maine DMR protocol is to not handle Atlantic salmon at fish passage facilities when the river temperature exceeds 73° F. While there is a low probability of salmon captures when water temperature exceeds 73° F (few salmon have been collected in the Union River at or above this temperature historically), Black Bear plans to modify its operational and handling procedures in case such a situation occurs in the future.

Using an assumed production of 3.0 smolts/100 square yards of stream bottom, and a marine survival of 1 - 3%, the habitat in the Union River upstream of Ellsworth could generate a self-sustaining run of about 250 to 750 salmon (Baum 1997 *cited in* URFCC 2010). It should be noted however, current marine survival has been estimated to be even lower, 0.09 to 1.02%, from 1995 to 2004 (ICES 2008 cited in USFWS and NMFS 2009) , which would result in a run of approximately 250 or less fish, given that this survival range is on the lower end or less than Baum (1997) used. Black Bear examined the Ellsworth fishway hopper capacity for salmon with regard to the estimated maximum self-sustained restored run size of 750 Atlantic salmon (Baum 1997 *cited in* URFCC 2010), and found that the Ellsworth lift hopper has more than four times the required capacity to pass a run of 750 Atlantic salmon (Black Bear 2014).

The upstream passage alternatives analysis also considered agency concern regarding effective passage of salmon during the river herring harvest operations and the potential for migration delay due to fishway crowding or infrequent trap and transport operation. Under current operations, the trap and hopper are visually inspected for Atlantic salmon and if one is spotted, the hopper is left in the water and the salmon is dip-netted out and placed in a holding tank. The salmon is then measured, examined for fin clips, fin wear, or other markings, a scale sample is taken, and the magnified scale image and fish photo is digitally captured. This information is transmitted to the Maine DMR who will then determine whether the Atlantic salmon caught in the fishway is to be released downstream of the Ellsworth Dam (hatchery or aquaculture escapees), moved via transport tank truck upstream (wild origin) and released in the West Branch of the Union River, approximately 17 miles upstream, or removed. Generally, this process takes one to two hours, and in the case of wild Atlantic salmon, they arrive in upstream habitat more quickly than they would if they had passed volitionally and swam the entire distance.

The current trap and transport facilities and operating protocols at Ellsworth have proven to be reliable and functional by handling river herring runs from 190,000 to 1,200,000 river herring and 0 to 8 Atlantic salmon annually from 2000 to 2015. Historically, this facility has handled up to 263 adult Atlantic salmon broodstock in a year. The trap and transport facility's original construction specifically targeted Atlantic salmon upstream passage. Trap and transport systems have been used successfully to pass other species such as shad on the Susquehanna River and river herring in the Sebasticook River. Sigourney et al. (2015) evaluated trap and transport of Atlantic salmon on the Penobscot River and found it was an effective means to increase migration success. However, the final upstream passage alternatives study report presents several options for increasing fish passage capacity in the future if necessary, discusses separation of river herring from Atlantic salmon passage, and examines alternative fishways (Appendix E-7). Black Bear will continue to consult with fisheries management agencies on the need for and, if necessary, the design of upstream fish passage improvements based upon the results of the relicensing studies and future management plans to be published by the fisheries management agencies.

There is a possibility that sturgeon could be encountered at the fish trap or during project maintenance activities (e.g., if the draft tubes need to be dewatered for maintenance activities). Black Bear has developed a draft protocol to provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered at the Project. The protocol is attached to the draft Biological Assessment in Appendix E-12.

Catadromous Species

Juvenile eels are able to access upstream habitats by ascending the wetted surface of dams and adjacent ledges. Aggregations of juvenile eels moving upstream over the Ellsworth and Graham Lake Dams were observed during several nighttime eel surveys conducted in 2014, but their upstream passage success rate is unknown (URFCC 2015). Black Bear proposes to consult with fisheries management agencies to develop and install upstream eel passage facilities at the Project. The installation of such facilities will enhance upstream eel passage.

Downstream Passage

Anadromous Species

Black Bear operates downstream passage facilities at both Project dams to provide downstream passage of out-migrating Atlantic salmon and river herring. At Graham Lake dam passage is provided at a surface weir that is operated specifically for downstream passage; passage is also available through the minimum flow tainter gate. At the Ellsworth dam, downstream passage facilities consist of three surface weirs. These facilities have been in operation since approximately 1990.

Maine DMR has suggested post-spawn alewife are not surviving downstream passage of the Project. This is based on Maine DMR's principle components analysis and cluster analysis (Wards Method) that the agency conducted on the age composition and repeat spawning frequency data collected by harvesters and Maine DMR (combined) for the period 2008-2012 at 29 Maine harvesting sites. The Ellsworth harvest on the Union River had a low frequency of repeat spawning (i.e., a high proportion of fish had not previously spawned) and young spawners (age-3 and age-4). Maine DMR concluded that in the Union River "...alewives are only successfully spawning in one year" and offered two explanations "...either older, previous spawners are not able to reach the top of the upstream fish passage facility or post-spawn adults are not surviving downstream passage of the project" (Maine DMR letter to FERC, dated July 1, 2013). However, as FERC noted in its September 4, 2013 Study Plan Determination, in an analysis conducted by ASMFC (2012), ASMFC noted that high exploitation rates (the percentage of population that is harvested) can also reduce the number of older, repeat spawners in the population. Based on a review of the annual URFCC reports, FERC noted that the exploitation rate for alewives in the Union River ranged from 65 to 88 percent from 2000 to 2012, and the observed exploitation rates in the Union River overlap with the exploitation rate calculated by ASMFC (2012) that could cause population collapse (i.e., 62% to 80% depending upon the assumptions used regarding the population growth rate). Therefore, it is possible that the lower number of older, repeat spawners in the Union River is the result of high exploitation rates, rather than low downstream passage survival of post-spawned adult alewives.

In either case, the alewife run has maintained high numbers of returns and has been the second largest run of alewives in the state. This is further supported by high numbers of returns in 2012, 2013, and 2014 when the total river herring run size (including both river herring harvested and transported upstream) was 1.2 million, 709,097, and 769,635, respectively. Licensee transported over 100,000 river herring (11.6 fish/acre) upstream annually since 2000, until increasing the spawning escapement to 125,000 in 2010, 150,000 (18 fish/acre) in 2011, and 315,000 in 2015. While the number of alewife returning to the Union River clearly demonstrates that there has been adequate escapement of downstream migrants to support the expanding run, there has not been a site specific study to examine the effectiveness of the existing downstream passage facilities or available passage routes at Ellsworth.

In order to examine the effectiveness of the downstream passage facilities at Ellsworth, and in accordance with the December 30, 2014 Determination on Requests for Study Modifications and New Studies for the Ellsworth Hydroelectric Project by FERC, Black Bear developed a study plan in consultation with the agencies, to conduct a field study in 2016 to evaluate the effectiveness of downstream passage of Atlantic salmon smolts at the Ellsworth Project. The study plan was filed with FERC on March 31, 2015 and approved by Order from the FERC dated April 21, 2015. This study proposes to monitor tagged salmon smolts passage through the Project area (from upstream of Graham Lake) using radio telemetry tags and monitoring gear, and passage survival at the Ellsworth Dam using acoustic tags and receivers (maintained by NFMS) downstream of the dam. The field study is planned for spring 2016, pending receipt of all required permits and approvals. Results of the study will be submitted to FERC by December 31, 2016.

Catadromous Species

There are no dedicated downstream fish passage measures for American eel at the Project. In response to a request by FERC in the Study Plan Determination dated December 30, 2014, Black Bear conducted a field study of downstream passage of eel at the Project in the fall of 2015. The preliminary study report is presented in Appendix E-8. Researchers tagged and tracked the movements of 47 adult American eels as they migrated downstream. The tagged eels were released by boat approximately 0.8 kilometers (0.5 miles) upstream of Graham Lake Dam at around sunset in three groups, starting on September 29; the last release was made on October 15 with monitoring continuing through November 12. Passage route and survival analyses were evaluated for both Graham Lake Dam and Ellsworth Dam. All 47 eels (100 percent) migrated through Graham Lake Dam and survived passage based on tag detections downstream at the Ellsworth Dam, a distance of approximately 7 river kilometers (4.3 miles). All 47 tagged eels continued downstream of the Ellsworth Project, with 43 detected passing through the turbines. No eels were detected using the downstream fish bypass or turbine Unit 1, but four passed the project through an unidentified route based on detections further downstream. Turbine passage survival was 25 percent for turbine Unit 2, 47 percent for Unit 3, and 86 percent for Unit 4. Overall, 53 percent of the tagged eels survived passage at the Ellsworth development.

The approved downstream eel passage study plan anticipates that the study will be conducted in two phases (2015 and 2016). The objectives and methodology of the second phase of the study, either to evaluate eel injury by passage route at the Ellsworth dam development, or to further evaluate passage routes and survival at the Ellsworth dam development, will be finalized after review of the se phase 1 study results and agency consultation regarding study needs. Final results of the study will be submitted to FERC by December 31, 2016 as required in the approved study plan.

Black Bear will continue to consult with fisheries management agencies on the need for and, if necessary, the design of downstream fish passage improvements, including downstream eel passage measures, pending the results of ongoing studies.

Predation

Atlantic salmon smolts and juvenile river herring face predation risk during their migration from freshwater to estuarine and marine environments. Anthropogenic factors may contribute to conditions that support known predators of Atlantic salmon, such as chain pickerel, smallmouth bass, and double crested cormorants (Fay et al., 2006). Dams may increase predation risk due to outmigrant disorientation, injuries, congregating behavior, and decreased abundance of other diadromous fishes that historically acted as a prey buffer by providing a robust alternative food source for predators (Northeast Salmon Team 2011). Dam passage may also affect predator detection and avoidance by outmigrating fish (Raymond 1979, Mesa 1994).

Fish species such as brook trout and American eel are native to all major drainages in Maine and likely feed on salmon and river herring eggs and juveniles. Introductions of top predator fish (e.g., smallmouth bass, chain pickerel, and brown trout are non-native fish species that occur in the Union River watershed) negatively affect resident fish communities by disrupting normal feeding behavior (Bystrom et al. 2007), decreasing prey abundance (He and Kitchell 1990, Findlay et al. 2005), and through extirpation of native species (Findlay et al. 2005, Bystrom et al. 2007). Striped bass are also known predators of Atlantic salmon smolts (Blackwell and Juanes 1998). A restored run of river herring in the Union River drainage is expected to be beneficial to Atlantic salmon restoration efforts, because river herring provide a predation buffer, by providing predators with alternative, and potentially more abundant prey.

Birds known to prey upon Atlantic salmon throughout their life cycle include species such as mergansers, belted kingfisher, bald eagles, ospreys, double-crested cormorants, gulls, and gannets (Fay et al. 2006). The USFWS has concluded that avian predation poses a high-level threat to the survival and recovery of GOM DPS Atlantic salmon (NMFS and USFWS 2005). Blackwell et al. (1997) reported that salmon smolts were the most frequently occurring food items in cormorants sampled at main stem dam foraging sites. In a study in the Penobscot River, cormorants were present during the spring smolt migration as migrants, stopping to feed before resuming northward migrations, and as resident nesting birds using Penobscot Bay nesting islands (Blackwell 1996, Blackwell and Krohn 1997). Another study found Atlantic salmon comprised 26% of cormorant’s diet during the smolt run (Hatch and Weseloh 1999). Meister and Gramlich (1967) studied salmon predation by cormorants in the Machias River estuary. The results of this study documented that cormorants consumed an estimated 8,000 tagged hatchery smolts during the period 1966-1967 in the Machias River. Predation rates on migrating hatchery-reared salmon smolts were found to be as high as 13.4% in the Machias River (Meister and Gramlich 1967).

Turbine Entrainment of Fish

While downstream passage facilities are operated at the Project, the potential to affect fisheries due to potential entrainment or impingement at the Ellsworth dam is discussed below.

As part of the relicensing process and consistent with the approved study plan, Black Bear conducted a desk-top assessment of downstream passage survival at the Project including the potential for entrainment, turbine-induced mortality, migratory route selection, and whole station survival (Black Bear 2014). Downstream migrating fish must use the Project's downstream weirs, or pass through the Project turbines, or during rare cases of spill, pass over the spillway to migrate downstream to the Union River estuary and Atlantic Ocean. The study incorporated various physical and operational aspects of the Project with empirical passage data collected at numerous regional projects and others across the U.S. The target fish species evaluated for this assessment consisted of adult silver phase American eel, adult and juvenile river herring (blueback herring and alewife), and adult and juvenile Atlantic salmon.

Fish impingement and intake avoidance were evaluated utilizing intake velocity calculations, fish burst swim speeds, and trashrack spacing. The trashrack clear spacing for the Ellsworth Dam turbine intakes vary with unit intake as described in Table E-16. The average approach velocities have been calculated as 1.16 feet/second at Unit 1, 2.97 feet/second at Units 2 and 3, and 2.79 feet/second at Unit 4 (Table E-16). Fish burst speeds were evaluated to predict the ability of target species to avoid entrainment (Table E-17). With the exception of juvenile river herring, the burst speed of fish species exceeded the intake velocity at all units.

Table E-16: Ellsworth Trashrack Spacing and Calculated Intake Velocities

Parameter	Unit 1	Unit 2*	Unit 3	Unit 4
Trashrack Clear Spacing (in)	2.44	1.00 (top)/2.37(bottom)		
Approach Intake Velocity (feet/s)	1.16	2.97	2.97	2.79

*The Unit 2 and 3 trashracks start 7.8 feet below the normal headwater elevation of 66.7' (first 7.8 feet is concrete), then have 1-in clear-space trashracks between 7.8 and 14.0 feet before the trashrack clear-spacing increases to 2.37 inches below 14.0 feet deep. The Unit 4 trashracks start 5.7 feet below the normal headwater elevation of 66.7' (first 5.7 feet is concrete), then has the same clear-spacing sizes at slightly different depths.

Table E-17: Target Species Burst Swimming Speeds

Life Stage	Target Species	Size Range (in)	Burst Swim Speed	
			feet/s	Reference
Adult	American Eel	24-30	3.1-4.4	Bell 1991
	Alewife	10-12	10.2-15.4	Clough et al. 2004
	Blueback Herring	9-10		
	Atlantic Salmon	25-32	16.5-19.7	Wolter and Arlinghaus 2003
Juvenile	Alewife	1-6	1.4-1.6	Griffiths 1979
	Blueback Herring	1-3		
	Atlantic Salmon Smolt	5-8	6.0	Peake et al. 1997

Black Bear collected field measurements in front of the trashracks at the Ellsworth Dam intakes to provide a more detailed understanding of intake velocities. Velocity measurements were also taken at the three entrances of the Ellsworth dam downstream fish bypass. Researchers took 240 water velocity measurements at 93 discrete positions in front of the trashracks at Units 2, 3, and 4 (Table E-16). Measurements were not taken in front of the Unit 1 intake because it is only accessible by diving. Velocity measurements at Unit 4 are considered to be representative of the velocity in front of Unit 1 because of the similarity between the units. Average water velocity ranged from -0.13 to 2.43 feet per second (fps). All velocity values in the upper 14 feet (with 1 inch spacing) were below 2 fps and 87% of all intake velocity values were less than 2 fps. Most of the higher velocity values were at water depths of 15 feet or more, below where most surface oriented fish would pass. The measurements were fairly uniform across the face of the racks, demonstrating that the variation in trashrack spacing combined with flows through the downstream fish bypass entrances does not create abnormal flow vectors in the intake area which is sometimes identified as an important threshold for evaluating entrainment risk for some fish species.

The field measurements of intake approach velocity were taken from the trash rake, which results in measurements at a position in front of the trash racks (approximately 3 feet in front of racks), while the calculated approach velocity was estimated at the trash rack face. Since approach velocity decreases with increasing distance from the racks the difference between calculated and field measured velocity is reasonable and suggests consistency between methods. The lower than estimated velocities in front of the 1-inch racks in the upper 14 feet of the intake are consistent with the reduced clear space for water to flow through the racks and should result in reduced entrainment levels for surface oriented fish. The technical memo detailing the field velocity measurements is included as Appendix E-5.

Table E-18: Velocities Measured at Ellsworth Trashracks

Unit Number	Unit 2	Unit 3	Unit 4	All Units
No. of positions on rack face	22	36	35	93
Minimum average velocity (fps)	0.10	-0.13	0.49	-0.13
Maximum average velocity (fps)	2.27	2.08	2.43	2.43

Proportional estimates of body width to total length for the target species were also used to determine the minimum length of each species excluded or impinged on the trashracks (Table E-19). Based on this assessment, the juvenile stages of the target species would not be excluded or impinged on the trashracks because their maximum reported sizes are smaller than the minimum estimated exclusion size; however, it is expected that the trashracks still provide some level of deterrence due to the presence of the structures (Fay et al. 2006; Alden 2012; Brown et al. 2009).

Table E-19: Estimated Minimum Lengths of Each Species Excluded By Project Trashracks

Target Species	Scaling Factor for Body Width[1]	Size Range (in)[2]		Minimum Size (in) Excluded at Respective Trashrack Clear-Spacing		
		Adult	Juvenile	1.00	2.37	2.44
American Eel	0.037	24-30	NA	27	64	66
Alewife	0.086	10-12	1-6	12	28	28
Blueback Herring	0.087	9-10	1-3	11	27	28
Atlantic Salmon	0.104	25-32	5-8	10	23	23

[1]Scaling factor expresses body width as a proportion of total length based on proportional measurements for the target/surrogate species in Smith (1985)

Entrainment risk was evaluated based on species presence in the basin, outmigration periodicity, and downstream fish passage operations at the Project. Juvenile river herring have the highest entrainment risk due to their small size and long outmigration periodicity. The presence of the surface-weirs attracts surface-oriented herring during outmigration, although the high abundance and ability to physically pass through all trashracks at the Project, particularly for blueback herring, make entrainment a possibility. Adult river herring have a moderate risk due to their relatively small size and potential to pass through the trashracks. There are currently very few salmon (smolts and kelts) expected to occur at the Project that would be at risk for entrainment. However, if the salmon run size increases, then smolts are predicted to have a moderate risk of entrainment due to their smaller size and ability to pass through the trashracks.[8] American eels have a higher risk of entrainment at the Project due to their benthic oriented outmigration and ability to pass through the trashracks at the lower levels of the units. They also have extensive outmigration periodicities (especially in the fall of the year), although abundances are not well known.

Whole station survival was estimated for each target species/lifestage and for direct survival at Ellsworth Dam as well as cumulative survival (Ellsworth Dam and Graham Lake Dam survival) (Table E-20). Estimated survival past both dams was 74.8 – 75.6 percent for adult eel, 91.5 – 92.6 percent for adult river herring, 94.7 – 95.2 percent for smolts, and 97.0 – 98.1 percent for

[8] A Project specific Atlantic Salmon Smolt Downstream Passage Study Plan has been approved and the study will be conducted in May and June of 2016.

juvenile river herring. Black Bear will be conducting an Atlantic salmon downstream passage survival study at the Project in the spring of 2016 to collect empirical data.

Adult American eels have the lowest whole station survival rates due to their longer lengths at the silver phase, lower blade strike survival, and tendency to migrate along the bottom where larger trashrack spacing allows for physical passage. However, eel tracking studies have shown that even with spacing large enough for eel to pass through, individuals may search for other routes of passage, potentially passing through the surface-weirs (Brown et al. 2009). The 2015 study of downstream passage of eel at the Project resulted in all 47 eels (100 percent) migrating successfully through Graham Lake Dam. All 47 tagged eels continued downstream of the Ellsworth Project, with 43 detected passing through the turbines. As discussed above, approximately 53 percent of the tagged eels survived passage at the Ellsworth development (turbine passage survival was 25 percent for turbine Unit 2, 47 percent for Unit 3, and 86 percent for Unit 4).

Juvenile blueback herring are predicted to have relatively high whole station survival at the Project due to their relatively small size and surface-orientation. Juvenile alewives also orient to the surface during outmigration and show slightly lower survival rates due to their large sizes. Adults of both species have whole station survival rates slightly lower than juvenile Atlantic salmon (Table E-20). Estimated Atlantic salmon kelt whole station survival is the highest of the target species, due to exclusion from entrainment by the trashracks. All kelt passage would occur through the surface-weirs at the river flows investigated, of which none resulted in spill at the Project. However, very few adult salmon currently access areas above the Ellsworth Dam due to extremely low returns.

Indirect survival, or delayed mortality, has been evaluated at some west coast projects. Alden (2012) used results from these studies that averaged 93% for indirect survival, and based on professional judgment, suggested that indirect survival would be 95% for Atlantic salmon passing the Penobscot River hydroelectric projects in Maine, due to the low head relative to the west coast projects where the studies were performed. There is considerable uncertainty regarding how to assess indirect survival, given the difficulty in measuring it. NMFS noted this in its Biological Opinion for evaluating project effects to Atlantic salmon for a number of Black Bear Penobscot River hydroelectric projects, and NMFS did not attempt to quantify delayed mortality (NMFS 2012). Therefore, indirect mortality was not evaluated as part of this Union River analysis, rather only direct survival was determined past Ellsworth Dam, in addition to passage through Graham Lake Dam (Black Bear 2014).

Table E-20: Whole Station Survival Estimates at the Project

Life Stage	Target Species	Size Range (in)	Outmigration Months	Ellsworth Development Total Survival			Cumulative Total Project Survival[1]		
				Exceedance Flow (%)[2]			Exceedance Flow (%)[2]		
				75%	50%	25%	75%	50%	25%
Adult	American Eel	24-30	July-November	0.753	0.753	0.761	0.748	0.748	0.756
	Alewife	10-12	July-October	0.919	0.919	0.919	0.915	0.915	0.915
	Blueback Herring	9-10	July-October	0.930	0.930	0.930	0.926	0.926	0.926
	Atlantic Salmon	25-32	April-May and October-November	0.990	0.990	0.990	0.985	0.985	0.985
Juvenile	American Eel	NA	NA	NA	NA	NA	NA	NA	NA
	Alewife	1-6	July-November	0.974	0.974	0.979	0.970	0.970	0.975
	Blueback Herring	1-3	July-November	0.986	0.986	0.986	0.981	0.981	0.981
	Atlantic Salmon	5-8	April-June	0.951	0.951	0.956	0.947	0.947	0.952

[1] Cumulative survival includes survival through the Graham Lake Dam Taintor gates and Ellsworth development.

[2] Varying inflows representing a dry, wet, and normal year were applied to this evaluation, which translated into using the 75%, 50%, and 25% monthly exceedance flows

Essential Fish Habitat

EFH for Atlantic salmon is described as all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut (NEFMC 1998). The EFH designated habitat for all life stages of Atlantic salmon (eggs, larvae, juveniles, and adults) in Maine includes the Union River and Union River Bay, including the Project area. The Project protects EFH for Atlantic salmon by providing upstream and downstream fish passage and migratory pathways to habitat, and by ensuring suitable habitat downstream of each dam through minimum flows.

Endangered Species

Atlantic Salmon

The Licensee provides a detailed assessment of the effects of the Ellsworth Project on Atlantic salmon and Atlantic salmon critical habitat in its draft Biological Assessment being developed with the NMFS and USFWS under the ESA consultation requirements. Appendix E-12.

Atlantic Sturgeon and Shortnose Sturgeon

Due to the rarity of these species at the Project, normal operations would not affect shortnose or Atlantic sturgeon. There is a possibility that sturgeon could be captured in the fish trap and handled during the sorting process. Black Bear has included in the draft Biological Assessment a sturgeon handling plan to provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered by personnel during fishway operations and Project maintenance operations (e.g., if the draft tubes need to be dewatered for maintenance activities).

Freshwater Mussels

The Brook Floater is listed as threatened under Maine's Endangered Species Act. No Brook Floater Mussels were found during the survey of the Union River.

4.4.3.3 Proposed Environmental Measures

Black Bear is proposing to continue to operate and maintain the Project under the existing licensed conditions including minimum flow, water level, and fish passage requirements. Black Bear proposes to enhance upstream eel passage by developing and implementing, in consultation with fisheries management agencies, plans for upstream eel passage at both Project dams. Black Bear proposes to consult with the fisheries management agencies on the need for and, if necessary, the design of 1) downstream eel passage measures, pending the results of ongoing downstream eel passage studies, and 2) upstream and downstream anadromous fish passage improvements pending the results of ongoing studies and development of the agencies' resource management plans. Black Bear also proposes to implement a sturgeon handling plan to provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered by personnel during fishway operations and Project maintenance operations.

4.4.3.4 Cumulative Effects

Impacts to fish from non-federal activities are largely unknown in the Union River. It is possible that occasional recreational fishing may result in incidental takes of Atlantic salmon. However, there is no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

Collectively, Lake Leonard and Graham Lake provide spawning habitat for alewives and are the primary stocking locations in the Union River drainage. Neither water body existed prior to the construction of dams, and probably contributed little to the historical alewife population (URFCC 2010). However, dams can create a physical impediment to upstream and downstream fish passage. Cumulative effects from passage of multiple dams may also result in increased mortality and reduced fitness of fish. Black Bear operates fish passage facilities at the Project to promote access to upstream reaches of the Union River as well as minimize impacts associated with passage. Previous studies conducted by Black Bear have shown that the existing fish passage facilities are effective, which is reflected in the continued high returns of alewives, and the diverse and abundant fish community in the Project area. Black Bear does not propose to change the operation of the Project and no geographic or temporal cumulative impacts to fish and aquatic resources are expected.

4.4.3.5 Unavoidable Impacts

Graham Lake was constructed and is operated as a storage reservoir, with no generation. Black Bear maintains water levels in Graham Lake on an annual basis between elevations 104.2' and 93.4'. The reservoir levels are typically lower in late fall and late winter to accommodate high flows associated with spring runoff. The Ellsworth development is operated in a run-of-river mode where all inflows into the Ellsworth headpond are passed either through the generating units or over the dam. Therefore, water level fluctuations in Lake Leonard are minimal and normally within 1-foot of full headpond elevation. There are no significant unavoidable adverse impacts occurring at the Ellsworth development. Water level fluctuations can be greater in Graham Lake and results in shifts in littoral habitat, but field observations have showed connectivity is maintained with tributaries even during lower reservoir levels (Black Bear 2014).

At the Ellsworth Dam, Black Bear provides upstream fish passage by trapping anadromous fish and transporting them to suitable habitat located upstream of the development. Operation of upstream trap and transport passage activities have been shown to be effective and current facilities are more than sufficient to meet management goals for river herring. It is anticipated that the annual river herring run will approach two million fish within 4 to 5 years through current trap and transport activities (URFCC 2015). Some potentially negative effects from the trapping and transporting of fish could include minor migration delay, handling and holding stress or injury. However, these activities do not appear to result in observed or measured immediate or delayed mortality, injury or stress.

Black Bear operates downstream passage facilities at both Ellsworth Dam and Graham Lake Dam, from April 1 to December 31 annually, as river conditions allow. Downstream migrating fish must use the Project's downstream facilities or pass through the Project turbines, or during rare cases of spill, pass over the spillway to migrate downstream to the Union River estuary and Atlantic Ocean. As described in the analysis above, fish passing through the turbines or over the spillway can incur injury or mortality; estimated total survival past both developments is estimated to be 74.8 – 75.6 percent for adult eels, 91.5 – 92.6 percent for adult river herring, 97.0 – 98.1 percent for juvenile river herring, and 94.7 – 95.2 percent for Atlantic salmon smolts. Black Bear's 2015 recent empirical downstream American eel survival study yielded a total passage survival of 53 percent through the Ellsworth Dam

Black Bear does not propose to change current operational conditions and new unavoidable adverse impacts are not expected to occur on the existing fisheries.

4.4.4 Wildlife Resources

4.4.4.1 Affected Environment

Wildlife Habitats

The Ellsworth Project is located in the Downeast region of Maine, on the lower reach of the Union River in the city of Ellsworth, the towns of Waltham and Mariaville, and Fletchers Landing Township in Hancock County. Other than the project dams, the Ellsworth powerhouse, and associated structures and facilities, development in the immediate vicinity of the project includes year round and seasonal residences, commercial businesses, and a large portion of undeveloped forested areas. The Project area and immediate vicinity provides some diversity of surroundings such as forests, open areas, wetlands, islands, and riverside habitats.

The defined Project area encompasses Graham Lake and nearby lands, the Union River between Graham Lake and Lake Leonard, Lake Leonard, and a small portion of the Union River downstream of the Ellsworth Dam. The Project boundary is at, or along the shoreline of the Union River between Graham Lake and Lake Leonard, and along Lake Leonard. The Project boundary is located at elevation 107' around Graham Lake which is 2.8 feet above normal full pond elevation of 104.2'. In total, the Project boundary encompasses approximately 3,350 acres of land and 10,099 acres of open water cover types (See Table E-22 in Section 4.4.5: Botanical Resources and Figure 2-8 of the Initial Study Report [ISR], 2014). Most of the upland habitats and associated wildlife resources surrounding the Project water bodies occur on private lands adjacent to, but outside the Project boundary.

A detailed description of cover types within the Project boundary is provided in Section 4.4.5 – Botanical Resources. Cover types within and immediately surrounding the Project boundary are primarily comprised of forested communities. The predominant community type within the Project boundary is Northern Hardwood Forest.

There are distinct forested areas within the Project boundary that may more closely fit the characteristics of the Oak-Northern Hardwood Forest and Oak-Northern Hardwood-White Pine Forest Communities (Gawler and Cutko, 2010). Other areas more closely resemble Spruce-Northern Hardwood Forest. The Northern Hardwood, Oak-Northern Hardwood, Oak-Northern Hardwood-White Pine, and Spruce- Northern Hardwood community types within the Project area intergrade gradually, and Northern Hardwood Forest can be considered the matrix forest cover. Forest downstream of Graham Lake and around Lake Leonard can be described as Oak-Northern Hardwood and Oak-Northern Hardwood-White Pine communities, with some areas of early successional forest cover. The eastern shore of Graham Lake is where most of the Spruce-Northern Hardwood Forest is found, whereas the western shore and islands are primarily where forest cover can be described as Northern Hardwood, Oak-Northern Hardwood, and Oak-Northern Hardwood-White Pine Forest.

There are lacustrine, riverine and estuarine wetland systems associated with Graham Lake, Lake Leonard, the Union River and tributaries, and a number of palustrine wetlands - Palustrine Unconsolidated Bottom (PUB), Palustrine Aquatic Bed (PAB), Palustrine Emergent (PEM), Palustrine Scrub-Shrub (PSS), and Palustrine Forested (PFO) - within the Project boundary (Cowardin et al, 1979). The vast majority of palustrine wetlands within the Project boundary are associated with Graham Lake. Many of the wetlands associated with Graham Lake are narrow fringes along the lake itself or along tributary streams; some areas comprised of numerous wetland classes are more extensive. PEM wetland is associated with the islands within Graham Lake and the tributary streams to Graham Lake. While discrete areas of PEM and/or PSS are located on three large islands and on the peninsula in the southern portion of the lake, most of these areas are interspersed with PEM and PSS vegetation. Bog habitats persist under current project conditions on the three large wetland islands and the large wetland peninsula on the southern side of Graham Lake. Forested swamps are also associated with Graham Lake and wetland complexes within the Project boundary. Narrow fringes of wetland are located along Lake Leonard and the Union River in some areas. Wetland habitats within the Project boundary are described in detail in Section 4.4.5 – Botanical Resources.

Other habitat types found within the Project boundary include open field, electric transmission maintained shrub, and mowed lawn. Those areas that are associated directly with the Project are very small in extent and are described in detail in Section 4.4.5 – Botanical Resources.

In addition to desktop level review, in order to accurately describe wildlife habitats within the Project boundary, Black Bear conducted wildlife habitat related studies in 2014 including a Common Loon Survey and a Marsh-Nesting Bird Habitat Survey (ISR, 2014).

Significant Habitat

Significant Wildlife Habitats are defined under Maine's Natural Resources Protection Act (NRPA), which is administered by the Maine Department of Environmental Protection (Maine DEP) (Maine DIFW, 2014a). Significant habitats which occur within the Project boundary include Deer Wintering Areas (DWA) and Inland Waterfowl/Wading-bird Habitat (IWWH). No known Significant Vernal Pools (SVP) are located within the Project boundary, although specific surveys for SVPs were not conducted.

Deer Wintering Areas (DWA)

Deer congregate in DWAs for shelter, forage and thermal refuge during deep snow and cold conditions. Typically, deer will seek DWAs when snow gets more than 12 inches deep in open areas and in hardwood stands, when the depth that deer sink into the snow exceeds 8 inches in open areas and in hardwood stands, and when mean daily temperatures are below 32 degrees (Maine DIFW 2014b). DWAs are typically located within conifer stands (particularly hemlock) with tree height greater than 30 feet and crown closure of greater than 60% (Maine DIFW, 2014b).

According to Maine Department of Inland Fisheries and Wildlife (Maine DIFW) records, one DWA occurs within the Ellsworth Project area. This DWA is located on the eastern shore of Graham Lake in the town of Waltham to the west of Route 179. Because on-site investigation and verification by Maine DIFW staff has not occurred, this DWA has an indeterminate status.

Inland Waterfowl / Wading -bird Habitat (IWWH)

The Maine DIFW identifies moderate and high value IWWH as significant wildlife habitat. Significant Waterfowl and Wading Bird Habitat and its associated protective buffer (250 feet) is identified based on a variety of factors including wetland type, the diversity of wetland types, the size of the wetland(s), the interspersion of the different wetland types, and the amount of open water (Maine DIFW, 2014a). IWWHs in organized townships were most recently mapped and rated by Maine DIFW in 2008, using the most current, high resolution imagery (Maine DIFW, 2014a).

Maine DIFW identifies nine IWWH areas within the Ellsworth Project boundary, all are associated with Graham Lake or tributaries to Graham Lake. Two of the IWWHs are associated with wetland islands within Graham Lake, one of the IWWHs is associated with the wetland peninsula on the southern side of Graham Lake (Great Meadow), and the other five are associated with emergent or emergent/shrub wetland complexes which are contiguous to tributaries to Graham Lake. One IWWH is located both along a tributary to Graham Lake and adjacent to the lake itself. Four of the IWWHs are ranked by Maine DIFW as moderate value and five are ranked as high value.

Bald Eagle Nest Sites

The bald eagle (*Haliaeetus leucocephalus*) was removed from the Federal endangered species list in 2007 and from the Maine endangered species list in 2009. For this reason, Essential Habitat designations and state regulations that were applied to bald eagle nest sites from 1990 - 2009 are no longer in effect. However, protection for bald eagles and their nests continues under the federal Bald Eagle and Golden Eagle Protection Act (BGEPA).

The U.S. Fish and Wildlife Service (USFWS) has been monitoring the occurrence of nesting bald eagles for many years, and maintains a comprehensive database of known bald eagle nest sites in the state of Maine. The USFWS database identifies three areas of historic bald eagle nesting within the Ellsworth Project boundary on Graham Lake as of 2013 (USFWS, 2015).

Correspondence with Maine DIFW on March 31, 2015 (E. Call, Maine DIFW, March 31, 2015), indicates that two of these nest sites were intact in 2013. One of the intact eagle nests is located on a small island in Graham Lake, south of Harwood Hill Island and approximately 6.8 miles northeast of the Graham Lake Dam. The other intact eagle nest is located on a small island on the southern end of Graham Lake, approximately one mile northeast of the Graham Lake Dam. The northern nest hosted a breeding pair and one fledgling in 2013, while the southern nest hosted a breeding pair, but no fledglings in 2013.

Wildlife

Based on identified habitats within the Ellsworth Project boundary and in its immediate vicinity, several mammalian and avian wildlife species have the potential to occur within the Project boundary. In order to obtain information on wildlife species occurrence and use, and to support an assessment of the potential effects of Project operation on these species, Black Bear conducted wildlife-related studies in 2014 and 2015. These studies consisted of a Common Loon Nesting Survey and a Marsh-Nesting Bird Habitat and Call Back Survey along with field observations of wildlife noted during other studies.

Several of the expected avian and mammalian wildlife species were observed (either directly or via sign) during the common loon nesting and marsh-nesting bird habitat surveys. The mammalian and avian wildlife species assemblage known or considered likely to occur in the area surrounding the Project is typical of those found in Hancock County, Maine. A representative listing of mammalian and avian wildlife species known or considered likely to occur in the vicinity of the Project is included in Table E-21 (DeGraaf and Yamasaki, 2001). Those species that were observed during field studies performed at the Ellsworth Project and State Species of Special Concern, state threatened species and state endangered species which may be located within the Project boundary are indicated in Table E-21; Rare, Threatened and Endangered (RTE) species are discussed in greater detail in Section 4.4.6 below.

Temporal and Spatial Distribution of Wildlife Resources

Some of the wildlife species that occur within the Project vicinity are likely to be present year-round. Other species may migrate seasonally, utilizing separate and distinct breeding and wintering areas. The range of these movements varies significantly among species. Many migratory avian species that utilize the Project vicinity during temperate seasons are absent from the region in winter. Other species tend to display more moderate seasonal shifts of habitat usage, utilizing seasonally distinct areas within the Project vicinity and surrounding region in summer versus winter. Deer and moose exemplify this type of movement, gravitating between preferred breeding and wintering habitats. Some species make only very limited movements between closely associated habitats within a small geographical area, using proximate yet distinctly different habitats or microhabitats by season. Examples of this may include some small mammal species. The specific habits of major species are further described, below.

Table E-21: Wildlife Species Which May Occur or Have Been Documented in the Vicinity of the Ellsworth Project

Common Name	Scientific Name
Mammals	
Beaver*	*Castor canadensis*
Big Brown Bat	*Eptesicus fuscus*
Black Bear*	*Ursus americanus*
Bobcat	*Lynx rufus*
Deer Mouse	*Peromyscus maniculatus*
Eastern Chipmunk	*Tamias striatus*
Eastern Coyote	*Canis latrans*
Ermine	*Mustela erminea*
Fisher	*Martes pennanti*
Little Brown Bat (E)	*Myotis lucifugus*
Mink*	*Mustela vison*
Moose*	*Alces alces*

Common Name	Scientific Name
Muskrat	*Ondatra zibethicus*
Northern Flying Squirrel	*Glaucomys sabrinus*
Northern Long-eared Bat (E)	*Myotis septentrionalis*
Porcupine	*Erethizon dorsatum*
Raccoon*	*Procyon lotor*
Red Fox*	*Vulpes vulpes*
Red Squirrel	*Tamiaciurus hudsonicus*
River Otter*	*Lontra canadnesis*
Silver-haired Bat (SC)	*Lasionycteris noctivagans*
Snowshoe Hare	*Lepus americanus*
Striped Skunk	*Mephitis mephitis*
White-tailed Deer*	*Odocoileus virginianus*
Birds	
American Black Duck*	*Anas rubripes*
American Crow	*Corvus brachyrhynchos*
American Goldfinch*	*Spinus tristis*
American Kestrel*	*Falco sparverius*
American Robin	*Turdus migratorius*
Bald Eagle (SC)*	*Haliaeetus leucocephalus*
Barred Owl	*Strix varia*
Bay-breasted Warbler	*Dendroica castanea*
Belted Kingfisher	*Ceryle alcyon*
Black Tern (E)	*Chlidonias niger*
Blackburnian Warbler	*Dendroica fusca*
Black-capped Chickadee	*Poecile atricapillus*
Black-throated Green Warbler	*Dendroica virens*
Blue Jay	*Cyanocitta cristata*
Blue-winged Teal*	*Anas discors*
Broad-winged Hawk*	*Buteo platypterus*
Canada Goose*	*Branta canadensis*
Cedar Waxwing*	*Bombycilla cedrorum*
Common Gallinule (T)	*Gallinula galeata*
Common Grackle	*Quiscalus quiscula*
Common Loon*	*Gavia immer*
Common Merganser	*Mergus merganser*
Common Raven	*Corvus corax*
Common Redpoll	*Carduelis flammea*
Common Yellowthroat *	*Geothlypis trichas*
Downy Woodpecker*	*Picoides pubescens*
Gray Jay	*Perisoreus canadensis*
Great Blue Heron (SC)*	*Ardea herodias*
Green-winged Teal*	*Anas crecca*

Common Name	Scientific Name
Hairy Woodpecker	*Picoides villosus*
Hermit Thrush*	*Catharus guttatus*
Hooded Merganser	*Lophodytes cucullatus*
Least Bittern (E)	*Ixobrychus exilis*
Lesser Yellowlegs (SC)*	*Tringa flavipes*
Mallard*	*Anas platyrhynchos*
Merlin*	*Falco columbarius*
Northern Flicker*	*Colaptes auratus*
Northern Goshawk	*Accipiter gentilis*
Northern Parula	*Parula americana*
Osprey*	*Pandion haliaetus*
Pileated Woodpecker*	*Dryocopus pileatus*
Pine Siskin	*Carduelis pinus*
Purple Finch	*Carpodacus purpureus*
Red-breasted Nuthatch	*Sitta canadensis*
Red-wing Blackbird	*Agelaius phoeniceus*
Ruffed Grouse	*Bonasa umbellus*
Sedge Wren (E)	*Cistothorus platensis*
Sharp-shinned Hawk	*Accipiter striatus*
Spotted Sandpiper	*Actitis macularia*
Swamp Sparrow*	*Melospiza georgiana*
White-breasted Nuthatch	*Sitta carolinensis*
Wood Duck*	*Aix sponsa*
Yellow Rail (SC)	*Coturnicops noveboracensis*

Source: DeGraaf and Yamasaki, 2001
* Observed during field surveys and noted in Northrop, Devine & Tarbell, Inc., 1990
(SC) State Species of Special Concern (Maine DIFW, 2015a)
(T) State Threatened, (E) State Endangered (Maine DIFW, 2015b and Maine State Legislature, 2015)

Large mammal species that are most likely to occur in the Project area and immediate vicinity are white-tailed deer and moose. Black bear may also be occasionally present.

White-tailed deer are resident species in the area surrounding the Project and signs of white-tailed deer use were observed during field studies performed in 2014. Deer are highly selective herbivores, concentrating on whatever plants or plant parts are currently most nutritious. During the course of the year, deer may browse several hundred species of plants. A few are highly preferred while many others are consumed only when the best have been depleted. Deer consume grasses, sedges, ferns, lichens, mushrooms, weeds, aquatics, leaves (green and fallen), fruits, hard mast (acorns, beech nuts, etc.), grains, and twigs and buds of woody plants. Deer consume twigs and buds of dormant trees and shrubs only when more nutritious foods are unavailable. (Maine DIFW, 2014b).

Major habitats that provide food and cover for white-tailed deer in Maine are forest lands, wetlands, reverting farmlands, and active farmlands. Forest stands containing little or no canopy closure, wetlands, and reverting and active farmland tend to yield ideal forage for deer (Maine DIFW, 2014b), particularly during temperate months. Several of these preferred habitats are available within and near the Project area. For this reason, deer are expected to be present in and near the Project area in temperate months.

During the winter months, when snow depth exceeds 12 inches, deer will converge in DWAs (Maine DIFW, 2014b). These areas provide browse and crucial protection from the elements. One DWA is mapped within the Ellsworth Project boundary.

Moose are year-round residents of forested habitats in the Project region. Moose primarily subsist by browsing on the leaves and twigs of woody plants. Willow, aspen, birch, maple, pin cherry, and mountain ash are important, high quality browse utilized by moose throughout the year. Balsam fir provides additional forage for moose over the winter. Sodium is also important to moose: aquatic plants, such as pondweed and water lily, have higher sodium content than woody vegetation and are an important part of a moose's diet. (Maine DIFW, 2014c).

Habitat use by moose varies by season, and by gender. In general, in the summer, moose tend to spend considerable time near wetlands, where they forage on emergent plant materials. Bulls and cows, however, do use somewhat different habitats during the summer. Cows are typically found at low elevations in regenerating stands and adjacent softwoods, where food sources are concentrated. This concentrated food source limits the amount of time cows spend feeding, which, in turn, limits calves vulnerability to predators. Meanwhile, bulls are typically found at higher elevations in mixed and hardwood stands, where food supply is less available, but shading provides thermal refuge from summer’s hot temperatures. (Maine DIFW, 2014c).

During the winter, moose tend to move to drier, mixed hardwood-coniferous habitats where they browse exclusively on trees. Regenerating clear-cuts and forest clearings are particularly important fall and winter foraging habitats for this species (DeGraaf and Yamasaki, 2001). Mature softwood is used as cover when snow depth exceeds 3 feet (Maine DIFW, 2014c).

Black bear are found nearly statewide in Maine, but are most common in northern, northwestern, and eastern Maine; black bear are rarely found in the heavily settled southern and central-coastal regions (Maine DIFW, 2014d). While not common, black bear may occasionally occur in the Project vicinity, particularly in temperate months.

Black bear require forests for protection and food. Bears are omnivores that feed opportunistically on a wide range of plant and animal sources, which vary seasonally. While bears do eat meat, their diet is primarily vegetarian. Early greening grasses, clover, and hardwood tree buds provide a forage base in the spring; fruits and berries are utilized in summer;

and beechnuts, acorns, and hazelnuts are foraged in the fall. This diet is supplemented with insects, including ants and bees (their larvae, adults, and honey), and occasional mammals and birds. Bears may occasionally prey on young deer and moose in late spring, and they will also consume carrion. (Maine DIFW, 2014d).

Black bear may exhibit seasonal habitat use, depending on food supplies. In general, bears will inhabit low elevations more frequently in spring and summer, and higher elevations in the fall. These trends are driven by the seasonal abundance of herbaceous vegetation, insects, various berries and nuts (DeGraaf and Yamasaki, 2001).

Small Mammals

The forested and agricultural habitats in the immediate vicinity of the Project provide year-round homes to a number of small mammal species. Most widespread throughout the region are red fox, raccoon, and striped skunk, which are associated with edge habitats. These species inhabit a variety of habitats consisting of forest, cropland, and pastureland. In addition, they make extensive use of riparian habitats along streams, such as the Union River and its tributaries, during dispersal and foraging. Fisher may inhabit the denser and more extensive areas of coniferous or mixed forest while seeking out forested wetlands during winter. Porcupine may be found in coniferous forests, or mixed or deciduous stands in the Project vicinity. (DeGraaf and Yamasaki, 2001).

Coyote may inhabit the Project area. Coyote often inhabit fragmented habitats, particularly along the edges of second-growth forests, open brushy fields, old pastures, and etcetera; however, Maine DIFW (2014e) states that coyotes now occupy almost every conceivable habitat type, from open agricultural country to dense forest to downtown urban areas. Coyote are opportunistic hunters and scavengers. They primarily eat small animals, such as snowshoe hares, mice, rats, woodchucks, beavers, squirrels, snakes, frogs, fish, and birds. During summer and fall, grasses, fruits and berries may be incorporated into their diet. In the spring and summer coyotes may target deer and fawns as well as other forage items. Coyote may hunt deer more successfully in winter than other seasons, when snow depth restricts deer’s movements, making them easier to capture. Where available, coyote will also eat carrion, pet food, garbage, garden crops, livestock and poultry. (Maine DIFW, 2014e). Coyote may occur within the Project vicinity year round.

Beaver are common inhabitants of rivers, streams, ponds, lakes, and occasionally watered roadside ditches in Maine. Beaver are known to be present in the Project vicinity, and are likely year-round inhabitants within the Project area. Bank dens are dug into the banks of streams, rivers and large ponds; they are used for shelter, birthing and rearing. One family of beavers may have several lodges or bank dens, but will typically use only one area during winter.

Preferred forage includes leaves, inner bark, and the twigs of deciduous trees and shrubs. Aspen is the favorite food item, followed by birch, cottonwood, willow, oak, and maple. Beaver will also eat herbaceous plants, grasses, and some aquatic plants. Beaver store food for the winter months by stashing stems underwater and anchoring them to the bottom of the lake or stream. When ice makes it impossible to forage on land, they feed on the bark and stems in their cache, and on the roots and stems of aquatic plants, such as pond lilies and cattails. Beaver do not hibernate, but are less active during winter, spending most of their time in the lodge or den. (Maine DIFW, 2014f).

Muskrat are also likely present in the Project area and are likely year round inhabitants. Muskrat are found throughout still or slow-moving waterways, including marshes, beaver ponds, reservoirs, and the marshy borders of lakes and rivers. Muskrat eat a wide variety of plants, including cattails, sedges, bulrush, arrowhead, water lilies, pondweed and ferns. They will also eat alfalfa, clover, corn and other crops that happen to be in their territory. Muskrat will occasionally eat shellfish, snails, fish, frogs and salamanders, but these are a small part of the diet and are generally consumed when plant foods are scarce. Depending on site conditions, muskrat dens are located in banks or lodges. Bank dens range from a short tunnel leading to an enlarged nest chamber, to a long and complex system of chambers, air ducts and entrances. In marshes and other areas lacking steep banks, muskrats build dome-shaped lodges from leaves, stems, roots and mud. Lodges are constructed in open water that is two to four feet deep, and are built high enough to keep the den above high-water levels. (Maine DIFW, 2014g).

River otter were not observed during field investigations during 2014 relicensing studies, however, they may occasionally occur within the Project area, and their presence is possible year round. This highly aquatic species is known to inhabit riparian streams bordered by forested areas such as those that occur along the Union River and its tributaries (DeGraaf and Yamasaki, 2001). Although seldom seen, river otter are relatively common throughout Maine. In winter, river otter frequent areas that remain ice-free, such as rapids, the outflows of lakes, and waterfalls (Maine DIFW, 2014h). River otter subsist on a variety of aquatic wildlife, such as fish, crayfish, crabs, frogs, birds' eggs, birds, and some reptiles such as turtles. They are also known to incorporate some aquatic plants into their diet. River otter may occasionally prey on other small mammals, such as muskrat or rabbit. River otter dens can be found along the water in abandoned burrows or empty hollows. Den entrances are generally located underwater, so they can be easily accessed from the water. (Maine DIFW, 2014h).

Smaller mammal species that are likely to occur at the Project include numerous squirrel and mouse species. Example species include red squirrel, northern flying squirrel, deer mouse, and eastern chipmunk. Bat species may also potentially occur within the Project area; these include big brown bat, little brown bat and silver-haired bat. None of these species of bats were observed during field investigations. The little brown bat is a state-listed endangered species and the silver-haired bat is a Species of Special Concern in Maine; these two bats are discussed in Section 4.4.6 below, Rare, Treatened and Endangered Species.

Big brown bats are likely to occur within the Project vicinity. Big brown bats are versatile in their habitat choice and will hunt for insects over water, open forests and cliff sides. Day roosts are generally within deciduous forests, with maternity colonies forming beneath loose bark or in tree crevices. Colonies may also use tree-lined meadows or waterbodies. These bats also commonly roost in man-made structures including house attics, eaves, barns, silos, church steeples, and underneath bridges, in both urban and rural areas. Female big brown bats form large maternity colonies from spring through summer, sometimes numbering hundreds of bats. Male bats are generally solitary and are more flexible about where they roost. These bats hibernate underground in caves and mines, or in buildings where temperatures seldom go below freezing. (Conserve Wildlife Foundation of New Jersey, 2015).

Birds

Bird species that occur within the Project boundary and immediate vicinity are those typical of Hancock County and of Downeast Maine. Waterfowl observed or likely to occur on the Project impoundment include Canada geese, mallard ducks, black ducks, blue-winged teal ducks, wood ducks, common mergansers, and hooded mergansers. Other avian species that are associated with aquatic environments, such as belted kingfisher, great blue heron, spotted sandpiper, lesser yellowlegs, osprey, common loon, and bald eagle, were also observed or are likely to occur within the Project boundary.

A diverse array of other species, such as corvids, woodpeckers, raptors, passerines, and game birds are also are expected to occur in shoreline and wetland habitats of the Project area. Many of these are migratory species, but some, such as black-capped chickadee, woodpecker species and corvid species, are expected to remain in the Project vicinity year-round.

Avian species that rely on open water habitats typically do not overwinter on lakes and ponds such as the Graham Lake and Lake Leonard impoundments, due to winter ice cover. Species such as osprey, common loon, great blue heron and other wading birds and waterfowl would typically leave the Project area by late fall or early winter. Some avian species that utilize open water habitats, such as bald eagle and common merganser, are highly individual in seasonal use. Individuals of these species may remain in the immediate area of the Project during part or all of the winter, utilizing isolated pockets of open water and/or other foraging areas; meanwhile other individuals of the same species may leave the region completely.

According to the listing of Species of Special Concern provided on Maine DIFW's website (last updated March 1, 2011) (Maine DIFW, 2015a), three of the avian species that are known or are likely to occur within the Project area are Species of Special Concern. These are great blue heron, bald eagle, and lesser yellowlegs. All three of these species were observed within in the Project area during the 2014 field investigation (see Table E-21). These bird species are discussed in Section 4.4.6 below, Rare, Threatened and Endangered Species.

Common loons occur and breed on Graham Lake. While not a rare species or a Species of Special Concern in Maine, common loons are frequently a subject of interest on bodies of water that are subject to water level fluctuations. The common loon is a piscivorous bird that is highly adapted for diving and submergent swimming. These adaptations include heavy bones and posteriorly attached webbed feet, which make the loon awkward and poorly mobile on land. Loons nest at the water's edge where their nests are very susceptible to water level fluctuations. Due to its susceptibility to the effects of water level fluctuations during the nesting season, the common loon is frequently identified by wildlife agencies as a species to be evaluated in connection with FERC relicensing of certain reservoir-inclusive projects, such as Graham Lake in the Ellsworth Project.

Common loons may be found in a wide variety of freshwater aquatic habitats, however, they generally prefer lakes larger than 60 acres with clear water, an abundance of small fish, numerous small islands, and an irregular shoreline that creates coves (Evers, 2007). As noted, loons nest in close proximity to the water’s edge. Preferred nesting sites include small islands, floating bog mats, and marshy hummocks. Marsh and mainland sites are less preferable and are typically only used when more preferable (particularly island) sites are unavailable (Evers, 2007).

In order to assess the potential impacts of Project operation on common loons nesting on Graham Lake, nesting surveys were performed on seven dates in 2014: June 9, 16 and 28; July 7, 16, and 29; and August 17. The results of the 2014 survey were reported in the ISR (2014) for the Project and are summarized below.

Of the four common loon pairs that attempted to nest on Graham Lake in 2014, three were judged to have been successful in hatching at least one chick. Each of the nesting pairs made a single nesting attempt on floating, or partially floating bog mats. The successful nests were located in the areas of Hardwood Hill East, Great Meadow, and Southeast Meadow. Evidence of hatch was observed at all three nests, however, offspring were observed only at Hardwood Hill East and at Great Meadow. At Southeast Meadow, no chicks were observed; successful nesting was deduced based on incubation time and eggshell fragments (that were consistent with hatching) located on the nest site.

Of the four total nesting attempts made among five territorial loon pairs on Graham Lake in 2014, one failed. The failed nest was located in the area of Hardwood Hill West. The two eggs at the Harwood Hill West nest site were abandoned, for unknown reasons, after partial incubation. While the actual cause of abandonment is unknown, common causes of nest abandonment while eggs are present include (but are not limited to) human disturbance, territorial interactions, and insect infestations. At the time of abandonment, and for some time after, this nest was judged by surveying biologists to be accessible to incubating loons. That is, water levels did not inundate or strand the nest during or after active incubation. For this reason, water levels have been discounted as a possible cause of nest failure.

4.4.4.2 Environmental Analysis

Effects of continued project operation on riparian, littoral and wetland habitat

Any potential effects of continued Project operation on wildlife habitats within the Project boundary would primarily be related to water level and flow regulation regimes. The Ellsworth Project is operated for water storage and power generation. Operationally, the Project is typically run as a peaking plant, with water being released from the Graham Lake reservoir, which provides storage and has no power facilities, and then is used to generate electricity at the downstream Ellsworth powerhouse. Ellsworth Dam operates in a run-of- river mode with water level variations limited to approximately one foot during normal operations. The Licensee releases a continuous minimum flow of 105 cfs from the Ellsworth Dam and the Graham Lake Dam from July 1 through April 30 and 250 cfs from May 1 through June 30 for the protection of fishery resources.

Water levels in Graham Lake are managed in accordance with the current FERC license between elevations of 93.4’ and 104.2’ and Lake Leonard between 65.7’ and 66.7’ (FERC, 1987). Water levels in Graham Lake on an annual basis can vary up to 10.8 feet per year, while water levels in Leonard Lake vary very little (approximately 1 foot) over the course of the year. Generally, this operation regime creates four distinct areas of hydraulic influence within the Project boundary: Graham Lake reservoir; a riverine portion of the Union River between Graham Lake and Lake Leonard; Lake Leonard impoundment; and the portion of the Union River in the Ellsworth Dam tailwater.

Habitats between 104.2’ and 107’ surrounding Graham Lake that are not associated with developed facilities are not affected by Project operation. Approximately 35 acres of uplands within the Project boundary are occupied by managed vegetation or development; these include open field (approximately 11 acres), electrical transmission corridor/shrubland meadow (approximately 4 acres, non-Project managed) and maintained lawn (approximately 20 acres associated with local residences, non-Project managed). No changes to the management of these areas are expected and no new impacts to habitats in these areas will occur.

No changes are proposed to current Project operation. Therefore, no adverse effects to wildlife habitats within the Project area are expected.

Graham Lake Reservoir

Graham Lake Dam impounds the Union River and creates Graham Lake, a water storage reservoir, which has a surface area of approximately 10,000 acres at a normal full pond surface elevation of 104.2’. The impoundment is fluctuated between full pond and elevation 93.4’, which can result in up to a 10.8-foot yearly drawdown. The Project generally follows an operating curve where the impoundment is drawn down during the summer and winter and refilled in the fall (partial) and spring (full). Habitats that currently exist within the Project area in the vicinity of the Graham Lake impoundment drawdown zone are, in part, a product of the current operational regime and are expected to persist as they have under present operation. No changes are proposed to current Project operations, therefore, no new effects to habitats within the drawdown zone are expected. No adverse impacts to existing wildlife habitats within the impoundment are expected to result from the continued operation of the Project, as proposed.

Riverine Portion of the Union River between Graham Lake and Lake Leonard

The portion of the Union River that is between Graham Lake and Lake Leonard is riverine. The Project boundary is basically the bank of the river. Habitats that currently exist within this reach of the Union River are, in part, a product of the current operational regime and are expected to persist as they have under present operation. No changes are proposed to current Project operations, therefore, no new effects to habitats within the Union River in this area are expected.

Lake Leonard Impoundment

The Ellsworth powerhouse operates based primarily on flow management out of Graham Lake. Lake Leonard is managed with very little fluctuation, generally within one foot of normal full pond. Lake Leonard has a surface area of approximately 90 acres at normal maximum pool elevation at 66.7’. Habitats that currently exist within the Lake Leonard impoundment are, in part, a product of the current operational regime and are expected to persist as they have under present operation. No changes are proposed to current Project operations, therefore, no new effects to habitats are expected. No adverse impacts to existing wildlife habitats within the impoundment are expected to result from the continued operation of the Project, as proposed.

Downstream of the Ellsworth Project Dam

Ellsworth Dam operates in a run-of-river mode automatically via pond level control, and passes seasonal continuous minimum flows of either 105 cfs or 250 cfs. As a result of this continuous minimum flow, aquatic based wildlife habitat downstream of the dam is maintained by normal operations throughout important bio-periods. Black Bear is not proposing any changes to current Project operations, therefore, no new effects to habitats downstream of the dam are expected.

For these reasons, it is anticipated that continued operations will not result in adverse effects on wildlife resources downstream of the dam.

Significant Habitat

Deer Wintering Areas (DWA)

Maine DIFW records indicate that a small portion of one indeterminate-status DWA is located within the Ellsworth Project boundary. The deer wintering area is on private property to the west of Route 179 in Waltham and overlaps a small portion of the Project boundary directly adjacent to the eastern side Graham Lake. This DWA is not subject to any effects related to current or proposed Project operation.

Inland Waterfowl and Wading-bird Habitat (IWWH)

Nine mapped IWWHs have been identified within the Ellsworth Project boundary; all of the mapped IWWHs are associated with Graham Lake or tributaries to Graham Lake. All of the IWWHs, as they currently exist, have developed in situ and have become established and stabilized under the existing operating regime. Because Black Bear is proposing no changes to the operation of the Ellsworth Project, it is anticipated that continued operations will not adversely impact these existing wetland communities.

Bald Eagle Nest Sites

The two intact and actively used bald eagle nests documented within the Project boundary in 2013 are both located on islands in Graham Lake (see Section 4.4.6 below for more information on bald eagles within the Project area). Black Bear is proposing to continue to operate the Project with existing water level management and seasonal minimum flows; there will be no change to the existing water level management which would affect these islands and the eagle nests which are located on them.

Effect of continued project operation on wildlife

Continued operation of the Ellsworth Project, as proposed, will have no adverse impacts to Project associated wildlife or wildlife habitats. Potential Project effects on wildlife species are limited to those species using areas that are directly subject to Project operation.

Long-term fluctuations of the Graham Lake reservoir resulting from Project operation will continue to result in an annual cycle of exposure and inundation of areas within the drawdown zone. Impacts to some species of wildlife may occur, but many species have adapted to the fluctuating water level regime, and will not be adversely affected. In addition, areas within the drawdown zone may present unique foraging opportunities, and may benefit some opportunistic foragers, such as some waterfowl, eagles, herons, shorebirds (e.g. sandpipers) and some small mammals. The Lake Leonard impoundment is very stable normally fluctuating only within a one foot range.

Approximately 35 acres of uplands within the Project boundary are occupied by managed vegetation (i.e. potential wildlife habitat); these include open field (approximately 11 acres), electrical transmission corridor/shrubland meadow (approximately 4 acres, non-Project managed), and maintained lawn (approximately 20 acre associated with local residences, non-Project managed). These areas provide habitat opportunities for several generalist, grassland and edge-habitat species. No changes to the management of these areas are expected or proposed and no new impacts to species that utilize these habitats will occur.

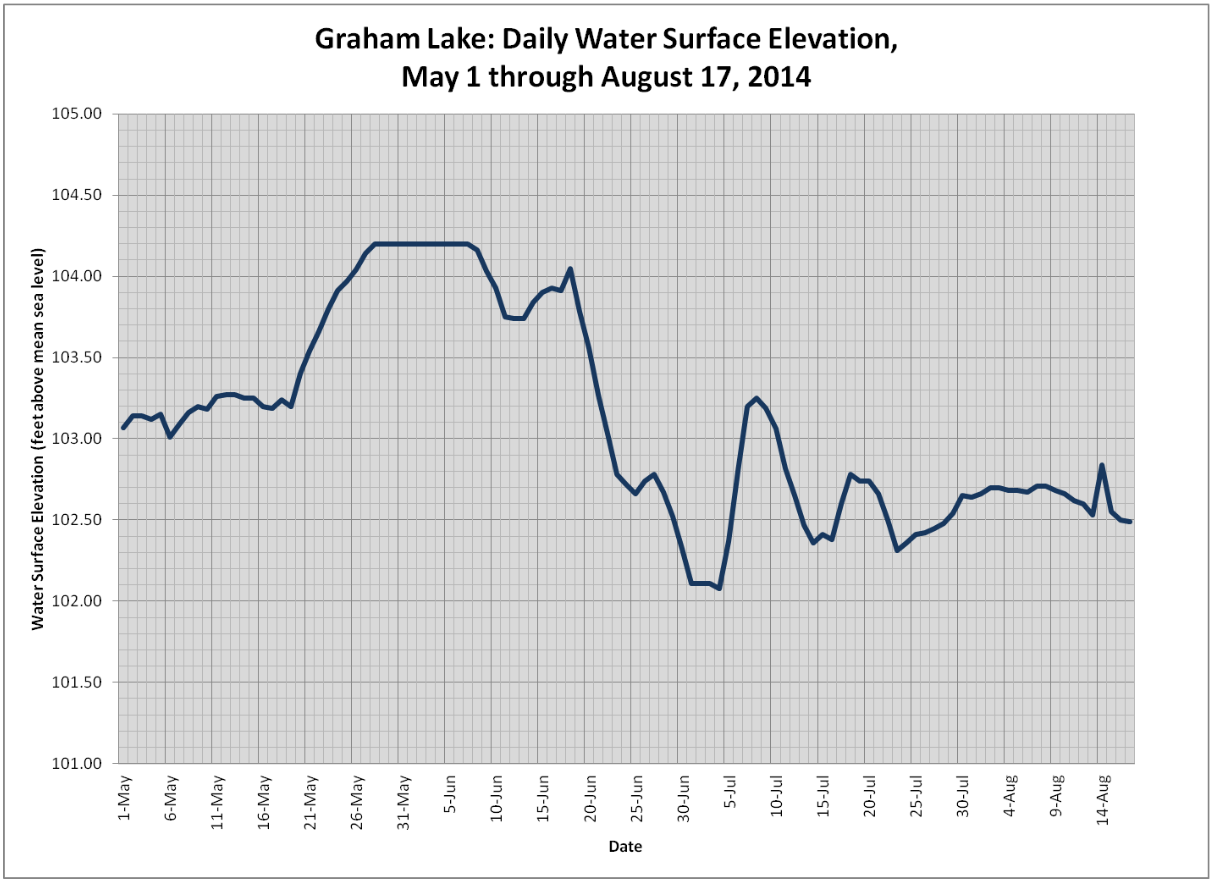
Effects of continued project operations on common loons

A study of common loon population and nesting success on the Ellsworth Project indicates that the continued operation of the Project, as proposed, will not result in adverse impacts to common loons. Generally, common loon nests are highly susceptible to water level fluctuations during the nesting season. It is known that, on average, a change in water level greater than 0.5 vertical feet up, or 1 vertical foot down occurring within a 28-day period can significantly impact the nesting success of common loons (Fair, 1979). Increases in water level can result in flooding of the nest, while decreases potentially hinder accessibility. Reduced accessibility may cause greater time elapse between attendant nest switches, leaving eggs exposed to cooling or predation, or it may render a nest entirely unreachable to the incubating birds.

In order to assess the potential impacts of water level fluctuations on common loons nesting on Graham Lake, Black Bear analyzed Graham Lake water level data for the common loon nesting season of 2014. Daily water levels for Graham Lake for the 2014 common loon nesting season were evaluated by graphing the daily recorded elevations at Graham Lake Dam for the period of May 1 to August 17, which encompasses the duration of common loon nesting activities on Graham Lake. These data are presented in Figure E-14.

Water level data were analyzed with attention to vertical magnitude, frequency, and rate of water level fluctuations during the breeding and nesting season. Daily and weekly changes expounding the bounds of known common loon tolerance during the nesting period were noted and, as appropriate, compared to the concurrent condition of observed nesting attempts on Graham Lake.

Figure E-14: Graham Lake Daily Water Surface Elevation, May 1 through August 17, 2014



This assessment shows that water level changes during the common loon nesting season in 2014 did exceed the range of fluctuation that is known to potentially impact common loon nesting success. Despite this fact, no loon nests failed due to water level fluctuations on Graham Lake in 2014. This is largely attributable to the fact that all four loon nests that were identified were located on floating, or partially floating bog mats, which buffered the effects of changing water levels by moving with them.

Floating bog mat islands are abundant and widely distributed on Graham Lake, making this substrate widely available for use by nesting loons throughout the lake. As previously noted, small islands and floating bog mats are among preferred nesting sites for common loons, with marsh and mainland sites typically only used when preferable sites are unavailable (Evers, 2007). This would suggest that loons are likely to select the abundant and widely available floating island sites on Graham Lake before selecting non-floating sites.

In summary, the continued operation of the Ellsworth Project, as proposed, will result in continued fluctuations of Graham Lake water levels that exceed the normal range of common loon tolerance. However, as shown in 2014, common loons can and do successfully nest on Graham Lake, despite water level fluctuations that exceeded the range that can cause adverse impacts to common loon nesting success. The abundance of floating bog mats on Graham Lake, and the preference of such habitat by loons for nesting (Evers, 2007) naturally mitigate the potential effects of water level fluctuation on nesting success.

Effects of continued project operation on aquatic furbearers

Beaver are known to be present in the Project vicinity, and are likely year-round inhabitants within the Project area. Black Bear is proposing to continue to operate the Project with existing water level management and seasonally variant minimum flows; there will be no change to the existing water level management which would affect beavers living within the Project area.

4.4.4.3 Proposed Environmental Measures

Black Bear is proposing to maintain the existing water level management regime on both Graham Lake (93.4' to 104.2') and Lake Leonard (65.7' to 66.7') and maintain seasonally variant minimum flows at the Project. There are no existing PME measures in-place relative to wildlife resources, and because there are no impacts to wildlife resources anticipated under proposed Project operations, none are proposed.

4.4.4.4 Unavoidable Adverse Impacts

No adverse impacts to Project wildlife or their habitats have been identified or are expected to occur as a result of continued operation of the Ellsworth Project, as proposed.

4.4.5 Botanical Resources

4.4.5.1 Affected Environment

General Setting

The Ellsworth Project lies within the Acadian Plains and Hills Level III Ecoregion. This mostly forested region, with dense concentrations of continental glacial lakes is less rugged than the Northeastern Highlands Ecoregion to the west, is considerably less populated than the Northeastern Coastal Zone Ecoregion to the south, and is bordered to the south and east by the Atlantic Ocean. Vegetation in this ecoregion is mostly spruce-fir on lowlands with maple, beech, and birch on the hills (Griffith et al, 2009). More locally, the project is predominantly within the Central Interior biophysical region of Maine; portions of the project also lie within the Eastern Lowlands and Penobscot Bay biophysical regions (USDA, 2005). In general, these biophysical regions are a transition zone from a northern Appalachian forest of oak, pine, and mixed hardwoods in southern Maine, to a spruce-fir-northern hardwood forest in northern and eastern Maine (Maine DIFW, 2005).

The Ellsworth Project is located on the lower reach of the Union River in the city of Ellsworth, and the towns of Waltham and Mariaville in Hancock County, Maine. The defined Project area encompasses Graham Lake and nearby lands, the Union River between Graham Lake and Lake Leonard, Lake Leonard, and a very short stretch of the Union River downstream of the Ellsworth Dam. The Project boundary is very close to the shoreline along the Union River between Graham Lake and Lake Leonard, and along Lake Leonard. The Project boundary is located at elevation 107' around Graham Lake which is 2.8 feet above the normal full pond elevation of 104.2' and includes associated tributary streams, wetlands and upland areas. In total, the Project boundary encompasses approximately 3,350 acres of land and 10,099 acres of open water cover types (Black Bear, 2014).

Vegetation cover type identification and mapping for the Ellsworth Project area was performed in 2014 as part of the Botanical Reconnaissance Survey (Black Bear, 2014). This effort included desktop photo interpretation, followed by field verification of general cover types. Based on these investigations, vegetation types and land use classifications were assigned. Presence of rare or unique species and habitat was investigated, with particular focus on bog bedstraw (*Galium labradoricum*), estuary bur-marigold (*Bidens hyperborea*), mudwort (*Limosella australis*), Nantucket shadbush (*Amelanchier nantucketensis*), and pale green orchis (*Platanthera flava var herbiola*). Significant communities of noxious and invasive species were also documented.

Open water and terrestrial cover types are summarized in Table E-22.

Table E-22: Cover Types Identified within the Ellsworth Project Boundary

Cover Type	Acres	% Total Project Acreage
Water		
Open Water	***10,099***	***75***
Land		
Forested Upland	2,144	16
Wetland	1,171	9
Palustrine Aquatic Bed (PAB)	0.1	
Palustrine Emergent (PEM)	222.2	
Palustrine Emergent/Scrub Shrub (PEM/PSS)	455.9	
Palustrine Forested (PFO)	354.0	

Cover Type	Acres	% Total Project Acreage
Palustrine Scrub-Shrub (PSS)	131.0	
Palustrine Unconsolidated Bottom (PUB)	7.4	
Non-Project Maintained Lawn	20	<1
Open Field	11	<1
Non-Project Electrical Transmission Corridor/Shrubland-Meadow	4	<1
Land subtotal	***3,350***	***25***
TOTAL:	***13,449***	

The predominant plant community on lands within the Project boundary is forest, followed by wetlands. Significantly smaller areas of maintained open field occur. Areas that are associated with Project facilities and Project-related recreation facilities are very small in extent (as compared to other cover types), and are comprised of gravel surfaces, mowed grass, and non-Project maintained electric transmission corridor, and unvegetated surfaces. A small area of maintained electric transmission corridor (non-Project managed) is associated with the Project facilities (Table E-22). Major community types are further described in the following paragraphs.

Upland Habitat Communities and Species

The majority of upland plant communities within the Project area are forest, with approximately 2,144 acres identified as this cover type (Table E-22). Upland plant communities within the Project area are predominantly variations of the Northern Hardwood Forest Community.

There are distinct forested areas within the Project boundary that may more closely fit the characteristics of the Oak-Northern Hardwood Forest and Oak-Northern Hardwood-White Pine Forest Communities (Gawler and Cutko, 2010). Other areas more closely resemble Spruce-Northern Hardwood Forest. The Northern Hardwood, Oak-Northern Hardwood, Oak-Northern Hardwood-White Pine, and Spruce- Northern Hardwood community types within the Project area intergrade gradually, and Northern Hardwood Forest can be considered the matrix forest cover. Forest downstream of Graham Lake and around Lake Leonard can be described as Oak-Northern Hardwood and Oak-Northern Hardwood-White Pine communities, with some areas of early successional forest cover. The eastern shore of Graham Lake is where most of the Spruce-Northern Hardwood Forest is found, whereas the western shore and islands are primarily where forest cover can be described as Northern Hardwood, Oak-Northern Hardwood, and Oak-Northern Hardwood-White Pine Forest.

Other upland plant communities occur far less frequently than forested areas within the Project boundary, collectively comprising <1% of the total area within the Project boundary. These small inclusions consist of isolated occurrences of open fields, electric transmission corridor (non-Project managed), shrubland-meadow, and maintained lawn associated with local residences (non-Project managed).

Wetland Habitat Communities and Species

Wetland cover types occupy approximately 1,171 acres (approximately 9% of all cover types, including water) within the Project boundary (Table E-22). Wetland types within the Project boundary are described herein based on the Cowardin (1979) classification system. Wetland types found within the Project boundary include Lacustrine, Riverine, Estuarine, Palustrine Unconsolidated Bottom (PUB), Palustrine Aquatic Bed (PAB), Palustrine Emergent (PEM), Palustrine Scrub-Shrub (PSS), and Palustrine Forested (PFO). The vast majority of palustrine wetlands within the Project boundary are associated with Graham Lake and the various types are generally found together as wetland complexes. Many of the wetlands associated with Graham Lake are narrow fringes along the lake itself or along tributary streams; some areas comprised of numerous wetland classes are more extensive. Narrow fringes of wetland are located along Lake Leonard and the Union River in some areas; these areas are classified as PAB, PEM, and PSS Black Bear, 2014).

Lacustrine areas within the Project boundary include Graham Lake and Lake Leonard, which are impoundments of the Union River. Much of the lacustrine areas within the Project area are not vegetated, however some of the shallower areas of Graham Lake are dominated by emergent vegetation. The Project boundary in the vicinity of the Union River between the two impoundments is generally the banks of the river; this area is classified as riverine. There is very little associated riparian wetland associated with the Union River between Graham Lake Dam and Lake Leonard. Below the Ellsworth Dam the Union River is classified as estuarine.

PEM/PSS is the most common vegetated wetland type associated with Graham Lake. PEM wetland is associated with the islands within Graham Lake and the tributary streams to Graham Lake. While discrete areas of PEM and/or PSS are located on three large islands and on the peninsula in the southern portion of the lake, most of these areas are interspersed with PEM and PSS vegetation, and are considered PEM/PSS wetlands. Some of the islands also contain PFO wetland areas. Many contiguous narrow fringes of PEM, PSS, and PFO wetland border Graham Lake or tributary streams within the Project boundary, making up wetlands with varying classifications; some of the wetland areas are more extensive. A few PUB wetlands are also located within the Project boundary.

Bog habitats, dominated by low-growing herbs and stunted shrubs, apparently present prior to Project inception many years ago, persist under current project conditions on the three large wetland islands and the large wetland peninsula on the southern side of Graham Lake. There are also many areas of sphagnum-dominated bog located on the islands and peninsula. These areas are generally classified as PEM/PSS, although they are sometimes classified as PSS where shrub species are the dominant strata. Dominant shrub species in these habitats are ericaceous shrubs. Subdominant but common species include herbaceous species which occur in nutrient-poor, generally soft waters.

Small scrub-shrub swamp habitats (PSS) are also located around the perimeter of Graham Lake and along tributary streams in conjunction with other wetland types. These wetland areas are generally dominated by deciduous shrubs. Forested swamps are also associated with Graham Lake and wetland complexes within the Project boundary.

Shallow fringing marshes dominated by emergent plants (PEM) are few and restricted to coves and other protected locations within the Project boundary. There are only small patches of deep marsh, apparently due to wave action (i.e., high-energy dynamics) that limits their presence. Some small shrubs are also found within PEM wetlands within the Project area. Limited areas of mudflats or vegetated-but-inundated communities were observed. Floating-leaved aquatic beds are uncommon in Graham Lake, with only a few sparse patches observed. Shallow open water PAB area is inundated by the impoundment, and is found in areas of low water velocities along the fringes of the deeper water of the impoundment.

Unique Plant Communities and RTE Botanical Resources

Maine Natural Areas Program (MNAP) online data (MNAP, 2011) and correspondence with MNAP identified five RTE/species of special concern (bog bedstraw, estuary bur-marigold, mudwort, Nantucket shadbush, and pale green orchis) as potentially occurring in the vicinity of the Project.

Of the five RTE plant species, including plants of special concern, reported as potentially occurring in the vicinity of the project by the MNAP, only Nantucket shadbush was observed during field surveys for botanical resources conducted on July 28 and 29, 2014. The shadbush was found on dry ledge, elevated several feet above the Project influence in the Project boundary, in the known location just downstream of the Ellsworth Dam. This plant is listed as threatened in the State of Maine and does not have a federal status. No other plant species federally- or state-listed as threatened or endangered, or tracked as a species of special concern by MNAP was encountered.

Suitable habitat for three of the other reported species – bog bedstraw, estuary bur-marigold, and pale green orchis – was not observed in the immediate Project environs. Suitable habitat for mudwort was observed in the Union River below Leonard Lake, as well as in some areas of shallow water in Graham Lake, but the species was not encountered. Each of these four species are listed as special concern in the State of Maine and are not listed federally listed.

Beginning with Habitat (BwH) mapping and MNAP correspondence indicates the presence of a raised level bog ecosystem (Great Meadow) within Graham Lake. Great Meadow is located on the wetland peninsula that juts into the southern portion of Graham Lake. This natural community is considered to be an outstanding example of a more common community type (S4). Raised level bog ecosystems are flat peatlands in basins with mostly closed drainage, receiving water from precipitation and runoff from the immediate surroundings. In general, Sphagum moss dominates the ground surface, the surface of the bog is flat and featureless, and often areas are partially treed with black spruce and larch (Gawler and Cutko, 2010). Field reconnaissance revealed that this bog ecosystem also contains eastern white pine.

Invasive Plants and Noxious Weeds

Noxious and invasive plant species that have been identified within the Project boundary are limited to common reed (*Phragmites australis*) , Japanese knotweed (*Fallopia japonica*), and purple loosestrife (*Lythrum salicaria*). Of these occurrences, only the common reed and Japanese knotweed form significant communities within the Project boundary; a few purple loosestrife plants were observed sporadically throughout the Project area. Three large stands of common reed are located on the western side of the northernmost island within Graham Lake; the emergent marsh in this location is dominated by the common reed. Small stands of common reed were observed sporadically along the northwestern and northeastern shores of Graham Lake and are generally near residences; these areas are too small to be depicted on the invasive species mapping. An approximately 150-foot long stand of Japanese knotweed and two other smaller stands of the plant were observed on the south side of Graham Lake adjacent to Route 179 in Ellsworth (Black Bear, 2014). No invasive, purely aquatic species such as variable-leaved milfoil were observed.

4.4.5.2 Environmental Analysis

Effects of continued project operation on riparian, littoral, and wetland habitat

The Ellsworth Project is operated for water storage and power generation. Operationally, the Project is run as a peaking plant, with water being released from the Graham Lake reservoir, which provides storage and has no power facilities and is then used to generate electricity at the downstream Ellsworth powerhouse. Ellsworth Dam operates in a run- of-river mode automatically via pond level control. As required by its FERC license, Black Bear releases a continuous minimum flow of 105 cfs from the Ellsworth Dam and the Graham Lake Dam from July 1 through April 30 and 250 cfs from May 1 through June 30.

Water levels in Graham Lake are managed in accordance with the current FERC license between elevations of 93.4’ and 104.2’ and Lake Leonard between 65.7’ and 66.7’ (FERC, 1987). Water levels in Graham Lake on an annual basis can vary up to 10.8 feet per year, while water levels in Leonard Lake vary very little (approximately 1 foot). Generally, this operation regime creates four distinct areas of hydraulic influence within the Project boundary: Graham Lake reservoir; a riverine portion of the Union River between Graham Lake and Lake Leonard; Lake Leonard impoundment; and the portion of the Union River in the Ellsworth Dam tailwater area.

Botanical resources within the Project boundary may be exposed to, or isolated from, different potential influences depending on their location relative to Project waters. Potential Project effects to botanical resources that are associated with the Project’s impoundments and riverine and estuarine components are discussed, respectively, below.

Very small amounts of upland are located within the Project boundary adjacent to the Ellsworth Dam tailrace, Lake Leonard, and the Union River between Graham Lake and Lake Leonard; the Project boundary is very close to the river and impoundment banks in these areas. Uplands between 104.2’ and 107’ surrounding Graham Lake that are not associated with Project facilities are not affected by Project operations. Approximately 35 acres of upland within the Project boundary are occupied by managed vegetation or development; these include open field (approximately 11 acres), electrical transmission corridor/shrubland meadow (approximately 4 acres, non-Project managed) and maintained lawn (approximately 20 acres associated with local residences, non-Project managed). No changes to the management of vegetation in these areas are expected, and because no changes are proposed to current Project operations, no new impacts to vegetation within these upland areas would occur.

Graham Lake Reservoir

Graham Lake Dam creates Graham Lake, a water storage reservoir, which has a surface area of approximately 10,000 acres at normal full pond elevation of 104.2’. The reservoir is fluctuated between full pond and elevation 93.4’, which can result in up to a 10.8-foot yearly drawdown. The Project generally follows an operating curve where the impoundment is drawn down during the summer and winter and refilled in the fall (partial) and spring (full). Plant communities within this drawdown zone are subject to water level fluctuations as a result of Project operations on an annual basis.

Approximately 1,171 acres of vegetated wetlands are found within the Project boundary, and the vast majority of these wetlands are associated with Graham Lake. The wetland plant communities that currently exist within the Ellsworth Project boundary and which are associated with the Graham Lake impoundment have become established and stabilized under the existing operating regime that has been in practice since 1979.

Because Black Bear is proposing no changes to the operation of the Ellsworth Project, it is anticipated that continued operations will have no impact on existing wetland communities and other botanical resources associated with Graham Lake.

Riverine Portion of the Union River between Graham Lake and Lake Leonard

The portion of the Union River that is between Graham Lake and Lake Leonard is riverine. This area of river has very little associated riparian wetland and the Project boundary is basically the bank of the river. Botanical and vegetation resources in this area are not subject to any effects as a result of the Ellsworth operations.

Lake Leonard Impoundment

Lake Leonard has a surface area of approximately 90 acres at normal full pond elevation of 66.7'. The Lake Leonard impoundment is managed within 1 foot on a daily basis. Plant communities within this zone are subject to very limited fluctuations as a result of Project operations. A very small amount of PAB, PEM, and PSS wetland is associated with Lake Leonard

Because Black Bear is proposing no changes to the operation of the Ellsworth Project, it is anticipated that continued operations will have no impact on existing wetland communities and other botanical resources associated with Lake Leonard.

Downstream of the Ellsworth Dam

Ellsworth Dam operates in a run-of-river mode automatically via pond level control. This results in a relatively uniform downstream flow. The Ellsworth Dam is located at the head-of-tide and as such is subject to varying water levels on a daily basis. Wetlands and wetland habitat downstream of the dam are maintained by normal operations and tidal flows throughout important bio-periods. Black Bear is not proposing any changes to current operations. For these reasons, it is anticipated that continued operations will not result in adverse effects on wetland or other botanical resources downstream of the dam.

Effects of continued project operation and maintenance on wildlife habitat

Emera (the local utility) manages vegetation on approximately 4 acres of electrical transmission corridor. Approximately 20 acres of maintained lawn associated with local residences is located within the Project boundary. These areas may provide habitats for several generalist, grassland, and upland edge habitat species. With respect to the transmission line corridor, Emera uses an integrated vegetation management strategy using a combination of hand-cutting and selective herbicide applications on an as-needed basis to maintain the integrity and functionality of the line, facilitate safety inspections, and maintain access for emergency repairs. Mechanical mowing may be used under unusual circumstances. There are also approximately 11 acres of open field that may provide wildlife habitat. No changes of the management of these areas are expected or proposed, and no effects from continued operation of the Project on species that use these habitats will occur.

Effects of continued project operation and maintenance on the Maine state threatened Nantucket shadbush

During consultations with the MNAP, Black Bear (via letter on October 3, 2012) was informed that Nantucket shadbush, a state threatened species, occurs downstream of the Ellsworth dam. A Nantucket shadbush was observed inside the Project boundary in the documented location in 2014 during botanical surveys, but the plant was located several feet above the Project influence. Given that no changes in Project operation are proposed, no impacts to this species or its habitat are expected. No other RTE plant species were documented within the Project boundary.

Effects of continued project operation and maintenance on invasive plants

Noxious and invasive plant species that have been identified within the Project boundary are limited to common reed, Japanese knotweed and purple loosestrife. Of these occurrences, only the common reed and Japanese knotweed form significant communities within the Project boundary; a few purple loosestrife plants were observed sporadically throughout the Project area. No purely aquatic invasive species such as variable-leaved milfoil were observed during botanical surveys. The larger invasive communities are generally located near residences on the shore of Graham Lake or adjacent to roads and their presence seems to be attributed to residential land use and road use or construction. Given that no changes in Project operation are proposed, no impacts to or spread of invasive species are expected as a result of continued Project operations.

4.4.5.3 Proposed Environmental Measures

Black Bear is proposing to continue to operate the Project with existing water level management and seasonally variant minimum flows. There are no existing PME measures in-place relative to wetland and botanical resources, and because there are no impacts to botanical resources anticipated under proposed Project operations, no PME measures are proposed.

4.4.5.4 Unavoidable Adverse Impacts

Continued operation of the Ellsworth Project, as proposed, will have no new impacts to existing Project area wetlands or botanical resources.

4.4.6 Rare, Threatened and Endangered Species

4.4.6.1 Affected Environment

The Ellsworth Project area includes aquatic and terrestrial habitats that are known to or have potential to be utilized by Federally-listed and state-listed rare, threatened, or endangered (RTE) species.

Federally-Listed RTE Species

The USFWS has identified two federally-listed endangered and two federally-listed threatened species as having the potential to occur within the Project boundary: Atlantic salmon (endangered), shortnosed sturgeon (endangered), Atlantic sturgeon (Gulf of Maine DPS threatened), and the northern long-eared bat (threatened). The affected environment for the three fish species is addressed in Section 4.4.3 of this Exhibit E.

Northern long-eared bats, a federally-listed threatened species, may occur within the Project area. DePue and the National Park Service documented northern long-eared bats in Acadia National Park in the summers of 2012 and 2014 (USFWS, Department of Interior, 2015). Northern long-eared bats primarily feed in the understory of forested areas on moths, flies, leafhoppers, caddisflies, and beetles, which they catch in flight with echolocation. They also glean insects from vegetation. In the summer, northern long-eared bats roost singly or in colonies underneath bark, in cavities or crevices in both live trees and in snags. Non-reproductive females and males sometimes also roost in cooler places, like caves or mines. Northern long-eared bats appear to be flexible in selecting roosts, choosing trees of varying species which are generally deciduous. Northern long-eared bats have rarely been observed roosting in human structures, such as barns and sheds. Northern long-eared bats spend the winter hibernating in hibernacula, which generally include caves or mines of varying sizes, with constant temperatures, high humidity, and no air current. Pregnant females roost in small colonies (generally 30 to 60 females and young) and give birth in the summer. (USFWS, 2015).

State-Listed Threatened and Endangered Species

Maine DIFW identified four state-listed threatened or endangered marsh-nesting bird species as having the potential to inhabit or occupy the Project area: least bittern (endangered), sedge wren (endangered), black tern (endangered), and common gallinule (threatened). In addition, the northern long-eared bat, a state-listed endangered species, is discussed in the section above on federally-listed RTE species, and the little brown bat, a state-listed endangered species, is discussed below. The affected environment for the brook floater, a state-listed threated mussel species, is addressed in Section 4.4.3 of this Exhibit E.

Least bitterns breed in freshwater marshes and usually nest in dense stands of cattails, bulrushes or similar growth about a foot above the water and near open water. Occasionally they nest in a low bush or tree or on the old nest of another bird. Least bitterns generally nest singly but several adjacent pairs may occur in suitable areas. (Baicich and Harrison 2005).

Sedge wrens breed in wet meadows or drier areas of marshes and bogs dominated by grasses and sedges. The birds nest low in grasses, sedges or similar herbaceous species, very near the ground or over shallow water. Nests are well hidden in the bases of growing vegetation but rarely can be 1-2 feet up in the vegetation. (Baicich and Harrison 2005).

Black terns breed on shallow, still water, in freshwater or brackish areas, that are often characterized by reedy vegetation and swampy marshes. The birds can create a variety of nests including: as a heap of floating vegetation in the water, anchored by growing plants, or on mats of floating aquatic vegetation or heaps of fallen herbaceous vegetation; on old muskrat houses, old grebe or coot nests, or floating driftwood; or on firm ground among marshy herbaceous vegetation. Black terns generally nest in small colonies. (Baicich and Harrison 2005).

Common gallinules breed at the edge of fresh water including lakes, rivers, small marshes, and ditches. The birds generally nest on the ground by water, or among plants in water, but sometimes they nest above ground in thick shrubs or in large old nests of other birds in trees. The birds may build additional nests (brood platforms) in territory, especially in marshy sites and use the platforms for brooding young. (Baicich and Harrison 2005).

Little brown bats, which were added to Maine's List of endangered species in May, 2015**,** are most likely to occur within the Project vicinity in summer. Little brown bats feed primarily over wetlands and other still water where insects are abundant. They also use rivers, streams, and trails as travel corridors to navigate across the landscape. Little brown bats may potentially use areas within the Project vicinity for summer roosting as well, as they prefer summer roosts that are close to water. During the summer, male and female little brown bats roost separately. Summer roosting areas may include barns, attics, outbuildings, bat houses and tree cavities. Female little brown bats will gather into maternity colonies, selecting very warm roosts in which to bear and nurse their young. Males roost in smaller colonies, and may use tree cavities as well as buildings. (NHF&G, 2014).

In the winter, male and female little brown bats hibernate together in clusters in moderately sheltered hibernacula, including caves, mine tunnels, and occasionally in hollow trees. (NHF&G, 2014). Many little brown bats leave the state of Maine in search of adequate hibernacula in winter. No winter hibernacula for little brown bats is known to occur in the Project vicinity.

State-Listed Species of Special Concern

Maine DIFW identified one state-listed special concern marsh-nesting bird species as having the potential to inhabit or occupy the Project area: yellow rail. In addition to the yellow rail, seven vertebrate wildlife species that are Species of Special Concern in Maine have the potential to or are known to occur in the Project vicinity: Arctic char, silver-haired bat, bald eagle, northern leopard frog, wood turtle, great blue heron and lesser yellowlegs.

Yellow rails build nests concealed in a natural hollow with overhanging tufts of vegetation or with grasses bent over to form a concealing canopy, thus they are often hard to locate. The bird nests in sedge marshes or wet meadows, on the ground in drier portions of grasses vegetation, and sometimes among grasses or plant tufts in several inches of water. (Baicich and Harrison 2005).

Silver haired bats, which are a Species of Special Concern in Maine, are less common in Maine than little brown bats. Silver haired bats are migratory, leaving Maine for southern states in winter. For this reason, silver haired bats only have potential to occur in the Project vicinity in summer. In summer, these bats are usually found in heavily forested areas where preferred daytime refuges and roost habitat include tree cavities and areas under loose bark (Fidel and Denham, 2014). They are sometimes known to use buildings for shelter as well. These bats prefer breeding grounds close to lakes and ponds (Fidel and Denham, 2014). The eating habits of the silver haired bat are similar to other Maine bats, and primarily consists of small to medium sized insects. If silver haired bats do occur in the Project vicinity, they would be expected to forage over and near Project waters and possibly roost in upland forested areas in the vicinity during temperate seasons.

An isolated population of silver char (formerly known as Sunapee or blueback trout) occurs within the Union River basin, in Floods Pond and Green Lake (URFCC 2010). Because of their preference for cold water, it is not expected that silver char would occur in Project waters.

As previously discussed, bald eagles are no longer recognized as a Threatened Species under federal or Maine state law. For this reason, Essential Habitat designations and state regulations that applied to bald eagle nest sites from 1990 - 2009 are no longer in effect. Protection for bald eagles and their nests continues under the BGEPA.

Bald eagle is the only bird Species of Special Concern with potential to occur in the Project area year-round. Bald eagles are highly nomadic and some individuals may roam great distances when not breeding. Alternatively, some individuals may stay in interior Maine over winter in areas where food is available. Bald eagles were observed frequently on the impoundments and in the vicinity during relicensing studies. Two intact and actively used eagle nests were documented within the Project boundary in 2013, according to correspondence with Maine

DIFW. One of the nests was located on a small island in Graham Lake, south of Harwood Hill Island and approximately 6.8 miles northeast of the Graham Lake dam. The other intact eagle nest was located on a small island on the southern end of Graham Lake, approximately 1.0 mile northeast of the Graham Lake dam. The northern nest hosted a breeding pair and one fledgling in 2013, while the southern nest hosted a breeding pair but no fledglings.

Northern leopard frogs live in wetlands, ponds, lakes, meadows, or fields in close proximity to water. Northern leopard frogs feed on insects, slugs, snails, and other frogs. The Northern leopard frog overwinters in the mud of lakes and large ponds (Tekiela, 2004). Northern leopard frogs are expected to utilize the Project area in the temperate seasons and overwinter in the Project impoundments.

Wood turtles can be found in slow rivers and streams with woodland floodplains. Wood turtles are a terrestrial species that feed on land consuming plants, berries, mushrooms, worms, and slugs. During the winter months, wood turtle reside underwater beneath the ice. Wood turtle females lay eggs in riverbanks and sandbars (Tekiela, 2004). Wood turtles are expected to utilize the Project area in temperate seasons and overwinter in the Project impoundments.

Great blue heron occur in various saltwater and freshwater habitats, including open coasts, marshes, sloughs, riverbanks, lakes and small ponds. Great blue herons typically stalk fish, frogs and other prey in shallow waters, but they also occasionally forage in grasslands and agricultural fields (Cornell, 2014). Breeding herons gather in colonies ("rookeries") and build stick nests high off the ground, in tall trees or snags. No heron rookeries are known to occur in the Project vicinity, and none were observed during the study. Great blue herons are a partial migrant; many migrate south to warmer climates in winter, but some may attempt to overwinter in southern Maine (Maine Encyclopedia: Great Blue Heron 2014). Great blue herons are not expected to overwinter in the Project area, but do utilize the Project area for foraging in wetland and shallow water areas during temperate seasons.

Lesser yellowlegs occur in various shallow saltwater and freshwater habitats. Lesser yellowlegs eat aquatic and terrestrial invertebrates, particularly flies and beetles, and occasionally small fish and seeds. Lesser yellowlegs are active feeders, often running through shallow water to chase prey. They breed in open boreal forest with scattered shallow wetlands; they do not breed within the Project vicinity (Cornell, 2015). Lesser yellowlegs are not expected to overwinter in the Project area, but do utilize the Project area for foraging in wetland and shallow water areas during temperate seasons.

4.4.6.2 Environmental Analysis

Effects of continued project operation on federally-listed endangered or threatened fish and critical habitat

The environmental analysis for Atlantic salmon, and Atlantic and shortnose sturgeon is addressed in Section 4.4.3.2 of this Exhibit E. Also, a detailed assessment of the effects of the Project on Atlantic salmon and critical habitat in the draft Biological Assessment is attached as Appendix E-12.

Due to the rarity of either sturgeon species being located at the Project, normal operations would likely not affect shortnose or Atlantic sturgeon. A sturgeon handling plan is included as an appendix to the draft Biological Assessment to provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered by personnel during fishway lift operations or Project maintenance operations.

Effects of continued project operation on federal- and state-listed wildlife species and species of special concern

One federally-threatened mammal species, which is also a state-endangered species, may occur within the Ellsworth Project area; the northern long-eared bat. This aerial insectivore may forage adjacent to Project waters in forested habitats in the summer, but is not expected to be adversely affected by water level fluctuations as a result of Project operation. This bat species roosts in upland areas outside of the range of potential Project operational affects. This bat species spends winters months in hibernacula, and is not expected to be adversely by water level fluctuations.

One state-endangered mammal species and one state Species of Special Concern may occur within the Ellsworth Project area; these are the little brown bat and silver haired bat, respectively. These aerial insectivores may forage over Project waters and along riparian edges in summer, but are not expected to be adversely affected by water level fluctuations as a result of Project operation. Both bat species roost in upland areas (trees, dwellings, and etc.), outside of the range of potential Project operational affects. Both bat species are expected to migrate out of the Project vicinity in winter.

Three avian state Species of Special Concern are known to occur within the Project area. These are bald eagle, great blue heron, and lesser yellowlegs. None of these species have foraging, breeding or nesting behaviors or needs that are expected to be adversely affected by fluctuating water levels as a result of Project operation.

Two other state Species of Special Concern, the northern leopard frog and the wood turtle may use the Project area. Neither of these species has foraging or breeding behaviors or needs that are expected to be adversely affected by fluctuating water levels as a result of Project operation.

Effects of continued project operation on marsh-nesting birds

In February 2013, Maine DIFW and USFWS expressed an interest in determining if any rare marsh-nesting birds occur in the Project area and if operation of the Graham Lake dam is potentially affecting their productivity. In accordance with the FERC approved RSP for the Ellsworth Project, Black Bear conducted a marsh-nesting bird habitat survey on Graham Lake in 2014 (Black Bear, 2014; Marsh-nesting Bird Habitat Survey). Based on agency consultation, the survey focused on identification of suitable habitat for RTE species, including least bittern (state endangered), sedge wren (state endangered), black tern (state endangered), common gallinule (state threatened), and yellow rail (state species of special concern). In accordance with the FERC approved RSP, the objectives of the survey were to: map the nature and extent of emergent marsh habitat associated with Graham Lake; and document the habitat quality and vegetative composition of this habitat.

Black Bear conducted a desktop study of emergent herbaceous/shrub wetlands associated with Graham Lake, based on review of aerial photographs and Maine DIFW-mapped inland waterfowl and wading bird habitats. A field verification survey was conducted on July 28 and 29, 2014. The survey identified 26 seasonally flooded emergent herbaceous or emergent herbaceous/shrub wetlands that are five acres in size or larger. These wetlands include the three large islands within Graham Lake, the wetland peninsula that juts out into the southern basin of Graham Lake, smaller islands, and numerous wetland complexes associated with tributary streams to Graham Lake. The wetland complexes identified range in size from approximately 5 acres to 417 acres.

After review of the marsh-nesting bird habitat survey data, the Maine DIFW requested broadcast call-back surveys be conducted in three areas mapped by Black Bear as emergent/shrub wetlands, based on coincidence with Maine DIFW-mapped IWWH. These three areas are large in size; one is the large wetland peninsula on the southern end of Graham Lake (Great Meadow) and the other two areas are large islands in the middle portion of Graham Lake. During consultation with the Maine IFW, the yellow rail was removed from the study request. In May/June 2015 the broadcast call-back survey was conducted on three separate occasions at each sampling location. Black Bear surveyed the two northern locations (9 sites) and the Maine DIFW surveyed the southern location (8 sites). No call-back responses were heard at any of the sampling sites during the six sampling periods (three north, three south).

Effects of continued project operation on mussels

The brook floater mussel is listed as threatened under Maine's Endangered Species Act. Maine DIFW requested that Black Bear conduct a study to document the presence of the brook floater (*Alasmidonta varicose*), which is a state-listed threatened mussel species. Black Bear conducted a survey for the brook floater in the riverine and shoreline areas of the Union River between

Graham Lake and Lake Leonard. Black Bear performed the survey on July 24, August 22, and September 22, 2014, using a combination of widely used methodologies (walking the entire shoreline, 19 survey transects using viewing tubes, face masks, and SCUBA, for determining presence/absence of freshwater mussels). No brook floaters were observed; nor were any brook floater shells found along the shore or in shell middens (Black Bear, 2015).

4.4.6.3 Proposed Environmental Measures

Black Bear is proposing to continue to operate the Project under the current operating regime. Proposed environmental measures for Atlantic salmon, and Atlantic and shortnose sturgeon is addressed in Section 4.4.3.3 of this Exhibit E. Black Bear is not proposing any PME for other RTE species having the potential to inhabit the Project area.

4.4.6.4 Unavoidable Adverse Impacts

Black Bear anticipates that no unavoidable adverse effects on RTE species would result from the proposed relicensing of the Ellsworth Project.

4.4.7 Recreation and Land Use

4.4.7.1 Affected Environment

Recreation Access and Facilities

The Project is located within the Downeast & Acadia Tourism Region (MOT, 2012). The region includes many tourist attractions including Acadia National Park and Lamoine State Park and offers boating (motorized and non-motorized), fishing, hunting, hiking, biking, and climbing opportunities and, whale watching and puffin watching.

The Ellsworth Project also provides a variety of public recreation opportunities. The area surrounding the Project is a mixture of year-round and seasonal residential development and undeveloped forest land. The Project is easily accessible from US Route 1 to the south and State Route 9 to the north via Route 179 along the easterly side of the Project and Route 180/181 on the westerly side of the Project. Public access to the Project is available over a combination of public highways, city streets, and private roads, as well as by boat from several launching areas on the impoundments. Black Bear provides public recreation access at several locations for motorized and non-motorized boating and shoreline fishing. Project recreation facilities owned and managed by the Black Bear include: a carry-in boat launch off Shore Road on the Lake Leonard impoundment; the Graham Lake Dam boat launch on Graham Lake; and a canoe portage trail around Graham Lake Dam.

Shore Road Carry-in Launch - The carry-in boat launch off Shore Street provides a small (2 vehicle) parking area and a six-foot wide concrete plank ramp for carry-in boat launch and take out on the east shore of Lake Leonard. Additional vehicles can park along the Pump Station Access Road. The site is also used by bank and shoreline anglers. A Part 8 sign is maintained on site.

Graham Lake Boat Launch - The Graham Lake Dam boat launch is a motorized boat launch with a 12-foot wide concrete plank ramp and gravel parking area just westerly of Graham Lake Dam. The parking area will accommodate approximately eight vehicles and trailers. Access to the site is off Mariaville Road (former Route 180) on the west side of the impoundment. Motorized boat launching is the primary activity at this site. A Part 8 sign is maintained on-site.

Canoe Portage Trail - The canoe portage trail is located on the east side of Graham Lake Dam off Patriot Road (former Route 180). The northerly portion of the trail (Graham Lake to Patriot Road) is approximately 200 feet long with minimal improvements. There is a "portage" sign facing inland near the take-out point on Graham Lake. The trail crosses Patriot Road and parking areas on either side of the road and extends through the woods on the south side of Patriot Road to multiple points on the Union River downstream of Graham Lake Dam. The trail from the parking area to the shoreline is well worn and steep from the parking area for approximately 60 feet. The total length of this section of the trail (south of Patriot Road) is approximately 100 to 160 (varies with downstream access points) feet. A "danger, water may rise" sign is located at approximately the mid-point of the trail. The two parking areas associated with this site along Patriot Road will accommodate approximately 19 vehicles. The primary use of this site is for shoreline angling downstream of Graham Lake Dam.

Municipal, state and private lands provide additional recreation access to the Project. These include: a picnic area/day use site (municipal) on Shore Road on the east shore of Lake Leonard opposite the Middle School; Infant Street access (municipal) on both sides of the Union River; Fletcher's Landing (State) an unimproved boat launch on Graham Lake; Mariaville carry-in boat launch (municipal) on the west side of Graham Lake; and a carry-in (private) on the West Branch of the Union River. There are no commercial recreation facilities that provide direct access to the Project.

Shore Road Picnic Site - The picnic area/day use site off Shore Street is located on City of Ellsworth property. The site provides two picnic shelters and informal trails and access to the east shore of Lake Leonard. Parking for the site is provided at the Ellsworth Elementary School across from the site.

Infant Street Access – Infant Street is a discontinued city street that once crossed the Union River approximately 1.5 miles upstream of Ellsworth Dam; the bridge has been removed and the city still owns the public right-of-way on either side of the Union River. The site consists of small parking areas (two vehicles on east shore; six vehicles on west shore) and informal footpaths to the respective shorelines. The east side is used primarily for shoreline angling and west shore for angling and picnicking.

Fletchers Landing - Fletchers Landing is located on the east side of Graham Lake in Fletchers Landing Township (T8 SD) and access is directly off Route 179. The site consists of a compacted gravel and grass parking area that will accommodate approximately ten trailer rigs. The boat launch area is approximately 15 feet wide and has an asphalt surface. The ramp facilitates the launching of small trailered watercraft. Site use appears to be primarily by local residents as evidenced by the number of boats stored on site, both in the parking area and tied up along the shoreline.

Mariaville Carry-in Launch - The Mariaville carry-in is located on the west shore of Graham Lake off the Morrison Farm Road in Mariaville. The site consists of a graveled circular entrance road and gravel launch area. Though signed as a carry-in launch, there is evidence that trailered boat launching occurs as well. The site has limited roadside parking for approximately six vehicles.

West Branch Access - The West Branch access site is located on the River Road at its junction with Route 181 in Mariaville. The site consists of a level gravel and grass parking area that accommodates approximately seven vehicles, and a short steep gravel/sand ramp for launching hand-carry watercraft into the West Branch. The launch area exhibits moderate erosion, which may be due to trailered boat launching that appears to occur at the site. This site is privately-owned.

Informal recreation likely occurs along undeveloped portions of the shoreline and on some of the islands on Graham Lake. Such areas can be accessed by boat and by vehicle over private roads. Camping and fishing are the likely predominant activities occurring at informal recreation sites.

Some boating occurs on the Union River between Graham Lake Dam and Lake Leonard, although sections of this stretch of the river may be limited to non-motorized boats due to shallow areas and scattered rips and rapids (Class I-II). Some whitewater boating occurs on this portion of the river based on the availability of flows below Graham Lake Dam, or coordinated releases for events such as the annual Maine Canoe & Kayak Race Organization's race from Graham Lake Dam to the tidal section of the Union River. Based on available data and information, whitewater boating use on this section of the river is low.

Winter activities within the Project area include snowmobiling, ice fishing, snowshoeing, Nordic skiing, and ice skating. A local snowmobile club trail crosses the Project on U.S. Route 1A over the Union River. There are no State Interconnected Trails System snowmobile trails in the Project area.

Recreation Use

Black Bear conducted recreational use counts at Project recreation facilities from April to October 2014. Based on a statistical analysis of the field data collected, annual Project recreational use is estimated to be approximately 2,620 recreation days with peak weekend use estimated at approximately 50 recreational users. FERC defines a recreation day as “each visit to a development for recreational purposes during any portion of a 24-hour period."

One hundred percent of the 2014 Project recreational use is attributable to daytime activities. Recreational use is fairly evenly spread among the Project recreation facilities: the Graham Lake Dam boat launch had an estimated 920 users, or 35 % of total use; the Lake Leonard carry-in site had an estimated 890 users, or 34 % of total use; and the Graham Lake portage trail/downstream access site had an estimated 820 users, or 31% of total Project use. Most of this latter use is downstream shoreline fishing, with very little portage use.

None of the recreation facilities were reported to be at peak capacity on non-holiday weekends. The Graham Lake Dam boat launch and Lake Leonard carry-in were both reported to be at approximately 20% capacity for non-holiday weekends, while the portage trail/downstream access was reported to be at approximately 10% of capacity on non-holiday weekends. Existing recreation facilities are adequate to meet current recreational use and demand.

Land Use

The project is located on the lower reach of the Union River in the City of Ellsworth, and the towns of Waltham, Mariaville and Fletchers Landing Township in Hancock County, Maine. The watershed is located in an area with mixed land uses. The City of Ellsworth, with a population of 7,741 (U.S. Census Bureau 2010) is located on the southerly portion of the Project and straddles the lower end of Lake Leonard. There are several smaller towns (Otis, Waltham, Eastbrook, Mariaville, Osborn, and Aurora) all with populations less than 600 are scattered throughout the watershed. Developed land including residential, commercial, industrial, transportation, and utility uses, accounts for only a small percentage of the land use in the watershed.

Much of the surrounding lands are privately owned, some by timber management companies. There are private docks scattered along both impoundments’ shorelines where there is residential development. Other than the urban portion of Ellsworth, there are no large-scale industrial or commercial developments in the area. Approximately 160 acres on the southern end of Hardwood Hill Island in Graham Lake has been placed under conservation by a local land trust. Black Bear's land use in the Project boundary is limited to project operations and maintenance. This includes the operation and maintenance of the Project facilities and powerhouse, and may include road and parking lot maintenance, as well as vegetation management.

Non-Project transmission lines cross through the Project boundary in the northern reach of Graham Lake, over the Union River between Lake Leonard and the Graham Lake Dam, near Branch Lake Brook, and south of Ellsworth Dam.

4.4.7.2 Environmental Analysis

Effects of continued project operation on existing recreational facilities and public access

The Ellsworth Project is located on the lower reach of the Union River, in central coastal Maine. The Project includes Graham Lake, a stretch of the Union River which flows from Graham Lake to Lake Leonard, and Leonard Lake which in turn discharges to the tidal portion of the Union River. The primary recreation interest at the Project is whether existing recreation facilities are adequate for current and future demand and whether the continued operation of the Project would impact the recreational facilities and use.

Black Bear's recreational use studies confirm that public use of Project recreation facilities and the impoundments is currently very low. The Project impoundments are used primarily for fishing and boating. The Graham Lake Dam tailwater area is popular with anglers. Recreation use data collected in 2014 as part of the relicensing studies and for the FERC Form 80 Report indicate that the existing Project area recreation facilities are adequate to meet demand and none of the facilities are at or near their capacity.

Nevertheless, Black Bear is proposing several improvements to enhance access and use of the Project lands and waters for recreational activities. Black Bear will improve the Graham Lake Dam boat launch parking area to improve vehicular access, relocate the existing canoe portage trail to address public safety, make improvements to the existing fishermen access trail below Graham Lake, and implement a Recreation Facilities Management Plan for the maintenance and improvement of recreation amenities at the Project for the term of the license. These measures will continue to maintain public access and recreation opportunities at the Project.

The proposed operation of the Project will continue to provide recreational access and support existing recreation uses and facilities, and will not alter or impact land use. Black Bear is not proposing any changes to current Project operations, and therefore, there will be no adverse impacts on recreation facilities, their use, or Project and adjacent lands.

Effects of continued project operation on flow releases and whitewater boating

At the January 15, 2013 Scoping Meeting, one individual from the public stated the Union River below Graham Lake Dam should be assessed for whitewater boating opportunities. Black Bear conducted a desk-top whitewater boating analysis. In addition, consultants with whitewater boating experience boated the Union River on two occasions and evaluated whitewater boating opportunities. Based on the desk-top analysis and the field reconnaissance, the Union River provides Class I-II boating opportunities. However, due to the limited number of whitewater features, the river is an occasional, local resource at most.

4.4.7.3 Proposed Environmental Measures

Black Bear proposes to make enhancements to several of the Project recreation facilities.

Black Bear will improve drainage at the Graham Lake Dam boat launch to remedy an erosion problem area near the top of the boat ramp. This will entail redirecting drainage from the parking lot away from the boat ramp and toward vegetative buffers on either side of the ramp and hardening the sloped gravel ramp approach with material that will not migrate toward the ramp and lake due to vehicle traffic and run-off events.

Black Bear proposes to relocate the existing portage trail to the west side of Graham Lake Dam (Figure E-15) and develop a take-out area on the existing Graham Lake Dam boat launch property separate from the hard surface ramp to avoid conflicts with launching and retrieving motorized watercraft. The portage trail would cross Mariaville Road and traverse a level field parallel the south side of the flood control structure to a new put-in on the Union River. Portage trail directional signage and “Danger Water May Rise” signage will be installed, and side and overhead vegetation along the trail cleared and maintained, where needed, to accommodate portaging a 16-foot canoe. Shoreline improvements at the downstream put-in will be required. Total length of the relocated trail will be approximately 1,000 feet, compared to approximately 360 feet for the existing trail. The portage trail is being relocated for safety considerations including the current trails very close proximity to the upstream boat barrier.

The downstream portion of the existing east shore access trail would still be maintained for downstream angler access.

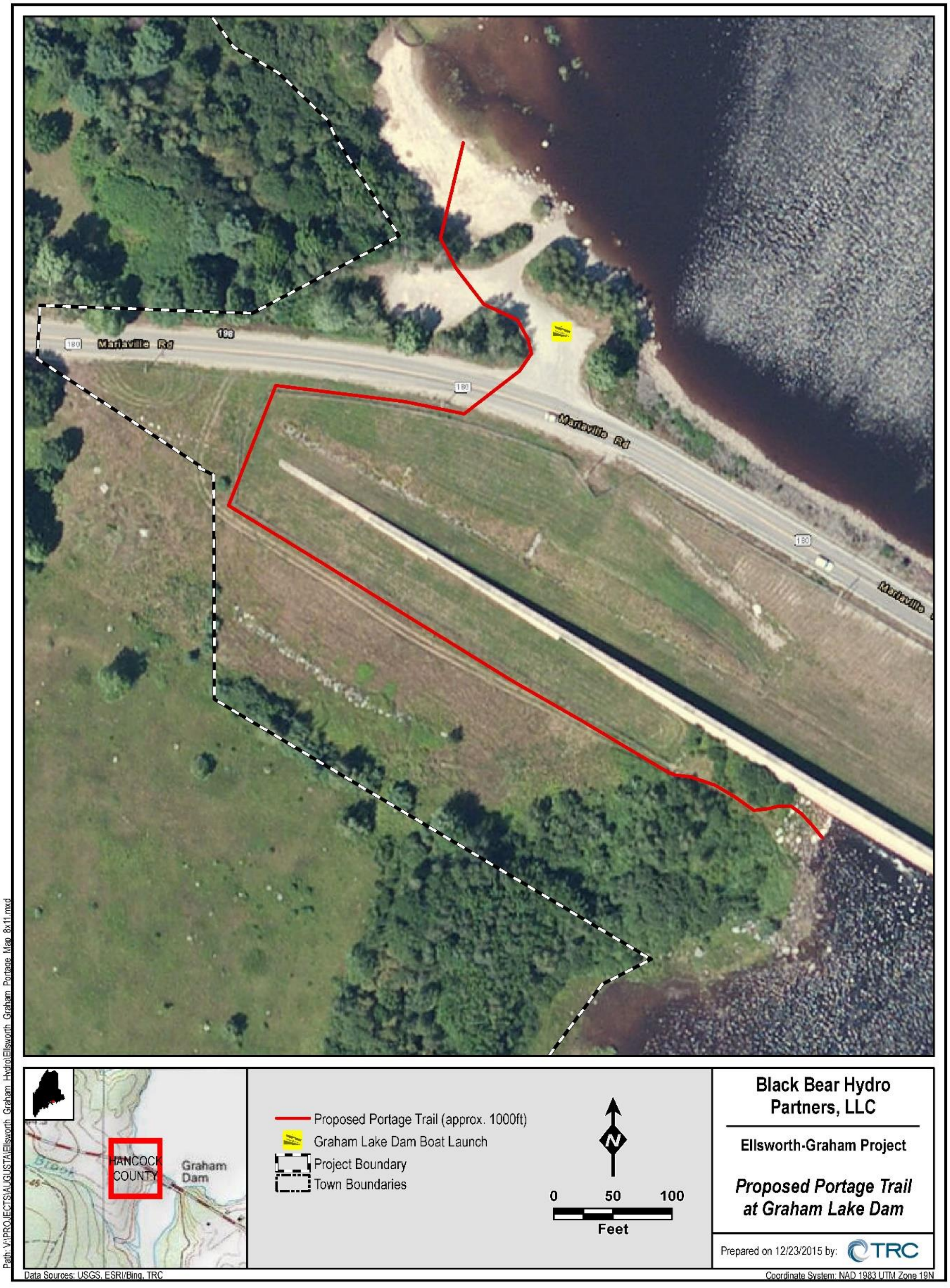
Black Bear proposes to implement a Recreation Facilities Management Plan (Appendix E-9) for the project, which will address management of Project recreation sites over the term of the new license.

Black Bear is not proposing any environmental measures associated with land use.

4.4.7.4 Unavoidable Adverse Impacts

The continued operation of the Ellsworth Project will support the existing recreational uses and will not alter land use associated with the Project. The proposed recreation enhancements will improve public access, public safety and provide additional opportunities at the Project.

Figure E-15: Portage Trail Map



4.4.8 Aesthetics

4.4.8.1 Affected Environment

The Project is located in south-central Hancock County, Maine. Both Project dams are located in the City of Ellsworth and the Graham Lake impoundment extends into the Towns of Mariaville, Waltham, and Fletchers Landing Township. Ellsworth Dam and the southerly portion of its associated impoundment, Leonard Lake, are within the urban area of the city and are adjacent to commercial and residential in-town development. The remainder of the Project is rural in nature with undeveloped forest lands and scattered residential development. Terrain around the immediate Project is relatively flat, though some low elevation mountains (< 1,600') are within view of the Project (Black Bear, 2012).

Though close to the downtown area and a major transportation corridor, the Lake Leonard shoreline is well buffered with vegetation and views of development along the shoreline are very limited. Riverbanks downstream of the Ellsworth Dam are of moderate slope; the west riverbank has a few residential structures along the top of the bank and a few commercial and municipal buildings are set back along the east riverbank (Black Bear, 2012).

Lake Leonard is approximately 0.3 mile wide at its widest point and extends approximately 1 mile upstream from the dam to where the impoundment becomes narrow and more riverine. Slopes along both shorelines are gentle with some scattered residential development. Public access points providing views of the impoundment exist from a public trail opposite the Ellsworth Middle School on the east shore and from the dam on the west shore. Limited views of the impoundment also occur along portions of the public roads on the east and west shorelines (Black Bear, 2012).

The Union River extends from the head of the Lake Leonard approximately 3 miles upstream (north) to Graham Lake Dam. This section of the river is approximately 200 feet wide and contains a few short Class I/II areas. Slopes along the river are gentle to moderate. Shore Road parallels the lower east shoreline providing some views of the river, and US Route 1A crosses the river approximately 0.7 mile upstream of the head of the Lake Leonard impoundment. Infant Street on the west shoreline provides access to and a limited view of the river. The shoreline along this section of river is wooded, except where Shore Road extends along the riverbank, with very minimal development (Black Bear, 2012).

The shorelines between Rt. 1A and Graham Lake Dam are mostly undeveloped with the exception of a small residential development on the east shore below Graham Lake Dam, a railroad crossing immediately upstream of the Rt. 1A Bridge, and a non-Project transmission line corridor crossing approximately 0.8 mile downstream of the dam. The shorelines are gentle wooded slopes interspersed with wetlands and minor water courses (Black Bear, 2012).

Graham Lake Dam is located in the northeasterly portion of Ellsworth. Graham Lake extends approximately 10 miles upstream from the dam to the East Branch and West Branch of the Union River. Several other tributaries also feed into the lake. Islands of various size ranging from less than one acre to Hardwood Hill Island (approximately 625 acres) are located throughout the lake. Slopes along the shoreline consist of gentle to moderate slopes (Black Bear, 2012).

The lake shoreline is a mixture of land use classifications. The majority of the shoreline consists of forest growth. Year-round and seasonal residences are scattered along the shoreline and are generally accessed by paved public or private gravel roads (Black Bear, 2012).

Routes 179 and 180/181 roughly parallel the east and west shores, respectively, and offer various views depending on proximity and elevation of the road to the shoreline. Views of much of the Project from these roads are screened by vegetation, topography, and/or distance. There are limited Project views from two high points along State roads: off Route 179 near the intersection of Cemetery Road (elevation 330’, view to the southwest); and off Route 181 south of Tannery Brook (elevation 220’, view to the southeast). Several public access points provide views of portions of the Project. These include the boat ramp and downstream fishing access trail near Graham Lake Dam, the Morrison Farm Road carry-in and the Route 181 boat launch both on the northern end of the Project in Mariaville, and Fletchers Landing off Route 179 on the southeast shoreline (Black Bear, 2012).

Although the limited views are scenic, the Project’s aesthetic quality is not unique, particularly for this area of coastal Maine. Acadia National Park is approximately 15 miles southwest of the Project (Black Bear, 2012).

4.4.8.2 Environmental Analysis

Operation of the Project facilities has little effect or impact on the aesthetic quality of the impoundments and the section of the Union River downstream of the Graham Lake and Ellsworth Dams.

4.4.8.3 Proposed Environmental Measures

Black Bear is proposing to operate the Project as it has in the past. This will maintain the existing scenic quality, therefore Black Bear is not proposing to specifically enhance Project aesthetics.

4.4.8.4 Unavoidable Adverse Impacts

The continued operation of the Ellsworth Project will have little impact on aesthetic resources of the Project.

4.4.9 Cultural Resources

Black Bear conducted several studies to identify cultural resources eligible for listing on the National Register of Historic Places (NRHP) in accordance with Section 106 of the National Historic Preservation Act (NHPA). Studies were conducted for Precontact resources (i.e., Native American archaeological resources), Postcontact resources (i.e., Euroamerican archaeological resources) and historic structures (i.e. architectural resources).

4.4.9.1 Affected Environment

Area of Potential Effect

The Area of Potential Effect (APE) for Precontact and Postcontact archaeological resources for the Ellsworth Project was defined in consultation with the MHPC as lands enclosed within the Project boundaries and/or lands located within 50 feet (15 meters) of the edge of the impoundments or river bank, whichever is the greater of the two areas.

The APE for architectural resources was defined in consultation with the MHPC as "the lands enclosed by the Project's boundary and lands or properties outside of the Project's boundary where Project construction and operation or Project-related recreational development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist."

Archaeological Resources

The Union River valley has a long history of human occupation with the arrival of people into the area approximately 11,000 years ago. Professional survey by archaeologists from the Abbe Museum in Bar Harbor and the Maine State Museum in Augusta (Bourque 1971; Bourque and Kopec 1984) showed that human use of the Project area around Leonard Lake has occurred almost continuously from the Late Archaic period up until the time of Native American contact with Europeans (ca, 5,000 - 400) years ago.

The Phase I archaeological investigation conducted for the Ellsworth Project included shoreline survey of Graham Lake and Lake Leonard, as well as all tasks specified in a letter dated September 10, 2012 from the MHPC. The investigation included Phase I archaeological survey testing to determine whether any evidence of the historic Learoyd Hill Farmstead (ME 145-013) (Mosher 2010) was present within the Project boundary. As part of the initial survey, Black Bear conducted background research and identified a number of previously known Precontact sites located at the Project vicinity. In addition, at the request of the Maine State Historic Preservation Officer (SHPO), Black Bear reviewed select existing archaeological reports and amateur artifact collections from the Project area. A desktop sensitivity analysis followed by field inspection and survey work led to the identification of three new Precontact sites. The sites range in age from the Late Archaic to Contact periods. All three sites were recommended for further evaluation (Phase II) to determine their potential eligibility for listing to the National Register of Historic Places (NRHP). Phase II investigation of the three new sites occurred in the summer of 2015 and recommended that two of the sites are eligible for listing in the NRHP. By letter dated December 22, 2015 the MHPC concurred with the finding. The Phase II study report, Phase II Archaeological Investigations of Precontact Sites: 58.29, 58.30 and 58.31 Leonard Lake – Ellsworth, Hancock County, Maine is included in Appendix E-10 filed as a separate Privileged volume of the FLA.

Historic and Architectural Resources

An architectural survey of the Project APE was conducted in November 2013, with follow up work in 2014. The purpose of the survey was to identify historic resources within the Project APE currently listed, or eligible for listing, in the NRHP. The historic architecture survey found, and the Maine State Historic Preservation Officer concurred (letter dated June 3, 2014), that there are three architectural resources in the project's area of potential effect that are either listed in or are eligible for listing in the NRHP. These include: the Ellsworth Powerhouse and Dam (NRHP listed), Graham Lake Dam and Bridge (previously determined NRHP eligible), and the Maine Central Railroad Bridge over the Union River (NRHP eligible). No other NRHP-eligible historic structures were found within the Project APE.

4.4.9.2 Environmental Analysis

Effects of continued project operation on historic properties and archaeological resources

Section 106 of the National Historic Preservation Act (NHPA) requires FERC to take into account the effect of its undertakings on historic properties and to allow the Advisory Council on Historic Preservation (ACHP) the opportunity to comment. For hydropower licensing actions, FERC typically completes Section 106 consultation by entering into a Programmatic Agreement (PA) or Memorandum of Agreement (MOA) with the licensee, the ACHP, and the state and tribal preservation offices. FERC typically requires the licensee to develop and implement a Historic Properties Management Plan (HPMP) as a license condition. Through an approved HPMP, FERC can require consideration and management of effects on historic properties for the license term, thus meeting the requirements of Section 106 for its undertakings.

An HPMP implemented under a license is a plan for considering and managing the effects of hydropower facility activities (such as construction, operation, and maintenance) on historic properties. Historic properties include those properties listed in, or eligible for listing in, the NRHP. The HPMP establishes a decision-making process for considering the potential effects on historic properties and manages the effects of implementing the license over its entire term.

Potential future effects to historic structures and archaeological resources over the term of the new license may occur due to facility maintenance, replacement, and repair; construction of new Project facilities, including recreation facilities; erosion, whether contributed to by natural processes, Project operation, or both; and permitted shoreline uses and activities such as recreational activities; and public use associated with recreation facilities at the Project.

Black Bear will minimize adverse effects to historic properties as a result of recreational facilities development by avoiding development in these areas where practicable. All archaeological site information and site locations will remain confidential relative to the general public so as to minimize the effects of site looting activities. Prior to construction of any recreational development that will require ground disturbing activities near known or potential historic properties, Black Bear will initiate consultation with the SHPO.

Black Bear will also consult with the SHPO prior to conducting any other planned, non-emergency, maintenance or construction activities that have the potential to adversely affect historic properties in the Project APE of the proposed undertaking in accordance with the management measures set forth in the final approved HPMP.

The limited amount of Precontact period cultural material found on Graham Lake may be the result of the lack of access to locations within close proximity to the submerged shoreline of the historic Union River channel. Even at its lowest drawdown elevation of 93.4’ the historic Union River channel within Graham Lake is fully submerged. Continued operation of the Project will likely not adversely impact any potential Graham Lake archaeological sites. Black Bear will however, coordinate with the SHPO to complete archaeological surveys of Graham Lake should it be determined that field conditions and planned impoundment levels (i.e., during times when planned maintenance activities requiring sufficiently prolonged low water levels occur) prevail to permit the safe and reasonable review of sites that may be located in the drawdown zone.

Two Precontact archaeological sites within the Project boundary were determined to be NRHP-eligible. These sites will be monitored on an annual basis for erosion in accordance with the final approved HPMP.

There are three (3) historic architectural resources within the Project APE that are listed or eligible for the NRHP – the Ellsworth Dam and powerhouse (NRHP-listed), the Graham Lake Dam/Bridge (NRHP-eligible), and the Central Maine Railroad Bridge (NRHP-eligible). Black Bear will consult with the SHPO prior to undertaking any planned non-emergency maintenance or construction activities (e.g., upstream American eel passage) that could adversely affect the historic integrity of the contributing resources of the Ellsworth Hydroelectric Facility or any other historic resources within the undertaking’s APE.

4.4.9.3 Proposed Environmental Measures

In order to manage and protect the cultural resources at the Project during the term of the new license, Black Bear is proposing to implement an HPMP for the Ellsworth Project. The draft of the HPMP (Appendix E-10) is being filed with the Maine HPC and FERC under separate cover as "*Privileged*" because it contains confidential archaeological site location information. The HPMP considers the effects of the Project and its continued operation on historic properties. Moreover, the HPMP establishes specific steps to be taken by Black Bear to protect and manage these historic properties over the term of the new license. With the implementation of an approved HPMP, the continued operation of the Project as proposed by Black Bear will have no adverse impacts on historic properties at the Project.

4.4.9.4 Unavoidable Adverse Impacts

No unavoidable adverse impacts to cultural resources are expected to occur as the result of the continued operation of the Ellsworth Project as proposed.

4.4.10 Socioeconomics

4.4.10.1 Affected Environment

The Ellsworth Project is located in Downeast Maine within Hancock County. Hancock County is the second most eastern county in the state and is the eighth most populous of the state's 16 counties. The Project boundary is contained within the City of Ellsworth, the Towns of Mariaville and Waltham, and Fletchers Landing Township. The following sections provide a summary of selected socioeconomic variables for Maine, Hancock County, the City of Ellsworth, and the Towns of Mariaville, and Waltham, as they are available.

General Land Use Patterns

Approximately 90.2 percent of Hancock County is comprised of forested land (USDA, 2005). The City of Ellsworth, Towns of Mariaville and Waltham, and Fletchers Landing Township are in the Northeast Maine nonmetropolitan area (BLS, 2013). While lands within the Project vicinity are predominately undeveloped forest lands and wetlands, the city of Ellsworth is an area of dense population (relatively) within the County. Forestry is a common land use in the area, while agricultural uses include apple orchards and blueberry barrens (Ellsworth Comprehensive Planning Committee, 2004, Mariaville Comprehensive Planning Committee, 2006).

Population Patterns

According to the US Census Bureau (2015), the population of Hancock County in 2010 was 54,418 (Table E-23). From April 1, 2010 to July 1, 2013, the population of the County increased by approximately 0.8 percent. The population density of the County in 2010 was 34.3 people per square mile within a land area of 1,586.89 square miles, which is approximately 20.4 percent lower than the state's average of 43.1 people per square mile (US Census Bureau, 2015h).

The City of Ellsworth had a population of 7,741 in 2010, while Mariaville had a population of 513, and Waltham had a population of 353 (US Census Bureau, 2015a, 2015d, 2015e, 2015f, and 2015g).

Table E-23: Population Statistics for Hancock County and the State of Maine

	Hancock County	Maine
Population		
Population (2013 Estimate)	54,845	1,328,702
Population (2010)	54,418	1,328,361
Population Growth (April 1, 2010 to July 1, 2013)	0.8%	Z*
Geography (2010)		
Land Area in Square Miles	1,586.89	30,842.92
Population Density (per square mile)	34.3	43.1
Gender (2013)		
Male	48.9%	49.0%
Female	51.1%	51.0%
Age (2013)		
Persons Under 5 Years Old	4.4%	4.9%
Persons Under 18 Years Old	17.6%	19.7%
Persons 18 to 64 Years Old	57.3%	57.5%
Persons 65 Years Old and Over	20.7%	17.7%
Race (2013)		
Caucasian	95.5%	94.0%
Black	0.6%	1.4%
American Indian and Alaska Native	0.5%	0.7%
Asian	1.0%	1.1%
Hispanic or Latino	1.3%	1.4%
Two or More Races	1.2%	1.6%

***** Value greater than zero but less than half of a percentage unit of measure shown.
Source: US Census Bureau, 2015h

Households/Family Distribution and Income

There were an estimated 24,355 households in Hancock County, which was approximately 4.4 percent of the state's households based upon the Census 2009-2013 American Community Survey Estimate values. The County had 2.17 persons per household, which is slightly less than the state's average household size of 2.33 people (US Census Bureau, 2015h).

The median household income in Hancock County was $47,460, which is approximately one percent below the state median household income of $48,453 between 2009 and 2013. In addition, Hancock County had a higher per capita income ($27,797) than the state of Maine ($26,824), based upon the Census 2009-2013 American Community Survey Estimate values. Approximately 14.0 percent of the population of Hancock County was below the poverty level, while the percent of the state's population living below poverty level was lower at 13.6 percent (US Census Bureau, 2015h). Hancock County had a higher unemployment rate (7.8 percent) as compared to the overall state (5.5 percent) in December 2014 based upon the data derived from the Local Area Unemployment Statistics (LAUS) program (Maine CRWI, 2015).

Project Vicinity Employment Sources

In Hancock County, as well as the entire state of Maine, the top two sources of employment are in education and health services (7,336 people employed) (Table E-24) and in the retail trade industry (3,286 people employed) (US Census, 2015b and 2015c). The largest employer in Hancock County is Jackson Laboratory, which employed over 1,000 people in 2014 (MDOL, 2014).

Table E-24: Employment Statistics for Hancock County and the State of Maine

	Hancock County	Maine
Civilian Labor Force Employment Status (2009 - 2013)		
Number Employed	27,336	647,099
Employment by Industry (2009 - 2013)		
Agriculture, Forestry, Fishing, Hunting, and Mining	1,522	15,732
Construction	2,547	45,585
Manufacturing	1,604	60,165
Wholesale Trade	436	15,318
Retail Trade	3,286	88,065
Transportation and Utilities	935	25,138
Information	548	11,762
Financial Activities	1,163	39,587

	Hancock County	Maine
Professional and Business Services	2,926	56,228
Education and Health Services	7,336	177,466
Leisure and Hospitality	2,767	55,256
Other Services	1,453	28,612
Public Administration	813	28,185

Source: US Census Bureau, 2015b and 2015c)

Flood Control

Graham Lake reservoir provides significant mitigation of downstream flooding in the downtown area of the City of Ellsworth by attenuating peak flows. Spring flooding is generally the period of most concern, when rain and snow melt combine to provide high levels of inflow. Graham Lake is generally operated in a manner such that the time of maximum drawdown, usually around late-March is just before the high spring flows that fill the lake by mid-May.

4.4.10.2 Environmental Analysis

The Project lands and waters are utilized by the City of Ellsworth, fishermen, and recreationists. Existing shoreline development is currently limited almost exclusively to private residences and seasonal cottages. Other than recreation and the seasonal harvesting of alewives for lobster bait, and American eel elvers for export, there are no significant non-Project socioeconomic resources or uses of the Ellsworth Project.

The Project provides a positive economic benefit to the City of Ellsworth each spring as alewife are harvested below the Ellsworth Dam on the Union River. Alewives have been harvested in Maine for economic purposes for many years. There is high demand for alewives for use as lobster bait. The City of Ellsworth holds a license for harvesting alewives in the Union River and in turn issues permits to fish alewives for commercial purposes, earning 40% of the license holder's revenue as a permit fee (College of the Atlantic 2004). The following table shows annual revenue to the city from the alewife harvest for the past 10 years.

Migrating American juvenile eel, also known as elvers, are also harvested by licensed fishermen on the Union River (Bangor Daily News, 2012). Elvers are second only to lobster in value in Maine's seafood industry (Boston Globe, 2013).

The recreational opportunities in the Project vicinity attract visitors for camping, birding, wildlife viewing, boating, and fishing. There will be no significant changes to the basic operations of the Project impoundments, and therefore, there would be no changes to any socioeconomic resources in the Project area.

Table E-25: City of Ellsworth Revenue from Alewife Harvest 2005 – 2014

Year	Revenue
2005	$9,500
2006	$2,778
2007	$21.053
2008	$20,287
2009	$12,355
2010	$13,306
2011	$11,700
2012	$58,799
2013	$31,816
2014	$35,872
Total	**$217,466**

*Data supplied by City of Ellsworth

4.4.10.3 Proposed Environmental Measures

Black Bear is proposing to continue to operate and maintain the Project under the existing operating regime. Black Bear will generally maintain the current Project schedule of seasonally variable minimum flows and pond level management.

Black Bear is making no proposal for the Project directly aimed at enhancing area socioeconomic resources. However, several of the resource proposals being made will indirectly support the continued use of the Project area for recreation, and will allow the Project to continue to contribute to the recreation and tourism based economy of the region.

4.4.10.4 Unavoidable Adverse Impacts

No unavoidable adverse impacts to socioeconomic resources are expected to occur as a result of the continued operation of the Ellsworth Project as proposed.

4.5 Economic Analysis

4.5.1 Costs and Value of Developmental Resources Associated with the Project

Black Bear is not proposing to add capacity or make major modifications to the project in this license application. The nameplate rated capacity of the Ellsworth Project is 8.9 MW. The Project has generated an average annual energy output of 30,511 MWh over the past 21 years. The values of developmental resources of the Project are discussed in Exhibit D.

4.5.2 Cost of Proposed PMEs

Recreational Facilities

Black Bear has developed a Recreation Management Plan to provide for management of Project recreational facilities throughout the term of the license.

- Black Bear proposes to improve the boat launch by grading/compacting the gravel section of the boat launch to improve drainage and stabilize existing erosion areas.
- Black Bear proposes to develop a new portage trail around Graham Lake Dam. The new trail would be located at the west end of the dam. The portage trail will originate in the vicinity of the existing hard-surfaced boat launch, but be designed to not conflict with the boat launch area. The trail will enter the Union River just below the existing flood control structure on the west side of the river.
- For safety reasons, Black Bear proposes to discontinue the existing portage trail at the east end of Graham Lake Dam while at the same time improving and maintaining a portion of the trail for fisherman access to the Union River below the dam.
- Black Bear will maintain appropriate Part 8 and directional and safety signage.

Fish Passage

- Black Bear proposes to develop and implement, in consultation with fisheries management agencies, plans for upstream eel passage at Ellsworth and Graham Lake Dams.
- Black Bear will consult with the fisheries management agencies on the need for and, if necessary, the design of downstream eel passage measures pending the results of downstream eel passage studies.
- Black Bear will consult with the fisheries management agencies on the need for and, if necessary, the design of upstream and downstream anadromous fish passage improvements pending the results of ongoing studies.

Cultural Resources

- Black Bear has developed a draft Historic Properties Management Plan to provide for appropriate management of effects on historic resources throughout the term of the license. Black Bear will implement and maintain the final approved HPMP for the term of the new license.

Table E- 26 below details the estimated cost of the proposed PME's.

Table E-26: Estimated Costs for Proposed PMEs for the Ellsworth Project (2015 dollars)

Proposed PME Measure	Construction Cost***	Annual Operation and Maintenance Cost
Finalize and implement Recreation Facilities Management Plan	$5,000	$5,000
Graham Lake Boat Launch Improvements	$35,000	N/A
Graham Lake New Portage Trail	$45,000	N/A
Graham Lake fisherman's downstream access trail improvements	$25,000	N/A
Part 8 and Directional and Safety Signage	$20,000	N/A
Recreation facilities and sites operation and maintenance**	NA	$26,000
Finalize and implement Historic Properties Management Plan*	$5,000	$5,000
Finalize and implement Operations Monitoring Plan	$5,000	$5,000
Upstream eel passage measures	$150,000	$20,000
Downstream eel passage measures	Unknown	Unknown
Upstream anadromous fish passage measures	Improvements unknown	$90,000
Downstream anadromous fish passage measures	Improvements unknown	$20,000

* Exclusive of costs of historic properties investigations that result from implementation of the HPMP.
** Exclusive of costs of major maintenance and repair projects.
*** Does not include costs to permit the measure, or costs of unknown environmental mitigation measures that may be required based upon the permitting process.

4.6 Consistency with Comprehensive Plans

Section 10(a)(2) of the Federal Power Act requires FERC to consider the extent to which a project is consistent with federal and state comprehensive plans for improving, developing, and conserving waterways affected by the project. The comprehensive plans are discussed in Exhibit H of this Final License Application.

5.0 REFERENCES

http://www.bestplaces.net/climate/city/maine/ellsworth Accessed April 2015

Alden Research Laboratory (Alden). 2012. Atlantic salmon survival estimates at mainstem hydroelectric projects on the Penobscot River. Holden, Massachusetts.

Atlantic States Marine Fisheries Commission (ASMFC). 2012. River herring benchmark stock assessment: volume 1. Stock Assessment Report No. 12-02. May 2012. http://www.asmfc.org/speciesDocuments/shad/stockassmtreports/riverHerringBenchmarkStockAssessmentVolumeIR_May2012.pdf. Accessed August 28, 2013. cited in FERC's September 4, 2013 Study Plan Determination

Atlantic Sturgeon Status Review Team. 2007. Status review of Atlantic sturgeon (Acipenser oxyrichus oxyrinchus). National Marine Fisheries Service. February 23, 2007. 188 pp.

ASMFC. 2012. American Eel Benchmark Stock Assessment. Stock Assessment Report 12-01 of the Atlantic States Marine Fisheries Commission. 342 pp.

ASMFC. 2014. Addendum IV to the Interstate Fishery Management Plan for American Eel. Approved October 2014. 26 pp.

Bakshtansky, E.L., I.A. Barybina, and V.D. Nesterov. 1976. Changes in the intensity of downstream migration of Atlantic salmon smolts according to abiotic conditions. ICES Anadromous and Catadromous Fish Committee C.M.1976/M:4.

Bangor Daily News. 2013. Restoration efforts put spotlight on once plentiful alewives. [Online] URL: http://bangordailynews.com/2013/05/04/outdoors/restoration-efforts-put-spotlight-on-once-plentiful-alewives/.

Bangor Daily News. 2012. Elvers fetching more than $2,000 per pound. [Online] URL: http://bangordailynews.com/2012/03/23/news/hancock/elvers-fetching-more-than-2000-per-pound/.

Bangor Hydro-Electric Company. 1984. Application for License for Major Project – Existing Dam. December 19, 1984

Bangor Pacific Hydro Associates (BPHA). 1994. 1994 Evaluation of Downstream Fish Passage Facilities at the West Enfield Hydroelectric Project. FERC #2600-029. Bangor-Pacific Hydro Associates. Bangor, ME. 18 pp. and appendices.

Baum, E.T. 1997. Maine Atlantic Salmon: A National Treasure. Atlantic Salmon Unlimited. Hermon, ME. 224 pp.

_____. 1982. The Union River: An Atlantic salmon management plan. Atlantic Sea Run Salmon Commission. Bangor, Maine. 27 p.

Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria. Report Prepared for US Army Corps of Engineers, North Pacific District, Portland, Oregon.

Bishop, M. Maine Department of Environmental Protection. 2014. (personal communication October 8, 2014).

Black Bear Hydro Partners, LLC. (Black Bear). 2015. Updated Study Report for the Ellsworth Hydroelectric Project, FERC No. 2727. August 2015.

Black Bear Hydro Partners, LLC. (Black Bear). 2014. Initial Study Report (ISR), Ellsworth Hydroelectric Project, FERC No. 2727. September 2014.

Black Bear Hydro Partners, LLC. (Black Bear). 2012 Pre-Application Document (PAD), Ellsworth Hydroelectric Project, FERC No. 2727. October 2012.

Blackwell, B.F. and W.B. Krohn. 1997. Spring foraging distribution and habitat selection by double-crested cormorants on the Penobscot River, Maine, USA. Colonial Waterbirds 20(1): 66-76.

Blackwell, B.F., W.B. Krohn, N.R. Dube, and A.J. Godin. 1997. Spring prey use by double-crested cormorants on the Penobscot River, Maine, USA. Colonial Waterbirds 20(1): 77-86.

Blackwell, B.F. 1996. Ecology of double-crested cormorants using the Penobscot River and Bay Maine. Doctoral dissertation, University of Maine.

Booth, R.K., E.B. Bombardier, RS. McKinley, D.A. Scruton, and R.F. Goosney. 1997. Swimming Performance of Post Spawning Adult (Kelts) and Juvenile (Smolts) Atlantic Salmon, *Salma salar*. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2406: V + 18 p.

Boschung, H.T. Jr., and R.L. Mayden. 2004. Fishes of Alabama. Smithsonian Institution, Washington, DC. 736 pages.

Boston Globe. 2013. Maine Limiting Lucrative Catch for Glass Eels. [Online] URL: www.bostonglobe.com/...elvers-maine-maine...eels/.../2013/12/14/Maine

Boston Globe. 2013. [Online] URL>www.bostonglobe.com/...elvers-maine-maine...eels/.../2013/12/14/Maine limiting lucrative catch for glass eels

Bourgeois, C.E. and M.F. O'Connell. 1986. Observations on the seaward migration of Atlantic salmon (*Salmo salar L.*) smolts through a large lake as determined by radio telemetry and Carlin tagging. Canadian Journal of Zoology 66: 685-691.

Bozeman, E.L., Jr., and M.J. VanDen Avyle. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic) -- alewife and blueback herring. U.S. Fish Wildl . Serv. Biol . Rep. 82(11.111). U.S. Army Corps of Engineers, TR EL-82-4. 17 pp.

Brown L.S., Haro A. and Castro-Santos T., 2009. Three-dimensional movements of silver-phase American eels in the forebay of a small hydroelectric facility. *In*: Casselman J.M. and Cairns D.K. (eds.), Eels at the edge: science, status and conservation concerns, *American Fisheries Society Symposium, 58*, Bethesda, 277–291.

Bureau of Labor Statistics (BLS). 2013. May 2013 Metropolitan and Nonmetropolitan Area Definitions. [Online] URL: http://www.bls.gov/oes/current/msa_def.htm#76750.

Burr, G. Maine DIFW, personal communication, July 23, 2014

______. Maine DIFW, personal communication, July 3, 2014

______. Maine DIFW, personal communication, July 18, 2013

______. Maine DIFW, personal communication, March 7, 2013

Clough, S.C., Lee-Elliott, I.E., Turnpenny, A.W.H., Holden, S.D.J., and Hinks, C. 2004. Swimming Speeds in Fish: phase 2 Literature Review. Environment Agency R&D Technical Report W2-049/TR2.

College of the Atlantic. 2004. Alewife Restoration in the Union River Watershed, A Report by the River Ecology and conservation Class. June, 2004.

Conserve Wildlife Foundation of New Jersey. 2015. New Jersey Endangered and Threatened Species Field Guide: Big Brown Bat. Website accessed April 1, 2015 at: http://www.conservewildlifenj.org/species/fieldguide/view/Eptesicus%20fuscus/

Cornell Lab of Ornithology. 2014. All About Birds. Website accessed November 21, 2014 at: http://www.allaboutbirds.org

______. 2015. All About Birds. Website accessed April 1, 2015 at: http://www.allaboutbirds.org

Cowardin, L.M., V.C. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 131 pp.

Davies, S.P. and L. Tsomides. 2002. Methods for biological sampling and analysis of Maine's rivers and streams. ME Dept. of Env. Prot. Augusta, ME. 31p.

DeGraaf, Richard M. and Yamasaki, Mariko. 2001. New England Wildlife: Habitat, Natural History, and Distribution. University Press of New England. Lebanon, NH.

E. Call, Maine DIFW, personal communication March 31, 2015

Ellsworth Comprehensive Planning Committee. 2004. Ellsworth Comprehensive Plan Update. [Online] URL: http://www.hcpcme.org/ellsworth.

Evers, D.C. 2007. Status assessment and conservation plan for the Common Loon (*Gavia immer*) in North America. BRI Report 2007-20. U.S. Fish and Wildlife Service, Hadley, MA.

Fair, Jeffrey S. 1979. Water level fluctuations and common loon nest failure. In: S. Sutcliffe (ed.) Proceed. N. Amer. Conf. Common Loon Res. Manage. 2: 57-63.

Fay C., M. Bartron, S. Craig, A. Hecht, J. Pruden, R. Saunders, T. Sheehan and J. Trial. 2006. Status review for anadromous Atlantic salmon (*Salmo salar*) in the United States. Report to the National Marine Fisheries Service and U.S. Fish and Wildlife Service. 294 pages.

Federal Energy Regulatory Commission (FERC). 1987. Environmental Assessment, Ellsworth Project, FERC No. 2727-003. Issued November 9, 1987.

Federal Energy Regulatory Commission. (FERC). 1987. Order Issuing New License (Major Project – Existing Dam) (FERC No. 2727). Issued December 28, 1987.

Federal Energy Regulatory Commission. (FERC). 1991. Order Approving Revised Report on Recreation Resources with Modification. May 22, 1991.

Federal Energy Regulatory Commission. (FERC). 1994. Order Amending Revised Recreation Report by Approving Hand-Carried Boat Access Facility. September 14, 1994.

Federal Energy Regulatory Commission. (FERC). 1995. Order Approving Fish Passage Drawings and Construction Schedule and Denying Extension of Time. Issued January 26, 1995.

Federal Energy Regulatory Commission (FERC). 1997. Final Environmental Impact Statement - Lower Penobscot River Basin, Maine (Basin Mills, Stillwater, and Milford Hydroelectric Projects - FERC Nos. 10981, 2712, and 2534, respectively). FERC, Washington, D.C.

Federal Energy Regulatory Commission. (FERC). 2006. Order Modifying Minimum Flow Study Plan under Article 404. Issued October 13, 2006.

Federal Energy Regulatory Commission, Division of Environmental Analysis, Office of Hydropower Licensing. 1987. Environmental Assessment Ellsworth Project FERC No. 2727.

Fennelly, D. Black Bear Hydro Partners, LLC. personal communication, July 23, 2014

Fernandes, S.J., G.B. Zydlewski, J.D. Zydlewski, G.S. Wippelhauser, and M.T. Kinnison. 2010. Seasonal distribution and movements of shortnose sturgeon and Atlantic sturgeon in the Penobscot River Estuary, Maine. Transactions of the American Fisheries Society 139: 1436-1449.

Ferwerda, J.A., K.J. LaFlamme, N.R. Kalloch, and R.V. Rourke. 1997. The Soils of Maine. Miscellaneous Report 402, Maine Agricultural and Forest Experiment Station, University of Maine.

Fidel, Jonah and J. Denham. 2014. New England Bats: A guide to bats including those affected by White Nose Syndrome. Report of the Essex Land Trust. Accessed online, November 17, 2014 at: http://nrca.uconn.edu/documents/NEWENGLANDBATSGUIDE.pdf

Gawler, S. and Cutko, A. 2010. Natural Landscapes of Maine: A Guide to Natural Communities and Ecosystems. Maine Natural Areas Program, Maine Department of Conservation, Augusta, Maine. 347 pp.

Great Northern Paper Company (GNP). 1989. 1989 report on downstream passage of Atlantic salmon smolts and kelts at Weldon Dam. Great Northern Paper, Millinocket, Maine. 94 pages plus appendices.

Griffith, G., J. Omernik, S. Bryce, J. Royte, W. Hoar, J. Homer, D. Keirstead, K. Metzler, and G. Hellyer. 2009. Ecoregions of New England (color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey (map scale 1:1,325,000). Reston, Virginia. Website accessed July 16, 2012 at: http://www.epa.gov/region1/neaeb2010/pdfs/PosterHellyerGreg.pdf

Griffiths, J.S. 1979. Effects of size and temperature on sustained swimming speeds of Great Lakes fishes., pp. 37: Ontario Hydro Research Division Report.

Hall, S.D. and S.L. Shepard. 1990. 1989 Progress report of Atlantic salmon kelt radio telemetry investigations on the lower Penobscot River. Bangor Hydro-Electric Company. Bangor, Maine. 30 pages.

Hanson, E.W., C.C. Rimmer, and J. Gobeille. 2002. The 2001 breeding status of Common Loons in Vermont. Unpublished Report, Vermont Institute of Natural Science, Woodstock, VT.

Hatch, J.J. and D.V. Weseloh. 1999. Double-crested Cormorant (*Phalacrocorax auritus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/441. Accessed April 2011.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. The Great Lake Entomologist. pgs. 31-39.

Hoar, W.S. 1988. The physiology of smolting salmonids. In Fish physiology Vol. XIB (Hoar, W. S. & D. J., Randall eds.). London: Academic Press. *Cited in* Svendsen 2008.

Howatt, K. Maine Department of Environmental Protection. 2015. (personal communication June 16, 2015).

Hynes, H.B.N. 1970. The Ecology of Running Waters. Univ. of Toronto. Toronto, CA 555p. Leeper, P. 2014.

Jacobson, G.L. 2014. Mane’s moist Climate: Available on line URL: http//www. Cocorahs.org/Media/docs/ClimateSum_ME.pdf

Jenkins, R.E. and N.M. Burkhead. 1993. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland.

Jonsson, B. and J. Ruud-Hansen. 1985. Water temperature as the primary influence on timing of seaward migrations of Atlantic salmon (*Salmo salar*) smolts. Canadian Journal of Fisheries and Aquatic Sciences 42:593-595.

Keeley, E.R. and J.W. A. Grant. 1997. Allometry of diet selectivity in juvenile Atlantic salmon (Salmo salar). Can. J. Fish. Aquat. Sci. 54: 1894–1902.

Kircheis, D., and T. Liebich. 2007. Draft habitat requirements and management considerations for Atlantic salmon (*Salmo salar*) in the Gulf of Maine Distinct Population Segment (GOM DPS). November 2007.

Maine Audubon. 2010. The Common Loon. Online publication accessed February 2015 at: http://maineaudubon.org/wp-content/uploads/2011/10/The-Common-Loon.pdf

Maine Center for Workforce Research and Information (Maine CWRI). 2015. Unemployment and Labor Force. [Online] URL: http://www.maine.gov/labor/cwri/laus.html.

Maine Department of Environmental Protection (Maine DEP), Maine Department of Inland Fisheries and Wildlife (MDIF&W), and Maine Office of GIS (MEGIS). 2009. Maine Lakes: Geographic & Morphometric Information. [Online] URL: http://www.gulfofmaine.org/kb/2.0/record.html?recordid=9680.

Maine Department of Environmental Protection (Maine DEP). 2012. 2012 Integrated Water Quality Monitoring and Assessment Report.

Maine Department of Inland Fish and Wildlife (Maine DIFW). 2015. Regional Fishing Information - Region C (The Downeast Region). [Online] URL: http://www.maine.gov/ifw/fishing/regional_information/region_c.htm. Accessed April 2015.

_____. 2013a. Maine Lake Survey Maps – Graham Lake. [Online] URL: http://www.maine.gov/ifw/fishing/ lakesurvey_maps/hancock/graham_lake.pdf. Accessed March 2013.

_____. 2013b. Maine Lake Survey Maps – Lake Leonard. [Online] URL: http://www.maine.gov/ifw/fishing/ lakesurvey_maps/hancock/leonard_lake.pdf. Accessed March 2013.

Maine Department of Inland Fisheries and Wildlife (Maine DIFW). 2008. Waterfowl and Wading Bird Habitat – General. 9-1-2005 (Updated 11-30-2008).

______. 2014a. Significant Wildlife Habitats. Website accessed November 17, 2014 at: http://www.maine.gov/ifw/wildlife/environmental/mdifw/significant.html

______. 2014b. Deer: White-tails in the Maine Woods. Website accessed November 17, 2014 at: http://www.maine.gov/ifw/wildlife/species/mammals/deer.html

______. 2014c. Moose. Website accessed November 17, 2014 at: http://www.maine.gov/ifw/wildlife/species/mammals/moose.html

______. 2014d. Black Bears. Website accessed November 17, 2014 at: http://www.maine.gov/ifw/wildlife/species/mammals/bear.html

______. 2014e. Coyotes. Website accessed November 17, 2014 at: http://www.maine.gov/ifw/wildlife/human/lww_information/coyotes.html

______. 2014f. Beavers. Website accessed November 17, 2014 at: http://www.maine.gov/ifw/wildlife/human/lww_information/beavers.html

______. 2014g. Muskrats. Website accessed November 17, 2014 at: http://www.maine.gov/ifw/wildlife/human/lww_information/muskrats.html

______. 2014h. River Otters. Website accessed November 21, 2014 at: http://www.maine.gov/ifw/wildlife/human/lww_information/otters.html

______. 2015a. Species of Special Concern. Website accessed March 31, 2015 at: http://www.maine.gov/ifw/wildlife/endangered/specialconcern.htm

______. 2015b. State List of Endangered & Threatened Species. Website accessed on April 3, 2015 at: http://www.maine.gov/ifw/wildlife/endangered/listed_species_me.htm

Maine Department of Inland Fisheries and Wildlife (Maine DIFW). 2005. Maine's Comprehensive Wildlife Conservation Strategy: Appendix 7 Biophysical Regions of Maine. Website accessed July 10, 2012 at: http://www.maine.gov/ifw/wildlife/groups_programs/comprehensive_strategy/table_contents.htm.

Maine Department of Inland Fisheries and Wildlife (MDIF&W). September 2005. Maine's Comprehensive Wildlife Conservation Strategy. Chapter 4. [Online] http://www.maine.gov/ifw/wildlife/groups_programs/comprehensive_strategy/pdfs/chapter4.pdf

Maine Department of Labor (MDOL). Second Quarter 2014. Top 50 Private Employers in Maine. [Online] URL: http://www.maine.gov/labor/cwri/publications/pdf/MaineTop50Employers.pdf.

Maine Department of Marine Resources (Maine DMR). 2014. American Shad Habitat Plan submitted to the Atlantic States Marine Fisheries Commission. Approved February 2014. 24 pp.

Maine DMR. 2015. Trap Count Statistics. [Online] URL: http://www.maine.gov/dmr/searunfish/trapcounts.shtml.

Maine Encyclopedia. 2014. Great Blue Heron. Website accessed November 21, 2014 at: http://maineanencyclopedia.com/great-blue-heron/

Maine Geological Survey (MGS). 2008. Bedrock Geology of the Ellsworth Quadrangle, Maine. [Online] http://www.maine.gov/doc/nrimc/mgs/pubs/online/bedrock/bd-ellsworth.pdf.

Maine Natural Areas Program (MNAP). September 8, 2011. Important Plants, Animals, and Habitats by Town (Ellsworth). Website accessed at: http://www.maine.gov/doc/nrimc/mnap/assistance/sgcn.htm.

Maine State Legislature. Approved May 29, 2015. An Act To Amend Maine's Threatened and Endangered Species List. [Online] URL: http://www.mainelegislature.org/legis/bills/getPDF.asp?paper=SP0281&item=3&snum=127.Mariaville Comprehensive Planning Committee. 2006. Mariaville Maine Comprehensive Plan 2005. [Online] URL: http://www.hcpcme.org/mariaville/mariavillecompplan112305.pdf.

McCormick, S.D., R.A. Cunjack, B. Dempson, M.F. O'Dea and J.B. Carey. 1999. Temperature-related loss of smolt characteristics in Atlantic salmon (*Salmo salar*) in the wild. Canadian Journal of Fisheries and Aquatic Sciences 56:1649-1658.

McCormick, S.D., L.P. Hansen, T.P. Quinn, and R.L. Saunders. 1998. Movement, migration, and smolting of Atlantic salmon (*Salmo salar*). Canadian Journal of Fisheries and Aquatic Sciences 55:77-92. *Cited in* Svendsen 2008 and Kircheis and Liebich 2007.

Meister, A.L. and F. J. Gramlich. 1967. Cormorant predation on tagged Atlantic salmon smolts. Final report of the 1966-67 Cormorant - Salmon Smolt Study. Atlantic Sea Run Salmon Commission, Orono, Maine.

Mesa, M.G. 1994. Effects of multiple acute stressors on the predator avoidance ability and physiology of juvenile chinook salmon. Transactions of the American Fisheries Society 123(5): 786-793. *Cited in* USFWS and NMFS 2009.

Michigan Department of Natural Resources (MDNR). 2014. Little Brown Bat (*Myotis lucifigus*). Website accessed November 17, 2014 at: http://www.michigan.gov/dnr/0,4570,7-153-10370_12145_12205-70016--,00.html

Mohler, R. Maine Department of Environmental Protection. 2015. (personal communication February 12, 2015).

Mote, T. City of Ellsworth. 2015. (personal communication April 21, 2015).

Mudre, J.M. and W.P. Saunders. 1987. Radio telemetric investigation of downstream passage of Atlantic salmon smolts at Bellows Falls station. Prepared for New England Power and Northeast Utilities; 21 pages w/appn.

National Marine Fisheries Service (NMFS). 2012. Dam Impact Assessment Model. Lab Reference Document. Northeast Fisheries Science Center, Woods Hole, MA.

_____. 2009. Endangered and Threatened Species. Designation of critical habitat for Atlantic salmon (Salmo salar) Gulf of Maine Distinct Population Segment. Final rule. Federal Register, Vol. 74, No. 117. June 19, 2009.

_____. 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland 104 pp.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2005. Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (Salmo salar). NMFS, Silver Spring, MD; USFWS, Hadley, MA. 325 pp.

Natural Resources Conservation Service (NRCS). 2015. NRCS Soil Series Data. [Online] http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

New England Fishery Management Council (NEFMC). 1998. Essential Fish Habitat Description Atlantic Salmon (Salmo salar). EFH Amendment. October 7, 1998.

New Hampshire Fish and Game (NHF&G). 2014. Little Brown Bat (*Myotis lucifigus*). Website accessed November 17, 2014 at: http://www.wildlife.state.nh.us/Wildlife/Wildlife_profiles/profile_LB_bat.htm

Nielsen, C., G. Holdensgaard, H.C. Petersen, B.T. Björnsson and S.S. Madsen. 2001. Genetic differences in physiology, growth hormone levels and migratory behaviour of Atlantic salmon smolts. Journal of Fish Biology 59, 28-44. *Cited in* Svendsen 2008.

Northeast Salmon Team. 2011. Managing the Impacts of Cormorant Predation on Smolts. NMFS. [Online] URL: http://www.nefsc.noaa.gov/salmon/Finalcormorantfactsheet.html. Accessed July 2011.

Northrop, Devine & Tarbell, Inc. (NDT). 1990. Study of the Effectiveness of Water Elevation Management Plan. Prepared for Bangor Hydro-Electric Company.

NRCS. 1998. Soil Survey of Hancock County Area, Maine. [Online] http://soildatamart.nrcs.usda.gov/manuscripts/ME611/0/hancock.pdf.

Orlov, A.V., Y.V. Gerasimov, and O.M. Lapshin. 2006. The feeding behavior of cultured and wild Atlantic salmon, *Salmo salar* L., in the Louvenga River, Kola Peninsula, Russia. ICES J. Mar. Sci. 63 (7):1297-1303.

Osgood, M.W. 1979. Abundance patterns of filter-feeding caddisflies (Trichoptera: Hydropsychidae) and seston in a Montana (U.S.A.) lake outlet. Hydrobiologia Vol. 63 (2):177-183.

Parker, C.R. and J.R. Voshell Jr. 1983. Production of filter-feeding Trichoptera in an impounded and a free-flowing river. Can. J. Zool. 61:70-87.

Peake, S.J., McKinley, R.S. and Scruton, D.A. 1997. Swimming performance of various freshwater Newfoundland salmonids relative to habitat selection and fishway design. Journal of Fish Biology 51: 710-723.

Power, J.H. and J.D. McCleave. 1980. Riverine movements of hatchery reared Atlantic salmon (*Salmo salar*) upon return as adults. Environmental Biology of Fishes 5(1):3-13.

Raymond, H.L. 1979. Effects of dams and impoundments on migrations of juvenile chinook salmon and steelhead from the Snake River, 1966 to 1975. Transactions of the American Fisheries Society 108(6):505-529. *Cited in* USFWS and NMFS 2009.

Riley, K. L. P. 2012. Recruitment of Estuarine-Dependent Alosines to Roanoke River and Albemarle sound, North Carolina. Ph.D. Dissertation, Department of Biology, East Carolina University, Greenville, North Carolina.

Ruggles, C.P. 1980. A review of downstream migration of Atlantic salmon. Canadian Technical Report of Fisheries and Aquatic Sciences No. 952. Freshwater and Anadromous Division.

Shepard, S.L. 1989. 1988 Progress Report of Atlantic Salmon Kelt Radio Telemetry Investigations in the Lower Penobscot River. Bangor Hydro-Electric Company. 30 pp.

_____. 1991. A radio telemetry investigation of Atlantic salmon smolt migration in the Penobscot River of Maine. Proceedings of the Atlantic salmon workshop, Rockport, Maine March 6-7, 1991. U.S. Fish and Wildlife Service. Pages 101-118.

_____. 1993. Survival and Timing of Atlantic Salmon Smolts Passing the West Enfield Hydroelectric Project. Bangor-Pacific Hydro Associates. 27 pp.

_____. 1995. Atlantic salmon spawning migrations in the Penobscot River, Maine: fishways, flows and high temperatures. MS Thesis. Univ. Maine. Orono, ME. 111 pp.

_____. 2015. American eel biological species report. U.S. Fish and Wildlife Service, Hadley, Massachusetts. xii +120 pages.

Shrimpton, J.M., B.T. Björnsson, and S.D. McCormick. 2000. Can Atlantic salmon smolt twice? Endocrine and biochemical changes during smolting. Canadian Journal of Fisheries and Aquatic Sciences 57:1969 - 1976. *Cited in* Svendsen 2008.

Sigourney, D.B., and J.D. Zydlewski, E. Hughes, and O. Cox. 2015. Transport, dam passage, and size selection of adult Atlantic salmon in the Penobscot River, Maine. N. Am. J. Fish. Mgmt. 35:1164-1176.

Smith, C. L. 1985. The inland fishes of New York State. The New York State Department of Environmental Conservation, Albany, New York.

Spence, J.A., and H.B.N. Hynes. 1971. Differences in benthos upstream and downstream of an impoundment. J. Fish. Res. Bd. Canada 28: 35-43.

Spencer, R., K. Gallant, and D. Buckley. 2011. 2010 Progress Report. Migratory behavior and spawning activity of adult sea-run Atlantic salmon translocated to novel upriver habitat within the Penobscot Basin, Maine. A Report for the West Enfield Fisheries Fund Committee. April 25, 2011.

_____. 2010. Migratory behavior and spawning activity of adult sea-run Atlantic salmon translocated to novel upriver habitat within the Penobscot Basin, Maine. A Progress Report to the West Enfield Fisheries Fund Committee. March 1, 2010.

Strayer, D.L., and D.R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society, Monograph 8, Bethesda, Maryland.

Taylor, K.M. and H. Vogel. 2003. Summary of New Hampshire Loon Preservation Committee Loon Activities in 2002. Unpublished report, Loon Preservation Committee, Moultonborough, NH.

Tekiela, Stan. Reptiles & Amphibians of Michigan Field Guide. Adventure Publications, Inc. Cambridge, MN. 2004.

_____. 2012. Pre-Application Document (PAD), Ellsworth Hydroelectric Project, FERC No. 2727. Submitted by Black Bear Hydro Partners, LLC. October.

Union River Fisheries Coordinating Committee. 2015. Comprehensive Fisheries Management Plan for the Union River Drainage 2015-2017. February 27, 2015.

Union River Fisheries Coordinating Committee (URFCC). 2015. 2014 Annual Report. Prepared by Black Bear Hydro Partners, LLC on behalf of Union River Fisheries Coordinating Committee. 33pp.

_____. 2010. Comprehensive Fishery Management Plan for the Union River Drainage 2011-2014. 29 pp.

USA Bassin. 2014. National Tournament Trail, Official Division Tournament Results, ME-04 Bangor Region Division. [Online] URL: http://www.usabassin.com. Accessed July 2014.

U.S. Atlantic Salmon Assessment Committee (USASAC). 1992. Annual Report of the U.S. Atlantic Salmon Assessment Committee. Report No. 4 – 1991 Activities.

US Census Bureau. 2015a. American FactFinder for Ellsworth City, Hancock County, Maine. [Online] URL: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml.

US Census Bureau. 2015b. American FactFinder for Hancock County, Maine. [Online] URL: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml.

US Census Bureau. 2015c. American FactFinder for Maine. [Online] URL: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml.

US Census Bureau. 2015d. American FactFinder for Mariaville Town, Hancock County, Maine. [Online] URL: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml.

US Census Bureau. 2015e. American FactFinder for Otis Town, Hancock County, Maine [Online] URL: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml.

US Census Bureau. 2015f. American FactFinder for Waltham Town, Hancock County, Maine [Online] URL: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml.

US Census Bureau. 2015g. QuickFacts for Ellsworth (City), Maine. [Online] URL: http://quickfacts.census.gov/qfd/states/23/2323200.html.

US Census Bureau. 2015h. QuickFacts for Hancock County, Maine. [Online] URL: http://quickfacts.census.gov/qfd/states/23/23009.html.

US Department of Agriculture (USDA). 2005. The Forests of Maine: 2003. Resource Bulletin NE-164. USDA Forest Service. 144 pp.

USFWS. 2015. Maine Field Office Bald Eagle Map Tool. Accessed March 31, 2015 at: http://fws.maps.arcgis.com/explorer/?open=5aa77d8ff7bc419f82a1a26d5712262b

U.S. Fish and Wildlife Service (USFWS). 2015. Northern Long-Eared Bat. Website accessed April 9, 2015 at: http://www.fws.gov/midwest/endangered/mammals/nlba/nlbaFactSheet.html

U.S. Fish and Wildlife Service (USFWS), Department of the Interior. 2015. Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Northern Long-eared Bat with 4(d) Rule

U.S. Fish and Wildlife Service (USFWS). 2011. USFWS Gulf of Maine Coastal Program (GOMP), GIS data: (USFWS MEASHS) Maine Atlantic Salmon Habitat Surveys. Publication_Date: 20110621. Title: ashab3. Geospatial Data Presentation Form: vector digital data. Online [URL]: http://www.maine.gov/megis/catalog/.

_____. 2005. Review of Water Quality Data and Phosphorus Loading Allocation for Graham Lake in Ellsworth, Maine: Final Report. February 2005.

_____. 2001. River herring habitat model. Online URL: http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/river_herring_model.htm. Accessed December 1, 2015

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2009. Endangered and Threatened Species. Determination of endangered status for the Gulf of Maine Distinct Population Segment of Atlantic salmon. Final rule. Federal Register, Vol. 74, No. 117. June 19, 2009.

_____. 2000. Endangered and Threatened Species. Gulf of Maine Distinct Population Segment of Atlantic salmon. Listing as endangered. Final rule. Federal Register, Vol. 65, No. 223. November 17, 2000.

Vanderpool, A.M. 1992. Migratory Patterns and Behavior of Atlantic Salmon Smolts in the Penobscot River, Maine. Thesis. University of Maine, Orono. 61pp.

Wolter and Arlinghaus. 2003. Navigation impacts on freshwater fish assemblages: the ecological relevance of swimming performance. Reviews in Fish Biology & Fisheries 13: 63-89.

Zydlewski, G. B., M. T. Kinnison, P. E. Dionne1, J. Zydlewski and G. S. Wippelhauser. 2011. Shortnose sturgeon use small coastal rivers: the importance of habitat connectivity. J. Appl. Ichthyol. 27 (Suppl. 2) (2011), 41–44 © 2011 Blackwell Verlag, Berlin. ISSN 0175–8659.

APPENDIX E-1

CONSULTATION SUMMARY

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Summary of Consultation Record

From	Date	To	Description
FERC	December 9, 2011	Kirk Francis, Chief Penobscot Indian Nation Bonnie Newsom, THPO Penobscot Indian Nation FERC Mailing List	Invitation to participate in relicensing process
Black Bear Hydro Partners, LLC	October 24, 2012	FERC Distribution List	Notice of Intent (NOI) and Pre-Application Document (PAD) for the Ellsworth Hydroelectric Project
Maine Historic Preservation Commission	November 20, 2012	Black Bear Hydro Partners, LLC K. Bose; USFERC	Correspondence on PAD the Ellsworth Hydroelectric Project
FERC	December 20, 2012		Notice of intent to File license application, filing of pre-application document (PAD), commencement of pre-filing process and scoping, request for comments on the PAD and scoping document, and identification of issues and associated study requests, and Scoping meeting dates and locations
FERC	January 15/16, 2013		Scoping Meetings
Mark Whiting	February 15, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
Maine Department of Marine Resources	February 19, 2013	FERC O. Cox, G. Wippelhauser, and R. Spencer; Maine DMR M. Brown; Maine DIFW K. Howatt; Maine DEP S. Shepard; USFWS S. McDermott and J. Murphy; NOAA	Comments on PAD, Scoping Document 1 and Request for Studies
Maine Department of Inland Fisheries	February 20, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
FERC	February 21, 2013	Black Bear Hydro Partners, LLC	Comments on PAD,

From	Date	To	Description
U.S. Fish and Wildlife Service	February 21, 2013	FERC A. Tittler; DOI/SOL K. Mendik; NPS C. Stringer; BIA R. Abele; EPA B.Towler; RO/EN K. Howatt; Maine DEP G. Wippelhauser and P. Christman; Maine DMR S. Walker and G. Burr; Maine DIFW Reading File	Comments on PAD, Scoping Document 1 and Request for Studies
NOAA	February 21, 2013	FERC S. Hall; Black Bear S. Shepard; USFWS O. Cox, G. Wippelhauser, and R. Spencer; Maine DMR S. Walker and G. Burr; Maine DIFW K. Howatt; Maine DEP	Comments on PAD, Scoping Document 1 and Request for Studies
Douglas H. Watts	February 21, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
Atlantic Salmon Federation	February 21, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
Maine Department of Environmental Protection	February 21, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
Downeast Salmon Federation	February 21, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
Atlantic Salmon Federation	February 21, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
Kenneth S. Cline	February 21, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
FERC	February 21, 2013	Black Bear Hydro Partners, LLC	Comments on PAD,

From	Date	To	Description
Penobscot East Resource Center	February 21, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
Downeast Salmon Federation	February 21, 2013	FERC	Comments on PAD, Scoping Document 1 and Request for Studies
Black Bear Hydro Partners, LLC	February 22, 2013	FERC	Submits the 2012 Annual Report - Union River Fisheries Coordinating Committee for the Ellsworth Hydroelectric Project
Proof of Publication – The Ellsworth American	February 25, 2013	FERC	NOI to file license application document commencement of pre-filing process & scoping; request for comment on the PAD & Scoping document & identification of issues & associated study requests
Black Bear Hydro Partners, LLC	April 08, 2013	FERC Distribution List	Submits its Proposed Study Plan for the Ellsworth Hydroelectric Project
FERC	April 4, 2013	Black Bear Hydro Partners, LLC	FERC issued SD 2
Black Bear Hydro Partners, LLC	April 22, 2013	FERC Distribution List	Submits notice of rescheduling of the Study Plan Meeting for the Ellsworth Hydroelectric Project
FERC	May 8, 2013	N. Palso, M Watts, B. Connelly, and Carolyn X, FERC S. Hall, D. Dominie, P. Browne, K. Maloney, Black Bear K. Hewett and R. Mohlar, Maine DEP J. Murphy and D. Dow, NOAA S. Shepard, USFWS O. Cox, Maine DMR	Study Plan Meeting and site visit
Black Bear Hydro Partners, LLC	May 9, 2013	Kathy Howatt, Rob Mohlar, and Barry Mower, Maine DEP	Discussion of Water Quality Standards and Protocols
Black Bear Hydro Partners, LLC	May 28, 2013	N. Palso, B. Connelly, FERC S. Hall, D. Dominie, P. Browne, K. Maloney, Black Bear J. Murphy, D. Dow, S. McDermott, NOAA S. Shepard, USFWS	Meeting with fisheries agencies to discuss Atlantic salmon issues

From	Date	To	Description
		O. Cox, R. Spencer.Maine DMR	
Maine Department of Environmental Protection	June 06, 2013	FERC	Comments on Proposed Study Plan
Black Bear Hydro Partners, LLC	June 19, 2013	B. Connelly, FERC S. Hall, D. Dominie, P. Browne, K. Maloney, Black Bear J. Murphy, NOAA S. Shepard, USFWS O. Cox, R. Spencer.Maine DMR M Beal, A. Atherton, City of Ellsworth G. Wippelhauser, Maine DMR Greg Burr, Maine DIFW Richard Welch Richard Dill	Meeting with fisheries agencies to discuss river herring issues
NOAA	June 28, 2013	FERC	Comments on Proposed Study Plan
Maine Department of Marine Resources	July 01, 2013	FERC O. Cox, G. Wippelhauser, and R. Spencer; Maine DMR K. Howatt; Maine DEP S. McDermott and J. Murphy; NOAA	Comments on Proposed Study Plan
FERC	July 08, 2013	Black Bear Hydro Partners, LLC	Comments on Proposed Study Plan
U.S. Fish and Wildlife Service	July 08, 2013	FERC A. Tittler; DOI/SOL K. Mendik; NPS C. Stringer; BIA R. Abele; EPA B.Towler; RO/EN K. Howatt; Maine DEP G. Wippelhauser and P. Christman; Maine DMR	Comments on Proposed Study Plan

From	Date	To	Description
		S. Walker and G. Burr; Maine DIFW Reading File	
Black Bear Hydro Partners, LLC	August 05, 2013	FERC Distribution List	Submits its Revised Study Plan for the Ellsworth Hydroelectric Project
Maine Department of Marine Resources	August 19, 2013	FERC O. Cox, G. Wippelhauser, and R. Spencer; Maine DMR J. Perry; Maine DIFW K. Howatt; Maine DEP S. Shepard; USFWS S. McDermott and J. Murphy; NOAA	Comments on Revised Study Plan
National Marine Fisheries Service	August 19, 2013	FERC S. Hall; BLACK BEAR S. Shepard; USFWS O. Cox, G. Wippelhauser, and R. Spencer; Maine DMR J. Perry and G. Burr; Maine DIFW K. Howatt; Maine DEP Service List	Comments on Revised Study Plan
U.S. Fish and Wildlife Service	August 19, 2013	FERC A. Tittler; DOI/SOL K. Mendik; NPS R. Abele; EPA B.Towler; RO/EN K. Howatt; Maine DEP G. Wippelhauser and O. Cox; Maine DMR J. Perry and G. Burr; Maine DIFW Reading File	Comments on Revised Study Plan
Maine Department of Environmental Protection	August 20, 2013	FERC	Comments on Revised Study Plan

From	Date	To	Description
National Marine Fisheries Service	August 16, 2013	FERC S. Hall; Black Bear S. Shepard; USFWS O. Cox, G. Wippelhauser, and R. Spencer; Maine DMR J. Perry and G. Burr; Maine DIFW K. Howatt; Maine DEP Service List	Comments on Revised Study Plan
Black Bear Hydro Partners, LLC	August 23, 2013	FERC Distribution List	Response to comments on Revised Study Plan
FERC	September 4, 2013	Scott Hall, Black Bear FERC Mailing List	FERC issued Study Plan Determination
Black Bear Hydro Partners, LLC	September 27, 2013	FERC D. Dominie; TRC	Response to Additional Information Request Study Plan Determination
National Marine Fisheries Service	September 30, 2013	FERC S. Shepard; USFWS O. Cox, G. Wippelhauser; Maine DMR J. Perry; Maine DIFW L. Chiarella and S. McDermott; HCD J. Murphy and K. Damon-Randall; PRD K. Howatt; Maine DEP Service List	Comments on Study Plan Determination
FERC	November, 8, 2013	Peter Browne and Mary McCann, Black Bear	Discussion re revision of Upstream Fish Passage Study Plan
FERC	January 29, 2014	Peter Browne, Black Bear	Discussion re revision of Upstream Fish Passage Study Plan
Black Bear Hydro Partners, LLC	February 03, 2014	FERC Distribution List	Submits the modified Upstream Fish Passage Study Plan
Black Bear Hydro Partners, LLC	February 10, 2014	FERC Distribution List	Submits its first study progress report

From	Date	To	Description
Black Bear Hydro Partners, LLC	April 03, 2014	FERC	2013 Annual Report - Union River Fisheries Coordination Committee, March 2014 Pursuant to Comprehensive Fishery Management Plan
Black Bear Hydro Partners, LLC	May 1, 2014	Barry Mower, Maine DEP	Flow data provided per Maine DEP request
Black Bear Hydro Partners, LLC	May 8, 2014	Kirk Mohney, Maine Historic Preservation Commission	Submitted Historic Architecture Survey
National Marine Fisheries Service	September 03, 2014	Black Bear Hydro Partners, LLC N. Palso; FERC R. Spencer; Maine DMR L. Zicari; USFWS J. Murphy and K. Damon-Randall; PRD	Follow up letter on unlawful take of endangered Atlantic salmon
Black Bear Hydro Partners, LLC	September 04, 2014	FERC Distribution List	Submits the Initial Study Report
National Marine Fisheries Service	September 18, 2014	Black Bear Hydro Partners, LLC K. Bose; FERC O. Cox and R. Spencer; Maine DMR S. Shepard; USFWS J. Perry; Maine DIFW K. Howatt; Maine DEP	Comments regarding the proposed 2014 Comprehensive Fisheries Management Plan
Black Bear Hydro Partners, LLC	October 02, 2014	FERC Distribution List	Initial Study Report Meeting Summary
Douglas H. Watts	October 02, 2014	FERC	Comments on Initial Study Report
Douglas H. Watts	October 03, 2014	FERC	Comments on Initial Study Report
Union Salmon Association	October 08, 2014	FERC	Comments on Initial Study meeting
Douglas H. Watts	October 10, 2014	FERC	Comments on Report
FERC	October 31, 2014	Black Bear Hydro Partners, LLC	Comments on ISR Meeting Summary
NOAA Fisheries Service	November 03, 2014	FERC and Black Bear Hydro Partners Service List	Comments on Request for Study Clarification and Modification

From	Date	To	Description
Maine Department of Environmental Protection	November 03, 2014	FERC S. Hall; Black Bear P. Browne; HDR Inc. D. Dominie; TRC Solutions O. Cox; Maine DMR J. Perry; Maine DIFW A. Bentivoglio; NOAA T. Burrowes; MDACF	Comments on Initial Study Report
Maine Department of Marine Resources	November 03, 2014	FERC O. Cox and G. Wippelhauser; Maine DMR J. Perry; Maine DIFW K. Howatt; Maine DEP L. Zicari, A. Bentivoglio; USFWS S. McDermott, J. Murphy; NOAA	Comments on Initial Study Report
Black Bear Hydro Partners, LLC	December 02, 2014	FERC	Submits the Response to Comments on Initial Study Report and Requests for Modified Study Plan
Black Bear Hydro Partners, LLC	December 15, 2014	B. Connelly, FERC	Provided requested information re Upstream and Downstream Fish Passage Studies
FERC	December 30, 2014	Scott Hall, Black Bear FERC Mailing List	Determination on Requests for Study Modifications and New Studies
Black Bear Hydro Partners, LLC	February 24, 2015	B. Connelly and N. Palo, FERC D. Dominie, F. Dunlap, and M. McCann, Black Bear	Telephone discussion of recommended downstream salmon passage study and possible extension of study schedule
Black Bear Hydro Partners, LLC	February 27, 2014	J. Murphy and S. McDermott NMFS S. Shepard, A. Bentivoglio, A. Firmenich, USFWS R. Spencer, C Enterline, and G. Wippelhauser, Maine DMR J. Perry, G. Burr, Maine DIFW B. Witham and G. Leinbaugh Union River Salmon Association A. Kane, Atlantic Salmon Federation	Article 406 Compliance – provided 2014 Annual Report – Union River Fisheries Coordinating Committee; Comprehensive Fishery Management Plan for the Union River Drainage

From	Date	To	Description
		M. Beal and A. Atherton, City of Ellsworth Ken Cline, College of the Atlantic	
Douglas H Watts	March 04, 2015	FERC	Comments and appendices on 2015-2017 URFCC Fisheries Plan
Black Bear Hydro Partners, LLC	March 30, 2015	FERC Distribution List R. Dewechter and J. Clere; Black Bear	Supplemental Information regarding changes in filing schedule for draft license application
Black Bear Hydro Partners, LLC	March 31, 2015	FERC J. Murphy; NMFS S. Shepard; USFWS R. Spencer; Maine DMR Ellsworth Project Relicensing Distribution List R. Dewechter and J. Clere; Black Bear	Submittal of Downstream Smolt Study Plan
Black Bear Hydro Partners, LLC	March 31, 2015	FERC J. Murphy, S. McDermott; NMFS S. Shepard, A. Bentivoglio; USFWS O. Cox, R. Spender; Maine DMR K. Howatt; Maine DEP J. Clere, R. Richter, A. Zarella, T. Wynn, R. Dewechter, J. Cole, J. Stayn, R. Brochu, N. Stevens, F. Dunlap; Black Bear	Supplemental Information regarding fish passage
Black Bear Hydro Partners, LLC	April 01, 2015	FERC	Form 80 Report for Ellsworth Dam & Lake Leonard
Black Bear Hydro Partners, LLC	April 01, 2015	FERC	2014 Form 80 Report for the Graham Dam & Lake
Black Bear Hydro Partners, LLC	April 03, 2015	FERC	Filing of Methodology 2015 FERC Form 80 Recreation Report Monitoring

From	Date	To	Description
FERC	April 21, 2015	K. Bernier, Black Bear	Approval of Atlantic Salmon Downstream Passage Study Plan
Maine DIFW	May 4, 2015	F. Dunlap, Black Bear	Approval of 2015 Marsh-nesting Bird Survey Scope
Maine DEP	June 16, 2015	K. Howatt, B. Mower, L. Tsomides, R. Mohler, M. Bergeron, A. McLauflin, D. Witherill Maine DEP F. Dunlap, D. Dominie, P. Leeper Black Bear	Discussion of Class B and GPA water quality classification, and macroinvertebrate sampling
Black Bear Hydro Partners, LLC	July 10, 2015	FERC Distribution List	Filed Draft License Application
Black Bear Hydro Partners, LLC	July 10, 2015	G. Cross, FERC	Letter requesting review of attached draft Supporting Design Report
Black Bear Hydro Partners, LLC	August 21, 2015	FERC Distribution List	Filed Updated Study Report
F. Moore Passamaquoddy	August 25, 2015	FERC	General comments
Black Bear Hydro Partners, LLC	August 25, 2015	USFWS, NMFS, MDMR	Meeting with fisheries agencies to discuss BA
Black Bear Hydro Partners, LLC	September 3, 2015	N. Palso, B. Connelly, Amy Chang (phone), Mike Watts (phone) – FERC O. Cox, R. Spencer – Maine DMR S. Shepard – USFWS J. Murphy, D. Dow, J. Higgins, S. McDermott (phone) – NOAA A. Kane – ASF M. Lambdin, G. Leinbaugh, D. Shaw, K. Winslow, D. Watts – DSF J. Newman – City of Ellsworth K. Cline – Sierra Club C. Petersen – COA A. Ajmani – Passamaquoddy F. Dorsey – Frenchman Bay Conservancy	Updated Study Report Meeting in Ellsworth

From	Date	To	Description
		S. Perrin – Friends of Taunton Bay C Kelly – URSA Perry, T. Stephenson, P. Laplant, T. Carlisle, T. Folsem, P. Ober, A. Clark, T. Little-Siebold, J. Minutolo, A. Atherton, J. Fortier residents F. Dunlap, K. Maloney, K. Bernier – Black Bear D. Dominie, M. Blair – TRC P. Browne, J. Gagnon, S. Arnold - HDR	
Black Bear Hydro Partners, LLC	September 9, 2015	FERC Distribution List	Updated Study Report Meeting Summary
FERC	October 8, 2015	FERC	Comments on Updated Study Report and DLA
K. Howatt, Maine DEP	October 7, 2015	FERC F. Dunlap – Black Bear	Comments on DLA
P. Keliher, Maine DMR	October 5, 2015	FERC O. Cox, G. Wippelhauser, Maine DMR J. Perry; Maine DIFW K. Howatt; Maine DEP S. McDermott, J. Murphy, D. Dow - NOAA	Comments on Updated Study Report and DLA
L. Chiarella NOAA	October 7, 2015	FERC service list	Comments on Updated Study Report and DLA
D. Cole, City of Ellsworth	October 5, 2015	FERC	General comments
Black Bear Hydro Partners, LLC	November 9, 2014	FERC	Response to Comments on Updated Study Report and Requests for Modified Study Plan
FERC	December 8, 2015	Frank Dunlap, Black Bear FERC Mailing List	Determination on Requested Study Modifications

From	Date	To	Description
Black Bear Hydro Partners, LLC	December 11, 2015	A. Spiess, MHPC	Phase II archaeology report for review
Maine SHPO	December 22, 2015	Frank Dunlap, Black Bear	Comments on Phase II archaeology report concurring with eligibility recommendations

APPENDIX E-2

CONSULTATION DOCUMENTATION

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ELLSWORTH HYDROELECTRIC PROJECT (FERC NO. 2727)

AGENCY COMMENTS ON DRAFT LICENSE APPLICATION

Black Bear Hydro Partners LLC (Black Bear) responds herein and in the Final License Application to the comments on the Draft License Application provided by the Stakeholders and the Federal Energy Regulatory Commission (FERC).

Commenter	Reference/comment #	Comment	Response
1. Maine DEP	Impoundment Trophic Status	Black Bear has provided sufficient data; additional data analysis may be needed to assess overall WQ.	Comment noted.
2. Maine DEP	Impoundment Aquatic Habitat Study	Based on information provided, aquatic life and habitat criteria of Maine's WQ standards are not met in Graham Lake under current operation conditions. It is unclear whether the methods used accurately calculate this criteria; more discussion and information is needed. At this time the information provided fails to clearly demonstrate that Class GPA WQ standards for aquatic life and habitat are met under current and proposed water level conditions for Graham Lake.	Black Bear will consult with Maine DEP to clarify the methods of the Impoundment Aquatic Habitat Study. Black Bear notes the comments regarding Class GPA water quality standards.
3. Maine DEP	Benthic Macroinvertebrates	Macroinvertebrate community structure and function show evidence of impairment; professional judgment raised the classification to Class C; the project did not meet the Class B WQ standard. The information provided fails to demonstrate the benthic macroinvertebrates in the outlet stream meets Class B aquatic life standards	Black Bear notes Maine DEP's comments regarding Class B water quality standards. Results of the 2015 benthic macroinvertebrate study are included in Exhibit E, Section 4.4.2.1.

Commenter	Reference/comment #	Comment	Response
		under current proposed minimum flow conditions. Additional macroinvertebrate data was collected in 2015 and is expected to be submitted for analysis. It is expected that these data will be presented in the FLA. The Department is unable to evaluate the project's attainment of WQ standards for this parameter at this time.	
4. Maine DEP	Dissolved Oxygen Monitoring	…measurements were collected every hour from Mid-July to mid-September using a Hobo water quality sonde.	Maine DEP misstated that DO measurements were obtained using a sonde.
5. Maine DEP	Outlet Stream Aquatic Habitat Study	The wetted width was measured at a flow of 150 cfs, however minimum flow at Graham Lake dam is 105 cfs, nearly 1/3 less than the flow that was measured. Based on the information provided the Department concludes that the information provided by Black Bear is unclear and therefore, at this time we are unable to determine the project meets Class A aquatic life and habitat standards.	As noted in the USR, the additional transect data collected further downstream as part of the Instream Flow and Tributary Access Study also indicated wetted width, and, coupled with the depth at the flow release at Graham Lake Dam of 150 cfs, provided adequate wetted zone of passage and habitat for aquatic organisms in the Union River, as discussed in detail for river herring and Atlantic salmon in the Habitat Suitability section of the Instream Flow and Tributary Access Study. For these seven transects, the wetted width was extrapolated for the target flow of 105 cfs and is presented in Table 3-4 (of the USR). This data demonstrates the wetted width under the target minimum flow was near or exceeded ¾ of the bankfull width. Maine DEP states that it is the Class A aquatic life and habitat standard that is to be met. Black Bear understands that the standard to be met is Class B as per the Maine Statute 38 M.R.S.A. §467.

Commenter	Reference/comment #	Comment	Response
6. Maine DEP	Other comments	The FLA should include final reports and data summaries for all studies. The department will be looking for the benthic macroinvertebrate studies conducted in 2015 as well as a more fully developed discussion of the impoundment aquatic habitat study and the outlet stream aquatic habitat study. The study discussions should present the findings in enough detail to allow Department staff to analyze the project's compliance with ME WQ standards. Black Bear must demonstrate compliance with all designated uses for the Department to issue a WQC; the WQ studies provide methods to address numeric and some narrative standards, but not all.	Studies completed as part of the licensing process are presented the Initial Study Report (September 4, 2014) and the Updated Study Report (August 21, 2015). Results of the 2015 benthic macroinvertebrate study are included in the FLA. Black Bear notes Maine DEP's comments regarding water quality certification.
7. Maine DMR	1. DLA, Proposed environmental measures	FLA should address USR and pending downstream studies and potential needs for improving downstream passage effectiveness.	Exhibit E Section 4.4.3.2 has been revised to discuss.
8. Maine DMR	2. DLA, Atlantic salmon	The project does not provide upstream passage for salmon because there are no upstream fish passage facilities. Instream flow study results would help determine if present instream flows ensure suitable habitat.	The trap and transport facility is a method of upstream passage, whose original construction specifically targeted Atlantic salmon. Trap and transport systems have been used successfully to pass other species such as shad restoration on the Susquehanna River and Penobscot River. (Sigourney, 2015) An instream flow habitat study was completed and the results were provided in the USR and discussed in the FLA.

Commenter	Reference/comment #	Comment	Response
9. Maine DMR	3. DLA, Eels	Description of Maine's fisheries for eel is outdated. Refer to benchmark stock assessment conducted by ASMFC (2013) and 2 addenda.	Exhibit E Section 4.4.3.1 of the FLA has been updated to address this comment.
10. Maine DMR	4. DLA, Shad	Focus of shad fish management is on measures that are implemented for other diadromous species including fish passage.	Agreed and stated as such in the FLA.
11. Maine DMR	5. DLA, Shad	Given 30 year new license term, potential for shad passage should be considered.	The upstream fish passage alternatives study report has been revised to more fully evaluate the potential for shad passage. The final report is appended to the FLA.
12. Maine DMR	6. DLA, Shad	DLA should mention that text in DLA should be changed to note that the fish passage facility is designed to also trap shad. DMR notes that they expect that shad broodstock from the Penobscot River to the Union River will occur during the term of the new license.	The fish passage facility was not originally designed for shad passage. Additional information on shad management goals and available habitat has been added to Exhibit E Section 4.4.3.1.
13. Maine DMR	7. DLA, fish passage	All fish must be handled at the project, even when water temperatures exceed 77°F.	Given the relatively close location of the Ellsworth Project to the estuary/marine environment (compared to the Penobscot, Kennebec or Androscoggin River Projects), Black Bear would not expect salmon to be present in the lower Union River during periods when water temperatures exceed 73 degrees. While we expect a very low probability of salmon captures when water temperature exceeds 73 degrees, we will include a discussion of this concern in the final study report to be appended to the FLA.
14. Maine DMR	8. DLA, trashrack spacing and intake velocity	Trashrack spacing is too wide and intake velocities are too high.	Black Bear measured water velocity in front of the trash racks in October 2015 and has reported the data in the FLA.

Commenter	Reference/comment #	Comment	Response
15. Maine DMR	9. DLA, smolt and eel passage studies	FLA will not be ready for environmental analysis until the smolt and eel passage studies are complete.	Black Bear acknowledges this statement. The FLA will describe the best available information. Subsequent study reports will be filed with FERC as they are completed.
16. NMFS	1. General Comments	The license orders issued by the Federal Energy Regulatory Commission (FERC) of 1975 and 1987 require installation of stream gages to monitor project related flows. The gages were to be installed in collaboration with state and federal resource agencies, and maintenance and operations fees advanced to the U.S. Geological Survey (USGS). As noted in the DLA (Page 5-11), no USGS stream gage data are available for the Union River. Licensee should clarify in the Final License Application (FLA) why stream flow gages were not installed as required by the license articles.	FERC approved the Stream Gaging Plan for the Project, required by Article 405 of the 1987 license order, on July 13, 1989. USGS maintains a gage on the West Branch of the Union River, approximately 5.5 miles upstream from the outlet to Graham Lake. Black Bear maintains sufficient stage and flow monitoring devices at the project and is in conformance with the required Minimum Flow Monitoring Plan (required by Condition 2B of the Project water quality certification).
17. NMFS	2. General Comments	It is unclear from the DLA who owns the fish trap facility and who is responsible for operating and maintaining the structure. Ownership and control of the trap facility is of critical importance to the site because fish are present at the site and fish passage is necessary to mitigate negative project related impacts. Currently, the existing trap is the only available dedicated means to capture fish for stocking above the Project. In the DLA, the Licensee claims the existing trap satisfies their fish passage responsibilities. However, previous licensing documents indicate the existing fish trap is owned by the Maine Department of Marine Resources. The resource agencies need certainty of	It is our understanding that the existing fish trap is owned by the Maine Department of Inland Fisheries and Wildlife and/or Atlantic Salmon Commission. However, the trap and truck facility is contained within the project boundary and is integral to the FERC approved Union River Comprehensive Fishery Management Plan. The Licensee's roles and responsibilities for the trap and truck facility are clearly laid out in the Plan and codified in the September 27, 2002 FERC Order Amending License Article 406 requiring compliance with the FERC approved Plan.

Commenter	Reference/comment #	Comment	Response
		requirements to maintain and support restoration efforts. We rely on the FERC issued license to ensure such requirements are enforceable license articles. If the Licensee does not own the fish trap facility, or if the fish trap is not considered part of the Project, then it must be clarified how operation of the trap will be required under the FERC license. The DLA needs to clarify whether the trap is part of the Project and the licensee's role, responsibility and ability to control operations of the trap.	
18. NMFS	3. General Comments	Units for average annual generation should be corrected. The DLA indicates 30,333,000 megawatt hours (MWh). This should be corrected to kilowatt hours (kWH).	This has been corrected in the FLA.
19. NMFS	4. General Comments	The DLA refers to the fishway as a fish lift. The structure is a trap. The fish are attracted to an entrance, led to the hopper and trapped for transport or harvest. The final license application should reflect this distinction.	The fishway has been referred to as a trap in the FLA.
20. NMFS	1. Exhibit B Section 1 1.1, Existing Operation Mode, Normal Operations	(Page B-1): The DLA identifies the Project as two developments, the Ellsworth Dam, which is described as run of river, and the Graham Dam which provides timed releases for generation at the Ellsworth Dam resulting in a "peaking" operation. The two dams operate under a single license. As such, the Ellsworth Project operates as a peaking facility with the associated environmental impacts below each dam and should be evaluated as such in the environmental analysis required under the National Environmental Policy Act.	As per FERC terminology the Ellsworth Project consists of two developments: Graham Lake Dam and Ellsworth Dam. The Project collectively is a peaking project utilizing stored water from Graham Lake for power production at Ellsworth Dam. Run-of-river operation refers to water levels at Lake Leonard (Ellsworth Dam) which are kept within a one foot fluctuation and are not fluctuated for power production (i.e. inflows to Lake Leonard are passed through equally at Ellsworth Dam). Nevertheless, operation terminology will be clarified in the FLA.

Commenter	Reference/comment #	Comment	Response
21. NMFS	2. Exhibit B Section 1.1.2, Existing Operation Mode, Adverse and High Water Condition Operation, low Flow	(Page B-2): This section states that drawdown of Graham Lake provides important flow augmentation during dry inflow periods benefiting water quality and habitat. The capacity to provide a consistent minimum flow may have value; however, there may be potential passage impediments in select sections at the current minimum standard. As described in the August 21, 2015, Updated Study Report (USR), portions of the upper and middle reach of the Union River below Graham Dam may be shallow with low flow velocities. The assessment was conducted at 150 cfs, significantly (-40%) greater that the existing minimum of 105 cfs. This hampers our ability to properly evaluate the existing conditions. Table 3-11 (USR, Page 3-63) provides extrapolated habitat conditions at 105 cfs, but the Licensee does not present the methods used to extrapolate the flow in the DLA. Those data only include a potential maximum depth. The potential minimum depth and flow velocity conditions could result in stranding or migration impediments. Extrapolation of the flow data to describe habitat conditions in the FLA should include minimum depths as well as information on how the extrapolation was conducted.	The maximum depths presented in the USR Table 3-11 providing the extrapolated values were appropriate to evaluate whether there was sufficient water depth to allow a zone of passage. Minimum depths would be near zero for every flow and transect when considering shoreline edge and thus would not be useful in evaluating habitat. However, the extrapolated 105 cfs water surface line will be added to the transect figures that show the four observed flows water surface lines. Average velocities were also provided. The extrapolated low flow data are presented similarly as has been done for other relicensing studies in Maine. Formulas for extrapolation have been added an appendix to the FLA.
22. NMFS	3. Exhibit B Section 2.2, FIow Data	(Page B-5): The method of calculating flows needs to be better described in the FLA. For instance, we are unable to determine if the calculation was based upon average daily generation or based upon unit output at certain time intervals. There is no indication	Further explanation of how the flow duration curves were developed is provided in Exhibit B Section 2.2.

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		of how spill may have been incorporated. It is unclear whether the flow calculation included the period of time when available flow was less than the minimum turndown flow for the units. In addition, it is not clear from the DLA whether the average head was assumed or determined by detailed PLC programmable logic controller) data; how unit efficiencies were determined; or why a regression curve was used when data was directly calculated from the plant. Without knowing how the flow was calculated, we are unable to evaluate the merits of the method.	
23. NMFS	4. Exhibit B Section 2.2, Flow Data, Table B-4	(Page B-6): The table for "Monthly Average River Flow 1994-2014 for Ellsworth Dam" includes periods of no flow (0 cfs). This suggests a problem with the flow calculation. See the previous comment. The flow calculation method needs greater detail in its description.	See response to Comment #22. Missing data that was mis-interpreted as "zero" and has been removed from the table.
24. NMFS	5. Exhibit B	The FLA should include a table indicating the monthly minimum, average, and maximum elevation of the Graham Lake impoundment.	The historic operating curves included in the DLA and FLA show the minimum, maximum and average daily Graham Lake elevations for the 1999 through 2014 period of record.
25. NMFS	Draft Exhibit C Section 3.0, Construction Schedule for New	Development (Page C-3): The FLA should propose to install a USGS-type steam flow gage downstream of both the Graham Lake and Ellsworth Project to demonstrate compliance with project license articles.	See response to Comment #16. Further, Ellsworth Dam is tidally influenced to the base of the dam and a USGS gage would be inconclusive and inappropriate in this location. The Operations Monitoring Plan includes the methodology that will be used to demonstrate compliance with both minimum flow and pond level requirements.

Commenter	Reference/comment #	Comment	Response
26. NMFS	1. Exhibit E Section 3.1.3, Existing Project operations Draft Exhibit E	(Page E-3-4): Figure E-2: Graham Lake Reservoir Operating Curves only contains data from 1999-present. Please present all headpond elevation data for Graham Lake Reservoir.	Black Bear believes the last 15 years of data is sufficient and representative period of record.
27. NMFS	2. Exhibit E Section 3.3.3, Proposed Action, Proposed Environmental Measures	(Page E-3-6): Several Protection, Mitigation and Enhancement (PME) measures are proposed, including upstream passage for American eel. No consideration is given to the need for upstream passage for Atlantic salmon or improving downstream passage for all diadromous fish. The FLA should address the findings of the updated study report filed on August 22nd and acknowledge the pending downstream studies and note the potential need for improving downstream passage protection.	The FLA addresses the findings of the USR and acknowledges that other fish passage studies are ongoing.
28. NMFS	3. Exhibit E Section 4.4.2, Water Resources, Affected Environment, Existing Water Quality	(Pages E-4-24 and 25): The FLA should present the results of all water quality sampling for 2013 in Graham Lake and Leonard Lake.	The 2013 water quality sampling results are presented in the ISR.
29. NMFS	4. Exhibit E Section 4.4.2, Water Resources, Affected Environment, Existing Water Quality	(Page E-4- 26): The Licensee states "The community structure and function found in the tailwater section of the Graham Lake Dam on the Union River shows evidence of organic enrichment and filter-feeder dominance which is a common phenomenon below lake outlets and impoundments (Hynes 1970, Spence and Hynes 1970, Parker and Voshell 1983)." Project operations, including ramping, likely affects the macroinvertebrate community structure and function below Ellsworth Dam.	The effect of project operations on the macroinvertebrate community is addressed in the FLA.

Commenter	Reference/comment #	Comment	Response
		Macroinvertebrates are a food source for juvenile fish such as Atlantic salmon parr and juvenile alosines. This impact should be considered in the FLA.	
30. NMFS	5. Exhibit E Section 4.4.2, Water Resources, Affected Environment, Impoundment Tributary Connectivity	(Page E-4-27): The Licensee did not conduct the impoundment tributary connectivity study at the lowest impoundment levels. The Graham Lake tributary study was conducted at El. 97.9’, more than four feet above the lowest allowable elevation (El. 93.4' msl). Similarly, the Lake Leonard tributary study was conducted between El. 65.7' and 66.7' msl although the impoundment can be drawn down to El. 65.7. No explanation is given for the deviation from the FERC approved study plan. The Project operating curves (Figure E-2; Page E-3-4) indicates 98' msl as the lowest level Graham Lake is currently managed. The tributary connectivity study does not represent the full history of operation at the Project. The study results do not document the full scope of potential effects to tributary connectivity at the Project if the Project continues to be operated at the current lowest allowable elevations of Lake Leonard and Graham Lake. The study should be completed per the study plan determination.	The target normal fall drawdown for Graham Lake is elevation 97.8 and occurs in mid-October (Attachment 1). The Graham Lake elevation during the study was 98.0’ only 0.2 feet above the normal target elevation and 1.1 foot below the 1999-2014 long term average of 98.9’. The lowest licensed elevation of 93.4’ is targeted for the end of March, when Graham Lake is under full ice cover and Atlantic salmon and river herring are not migrating. As such, conducting the study at this time of year to capture the maximum licensed drawdown is impractical and without purpose and is not consistent with the “maximum normal fall drawdown” elevation. Furthermore, as noted in the USR many of the Graham Lake tributaries flow across very flat land as they enter the lake and barriers to connectivity were not found to exist. None-the-less, to address stakeholder comments on the USR, and in accord with FERC’s December 8, 2015 Determination on Requested Study Modifications, Black Bear will provide gradient profiles for the Graham Lake and Lake Leonard tributaries as indicated in the Study Plan Determination and will collect zone of passage information from tributaries selected in consultation with the fisheries agencies. Black Bear will collect this information and file it with FERC by December 31, 2016 as additional information to the FLA.

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31. NMFS	6. Exhibit E Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Atlantic Salmon	(Page E-4-40): The DLA indicates "The Project protects EFH for Atlantic salmon by providing upstream and downstream fish passage and migratory pathways to habitat, and ensuring suitable habitat downstream of each development through minimum flows." The Project does not provide upstream passage for Atlantic salmon as there are no upstream fish passage facilities at either dam. Fish are trapped and moved around the Project via a truck which requires fish be removed from the Union River. The Union River between Ellsworth Dam and Graham Dam is completely blocked to migratory fish species including Atlantic salmon. The FLA should reflect this. Further, it remains uncertain whether the present instream flow requirements ensure suitable habitat below Graham Dam. Results of the required instream flow study would help determine the extent of that benefit, if a benefit is observed at all.	See response to Comment # 8. Further, alewife and blueback herring, to the extent they occur within the alosid spring migration, are transported into Lake Leonard where Union River habitat between Ellsworth Dam and Graham Dam is available. If determined appropriate by the URFCC, additional species including salmon could be transported to the Lake Leonard reach as well. An instream flow habitat study was completed and the results were provided in the USR and discussed in the FLA.
32. NMFS	7. Exhibit E Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Atlantic Sturgeon and Shortnose Sturgeon	(Page E-4-41): The FLA should present the "limited bathymetry data for the original river channel" mentioned in this section.	The available bathymetry information was provided in the DLA (pages E-4-20 and 21) and is provided in Exhibit E of the FLA.
33. NMFS	8. Exhibit E Section 4.4.3.1, Fish and Aquatic Resources, Affected	(Page E-4-43): The FLA should include a citation to support its claim that a lack of American shad broodstock prevents restoration of shad to the Union River. The claim is contrary to the fact that a significant	The DLA statement "Due to the lack of an available source of brood stock, there currently are no plans for active restoration of shad to the Union River." was taken from the *Comprehensive Fisheries Management Plan for the Union River Drainage –*

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	Environment, Other Diadromous Fish	run of American shad that has been restored to the Penobscot River in Maine without the use of broodstock. The run of American shad in the Penobscot River is a direct response to improved passage conditions in the lower river. Unless the Licensee's claim can be substantiated, it is simple supposition and cannot be used to support a license order.	*2015-2017* as referenced in the next DLA sentence "The Maine DMR plans to focus its shad restoration efforts on rivers other than the Union River from 2015 to 2017 as identified in the CFMP (URFCC 2015)."
34. NMFS	9. Exhibit E Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Diadromous Fish, American eel	(Page E-4-43): The conclusion of this section is that some American eel enter the project under current operating conditions. Although some eel might enter the project through cracks and leaks in the structure, we do not believe that such conditions constitute safe, timely or effective upstream passage for eel. Therefore, we are supportive of BBHP's proposal to install a dedicated upstream eelway as a PME (see Section 3.3.3, Proposed Action, Proposed Environmental Measures on page E-3-6). Based on data in the DLA, the juvenile eel harvest in the Union River is an important fishery. The upstream eelway will support that harvest. Results of the downstream passage study will inform the need for downstream passage protective measures.	Comment noted. Black Bear maintains the proposal to install upstream eel passage. The potential need and alternatives for downstream protective measures will be considered pending analysis of 2015 downstream eel studies.
35. NMFS	10. Exhibit E Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Diadromous Fish, Other Diadromous Fish	(Page E-4-44): The DLA indicates there are no current plans for American shad restoration in the Union River. This is correct. However, the new license will likely cover a 30 year period. Restoration priorities may change in the future. The potential for American shad passage should be considered.	The upstream fish passage alternatives study report has been revised to more fully evaluate the potential for shad passage. The final report is appended to the FLA.

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36. NMFS	11. Exhibit E Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Fish passage	(Page E- 4-44): The Licensee should clarify the origins of the fish trap at the Ellsworth Project. Specifically, the FLA should state who originally constructed the fish trap, and who is responsible for operation and maintenance of the facility.	See response to Comment #17. This discussion has been added to the FLA.
37. NMFS	12. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis	(Page E-4-50): The Project operates in a peaking mode. The DLA does not address the potential for ramping impacts on aquatic species or habitat. The FLA should include an analysis describing the extent of existing flow fluctuations in terms of rate of stage change (ramp rate) and frequency in the riverine reach below the Ellsworth Project. This analysis should describe the physical extent of streambed habitat affected by peaking operations at Ellsworth. The analysis should also describe the potential for down-ramping to strand fish. The FLA should present hourly generation data at the project over the last 10 years to support this analysis.	As noted in the Upstream Fish Passage Study report, contained in the 9/4/14 ISR: "The one consistent observation made throughout this year's study and supplemented with historical observations, was that fish (river herring) occurrence and densities were higher in the afternoon hours, regardless of other conditions. A review of project operations/ river flow data did not suggest the fish migration or fishway numbers responded to changes in flow." These observations were supported by the observations during the 2015 Upstream Atlantic Salmon Passage Study where alewife movement was more directly related to afternoon and evening hours and incoming tides, and not to project discharge. Generation flows are recorded during the river herring trap and truck operations, and no effects to river herring presence and abundance occur as a function of turbine discharge. Because river herring can access the river below Ellsworth Dam, it is expected that turbine discharge would not affect other diadromous fish from accessing Ellsworth Dam. Based on visual observations of aquatic habitat downstream of the Project, which is affected by tidal flows, the riverbed remains watered under

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			minimum flow conditions. There were no areas of potential stranding evident.
38. NMFS	13. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Water level Fluctuations	(Page E-4-52): The Licensee states "Observations in Graham Lake indicated tributaries maintain connectivity through at least early fall seasonal drawdown (Black Bear 2014)." The FLA should include a description of tributary connectivity during mid to late fall for Atlantic salmon.	Exhibit E Section 4.4.3.2 of the FLA has been revised to address this comment.
39. NMFS	14. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Water level Fluctuations	(Page E-4-52): The Licensee states "There is very little, if any, adverse impact to the resident fish or diadromous fish from the current operating regime for the Ellsworth Project." Information within the DLA does not support this conclusion as the result of several studies (Atlantic salmon smolt study, tributary connectivity study, instream flow study) that would inform such an analysis are not presented in the document.	Information from the tributary connectivity study was included in the DLA (pages E-4-27 and 28) as was the instream flow study (pages E-4-48 to 50). Exhibit E Section 4.4.3.2 of the FLA has been revised to further address tributary connectivity. See response to Comment #30. The final results of the ongoing or planned studies, American eel downstream passage study and the Atlantic salmon smolt study will be reported separately by December 31, 2016.
40. NMFS	15. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species	(Page E-4-52): The Licensee conducted a visual upstream fish passage study. This study provides qualitative observations of behavior and movement of river herring. Visual observations for evaluating migration delay are inadequate. Results would be based on many assumptions and cannot provide specific data regarding fish migration behavior at the fishway and Project tailrace and spillway. These data will not provide information about timing of passage (duration and energetics) from approach to trap. Therefore, results from this study cannot be used to support a license order.	The upstream passage study was conducted consistent with the FERC approved study plan. The 2015 fish passage season demonstrated the capability of the fishway and trap system to transport the requested escapement numbers and returns supporting one of the state's largest alewife fisheries (harvest). In addition, the results of the 2015 Upstream Atlantic Salmon Passage Study are reported in the FLA and include observations of river herring throughout the 2015 season.

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41. NMFS	16. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species	(Page E-4-53): BBHP's conducted a visual upstream fish passage study. The FLA should include observation of fish present within 24 hours of opening the fishway entrance. This information would indicate whether the timing for initiating operations is adequate or needs modification to an earlier date.	The results of the 2015 Upstream Atlantic Salmon Passage Study are reported in the FLA and include observations of river herring throughout the 2015 season.
42. NMFS	17. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species	(Page E-4-54): The Licensee states the fish trap at the Project has a positive effect on Atlantic salmon. This claim in unsubstantiated since neither the effectiveness of the fish trap nor survival of Atlantic salmon at the trap has been documented at the Project. Absent substantial scientific information such conclusions should not be included in the FLA.	The low numbers of Atlantic salmon returning to the Union River over the past decade has precluded conducting specific effectiveness testing of the existing trap and truck system. However, it is important to note that Atlantic salmon were the target species for the trap's construction. Salmon captures at Ellsworth prior to 2006 (up to 263 salmon per year) demonstrated the effectiveness of the fishway. Further, information that is available and presented in the upstream fish passage study section of the ISR indicated that Atlantic salmon that used the fishway but were returned downstream of the fishway (as opposed to transport upstream of Graham Lake) often returned to use the fishway again (recaptures), indicating fishway survival was good.
43. NMFS	18. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species	(Page E-4-54): This section notes the Upstream Atlantic Salmon Passage Study. The FLA should consider the effects of the two electrical pumps located right beside the entrance on the behavior of Atlantic salmon.	The studies have been conducted in accordance with the study plans. It is unclear why NMFS suggests the two pumps may be impacting the fishway operation or effectiveness. The pumps have been in place since the fishway was constructed and as discussed above, salmon captures prior to 2006 demonstrate the trap's effectiveness.

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44. NMFS	19. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species	(Page E-4-54): This section incompletely states potential impacts as follows: "Hydroelectric facilities may result in delays of both upstream and downstream migration of Atlantic salmon." The FLA should also include a statement on the potential for hydroelectric facilities to prevent Atlantic salmon from reaching spawning habitat.	Black Bear disagrees with the statement that hydroelectric facilities prevent salmon from reaching spawning habitat when fish passage is provided at Ellsworth and has been historically utilized by Atlantic salmon. However, a discussion of the potential for delay is included in the FLA. Effects of the Project on downstream passage are pending ongoing studies.
45. NMFS	20. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species	(Page E-4-55): This section states that the trap is not operated at water temperatures above 77°F. State of Maine handling protocol requires handling of adult Atlantic salmon to cease during periods of warm water conditions to prevent mortality from the stress of handling the fish. Because of the existing trap, all fish must be handled at the Ellsworth Project. Therefore, during periods of warmer water, the Ellsworth Project trap is not operated for Atlantic salmon; salmon cannot volitionally pass the Project. By contrast, Milford, West Enfield, and Mattaceunk on the Penobscot have fishways that allow passage regardless of temperature because handling of fish is not required.	See response to Comment # 13.
46. NMFS	21. Exhibit E Table E-1, Ellsworth Trashrack Spacing and Calculated Intake Velocities	(Page E-4-56): The trashrack spacing will not physically exclude downstream migrating smolts or alosine. Trashracks spacing of greater than 2 inch will allow downstream migrating smolts to be entrained. These velocities are well above the US Fish and Wildlife Service's recommended 2 feet per second. Juvenile river herring will certainly be entrained at these velocities.	Comment noted – potential entrainment of downstream migrating smolts and alosines was discussed in the DLA and is maintained in the FLA. Water velocities at the trashracks and fish passage weirs were measured in October 2015 and are reported in the FLA.

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47. NMFS	22. Exhibit E	On October 5, 2015, the Downeast Salmon Federation filed documentation of a juvenile river herring kill below the Ellsworth Project. Injuries observed are consistent with turbine entrainment. In 2014, a similar fish kill was observed. The Licensee responded by evaluating potential areas of impact, consulting with the resource agencies, and making improvements to an auxiliary cooling water system. That action had the intended benefit of preventing future entrainment in that system; however, it did not address the larger concern identified for entrainment at the turbine intakes. The current field observations submitted by the Downeast Salmon Federation indicate the Project continues to impact out migrating fish. What remains unknown is the scale of this impact. We look forward to the results of the downstream passage studies for smolts and eel to further inform the process.	See Brookfield's letters to FERC dated October 21 and November 10, 2015 in response to the Downeast Salmon Federation filing.
48. NMFS	23. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage	(Page E-4-57): The Licensee qualitatively evaluates risk of entrainment but does not explain how operation of the Project will protect outmigrating fish from project related injury and mortality such that stocks can grow in the Union River to meet management goals. Based on the limited information provided in the DLA, we are unable to concur that out migrating fish will be protected. The anticipated downstream passage survival studies for Atlantic salmon smolts and American eel will be informative on this issue.	The Project operates downstream fishways at both dams to facilitate safe passage downstream. The fact that the Union River supports one of the best alewife fisheries in the country indicates downstream passage for this species is safe and effective. The results of additional studies on downstream eel and Atlantic salmon will be filed by December 31, 2016 and will provide additional empirical data.

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49. NMFS	24. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage,	(Page E-4-57): The desktop analysis completed by BBHP was approved in the study plan determination. These data suggest a (1) potentially high survival for alewife and Atlantic salmon and (2) the potential immediate and delayed survival for American eel is low. The desk top analysis is a modeled sample representing potential site conditions. Site specific studies are needed to verify the desk top analysis and account for Project specific attributes. A site specific study will provide information regarding fish behavior at the intakes under existing conditions, as well as a more precise evaluation of entrainment and impingement impacts. As noted above, we await the results of the required Atlantic salmon smolt and American eel adult downstream studies, including balloon tags, for survival estimates. These studies will provide important Project specific data which will inform the licensing decision. Therefore the FLA will not be ready for environmental analysis before the two studies are complete and analyzed.	Comment noted.
50. NMFS	25. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage,	(Page E-4-57): This section states: "Since there are currently very few salmon expected at the Project, salmon (smolts and kelts) have a very low risk of entrainment..." 'We disagree with this statement. Risk of entrainment is not related to the number of fish present; rather, it is the risk to those fish present. Based on rack spacing and velocities, we contend that the risk of entrainment is high.	Black Bear will remove this sentence from the FLA. Velocities were measured at the intake racks and downstream fish passage weirs in October 2015 and are reported in the FLA. The results of the downstream smolt passage study to be conducted in the spring of 2016 will be reported by December 31, 2016.

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51. NMFS	26. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage,	(Page E-4-58): The Licensee states all kelts will pass downstream of the project via surface weirs. This assumes that 100% of all kelts will successfully locate and enter the surface weirs in a timely manner. This statement is unsubstantiated and should not be included in the FLA. No fishway has ever been documented to be 100% successful in passing migratory fish species. Post-spawned Atlantic salmon kelts return to the ocean and can return to spawn again as multi-sea winter adults. Repeat spawners produce more eggs per adult and thus, are highly important to the population in terms of reproductive capacity. Kelts that do not enter the surface weirs will likely die upstream of the project if they cannot return to the ocean.	The statement referenced in the DLA is accurate as stated "All kelt passage would occur through the surface-weirs *at the river flows investigated, of which none resulted in spill at the Project*." [emphasis added] given that trash rack spacing would exclude kelt entrainment (see table on DLA page E-4-57) and no spill conditions leave the surface weirs as the only option for passage.
52. NMFS	27. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage,	(Page E-4-58): The Licensee states that very few salmon are in the Union River due to "extremely low returns." This statement ignores that fact that the fish trap at Ellsworth is functional for Atlantic salmon for about 6 hours per day for 19-39 days a year. By comparison, the migration season at fishways in Maine is typically 200 days between April 15 and November 1, five times the number of functioning days of the fish trap. Increasing the days of activity at the Ellsworth trap may increase the potential for observing Atlantic salmon.	In response to similar comments and additional study request from FERC, Black Bear conducted an upstream fish passage effectiveness study in 2015 where the fish trap was operated from May 1 through October 31, from sunrise to sunset daily. The fish trap was checked 4 times per day. No Atlantic salmon were collected or observed near the fishway entrance.

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53. NMFS	28. Exhibit E Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Endangered Species, Atlantic Sturgeon and Shortnose Sturgeon	(Page E-4-62): The Licensee states "Due to the rarity of these species at the Project, normal operations would not affect shortnose or Atlantic sturgeon." "Rarity" does not preclude impact. Presently, we have no data to support a conclusion on impacts to Atlantic and shortnose sturgeon. We agree that little information is currently available regarding use of the Union River by shortnose and Atlantic sturgeon. The FLA should consider the effects of Project operations, specifically peaking flows, on sturgeon habitat and their use of the river.	In the Status Review of Atlantic sturgeon, it was noted that "The geomorphology of most small coastal rivers in Maine is not sufficient to support Atlantic sturgeon spawning populations, except for the Penobscot and the estuarial complex of the Kennebec, Androscoggin, and Sheepscot Rivers" though subadults may use the estuaries of smaller coastal drainages during the summer months (Atlantic Sturgeon Status Review Team 2007). Zydlewski et al. (2011) found that shortnose sturgeon use small coastal rivers as they migrate between the Kennebec and Penobscot Rivers. However, as noted above, only one shortnose sturgeon and no Atlantic sturgeon tagged at other locations have been detected by the acoustic receivers deployed in the lower Union River (G. Zydlewski, University of Maine, personal communication July 9, 2014 and August 20, 2015). From review of the limited bathymetry data of the original river channel that has been inundated by Lake Leonard there may be steep gradient reaches that would have historically kept Atlantic and shortnose sturgeon from accessing the Union River in the Project vicinity.
54. NMFS	29. Exhibit E Section 4.4.3.4 Fish and Aquatic Resources, Environmental Analysis, Cumulative Effects	(Page E-4-62): The Licensee suggests that the fishway facilities are effective. This cannot be concluded based on the information provided. Required studies for downstream passage survival have not been completed. Further, we have no indication of the effectiveness for Atlantic salmon and American shad upstream passage. Therefore, we cannot concur with this statement at this time.	The fishway has proven effective based on the continued high returns of alewife. Historically, Atlantic salmon successfully used the fishway as well but returns declined as restoration priorities changed to focus on other river systems. The efficacy of the trap and transport facility for Atlantic salmon passage was evaluated and discussed in the ISR and FLA. It should be noted that, according to the Maine DMR American Shad

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			Habitat Plan, Submitted to the Atlantic States Marine Fisheries Commission as a requirement of Amendment 3 to the Interstate Management Plan for Shad and River Herring, Approved February 6, 2014, there is only 5 miles of historic shad habitat in the Union River, the majority of which is downstream of Ellsworth Dam. Furthermore, there are no current active shad management plans for the River – see response to Comment #33.
55. City of Ellsworth	Graham Lake water levels	Requests impact of water levels in Graham Lake especially during the summer months of July and August be taken into consideration. City recalls that BHE kept levels higher; recent trends have resulted in lower water levels; creates safety hazards for boaters; higher levels would result in additional recreation benefits for all lake users.	By the 1987 FERC order granting a new license for the Project, the normal high water elevation for Graham Lake was lowered from 105.2' to 104.2' to address shoreline erosion issues. Since that time water levels in the lake have been managed to the extent practicable in accordance with the historic operating curves presented in Exhibit E.
56. Joe Minutolo, Graham Lake resident	Graham Lake water levels	Timing of summer drawdown damages recreational experiences on the lake; lowers Gram Lake property values; impacts jobs and tax revenue for local communities;	Summer lake elevations are targeted between 104.2 feet and 99 feet between Memorial Day and Labor Day.
57. FERC	1. Initial Statement	Include the address of the Town of Bar Harbor.	The Town of Bar Harbor has been added to the Initial Statement
58. FERC	2. Project Description	Revise Exhibit A to include: (1) Lengths and heights of each section of the dams (i.e., earthen embankments, spillways, abutments at Graham Lake and Lake Leonard (2) Heights of 3 spillway gates, sluiceway, flood wall, wing wall, and steel cell at Graham lake (3) Gross storage volume at Graham Lake	Table A-2 with the requested information has been added to Exhibit A.

Commenter	Reference/comment #	Comment	Response
		(4) Dimensions of the 2 intake facilities and associated facilities at Ellsworth development, including the number and dimensions of each headgate and the clear bar spacing of the trashracks (5) Lengths of all 4 penstocks at the Ellsworth development (6) Dimensions and hydraulic capacities of the upstream and downstream fish [passage facilities at the Graham Lake and Ellsworth developments (7) The minimum hydraulic capacity of each turbine unit at the Ellsworth development The voltage of the 320-foot long transmission line	
59. FERC	3. Project Operations	Sections 1.0 and 2.0 – Describe how the dependable capacity of 8.9 megawatts was calculated, including descriptions of data sources, assumptions, and computations.	Dependable capacity methodology has been added to Exhibit B.
60. FERC	4. Project Operations	Section 2.2 – revise Table B-4 with flow calculated based on project generation, minimum flows, and fish passage facility flows. This would address mean monthly flows in August 2006, and September 2006 and 2007 when 0 flow is shown.	Table B-4 has been corrected to remove a "zero" entry where historic flow data is missing.
61. FERC	5. Project Operations	Appendix B-1 Provide revised flow duration curves that use appropriate minimum flows and downstream fish passage flows to represent the low flow values in Appendix B 1 which currently use 323 cfs.	See response to Comment #22.

Commenter	Reference/comment #	Comment	Response
62. FERC	6. Project Boundary	Lands that do not serve a project purpose should be removed from the Project boundary.	Black Bear has reviewed lands within the project boundary, which generally follow an elevation surrounding the project impoundments as well as project structures. No changes to the existing project boundary are proposed at this time.
63. FERC	7. Project Boundary	Exhibit G drawings should be corrected to show and label all principal project works enclosed within the project boundary including the carry-in boat launch off Shore Road, the Graham lake dam boat launch, the 320-foot long t/l and the vertical slot fishway and trap facility.	Corrections made; see Exhibit G
64. FERC	8. Project Boundary	Exhibit G drawings need to be stamped by a registered land surveyor.	The Exhibit G drawings have been finalized and stamped by a registered land surveyor; see Exhibit G
65. FERC	9. Fish and Aquatic Resources	E-4-45 and 46 Provide all current information about the operation of the project's upstream and downstream fish passage facilities including: attraction and conveyance flows; a description of the stoplog adjustment protocol for the two surface weirs at the Ellsworth development.	Current operations are described in the USR upstream passage alternatives study report and future operations will be guided by the Fish Passage Operations and Maintenance Plan submitted to FERC on November 10, 2015.
66. FERC	10. Fish and Aquatic Resources	E-4-46 Include a copy of the Operation and Maintenance Plan for the project's upstream and downstream fish passage facility.	A copy of the Ellsworth Project's Fish Passage Operations and Maintenance Plan was filed with FERC on November 10, 2015.
67. FERC	11. Wildlife and Botanical Resources	Section 4.4.5.1 Provide acreages of each of the 8 wetland cover types identified.	Table E-22 in Exhibit E Section 4.4.5.1 has been modified to include acreages of the wetland cover types.

Commenter	Reference/comment #	Comment	Response
68. FERC	12. Wildlife and Botanical Resources	Section 4.4.5.2 Include description of standard vegetation maintenance practices (mechanical, chemical, etc.) standard maintenance schedule – annually, seasonally, as needed etc.); procedures form managing vegetation in sensitive habitats (wetlands, riparian habitat, etc.); and procedures when RTE plants or animals are encountered during routine maintenance. 35 acres of upland managed within the project boundary.	See Exhibit E, Sections 4.4.5.2 for a discussion of effects of vegetation maintenance practices.
69. FERC	13. Recreation	Include a map that shows the location and relative length of the proposed new portage trail at Graham Lake.	A new portage trail map has been added.
70. Passamaquoddy	Fish Passage	Recommended fish passage facility improvements: • Installation of fish lift 24/7 April through October • Lift engineered to accommodate increased run numbers of all species • Safe and timely passage of multiple species including: river herring, Atlantic salmon, eels, and American shad • A fish ladder at Graham Lake Dam designed for safe and effective passage of large numbers of multiple species • Studies to monitor estuarine anadromous populations below Ellsworth Dam to ensure all species have opportunity to pass both facilities Operational procedure changes: • Modernize attraction flow rates to current USFWS standards	Recommendations noted. Any modifications to fish passage measures will be made based upon the results of the continuing passage studies.

Commenter	Reference/comment #	Comment	Response
		• 24/7 hours of operation • Operation season April through October • Check trap more efficiently and regularly for Atlantic salmon • Perform daily walks on both sides of the river for fish kills regularly throughout 24-hour cycle; assess and address issues immediately	
71. USFWS	5. Fish Passage	The dates for the Ellsworth fish passage facilities should be researched, verified, and included in the FLA.	Comment noted.
72. USFWS	6. Fish Passage	The ownership of the fish trap is unclear. This should be researched and a determination made as to whether Black Bear needs to acquire right, title or interest in order to operate the facility.	See response to Comment #17.
73. USFWS	7. Fish Passage	Section 4.4.3 should mention plans for improving upstream passage of anadromous species, or downstream eel passage. The FLA should address the findings of the Updated Study Report and acknowledge the pending downstream studies and the potential for improving downstream passage effectiveness (e.g., intake rack velocities).	Black Bear will continue consultation with agencies regarding fish passage improvements pending ongoing fish passage studies.
74. USFWS	8. Fish Passage	USFWS notes that operational problems and equipment failures (pump) were not mentioned in the DLA.	See Brookfield’s letters to FERC dated October 21 and November 10, 2015 in response to the Downeast Salmon Federation filing for information regarding the downstream fishway

Commenter	Reference/comment #	Comment	Response
75. USFWS	9. Fish Passage	USFWS feels the configuration of the Ellsworth downstream bypass discharge is likely to cause injury or death of downstream migrants. They would like the orientation of the pipe can be modified at minimal cost and without a specific study.	Downstream passage studies are ongoing for the Project.
76. USFWS	10. Fish Passage	USFWS requires studies using commonly accepted empirical field methods (e.g., telemetry) evaluating the effectiveness of the upstream and downstream passage facilities in order to engage in informal fish passage negotiations.	Downstream passage studies are ongoing for the Project.
77. USFWS	11. Fish Passage	The FLA should acknowledge the management goal of American shad restoration on the Union River.	See response to Comment #33.
78. USFWS	13. Generation	Use correct units for generation: 30,333 MWh	Correction has been made in the FLA
79. USFWS	14. American eel	The description of the American eel fisheries and conservation measures included in the DLA, 4-42 should be expanded and updated. Reference ASMFC Addenda of August 2013 and October 2014.	The discussion of the American eel fishery has been expanded and updated in the FLA.

STAKEHOLDER COMMENTS ON
THE DRAFT LICENSE APPLICATION

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PAUL R. LEPAGE
GOVERNOR

AVERY T. DAY
ACTING COMMISSIONER

October 7, 2015

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Comments on Draft License Application
Ellsworth Hydroelectric Project
FERC No. 2727

Dear Ms. Bose:

The Department of Environmental Protection (Department) reviewed the Draft License Application for the Ellsworth Hydroelectric Project (FERC 2727), located on the Union River in the City of Ellsworth and the towns of Waltham and Mariaville and Fletchers Landing Township in Hancock County, Maine.

The existing Ellsworth Hydroelectric Project consists of a lower dam with a ~90 acres impoundment (Leonard Lake) and an upper dam with a ~10,000 acres storage reservoir (Graham Lake). The lower dam, at Leonard Lake, contains a powerhouse containing four turbine-generator units with a total authorized capacity of 8.9 MW. The project includes a 320-foot transmission lines to transfer the project's electricity to the Project's step-up transformers, as well as appurtenant facilities to operate and maintain the hydropower facility.

The Department understands that Black Bear Hydro Partners, LLC (Black Bear) is proposing no changes to project facilities or operations. Current project operations include:

- Operation of a water storage facility and peaking generation facility; timed releases at Graham Lake are used at Ellsworth dam for power production. The releases can result in minor (~1-foot) surface elevation changes in Lake Leonard. Graham Lake generally follows an operating curve that has historically resulted in fluctuations approaching 11 feet;

- Minimum flows of 105 cfs from the Ellsworth dam (at Leonard Lake) and Graham dam from July 1 through April 30 and a continuous minimum flow of 250 cfs from May 1 through June 30; (flows may be temporarily modified if required by operating emergencies beyond Black Bear's control, and for short periods upon agreement among Black Bear, United States Fish and Wildlife Service (USFWS) and the Department); and

- Water levels at Leonard Lake are maintained between the elevations of 65.7'msl and 66.7' msl, and water levels in Graham Lake are maintained between elevations of 104.2' msl and 93.4' msl. (Water levels may be temporarily modified if required by operating emergencies beyond Black Bear's control, and for short periods upon agreement among Black Bear, USFWS and the Department).

The Department understands that based on a Generator Enhancement Study Black Bear is not proposing the addition of any turbine-generator units as part of this relicensing, and no new construction is planned. We further understand that, in response to comments from state and federal resource agencies, Black Bear has conducted various studies to assess the impact of project operations on environmental resources. Finally, the Department understands that Black Bear is proposing measures designed to protect and enhance affected resources.

Specifically, Brookfield is proposing to:

- Implement erosion controls at the existing Graham Lake boat launch facility

- Develop a new portage trail at the west end of Graham Lake dam;

- Improve a fisherman's downstream access trail on the east side of Graham Lake dam;

- Develop, in consultation with fisheries agencies, plans for upstream eel passage at Ellsworth and Graham Lake dams.

- Develop a Recreation Facilities Management Plan to provide for appropriate management of recreation facilities throughout the term of the license; and

- Develop a Historic Properties Management Plan to provide for management of historic resources throughout the term of the license.

The Department has the following comments on the draft application.

General Comments

1. The Project history and proposal are reasonably well documented.

2. Baseline water quality studies conducted at the impounded Graham Lake and Lake Leonard and in the Union River between the Graham Lake dam and Lake Leonard pursuant to the Revised Study Plan in support of water quality certification included:

a. Collection of Impoundment Trophic State data;
b. A Dissolved Oxygen Study, including collection of baseline dissolved oxygen and water temperature data;
c. Impoundment Aquatic Habitat Study;
d. Benthic Macroivertebrate Sampling; and
e. Outlet Stream Aquatic Habitat Study.

The water quality studies provide current water quality conditions in both Lake Leonard and in Graham Lake, document dissolved oxygen concentrations and water temperatures upstream and downstream of both dams, document benthic macroinvertebrate community structure and function downstream of the Graham Lake dam, and determine the effect of project operations on the habitat for fish and other aquatic life.

Impoundment Trophic State Data Collection

On February 21, 2013, the Department filed comments on the Pre-Application Document for the Ellsworth Hydroelectric Project (P-2727) requesting that Black Bear submit a plan for Department approval to determine the trophic state of the Graham Lake and Lake Leonard impoundments. The plan was to be developed in accordance with the Department's "Lake Trophic State Sampling Protocol for Hydropower Studies".

All requested studies were performed as specified and no further data are needed. Data collection was carried out April through October 2013 in Graham Lake and between June and October in Lake Leonard. Samples were collected for Secchi disk transparency, phosphorus, Chlorophyll-a, color, dissolved oxygen, temperature, pH, turbidity, total alkalinity, manganese, magnesium, iron, calcium, silica, and sulfate. Late season samples were collected in August 2013 as specified in the sampling protocol.

Thermal stratification was documented in Lake Leonard in July, August and September. The top of the thermocline was measured between 9 and 12 meters. Thermal stratification was documented in Graham Lake on at all three sampling stations; on June 27 at Station 1 (central area of the lake), on July 18 at Station 3 (north end), and on July 2 and 18, and on August 1 and 28 at Station 2 (south end). The top of the thermocline was measured between 3 and 4 meters in June and on July 18, and between 10 and 11 meters on July 2 and in August.

Sampling results indicates that the Graham Lake impoundment is turbid but does not show signs of nutrient enrichment. The Lake Leonard impoundment is not significantly impacted by water quality conditions in Graham Lake. Lake Leonard does not show signs of nutrient enrichment.

Based on the results of sampling and information contained in the draft application as well as initial and revised study results, the Department concludes that Brookfield has provided sufficient data and both Lake Leonard and Graham Lake are likely free of culturally induced algal blooms which impair its use or enjoyment. Analytical data was not analyzed by Black Bear, only compared and found consistent with previous sampling efforts. Additional data analysis may be needed to assess overall water quality. The Department concludes that the trophic state in each of the two project impoundments is stable or declining.

Impoundment Aquatic Habitat Study

On February 21, 2013, the Department filed comments on the Pre-Application Document for the Ellsworth Hydroelectric Project (P-2727) requesting that Black Bear submit a plan for Department approval to evaluate aquatic habitat in the Graham Lake impoundment.

The littoral area for Graham Lake was determined based on bathymetry calculated from ortho-photos at different water elevations. Using a depth of twice the mean Secchi disc transparency measured (1.77 meters or 5.8 feet), the littoral zone was found to be 11.6 feet, or an elevation of 92.6 feet msl. Data collected indicated that water levels need to be at an elevation of 102.5 feet or higher to ensure that at least 75% of the littoral zone remains wet. The Study Report indicates that the operational minimum water level is 93.4 feet msl and that the average daily minimum elevation is ~98 feet msl.

The littoral area of Lake Leonard was not determined. Lake Leonard is operated in a run-of-river mode with water level elevations normally maintained between 65.7 feet msl and 66.7 feet msl. Lake Leonard is found to maintain at least 75% of the littoral zone based on operations.

Based on the information provided by the Applicant, it appears that the aquatic life and habitat criteria of Maine's Water Quality Standards are not met in Graham Lake under the current operating conditions. It is unclear whether the methods used in the Impoundment Aquatic Habitat Study accurately calculate this criteria, more discussion and information is needed We conclude, therefore, that at this time the information provided fails to clearly demonstrate that Class GPA water quality standards for aquatic life and habitat are met under current and proposed impoundment water levels conditions for Graham Lake.

Benthic Macroinvertebrate Monitoring- Impoundment

On February 21, 2013, the Department filed comments on the Pre-Application Document for the Ellsworth Hydroelectric Project (P-2727) requesting that Black Bear submit a plan for Department approval to sample the benthic macroinvertebrate community. One location was selected approximately 100 meters downstream of the Graham Lake dam and the survey was conducted in accordance with the Department's Methods for Biological Sampling and Analysis of Maine's Inland Waters (Davies and Tsomides 2002).

Analysis of the results of the sampling, including associated field sheets, using the DEP's linear discriminant model indicates that the sampled macroinvertebrate community did not meet applicable Class B standards for aquatic life. Macroinvertebrate community structure and function show evidence of impairment, specifically mayflies and stoneflies were not well represented. Professional judgment was utilized to account for the lake outlet effect on the sampled community, raising the classification to Class C; the project did not meet the Class B water quality standard.

Additional benthic macroinvertebrate sampling was conducted in July and August 2015 at three locations in the Union River. The 2015 sampling locations were chosen to reflect substrate types described in DEP protocols and according to field conditions and the consultant's professional experience. Results of those samples are not available at the time of the Department's comments on the Draft License Application.

Based on the results of the sampling and the information contained in the draft application, we conclude that information provided by Black Bear fails to demonstrate that the benthic macroinvertebrate in the outlet stream meets Class B aquatic life standards under current and proposed minimum flow conditions. Additional data was collected in the summer of 2015 and is expected to be submitted for analysis. It is expected that these data will be presented in the Final License Application. Therefore, the Department is unable to evaluate the project's attainment of water quality standards for this parameter at this time.

Dissolved Oxygen Monitoring

On February 21, 2013, the Department filed comments on the Pre-Application Document for the Ellsworth Hydroelectric Project (P-2727) requesting that Black Bear submit a plan for Department approval to sample dissolved oxygen in the Union River below Graham Lake dam. Dissolved oxygen was not sampled in the tailwater of the Ellsworth dam because the Union Rvier below the dam is tidal. Therefore, one location was selected and the survey was conducted in accordance with the DEP Sampling Protocol for Hydropower Studies (June 2014).

Dissolved oxygen and temperature data were collected at the Ellsworth Hydroelectric project above and below the Graham Lake dam and in Lake Leonard. DO data collected in the impoundment aids interpretation of attainment of DO criteria downstream. The data collected indicates that both impoundments stratify thermally, therefore oxygen depleted water from Graham Lake could be a source of water with low DO passed downstream. Analysis of the sampling results indicates that water sampled below the thermocline at Graham Lake exhibited low oxygen, and that water sampled below the thermocline in Lake Leonard dropped below 7 ppm on only one date.

Water quality sampling in the river below the dam DO and temperature measurements were collected every hour from mid-July to mid-September using a Hobo water quality data sonde at one location, in accordance with a study plan reviewed and approved by the DEP.

Analysis of the sampling results indicates that dissolved oxygen concentrations in the Union River met or exceeded applicable Class A standards of 7 parts per million or 75% saturation, whichever is higher, under conditions of low stream flow and high water temperature.

Based on the results of sampling and the information contained in the draft application as well as the initial study results, the Department concludes that Black Bear has provided sufficient information to demonstrate that the project outlet stream meets applicable Class A dissolved oxygen standards under critical water quality conditions.

<u>Outlet Stream Aquatic Habitat Study</u>

On February 21, 2013, the Department filed comments on the Pre-Application Document for the Ellsworth Hydroelectric Project (P-2727) requesting that Black Bear submit a plan for Department approval to evaluate the Outlet Stream Habitat in the Union River below Graham Lake dam.

Bank full and wetted widths were measured in the Union River at a location just below Graham Lake dam. The wetted width was measured at a flow of 150 cfs, however minimum flow at Graham Lake dam is 105 cfs, nearly 1/3 less than the flow that was measured.

Instream flow and tributary access were also studied for four flows on the Union River. Black Bear reports that adequate zone of passage exists for river herring and Atlantic salmon at all flows analyzed, and that adequate connectivity was maintained at low flows to Greys, Shackford, Moore, and Gilpartick brook tributaries of the Union River.

Based on the information provided in the draft application and in the Updated Study Report, the Department concludes that information provided by Black Bear is unclear and, therefore, at this time we are unable to determine that the project meets Class A aquatic life and habitat standards.

<u>Other Comments</u>

The final license application should include final reports and data summaries for all of the studies requested by various stakeholders. In particular, the Department will be looking for the report of benthic macroinvertebrate studies conducted in 2015, as well as a more fully developed discussion of the impoundment aquatic habitat study and the outlet stream aquatic habitat study, in support of water quality certification. The study discussions should present the findings in enough detail to allow Department staff to analyze the projects compliance with Maine's water quality standards.

Additionally, Black Bear must demonstrate compliance with all designated uses in order for the Department to issue a water quality certification for the Ellsworth Hydroelectric Project. The water quality study protocols provide methods to address numeric and some narrative standards, but not all.

Thank you for this opportunity to comment. Please contact me by telephone at (207) 446-2642 or by email at Kathy.Howatt@maine.gov if you have any questions.

Sincerely,

Kathy Howatt

Kathy Davis Howatt
Hydropower Coordinator
Division of Land Resource Regulation

Cc: Mr. Frank Dunlap
Brookfield Renewable Energy Group
26 Katherine Drive
Hallowell, Maine 04347

Document Content(s)

STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
21 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0021

PAUL R. LEPAGE
GOVERNOR

PATRICK C. KELIHER
COMMISSIONER

October 5, 2015

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Ellsworth Project (P-2727)
Draft License Application and August 21, 2015, Updated Study Report

Dear Secretary Bose:

On July 10, 2015, Black Bear Hydro Partners, LLC (BBHP) submitted a Draft License Application (DLA) for the Ellsworth Project (P-2727) on the Union River in Maine. On August 21, 2015, BBHP submitted an Updated Study Report. The Maine Department of Marine Resources (MDMR) has reviewed both the DLA and the Updated Study Report, and offers the following comments:

Draft License Application

Draft Exhibit E

1. Section 3.3.3, Proposed Action, Proposed Environmental Measures (page E-3-6): Several Protection, Mitigation and Enhancement (PME) measures are proposed, including upstream passage for American eel. However, the DLA does not mention plans for improving upstream passage for anadromous species and improving downstream passage for all diadromous fish. The FLA should address the findings of the updated study report filed on August 21, and acknowledge the pending downstream studies and the potential need for improving downstream passage effectiveness.

2. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Atlantic Salmon (Page E-4-40): The DLA indicates "The Project protects EFH for Atlantic salmon by providing upstream and downstream fish passage and migratory pathways to habitat, and ensuring suitable habitat downstream of each development through minimum flows." The Project does not provide upstream passage for Atlantic salmon as there are no upstream fish passage facilities at either dam. Passage is provided via a truck which requires fish be removed from the Union River. The Union River between Ellsworth Dam and Graham Dam is completely blocked to migratory fish species including Atlantic salmon. It remains uncertain whether the

present instream flow requirements ensure suitable habitat. Instream flow study results would help determine the extent of that benefit, if a benefit is observed at all.

3. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Other Diadromous Fish (page E-4-42): The description of Maine's fisheries for American eel is outdated. A benchmark stock assessment conducted by the Atlantic States Marine Fisheries Commission (ASMFC 2012) indicated that the American eel stock has declined in recent decades, and the stock is now considered depleted. ASMFC subsequently approved Addendum III (August 2013) and Addendum IV (October 2014) to the American Eel Interstate Fisheries Management Plan with the goal of reducing mortality and increasing conservation of American eel stocks across all life stages. Addendum III eliminated the harvest of silver eels in all states with the exception of New York's weir fishery on the Delaware River. Addendum IV established a 907,671 pound coastwide quota for yellow eel fisheries, and reduced Maine's glass eel quota (for 2014 landings) to 9,688 pounds.

4. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Other Diadromous Fish (page E-4-43): This section is incomplete. The Comprehensive Fisheries Management Plan For The Union River Drainage 2015 – 2017 states (bold added for emphasis) "The MDMR plans to focus its shad restoration efforts on rivers other than the Union during the period 2015-2017, including the Kennebec, Androscoggin, Saco, Penobscot, and St. Croix. There is also no convenient source of broodstock for the Union that would support an active shad stocking program. **Until such resources become available, management of shad in the Union River will be accomplished using measures that are implemented for other diadromous species, including the provision of interim and permanent fish passage at the lower river dams, and continuation of instream flows at the Ellsworth Hydroelectric Project."**

5. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Diadromous Fish, Other Diadromous Fish (page E-4-44): The DLA correctly indicates there are no current plans for American shad restoration. However, the new license will likely cover a 30 year period, and restoration priorities may change. The potential for American shad passage should be considered.

6. Section 4.4.3.2, Environmental Analysis, Upstream Passage, Anadromous species (page E-4-52): The DLA states that the fish passage facility is designed to trap Atlantic salmon and river herring, and to transport fish to suitable upstream habitat located above the Project dams. American shad should be added to this list. Page E-4-3 of the DLA states that the Federal Energy Regulatory Commission identified American shad as a resource that could be cumulatively affected by the proposed operation of the Ellsworth Project. Likewise, the Comprehensive Fisheries Management Plan for the Union River 2015-2017 (section 3.1.3 p14) and the previous version identify the restoration of American shad as a management goal. The plan states that "When resources become available, shad restoration will focus on the historically accessible mainstem and tributary habitat located above and below the Ellsworth Dam." The documented American shad run on the Penobscot River increased from a five-year mean (2009-2013) of 2 shad at the Veazie Dam fishway to 1,806 shad in 2015 at the Milford Dam fish lift following fish passage improvements (removal of the Veazie and

Great Works Dams; installation of a fish lift at the Milford project). Thus, the probability of transferring American shad broodstock from the Penobscot River to the Union River during the span of the new license is high.

7. Section 4.4.3.2, Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species (P. E-4-55): This section states that the ladder and trap are not operated at water temperatures above 77F. This is a drawback of this facility's operations which is to stop operation and prevent passage of adult Atlantic salmon when temperatures are too high to prevent mortality from the stress of handling the fish. All fish must be handled at the Ellsworth Project. Milford, West Enfield, and Mattaceunk on the Penobscot do no operate in this manner. At those projects, fish are allowed passage regardless of temperature because handling of fish is not required.
8. Table E-14, Ellsworth Trashrack Spacing and Calculated Intake Velocities (page E-4-56): The trashrack spacing will not physically exclude downstream migrating smolts or alosines. Trashracks spacing of greater than 1/2 inch will allow downstream migrating smolts to be entrained. These velocities are well above the US Fish and Wildlife Service's recommended 2 feet per second. Juvenile river herring will certainly be entrained at these velocities.

9. Section 4.4.3.2, Fish and Aquatic Resources, Environmental Analysis, Downstream Passage, (page E-4-57): The results of a desktop analysis completed by BBHP indicate a potentially high survival for alewife and Atlantic salmon and a potentially low survival for American eel. Site specific studies on adult American eels (ongoing) and salmon smolts (planned for spring 2016) will provide information on passage effectiveness. These studies will provide important Project specific data which will inform the licensing decision. Therefore, the FLA will not be ready for environmental analysis until the two studies are complete and analyzed.

10. Section 4.4.3.2, Fish and Aquatic Resources, Environmental Analysis, Downstream Passage, (page E-4-60): MDMR still contends that the low proportion of repeat spawners is an indication of poor downstream survival for post-spawn alewives. The smolt passage studies may provide some insight into this question of downstream passage effectives. In addition, MDMR has reduced the exploitation rate of the run and will be able to evaluate changes in the proportion of repeat spawners starting in 2016.

Updated Study Report, Upstream Fish Passage Alternative Study

1. Section 1.2, Project Downstream Passage, Ellsworth Dam (Page 7): Water and fish exit the transport pipe perpendicular to the face of the dam and are then conveyed down the face of the dam to the tailrace area (Photo 1). The existing discharge and conveyance of fish may lead to injury or mortality.

2. Section 1.2, Project Downstream Passage, Ellsworth Dam (Page 7): The downstream passage facilities have never been tested for their overall ability to pass fish safely and effectively. The required downstream passage studies for smolt and American eel will

provide data critical to the evaluation of Project related impacts on emigrating fish. These data will be informative for the development of license articles and fishway prescriptions.

3. Section 1.3, Upstream Fishway Design Parameters (Page 14): The description of the existing upstream fish passage facility and accompanying figure (Figure 9) are not sufficient. The description of the facility and/or Figure 9 should include 1) fishway channel slope; 2) pool dimensions; 3) drop per pool; and 4) detailed drawing and dimensions of the vertical slot baffle.

4. Section 1.3, Upstream Fishway Design Parameters (Page 14): Ellsworth powerhouse flow capacity is approximately 2,320 cfs and fishway pumped attraction flow is up to 50 cfs at Ellsworth, depending on tailwater elevation. Pumped attraction flow is approximately 2% of station capacity. Current USFWS standard is 3% of station Hydraulic Capacity or 70 cfs. NMFS has been using 3-5% of station hydraulic capacity on the East Coast and 5% per entrance of the flow duration curve for the fish passage season on the west coast. The attraction flow will need to be evaluated by the Licensee specifically for Atlantic salmon.

5. Section 1.3, Upstream Fishway Design Parameters (Page 14): Diffused attraction flow grating has a flow velocity of 1.5 fps. Contrast, the current USFWS criteria is 0.5 fps for horizontal diffusers and 1.0 fps for vertical diffusers. The effects of diffused attraction flow at the Project will need evaluation by the Licensee.

6. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 16): The DLA correctly states that the agencies have expressed their concerns with the overall capacity of the fishway to handle full design populations of river herring and American shad and the safe timely and effective passage of Atlantic salmon. However, any upstream passage facility should also be designed to accommodate American shad (see comments in paragraph 3 for Draft Exhibit E).

7. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 16): This section indicates a "USFWS design criteria peak hourly rate of 4,725 river herring per hour". This number is incorrect. The design criterion for the cycle time and hopper volume is 12,088 river herring per hour for the peak hour of the peak day.

8. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 16): The existing hopper is only 61 cubic feet (cf) and should be 166 cf. The harvesting hopper does not hold water, therefore when it is lifted the fish are in the dry (Photo 2).

9. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 16): The stated cycle time is 12 minutes. This does not include the amount of time the trap fishes, not just the time to raise, dump, and lower. Therefore, the true cycle time is much longer, which changes the fishing time and ability to capture an Atlantic salmon, if present.

10. Section 2.1, Trap and Transport Alternatives, Existing Facility (Page 16): This section states: "The 2015 season experience clearly demonstrated the capacity to handle over a half million river herring and the doubled spawning escapement." For clarity, the 555,015 river herring is

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a combined total of the harvest and new escapement target. It should be recognized that the current facility managed over a million river herring in 2012. The management goal is twice that volume. With the increased stocking rate, we anticipate returns of river herring to approach the 2.3 million river herring goal in the coming 4-5 years. Decisions made in this proceeding will affect the ability to meet management goals to support a sustainable run and an important harvest, and our ability to support recovery of Atlantic salmon. This should be clarified in the FLA.

11. Section 2.1, Trap and Transport Alternatives, Existing Facility (Page 16): This section states: "The current trap and transport facilities and operating protocols at Ellsworth have proven reliability and functionality by handling river herring runs from 190,000 to 1,200,000 river herring and 0 to 8 Atlantic salmon annually from 2000 to 2015…" We disagree. There are no data to indicate the existing facility and operating protocol have been proven reliable or to function for Atlantic salmon.

12. Section 2.1, Trap and Transport Alternatives, Existing Facility (Page 16): The current trap and truck system does not provide safe fish passage for Atlantic salmon throughout the migratory season. Trap and truck methodology requires cool river temperatures (less than 23°C) to reduce temperature related stress and mortality of salmon during handling; but that water temperature threshold is exceeded during portions of a typical trapping season at Ellsworth. During warm summers, fish passage for Atlantic salmon may be reduced or eliminated for weeks during the migratory window due to the absence of volitional fish passage facilities (fish ladders and fishlifts). These closures are avoidable if Atlantic salmon did not need to be handled and trucked.

13. Section 2.2, Hopper Improvements and Fish Trap Capacity, Ellsworth Fish Trap Capacity (Page 18): The report indicates the fishway pool has a depth of 4.25 feet and total capacity of 255 cubic feet. Without detailed construction drawings these dimensions cannot be verified for the holding pool or the fishway pools. Figure 9 is insufficient. However, based upon Figure 9 the water depth is only 3.25 feet not 4.25 feet as suggested. Construction drawing for the fishway should be provided in the FLA and the depth and calculation verified.

14. Section 2.2, Hopper Improvements and Fish Trap Capacity, Ellsworth Fish Trap Capacity (Page 18): The harvesting hopper does not hold water, thus the capacity is 0 (Photo 2). Retaining water during lifting operation is important for the proper handling of Atlantic salmon.

15. Section 2.2, Hopper Improvements and Fish Trap Capacity, Ellsworth Fish Trap Capacity (Page 18): The "hopper dimensions" provided are the dimensions of the concrete and are incorrectly applied in the report. The hopper capacity does not include the screened wall panels (Photo 3). The capacity is only based upon the watered up portion of the hopper. The inside dimension of the hopper is 5.75 square feet with only 2 feet of water.

16. Section 2.2, Hopper Improvements and Fish Trap Capacity, Ellsworth Fish Trap Capacity (Page 18): This section states: "…the dimensions of the hopper pool walls that establish the

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maximum hopper size." This statement is incorrect. Hopper size is determined by only the inside dimensions of the watered up section of the hopper walls.

17. Section 2.3.2, Separation of River Herring from Atlantic Salmon Passage, Phase 2 – Add Volitional Fish Ladder to Expanded Hopper Pool (Page 22): This section indicates that a steeppass or Denil could be accommodated for Atlantic salmon. MDMR would not recommend a steeppass or Denil fishway for this amount of head (~65 feet).

18. Section 3.1.1, Fish ladder Alternatives, Steeppass Denil (Page 23): The Steeppass alternative evaluated would be approximately 250 to 300 ft. long, and would include a 170-foot long section on a 30% slope. We have no data to suggest it would be effective for any of the target species.

19. Section 3.1.2, Fish ladder Alternatives, Standard Denil (Page 25): The standard Denil alternative evaluated would be approximately 700 feet long, and would include a 385-foot section on a 12.5% slope with five 180° turning pools. We have no data to suggest it would be effective for any of the target species.

20. Section 3.1.2, Fish ladder Alternatives, Standard Denil (Page 25): The standard Denil alternative evaluated could potentially pass 1,000,000 or more fish. Fishways are designed for the peak hour of the peak day of migration. Therefore we would expect a significant amount of delay to occur in the passage timing at these high numbers.

If you have any questions, please contact Gail Wippelhauser at 207-624-6349 or by email at gail.wippelhauser@maine.gov.

Sincerely,

Patrick C. Keliher, Commissioner

cc: Gail Wippelhauser, Oliver Cox, DMR
John Perry, DIFW
Kathy Howatt, DEP
Steven Shepard, Brett Towler, USFWS
Sean McDermott, Jeff Murphy, Don Dow, NOAA

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

OCT 7 2015

RE: Comments on Black Bear Hydro Partners, LLC Draft License Application for the Ellsworth Project (FERC No. 2727) and August 21, 2015, Updated Study Report

Dear Secretary Bose:

On July 10, 2015, Black Bear Hydro Partners, LLC (BBHP) submitted a draft license application for the Ellsworth Project (P-2727) on the Union River in Maine. We have reviewed the draft application and offer the attached comments regarding the accuracy and completeness of information provided. Our principle interests at this Project are: to support implementation of measures aimed at recovering Atlantic salmon;, to protect federally listed Atlantic and shortnose sturgeon; to support the management goals for a sustained run and commercial harvest of alewife and American eel; and, to provide conditions suitable for any future effort to manage diadromous species. Actions taken at the Ellsworth Project as a result of this current licensing proceeding, and the broader National Environmental Policy Act analysis, will shape the management, recovery and protection of these fish for the next 30 to 50 years in the Union River. That analysis will be guided by information generated throughout this process including data from the required studies. Our technical comments are largely intended to clarify the information and improve the quality of information in the pending Final License Application.

The Updated Study Report was provided on August 21, 2015. Several studies of interest to us were included in this report, specifically the instream flow and tributary access study, impoundment aquatic habitat study, and upstream fish passage alternative analysis. Data from these studies are important to assess the appropriateness of the proposed Project operations and fish passage mitigation measures relative to design standards of contemporary fishway technology, and whether the habitat needs for critically endangered species and other trust resources are properly addressed. Our technical comments on the Updated Study Report are attached. Our comments generally pertain to the adequacy of the study methodologies and adherence to the study plan determination. In our view, several studies were not adequately conducted. For instance, the tributary access study was not conducted at the lowest allowable headpond level as required by the study plan determination. Failure to previously conduct these studies negatively impacts our ability to determine the full scope of Project related impacts on tributary access. All studies must be completed per the study plan determination and prior to the final license application being accepted as Ready for Environmental Assessment.

If you have any questions, please contact Sean McDermott of our Habitat Conservation Division at (978) 281-9113 or Sean.McDermott@noaa.gov. For ESA or the section 7 process, contact Jeff Murphy at (207)-866-7379 or Jeff.Murphy@noaa.gov.

Sincerely,

Louis A. Chiarella
Assistant Regional Administrator
for Habitat Conservation

cc: Service List

National Marine Fisheries Service's Comments on Black Bear Hydro Partners, LLC Draft License Application for the Ellsworth Project (FERC No. 2727)

October 7, 2015

On July 10, 2015, Black Bear Hydro Partners, LLC filed a draft license application (DLA) for a new major license at the Ellsworth Project on the Union River in Maine. Below are our comments on the DLA.

General Comments

1. The license orders issued by the Federal Energy Regulatory Commission (FERC) of 1975 and 1987 require installation of stream gages to monitor project related flows[1]. The gages were to be installed in collaboration with state and federal resource agencies, and maintenance and operations fees advanced to the U.S. Geological Survey (USGS). As noted in the DLA (Page 5-11), no USGS stream gage data are available for the Union River. Licensee should clarify in the Final License Application (FLA) why stream flow gages were not installed as required by the license articles.
2. It is unclear from the DLA who owns the fish trap facility and who is responsible for operating and maintaining the structure. Ownership and control of the trap facility is of critical importance to the site because fish are present at the site and fish passage is necessary to mitigate negative project related impacts. Currently, the existing trap is the only available dedicated means to capture fish for stocking above the Project. In the DLA, the Licensee claims the existing trap satisfies their fish passage responsibilities. However, previous licensing documents indicate the existing fish trap is owned by the Maine Department of Marine Resources[2]. The resource agencies need certainty of requirements to maintain and support restoration efforts. We rely on the FERC issued license to ensure such requirements are enforceable license articles. If the Licensee does not own the fish trap facility, or if the fish trap is not considered part of the Project, then it must be clarified how operation of the trap will be required under the FERC license. The DLA needs to clarify whether the trap is part of the Project and the licensee's role, responsibility and ability to control operations of the trap.
3. Units for average annual generation should be corrected. The DLA indicates 30,333,000 megawatt hours (MWH). This should be corrected to kilowatt hours (kWH).

[1] Article 405, FERC Order issuing new license, December 28, 1987; Article 8, Terms and Conditions for Constructed Major Project Affecting Navigable Waters of the United States, revised October 1975.
[2] Water Quality Certificate, Board of Environmental Protection, Maine Department of Environmental Protection, April 22, 1987.

4. The DLA refers to the fishway as a fish lift. The structure is a trap. The fish are attracted to an entrance, led to the hopper and trapped for transport or harvest. The final license application should reflect this distinction.

Draft Exhibit B

1. Section 1.1.1, Existing Operation Mode, Normal Operations (Page B-1): The DLA identifies the Project as two developments, the Ellsworth Dam, which is described as run of river, and the Graham Dam which provides timed releases for generation at the Ellsworth Dam resulting in a "peaking" operation. The two dams operate under a single license. As such, the Ellsworth Project operates as a peaking facility with the associated environmental impacts below each dam and should be evaluated as such in the environmental analysis required under the National Environmental Policy Act.
2. Section 1.1.2, Existing Operation Mode, Adverse and High Water Condition Operation, low Flow (Page B-2): This section states that drawdown of Graham Lake provides important flow augmentation during dry inflow periods benefiting water quality and habitat. The capacity to provide a consistent minimum flow may have value; however, there may be potential passage impediments in select sections at the current minimum standard. As described in the August 21, 2015, Updated Study Report (USR), portions of the upper and middle reach of the Union River below Graham Dam may be shallow with low flow velocities. The assessment was conducted at 150 cfs, significantly (~40%) greater that the existing minimum of 105 cfs. This hampers our ability to properly evaluate the existing conditions. Table 3-11 (USR, Page 3-63) provides extrapolated habitat conditions at 105 cfs, but the Licensee does not present the methods used to extrapolate the flow in the DLA. Those data only include a potential maximum depth. The potential minimum depth and flow velocity conditions could result in stranding or migration impediments. Extrapolation of the flow data to describe habitat conditions in the FLA should include minimum depths as well as information on how the extrapolation was conducted.
3. Section 2.2, Flow Data (Page B-5): The method of calculating flows needs to be better described in the FLA. For instance, we are unable to determine if the calculation was based upon average daily generation or based upon unit output at certain time intervals. There is no indication of how spill may have been incorporated. It is unclear whether the flow calculation included the period of time when available flow was less than the minimum turndown flow for the units. In addition, it is not clear from the DLA whether the average head was assumed or determined by detailed PLC (programmable logic controller) data; how unit efficiencies were determined; or why a regression curve was used when data was directly calculated from the plant. Without knowing how the flow was calculated, we are unable to evaluate the merits of the method.

4. Section 2.2, Flow Data, Table B-4 (Page B-6): The table for "Monthly Average River Flow 1994-2014 for Ellsworth Dam" includes periods of no flow (0 cfs). This suggests a problem with the flow calculation. See the previous comment. The flow calculation method needs greater detail in its description.
5. The FLA should include a table indicating the monthly minimum, average, and maximum elevation of the Graham Lake impoundment.

Draft Exhibit C

Section 3.0, Construction Schedule for New Development (Page C-3): The FLA should propose to install a USGS-type steam flow gage downstream of both the Graham Lake and Ellsworth Project to demonstrate compliance with project license articles.

Draft Exhibit E

1. Section 3.1.3, Existing Project Operations (Page E-3-4): Figure E-2: Graham Lake Reservoir Operating Curves only contains data from 1999-present. Please present all headpond elevation data for Graham Lake Reservoir.
2. Section 3.3.3, Proposed Action, Proposed Environmental Measures (Page E-3-6): Several Protection, Mitigation and Enhancement (PME) measures are proposed, including upstream passage for American eel. No consideration is given to the need for upstream passage for Atlantic salmon or improving downstream passage for all diadromous fish. The FLA should address the findings of the updated study report filed on August 21st and acknowledge the pending downstream studies and note the potential need for improving downstream passage protection.
3. Section 4.4.2, Water Resources, Affected Environment, Existing Water Quality (Pages E-4-24 and 25): The FLA should present the results of all water quality sampling for 2013 in Graham Lake and Leonard Lake.
4. Section 4.4.2, Water Resources, Affected Environment, Existing Water Quality (Page E-4-26): The Licensee states "The community structure and function found in the tailwater section of the Graham Lake Dam on the Union River shows evidence of organic enrichment and filter-feeder dominance which is a common phenomenon below lake outlets and impoundments (Hynes 1970, Spence and Hynes 1970, Parker and Voshell 1983)." Project operations, including ramping, likely affects the macroinvertebrate community structure and function below Ellsworth Dam. Macroinvertebrates are a food source for juvenile fish such as Atlantic salmon parr and juvenile alosines. This impact should be considered in the FLA.

5. Section 4.4.2, Water Resources, Affected Environment, Impoundment Tributary Connectivity (Page E-4-27): The Licensee did not conduct the impoundment tributary connectivity study at the lowest impoundment levels. The Graham Lake tributary study was conducted at El. 97.9, more than four feet above the lowest allowable elevation (El. 93.4' msl). Similarly, the Lake Leonard tributary study was conducted between El. 65.7' and 66.7' msl although the impoundment can be drawn down to El. 65.7. No explanation is given for the deviation from the FERC approved study plan. The Project operating curves (Figure E-2; Page E-3-4) indicates 98' msl as the lowest level Graham Lake is currently managed. The tributary connectivity study does not represent the full history of operation at the Project. The study results do not document the full scope of potential effects to tributary connectivity at the Project if the Project continues to be operated at the current lowest allowable elevations of Lake Leonard and Graham Lake. The study should be completed per the study plan determination.

6. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Atlantic Salmon (Page E-4-40): The DLA indicates "The Project protects EFH for Atlantic salmon by providing upstream and downstream fish passage and migratory pathways to habitat, and ensuring suitable habitat downstream of each development through minimum flows." The Project does not provide upstream passage for Atlantic salmon as there are no upstream fish passage facilities at either dam. Fish are trapped and moved around the Project via a truck which requires fish be removed from the Union River. The Union River between Ellsworth Dam and Graham Dam is completely blocked to migratory fish species including Atlantic salmon. The FLA should reflect this. Further, it remains uncertain whether the present instream flow requirements ensure suitable habitat below Graham Dam. Results of the required instream flow study would help determine the extent of that benefit, if a benefit is observed at all.

7. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Atlantic Sturgeon and Shortnose Sturgeon (Page E-4-41): The FLA should present the "limited bathymetry data for the original river channel" mentioned in this section.

8. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Other Diadromous Fish (Page E-4-43): The FLA should include a citation to support its claim that a lack of American shad broodstock prevents restoration of shad to the Union River. The claim is contrary to the fact that a significant run of American shad that has been restored to the Penobscot River in Maine without the use of broodstock. The run of American shad in the Penobscot River is a direct response to improved passage conditions in the lower river. Unless the Licensee's claim can be substantiated, it is simple supposition and cannot be used to support a license order.

9. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Diadromous Fish, American eel (Page E-4-43): The conclusion of this section is that some American eel enter the project under current operating conditions. Although some eel might enter the

project through cracks and leaks in the structure, we do not believe that such conditions constitute safe, timely or effective upstream passage for eel. Therefore, we are supportive of BBHP's proposal to install a dedicated upstream eelway as a PME (see Section 3.3.3, Proposed Action, Proposed Environmental Measures on page E-3-6). Based on data in the DLA, the juvenile eel harvest in the Union River is an important fishery. The upstream eelway will support that harvest. Results of the downstream passage study will inform the need for downstream passage protective measures.

10. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Diadromous Fish, Other Diadromous Fish (Page E-4-44): The DLA indicates there are no current plans for American shad restoration in the Union River. This is correct. However, the new license will likely cover a 30 year period. Restoration priorities may change in the future. The potential for American shad passage should be considered.

11. Section 4.4.3.1, Fish and Aquatic Resources, Affected Environment, Fish passage (Page E-4-44): The Licensee should clarify the origins of the fish trap at the Ellsworth Project. Specifically, the FLA should state who originally constructed the fish trap, and who is responsible for operation and maintenance of the facility.

12. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis (P. E-4-50): The Project operates in a peaking mode. The DLA does not address the potential for ramping impacts on aquatic species or habitat. The FLA should include an analysis describing the extent of existing flow fluctuations in terms of rate of stage change (ramp rate) and frequency in the riverine reach below the Ellsworth Project. This analysis should describe the physical extent of streambed habitat affected by peaking operations at Ellsworth. The analysis should also describe the potential for down-ramping to strand fish. The FLA should present hourly generation data at the project over the last 10 years to support this analysis.

13. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Water level Fluctuations (P. E-4-52): The Licensee states "Observations in Graham Lake indicated tributaries maintain connectivity through at least early fall seasonal drawdown (Black Bear 2014)." The FLA should include a description of tributary connectivity during mid to late fall for Atlantic salmon.

14. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Water level Fluctuations (P. E-4-52): The Licensee states "There is very little, if any, adverse impact to the resident fish or diadromous fish from the current operating regime for the Ellsworth Project." Information within the DLA does not support this conclusion as the result of several studies (Atlantic salmon smolt study, tributary connectivity study, instream flow study) that would inform such an analysis are not presented in the document.

15. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species (P. E-4-52): The Licensee conducted a visual upstream fish passage

study. This study provides qualitative observations of behavior and movement of river herring. Visual observations for evaluating migration delay are inadequate. Results would be based on many assumptions and cannot provide specific data regarding fish migration behavior at the fishway and Project tailrace and spillway. These data will not provide information about timing of passage (duration and energetics) from approach to trap. Therefore, results from this study cannot be used to support a license order.

16. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species (P. E-4-53): BBHP's conducted a visual upstream fish passage study. The FLA should include observation of fish present within 24 hours of opening the fishway entrance. This information would indicate whether the timing for initiating operations is adequate or needs modification to an earlier date.

17. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species (P. E-4-54): The Licensee states the fish trap at the Project has a positive effect on Atlantic salmon. This claim in unsubstantiated since neither the effectiveness of the fish trap nor survival of Atlantic salmon at the trap has been documented at the Project. Absent substantial scientific information such conclusions should not be included in the FLA.

18. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species (P. E-4-54): This section notes the Upstream Atlantic Salmon Passage Study. The FLA should consider the effects of the two electrical pumps located right beside the entrance on the behavior of Atlantic salmon.

19. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species (P. E-4-54): This section incompletely states potential impacts as follows: "Hydroelectric facilities may result in delays of both upstream and downstream migration of Atlantic salmon." The FLA should also include a statement on the potential for hydroelectric facilities to prevent Atlantic salmon from reaching spawning habitat.

20. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Upstream Passage, Anadromous Species (P. E-4-55): This section states that the trap is not operated at water temperatures above 77°F. State of Maine handling protocol requires handling of adult Atlantic salmon to cease during periods of warm water conditions to prevent mortality from the stress of handling the fish. Because of the existing trap, all fish must be handled at the Ellsworth Project. Therefore, during periods of warmer water, the Ellsworth Project trap is not operated for Atlantic salmon; salmon cannot volitionally pass the Project. By contrast, Milford, West Enfield, and Mattaceunk on the Penobscot have fishways that allow passage regardless of temperature because handling of fish is not required.

21. Table E-14, Ellsworth Trashrack Spacing and Calculated Intake Velocities (Page E-4-56): The trashrack spacing will not physically exclude downstream migrating smolts or alosine. Trashracks spacing of greater than 1/2 inch will allow downstream migrating smolts to be

entrained. These velocities are well above the US Fish and Wildlife Service's recommended 2 feet per second. Juvenile river herring will certainly be entrained at these velocities.

22. On October 5, 2015, the Downeast Salmon Federation filed documentation of a juvenile river herring kill below the Ellsworth Project (accession number 20151005-5376). Injuries observed are consistent with turbine entrainment. In 2014, a similar fish kill was observed. The Licensee responded by evaluating potential areas of impact, consulting with the resource agencies, and making improvements to an auxiliary cooling water system. That action had the intended benefit of preventing future entrainment in that system; however, it did not address the larger concern identified for entrainment at the turbine intakes. The current field observations submitted by the Downeast Salmon Federation indicate the Project continues to impact out migrating fish. What remains unknown is the scale of this impact. We look forward to the results of the downstream passage studies for smolts and eel to further inform the process.

23. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage, (P. E-4-57): The Licensee qualitatively evaluates risk of entrainment but does not explain how operation of the Project will protect outmigrating fish from project related injury and mortality such that stocks can grow in the Union River to meet management goals. Based on the limited information provided in the DLA, we are unable to concur that out migrating fish will be protected. The anticipated downstream passage survival studies for Atlantic salmon smolts and American eel will be informative on this issue.

24. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage, (P. E-4-57): The desktop analysis completed by BBHP was approved in the study plan determination. These data suggest a (1) potentially high survival for alewife and Atlantic salmon and (2) the potential immediate and delayed survival for American eel is low. The desk top analysis is a modeled sample representing potential site conditions. Site specific studies are needed to verify the desk top analysis and account for Project specific attributes. A site specific study will provide information regarding fish behavior at the intakes under existing conditions, as well as a more precise evaluation of entrainment and impingement impacts. As noted above, we await the results of the required Atlantic salmon smolt and American eel adult downstream studies, including balloon tags, for survival estimates. These studies will provide important Project specific data which will inform the licensing decision. Therefore the FLA will not be ready for environmental analysis before the two studies are complete and analyzed.

25. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage, (P. E-4-57): This section states: "Since there are currently very few salmon expected at the Project, salmon (smolts and kelts) have a very low risk of entrainment..." We disagree with this statement. Risk of entrainment is not related to the number of fish

present; rather, it is the risk to those fish present. Based on rack spacing and velocities, we contend that the risk of entrainment is high.

26. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage, (P. E-4-58): The Licensee states all kelts will pass downstream of the project via surface weirs. This assumes that 100% of all kelts will successfully locate and enter the surface weirs in a timely manner. This statement is unsubstantiated and should not be included in the FLA. No fishway has ever been documented to be 100% successful in passing migratory fish species. Post-spawned Atlantic salmon kelts return to the ocean and can return to spawn again as multi-sea winter adults. Repeat spawners produce more eggs per adult and thus, are highly important to the population in terms of reproductive capacity[3]. Kelts that do not enter the surface weirs will likely die upstream of the project if they cannot return to the ocean.
27. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Downstream Passage, (P. E-4-58): The Licensee states that very few salmon are in the Union River due to "extremely low returns." This statement ignores that fact that the fish trap at Ellsworth is functional for Atlantic salmon for about 6 hours per day for 19-39 days a year. By comparison, the migration season at fishways in Maine is typically 200 days between April 15 and November 1, five times the number of functioning days of the fish trap. Increasing the days of activity at the Ellsworth trap may increase the potential for observing Atlantic salmon.
28. Section 4.4.3.2 Fish and Aquatic Resources, Environmental Analysis, Endangered Species, Atlantic Sturgeon and Shortnose Sturgeon (P. E-4-62): The Licensee states "Due to the rarity of these species at the Project, normal operations would not affect shortnose or Atlantic sturgeon." "Rarity" does not preclude impact. Presently, we have no data to support a conclusion on impacts to Atlantic and shortnose sturgeon. We agree that little information is currently available regarding use of the Union River by shortnose and Atlantic sturgeon. The FLA should consider the effects of Project operations, specifically peaking flows, on sturgeon habitat and their use of the river.
29. Section 4.4.3.4 Fish and Aquatic Resources, Environmental Analysis, Cumulative Effects (P. E-4-62): The Licensee suggests that the fishway facilities are effective. This cannot be concluded based on the information provided. Required studies for downstream passage survival have not been completed. Further, we have no indication of the effectiveness for Atlantic salmon and American shad upstream passage. Therefore, we cannot concur with this statement at this time.

[3] Baum, E.T. 1997. Maine Atlantic Salmon: A National Treasure, 1st Ed. Hermon, ME: Atlantic Salmon Unlimited

National Marine Fisheries Service's Comments on Black Bear Hydro Partners, LLC Updated Study Report for the Ellsworth Project (FERC No. 2727) dated August 21, 2015

October 7, 2015

On August 21, 2015, Black Bear Hydro Partners, LLC filed an Updated Study report for studies conducted at the Ellsworth Project on the Union River in Maine. We participated in the Updated Study Report meeting held in Ellsworth, ME on September 3, 2015. Below are our comments on the report.

Section 3.2.1, Impoundment Aquatic Habitat Study

1. The Licensee's August 5, 2013 Revised Study Plan stated tributary access in the impoundments will be assessed "during maximum normal fall drawdown." The study was conducted when Graham Lake was at an elevation almost 6 ft higher than the licensed drawdown conditions (El. 93.4). At an elevation 6 feet lower, tributary connectivity in Graham Lake would be different than observed in the study. Based on the study methods used instead of those approved, the purpose of the study was not achieved; it remains unknown whether tributary access would remain suitable at lower water levels or become more challenging to fish species including river herring and Atlantic salmon. As such, we request the Licensee be required to evaluate tributary access in Graham Lake at the lowest licensed elevation of El. 93.4, if the facility is to operate at the existing lowest elevation levels.
2. During the Updated Study report meeting held in Ellsworth on September 3, 2015, the Licensee acknowledged that water levels were not studied at the licensed elevation of El. 93.4. Therefore, the Impoundment Aquatic Habitat and Tributary Access studies did not demonstrate the full scope of potential Project related impacts on aquatic resources. Project related impacts on aquatic resources associated with peaking operations remains unknown. This study should be completed under the full head pond range provided under the current license conditions.
3. By letter dated July 8, 2013, the FERC stated the impoundment tributary access study should include photos of the exposed tributary deltas when the impoundments are drawn down and tributary gradient profiles for the normal range of impoundment operating elevations. The Licensee did not collect the required tributary gradient profiles. As such, we request the Licensee be required to collect the tributary gradient profiles at the licensed drawdown El. 93.4.
4. All photographs of Graham Lake tributaries collected during the assessment should be included.

5. The Licensee did not evaluate zone-of-passage conditions in Graham Lake tributaries using established scientific criteria for fish species. During the Updated Study report meeting held in Ellsworth on September 3rd, the Licensee acknowledged that no zone of passage criteria were used for various life stages of Atlantic salmon, river herring or American eel to evaluate tributary connectivity. Stream hydraulic factors such as channel depth and velocities must be related to the various life stages of fish species to determine whether a suitable zone-of-passage exists at these tributaries. Simply judging them to be passable without reference to understood criteria related to various species, as was done by the Licensee, is far too subjective and does not comport with standard scientific principles. Therefore the Licensee's conclusions cannot be relied upon and cannot support the development of license articles.

Section 3.2.2, Outlet Stream Aquatic Habitat Study

1. The purpose of this study was to evaluate instream aquatic habitat in the outlet stream below Graham Lake as a migration pathway for Atlantic salmon, American shad, alewife, and American eel. The study was also required to evaluate this reach of river for production of brook trout, Atlantic salmon, American shad, alewife, and American eel. The Licensee's August 5, 2013 Revised Study Plan required four flow levels be evaluated including: 105 cfs, 250 cfs, a mid-level generating capacity flow, and a high-level generating capacity flow. The lowest observed flow observed during the study was 150 cfs. A flow of 150 cfs is over 40% higher than the 105 cfs minimum flow. The Licensee did not conduct the approved study as provided in the study plan determination. Further, the Licensee provides no reasonable cause or justification for not studying the 105 cfs flow. As such, we request the Licensee be required to collect data in the outlet stream as provided in the August 5, 2013 Revised Study Plan at a flows of 105 cfs.
2. No methodology was provided describing how the flow data were extrapolated for assessing flow impacts. Past compliance reports indicate that the Licensee is capable maintaining minimum flows at the project. The Final License Application (FLA) should include all formulas and calculations for extrapolating the wetted width to the unobserved 105 cfs study flow.
3. The Licensee states that changes in instream flow for the Ellsworth Project would not be expected to affect diadromous fish downstream of the Ellsworth Dam due to tidal influence. Peaking, however, has been demonstrated to negatively impacts migrating fish (e.g., Hunter 1992[4]). To verify the Licensee's statement, hourly generation flows during

[4] Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: a review of the biological effects, mechanical causes, and options for mitigation. Washington Department of Fisheries Technical Report 119. Olympia, Washington. 46 pp.

the upstream migration period in the Union River (April 1 – November 1) should be provided for the last 10 years. These data can be used to evaluate the potential for Atlantic salmon passage in the tailrace. Absent such data, the Licensee's conclusion is mere supposition and cannot be relied upon by FERC and the resource agencies.

4. The Licensee's August 5, 2013 Revised Study Plan required stage, velocity, and depth measurements at all nine transects to verify the measured flow against the recorded flows. On p. 3-60 of the Updated Study Report, the Licensee states that stage, velocity, and depth data were collected at each transect at the lowest flow evaluated. Those data should be presented for review to the resource agencies. These may be made available in the FLA.

5. The Licensee states that the velocity meter used during the study malfunctioned and an alternative method was used to calculate velocities along transects was used. Each estimated velocity should be clearly identified in the FLA.

6. Table 3-8 on p. 3-61. Data from actual stream gaging (depth x velocity x width) at each transect pursuant to p. 3-60 of the report should be added.

7. The Licensee did not evaluate zone-of-passage conditions in at outlet stream tributaries using established scientific criteria for fish species, as required in the study plan determination. Stream hydraulic factors such as channel depth, width, and velocities must be related to the various life stages of fish species to determine whether a suitable zone-of-passage exists at these tributaries. Judging them to be passable without reference to understood criteria related to various species, as described in the report, is subjective and does not comport with standard scientific methodologies. Therefore the results cannot be used to evaluate project related impacts or support the development of license articles.

8. All photographs taken during this study should be provided in the FLA.

9. Table 3-12 on p. 3-74. Data within this table are not clearly defined. To enhance our understanding of this table, use of the 50% optimal cutoff should be explained in the methodology.

Attachment 3-1, Upstream Fish Passage Alternatives Study

1. In the Introduction, the study purpose is defined as "…reviewing previously developed fish passage design concepts considered for the Ellsworth Project in the past and updating them, as well as an assessment of any newer fish passage technologies that may be appropriate for the site." Typically, an ice harbor pool and weir type fishway or a fish lift is recommended for a hydropower facility of this design. The ice harbor alternative was not considered. Including an ice harbor fishway design would provide a more complete

understanding of options at this site. Therefore we recommend the FLA include additional analysis of fish passage options to include consideration of an ice harbor design.

2. Section 1.2, Ellsworth Project Site Description (Page 1). The section states the following "…an average annual generation of 30,333,000 megawatt-hours (MWH)." This is incorrectly labeled. The units should be kilowatt-hours (kWH). See also Section 7, Estimated Generation Costs of Alternatives (Page 157).

3. Section 1.2, Project Downstream Passage, Ellsworth Dam (Page 7): It is important to note that water and fish exit the transport pipe perpendicular to the face of the dam and are then conveyed down the face of the dam to the tailrace area (Photo 1). The existing discharge and conveyance of fish may lead to injury or mortality.

4. Section 1.2, Project Downstream Passage, Ellsworth Dam (Page 7): Downstream passage facilities are present at the project with modifications as described in the study. The downstream passage facilities have never been tested for their overall ability to pass fish safely and effectively. The required downstream passage studies for smolt and American eel will provide data critical to the evaluation of Project related impacts on out migrating fish. These data will be informative for the development of license articles and fishway prescriptions and the FLA will not be ready for environmental analysis until these studies are completed.

5. Section 1.2, Project Downstream Passage, Graham Dam (Page 7): A surface weir is used at the Graham Dam to provide downstream passage of out-migrating fish. Additional information should be provided to clarify whether the weir functions for passage under all headpond conditions and identify the flow rate provided under all headpond conditions.

6. Section 1.2, Project Downstream Passage, Graham Dam (Page 7): Figure 4 shows the downstream passage discharge as viewed from below the dam. The photo station is out of range to clearly show the discharge conditions. We recommend additional photos of this Project feature, including photos clearly showing the pipe-dam interaction point.

7. Section 1.2, Project Upstream Passage (Page 10): This section indicates that no Atlantic salmon returned to the Union River between 2006 and 2011. This statement cannot be substantiated because, among other reasons, the fish trap is only operated 1/5th of the period of the Atlantic salmon migration. At most, the Licensee can state that it did not observe Atlantic salmon during this period.

8. Section 1.2, Project Upstream Passage, Ellsworth Dam (Page 10): This section states "The Ellsworth Dam trap and transport facility is equipped with a four-weir vertical slot upstream fishway leading to a trap…" This is a flawed description of the fishway as a "weir." This is a vertical slot fishway with pools leading to the trap, not a pool and weir fishway. This section should be corrected in the FLA.

9. Section 1.2, Project Upstream Passage, Ellsworth Dam (Page 10): Additional information should be provided in the FLA to clarify the operations: time period of operating the fish trap during this period (date to date); days of the week the fish trap was operated; time of day was the fishtrap was operated; frequency of checking the fish trap; etc. This information defines the availability of the trap for Atlantic salmon and the probability of operators to observe individual fish.

10. Section 1.2, Project Upstream Passage (Page 11): Captions for Figures 6 and 7 indicate the fish passage facility is a fish lift. Technically this is a fish trap. There is no swim though capability at this site. This should be corrected in the FLA.

11. Section 1.2, Project Upstream Passage, Graham Dam (Page 11): Noted in this section is that Graham Dam does not have a fishway. Atlantic salmon that fall back over the Graham Dam have no ability to pass upstream. Their ability to access spawning habitat is restricted. This is a significant impact on the migratory habitat of Atlantic salmon. Passage at both dams associated with the Ellsworth Project will need passage facilities to mitigate impacts on migratory fish.

12. Section 1.2, Project Upstream Passage (Page 13): The Operations and Maintenance plan agency consultation remains ongoing. We are working cooperatively with the Licensee to complete that document.

13. Section 1.3, Upstream Fishway Design Parameters (Page 14): Ellsworth powerhouse flow capacity is approximately 2,320 cfs and fishway pumped attraction flow is up to 50 cfs at Ellsworth, depending on tailwater elevation. Pumped attraction flow is approximately 2% of station capacity. Current USFWS standard is 3% of station Hydraulic Capacity or 70 cfs. We have been using 3-5% of station hydraulic capacity on the East Coast and 5% per entrance of the flow duration curve for the fish passage season on the West Coast. The attraction flow will need to be evaluated by the Licensee specifically for Atlantic salmon.

14. Section 1.3, Upstream Fishway Design Parameters (Page 14): The diffused attraction flow grating at the fish trap has a flow velocity of 1.5 fps. By contrast, the current USFWS criteria is 0.5 fps for horizontal diffusers and 1.0 fps for vertical diffusers. The effects of diffused attraction flow at the Project will need evaluation by the Licensee.

15. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 16): This section indicates a "USFWS design criteria peak hourly rate of 4,725 river herring per hour." This number is incorrect. The design criterion for the cycle time and hopper volume is 12,088 river herring per hour for the peak hour of the peak day.

16. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 16): The existing hopper is only 61 cf. The harvesting hopper does not hold water, therefore when it is lifted the fish are in the dry (Photo 2). The hopper should be 166 cf to meet design standards.

17. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 16): The stated cycle time is 12 minutes. This cycle time only accounts for the time to raise, dump, and lower; it does not include the amount of time the trap fishes. Therefore, the true cycle time is much longer, which changes the fishing time and ability to capture an Atlantic salmon, if present.

18. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 16): The current handling of salmon includes dip netting. Dip netting salmon is not an acceptable way to handle the fish due to the potential for injury and stress to the fish. Protocols for handling salmon will need to be improved regardless of the ultimate fish passage method installed. This will be completed in consultation with the resource agencies.

19. Section 2.1 Trap and Transport Alternatives, Existing Facilities (Page 17): The report suggests that capture, handling and release of wild Atlantic salmon can be completed within a couple hours. The timing depends upon how often the trap is checked. A salmon could be in the process for a total of 5 hours since the trap is only checked once every 3 hours. Therefore, the potential time for handling and associated stress is greater than described in the DLA.

20. Section 2.1, Trap and Transport Alternatives, Existing Facility (Page 16): This section states: "The 2015 season experience clearly demonstrated the capacity to handle over a half million river herring and the doubled spawning escapement." For clarity, the 555,015 river herring is a combined total of the harvest and new escapement target. It should be recognized that the current facility managed over a million river herring in 2012. The management goal is twice that volume. With the increased stocking rate, we anticipate returns of river herring to approach the 2.3 million river herring goal in the coming 4-5 years. Decisions made in this proceeding will affect the ability to meet management goals to support a sustainable run and an important harvest, and our ability to support recovery of Atlantic salmon. This should be clarified in the FLA.

21. Section 2.1, Trap and Transport Alternatives, Existing Facility (Page 16): This section states: "The current trap and transport facilities and operating protocols at Ellsworth have proven reliability and functionality by handling river herring runs from 190,000 to 1,200,000 river herring and 0 to 8 Atlantic salmon annually from 2000 to 2015…" We disagree. There are no data to indicate the existing facility and operating protocol have been proven reliable or that they function properly for Atlantic salmon.

22. Section 2.2 Hopper Improvements and Fish Trap Capacity, Ellsworth Fish Trap Capacity (Page 18): The report indicates the fishway pool has a depth of 4.25 feet and total capacity of 255 cubic feet. Without detailed construction drawings, these dimensions cannot be verified for the holding pool or the fishway pools. Figure 9 is insufficient. However, based upon Figure 9 the water depth is only 3.25 feet not 4.25 feet as suggested. Construction drawing for the fishway should be provided in the FLA and the depth and calculation verified.

23. Section 2.2 Hopper Improvements and Fish Trap Capacity, Ellsworth Fish Trap Capacity (Page 18): The harvesting hopper does not hold water, thus the capacity is 0 (Photo 2). Retaining water during lifting operation is important for the proper handling of Atlantic salmon.

24. Section 2.2 Hopper Improvements and Fish Trap Capacity, Ellsworth Fish Trap Capacity (Page 18): The "hopper dimensions" provided are the dimensions of the concrete and are incorrectly applied in the report. The hopper capacity does not include the screened wall panels (Photo 3). The capacity is only based upon the watered up portion of the hopper. The inside dimension of the hopper is 5.75 square feet with only 2 feet of water.

25. Section 2.2 Hopper Improvements and Fish Trap Capacity, Ellsworth Fish Trap Capacity (Page 18): This section states: "...the dimensions of the hopper pool walls that establish the maximum hopper size." This statement is incorrect. Hopper size is determined by only the inside dimensions of the watered up section of the hopper walls.

26. Section 2.3.2, Separation of River Herring from Atlantic Salmon Passage, Phase 2 – Add Volitional Fish Ladder to Expanded Hopper Pool (Page 22): This section indicates that a steeppass or Denil could be accommodated for Atlantic salmon. We generally would not recommend a steeppass fishway for this high amount of head. A standard 4 foot wide Denil could be used for Atlantic salmon. However, we would not recommend a Denil for American shad or river herring because of the amount of head.

27. Section 3.0, Fish ladder Alternatives (Page 23): We appreciate the effort to complete this required study. The licensee will need to provide their proposed alternative in the FLA. Our conclusion on the appropriateness of any one design will be formulated when all data are available and the application is ready for environmental analysis notice. We do not typically recommend or prescribe trap and truck for hydropower facilities less 250 feet in head because there are alternative fishway designs that better accommodate the migration behavior.

28. Section 3.0, Fish ladder Alternatives (Page 23): Analysis of fish ladder alternatives is based on the assumption that the existing vertical slot trap functions efficiently and effectively. While the vertical slot trap has been effective in meeting the stocking management goals for river herring, the trap has not been evaluated for its efficiency to attract and capture fish. Similarly, we have no data to determine whether the vertical slot trap functions effectively or efficiently for Atlantic salmon. Therefore, we are not able to assess the potential success of this structure for meeting passage and survival goals for Atlantic salmon.

29. Section 3.0, Fish ladder Alternatives (Page 23): The fish ladder alternative introduces pumping river herring out of the holding pool. This represents a new handling action that would require evaluation for post handling injury and mortality. If this design was

implemented and handling mortality and injury were found significant, further alternatives would need to be considered and implemented.

30. Section 3.1.1, Fish ladder Alternatives, Steeppass Denil (Page 23): The Steeppass alternative evaluated would be approximately 250 to 300 ft long. This would be one of the longest Steeppass fishways in the world; we know of no other that would be this long. We, therefore, have no monitoring data from similar fishways to guide the analysis. Although it is appropriate for the alternatives analysis, we have no data to suggest it would be effective for any of the target species.

31. Section 3.1.2, Fish ladder Alternatives, Standard Denil (Page 25): The standard Denil alternative evaluated would be one of the longer Denils in the world. The Woodland Denil fishway on the St. Croix River in Maine has been said to be the longest in the world at almost 700 ft in total length. We have no data to suggest a Denil at the Ellsworth Project would be effective for any of the target species. Although it is appropriate for the alternatives analysis, we have no data to suggest it would be effective for any of the target species.

32. Section 3.1.2, Fish ladder Alternatives, Standard Denil (Page 25): The standard Denil alternative evaluated could potentially pass 1,000,000 or more fish. However, it is intended for a smaller design population. Fishways are designed for the peak hour of the peak day of migration. At this high number, we anticipate the returns to overwhelm the fishway and result in significant delay in the passage timing.

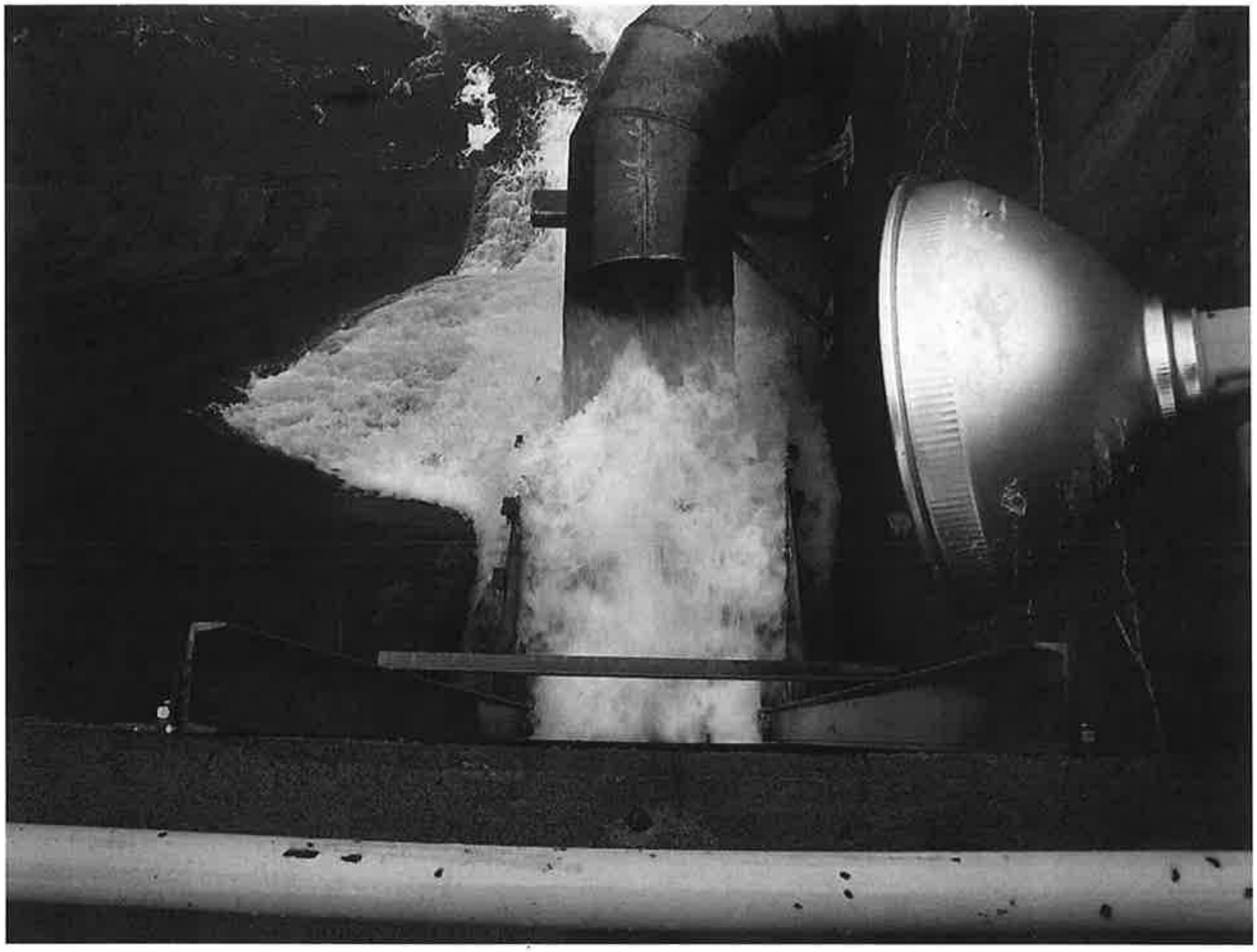

Photo 1. This view is looking down the face of the dam from above the surface weir adjacent to the Unit 1. In view is water discharged from surface weir and the transport pipe directing flow from two stoplog controlled surface weirs above Units 2 through 4. The two structures converge at this point with fish and water passing down the dam to a plunge pool. Photo: Don Dow, NMFS.

Photo 2. The harvest hopper does not hold water. Fish are in the dry when the hopper is lifted. Photo: Don Dow, NMFS.

Photo 3. The hopper capacity does not include the screened wall panels. The capacity is only based upon the watered up portion of the hopper as measured from the interior walls. Photo: Don Dow, NMFS.

Document Content(s)

City of ELLSWORTH
Business, Leisure, Life.

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October 5, 2015

Nicholas Palso, Moderator
Federal Energy Regulatory Commission
888 First Street, NE
Room 62-30
Washington, DC 20426

RE: Impacts of Graham Lake Water Levels on Recreation
Relicensing of Ellsworth Hydroelectric Project (# 2727)
DELIVERED VIA EMAIL (nicholas.palso@ferc.gov)

Dear Mr. Palso;

The City of Ellsworth is looking forward to having the Ellsworth Hydroelectric Project in productive use for another 30 years. The two dams have provided many benefits to the community, including recreational opportunities on both Graham Lake and the Union River. As part of the relicensing of the Ellsworth Hydroelectric Project, the City respectfully requests that the impact of low water levels in Graham Lake (especially during the summer months of July and August) be taken into consideration during the upcoming review process.

To the best of our recollection it seems that while under Bangor Hydroelectric management, Graham Lake water levels were typically kept higher through the summer months, and through to the Labor Day holiday. More recent water drawdown trends have resulted in lower water levels during the summer, making the lake more unpredictable, and thus creating potential safety hazard conditions for boaters. Keeping higher water levels through the summer would result in additional recreational benefits for all lake users.

It would be very much appreciated if you would take our concern into consideration and have it go on record. I look forward to having a chance to further discuss this matter.

Respectfully submitted,

David Cole/pw

David A. Cole

Document Content(s)

Joe Minutolo
77 Whitmore Road
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October 7, 2015

Nicholas Palso, Moderator
FERC
888 First Street, NE
Room 62-30
Washington, DC 20426
nicholas.palso@ferc.gov

RE. Relicensing of Ellsworth Hydro Electric Project #2727

VIA EMAIL

Dear Mr. Palso,

I recently attended a public meeting at the Ellsworth City Hall concerning the relicensing for operating the Dam on Graham Lake. It was a well attended meeting that lasted for 3 1/2 hours. The majority of the meeting was concern for the fish, eel and alewives habitat and population. The discussion was in depth and very informative, with exchanges in dialog between many organized groups, such as: U.S. Fish and Wildlife, National Marine Fisheries Service, Atlantic Salmon Federation, Downeast Salmon Federation, College of the Atlantic, Frenchman's Bay Conservancy and more.

To my surprise there was nobody representing the landowners and residents of Graham Lake except for myself. I found out about this meeting by chance, and after asking questions to some of my neighbors, it appears that nobody knew about it, or they would have come. This is a very important part of the picture needed to construct the details of the future licensing. The 30 year agreement is a big deal as it affects all the surrounding communities in so many ways. The interests of this group need to be heard and taken into consideration.

I have lived on Graham Lake for four years. When I talk to people about the lake, one of the biggest concerns that I constantly hear is the drawdown of the water level in the summer. It starts in July, and in August, Graham Lake can be so low that it can be deemed unsafe to use any type of boat or watercraft. This is the best time of the year in Maine. It's time to swim, boat, kayak, go fishing, and use Graham Lake to its fullest potential. The timing of this drawdown damages all recreational experiences on the lake. In turn, this has a great affect on the recreational users, property owners, and residents. Even on the communities that surround Graham Lake. We all know that to this point, Graham Lakes land value is lower than any of the surrounding lakes per acre. The reason for that is the uncertainty of the water levels in the summer months. The lower water levels create an environment that is not desirable to the recreational users. That is why the other lakes exceed in recreational use, and land values. People invest on lakes to recreate, this creates value. When the value is higher, people invest. It creates jobs, raises more tax revenue for local communities. That's what builds schools, repairs roads and creates more jobs.

Graham Lake has the potential to be one of the most dynamic resources in Hancock County. The population is growing and headed this way. That makes it imperative to protect these water levels. The other lakes are already getting overcrowded, and the fact that the size and scale of GL are such it exceeds Beech Hill Pond, Green Lake, and Branch Lake combined. That alone will help with the demand on these resources, and improve the recreational experiences for all.

As a side note, I request to be added to the Distribution List dealing with this matter.

Sincerely,

Joseph Minutolo

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, DC 20426
October 8, 2015

OFFICE OF ENERGY PROJECTS

Project No. 2727-086-Maine
Ellsworth Hydroelectric Project
Brookfield White Pine Hydro LLC

Mr. Frank H. Dunlap
Brookfield White Pine Hydro LLC
26 Katherine Drive
Hallowell, ME 04347

RE: Comments on Draft License Application and Updated Study Report

Dear Mr. Dunlap:

Pursuant to 18 CFR § 5.16(e), this letter contains Commission staff's comments on your July 10, 2015, draft license application for the Ellsworth Hydroelectric Project. Our specific comments on the application are outlined in Appendix A.

In the draft license application, you indicate that additional information will be provided in the final license application.[1] This information and the information requested in Appendix A should be included in your final license application or the Commission may find that the application is not ready for environmental analysis, pursuant to 18 CFR § 5.22 of the Commission's regulations.

Additionally, pursuant to 18 C.F.R. § 5.15(f), Black Bear Hydro Partners, LLC (Black Bear Hydro) conducted a meeting on September 3, 2015, with relicensing stakeholders and Commission staff, to provide an updated report on the studies required by the Commission-approved study plan.[2] Our comments on the updated study report are attached in Appendix B. On September 9, 2015, Black Bear Hydro filed its initial study report meeting summary. We have no comments on or disagreements with the meeting summary.[3]

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[1] This information includes the field component of the Upstream Atlantic Salmon Passage Study and the Downstream American Eel Passage Study.

[2] See the Commission's September 4, 2013, study determination letter and December 30, 2014, study modification letter.

[3] See section 5.15(c)(4) of the Commission's regulations.

If you have any questions regarding this letter or the contents of your final license application, please contact Dr. Nicholas Palso at (202) 502-8854, or via email at nicholas.palso@ferc.gov.

Sincerely,

Bob Easton, Chief
New England Branch
Division of Hydropower Licensing

Attachments: Appendix A – Comments on Draft License Application
Appendix B—Comments on the Updated Study Report

cc: Mailing List, Public Files

Appendix A
Comments on Draft License Application

Commission staff's review of your draft license application (DLA) has identified the following deficiencies, additional information, and clarifications that should be addressed in your final license application (FLA).

Initial Statement

1. The Initial Statement includes the name and mailing address of municipalities of over 5,000 residents within 15 miles of the project, as required by section 5.18(a)(2)(ii)(B); however, the list does not include the Town of Bar Harbor. You should include the address of the Town of Bar Harbor in the FLA.

Project Description

2. Exhibit A does not provide all of the information that is required by section 4.51(b) of the Commission's regulations. To address this deficiency, Exhibit A of the FLA should be revised to describe the following facilities: (1) respective dimensions (i.e., lengths and heights) of each section of the dams at the Ellsworth and Graham Lake Developments (i.e., earthen embankments, spillways, and abutments); (2) heights of the three spillway gates, sluiceway, flood wall, wing wall, and steel cell at the Graham Lake Development; (3) gross storage volume of Graham Lake; (4) dimensions of the two intake facilities and associated facilities at the Ellsworth Development, including the number and dimension of each headgate and the clear bar spacing of the trashracks; (5) lengths of all four penstocks at the Ellsworth Development; (6) dimensions and hydraulic capacities of the upstream and downstream fish passage facilities at the Graham Lake and Ellsworth Developments; (7) the minimum hydraulic capacity of each turbine unit at the Ellsworth Development; and (8) the voltage of the 320-foot-long transmission line.

Project Operation

3. Sections 1.0 and 2.0 of Exhibit B describe the installed capacity and dependable capacity of the project as 8.90 megawatts (MW) and 9.05 MW, respectively. You should describe how the dependable capacity was calculated, including descriptions of data sources, assumptions, and computations in the FLA.

4. Section 2.2 of the DLA states that you calculated mean monthly flow data for the project based on project generation because there are no United States Geological Survey gauges in the Union River watershed. However, table B-4 indicates that the mean monthly flow for August 2006, September 2006, and September 2007 was 0 cubic feet per second (cfs). While the project may not have generated during these months, it seems unlikely that there was no flow through project. Therefore, you should include a revised

table B-4 with flow calculated based on project generation, minimum flows, and fish passage facility flows in the FLA.

5. You state that the low flow value shown on the flow duration curves in Appendix B-1 (323 cfs) is based on the required minimum flows for the project and the flow through the fish passage facilities. However, you use 323 cfs for nearly all the monthly flow duration curves even though the required minimum flow for the project is 250 cfs from May 1 through June 30 and 105 cfs from July 1 through April 30. Therefore, you should provide revised flow duration curves that use the appropriate minimum flows and downstream fish passage flows to represent the low flow value in the FLA.

Project Boundary

6. Section 1.0 of Exhibit A and the Exhibit G drawings indicate that the proposed project boundary around the Graham Lake impoundment is generally established by contour elevation 107 feet mean sea level (msl), which is 2.8 feet above the impoundment's normal maximum water surface elevation of 104.2 feet msl. Section 4.41(h)(2) of the Commission's regulations requires that the project boundary must include "only those lands necessary for operation and maintenance of the project and for other project purposes, such as recreation, shoreline control, or protection of environmental resources." The FLA should describe any project related uses of the lands above the normal maximum water surface elevation. If the lands above the impoundment's normal maximum water surface elevation do not serve a project purpose, you should propose to remove these lands from the project boundary and revise your descriptions of the proposed project boundary in Exhibits A, E, and G of the FLA, as appropriate.

7. The Exhibit G drawings filed with the DLA do not enclose all lands necessary for operation and maintenance of the project and for other project related purposes, such as recreation, shoreline control, and protection of environmental resources as required by Section 4.41(h)(2) of the Commission's regulations. To correct this deficiency, the Exhibit G drawings filed with the FLA must show and label all principal project works necessary for operation and maintenance of the project enclosed within the project boundary, including the a carry-in boat launch off Shore Road, the Graham Lake Dam boat launch, the 320-foot-long transmission line, and the vertical slot fishway and trap facility.

8. The Exhibit G drawings filed with the DLA have not been stamped by a registered land surveyor as required by Section 4.39(a) of the Commission's regulations. To correct this deficiency, the Exhibit G drawings filed with the FLA must be stamped by a registered land surveyor.

Fish and Aquatic Resources

9. Pages E-4-45 and E-4-46 of Exhibit E provide descriptions and information about the operation of upstream and downstream fish passage facilities at the Ellsworth and Graham Lake Developments but do not provide any information about attraction or conveyance flows for the passage facilities. You provided some information about attraction and conveyance flows for the fish passage facilities at the Ellsworth Development in Section 6.3.3 of your proposed study plan but did not provide any information about the attraction flow for the downstream fish passage facility at the Graham Lake Development. Additionally, page E-4-45 of Exhibit E states that two of the surface weirs at the Ellsworth Development are controlled with stoplogs, but you do not provide any information about the water level conditions that would require adjustment of the stoplogs. Lastly, your March 31, 2015, letter indicated that you have acquired new information about the operation of the fish passage facilities at the Ellsworth Development. You should provide all current information about the operation of the projects' upstream and downstream passage facilities, including the attraction and conveyance flows, and a description of the stoplog adjustment protocol for the two surface weirs at the Ellsworth Development in the FLA.

10. Pages E-4-46 of Exhibit E states that Black Bear Hydro developed an operation and maintenance plan (O&M plan) for the for the project's upstream and downstream fish passage facility and that Black Bear Hydro would implement the plan in 2015 and future years. However, the O&M plan was not included in the DLA. You should include a copy of the O&M plan in the FLA.

Wildlife and Botanical Resources

11. Section 4.4.5.1 identifies eight wetland cover types (i.e., lacustrine, riverine, estuarine, palustrine emergent, palustrine scrub-shrub, palustrine forested, palustrine aquatic bed, and palustrine unconsolidated bottom) in the project boundary; however, the acreages of each wetland cover type were not provided. To the extent possible, you should provide the acreages of each wetland cover type identified in the FLA.

12. Section 4.4.5.2 states that about 35 acres of uplands are managed within the project boundary. In the FLA, you should include a description of your standard vegetation maintenance practices, including the methods you use to manage vegetation (i.e., mechanical, chemical, etc.); your standard maintenance schedule (i.e., activities performed annually, seasonally, as-needed, etc.); your procedures for managing vegetation in sensitive habitats (i.e., wetlands, riparian habitat, etc.); and your procedures when rare, threatened, or endangered plants or animals are encountered during routine maintenance.

Recreation

13. Section 4.4.7.3 of Exhibit E describes a new portage trail around Graham Lake dam to replace the existing trail. The DLA does not include a map of the proposed portage trail. You should include a map that shows the location and relative length of the proposed portage trail in the FLA.

Appendix B
Comments on Updated Study Report

Impoundment Aquatic Habitat Study

1. Section 3.2.1.6 of the updated study report (USR) states that you did not measure the stream gradient profiles for the tributaries entering Graham Lake and Lake Leonard as required by the Commission's study modification determination letter issued on December 30, 2014. This information is needed for staff's analysis of the effects of impoundment elevations on tributary connectivity; therefore, you must measure the stream gradient profiles for the tributaries entering Graham Lake and Lake Leonard and file with the results of your Atlantic salmon smolt downstream passage study.

Upstream Fish Passage and Decommissioning Alternative Study

2. The results of the Upstream Fish Passage and Decommissioning Alternative Study include a brief discussion of the ability of Atlantic salmon and river herring to migrate upstream using each of the upstream passage alternatives. However, the Union River Fisheries Coordinating Committee's 2015 Comprehensive Fisheries Management Plan indicates that other migratory species, including American shad, Atlantic sturgeon, Atlantic tomcod, rainbow smelt, sea lamprey, and striped bass have been observed in the Union River downstream of Ellsworth dam.[4] The study results did not discuss the effects of each passage alternative on these other migratory species as required by the Commission's study modification determination letter. Therefore, you should include a discussion of the potential effects of each alternative on each of these migratory fish species in the final license application (FLA).

3. The upstream fish passage alternatives presented in the USR considered long steeppass and Denil fishways. To the extent possible, you should include a list of other hydropower projects with long steeppass or Denil fishways and any available information regarding the effectiveness of those fishways in the FLA.

4. The Atlantic Salmon Commission's guidance recommends not handling salmon at water temperatures greater than 77º F and not transporting salmon at water temperatures greater than 72º F to avoid exacerbating the effects of temperature-related stress on the fish.[5] However, the results of the Upstream Fish Passage and Decommissioning

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[4] Black Bear Hydro filed the Comprehensive Fisheries Management Plan on February 27, 2015.

[5] Black Bear Hydro included the ASC guidance in the 2006 URFCC report filed on March 7, 2007.

Alternative Study did not discuss how water temperature would affect the operation of each upstream passage alternative for Atlantic salmon. Therefore, you should include a discussion of the effects of water temperature on the operation of each upstream fish passage alternative in the FLA.

5. The results of the Upstream Fish Passage and Decommissioning Alternative Study refer to the 2015 operation and maintenance costs for the existing trap and haul facility but did not provide the actual costs. So that staff can compare the costs of the existing trap and haul facility to the alternatives discussed in the USR, you should provide the operation and maintenance costs for the existing trap and haul facility in the FLA.

Pleasant Point Reservation
P.O. Box 343 • Perry, Maine 04667
Tel. (207) 853-2600

October 8, 2015

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

RE: Ellsworth Project (P-2727)

Dear Secretary Bose,

As stated in a letter Chief Frederick Moore III signed and submitted on August 25, 2015, the Pleasant Point Passamaquoddy Tribe has a vested interest in protecting watersheds and lands within the Passamaquoddy Aboriginal Homeland. The Union River falls within these traditional boundaries and connects to the larger Gulf of Maine, a culturally significant ecosystem to the Passamaquoddy. The Passamaquoddy are actively involved in conserving this ecosystem and providing uninhibited access to culturally important species. In order to sustainably manage fish, a traditional food source, the Passamaquoddy recognize the necessity in restoring fish species to their home waters.

The Passamaquoddy believe that no action should directly or indirectly result in the endangerment of any species. All living creatures, brothers and sisters in this world, deserve the respect and right to fully use and inhabit their native lands and waters. Guided by this principle, the Passamaquoddy ask for safe, timely and effective fish passage for all aquatic species within the Union River and its tributaries.

Current Passage Critique

Upstream passage at the Ellsworth and Graham Lake project sites needs extensive modifications. Currently, fish passage through the Ellsworth Dam and Graham Lake Dam projects is inadequate. The trap and truck operation is inefficient, creating a backlog when the trap is closed, preventing passage for all species. The harvest-style trap dewaters when lifted, leaving the fish dry and exposed to crushing, coupled with handling and transportation stress, increasing the risk of delayed mortality. The percentage of fish required to pass does not reflect a long-term (30-50 years) increase in river herring or Atlantic salmon returns. Current operations do not address the return of other species (American shad, American eel, Rainbow smelt, Atlantic tomcod) to the watershed.

We find it unacceptable that fish have no safe and effective downstream passage route. Downstream passage at Ellsworth Dam has proven to be lethal for herring and eels. The downstream passage facility has a turn that does not provide safe passage. Part of the spillway falls onto rocks, increasing the risk of injury and mortality to downstream migrants. Passage through the turbines is lethal for many species, resulting in dismemberment or death from pressure changes. Those that may survive should be examined for internal injuries and assessed for mortality further downstream. These should include experimentation with turbine exclusion grates, screens, and other modifications that help all fish species pass downstream in a safe, timely and effective manner.

Fish Passage Recommendations

The Passamaquoddy Tribe requires that safe, timely and effective fish passage be provided for all species utilizing the Union River and its tributaries. We recommend the following fish passage facility improvements: the installation of a fish lift at the Ellsworth Dam facility, operated on a 24 hour basis from April through October. Fish passage facility improvements should include:

- Installation of a fish lift at the Ellsworth Dam facility, operated on a 24 hour basis from April through October.
- The lift needs to have the engineered capacity to accommodate dramatic increases in the number of returns for all species.
- Safe and timely passage to multiple species, including river herring, Atlantic salmon, eels and American Shad.
- At Graham Lake Dam, a fish ladder designed to safely and effectively pass large numbers of multiple species.
- Provide upstream eel passage at both facilities.
- Ongoing studies to monitor the estuarine anadromous fish population below Ellsworth Dam, to ensure all species present have the opportunity to pass above both facilities.

Seasonal operation of the trap does not coincide with the main upstream migration time of Atlantic salmon. The trap ceases operation in mid-June, preventing passage of fall returning Atlantic salmon. Current operating flows are high during the day, and lower at night, which may inhibit the ability of fish to find their way upstream. Operational procedure changes need to include:

- Modernize attraction flow rates to current US Fish and Wildlife standards.
- Provide upstream access 24 hours a day. Current trap operations run only during working hours, and passage is closed at night.
- Increase the operational season, to provide access from April through October.
- Check the trap more efficiently and regularly for Atlantic salmon. Currently, the trap is checked every 3 hours for the presence of Atlantic salmon. It is raised until approximately 3 feet of water remains in the bottom. In these conditions and with an abundance of herring in the trap, it would be easy to miss spotting a salmon.
- Perform daily walks for fish kills on both sides of the river, regularly throughout a 24 hour cycle and the entirety of the downstream passage season. Assess and address issues immediately, to prevent lethal passage.

Current Study Critiques

In regards to the downstream eel passage study, we feel a larger sample size would more adequately represent the population's behavior. The current study assumes all PIT tags detected downstream are survivals, which may be erroneous, as mortalities may travel downstream and pass through the antennae. It is important to conduct the study in such a way that distinguishes between true survivals and mortalities. Injuries in survivals and mortalities should be assessed and documented.

Current tributary connectivity results indicate that a few inches to 5+ feet of water connect all tributaries to the Union River during drawdown periods. However, Atlantic salmon require more than a few inches of water for successful upstream passage and spawning. Also, the study was not conducted at minimum lake elevation, and depths are not indicative of what they would be at the lowest flow levels. No measurements were taken and no criteria established. Based on this study, it is impossible to determine whether the tributaries are passable. The study should be redone at the lowest drawdown level, adhering to established criteria and providing critical measurements to assess whether the tributaries are truly accessible.

Studies determined that winter dewatering of the littoral zone had no impact on fish communities. However, the study failed to assess whether dewatering would negatively impact food growth and availability for juvenile herring. It is imperative that juvenile fish have access to a prey base for growth and survival. The study should be redone at the lowest lake elevation level to determine the effect of dewatering on the prey community.

The Passamaquoddy are connected to the land and waters through culture, tradition, ancestry, and history. The Passamaquoddy empathize with all animals unable to inhabit and use their traditional territory. For decades, fish have been denied access to their native waters. It is time to welcome the fish home.

Sincerely,

Asha Ajmani

Asha Ajmani, MS
Environmental Scientist
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Passamaquoddy Tribe – Pleasant Point
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Document Content(s)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
Maine Field Office
17 Godfrey Drive, Suite 2
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207/866-3344 Fax: 207/866-3351

October 8, 2015

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

FILED ELECTRONICALLY

RE: U.S. FISH & WILDLIFE SERVICE COMMENTS
Draft License Application, Ellsworth Hydroelectric Project, FERC No. 2727

Dear Secretary Bose:

The U.S. Fish and Wildlife Service (Service) has reviewed the Draft License Application (DLA) for the Ellsworth Project (P-2727) dated July 10, 2015. The Service has participated in the Ellsworth Project relicensing by attending the site visit/scoping meeting, filing comments on the PAD, requesting various studies, providing study plan comments, and attended the meeting to review study results. Our office has also brought certain Ellsworth Project fish passage issues to the attention of the Federal Energy Regulatory Commission (FERC) and we appreciate the diligence of FERC staff in addressing these matters.

The License is proposing no changes in the way the Ellsworth Project is currently operated (DLA page E-3-6). The Service provides the following comments on the Licensee's proposal in the DLA, with reference to relevant documents in the Ellsworth Project docket.

FISH PASSAGE COMMENTS

1. It is the Service's opinion that the existing fish trap does not provide safe, timely and effective upstream passage. The current Comprehensive Fishery Management Plan for the Union River Drainage (CFMP) includes a spawning escapement goal of 315,000 river herring. This spawning escapement will increase to 357,151 when a few remaining portions of the watershed become accessible (DLA page E-4-37). The CFMP also calls for a harvestable surplus of two million river herring, which the Licensee contends could be harvested from the trap.

   The Service and NOAA-Fisheries have evaluated the capacity of the current trap design. They conclude that the vertical slot portion of the trap has the capacity to pass about 900,000 river herring, well short of the 2,357,151 combined harvest and spawning escapement goal. The Service and NOAA-Fisheries also calculated that the live transport hopper has a capacity of 219,000 river herring. This hopper capacity is only nine percent of the harvest and spawning escapement goal. However, if one assumes that the live capture hopper is only used to capture the river herring spawning escapement (i.e., the harvest hopper is used at other times), then the hopper capacity meets 61 percent of the spawning escapement goal.

The Licensee proposes that the trap will also be used for Atlantic salmon and American shad. Since the spawning migration of these species overlaps with the timing of the river herring run, they further reduce the capacity of the fish trap. Due to these capacity shortcomings, the trap cannot provide safe, timely and effective upstream passage for migratory fish in the Union River.

2. The maximum Ellsworth Dam powerhouse flow is approximately 2,320 cfs and fishway pumped attraction flow is up to 50 cfs, depending on tailwater elevation. Thus, the pumped attraction flow is approximately two percent of station capacity. Currently, the Service requires three to five percent of station hydraulic capacity (i.e., 70-116 cfs) for fishway attraction flow at the entrance. The attraction flow will need to be increased to meet this requirement. Alternatively, the Licensee must provide studies to demonstrate the effectiveness of the current facility with the lower attraction flow.

3. The DLA does not describe the attraction water configuration of the existing fish trap, nor does it describe any of the standard operating procedures for the trap. It is our understanding that two pumps are used to operate the trap. The original pump may still be in use and if so, it dates to circa 1974. This pump discharges to the hopper pit and provides flow through the trap and vertical slot section. The second pump was added pursuant to requirements of the previous relicensing of the Ellsworth Project. The second pump introduces water from the tailrace through a side diffuser in the lower pool of the vertical slot section. The velocity of this attraction water is 1.5 fps at the diffuser grating (DLA page 14) which exceeds the Service criterion of 0.5 fps. Flow from both pumps is discharged at the entrance.

   Detailed information should be included on the pumps and diffusion configuration. Specifically, what are the pump capacities, their manufacture, and age? What is the diffuser grating size? What is the tidal gate configuration and how is the tidal gate operated? Is the tidal gate automated? How is the vertical slot section operated? Does the vertical slot section include any baffles or barrier screens? Any other relevant details of the trap operation should be included.

4. The existing harvest hopper does not hold water and is not suitable to move live fish. The live transport hopper holds only 61 cubic feet and does not meet Service criteria which would require a hopper with 166 cubic feet of capacity. The existing trap requires a large hopper to meet Service criteria.

5. The DLA Table on page C-2 notes that in 1986 the “fish passage facility (was) installed” at Ellsworth and also notes 2004 as the date that “a stop log system used for downstream passage of migratory fish” was installed at Ellsworth. Neither date is correct. The

upstream trapping facility was installed in 1974 with roughly half the funding from the Anadromous Fish Conservation Act (federal monies) and the remaining funds split nearly equally among the Licensee and private sources.[1] The downstream passage system, including the weirs and pump-back system, were installed as part of the remedial safety measures built in 1993. The reference to downstream passage installation in 2004 may be for the downstream passage weir installed at the Graham Lake Dam. (Note: DLA page E-4-45 states that the Graham Lake downstream passage weir became operational in 2003.) The dates for the construction of the Ellsworth Project fish passage facilities should be researched, verified, and included in the Final License Application.

6. The DLA is not clear regarding ownership of the fish trap. Although the Licensee states that the facility meets the requirements for fish passage at the site, the facility may be owned by the State of Maine. If that is the case, then there may be jurisdictional issues. The Licensee should research this issue and determine if they need to acquire right, title or interest in order to operate the facility.

7. The Licensee proposes a new upstream passage facility for American eel in Section 4.4.3. However, this section of the DLA does not mention plans for improving upstream passage for any of the anadromous species, nor does it propose to and improve downstream passage for American eel. With regard to downstream passage, the DLA notes that intake velocities at the trash racks of units 2, 3 and 4 are close to three feet per second (DLA Table E-14). This velocity exceeds the Service criterion of 2.0 fps, as measured normal to, and one foot from, the trash racks. The FLA should address the findings of the updated study report filed on August 21, and acknowledge the pending downstream studies and the potential need for improving downstream passage effectiveness.

8. The DLA does not include any discussion of the operational problems and equipment failures that have plagued the Ellsworth dam downstream passage system. This includes the pump failure that compromised the downstream fishway during the 2014 migration. It is worth noting that the same pump has failed again in the last few days, coincident with high river flows that have triggered the fall migration of juvenile river herring and adult eels. Anecdotal accounts lead us to believe that this pump has not functioned properly since it was installed.

9. It is our opinion that the configuration of the Ellsworth downstream bypass discharge is likely to cause injury or death of downstream migrants. Although this opinion has been provided to the Licensee on several occasions, the DLA does not described the issue, nor provide any solution. The Service does not recommend a study of this issue, but believes the orientation of the pipe can be modified at minimal cost and without a specific study.

10. Until the current relicensing proceeding, none of the upstream and downstream fish passage facilities have ever been evaluated for effectiveness using commonly accepted empirical field methods such as telemetry. As stated in the record for the relicensing that

[1] Baum, E.T. 1982. The Union River: An Atlantic salmon management report. Maine Atlantic Sea Run Salmon Commission, Bangor, Maine. 27 pages.

was completed in 1987, and restated in this proceeding, upstream and downstream passage studies are needed for Atlantic salmon, river herring, and American eel. The Service requires such information in order to engage in informed fish passage negotiations with the Licensee.

11. The DLA does not address upstream or downstream passage requirements of American shad. Page E-4-3 of the DLA notes that the Federal Energy Regulatory Commission identified American shad as a resource that could be cumulatively affected by the proposed operation of the Ellsworth Project. The Union River CFMP (section 3.1.3), as well as the previous Union River CFMP, identified American shad restoration as a management goal. American shad recovery on the Penobscot, Sebasticook and Kennebec Rivers indicate this feasible. The nearby Milford broodstock collection facility on the Penobscot River could provide a donor stock. The FLA should acknowledge this management goal and the possibility of implementing American shad restoration during the term of the license.

12. Required studies of adult American eel and salmon smolt downstream passage are ongoing and will be completed in 2016. These studies will provide important Project specific data on passage effectiveness and turbine mortality. These data will inform the licensing decision. Therefore, the FLA will not be ready for environmental analysis until the two studies are complete and analyzed.

OTHER COMMENTS

13. There is some confusion regarding the annual generation of the Ellsworth Project. The Licensee has previously filed documents with the FERC stating that:

    a. the average annual Ellsworth Project generation is 29,907 MWh, and

    b. the gross generation from 10/1/2013 – 9/30/2014 was 31,431 MWh.

    The DLA uses the wrong units but apparently intends to convey that annual generation is 30,333 MWh. The Licensee should provide an accurate figure for average annual generation for the project, with the correct units and clear attribution/citation.

14. The Licensee should expand and update the description of American eel fisheries and conservation measures included in the DLA at page 4-42. The recent Atlantic States Marine Fisheries Commission benchmark stock assessment concluded that the American eel stock has declined in recent decades and the stock is now considered depleted.[2] The ASMFC has subsequently approved two Addenda (in August 2013 and October 2014) to the American Eel Interstate Fisheries Management Plan in order to reduce eel mortality and conserve all life stages of American eel. These Addenda have eliminated the harvest of silver eels in all states, except for a small artisanal fishery on the Delaware River and reduced the harvests of yellow and glass eels. The Maine glass eel fishery has been reduced by more than half in the last three years.

[2] ASMFC. 2012. American Eel Benchmark Stock Assessment. Stock Assessment Report No. 12–01 of the Atlantic States Marine Fisheries Commission. 342 pages.

The Service thanks the FERC for their consideration of Service comments on the DLA. Should you have any questions regarding our comments, please contact Steve Shepard by email at: *steven_shepard@fws.gov* or by telephone at 207/866-3344 Extension 1116.

Sincerely,

Laury A. Zicari,
Field Supervisor
Maine Field Office

ec: Gail Wippelhauser, Paul Christman, MDMR – Augusta, Maine
Oliver Cox, MDMR – Bangor, Maine
Sean McDermott, NOAA – Gloucester, Massachusetts
Jeff Murphy, NOAA – Orono, Maine
Kathy Howatt, MDEP – Augusta, Maine
Laury Zicari, USFWS – Orono, Maine
Brett Towler -- Hadley, Maine

Document Content(s)

APPENDIX E-3

2015 MACROINVERTEBRATE SAMPLING STUDY

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2015

Macroinvertebrate Sampling Study

Downstream

of

Graham Lake Dam

Ellsworth Maine

FERC #2727

Submitted by:

Paul C. Leeper

Moody Mountain Environmental

137 Diamond Street

Searsmont Maine 04973

Submitted to:

TRC

249 Western Avenue

Augusta, ME 04330

Date: December 2015

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Introduction

This macroinvertebrate sampling study was conducted in support of the relicensing of the Ellsworth Hydroelectric Project (Project or Ellsworth Project), Federal Energy Regulatory Commission (FERC) Project No. 2727. This report details the Year 2 (2015 field season) study efforts as part of the Water Quality Sampling Study.

Study Objectives

The goal of the macroinvertebrate sampling study was to generate data on the aquatic macroinvertebrate community in the Union River downstream of the Graham Lake Dam and assess this community in terms of Maine's Aquatic Life Standards.

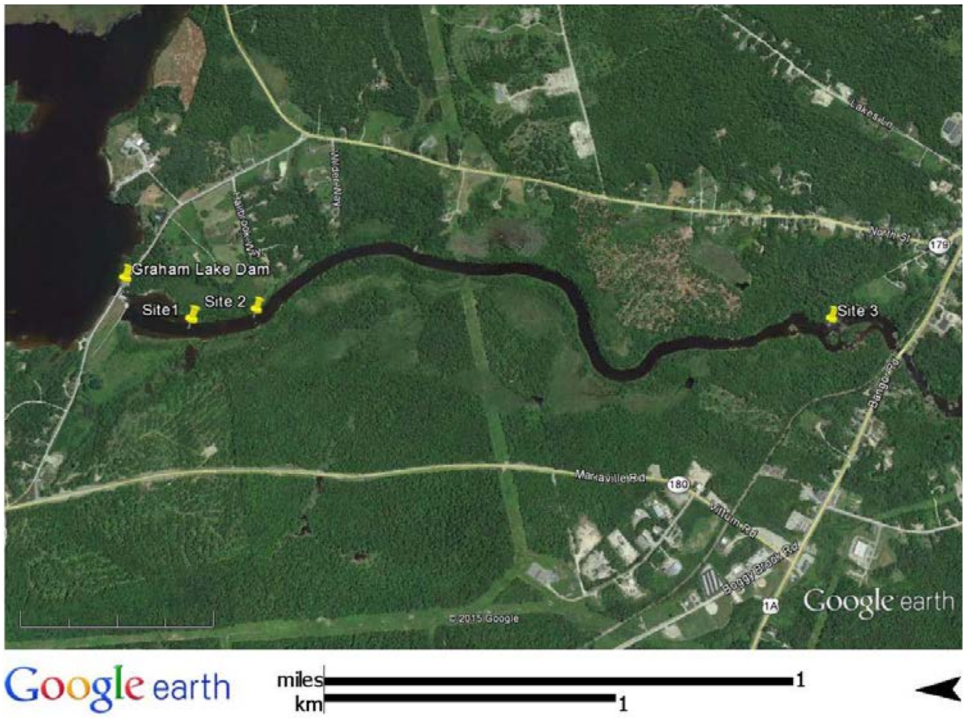
Study Area

In 2015 we placed samples at three (3) sites in the Union River downstream of the Graham Lake Dam to study aquatic macroinvertebrates (Figure 1).

Site 1 was located at the downstream end of the "pool" below the Graham Lake Dam. This site was approximately 950 ft downstream of the dam. **Site 2** was located was located approximately 1750 ft downstream of the dam. **Site 3** was located approximately 1.92 miles downstream of the dam, approximately 850 ft upstream of the railroad crossing. Site 3 was just downstream of a bedrock hydraulic constriction that changed the character of the river from slow moving meandering flat water to rapids.

Moody Mountain Environmental 137 Diamond Str Searsmont ME 04973 ph.207-592-8540 moodymtn@tidewater.net

Figure 1. Location of aquatic macroinvertebrate sampling sites downstream of the Graham Lake Dam. Union River, July, August 2015.



Water Classification

The Union River downstream of the Graham Lake Dam is classified Class B (38 M.R.S.A § 467(18)(A)(1)). With respect to designated uses, the Maine Water Quality Law requires that "Class B waters must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; navigation; and as habitat for fish and other aquatic life. The habitat must be characterized as unimpaired" (38 M.R.S.A. § 465(3)(A)). The word "unimpaired" is defined to mean "without a diminished capacity to support aquatic life" (38 M.R.S.A. § 466(11)). In addition, for Class B waters, "Discharges to Class B waters may not cause adverse impact to aquatic life in that the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community" (38 M.R.S.A. § 465(3)(C)). The term "resident biological community" is defined as "aquatic life expected to exist in a habitat which is free from the influence of the discharge of any pollutant" (38 M.R.S.A. § 466(10)). The term "without detrimental changes in the resident biological community" means no significant loss of species or excessive dominance by any species or group of species attributable to human activity" ((38 M.R.S.A. § 466(12)).

Study Methods

The Maine Department of Environmental Protection (DEP) "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides 2002) were used as the basis of the field and laboratory procedures in the macroinvertebrate sampling study. A summary of these methods is given below.

The DEP standard rock bag samplers were used for this study. These samplers hold approximately 16 lbs of clean, washed, bank-run cobble, graded to uniform diameter range of 1.5 to 3 inches. Three (3) samplers were placed at each sample site; samplers are left in the river for approximately 28 days (± 4 days) to allow for invertebrate colonization. Retrieval of the samplers was done using an aquatic D-net. The net was placed directly downstream of a sampler; the sampler was then picked up and placed in the net. The contents of each sampler and the net were washed through a sieve bucket and preserved in labeled jars. Habitat measurements including substrate type, depth, and temperature were collected at sampler collection retrieval.

Samples from Sites 2 and 3were collected, preserved, and transported to the Moody Mountain Environmental laboratory. Samples from Site 1 had been pulled up and then dropped again to the bottom. Because of the obvious disturbance the samplers were not further analyzed.

The three (3) samplers (replicates) from Sites 2 and 3 were sorted, identified, and enumerated.

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Results

The samplers were placed in the river on July 15, 2015. Samplers were retrieved on August 11, 2015. Habitat measurements for Site 2 and 3 are shown in Table 1. Photos of the areas around the samples sites are included below.

Table 1. Habitat measurements in the Union River downstream of Graham Lake Dam for aquatic macroinvertebrate sampling. July 2015

Macroinvertebrate Field Data Sheet

Log Number ___________	Directions________________	Type of Sampler**RB**
Station Number 2	________________	Date Deployed **7-15-15**
Waterbody **Union**	________________	Number Deployed **3**
River Basin **Union**	Lat-Long Coordinates	Date Retrieved **8-11-15**
Town **Ellsworth**	Latitude **44°35'11.29"N**	Number Retrieved **3**
Stream Order **6**	Longitude **68°26'31.47"W**	Collector(s) **P Leeper MME**

1. **Land Use** (surrounding watershed)		2. **Terrain**	3. **Canopy Cover**
☐ Urban	☐ Upland conifer	☐ Flat	☐ Dense (75-100% shaded)
☐ Cultivated	X Swamp hardwood	X Rolling	☐ Partly open (25-75% shaded)
☐ Pasture	☐ Swamp conifer	☐ Hilly	X Open (0-25% shaded)
X Upland hardwood	☐ Marsh	☐ Mountains	(% daily direct sun) **100%**

4. **Physical Characteristics of Bottom** estimate % over 12 m stretch			
[ ] Bedrock	**[30**] Cobble (2.5" – 10")	**[30]** Sand (<1/8")	[ ] Clay
[20] Boulders (>10")	**[20**] Gravel (1/8" – 2.5")	[Silt	[ ] Muck

5. **Habitat Characteristics** (immediate area)		Temp. Probe #	7. **Water Samples**
Time **1030h**	Time	☐ deployed	☐ Standard
Wetted Width	Wetted Width (m) Bank	6. **Observations**	☐ Other
Bank Fl Width 193'	Full Width (m)	7-15-15 –	Lab Number
Depth **3.8'**	Depth	Tapegrass sunken timber	8. **Photograph**
Velocity **0.57f/s**	Velocity 0.55		Put-In **Yes**
Diss. O_2 (ppm)**8.6**	Diss. O_2 (ppm) 8.3		Take-Out **Yes**
Temp (C) **23.3**	Temp (C) 22.3		
Turbidity **3.72 ntu**	Turbidity		
DO Meter #______Cal? **Y** / N?	DO Meter #______Cal? Y / N		

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Table 1 continued.

Macroinvertebrate Field Data Sheet

Log Number ________	Directions________________	Type of Sampler**RB**
Station Number 3	________________	Date Deployed 7-**15-15**
Waterbody **Union**	________________	Number Deployed **3**
River Basin **Union**	Lat-Long Coordinates	Date Retrieved **8-11-15**
Town **Ellsworth**	Latitude **44°34'1.79"N**	Number Retrieved **3**
Stream Order **6**	Longitude **68°26'35.79"W**	Collector(s) **P Leeper MME**

1. Land Use (surrounding watershed)		2. Terrain	3. Canopy Cover
☐ Urban	☐ Upland conifer	☐ Flat	☐ Dense (75-100% shaded)
☐ Cultivated	**X** Swamp hardwood	**X** Rolling	☐ Partly open (25-75% shaded)
☐ Pasture	☐ Swamp conifer	☐ Hilly	**X** Open (0-25% shaded)
X Upland hardwood	☐ Marsh	☐ Mountains	(% daily direct sun) **100%**

4. Physical Characteristics of Bottom estimate % over 12 m stretch			
[**40**] Bedrock	[**20**] Cobble (2.5" – 10")	[ ] Sand (<1/8")	[ ] Clay
[**20**] Boulders (>10")	[**20**] Gravel (1/8" – 2.5")	[Silt	[ ] Muck

5. Habitat Characteristics (immediate area)		Temp. Probe #	7. Water Samples
Time **1115h**	Time **1140h**	☐ deployed	☐ Standard
Wetted Width	Wetted Width (m) Bank	**6. Observations**	☐ Other
Bank Fl Width **167'**	Full Width (m)		Lab Number
Depth **2.7'**	Depth		
Velocity **2.06f/s**	Velocity **1.2f/s**		**8. Photograph**
Diss. O_2 (ppm)**8.4**	Diss. O_2 (ppm) **8.3**		Put-In **Yes**
Temp (C) **22.9**	Temp (C) **22.8**		Take-Out **Yes**
Turbidity **3.94ntu**	Turbidity		
DO Meter #______Cal? **Y** / N?	DO Meter #______Cal? **Y** / N		

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Photo 1. Sample Site 2 view southeast (downstream). Union R. 7-15-15

Photo 2. Sample Site 2 view north (upstream). Union R. 7-15-15

Photo 3. Sample Site 2 view west. Union R. 7-15-15

Photo 4. Sample Site 3 view southeast (downstream). Union R. 7-15-15

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Photo 5. Sample Site 3 view northeast (upstream). Union R. 7-15-15

Photo 6. Sample Site 3 view west. Union R. 7-15-15

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Photo 7. Sample Site 3 view east. Union R. 7-15-15

Sites 2 and 3 Community Analysis

The macroinvertebrate communities sampled downstream of the Graham Lake Dam were abundant but not very rich in taxa (Appendix 1). The community at Site 2 was populated with 26 different taxa with a Mean Total Abundance of 355. The Site 3 community was much more numerous (Total Abundance of 2430) but was less rich with 15 taxa. Both communities were dominated by filter-feeding caddisflies, representing over 67% of Total Abundance at Site 2 and over 93% at Site 3. The Diversity values were correspondingly low at 1.70 (Site 2) and 1.76 (Site 3). Structural indices for the sampled community are shown in Tables 2 and 3.

Table 2. Indices of community structure for the aquatic invertebrate community downstream of the Graham Lake Dam. Union River, July-August 2015.

Site	Tot. Abund.	Taxa Richness	S-W Div.	Hils. Biotic Index (HBN)	Water Quality indication from HBN	Mayfly, Stonefly, Caddisfly (EPT) Richness	Mayfly, Stonefly (EP)		Midge	
							Rich	% Ab	Rich	% Ab
Site 2	355	26	1.70	4.30	Good	10	3	3.3	9	4.7
Site 3	2430	15	1.76	4.36	Good	9	2	2.0	4	2.0

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Indexes measuring the tolerance to poor water quality conditions revealed that caddisflies adapted to a wide range of conditions dominated the communities. The EP index of sensitive mayflies and stoneflies showed 3 and 2 taxa respectively. These insect orders represented less than 4% of the communities. No stoneflies were collected at either sampling site. The Hilsenhoff Biotic Index values, 4.30 (Site 2) and 4.36 (Site 3), indicated good water quality (Hilsenhoff 1987).

Dominant organisms (representing over 5% of the Total Abundance) in the community are shown in Table 3 arranged from the most sensitive organisms to the organisms most tolerant of poor water quality conditions. The Site 2 community had four (4) organisms that made up 84% of the total abundance. This community was dominated by intermediate organisms (middling between sensitive and tolerant). The Site 3 community had five (5) organisms that made up 94% of the community. Intermediate organisms also dominated this community although, it should be noted that sensitive organisms made up 21% of the community.

Table 3. Dominant aquatic invertebrate organisms downstream of the Graham Lake Dam. Union River, July- August 2015.

	Site 2		Site 3	
Sensitivity to Poor Water Quality	**Dominant Organism**	**% of Community**	**Dominant Organism**	**% of Community**
Sensitive			Macrostemum	15
			Chimarra	6
Intermediate	Cheumatopsyche	54	Hydropsyche	29
	Neureclipsis	11	Cheumatopsyche	31
			Neureclipsis	13
Tolerant	Hydrobiidae	11		
	Planariidae	8		

The community structure and function found downstream of the Graham Lake Dam on the Union River indicates evidence of organic enrichment and filter-feeder dominance which is a

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common phenomenon below lake outlets and impoundments (Hynes 1970, Spence and Hynes 1970, Parker and Voshell 1983).

Enrichment and caddisfly dominance downstream of lake outlets and dam outlets is a common phenomenon that has long been reported in the literature. Illies (1956 in Spence and Hynes 1970) reported an increase in the number of filter-feeding Trichoptera below a lake when compared to upstream communities. He attributed this to an increase in food availability. Filter-feeding organisms, including *Cheumatopsyche* and *Neureclipsis,* are often the dominant organism in streams and rivers (Hynes 1970) and frequently are very abundant at lake outlets (Carlsson et al. 1977; Valett and Stanford 1987). The density or biomass of these filter-feeders typically decline the farther one looks downstream (Osgood 1979). This blossoming and decline of the aquatic community may be in response to a gradient in the quantity and/or quality of the food resources. High quality lake seston (the particulate matter in the water), typically made up of algal cells, is processed by the filter-feeders near the outlet and may be transformed to lower quality detritus (Benke and Wallace 1980, Valett and Stanford 1987).

This phenomenon has also been long observed at impoundment outlets. Spence and Hynes (1971) reported increased numbers of Hydropsychidae (*Cheumatopsyche* is a genus in the family Hydropsychidae) and other organisms downstream of an impoundment and stated that the downstream differences were comparable to mild organic enrichment. Parker and Voshell (1983) reported production of filter-feeding Trichoptera to be the highest at a site closest to the dam when compared to sites farther downstream and sites on free-flowing rivers. They concluded that, not only the amount of high quality food, but the specific size of the seston, contributed to the ability of the caddisflies to occupy this niche.

Of note in this study was the increase in filter-feeders at the most downstream site (Site 3) compared with the site 1.6 miles closer to the dam (Site 2). It may be that the slow meandering riverine habitat between the two sites also produces large amounts of algae that is then available to the filter-feeders.

The communities sampled are influenced by the food suspended in the water. This resource allows the aquatic caddisfly filter feeders to flourish. However, the lack of stoneflies in

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the community, and the small proportion of mayflies, indicates changes to the resident biological community.

Therefore is my professional opinion that the communities downstream of Graham Lake Dam on the Union River do not attain Class B aquatic life standards.

Summary

1. The objective of the macroinvertebrate sampling study was to generate data on the aquatic macroinvertebrate community in the Union River downstream of the Graham Lake Dam and assess this community in terms of Maine's Aquatic Life Standards. The Union River downstream of the dam is classified Class B.
2. The Maine Department of Environmental Protection (DEP) "Methods for Biological Sampling and Analysis of Maine's Inland Waters" (Davies and Tsomides 2002) were used as the basis of the field and laboratory procedures in this study.
3. Samplers were retrieved from two sample sites, 950 ft and 1750 ft and 1.92 miles downstream of the dam, on August 11, 2015 within an acceptable colonization time frame. Site 1 samplers had been disturbed and were not analyzed further.
4. The invertebrate communities sampled downstream of the Graham Lake Dam were abundant, and dominated by filter-feeders. The dominance of filter-feeders is a natural response to the food resource exiting the lake. This response is also found at natural lake outlets. The most downstream community may be responding to food produced in the slow riverine habitat upstream.
5. The community structure and function found downstream of the Graham Lake Dam: specifically the lack of stoneflies and the small numbers of mayflies indicates that there have been changes to the resident biological community.
6. It is my professional opinion that the macroinvertebrate communities sampled downstream of the Graham Lake Dam on the Union River do not attain Class B aquatic life standards.
7. The data was sent to MDEP for analysis in the State's linear discriminant model, and based on the model results and best professional judgment, the MDEP determined that the sites attained Class C standards.

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References

Benke, A.C. and J.B. Wallace. 1980. Trophic basis of production among net-spinning caddisflies in a southern Appalachian stream. Ecology 61: 108-118.

Carlsson, M., L.M. Nilsson, Bj. Svensson, and S. Ulfstrand, 1977. Lacustrine seston and other factors influencing blackflies (Diptera: Simuliidae) inhabiting lake outlets in Swedish Lapland. Oikos 29: 229-238.

Davies, S.P. and L. Tsomides. 2002. Methods for biological sampling and analysis of Maine's rivers and streams. ME Dept. of Env. Prot. Augusta, ME. 31p.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. The Great Lake Entomologist. Pgs. 31-39.

Hynes, H.B.N. 1970. The Ecology of Running Waters. Univ. of Toronto. Toronto, CA 555p.

Osgood, M.W. 1979. Abundance patterns of filter-feeding caddisflies (Trichoptera: Hydropsychidae) and seston in a Montana (U.S.A.) lake outlet. Hydrobiologia Vol. 63 (2):177-183.

Parker, C.R. and J.R. Voshell Jr. 1983. Production of filter-feeding Trichoptera in an impounded and a free-flowing river. Can. J. Zool. 61:70-87.

Spence, J.A., and H.B.N. Hynes. 1971. Differences in benthos upstream and downstream of an impoundment. J. Fish. Res. Bd. Canada 28: 35-43.

Valett, H.M. and A. Stanford. 1987. Food quality and Hydropsychidae caddisfly density in a lake outlet stream in Glacier National Park, Montana, U.S.A. Can. J. Fish Aquat. Sci. 44: 77-82.

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Appendix 1

Site 2					
Taxon Name	**Rep 1**	**Rep 2**	**Rep 3**	**Total**	**%**
Planariidae	29	29	24	27.3	7.7%
Annelida	1	3	2	2.0	0.6%
Hyalella azteca	1	0	0	0.3	0.1%
Argia	4	2	5	3.7	1.0%
Heptageniidae	21	3	9	11.0	3.1%
Stenonema	1	0	1	0.7	0.2%
Attenella	1	0	0	0.3	0.1%
Neureclipsis	35	40	47	40.7	11.5%
Cheumatopsyche	246	130	202	192.7	54.3%
Macrostemum	4	3	11	6.0	1.7%
Ochrotrichia	4	7	2	4.3	1.2%
Oxyethira	0	1	0	0.3	0.1%
Ceraclea	5	1	1	2.3	0.7%
Oecetis	2	1	4	2.3	0.7%
Sialis	0	1	0	0.3	0.1%
Ablabesmyia	22	6	3	10.3	2.9%
Pentaneura	0	0	1	0.3	0.1%
Cricotopus	0	1	0	0.3	0.1%
Nanocladius	2	2	0	1.3	0.4%
Tanytarsus	1	1	0	0.7	0.2%
Dicrotendipes	1	0	0	0.3	0.1%
Microtendipes	0	0	1	0.3	0.1%
Parachironomus	5	2	2	3.0	0.8%
Polypedilum	0	1	0	0.3	0.1%
Hydrobiidae	32	60	23	38.3	10.8%
Sphaeriidae	0	15	1	5.3	1.5%
		Richness	**26**		
		Total Ab.	**355**		

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Site 3					
Taxon Name	**Rep 1**	**Rep 2**	**Rep 3**	**Total**	**%**
Planariidae	40	8	32	26.7	1.1%
Baetidae	17	2	24	14.3	0.6%
Heptageniidae	47	0	24	23.7	1.0%
Plauditus	0	1	0	0.3	0.0%
Stenonema	16	5	8	9.7	0.4%
Chimarra	72	223	168	154.3	6.4%
Neureclipsis	80	192	640	304.0	12.5%
Cheumatopsyche	496	1271	477	748.0	30.8%
Hydropsyche	688	930	498	705.3	29.0%
Macrostemum	280	602	181	354.3	14.6%
Ochrotrichia	38	1	9	16.0	0.7%
Oecetis	42	1	3	15.3	0.6%
Ablabesmyia	6	11	2	6.3	0.3%
Cricotopus	0	3	4	2.3	0.1%
Rheotanytarsus	3	2	2	2.3	0.1%
Polypedilum	7	118	16	47.0	1.9%
Simulium	0	1	0	0.3	0.0%
			Richness	**15**	
			Tot. Ab.	**2430.3**	

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APPENDIX E-4

FLOW STUDY REPORT – ADDITIONAL INFORMATION

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Additional Information on the Instream Flow and Union River Tributary Access Study

The following information is provided in response to requested information by stakeholders in comments on the Updated Study Report, which was filed with FERC on August 21, 2015. The requested information consists of:

1. Calculations for extrapolated data down to the minimum flows of 105 cfs.
2. Updated transect profile data showing the extrapolated 105 cfs.
3. Field data used to calculate extrapolated data
4. Photographs of the tributary stream connectivity at the lowest observed flow of 150 cfs

The field study was conducted under low flow conditions that were estimated by Black Bear to be 150 cfs based on Graham Lake Dam gate settings. Since the licensed minimum flow is 105 cfs, the hydraulic parameters, including wetted width, depth and average velocity were extrapolated down to 105 cfs based on the four measured flows observed during the study. Further information was requested to explain the USR Flow Study extrapolation used to estimate the hydraulic parameters for a flow of 105 cfs. The USR Table 3-11 provided the extrapolated values for the hydraulic parameters estimated for a flow of 105 cfs. Note that the red text indicates the addition to the USR table to provide clarification requested after agency review of the USR.

(USR) **Table 3-11: Extrapolated Transect Hydraulic Parameters at Graham Lake Dam Release Flow of 105 cfs**

Transect		Estimated Hydraulic Parameters at Graham Lake Dam Release Flow of 105 cfs[3]				
Sub-Reach	**Type**	**Wetted Width (ft)**	**Wetted Width % Bankfull**	**Wetted Area (sq ft)**	**Maximum Depth (ft)**	**Average Velocity[1] (ft/s)**
Upper	Riffle/ Run	304.0	83	941	6.5	0.12
	Pool[2]	123 (191)	55 (83)	695	9.2	0.16
Middle	Riffle	178.8	74	316	6.7	0.35
	Pool	172.0	73	404	4.5	0.27
	Run	128.1	68	238	2.8	0.47
Lower	Riffle	173.1	73	739	9.1	0.15
	Pool/ Run	139.3	74	1,061	11.0	0.10

Notes:

[1]The average velocity is the channel average velocity based on the wetted transect area and a Graham Lake Dam release flow of 105 cfs, and does not include potential flow contribution below Graham Lake Dam.

[2]Both the measured wetted width at the vegetated low terrace, and the estimated wetted width of the pool just upstream of the vegetated low terrace in parenthesis, are provided to best represent the pool transect.

[3]Hydraulic parameters presented are estimated for the minimum flow of 105 cfs by using extrapolation from the measured parameter from four observed flows to the estimated parameter value at the flow of 105 cfs provided in this table. The extrapolation is calculated using the "Interpolate" function available in the *XlXtrFun* function add-in package for Microsoft Excel, which is a free software download available at www.xlxtrfun.com.

The USR Figures 3-23, 3-24 and 3-25 provide the graphic representation of this extrapolation. The extrapolation is calculated using double parabolic curve interpolation, to allow for an array of values to be used to fit a curve to estimate an additional value not measured. *XlXtrFun* is a collection of functions which extends the capabilities of Microsoft Excel, developed primarily to facilitate interpolation of 2-dimensional and 3-dimensional data, and simplify 2-variable curve fitting. The "Interpolate" function available in the *XlXtrFun* function add-in package for Microsoft Excel was utilized to develop the double parabolic curve for the measured data and estimate additional data along this curve. An example of the extrapolation equation used in the Microsoft Excel function "Interpolate" is provided below:

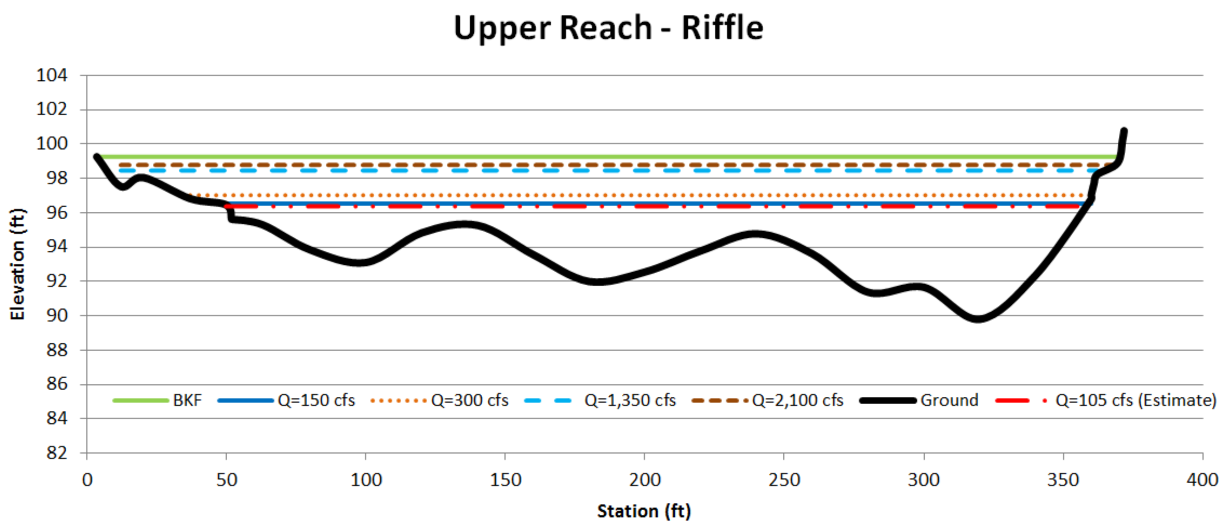
> Extrapolated wetted width for 105 cfs = Interpolate ((Array of X= Measured Discharges 150, 300, 1,350, and 2,100), (Array of Y=Measured Wetted Width 310, 329, 358, 362, 366), (Given X= Extrapolated Discharge 105 cfs), (Extrapolation=True), (Parabolic=True))

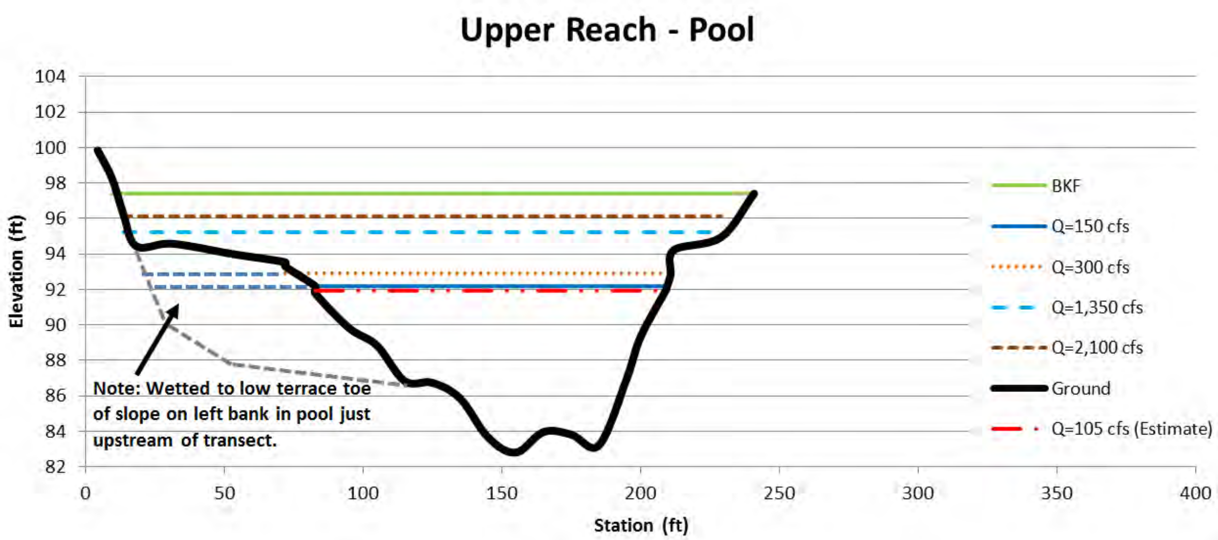
The following table provides the example of the extrapolation setup.

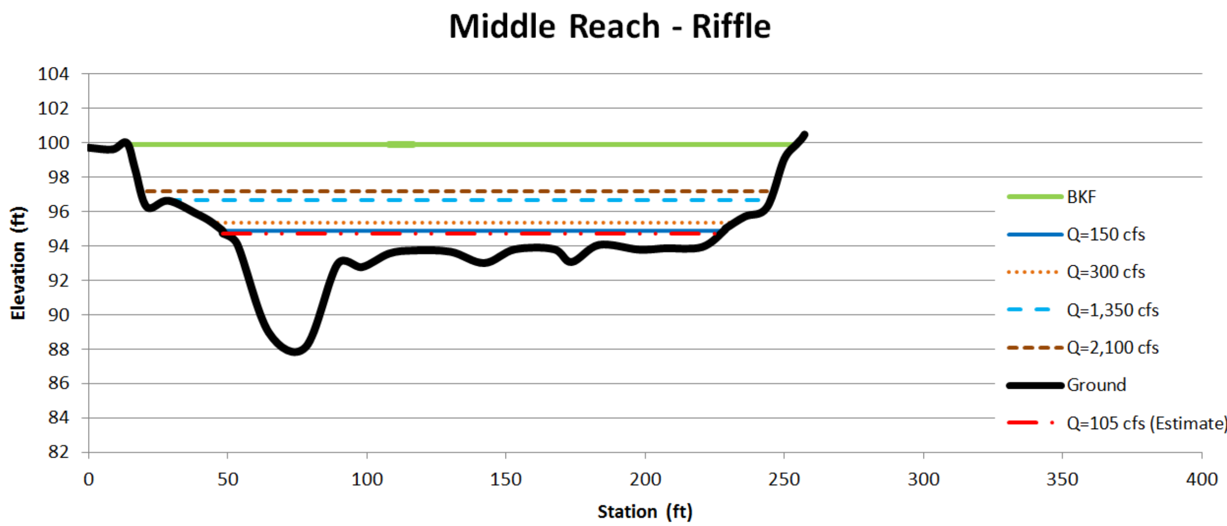
***(Extra Table for example of extrapolation)*: Example of Extrapolation for Wetted Width for *Instream Flow and Tributary Access Study* Transects**

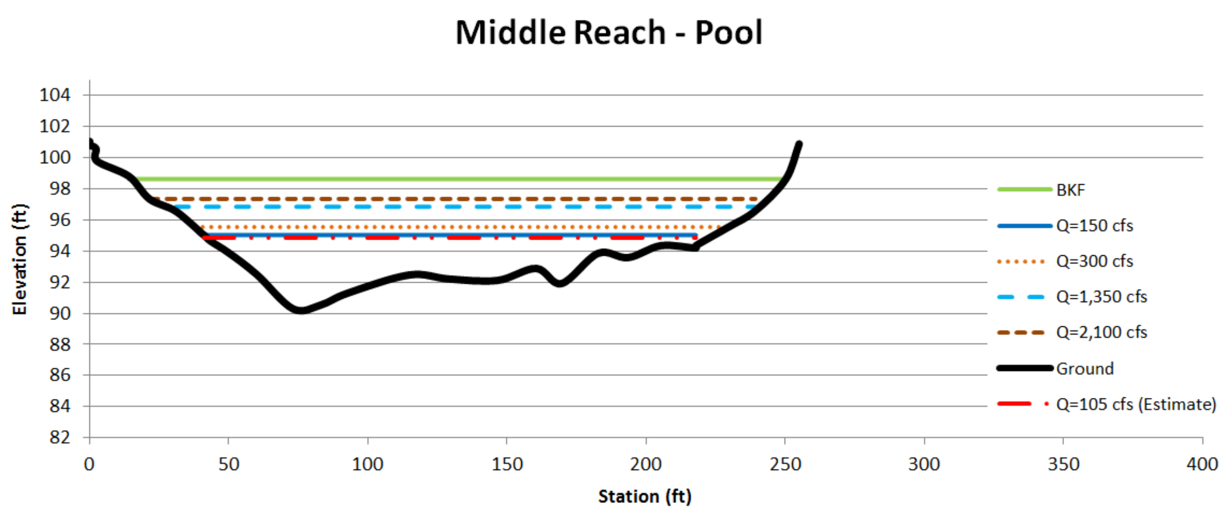
Transect		**Example Calculation Equation Components**	**Graham Dam Release Discharge (cfs)**	**Wetted Width (ft)**
Sub-Reach	**Type**			
Upper Reach	Riffle/Run	Extrapolated Value	105	304
		Array Values of Measured Data	150	310
			300	329
			1,350	358
			2,100	362
			Bankfull	**366**

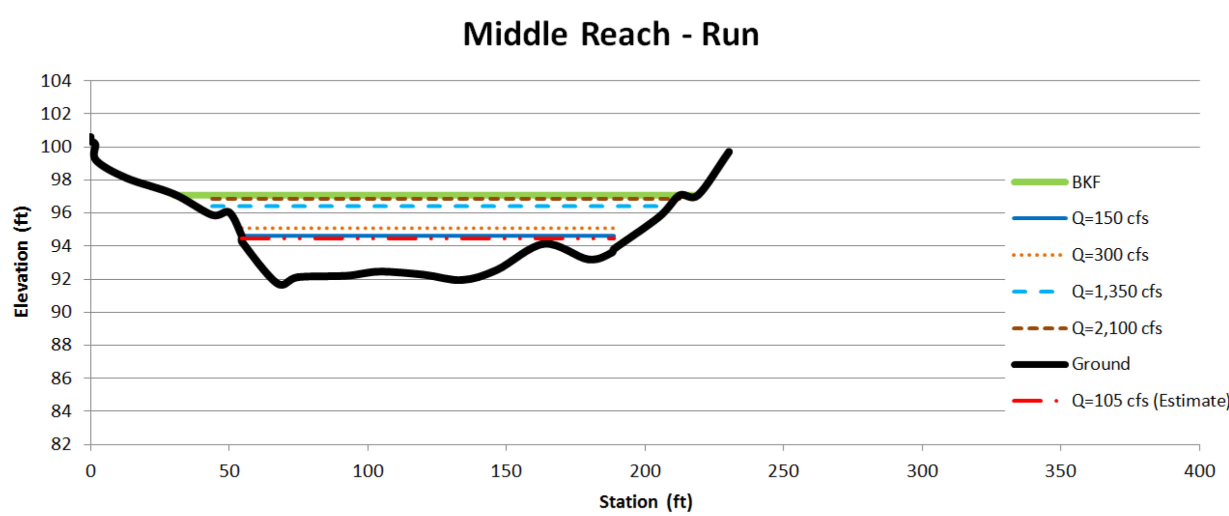
Further information was requested to explain the USR Flow Study minimum depth estimated at each transect for a flow of 105 cfs. The following Figures are the USR Figures 3-23, 3-24 and 3-25, updated to add the estimated water surface level at each transect for a flow of 105 cfs. These Figures show that there is very little difference in the water level at each transect between a flow of 150 cfs and a flow of 105 cfs, and suggest that at a flow of 105 cfs, the Study reach continues to meet the aquatic habitat criteria providing adequate wetted area to provide connectivity for adequate zone of passage.

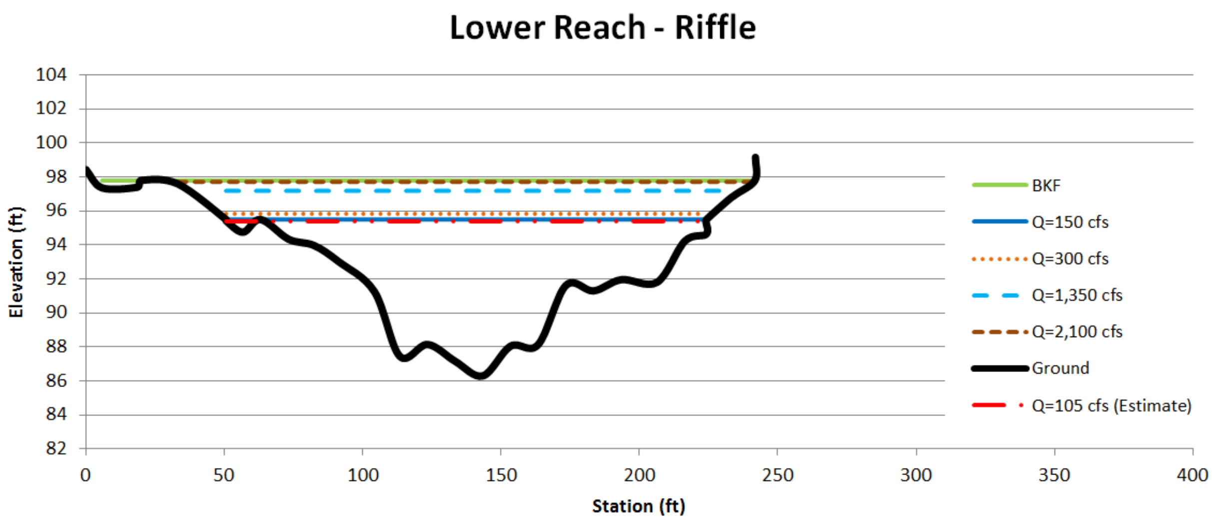


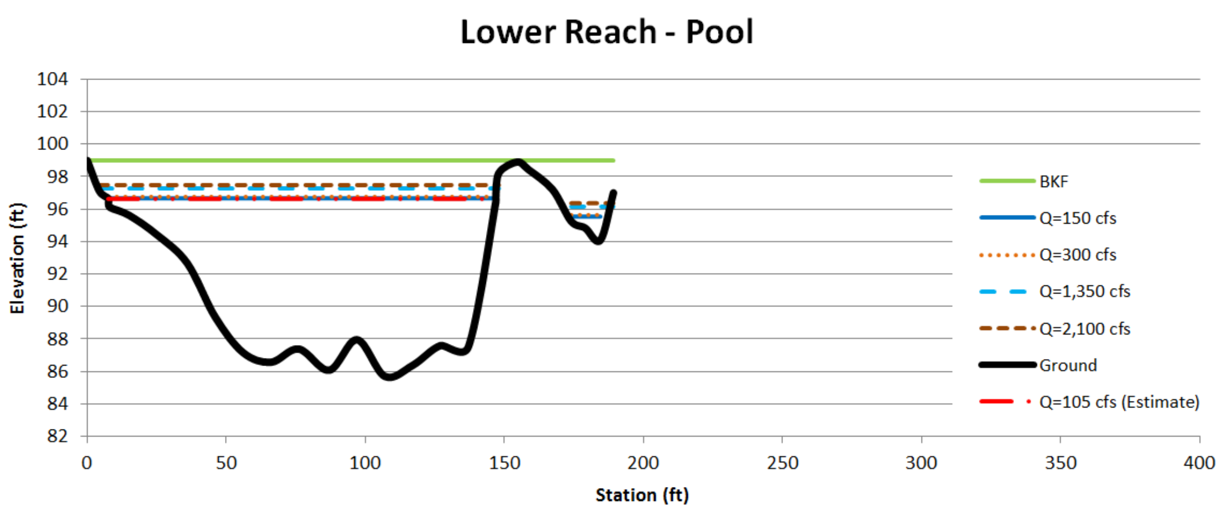



Middle Reach - Riffle
Elevation (ft)
104
102
100
98
96
94
92
90
88
86
84
82
0
50
100
150
200
250
300
350
400
Station (ft)
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)


Middle Reach - Pool
Elevation (ft)
104
102
100
98
96
94
92
90
88
86
84
82
0
50
100
150
200
250
300
350
400
Station (ft)
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)


Middle Reach - Run
Elevation (ft)
104
102
100
98
96
94
92
90
88
86
84
82
0
50
100
150
200
250
300
350
400
Station (ft)
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)





Further information was requested to provide the field collected and calculated data for the USR Flow Study. This data is provided below.

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Upper Reach Flow Data

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Project	**Ellsworth Flow Study**				
Transect Name	**Upper Reach Riffle**	Date	**9/9/2014**		
Purpose / Project	**Verification flow measurement reportedly 150 cfs**	Time	**Begin**	**17:30**	
			End	**18:15**	
Conditions / Test	**Minimum flow**				
Transect Location	**Union River - Upstream of Rt 1A Bridge**				
Zero Station Location					
Verification Team	Gagnon/Sears/MacVane	**Total Flow =**	235.7	**cfs**	

Data

Field Measurements					**Calculations**				
Personnel / Method	**Node**	**Station Distance (ft)** (tag line)	**Station Depth (ft)**	**Mean Station Velocity (ft/sec)**	**Incremental Nodal Area (ft^2)**	**Incremental Mean Nodal Velocity (ft/sec)**	**Incremental Nodal Flow (cfs)**	**Total Accumulated Flow (cfs)**	**Comment**
Manual	0	51.8	0.00	0.000	0.00	0.00	0.00	0.00	LEW
Manual	1	53.4	0.80	0.650	0.64	0.33	0.21	0.21	
Manual	2	59.0	1.00	0.530	5.04	0.59	2.97	3.18	
Manual	3	64.0	1.20	0.670	5.50	0.60	3.30	6.48	
Manual	4	75.0	2.20	0.010	18.70	0.34	6.36	12.84	Large Boulders US
Manual	5	90.0	3.40	0.535	42.00	0.27	11.45	24.28	
Manual	6	105.0	3.40	0.535	51.00	0.54	27.29	51.57	
Manual	7	120.0	1.80	0.700	39.00	0.62	24.08	75.65	
Manual	8	135.0	1.40	0.020	24.00	0.36	8.64	84.29	Large Boulders US
Manual	9	150.0	2.20	0.660	27.00	0.34	9.18	93.47	
Manual	10	165.0	3.10	0.700	39.75	0.68	27.03	120.50	Large Woody Debris US
Manual	11	180.0	4.40	0.350	56.25	0.53	29.53	150.03	Large Woody Debris US
Manual	12	195.0	3.30	0.315	57.75	0.33	19.20	169.24	Large Woody Debris US
Manual	13	210.0	3.00	0.280	47.25	0.30	14.06	183.29	Large Woody Debris US
Manual	14	225.0	3.00	0.140	45.00	0.21	9.45	192.74	
Manual	15	240.0	1.80	0.310	36.00	0.23	8.10	200.84	
Manual	16	260.0	2.92	0.150	47.15	0.23	10.84	211.69	Too deep for wadding measurement;
Manual	17	280.0	5.155	0.1	80.70	0.13	10.09	221.77	no flow due to large woody debris in velocity columns
Manual	18	300.0	4.86	0.05	100.15	0.08	7.51	229.29	Use depth from transect/ tapper velocity to 0
Manual	19	320.0	6.73	0.025	115.90	0.04	4.35	233.63	
Manual	20	340.0	4.176	0.01	109.06	0.02	1.91	235.54	
Manual	21	360.0	0	0	41.76	0.01	0.21	235.75	REW
Manual	22				0.00	0.00	0.00	235.75	
Manual	23				0.00	0.00	0.00	235.75	
Manual	24				0.00	0.00	0.00	235.75	
Manual	25				0.00	0.00	0.00	235.75	
Manual	26				0.00	0.00	0.00	235.75	
Manual	27				0.00	0.00	0.00	235.75	
Manual	28				0.00	0.00	0.00	235.75	
Manual	29				0.00	0.00	0.00	235.75	
Manual	30				0.00	0.00	0.00	235.75	
Manual	31				0.00	0.00	0.00	235.75	
Manual	32				0.00	0.00	0.00	235.75	
Manual	33				0.00	0.00	0.00	235.75	
Manual	34				0.00	0.00	0.00	235.75	
Manual	35				0.00	0.00	0.00	235.75	
Manual	36				0.00	0.00	0.00	235.75	
Manual	37				0.00	0.00	0.00	235.75	
Manual	38				0.00	0.00	0.00	235.75	
Manual	39				0.00	0.00	0.00	235.75	
Manual	40				0.00	0.00	0.00	235.75	
Manual	41				0.00	0.00	0.00	235.75	
Manual	42				0.00	0.00	0.00	235.75	
Manual	43				0.00	0.00	0.00	235.75	
Manual	44				0.00	0.00	0.00	235.75	
Manual	45				0.00	0.00	0.00	235.75	
Manual	46				0.00	0.00	0.00	235.75	
Manual	47				0.00	0.00	0.00	235.75	
Manual	48				0.00	0.00	0.00	235.75	
Manual	49				0.00	0.00	0.00	235.75	
Manual	50				0.00	0.00	0.00	235.75	
Manual	51				0.00	0.00	0.00	235.75	

Project	**Ellsworth Flow Study**				
Transect Name	**Upper Reach Pool**	Date	**9/9/2014**		
Purpose / Project	**Verification flow measurement reportedly 150 cfs**	Time	**Begin**	**17:30**	
			End	**18:15**	
Conditions / Test	**Minimum flow**				
Transect Location	**Union River - Upstream of Rt 1A Bridge**				
Zero Station Location					
Verification Team	Gagnon/Sears/MacVane	**Total Flow =**	283.8	**cfs**	

Data

Field Measurements					**Calculations**				
Personnel / Method	**Node**	**Station Distance (ft)** (tag line)	**Station Depth (ft)**	**Mean Station Velocity (ft/sec)**	**Incremental Nodal Area (ft^2)**	**Incremental Mean Nodal Velocity (ft/sec)**	**Incremental Nodal Flow (cfs)**	**Total Accumulated Flow (cfs)**	**Comment**
Manual	0	82.8	0.00	0.000	0.00	0.00	0.00	0.00	LEW
Manual	1	90.4	1.30	0.000	4.94	0.00	0.00	0.00	Boulder/Bedrock outcrop
Manual	2	95.0	2.50	0.030	8.74	0.02	0.13	0.13	Boulder/Bedrock outcrop
Manual	3	100.0	3.20	0.095	14.25	0.06	0.89	1.02	
Manual	4	105.0	4.40	0.275	19.00	0.19	3.52	4.54	Woody debris
Manual	5	110.0	4.60	0.255	22.50	0.27	5.96	10.50	
Manual	6	115.0	4.60	0.420	23.00	0.34	7.76	18.26	
Manual	7	120.0	5.20	0.480	24.50	0.45	11.03	29.29	
Manual	8	125.0	5.70	0.360	27.25	0.42	11.45	40.73	Woody debris
Manual	9	130.0	6.50	0.405	30.50	0.38	11.67	52.40	
Manual	10	135.0	5.90	0.395	31.00	0.40	12.40	64.80	TWG
Manual	11	140.0	6.30	0.505	30.50	0.45	13.73	78.52	Woody debris
Manual	12	145.0	8.67	0.605	37.42	0.56	20.77	99.29	Survey rod measured depth
Manual	13	150.0	8.42	0.645	42.71	0.63	26.69	125.98	Survey rod measured depth
Manual	14	155.0	9.33	0.545	44.38	0.60	26.40	152.39	Survey rod measured depth
Manual	15	160.0	8.67	0.440	45.00	0.49	22.16	174.55	Survey rod measured depth
Manual	16	165.0	8.17	0.490	42.08	0.47	19.57	194.12	Survey rod measured depth
Manual	17	170.0	7.58	0.410	39.38	0.45	17.72	211.84	Survey rod measured depth
Manual	18	175.0	8.333333	0.39	39.79	0.40	15.92	227.75	Survey rod measured depth
Manual	19	180.0	7.25	0.38	38.96	0.39	15.00	242.75	Survey rod measured depth
Manual	20	185.0	9	0.365	40.63	0.37	15.13	257.88	Survey rod measured depth
Manual	21	190.0	7.333333	0.265	40.83	0.32	12.86	270.75	Survey rod measured depth
Manual	22	195.0	4.6	0.24	29.83	0.25	7.53	278.28	
Manual	23	200.0	2.4	0.23	17.50	0.24	4.11	282.39	
Manual	24	206.0	1.5	0.01	11.70	0.12	1.40	283.80	
Manual	25	209.0	0	0	2.25	0.01	0.01	283.81	REW
Manual	26				0.00	0.00	0.00	283.81	
Manual	27				0.00	0.00	0.00	283.81	
Manual	28				0.00	0.00	0.00	283.81	
Manual	29				0.00	0.00	0.00	283.81	
Manual	30				0.00	0.00	0.00	283.81	
Manual	31				0.00	0.00	0.00	283.81	
Manual	32				0.00	0.00	0.00	283.81	
Manual	33				0.00	0.00	0.00	283.81	
Manual	34				0.00	0.00	0.00	283.81	
Manual	35				0.00	0.00	0.00	283.81	
Manual	36				0.00	0.00	0.00	283.81	
Manual	37				0.00	0.00	0.00	283.81	
Manual	38				0.00	0.00	0.00	283.81	
Manual	39				0.00	0.00	0.00	283.81	
Manual	40				0.00	0.00	0.00	283.81	
Manual	41				0.00	0.00	0.00	283.81	
Manual	42				0.00	0.00	0.00	283.81	
Manual	43				0.00	0.00	0.00	283.81	
Manual	44				0.00	0.00	0.00	283.81	
Manual	45				0.00	0.00	0.00	283.81	
Manual	46				0.00	0.00	0.00	283.81	
Manual	47				0.00	0.00	0.00	283.81	
Manual	48				0.00	0.00	0.00	283.81	
Manual	49				0.00	0.00	0.00	283.81	
Manual	50				0.00	0.00	0.00	283.81	
Manual	51				0.00	0.00	0.00	283.81	

Ellsworth
Upper Reach

Survey Date: 9/9/2014

Note: Left half transect full riffle, right half of transect riffle/run.

	BM	100	
Riffle	HI1	102.7188	
Station	FS	El	Notes
3.5	2.71875	100	LP Top
3.5	3.458333	99.26042	LP G BKF
12.1	5.1875	97.53125	LT Boulders
20.2	4.666667	98.05208	LT Boulders
37	5.895833	96.82292	LT Boulders
49.8	**6.25**	96.46875	LEW CG
51.8	6.1875	95.625	WS LEW at SG
51.8	7.09375	95.625	CG at SG
63	7.416667	95.30208	CG
80	8.875	93.84375	CG
100	9.614583	93.10417	CG
120	7.885417	94.83333	CG
140	7.447917	95.27083	CG
160	9.15625	93.5625	CG
180	10.71875	92	CG
200	10.16667	92.55208	CG
220	8.9375	93.78125	CG
240	7.9375	94.78125	CG - Boulder
260	9.104167	93.61458	CG
280	11.34375	91.375	CG
300	11.05208	91.66667	CG
320	12.91667	89.80208	CG
340	10.36458	92.35417	CG
360	5.927083	96.79167	REW CG; 50% Emergent Veg, barely wetted
360	**5.708333**	97.01042	WS REW
361	5.041667	97.67708	LT Toe Bank
362.2	4.489583	98.22917	MT Top Bank
369.5	3.8125	98.90625	MT BKF Toe
371.2	2.520833	100.1979	HT BKF Top
371.8	1.947917	100.7708	Tree G

9/9/2014	9/10/2014	9/11/2014	9/11/2014	
SG Reading (inches)				
1.5	7.375	24.625	28.5	
Q=150 cfs	Q=300 cfs	Q=1,350 cfs	Q=2,100 cfs	BKF

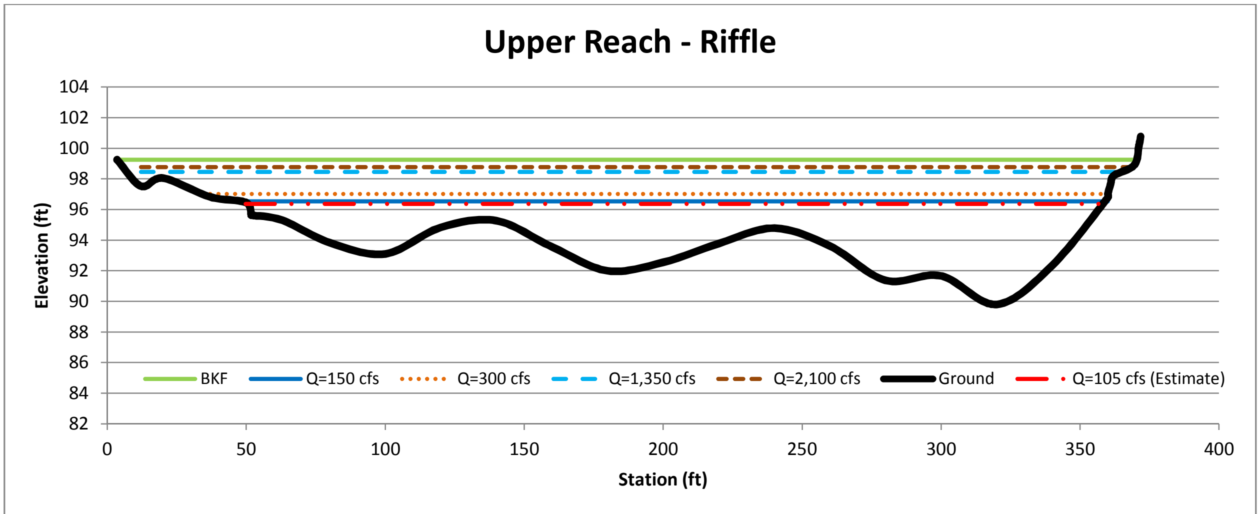
Ellsworth
Upper Reach

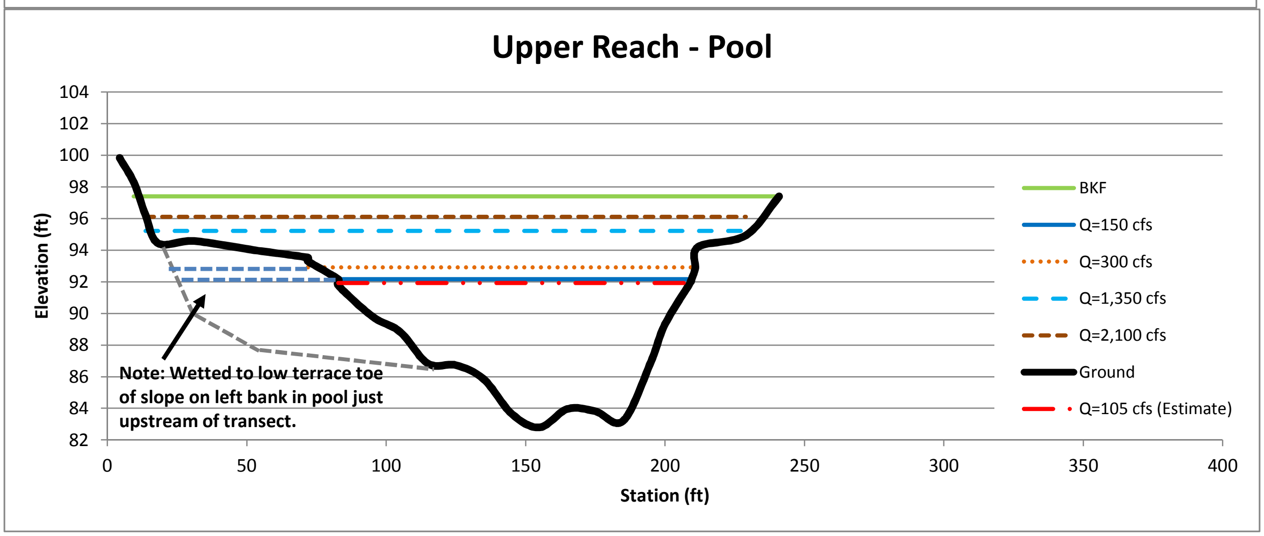
Survey Date: 9/9/2014

Note: Left LT Boulder Shelf. Transect located just upstream of Rt 1A Bridge.

	BM	100	
Pool	HI1	99.66667	
Station	FS	El	Notes
4.4	-0.16667	99.83333	LP G
9.5	1.385417	98.28125	BKF Top HT
13.7	3.447917	96.21875	G Mid Slope
18.3	5.239583	94.42708	LT Toe Slope
31.2	5.09375	94.57292	LT Boulder shelf
52.7	5.666667	94	LT Veg Boulder shelf
71.9	6.135417	93.53125	LT Veg Boulder shelf
71.9	6.364583	93.30208	LT Toe riprap
82.8	**7.5**	92.16667	WS LEW
82.8	7.895833	91.77083	LEW CG
95	9.854167	89.8125	CG Bedrock slope
105	10.83333	88.83333	CG
115	12.84375	86.82292	CG
125	12.9375	86.72917	CG
135	13.82292	85.84375	TWG
145	16.01042	83.65625	CG
155	16.875	82.79167	CG
165	15.70833	83.95833	CG
175	15.85417	83.8125	CG
185	16.45833	83.20833	CG
195	12.69792	86.96875	CG
200	10.34375	89.32292	CG
209.3	7.65625	92.01042	REW CG
209.3	**7.59375**	92.07292	WS REW
210.8	6.84375	92.82292	LT Toe Mud
212	5.447917	94.21875	MT Top; Veg
229	4.729167	94.9375	BKF Toe
240.9	2.270833	97.39583	RP G BKF Top
240.9	0.895833	98.77083	RP Top

9/9/2014	9/10/2014	9/11/2014	9/11/2014	
SG Reading (inches)				
3.625	12.5	40.2	51	
Q=150 cfs	Q=300 cfs	Q=1,350 cfs	Q=2,100 cfs	BKF


Upper Reach - Riffle
104
102
100
98
96
94
92
90
88
86
84
82
Elevation (ft)
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)
0
50
100
150
200
250
300
350
400
Station (ft)


Upper Reach - Pool
104
102
100
98
96
94
92
90
88
86
84
82
Elevation (ft)
Note: Wetted to low terrace toe of slope on left bank in pool just upstream of transect.
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)
0
50
100
150
200
250
300
350
400
Station (ft)

******************************WinXSPRO*******************************
C:\WinXSPro\UpRif2.out
Input File: C:\WinXSPro\UpRif.sec
Run Date: 10/17/14
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 9/08/14

Subsections/Dividing positions

Resistance Method: Manning's n
SECTION A
Low Stage n 0.035
High Stage n 0.035

Unadjusted horizontal distances used

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
6.7	T	985.82	311.5	310.1	3.16	3.18
6.71	T	988.92	311.91	310.51	3.17	3.18
6.72	T	992.03	312.32	310.91	3.18	3.19
6.73	T	995.14	312.72	311.32	3.18	3.2
6.74	T	998.26	313.13	311.73	3.19	3.2
6.75	T	1001.38	313.54	312.13	3.19	3.21
6.76	T	1004.5	313.95	312.54	3.2	3.21
6.77	T	1007.63	314.35	312.95	3.21	3.22
6.78	T	1010.76	314.76	313.35	3.21	3.23
6.79	T	1013.9	315.17	313.76	3.22	3.23
6.8	T	1017.04	315.58	314.17	3.22	3.24
6.81	T	1020.18	315.99	314.57	3.23	3.24
6.82	T	1023.33	316.39	314.98	3.23	3.25
6.83	T	1026.48	316.8	315.38	3.24	3.25
6.84	T	1029.64	317.21	315.79	3.25	3.26
6.85	T	1032.8	317.62	316.2	3.25	3.27
6.86	T	1035.96	318.02	316.6	3.26	3.27
6.87	T	1039.13	318.43	317.01	3.26	3.28
6.88	T	1042.31	318.84	317.42	3.27	3.28
6.89	T	1045.48	319.25	317.82	3.27	3.29
6.9	T	1048.66	319.66	318.23	3.28	3.3
6.91	T	1051.85	320.06	318.64	3.29	3.3
6.92	T	1055.04	320.47	319.04	3.29	3.31
6.93	T	1058.23	320.88	319.45	3.3	3.31
6.94	T	1061.43	321.29	319.86	3.3	3.32

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
6.95	T	1064.63	321.69	320.26	3.31	3.32
6.96	T	1067.83	322.1	320.67	3.32	3.33
6.97	T	1071.04	322.51	321.08	3.32	3.34
6.98	T	1074.26	322.92	321.48	3.33	3.34
6.99	T	1077.47	323.32	321.89	3.33	3.35
7	T	1080.7	323.7	322.25	3.34	3.35
7.01	T	1083.92	324.07	322.61	3.34	3.36
7.02	T	1087.15	324.44	322.97	3.35	3.37
7.03	T	1090.38	324.6	323.13	3.36	3.37
7.04	T	1093.61	324.75	323.26	3.37	3.38
7.05	T	1096.85	324.9	323.4	3.38	3.39
7.06	T	1100.08	325.04	323.54	3.38	3.4
7.07	T	1103.32	325.19	323.67	3.39	3.41
7.08	T	1106.56	325.34	323.81	3.4	3.42
7.09	T	1109.8	325.49	323.95	3.41	3.43
7.1	T	1113.04	325.63	324.08	3.42	3.43
7.11	T	1116.28	325.78	324.22	3.43	3.44
7.12	T	1119.52	325.93	324.36	3.43	3.45
7.13	T	1122.77	326.07	324.49	3.44	3.46
7.14	T	1126.02	326.22	324.63	3.45	3.47
7.15	T	1129.26	326.37	324.77	3.46	3.48
7.16	T	1132.51	326.52	324.9	3.47	3.49
7.17	T	1135.76	326.66	325.04	3.48	3.49
7.18	T	1139.01	326.81	325.18	3.49	3.5
7.19	T	1142.27	326.96	325.31	3.49	3.51
7.2	T	1145.52	327.1	325.45	3.5	3.52
7.21	T	1148.78	327.25	325.59	3.51	3.53
7.22	T	1152.04	327.41	325.74	3.52	3.54
7.23	T	1155.29	327.56	325.89	3.53	3.55
7.24	T	1158.55	327.72	326.04	3.54	3.55
7.25	T	1161.82	327.87	326.2	3.54	3.56
7.26	T	1165.08	328.03	326.35	3.55	3.57
7.27	T	1168.34	328.18	326.5	3.56	3.58
7.28	T	1171.61	328.34	326.65	3.57	3.59
7.29	T	1174.88	328.49	326.8	3.58	3.6
7.3	T	1178.15	328.65	326.96	3.58	3.6
7.31	T	1181.42	328.8	327.11	3.59	3.61
7.32	T	1184.69	328.96	327.26	3.6	3.62
7.33	T	1187.97	329.11	327.41	3.61	3.63
7.34	T	1191.24	329.27	327.56	3.62	3.64
7.35	T	1194.52	329.42	327.71	3.63	3.65
7.36	T	1197.8	329.58	327.87	3.63	3.65
7.37	T	1201.08	329.73	328.02	3.64	3.66
7.38	T	1204.36	329.89	328.17	3.65	3.67
7.39	T	1207.64	330.04	328.32	3.66	3.68

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
7.4	T	1210.93	330.2	328.47	3.67	3.69
7.41	T	1214.21	330.36	328.62	3.68	3.69
7.42	T	1217.5	330.51	328.78	3.68	3.7
7.43	T	1220.79	330.67	328.93	3.69	3.71
7.44	T	1224.08	330.82	329.08	3.7	3.72
7.45	T	1227.37	330.98	329.23	3.71	3.73
7.46	T	1230.67	331.13	329.38	3.72	3.74
7.47	T	1233.96	331.29	329.53	3.72	3.74
7.48	T	1237.26	331.44	329.69	3.73	3.75
7.49	T	1240.56	331.6	329.84	3.74	3.76
7.5	T	1243.86	331.75	329.99	3.75	3.77
7.51	T	1247.16	331.91	330.14	3.76	3.78
7.52	T	1250.46	332.06	330.29	3.77	3.79
7.53	T	1253.77	332.22	330.44	3.77	3.79
7.54	T	1257.07	332.37	330.6	3.78	3.8
7.55	T	1260.38	332.53	330.75	3.79	3.81
7.56	T	1263.69	332.68	330.9	3.8	3.82
7.57	T	1267	332.84	331.05	3.81	3.83
7.58	T	1270.31	332.99	331.2	3.81	3.84
7.59	T	1273.62	333.15	331.35	3.82	3.84
7.6	T	1276.94	333.3	331.51	3.83	3.85
7.61	T	1280.26	333.46	331.66	3.84	3.86
7.62	T	1283.57	333.61	331.81	3.85	3.87
7.63	T	1286.89	333.77	331.96	3.86	3.88
7.64	T	1290.21	333.92	332.11	3.86	3.88
7.65	T	1293.54	334.08	332.26	3.87	3.89
7.66	T	1296.86	334.23	332.42	3.88	3.9
7.67	T	1300.19	334.39	332.57	3.89	3.91
7.68	T	1303.51	334.54	332.72	3.9	3.92
7.69	T	1306.84	334.7	332.87	3.9	3.93
7.7	T	1310.17	334.85	333.02	3.91	3.93
7.71	T	1313.5	335.01	333.18	3.92	3.94
7.72	T	1316.84	335.16	333.33	3.93	3.95
7.73	T	1320.17	335.34	333.5	3.94	3.96
7.74	T	1323.51	335.7	333.86	3.94	3.96
7.75	T	1326.85	336.06	334.21	3.95	3.97
7.76	T	1330.2	336.43	334.57	3.95	3.98
7.77	T	1333.54	336.79	334.93	3.96	3.98
7.78	T	1336.9	337.15	335.29	3.97	3.99
7.79	T	1340.25	337.51	335.64	3.97	3.99
7.8	T	1343.61	337.87	336	3.98	4
7.81	T	1346.97	338.23	336.36	3.98	4
7.82	T	1350.34	338.6	336.71	3.99	4.01
7.83	T	1353.71	338.96	337.07	3.99	4.02
7.84	T	1357.08	339.32	337.43	4	4.02

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
7.85	T	1360.46	339.68	337.78	4.01	4.03
7.86	T	1363.84	340.04	338.14	4.01	4.03
7.87	T	1367.22	340.4	338.5	4.02	4.04
7.88	T	1370.61	340.77	338.86	4.02	4.04
7.89	T	1374	341.14	339.22	4.03	4.05
7.9	T	1377.4	341.5	339.59	4.03	4.06
7.91	T	1380.79	341.87	339.95	4.04	4.06
7.92	T	1384.2	342.24	340.31	4.04	4.07
7.93	T	1387.6	342.61	340.68	4.05	4.07
7.94	T	1391.01	342.98	341.04	4.06	4.08
7.95	T	1394.42	343.34	341.4	4.06	4.08
7.96	T	1397.84	343.71	341.77	4.07	4.09
7.97	T	1401.26	344.08	342.13	4.07	4.1
7.98	T	1404.69	344.45	342.5	4.08	4.1
7.99	T	1408.11	344.81	342.86	4.08	4.11
8	T	1411.54	345.18	343.22	4.09	4.11
8.01	T	1414.98	345.55	343.59	4.09	4.12
8.02	T	1418.42	345.92	343.95	4.1	4.12
8.03	T	1421.86	346.28	344.31	4.11	4.13
8.04	T	1425.3	346.65	344.68	4.11	4.14
8.05	T	1428.75	347.02	345.04	4.12	4.14
8.06	T	1432.21	347.39	345.41	4.12	4.15
8.07	T	1435.66	347.75	345.77	4.13	4.15
8.08	T	1439.12	348.12	346.13	4.13	4.16
8.09	T	1442.59	348.49	346.5	4.14	4.16
8.1	T	1446.05	348.86	346.86	4.15	4.17
8.11	T	1449.53	349.23	347.22	4.15	4.17
8.12	T	1453	349.59	347.59	4.16	4.18
8.13	T	1456.48	349.96	347.95	4.16	4.19
8.14	T	1459.96	350.33	348.32	4.17	4.19
8.15	T	1463.45	350.7	348.68	4.17	4.2
8.16	T	1466.94	351.06	349.04	4.18	4.2
8.17	T	1470.43	351.43	349.41	4.18	4.21
8.18	T	1473.93	351.8	349.77	4.19	4.21
8.19	T	1477.43	352.17	350.13	4.2	4.22
8.2	T	1480.93	352.53	350.5	4.2	4.23
8.21	T	1484.44	352.9	350.86	4.21	4.23
8.22	T	1487.95	353.27	351.23	4.21	4.24
8.23	T	1491.46	353.64	351.59	4.22	4.24
8.24	T	1494.98	354	351.95	4.22	4.25
8.25	T	1498.5	354.36	352.31	4.23	4.25
8.26	T	1502.03	354.44	352.38	4.24	4.26
8.27	T	1505.55	354.51	352.45	4.25	4.27
8.28	T	1509.08	354.59	352.52	4.26	4.28
8.29	T	1512.61	354.66	352.59	4.26	4.29

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
8.3	T	1516.13	354.74	352.67	4.27	4.3
8.31	T	1519.66	354.81	352.74	4.28	4.31
8.32	T	1523.19	354.89	352.81	4.29	4.32
8.33	T	1526.72	354.96	352.88	4.3	4.33
8.34	T	1530.25	355.03	352.95	4.31	4.34
8.35	T	1533.78	355.11	353.02	4.32	4.34
8.36	T	1537.31	355.18	353.09	4.33	4.35
8.37	T	1540.84	355.26	353.17	4.34	4.36
8.38	T	1544.37	355.33	353.24	4.35	4.37
8.39	T	1547.91	355.41	353.31	4.36	4.38
8.4	T	1551.44	355.48	353.38	4.36	4.39
8.41	T	1554.98	355.56	353.45	4.37	4.4
8.42	T	1558.51	355.63	353.52	4.38	4.41
8.43	T	1562.05	355.73	353.62	4.39	4.42
8.44	T	1565.59	355.89	353.78	4.4	4.43
8.45	T	1569.13	356.05	353.94	4.41	4.43
8.46	T	1572.67	356.21	354.1	4.41	4.44
8.47	T	1576.21	356.37	354.25	4.42	4.45
8.48	T	1579.75	356.53	354.41	4.43	4.46
8.49	T	1583.3	356.69	354.57	4.44	4.47
8.5	T	1586.85	356.85	354.73	4.45	4.47
8.51	T	1590.4	357.01	354.88	4.45	4.48
8.52	T	1593.95	357.17	355.04	4.46	4.49
8.53	T	1597.5	357.32	355.2	4.47	4.5
8.54	T	1601.05	357.48	355.36	4.48	4.51
8.55	T	1604.61	357.64	355.51	4.49	4.51
8.56	T	1608.16	357.8	355.67	4.49	4.52
8.57	T	1611.72	357.96	355.83	4.5	4.53
8.58	T	1615.28	358.12	355.99	4.51	4.54
8.59	T	1618.84	358.28	356.14	4.52	4.55
8.6	T	1622.41	358.44	356.3	4.53	4.55
8.61	T	1625.97	358.6	356.46	4.53	4.56
8.62	T	1629.54	358.76	356.62	4.54	4.57
8.63	T	1633.1	358.92	356.77	4.55	4.58
8.64	T	1636.67	359.07	356.93	4.56	4.59
8.65	T	1640.24	359.23	357.09	4.57	4.59
8.66	T	1643.82	359.39	357.25	4.57	4.6
8.67	T	1647.39	359.55	357.4	4.58	4.61
8.68	T	1650.97	359.71	357.56	4.59	4.62
8.69	T	1654.54	359.87	357.72	4.6	4.63
8.7	T	1658.12	360.03	357.88	4.61	4.63
8.71	T	1661.7	360.19	358.04	4.61	4.64
8.72	T	1665.28	360.35	358.19	4.62	4.65
8.73	T	1668.87	360.51	358.35	4.63	4.66
8.74	T	1672.45	360.66	358.51	4.64	4.67

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
8.75	T	1676.04	360.82	358.67	4.65	4.67
8.76	T	1679.63	360.98	358.82	4.65	4.68
8.77	T	1683.22	361.14	358.98	4.66	4.69
8.78	T	1686.81	361.3	359.14	4.67	4.7
8.79	T	1690.4	361.46	359.3	4.68	4.7
8.8	T	1694	361.62	359.45	4.68	4.71
8.81	T	1697.59	361.78	359.61	4.69	4.72
8.82	T	1701.19	361.94	359.77	4.7	4.73
8.83	T	1704.79	362.1	359.93	4.71	4.74
8.84	T	1708.39	362.26	360.08	4.72	4.74
8.85	T	1711.99	362.41	360.24	4.72	4.75
8.86	T	1715.6	362.57	360.4	4.73	4.76
8.87	T	1719.2	362.73	360.56	4.74	4.77
8.88	T	1722.81	362.89	360.71	4.75	4.78
8.89	T	1726.42	363.05	360.87	4.76	4.78
8.9	T	1730.03	363.21	361.03	4.76	4.79
8.91	T	1733.64	363.37	361.19	4.77	4.8
8.92	T	1737.25	363.53	361.34	4.78	4.81
8.93	T	1740.87	363.69	361.5	4.79	4.82
8.94	T	1744.48	363.85	361.66	4.79	4.82
8.95	T	1748.1	364.01	361.82	4.8	4.83
8.96	T	1751.72	364.16	361.97	4.81	4.84
8.97	T	1755.34	364.32	362.13	4.82	4.85
8.98	T	1758.97	364.48	362.29	4.83	4.86
8.99	T	1762.59	364.64	362.45	4.83	4.86
9	T	1766.22	364.8	362.61	4.84	4.87
9.01	T	1769.85	364.96	362.76	4.85	4.88
9.02	T	1773.47	365.12	362.92	4.86	4.89
9.03	T	1777.11	365.28	363.08	4.87	4.89
9.04	T	1780.74	365.44	363.24	4.87	4.9
9.05	T	1784.37	365.6	363.39	4.88	4.91
9.06	T	1788.01	365.75	363.55	4.89	4.92
9.07	T	1791.64	365.91	363.71	4.9	4.93
9.08	T	1795.28	366.07	363.87	4.9	4.93
9.09	T	1798.92	366.23	364.02	4.91	4.94
9.1	T	1802.56	366.39	364.18	4.92	4.95
9.11	T	1806.21	366.49	364.28	4.93	4.96
9.12	T	1809.85	366.56	364.34	4.94	4.97
9.13	T	1813.5	366.63	364.4	4.95	4.98
9.14	T	1817.14	366.69	364.47	4.96	4.99
9.15	T	1820.79	366.76	364.53	4.96	4.99
9.16	T	1824.43	366.83	364.59	4.97	5
9.17	T	1828.08	366.9	364.66	4.98	5.01
9.18	T	1831.73	366.96	364.72	4.99	5.02
9.19	T	1835.38	367.03	364.78	5	5.03

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
9.2	T	1839.03	367.1	364.84	5.01	5.04
9.21	T	1842.68	367.16	364.91	5.02	5.05
9.22	T	1846.33	367.23	364.97	5.03	5.06
9.23	T	1849.98	367.3	365.03	5.04	5.07
9.24	T	1853.63	367.37	365.1	5.05	5.08
9.25	T	1857.28	367.43	365.16	5.05	5.09
9.26	T	1860.93	367.5	365.22	5.06	5.1
9.27	T	1864.59	367.57	365.28	5.07	5.1
9.28	T	1868.24	367.64	365.35	5.08	5.11
9.29	T	1871.89	367.7	365.41	5.09	5.12
9.3	T	1875.55	367.77	365.47	5.1	5.13
9.31	T	1879.21	367.84	365.54	5.11	5.14
9.32	T	1882.86	367.9	365.6	5.12	5.15
9.33	T	1886.52	367.97	365.66	5.13	5.16
9.34	T	1890.18	368.04	365.73	5.14	5.17
9.35	T	1893.83	368.11	365.79	5.14	5.18
9.36	T	1897.49	368.17	365.85	5.15	5.19
9.37	T	1901.15	368.24	365.91	5.16	5.2
9.38	T	1904.81	368.31	365.98	5.17	5.2
9.39	T	1908.47	368.38	366.04	5.18	5.21
9.4	T	1912.14	368.44	366.1	5.19	5.22
9.41	T	1915.8	368.51	366.17	5.2	5.23
9.42	T	1919.46	368.58	366.23	5.21	5.24
9.43	T	1923.12	368.65	366.29	5.22	5.25
9.44	T	1926.79	368.71	366.35	5.23	5.26
9.45	T	1930.45	368.78	366.42	5.23	5.27
9.46	T	1934.12	368.84	366.47	5.24	5.28
9.47	T	1937.78	368.86	366.48	5.25	5.29
9.48	T	1941.45	368.89	366.49	5.26	5.3
9.49	T	1945.11	368.92	366.51	5.27	5.31

******************************WinXSPRO********************************

C:\WinXSPro\UpPool2.out

Input File: C:\WinXSPro\UpPool.sec

Run Date: 10/17/14

Analysis Procedure: Hydraulics

Cross Section Number: 1

Survey Date: 9/08/14

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION A

Low Stage n 0.035

High Stage n 0.035

Unadjusted horizontal distances used

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
9.3	T	717.54	129.32	126.54	5.55	5.67
9.31	T	718.81	129.35	126.56	5.56	5.68
9.32	T	720.07	129.39	126.58	5.57	5.69
9.33	T	721.34	129.42	126.6	5.57	5.7
9.34	T	722.6	129.45	126.62	5.58	5.71
9.35	T	723.87	129.48	126.64	5.59	5.72
9.36	T	725.14	129.51	126.66	5.6	5.73
9.37	T	726.4	129.55	126.68	5.61	5.73
9.38	T	727.67	129.62	126.75	5.61	5.74
9.39	T	728.94	129.74	126.86	5.62	5.75
9.4	T	730.21	129.86	126.98	5.62	5.75
9.41	T	731.48	129.98	127.09	5.63	5.76
9.42	T	732.75	130.1	127.21	5.63	5.76
9.43	T	734.02	130.22	127.33	5.64	5.76
9.44	T	735.3	130.34	127.44	5.64	5.77
9.45	T	736.57	130.46	127.56	5.65	5.77
9.46	T	737.85	130.57	127.67	5.65	5.78
9.47	T	739.13	130.69	127.79	5.66	5.78
9.48	T	740.41	130.81	127.91	5.66	5.79
9.49	T	741.69	130.93	128.02	5.66	5.79
9.5	T	742.97	131.05	128.14	5.67	5.8
9.51	T	744.25	131.17	128.25	5.67	5.8
9.52	T	745.53	131.29	128.37	5.68	5.81
9.53	T	746.82	131.41	128.49	5.68	5.81
9.54	T	748.1	131.53	128.6	5.69	5.82

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
9.55	T	749.39	131.64	128.72	5.69	5.82
9.56	T	750.68	131.76	128.83	5.7	5.83
9.57	T	751.97	131.88	128.95	5.7	5.83
9.58	T	753.26	132	129.07	5.71	5.84
9.59	T	754.55	132.12	129.18	5.71	5.84
9.6	T	755.84	132.24	129.3	5.72	5.85
9.61	T	757.14	132.36	129.41	5.72	5.85
9.62	T	758.43	132.48	129.53	5.73	5.86
9.63	T	759.73	132.6	129.65	5.73	5.86
9.64	T	761.02	132.71	129.76	5.73	5.86
9.65	T	762.32	132.83	129.88	5.74	5.87
9.66	T	763.62	132.95	129.99	5.74	5.87
9.67	T	764.92	133.07	130.11	5.75	5.88
9.68	T	766.23	133.19	130.23	5.75	5.88
9.69	T	767.53	133.31	130.34	5.76	5.89
9.7	T	768.83	133.43	130.46	5.76	5.89
9.71	T	770.14	133.55	130.57	5.77	5.9
9.72	T	771.44	133.67	130.69	5.77	5.9
9.73	T	772.75	133.78	130.81	5.78	5.91
9.74	T	774.06	133.9	130.92	5.78	5.91
9.75	T	775.37	134.02	131.04	5.79	5.92
9.76	T	776.68	134.14	131.15	5.79	5.92
9.77	T	777.99	134.26	131.27	5.79	5.93
9.78	T	779.31	134.38	131.39	5.8	5.93
9.79	T	780.62	134.5	131.5	5.8	5.94
9.8	T	781.94	134.62	131.62	5.81	5.94
9.81	T	783.26	134.74	131.73	5.81	5.95
9.82	T	784.57	134.85	131.85	5.82	5.95
9.83	T	785.89	134.97	131.97	5.82	5.96
9.84	T	787.21	135.09	132.08	5.83	5.96
9.85	T	788.54	135.21	132.2	5.83	5.96
9.86	T	789.86	135.33	132.31	5.84	5.97
9.87	T	791.18	135.45	132.43	5.84	5.97
9.88	T	792.51	135.57	132.55	5.85	5.98
9.89	T	793.83	135.69	132.66	5.85	5.98
9.9	T	795.16	135.81	132.78	5.86	5.99
9.91	T	796.49	135.92	132.9	5.86	5.99
9.92	T	797.82	136.04	133.01	5.86	6
9.93	T	799.15	136.16	133.13	5.87	6
9.94	T	800.48	136.28	133.24	5.87	6.01
9.95	T	801.82	136.4	133.36	5.88	6.01
9.96	T	803.15	136.52	133.48	5.88	6.02
9.97	T	804.49	136.64	133.59	5.89	6.02
9.98	T	805.82	136.76	133.71	5.89	6.03
9.99	T	807.16	136.88	133.82	5.9	6.03

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10	T	808.5	137	133.94	5.9	6.04
10.01	T	809.84	137.11	134.06	5.91	6.04
10.02	T	811.18	137.23	134.17	5.91	6.05
10.03	T	812.53	137.35	134.29	5.92	6.05
10.04	T	813.87	137.46	134.39	5.92	6.06
10.05	T	815.21	137.57	134.5	5.93	6.06
10.06	T	816.56	137.68	134.6	5.93	6.07
10.07	T	817.91	137.79	134.71	5.94	6.07
10.08	T	819.25	137.9	134.81	5.94	6.08
10.09	T	820.6	138.01	134.92	5.95	6.08
10.1	T	821.95	138.12	135.02	5.95	6.09
10.11	T	823.3	138.23	135.13	5.96	6.09
10.12	T	824.66	138.34	135.23	5.96	6.1
10.13	T	826.01	138.45	135.33	5.97	6.1
10.14	T	827.36	138.56	135.44	5.97	6.11
10.15	T	828.72	138.67	135.54	5.98	6.11
10.16	T	830.08	138.78	135.65	5.98	6.12
10.17	T	831.43	138.89	135.75	5.99	6.12
10.18	T	832.79	139	135.86	5.99	6.13
10.19	T	834.15	139.11	135.96	6	6.14
10.2	T	835.51	139.22	136.07	6	6.14
10.21	T	836.87	139.33	136.17	6.01	6.15
10.22	T	838.23	139.44	136.28	6.01	6.15
10.23	T	839.6	139.55	136.38	6.02	6.16
10.24	T	840.96	139.66	136.49	6.02	6.16
10.25	T	842.33	139.77	136.59	6.03	6.17
10.26	T	843.7	139.88	136.69	6.03	6.17
10.27	T	845.06	139.99	136.8	6.04	6.18
10.28	T	846.43	140.1	136.9	6.04	6.18
10.29	T	847.8	140.21	137.01	6.05	6.19
10.3	T	849.17	140.32	137.11	6.05	6.19
10.31	T	850.54	140.43	137.22	6.06	6.2
10.32	T	851.92	140.53	137.32	6.06	6.2
10.33	T	853.29	140.64	137.43	6.07	6.21
10.34	T	854.67	140.75	137.53	6.07	6.21
10.35	T	856.04	140.86	137.64	6.08	6.22
10.36	T	857.42	140.97	137.74	6.08	6.22
10.37	T	858.8	141.08	137.85	6.09	6.23
10.38	T	860.18	141.19	137.95	6.09	6.24
10.39	T	861.56	141.3	138.05	6.1	6.24
10.4	T	862.94	141.41	138.16	6.1	6.25
10.41	T	864.32	141.52	138.26	6.11	6.25
10.42	T	865.7	141.63	138.37	6.11	6.26
10.43	T	867.09	141.74	138.47	6.12	6.26
10.44	T	868.47	141.85	138.58	6.12	6.27

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10.45	T	869.86	141.96	138.68	6.13	6.27
10.46	T	871.25	142.07	138.79	6.13	6.28
10.47	T	872.64	142.18	138.89	6.14	6.28
10.48	T	874.03	142.29	139	6.14	6.29
10.49	T	875.42	142.4	139.1	6.15	6.29
10.5	T	876.81	142.51	139.21	6.15	6.3
10.51	T	878.2	142.62	139.31	6.16	6.3
10.52	T	879.6	142.64	139.32	6.17	6.31
10.53	T	880.99	142.67	139.33	6.18	6.32
10.54	T	882.38	142.69	139.34	6.18	6.33
10.55	T	883.78	142.71	139.35	6.19	6.34
10.56	T	885.17	142.74	139.35	6.2	6.35
10.57	T	886.57	142.76	139.36	6.21	6.36
10.58	T	887.96	142.78	139.37	6.22	6.37
10.59	T	889.35	142.81	139.38	6.23	6.38
10.6	T	890.75	142.83	139.39	6.24	6.39
10.61	T	892.14	142.85	139.4	6.25	6.4
10.62	T	893.54	142.88	139.41	6.25	6.41
10.63	T	894.93	142.9	139.41	6.26	6.42
10.64	T	896.32	142.92	139.42	6.27	6.43
10.65	T	897.72	142.95	139.43	6.28	6.44
10.66	T	899.11	142.97	139.44	6.29	6.45
10.67	T	900.51	142.99	139.45	6.3	6.46
10.68	T	901.9	143.02	139.46	6.31	6.47
10.69	T	903.3	143.04	139.47	6.32	6.48
10.7	T	904.69	143.06	139.48	6.32	6.49
10.71	T	906.09	143.08	139.48	6.33	6.5
10.72	T	907.48	143.11	139.49	6.34	6.51
10.73	T	908.88	143.13	139.5	6.35	6.52
10.74	T	910.27	143.18	139.54	6.36	6.52
10.75	T	911.67	143.61	139.96	6.35	6.51
10.76	T	913.07	144.03	140.38	6.34	6.5
10.77	T	914.48	144.45	140.79	6.33	6.5
10.78	T	915.89	144.88	141.21	6.32	6.49
10.79	T	917.31	145.3	141.63	6.31	6.48
10.8	T	918.72	145.72	142.05	6.3	6.47
10.81	T	920.15	146.14	142.47	6.3	6.46
10.82	T	921.57	146.57	142.89	6.29	6.45
10.83	T	923.01	146.99	143.3	6.28	6.44
10.84	T	924.44	147.41	143.72	6.27	6.43
10.85	T	925.88	147.84	144.14	6.26	6.42
10.86	T	927.32	148.26	144.56	6.25	6.41
10.87	T	928.77	148.68	144.98	6.25	6.41
10.88	T	930.22	149.11	145.4	6.24	6.4
10.89	T	931.68	149.53	145.81	6.23	6.39

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10.9	T	933.14	149.95	146.23	6.22	6.38
10.91	T	934.61	150.37	146.65	6.22	6.37
10.92	T	936.07	150.8	147.07	6.21	6.36
10.93	T	937.55	151.22	147.49	6.2	6.36
10.94	T	939.03	151.64	147.91	6.19	6.35
10.95	T	940.51	152.07	148.32	6.18	6.34
10.96	T	941.99	152.49	148.74	6.18	6.33
10.97	T	943.48	152.91	149.16	6.17	6.33
10.98	T	944.98	153.34	149.58	6.16	6.32
10.99	T	946.47	153.76	150	6.16	6.31
11	T	947.98	154.18	150.41	6.15	6.3
11.01	T	949.48	154.6	150.83	6.14	6.29
11.02	T	950.99	155.03	151.25	6.13	6.29
11.03	T	952.51	155.45	151.67	6.13	6.28
11.04	T	954.03	155.87	152.09	6.12	6.27
11.05	T	955.55	156.3	152.51	6.11	6.27
11.06	T	957.08	156.72	152.92	6.11	6.26
11.07	T	958.61	157.14	153.34	6.1	6.25
11.08	T	960.15	157.56	153.76	6.09	6.24
11.09	T	961.69	157.99	154.18	6.09	6.24
11.1	T	963.23	158.41	154.6	6.08	6.23
11.11	T	964.78	158.83	155.02	6.07	6.22
11.12	T	966.33	159.26	155.43	6.07	6.22
11.13	T	967.89	159.68	155.85	6.06	6.21
11.14	T	969.45	160.1	156.27	6.06	6.2
11.15	T	971.01	160.53	156.69	6.05	6.2
11.16	T	972.58	160.95	157.11	6.04	6.19
11.17	T	974.16	161.37	157.53	6.04	6.18
11.18	T	975.73	161.79	157.94	6.03	6.18
11.19	T	977.32	162.22	158.36	6.02	6.17
11.2	T	978.9	162.64	158.78	6.02	6.17
11.21	T	980.49	163.06	159.19	6.01	6.16
11.22	T	982.09	163.45	159.58	6.01	6.15
11.23	T	983.69	163.83	159.96	6	6.15
11.24	T	985.29	164.22	160.34	6	6.14
11.25	T	986.89	164.61	160.73	6	6.14
11.26	T	988.5	165	161.11	5.99	6.14
11.27	T	990.12	165.39	161.5	5.99	6.13
11.28	T	991.73	165.78	161.88	5.98	6.13
11.29	T	993.35	166.17	162.26	5.98	6.12
11.3	T	994.98	166.55	162.65	5.97	6.12
11.31	T	996.61	166.94	163.03	5.97	6.11
11.32	T	998.24	167.33	163.42	5.97	6.11
11.33	T	999.88	167.72	163.8	5.96	6.1
11.34	T	1001.52	168.11	164.18	5.96	6.1

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
11.35	T	1003.16	168.5	164.57	5.95	6.1
11.36	T	1004.81	168.89	164.95	5.95	6.09
11.37	T	1006.46	169.28	165.33	5.95	6.09
11.38	T	1008.12	169.66	165.72	5.94	6.08
11.39	T	1009.78	170.05	166.1	5.94	6.08
11.4	T	1011.44	170.44	166.49	5.93	6.08
11.41	T	1013.11	170.83	166.87	5.93	6.07
11.42	T	1014.78	171.22	167.25	5.93	6.07
11.43	T	1016.45	171.68	167.72	5.92	6.06
11.44	T	1018.13	172.3	168.33	5.91	6.05
11.45	T	1019.82	172.91	168.94	5.9	6.04
11.46	T	1021.51	173.52	169.55	5.89	6.02
11.47	T	1023.21	174.13	170.16	5.88	6.01
11.48	T	1024.92	174.74	170.78	5.87	6
11.49	T	1026.63	175.36	171.39	5.85	5.99
11.5	T	1028.34	175.97	172	5.84	5.98
11.51	T	1030.07	176.58	172.61	5.83	5.97
11.52	T	1031.8	177.19	173.22	5.82	5.96
11.53	T	1033.53	177.81	173.83	5.81	5.95
11.54	T	1035.28	178.42	174.45	5.8	5.93
11.55	T	1037.02	179.03	175.06	5.79	5.92
11.56	T	1038.78	179.64	175.67	5.78	5.91
11.57	T	1040.54	180.25	176.28	5.77	5.9
11.58	T	1042.3	180.87	176.89	5.76	5.89
11.59	T	1044.08	181.48	177.51	5.75	5.88
11.6	T	1045.85	182.09	178.12	5.74	5.87
11.61	T	1047.64	182.7	178.73	5.73	5.86
11.62	T	1049.43	183.32	179.34	5.72	5.85
11.63	T	1051.23	183.93	179.95	5.72	5.84
11.64	T	1053.03	185	181.03	5.69	5.82
11.65	T	1054.85	186.53	182.55	5.66	5.78
11.66	T	1056.68	188.05	184.07	5.62	5.74
11.67	T	1058.53	189.58	185.6	5.58	5.7
11.68	T	1060.4	191.1	187.12	5.55	5.67
11.69	T	1062.27	192.63	188.64	5.51	5.63
11.7	T	1064.17	194.15	190.16	5.48	5.6
11.71	T	1066.08	195.68	191.69	5.45	5.56
11.72	T	1068	197.2	193.21	5.42	5.53
11.73	T	1069.94	198.73	194.73	5.38	5.49
11.74	T	1071.9	200.25	196.25	5.35	5.46
11.75	T	1073.87	201.78	197.77	5.32	5.43
11.76	T	1075.86	203.3	199.3	5.29	5.4
11.77	T	1077.86	204.83	200.82	5.26	5.37
11.78	T	1079.87	206.35	202.34	5.23	5.34
11.79	T	1081.9	206.7	202.69	5.23	5.34

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
11.8	T	1083.93	206.97	202.96	5.24	5.34
11.81	T	1085.96	207.23	203.22	5.24	5.34
11.82	T	1087.99	207.5	203.48	5.24	5.35
11.83	T	1090.03	207.76	203.74	5.25	5.35
11.84	T	1092.07	208.03	204.01	5.25	5.35
11.85	T	1094.11	208.29	204.27	5.25	5.36
11.86	T	1096.15	208.55	204.53	5.26	5.36
11.87	T	1098.2	208.82	204.79	5.26	5.36
11.88	T	1100.25	209.08	205.05	5.26	5.37
11.89	T	1102.3	209.35	205.32	5.27	5.37
11.9	T	1104.36	209.61	205.58	5.27	5.37
11.91	T	1106.42	209.88	205.84	5.27	5.38
11.92	T	1108.48	210.14	206.1	5.27	5.38
11.93	T	1110.54	210.41	206.37	5.28	5.38
11.94	T	1112.6	210.67	206.63	5.28	5.38
11.95	T	1114.67	210.93	206.89	5.28	5.39
11.96	T	1116.74	211.2	207.15	5.29	5.39
11.97	T	1118.82	211.46	207.42	5.29	5.39
11.98	T	1120.89	211.73	207.68	5.29	5.4
11.99	T	1122.97	211.99	207.94	5.3	5.4
12	T	1125.05	212.26	208.2	5.3	5.4
12.01	T	1127.14	212.52	208.46	5.3	5.41
12.02	T	1129.22	212.78	208.73	5.31	5.41
12.03	T	1131.31	213.05	208.99	5.31	5.41
12.04	T	1133.4	213.31	209.25	5.31	5.42
12.05	T	1135.5	213.58	209.51	5.32	5.42
12.06	T	1137.59	213.84	209.78	5.32	5.42
12.07	T	1139.69	214.11	210.04	5.32	5.43
12.08	T	1141.8	214.37	210.3	5.33	5.43
12.09	T	1143.9	214.63	210.56	5.33	5.43
12.1	T	1146.01	214.9	210.82	5.33	5.44
12.11	T	1148.12	215.16	211.09	5.34	5.44
12.12	T	1150.23	215.43	211.35	5.34	5.44
12.13	T	1152.35	215.69	211.61	5.34	5.45
12.14	T	1154.46	215.96	211.87	5.35	5.45
12.15	T	1156.58	216.13	212.05	5.35	5.45
12.16	T	1158.7	216.21	212.12	5.36	5.46
12.17	T	1160.83	216.29	212.19	5.37	5.47
12.18	T	1162.95	216.36	212.27	5.38	5.48
12.19	T	1165.07	216.44	212.34	5.38	5.49
12.2	T	1167.2	216.52	212.42	5.39	5.49
12.21	T	1169.32	216.59	212.49	5.4	5.5
12.22	T	1171.45	216.67	212.56	5.41	5.51
12.23	T	1173.57	216.75	212.64	5.41	5.52
12.24	T	1175.7	216.82	212.71	5.42	5.53

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
12.25	T	1177.83	216.9	212.79	5.43	5.54
12.26	T	1179.96	216.98	212.86	5.44	5.54
12.27	T	1182.09	217.06	212.94	5.45	5.55
12.28	T	1184.22	217.13	213.01	5.45	5.56
12.29	T	1186.35	217.21	213.08	5.46	5.57
12.3	T	1188.48	217.29	213.16	5.47	5.58
12.31	T	1190.61	217.36	213.23	5.48	5.58
12.32	T	1192.75	217.44	213.31	5.49	5.59
12.33	T	1194.88	217.52	213.38	5.49	5.6
12.34	T	1197.01	217.59	213.45	5.5	5.61
12.35	T	1199.15	217.67	213.53	5.51	5.62
12.36	T	1201.29	217.75	213.6	5.52	5.62
12.37	T	1203.42	217.83	213.68	5.52	5.63
12.38	T	1205.56	217.9	213.75	5.53	5.64
12.39	T	1207.7	217.98	213.82	5.54	5.65
12.4	T	1209.84	218.06	213.9	5.55	5.66
12.41	T	1211.98	218.13	213.97	5.56	5.66
12.42	T	1214.12	218.21	214.05	5.56	5.67
12.43	T	1216.26	218.29	214.12	5.57	5.68
12.44	T	1218.4	218.36	214.19	5.58	5.69
12.45	T	1220.54	218.44	214.27	5.59	5.7
12.46	T	1222.69	218.52	214.34	5.6	5.7
12.47	T	1224.83	218.6	214.42	5.6	5.71
12.48	T	1226.98	218.67	214.49	5.61	5.72
12.49	T	1229.12	218.75	214.57	5.62	5.73
12.5	T	1231.27	218.83	214.64	5.63	5.74
12.51	T	1233.42	218.9	214.71	5.63	5.74
12.52	T	1235.56	218.98	214.79	5.64	5.75
12.53	T	1237.71	219.06	214.86	5.65	5.76
12.54	T	1239.86	219.13	214.94	5.66	5.77
12.55	T	1242.01	219.21	215.01	5.67	5.78
12.56	T	1244.16	219.29	215.08	5.67	5.78
12.57	T	1246.32	219.37	215.16	5.68	5.79
12.58	T	1248.47	219.44	215.23	5.69	5.8
12.59	T	1250.62	219.52	215.31	5.7	5.81
12.6	T	1252.77	219.6	215.38	5.7	5.82
12.61	T	1254.93	219.67	215.45	5.71	5.82
12.62	T	1257.08	219.75	215.53	5.72	5.83
12.63	T	1259.24	219.83	215.6	5.73	5.84
12.64	T	1261.4	219.9	215.68	5.74	5.85
12.65	T	1263.56	219.98	215.75	5.74	5.86
12.66	T	1265.71	220.06	215.82	5.75	5.86
12.67	T	1267.87	220.14	215.9	5.76	5.87
12.68	T	1270.03	220.21	215.97	5.77	5.88
12.69	T	1272.19	220.29	216.05	5.78	5.89

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
12.7	T	1274.35	220.37	216.12	5.78	5.9
12.71	T	1276.52	220.44	216.2	5.79	5.9
12.72	T	1278.68	220.52	216.27	5.8	5.91
12.73	T	1280.84	220.6	216.34	5.81	5.92
12.74	T	1283.01	220.67	216.42	5.81	5.93
12.75	T	1285.17	220.75	216.49	5.82	5.94
12.76	T	1287.34	220.83	216.57	5.83	5.94
12.77	T	1289.5	220.91	216.64	5.84	5.95
12.78	T	1291.67	220.98	216.71	5.85	5.96
12.79	T	1293.84	221.06	216.79	5.85	5.97
12.8	T	1296.01	221.14	216.86	5.86	5.98
12.81	T	1298.18	221.21	216.94	5.87	5.98
12.82	T	1300.35	221.29	217.01	5.88	5.99
12.83	T	1302.52	221.37	217.08	5.88	6
12.84	T	1304.69	221.44	217.16	5.89	6.01
12.85	T	1306.86	221.52	217.23	5.9	6.02
12.86	T	1309.04	221.6	217.31	5.91	6.02
12.87	T	1311.21	221.68	217.38	5.92	6.03
12.88	T	1313.38	221.75	217.45	5.92	6.04
12.89	T	1315.56	221.83	217.53	5.93	6.05
12.9	T	1317.74	221.91	217.6	5.94	6.06
12.91	T	1319.91	221.98	217.68	5.95	6.06
12.92	T	1322.09	222.06	217.75	5.95	6.07
12.93	T	1324.27	222.14	217.83	5.96	6.08
12.94	T	1326.45	222.21	217.9	5.97	6.09
12.95	T	1328.63	222.29	217.97	5.98	6.1
12.96	T	1330.81	222.37	218.05	5.98	6.1
12.97	T	1332.99	222.44	218.12	5.99	6.11
12.98	T	1335.17	222.52	218.2	6	6.12
12.99	T	1337.35	222.6	218.27	6.01	6.13
13	T	1339.54	222.68	218.34	6.02	6.13
13.01	T	1341.72	222.75	218.42	6.02	6.14
13.02	T	1343.91	222.83	218.49	6.03	6.15
13.03	T	1346.09	222.91	218.57	6.04	6.16
13.04	T	1348.28	222.98	218.64	6.05	6.17
13.05	T	1350.47	223.06	218.71	6.05	6.17
13.06	T	1352.66	223.14	218.79	6.06	6.18
13.07	T	1354.84	223.21	218.86	6.07	6.19
13.08	T	1357.03	223.29	218.94	6.08	6.2
13.09	T	1359.22	223.37	219.01	6.09	6.21
13.1	T	1361.41	223.45	219.08	6.09	6.21
13.11	T	1363.61	223.52	219.16	6.1	6.22
13.12	T	1365.8	223.6	219.23	6.11	6.23
13.13	T	1367.99	223.68	219.31	6.12	6.24
13.14	T	1370.19	223.75	219.38	6.12	6.25

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
13.15	T	1372.38	223.83	219.46	6.13	6.25
13.16	T	1374.58	223.91	219.53	6.14	6.26
13.17	T	1376.77	223.98	219.6	6.15	6.27
13.18	T	1378.97	224.06	219.68	6.15	6.28
13.19	T	1381.17	224.14	219.75	6.16	6.29
13.2	T	1383.36	224.22	219.83	6.17	6.29
13.21	T	1385.56	224.29	219.9	6.18	6.3
13.22	T	1387.76	224.37	219.97	6.19	6.31
13.23	T	1389.96	224.45	220.05	6.19	6.32
13.24	T	1392.17	224.52	220.12	6.2	6.32
13.25	T	1394.37	224.6	220.2	6.21	6.33
13.26	T	1396.57	224.68	220.27	6.22	6.34
13.27	T	1398.77	224.75	220.34	6.22	6.35
13.28	T	1400.98	224.83	220.42	6.23	6.36
13.29	T	1403.18	224.91	220.49	6.24	6.36
13.3	T	1405.39	224.99	220.57	6.25	6.37
13.31	T	1407.6	225.06	220.64	6.25	6.38
13.32	T	1409.8	225.14	220.72	6.26	6.39
13.33	T	1412.01	225.22	220.79	6.27	6.4
13.34	T	1414.22	225.29	220.86	6.28	6.4
13.35	T	1416.43	225.37	220.94	6.28	6.41
13.36	T	1418.64	225.45	221.01	6.29	6.42
13.37	T	1420.85	225.52	221.09	6.3	6.43
13.38	T	1423.06	225.6	221.16	6.31	6.43
13.39	T	1425.27	225.68	221.23	6.32	6.44
13.4	T	1427.49	225.76	221.31	6.32	6.45
13.41	T	1429.7	225.83	221.38	6.33	6.46
13.42	T	1431.92	225.91	221.46	6.34	6.47
13.43	T	1434.13	225.98	221.53	6.35	6.47
13.44	T	1436.35	226.06	221.6	6.35	6.48
13.45	T	1438.56	226.13	221.67	6.36	6.49
13.46	T	1440.78	226.2	221.73	6.37	6.5
13.47	T	1443	226.27	221.8	6.38	6.51
13.48	T	1445.22	226.35	221.87	6.39	6.51
13.49	T	1447.44	226.42	221.94	6.39	6.52
13.5	T	1449.66	226.49	222.01	6.4	6.53
13.51	T	1451.88	226.56	222.08	6.41	6.54
13.52	T	1454.1	226.63	222.15	6.42	6.55
13.53	T	1456.32	226.71	222.22	6.42	6.55
13.54	T	1458.55	226.78	222.28	6.43	6.56
13.55	T	1460.77	226.85	222.35	6.44	6.57
13.56	T	1462.99	226.92	222.42	6.45	6.58
13.57	T	1465.22	226.99	222.49	6.45	6.59
13.58	T	1467.45	227.07	222.56	6.46	6.59
13.59	T	1469.67	227.14	222.63	6.47	6.6

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
13.6	T	1471.9	227.21	222.7	6.48	6.61
13.61	T	1474.13	227.28	222.77	6.49	6.62
13.62	T	1476.35	227.36	222.84	6.49	6.63
13.63	T	1478.58	227.43	222.9	6.5	6.63
13.64	T	1480.81	227.5	222.97	6.51	6.64
13.65	T	1483.04	227.57	223.04	6.52	6.65
13.66	T	1485.28	227.64	223.11	6.52	6.66
13.67	T	1487.51	227.72	223.18	6.53	6.67
13.68	T	1489.74	227.79	223.25	6.54	6.67
13.69	T	1491.97	227.86	223.32	6.55	6.68
13.7	T	1494.21	227.93	223.39	6.56	6.69
13.71	T	1496.44	228	223.45	6.56	6.7
13.72	T	1498.68	228.08	223.52	6.57	6.7
13.73	T	1500.91	228.15	223.59	6.58	6.71
13.74	T	1503.15	228.22	223.66	6.59	6.72
13.75	T	1505.39	228.29	223.73	6.59	6.73
13.76	T	1507.63	228.37	223.8	6.6	6.74
13.77	T	1509.86	228.44	223.87	6.61	6.74
13.78	T	1512.1	228.51	223.94	6.62	6.75
13.79	T	1514.34	228.58	224	6.62	6.76
13.8	T	1516.59	228.65	224.07	6.63	6.77
13.81	T	1518.83	228.73	224.14	6.64	6.78
13.82	T	1521.07	228.8	224.21	6.65	6.78
13.83	T	1523.31	228.87	224.28	6.66	6.79
13.84	T	1525.56	228.94	224.35	6.66	6.8
13.85	T	1527.8	229.01	224.42	6.67	6.81
13.86	T	1530.04	229.09	224.49	6.68	6.82
13.87	T	1532.29	229.16	224.55	6.69	6.82
13.88	T	1534.54	229.23	224.62	6.69	6.83
13.89	T	1536.78	229.3	224.69	6.7	6.84
13.9	T	1539.03	229.37	224.76	6.71	6.85
13.91	T	1541.28	229.45	224.83	6.72	6.86
13.92	T	1543.53	229.52	224.9	6.73	6.86
13.93	T	1545.78	229.59	224.97	6.73	6.87
13.94	T	1548.03	229.66	225.04	6.74	6.88
13.95	T	1550.28	229.74	225.1	6.75	6.89
13.96	T	1552.53	229.81	225.17	6.76	6.89
13.97	T	1554.79	229.88	225.24	6.76	6.9
13.98	T	1557.04	229.95	225.31	6.77	6.91
13.99	T	1559.29	230.02	225.38	6.78	6.92
14	T	1561.55	230.1	225.45	6.79	6.93
14.01	T	1563.8	230.17	225.52	6.79	6.93
14.02	T	1566.06	230.24	225.59	6.8	6.94
14.03	T	1568.32	230.31	225.66	6.81	6.95
14.04	T	1570.57	230.38	225.72	6.82	6.96

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
14.05	T	1572.83	230.46	225.79	6.82	6.97
14.06	T	1575.09	230.53	225.86	6.83	6.97
14.07	T	1577.35	230.6	225.93	6.84	6.98
14.08	T	1579.61	230.67	226	6.85	6.99
14.09	T	1581.87	230.75	226.07	6.86	7
14.1	T	1584.13	230.82	226.14	6.86	7.01
14.11	T	1586.39	230.89	226.21	6.87	7.01
14.12	T	1588.66	230.96	226.27	6.88	7.02
14.13	T	1590.92	231.03	226.34	6.89	7.03
14.14	T	1593.18	231.11	226.41	6.89	7.04
14.15	T	1595.45	231.18	226.48	6.9	7.04
14.16	T	1597.71	231.25	226.55	6.91	7.05
14.17	T	1599.98	231.32	226.62	6.92	7.06
14.18	T	1602.25	231.39	226.69	6.92	7.07
14.19	T	1604.52	231.47	226.76	6.93	7.08
14.2	T	1606.78	231.54	226.82	6.94	7.08
14.21	T	1609.05	231.61	226.89	6.95	7.09
14.22	T	1611.32	231.68	226.96	6.95	7.1
14.23	T	1613.59	231.76	227.03	6.96	7.11
14.24	T	1615.86	231.83	227.1	6.97	7.12
14.25	T	1618.14	231.9	227.17	6.98	7.12
14.26	T	1620.41	231.97	227.24	6.99	7.13
14.27	T	1622.68	232.04	227.31	6.99	7.14
14.28	T	1624.96	232.12	227.37	7	7.15
14.29	T	1627.23	232.19	227.44	7.01	7.15
14.3	T	1629.51	232.26	227.51	7.02	7.16
14.31	T	1631.78	232.33	227.58	7.02	7.17
14.32	T	1634.06	232.4	227.65	7.03	7.18
14.33	T	1636.34	232.48	227.72	7.04	7.19
14.34	T	1638.61	232.55	227.79	7.05	7.19
14.35	T	1640.89	232.62	227.86	7.05	7.2
14.36	T	1643.17	232.69	227.93	7.06	7.21
14.37	T	1645.45	232.77	227.99	7.07	7.22
14.38	T	1647.73	232.84	228.06	7.08	7.22
14.39	T	1650.01	232.91	228.13	7.08	7.23
14.4	T	1652.3	232.98	228.2	7.09	7.24
14.41	T	1654.58	233.05	228.27	7.1	7.25
14.42	T	1656.86	233.13	228.34	7.11	7.26
14.43	T	1659.15	233.2	228.41	7.11	7.26
14.44	T	1661.43	233.27	228.48	7.12	7.27
14.45	T	1663.72	233.34	228.54	7.13	7.28
14.46	T	1666	233.41	228.61	7.14	7.29
14.47	T	1668.29	233.49	228.68	7.15	7.3
14.48	T	1670.58	233.56	228.75	7.15	7.3
14.49	T	1672.87	233.63	228.82	7.16	7.31

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
14.5	T	1675.16	233.7	228.89	7.17	7.32
14.51	T	1677.45	233.77	228.96	7.18	7.33
14.52	T	1679.74	233.85	229.03	7.18	7.33
14.53	T	1682.03	233.92	229.09	7.19	7.34
14.54	T	1684.32	233.99	229.16	7.2	7.35
14.55	T	1686.61	234.06	229.23	7.21	7.36
14.56	T	1688.9	234.14	229.3	7.21	7.37
14.57	T	1691.2	234.21	229.37	7.22	7.37
14.58	T	1693.49	234.28	229.44	7.23	7.38
14.59	T	1695.79	234.35	229.51	7.24	7.39
14.6	T	1698.08	234.42	229.58	7.24	7.4
14.61	T	1700.38	234.47	229.61	7.25	7.41
14.62	T	1702.68	234.5	229.63	7.26	7.41
14.63	T	1704.97	234.53	229.65	7.27	7.42
14.64	T	1707.27	234.57	229.67	7.28	7.43
14.65	T	1709.57	234.6	229.69	7.29	7.44
14.66	T	1711.87	234.63	229.71	7.3	7.45
14.67	T	1714.16	234.66	229.73	7.3	7.46
14.68	T	1716.46	234.7	229.75	7.31	7.47
14.69	T	1718.76	234.73	229.77	7.32	7.48

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Middle Reach Flow Data

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Project	Ellsworth Flow Study			
Transect Name	Middle Reach Riffle	Date	9/8/2014	
Purpose / Project	Verification flow measurement reportedly 150 cfs	Time	Begin	10:30
			End	12:00
Conditions / Test	Minimum flow			
Transect Location	Downstream of Rt 1A Bridge			
Zero Station Location				
Verification Team	Gagnon/Sears/MacVane	Total Flow =	296.4	cfs

Data

Field Measurements					Calculations				
Personnel / Method	Node	Station Distance (ft) (tag line)	Station Depth (ft)	Mean Station Velocity (ft/sec)	Incremental Nodal Area (ft^2)	Incremental Mean Nodal Velocity (ft/sec)	Incremental Nodal Flow (cfs)	Total Accumulated Flow (cfs)	Comment
Manual	0	50.0	0.00	0.000	0.00	0.00	0.00	0.00	LEW
Manual	1	65.0	3.50	0.740	26.25	0.37	9.71	9.71	
Manual	2	77.9	3.60	0.865	45.80	0.80	36.75	46.46	
Manual	3	88.0	2.00	1.690	28.28	1.28	36.13	82.59	
Manual	4	98.0	1.90	2.860	19.50	2.28	44.36	126.95	TWG
Manual	5	107.0	0.90	2.220	12.60	2.54	32.00	158.96	
Manual	6	116.6	0.70	0.340	7.68	1.28	9.83	168.79	
Manual	7	130.0	1.20	1.420	12.73	0.88	11.20	179.99	
Manual	8	142.1	1.70	2.820	17.55	2.12	37.20	217.19	
Manual	9	153.1	1.30	1.175	16.50	2.00	32.96	250.14	
Manual	10	167.1	1.00	0.780	16.10	0.98	15.74	265.88	
Manual	11	173.5	1.60	0.100	8.32	0.44	3.66	269.54	Boulder US
Manual	12	183.4	0.70	1.840	11.39	0.97	11.04	280.59	
Manual	13	197.8	1.10	0.220	12.96	1.03	13.35	293.93	Boulders
Manual	14	207.1	0.80	0.130	8.83	0.18	1.55	295.48	Boulders
Manual	15	220.4	1.00	0.020	11.97	0.08	0.90	296.38	
Manual	16	228.7	0.00	0.000	4.15	0.01	0.04	296.42	REW
Manual	17				0.00	0.00	0.00	296.42	
Manual	18				0.00	0.00	0.00	296.42	
Manual	19				0.00	0.00	0.00	296.42	
Manual	20				0.00	0.00	0.00	296.42	
Manual	21				0.00	0.00	0.00	296.42	
Manual	22				0.00	0.00	0.00	296.42	
Manual	23				0.00	0.00	0.00	296.42	
Manual	24				0.00	0.00	0.00	296.42	
Manual	25				0.00	0.00	0.00	296.42	
Manual	26				0.00	0.00	0.00	296.42	
Manual	27				0.00	0.00	0.00	296.42	
Manual	28				0.00	0.00	0.00	296.42	
Manual	29				0.00	0.00	0.00	296.42	
Manual	30				0.00	0.00	0.00	296.42	
Manual	31				0.00	0.00	0.00	296.42	
Manual	32				0.00	0.00	0.00	296.42	
Manual	33				0.00	0.00	0.00	296.42	
Manual	34				0.00	0.00	0.00	296.42	
Manual	35				0.00	0.00	0.00	296.42	
Manual	36				0.00	0.00	0.00	296.42	
Manual	37				0.00	0.00	0.00	296.42	
Manual	38				0.00	0.00	0.00	296.42	
Manual	39				0.00	0.00	0.00	296.42	
Manual	40				0.00	0.00	0.00	296.42	
Manual	41				0.00	0.00	0.00	296.42	
Manual	42				0.00	0.00	0.00	296.42	
Manual	43				0.00	0.00	0.00	296.42	
Manual	44				0.00	0.00	0.00	296.42	
Manual	45				0.00	0.00	0.00	296.42	
Manual	46				0.00	0.00	0.00	296.42	
Manual	47				0.00	0.00	0.00	296.42	
Manual	48				0.00	0.00	0.00	296.42	
Manual	49				0.00	0.00	0.00	296.42	
Manual	50				0.00	0.00	0.00	296.42	
Manual	51				0.00	0.00	0.00	296.42	

Project	Ellsworth Flow Study			
Transect Name	**Middle Reach Pool**	Date	9/8/2014	
Purpose / Project	**Verification flow measurement reportedly 150 cfs**	Time	Begin	13:30
			End	14:15
Conditions / Test	**Minimum flow**			
Transect Location	**Downstream of Rt 1A Bridge**			
Zero Station Location				
Verification Team	Gagnon/Sears/MacVane	Total Flow =	433.3	cfs

Data

Field Measurements					Calculations				
Personnel / Method	Node	Station Distance (ft) (tag line)	Station Depth (ft)	Mean Station Velocity (ft/sec)	Incremental Nodal Area (ft^2)	Incremental Mean Nodal Velocity (ft/sec)	Incremental Nodal Flow (cfs)	Total Accumulated Flow (cfs)	Comment
Manual	0	43.6	0.00	0.000	0.00	0.00	0.00	0.00	LEW
Manual	1	50.0	1.00	0.000	3.20	0.00	0.00	0.00	
Manual	2	60.0	2.70	0.405	18.50	0.20	3.75	3.75	Bottom Vegetated
Manual	3	73.1	3.70	0.980	41.92	0.69	29.03	32.78	
Manual	4	83.1	4.80	1.265	42.50	1.12	47.71	80.48	
Manual	5	97.4	2.40	1.040	51.48	1.15	59.33	139.81	
Manual	6	114.8	2.40	2.020	41.76	1.53	63.89	203.71	
Manual	7	129.2	2.20	2.060	33.12	2.04	67.56	271.27	
Manual	8	146.6	2.70	0.930	42.63	1.50	63.73	335.00	Boulders 5 ft US
Manual	9	157.0	2.00	1.130	24.44	1.03	25.17	360.18	
Manual	10	169.6	1.90	1.320	24.57	1.23	30.10	390.27	
Manual	11	182.7	1.00	1.590	19.00	1.46	27.64	417.91	Boulders along REW
Manual	12	193.5	1.10	0.600	11.34	1.10	12.42	430.33	Boulders along REW
Manual	13	205.3	0.20	0.160	7.67	0.38	2.91	433.24	Boulders along REW
Manual	14	217.9	0.00	0.000	1.26	0.08	0.10	433.34	REW
Manual	15				0.00	0.00	0.00	433.34	
Manual	16				0.00	0.00	0.00	433.34	
Manual	17				0.00	0.00	0.00	433.34	
Manual	18				0.00	0.00	0.00	433.34	
Manual	19				0.00	0.00	0.00	433.34	
Manual	20				0.00	0.00	0.00	433.34	
Manual	21				0.00	0.00	0.00	433.34	
Manual	22				0.00	0.00	0.00	433.34	
Manual	23				0.00	0.00	0.00	433.34	
Manual	24				0.00	0.00	0.00	433.34	
Manual	25				0.00	0.00	0.00	433.34	
Manual	26				0.00	0.00	0.00	433.34	
Manual	27				0.00	0.00	0.00	433.34	
Manual	28				0.00	0.00	0.00	433.34	
Manual	29				0.00	0.00	0.00	433.34	
Manual	30				0.00	0.00	0.00	433.34	
Manual	31				0.00	0.00	0.00	433.34	
Manual	32				0.00	0.00	0.00	433.34	
Manual	33				0.00	0.00	0.00	433.34	
Manual	34				0.00	0.00	0.00	433.34	
Manual	35				0.00	0.00	0.00	433.34	
Manual	36				0.00	0.00	0.00	433.34	
Manual	37				0.00	0.00	0.00	433.34	
Manual	38				0.00	0.00	0.00	433.34	
Manual	39				0.00	0.00	0.00	433.34	
Manual	40				0.00	0.00	0.00	433.34	
Manual	41				0.00	0.00	0.00	433.34	
Manual	42				0.00	0.00	0.00	433.34	
Manual	43				0.00	0.00	0.00	433.34	
Manual	44				0.00	0.00	0.00	433.34	
Manual	45				0.00	0.00	0.00	433.34	
Manual	46				0.00	0.00	0.00	433.34	
Manual	47				0.00	0.00	0.00	433.34	
Manual	48				0.00	0.00	0.00	433.34	
Manual	49				0.00	0.00	0.00	433.34	
Manual	50				0.00	0.00	0.00	433.34	
Manual	51				0.00	0.00	0.00	433.34	

Project	Ellsworth Flow Study			
Transect Name	**Middle Reach Run**	Date	9/8/2014	
Purpose / Project	**Verification flow measurement reportedly 150 cfs**	Time	Begin	15:00
			End	15:50
Conditions / Test	**Minimum flow**			
Transect Location	**Downstream of Rt 1A Bridge**			
Zero Station Location				
Verification Team	Gagnon/Sears/MacVane	**Total Flow =**	324.1	cfs

Data

Field Measurements					Calculations				
Personnel / Method	Node	Station Distance (ft) (tag line)	Station Depth (ft)	Mean Station Velocity (ft/sec)	Incremental Nodal Area (ft^2)	Incremental Mean Nodal Velocity (ft/sec)	Incremental Nodal Flow (cfs)	Total Accumulated Flow (cfs)	Comment
Manual	0	54.5	0.00	0.000	0.00	0.00	0.00	0.00	
Manual	1	56.8	1.70	0.440	1.96	0.22	0.43	0.43	LEW; Rock face EB
Manual	2	66.2	2.70	1.720	20.68	1.08	22.33	22.76	Rock face EB
Manual	3	74.8	2.50	3.830	22.36	2.78	62.05	84.81	TWG
Manual	4	92.2	2.10	0.900	40.02	2.37	94.65	179.46	
Manual	5	104.3	2.30	0.270	26.62	0.59	15.57	195.03	Behind Boulder
Manual	6	120.3	2.20	1.870	36.00	1.07	38.52	233.55	
Manual	7	133.9	2.50	0.870	31.96	1.37	43.79	277.34	
Manual	8	146.5	2.10	1.130	28.98	1.00	28.98	306.32	Boulders along REW
Manual	9	163.5	0.40	0.330	21.25	0.73	15.51	321.83	Boulders along REW
Manual	10	179.5	0.60	0.180	8.00	0.26	2.04	323.87	Boulders along REW
Manual	11	188.1	0.00	0.000	2.58	0.09	0.23	324.10	REW
Manual	12				0.00	0.00	0.00	324.10	
Manual	13				0.00	0.00	0.00	324.10	
Manual	14				0.00	0.00	0.00	324.10	
Manual	15				0.00	0.00	0.00	324.10	
Manual	16				0.00	0.00	0.00	324.10	
Manual	17				0.00	0.00	0.00	324.10	
Manual	18				0.00	0.00	0.00	324.10	
Manual	19				0.00	0.00	0.00	324.10	
Manual	20				0.00	0.00	0.00	324.10	
Manual	21				0.00	0.00	0.00	324.10	
Manual	22				0.00	0.00	0.00	324.10	
Manual	23				0.00	0.00	0.00	324.10	
Manual	24				0.00	0.00	0.00	324.10	
Manual	25				0.00	0.00	0.00	324.10	
Manual	26				0.00	0.00	0.00	324.10	
Manual	27				0.00	0.00	0.00	324.10	
Manual	28				0.00	0.00	0.00	324.10	
Manual	29				0.00	0.00	0.00	324.10	
Manual	30				0.00	0.00	0.00	324.10	
Manual	31				0.00	0.00	0.00	324.10	
Manual	32				0.00	0.00	0.00	324.10	
Manual	33				0.00	0.00	0.00	324.10	
Manual	34				0.00	0.00	0.00	324.10	
Manual	35				0.00	0.00	0.00	324.10	
Manual	36				0.00	0.00	0.00	324.10	
Manual	37				0.00	0.00	0.00	324.10	
Manual	38				0.00	0.00	0.00	324.10	
Manual	39				0.00	0.00	0.00	324.10	
Manual	40				0.00	0.00	0.00	324.10	
Manual	41				0.00	0.00	0.00	324.10	
Manual	42				0.00	0.00	0.00	324.10	
Manual	43				0.00	0.00	0.00	324.10	
Manual	44				0.00	0.00	0.00	324.10	
Manual	45				0.00	0.00	0.00	324.10	
Manual	46				0.00	0.00	0.00	324.10	
Manual	47				0.00	0.00	0.00	324.10	
Manual	48				0.00	0.00	0.00	324.10	
Manual	49				0.00	0.00	0.00	324.10	
Manual	50				0.00	0.00	0.00	324.10	
Manual	51				0.00	0.00	0.00	324.10	

Ellsworth Flow Study
Middle Reach

Survey Date: 9/8/2014

		BM 100	
Riffle		HI1 101.165	
Station	FS	El	Notes
0	1.45	99.715	LP G
8.6	1.55	99.615	FP G
13.7	1.165	100	FP BKF Tree
16.7	2.71	98.455	LT Toe at tree
20.9	4.9	96.265	LT G
28.6	4.53	96.635	LT G
39.1	5.32	95.845	LT G
43.5	5.71	95.455	LT G
48.2	6.29	**94.875**	WS LEW
48.2	6.43	94.735	LEW CG
53.4	7.06	94.105	CG at SG
64.7	12.2	88.965	CG
77.9	13.06	88.105	CG
89.4	8.22	92.945	CG
98.1	8.4	92.765	CG - TWG
107.9	7.61	93.555	CG
116.6	7.43	93.735	CG
130	7.5	93.665	CG
142.1	8.16	93.005	CG
153.1	7.36	93.805	CG
167.1	7.35	93.815	CG
173.5	8.1	93.065	CG
183.4	7.1	94.065	CG
197.8	7.38	93.785	CG - Large Boulders
207.1	7.3	93.865	CG - Large Boulders
220.4	7.23	93.935	CG - Large Boulders
228.7	6.21	94.955	REW CG
228.7	6.16	**95.005**	WS REW
235.7	5.46	95.705	LT
243.7	4.92	96.245	LT Toe
249.9	2.1	99.065	Mid Slope
254.3	1.26	99.905	BKF
256	0.96	100.205	RP G
257.2	0.69	100.475	G Tree

9/9/2014	9/10/2014	9/11/2014	9/11/2014	
SG Reading (cm)				
0	14.6	54.7	70.3	
Q=150 cfs	Q=300 cfs	Q=1,350 cfs	Q=2,100 cfs	BKF

Ellsworth Flow Study
Middle Reach

Survey Date: 9/8/2014

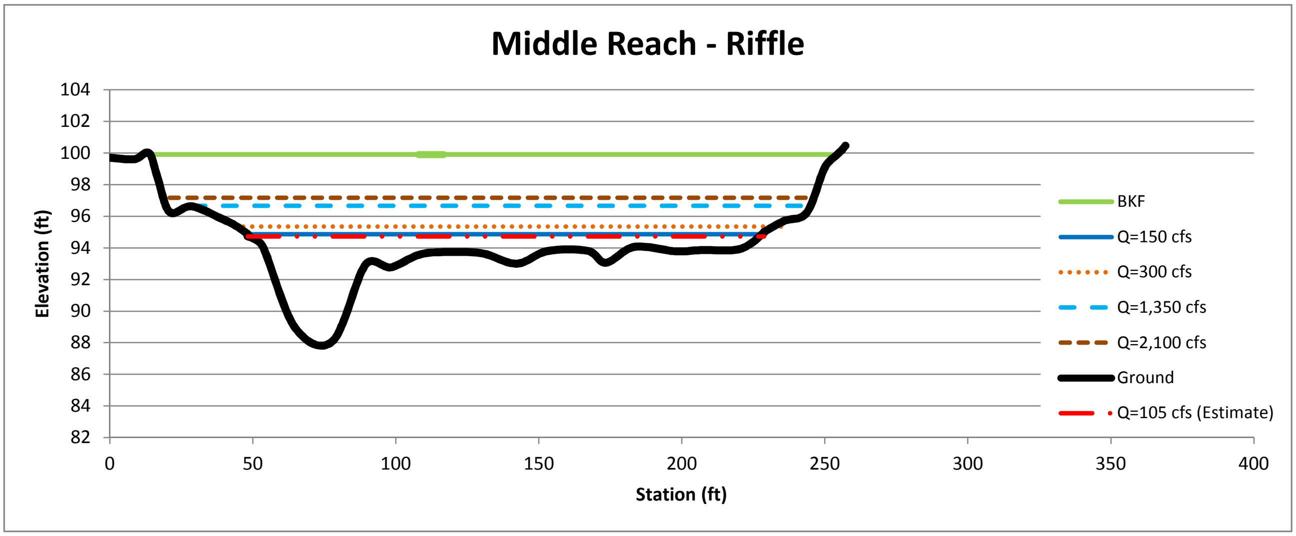
Pool	HI2	100.9		9/9/2014	9/10/2014	9/11/2014	9/11/2014	
Station	FS	El	Notes	SG Reading (cm)				
0	0.12	101.045	LP Top	0	15.9	55.6	71	
0	0.345	100.82	LP G	Q=150 cfs	Q=300 cfs	Q=1,350 cfs	Q=2,100 cfs	BKF
2.3	0.59	100.575	BKF					
2.6	1.38	99.785	MT Toe					
14.1	2.36	98.805	LT Toe					
21.5	3.82	97.345	LT Toe					
31	4.61	96.555	LT Toe					
40.6	6.08	95.085	LEW G					
41.1	**6.14**	95.025	WS LEW					
43.6	6.54	94.625	CG at SG					
50	7.28	93.885	CG					
60	8.66	92.505	CG					
73.1	10.88	90.285	CG					
83.1	10.63	90.535	CG					
92.7	9.87	91.295	CG - Large Boulders					
114.8	8.7	92.465	CG - Large Boulders					
129.2	8.96	92.205	CG - TWG					
146.6	9.05	92.115	CG					
160.5	8.28	92.885	CG					
169.6	9.25	91.915	CG - Large Boulders					
182.7	7.31	93.855	CG - Large Boulders					
193.5	7.32	93.58	CG - Large Boulders					
205.3	6.55	94.35	CG - Large Boulders					
217.9	6.71	94.19	REW CG					
217.9	**6.55**	94.35	WS REW					
229.6	5.36	95.54	LT					
239.3	4.31	96.59	LT Toe					
250.2	2.28	98.62	BKF MT					
255	0.02	100.88	RP G					

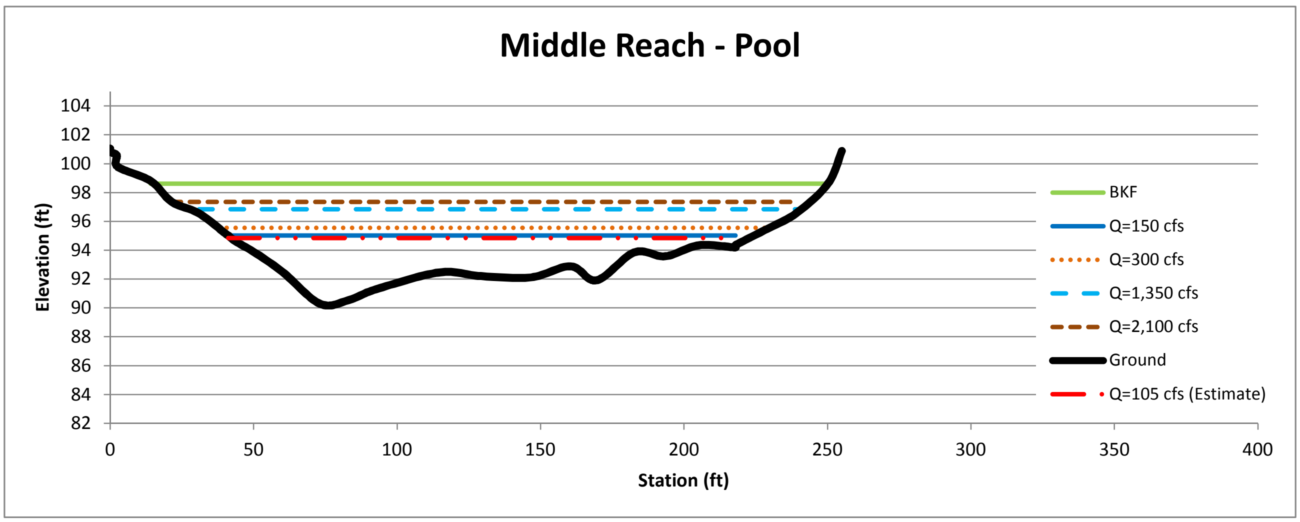
Ellsworth Flow Study
Middle Reach

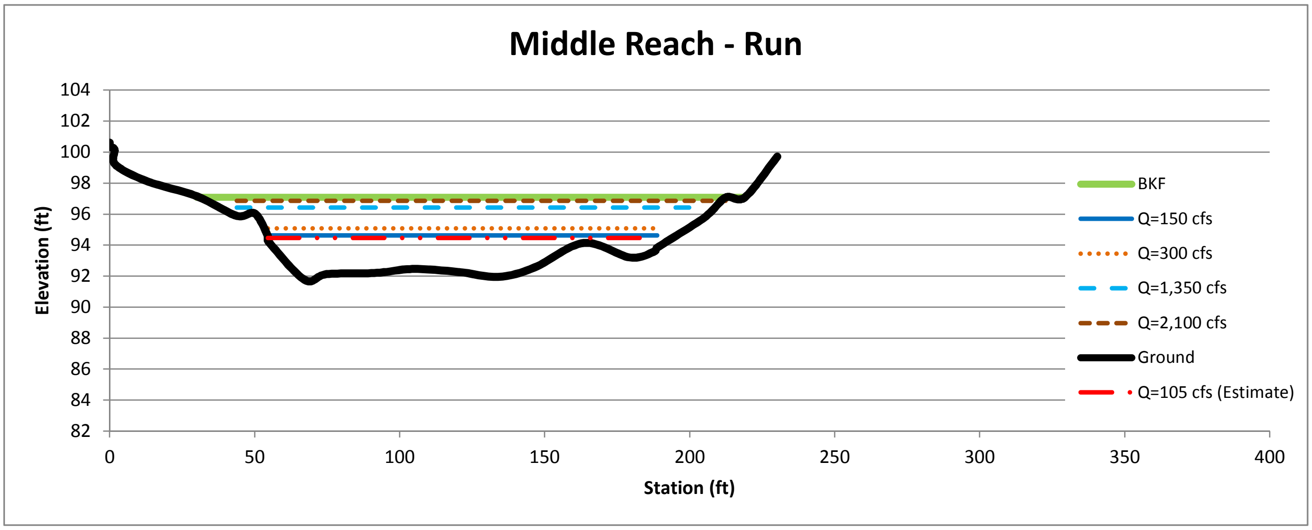
Survey Date: 9/8/2014

Run	HI3	101.88	
Station	FS	El	Notes
0	1.27	100.61	LP Top
0	1.52	100.36	LP G
1.7	1.72	100.16	BKF
2	2.69	99.19	LT Toe
12.8	3.75	98.13	LT
30.1	4.73	97.15	LT
43.8	5.99	95.89	LT
50	5.83	96.05	LT
54.5	7.26	**94.62**	WS LEW
54.5	7.38	94.5	LEW CG
54.7	7.64	94.24	CG at SG
67.3	10.13	91.75	CG
74.8	9.75	92.13	CG
92.2	9.67	92.21	CG
104.3	9.42	92.46	CG
120.3	9.61	92.27	CG
133.9	9.93	91.95	CG
146.5	9.32	92.56	CG
163.5	7.74	94.14	CG
179.5	8.68	93.2	CG
188.1	8.26	93.62	REW CG
188.8	8.04	**93.84**	WS REW
205	6.11	95.77	LT
212.4	4.8	97.08	LT
219	4.8	97.08	BKF
230.2	2.17	99.71	RP G

9/9/2014	9/10/2014	9/11/2014	9/11/2014	
SG Reading (cm)				
12.5	26.8	67.3	81	
Q=150 cfs	Q=300 cfs	Q=1,350 cfs	Q=2,100 cfs	BKF


Middle Reach - Riffle
104
102
100
98
96
94
92
90
88
86
84
82
Elevation (ft)
0
50
100
150
200
250
300
350
400
Station (ft)
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)


Middle Reach - Pool
104
102
100
98
96
94
92
90
88
86
84
82
Elevation (ft)
0
50
100
150
200
250
300
350
400
Station (ft)
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)


Middle Reach - Run
Elevation (ft)
Station (ft)
104
102
100
98
96
94
92
90
88
86
84
82
0
50
100
150
200
250
300
350
400
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)

*****************************WinXSPRO*******************************
C:\WinXSPro\MidRiffle2.out
Input File: C:\WinXSPro\MidRiffle.sec
Run Date: 10/17/14
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 9/08/14

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
6.7	T	333.95	181.74	179.28	1.84	1.86
6.71	T	335.75	181.83	179.36	1.85	1.87
6.72	T	337.54	181.92	179.44	1.86	1.88
6.73	T	339.34	182.02	179.52	1.86	1.89
6.74	T	341.13	182.11	179.6	1.87	1.9
6.75	T	342.93	182.2	179.69	1.88	1.91
6.76	T	344.73	182.29	179.77	1.89	1.92
6.77	T	346.53	182.38	179.85	1.9	1.93
6.78	T	348.32	182.55	180.01	1.91	1.94
6.79	T	350.13	182.71	180.17	1.92	1.94
6.8	T	351.93	182.87	180.34	1.92	1.95
6.81	T	353.73	183.04	180.5	1.93	1.96
6.82	T	355.54	183.2	180.66	1.94	1.97
6.83	T	357.35	183.37	180.82	1.95	1.98
6.84	T	359.16	183.53	180.99	1.96	1.98
6.85	T	360.97	183.69	181.15	1.97	1.99
6.86	T	362.78	183.78	181.23	1.97	2
6.87	T	364.59	183.88	181.31	1.98	2.01
6.88	T	366.41	183.97	181.39	1.99	2.02
6.89	T	368.22	184.06	181.47	2	2.03
6.9	T	370.04	184.15	181.55	2.01	2.04
6.91	T	371.85	184.33	181.74	2.02	2.05
6.92	T	373.67	184.52	181.92	2.03	2.05
6.93	T	375.49	184.7	182.1	2.03	2.06

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
6.94	T	377.32	184.88	182.28	2.04	2.07
6.95	T	379.14	185.06	182.46	2.05	2.08
6.96	T	380.97	185.24	182.64	2.06	2.09
6.97	T	382.79	185.43	182.82	2.06	2.09
6.98	T	384.62	185.61	183	2.07	2.1
6.99	T	386.45	185.79	183.18	2.08	2.11
7	T	388.29	185.97	183.37	2.09	2.12
7.01	T	390.12	186.16	183.55	2.1	2.13
7.02	T	391.96	186.34	183.73	2.1	2.13
7.03	T	393.8	186.52	183.91	2.11	2.14
7.04	T	395.64	186.7	184.09	2.12	2.15
7.05	T	397.48	186.88	184.27	2.13	2.16
7.06	T	399.32	187.07	184.45	2.13	2.16
7.07	T	401.17	187.25	184.63	2.14	2.17
7.08	T	403.02	187.43	184.81	2.15	2.18
7.09	T	404.87	187.61	184.99	2.16	2.19
7.1	T	406.72	187.8	185.18	2.17	2.2
7.11	T	408.57	187.98	185.36	2.17	2.2
7.12	T	410.43	188.16	185.54	2.18	2.21
7.13	T	412.28	188.34	185.72	2.19	2.22
7.14	T	414.14	188.52	185.9	2.2	2.23
7.15	T	416	188.71	186.08	2.2	2.24
7.16	T	417.86	188.89	186.26	2.21	2.24
7.17	T	419.73	189.07	186.44	2.22	2.25
7.18	T	421.59	189.25	186.62	2.23	2.26
7.19	T	423.46	189.44	186.81	2.24	2.27
7.2	T	425.33	189.62	186.99	2.24	2.27
7.21	T	427.2	189.8	187.17	2.25	2.28
7.22	T	429.07	189.98	187.35	2.26	2.29
7.23	T	430.95	190.16	187.53	2.27	2.3
7.24	T	432.83	190.35	187.71	2.27	2.31
7.25	T	434.7	190.53	187.89	2.28	2.31
7.26	T	436.58	190.71	188.07	2.29	2.32
7.27	T	438.47	190.89	188.25	2.3	2.33
7.28	T	440.35	191.07	188.44	2.3	2.34
7.29	T	442.24	191.26	188.62	2.31	2.34
7.3	T	444.12	191.44	188.8	2.32	2.35
7.31	T	446.01	191.62	188.98	2.33	2.36
7.32	T	447.9	191.8	189.16	2.34	2.37
7.33	T	449.8	191.99	189.34	2.34	2.38
7.34	T	451.69	192.17	189.52	2.35	2.38
7.35	T	453.59	192.35	189.7	2.36	2.39
7.36	T	455.49	192.56	189.92	2.37	2.4
7.37	T	457.39	192.78	190.13	2.37	2.41
7.38	T	459.29	192.99	190.34	2.38	2.41

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
7.39	T	461.2	193.21	190.55	2.39	2.42
7.4	T	463.1	193.42	190.77	2.39	2.43
7.41	T	465.01	193.63	190.98	2.4	2.43
7.42	T	466.92	193.85	191.19	2.41	2.44
7.43	T	468.84	194.06	191.41	2.42	2.45
7.44	T	470.75	194.27	191.62	2.42	2.46
7.45	T	472.67	194.49	191.83	2.43	2.46
7.46	T	474.59	194.7	192.04	2.44	2.47
7.47	T	476.51	194.92	192.26	2.44	2.48
7.48	T	478.43	195.13	192.47	2.45	2.49
7.49	T	480.36	195.34	192.68	2.46	2.49
7.5	T	482.29	195.56	192.9	2.47	2.5
7.51	T	484.22	195.77	193.11	2.47	2.51
7.52	T	486.15	195.98	193.32	2.48	2.51
7.53	T	488.09	196.2	193.53	2.49	2.52
7.54	T	490.02	196.41	193.75	2.49	2.53
7.55	T	491.96	196.63	193.96	2.5	2.54
7.56	T	493.9	196.84	194.17	2.51	2.54
7.57	T	495.85	197.05	194.39	2.52	2.55
7.58	T	497.79	197.27	194.6	2.52	2.56
7.59	T	499.74	197.48	194.81	2.53	2.57
7.6	T	501.69	197.7	195.03	2.54	2.57
7.61	T	503.64	197.96	195.29	2.54	2.58
7.62	T	505.6	198.22	195.55	2.55	2.59
7.63	T	507.55	198.48	195.81	2.56	2.59
7.64	T	509.51	198.74	196.07	2.56	2.6
7.65	T	511.48	199.01	196.33	2.57	2.61
7.66	T	513.44	199.27	196.59	2.58	2.61
7.67	T	515.41	199.53	196.85	2.58	2.62
7.68	T	517.38	199.79	197.11	2.59	2.62
7.69	T	519.35	200.05	197.37	2.6	2.63
7.7	T	521.33	200.31	197.64	2.6	2.64
7.71	T	523.3	200.58	197.9	2.61	2.64
7.72	T	525.29	200.84	198.16	2.62	2.65
7.73	T	527.27	201.1	198.42	2.62	2.66
7.74	T	529.25	201.36	198.68	2.63	2.66
7.75	T	531.24	201.64	198.96	2.63	2.67
7.76	T	533.23	201.93	199.24	2.64	2.68
7.77	T	535.23	202.21	199.52	2.65	2.68
7.78	T	537.23	202.49	199.8	2.65	2.69
7.79	T	539.23	202.77	200.09	2.66	2.69
7.8	T	541.23	203.05	200.37	2.67	2.7
7.81	T	543.23	203.33	200.65	2.67	2.71
7.82	T	545.24	203.62	200.93	2.68	2.71
7.83	T	547.25	203.9	201.21	2.68	2.72

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
7.84	T	549.27	204.18	201.49	2.69	2.73
7.85	T	551.28	204.46	201.77	2.7	2.73
7.86	T	553.3	204.74	202.05	2.7	2.74
7.87	T	555.33	205.03	202.33	2.71	2.74
7.88	T	557.35	205.31	202.62	2.71	2.75
7.89	T	559.38	205.59	202.9	2.72	2.76
7.9	T	561.41	205.87	203.18	2.73	2.76
7.91	T	563.44	206.15	203.46	2.73	2.77
7.92	T	565.48	206.43	203.74	2.74	2.78
7.93	T	567.52	206.72	204.02	2.75	2.78
7.94	T	569.56	207	204.3	2.75	2.79
7.95	T	571.61	207.28	204.58	2.76	2.79
7.96	T	573.65	207.56	204.86	2.76	2.8
7.97	T	575.7	207.84	205.15	2.77	2.81
7.98	T	577.76	208.13	205.43	2.78	2.81
7.99	T	579.81	208.41	205.71	2.78	2.82
8	T	581.87	208.69	205.99	2.79	2.82
8.01	T	583.93	208.97	206.27	2.79	2.83
8.02	T	586	209.25	206.55	2.8	2.84
8.03	T	588.07	209.53	206.83	2.81	2.84
8.04	T	590.14	209.82	207.11	2.81	2.85
8.05	T	592.21	210.1	207.39	2.82	2.86
8.06	T	594.29	210.38	207.68	2.82	2.86
8.07	T	596.36	210.66	207.96	2.83	2.87
8.08	T	598.45	210.94	208.24	2.84	2.87
8.09	T	600.53	211.23	208.52	2.84	2.88
8.1	T	602.62	211.51	208.8	2.85	2.89
8.11	T	604.71	211.79	209.08	2.86	2.89
8.12	T	606.8	212.07	209.36	2.86	2.9
8.13	T	608.9	212.35	209.64	2.87	2.9
8.14	T	610.99	212.63	209.92	2.87	2.91
8.15	T	613.09	212.79	210.08	2.88	2.92
8.16	T	615.2	212.95	210.24	2.89	2.93
8.17	T	617.3	213.34	210.62	2.89	2.93
8.18	T	619.41	213.73	211	2.9	2.94
8.19	T	621.52	214.12	211.38	2.9	2.94
8.2	T	623.64	214.5	211.77	2.91	2.94
8.21	T	625.76	214.89	212.15	2.91	2.95
8.22	T	627.88	215.28	212.53	2.92	2.95
8.23	T	630.01	215.67	212.91	2.92	2.96
8.24	T	632.14	216.05	213.3	2.93	2.96
8.25	T	634.28	216.44	213.68	2.93	2.97
8.26	T	636.42	216.83	214.06	2.94	2.97
8.27	T	638.56	217.22	214.44	2.94	2.98
8.28	T	640.71	217.6	214.83	2.94	2.98

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
8.29	T	642.86	217.99	215.21	2.95	2.99
8.3	T	645.01	218.38	215.59	2.95	2.99
8.31	T	647.17	218.77	215.97	2.96	3
8.32	T	649.33	219.15	216.35	2.96	3
8.33	T	651.5	219.54	216.74	2.97	3.01
8.34	T	653.67	219.93	217.12	2.97	3.01
8.35	T	655.84	220.32	217.5	2.98	3.02
8.36	T	658.02	220.7	217.88	2.98	3.02
8.37	T	660.2	221.09	218.27	2.99	3.02
8.38	T	662.38	221.48	218.65	2.99	3.03
8.39	T	664.57	221.87	219.03	3	3.03
8.4	T	666.76	222.25	219.41	3	3.04
8.41	T	668.96	222.64	219.79	3	3.04
8.42	T	671.16	223.03	220.18	3.01	3.05
8.43	T	673.37	223.42	220.56	3.01	3.05
8.44	T	675.57	223.8	220.94	3.02	3.06
8.45	T	677.79	224.19	221.32	3.02	3.06
8.46	T	680	224.58	221.71	3.03	3.07
8.47	T	682.22	224.97	222.09	3.03	3.07
8.48	T	684.44	225.35	222.47	3.04	3.08
8.49	T	686.67	225.74	222.85	3.04	3.08
8.5	T	688.9	226.13	223.24	3.05	3.09
8.51	T	691.14	226.52	223.62	3.05	3.09
8.52	T	693.38	226.9	224	3.06	3.1
8.53	T	695.62	227.28	224.37	3.06	3.1
8.54	T	697.86	227.32	224.41	3.07	3.11
8.55	T	700.11	227.37	224.45	3.08	3.12
8.56	T	702.35	227.41	224.49	3.09	3.13
8.57	T	704.6	227.46	224.53	3.1	3.14
8.58	T	706.84	227.51	224.57	3.11	3.15
8.59	T	709.09	227.55	224.62	3.12	3.16
8.6	T	711.34	227.6	224.66	3.13	3.17
8.61	T	713.58	227.64	224.7	3.13	3.18
8.62	T	715.83	227.69	224.74	3.14	3.19
8.63	T	718.08	227.74	224.78	3.15	3.19
8.64	T	720.33	227.78	224.82	3.16	3.2
8.65	T	722.58	227.83	224.86	3.17	3.21
8.66	T	724.83	227.87	224.9	3.18	3.22
8.67	T	727.08	227.92	224.94	3.19	3.23
8.68	T	729.33	227.96	224.99	3.2	3.24
8.69	T	731.58	228.01	225.03	3.21	3.25
8.7	T	733.83	228.06	225.07	3.22	3.26
8.71	T	736.08	228.1	225.11	3.23	3.27
8.72	T	738.33	228.15	225.15	3.24	3.28
8.73	T	740.58	228.19	225.19	3.25	3.29

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
8.74	T	742.84	228.24	225.23	3.25	3.3
8.75	T	745.09	228.28	225.27	3.26	3.31
8.76	T	747.34	228.33	225.32	3.27	3.32
8.77	T	749.6	228.38	225.36	3.28	3.33
8.78	T	751.85	228.42	225.4	3.29	3.34
8.79	T	754.11	228.47	225.44	3.3	3.35
8.8	T	756.36	228.51	225.48	3.31	3.35
8.81	T	758.62	228.56	225.52	3.32	3.36
8.82	T	760.87	228.61	225.56	3.33	3.37
8.83	T	763.13	228.65	225.6	3.34	3.38
8.84	T	765.38	228.7	225.64	3.35	3.39
8.85	T	767.64	228.74	225.69	3.36	3.4
8.86	T	769.9	228.79	225.73	3.37	3.41
8.87	T	772.16	228.83	225.77	3.37	3.42
8.88	T	774.42	228.88	225.81	3.38	3.43
8.89	T	776.67	228.93	225.85	3.39	3.44
8.9	T	778.93	228.97	225.89	3.4	3.45
8.91	T	781.19	229.02	225.93	3.41	3.46
8.92	T	783.45	229.06	225.97	3.42	3.47
8.93	T	785.71	229.11	226.02	3.43	3.48
8.94	T	787.97	229.15	226.06	3.44	3.49
8.95	T	790.24	229.2	226.1	3.45	3.5
8.96	T	792.5	229.25	226.14	3.46	3.5
8.97	T	794.76	229.29	226.18	3.47	3.51
8.98	T	797.02	229.34	226.22	3.48	3.52
8.99	T	799.28	229.38	226.26	3.48	3.53
9	T	801.55	229.43	226.3	3.49	3.54
9.01	T	803.81	229.48	226.34	3.5	3.55
9.02	T	806.08	229.52	226.39	3.51	3.56
9.03	T	808.34	229.57	226.43	3.52	3.57
9.04	T	810.61	229.61	226.47	3.53	3.58
9.05	T	812.87	229.66	226.51	3.54	3.59
9.06	T	815.14	229.7	226.55	3.55	3.6
9.07	T	817.4	229.75	226.59	3.56	3.61
9.08	T	819.67	229.8	226.63	3.57	3.62
9.09	T	821.94	229.84	226.67	3.58	3.63
9.1	T	824.2	229.89	226.72	3.59	3.64
9.11	T	826.47	229.93	226.76	3.59	3.64
9.12	T	828.74	229.98	226.8	3.6	3.65
9.13	T	831.01	230.02	226.84	3.61	3.66
9.14	T	833.28	230.07	226.88	3.62	3.67
9.15	T	835.55	230.12	226.92	3.63	3.68
9.16	T	837.82	230.16	226.96	3.64	3.69
9.17	T	840.09	230.21	227	3.65	3.7
9.18	T	842.36	230.25	227.04	3.66	3.71

STAGE (ft)	#SEC	AREA (sq ft)	PERIM (ft)	WIDTH (ft)	R (ft)	DHYD (ft)
9.19	T	844.63	230.3	227.09	3.67	3.72
9.2	T	846.9	230.35	227.13	3.68	3.73
9.21	T	849.17	230.39	227.17	3.69	3.74
9.22	T	851.45	230.44	227.21	3.69	3.75
9.23	T	853.72	230.48	227.25	3.7	3.76
9.24	T	855.99	230.53	227.29	3.71	3.77
9.25	T	858.26	230.57	227.33	3.72	3.78
9.26	T	860.54	230.62	227.37	3.73	3.78
9.27	T	862.81	230.67	227.42	3.74	3.79
9.28	T	865.09	230.71	227.46	3.75	3.8
9.29	T	867.36	230.76	227.5	3.76	3.81
9.3	T	869.64	230.8	227.54	3.77	3.82
9.31	T	871.92	230.85	227.58	3.78	3.83
9.32	T	874.19	230.9	227.62	3.79	3.84
9.33	T	876.47	230.94	227.66	3.8	3.85
9.34	T	878.75	230.99	227.7	3.8	3.86
9.35	T	881.02	231.03	227.74	3.81	3.87
9.36	T	883.3	231.08	227.79	3.82	3.88
9.37	T	885.58	231.12	227.83	3.83	3.89
9.38	T	887.86	231.17	227.87	3.84	3.9
9.39	T	890.14	231.22	227.91	3.85	3.91
9.4	T	892.42	231.26	227.95	3.86	3.91
9.41	T	894.7	231.31	227.99	3.87	3.92
9.42	T	896.98	231.35	228.03	3.88	3.93
9.43	T	899.26	231.4	228.07	3.89	3.94
9.44	T	901.54	231.44	228.12	3.9	3.95
9.45	T	903.82	231.49	228.16	3.9	3.96
9.46	T	906.11	231.54	228.2	3.91	3.97
9.47	T	908.39	231.58	228.24	3.92	3.98
9.48	T	910.67	231.63	228.28	3.93	3.99
9.49	T	912.95	231.67	228.32	3.94	4
9.5	T	915.24	231.72	228.36	3.95	4.01
9.51	T	917.52	231.77	228.4	3.96	4.02
9.52	T	919.81	231.81	228.44	3.97	4.03
9.53	T	922.09	231.86	228.49	3.98	4.04
9.54	T	924.38	231.9	228.53	3.99	4.04
9.55	T	926.66	231.95	228.57	4	4.05
9.56	T	928.95	231.99	228.61	4	4.06
9.57	T	931.24	232.04	228.65	4.01	4.07
9.58	T	933.52	232.09	228.69	4.02	4.08
9.59	T	935.81	232.13	228.73	4.03	4.09
9.6	T	938.1	232.18	228.77	4.04	4.1
9.61	T	940.39	232.22	228.81	4.05	4.11
9.62	T	942.68	232.27	228.86	4.06	4.12
9.63	T	944.97	232.31	228.9	4.07	4.13

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
9.64	T	947.26	232.36	228.94	4.08	4.14
9.65	T	949.55	232.41	228.98	4.09	4.15
9.66	T	951.84	232.45	229.02	4.09	4.16
9.67	T	954.13	232.5	229.06	4.1	4.17
9.68	T	956.42	232.54	229.1	4.11	4.17
9.69	T	958.71	232.59	229.14	4.12	4.18
9.7	T	961	232.64	229.19	4.13	4.19
9.71	T	963.3	232.68	229.23	4.14	4.2
9.72	T	965.59	232.73	229.27	4.15	4.21
9.73	T	967.88	232.77	229.31	4.16	4.22
9.74	T	970.18	232.82	229.35	4.17	4.23
9.75	T	972.47	232.86	229.39	4.18	4.24
9.76	T	974.76	232.91	229.43	4.19	4.25
9.77	T	977.06	232.96	229.47	4.19	4.26
9.78	T	979.36	233	229.51	4.2	4.27
9.79	T	981.65	233.05	229.56	4.21	4.28
9.8	T	983.95	233.09	229.6	4.22	4.29
9.81	T	986.24	233.14	229.64	4.23	4.29
9.82	T	988.54	233.18	229.68	4.24	4.3
9.83	T	990.84	233.23	229.72	4.25	4.31
9.84	T	993.14	233.28	229.76	4.26	4.32
9.85	T	995.43	233.32	229.8	4.27	4.33
9.86	T	997.73	233.37	229.84	4.28	4.34
9.87	T	1000.03	233.41	229.89	4.28	4.35
9.88	T	1002.33	233.46	229.93	4.29	4.36
9.89	T	1004.63	233.51	229.97	4.3	4.37
9.9	T	1006.93	233.55	230.01	4.31	4.38
9.91	T	1009.23	233.6	230.05	4.32	4.39
9.92	T	1011.53	233.64	230.09	4.33	4.4
9.93	T	1013.84	233.69	230.13	4.34	4.41
9.94	T	1016.14	233.73	230.17	4.35	4.41
9.95	T	1018.44	233.78	230.21	4.36	4.42
9.96	T	1020.74	233.83	230.26	4.37	4.43
9.97	T	1023.05	233.87	230.3	4.37	4.44
9.98	T	1025.35	233.92	230.34	4.38	4.45
9.99	T	1027.65	233.96	230.38	4.39	4.46
10	T	1029.96	234.01	230.42	4.4	4.47
10.01	T	1032.26	234.05	230.46	4.41	4.48
10.02	T	1034.57	234.1	230.5	4.42	4.49
10.03	T	1036.88	234.15	230.54	4.43	4.5
10.04	T	1039.18	234.19	230.59	4.44	4.51
10.05	T	1041.49	234.24	230.63	4.45	4.52
10.06	T	1043.79	234.28	230.67	4.46	4.53
10.07	T	1046.1	234.33	230.71	4.46	4.53
10.08	T	1048.41	234.38	230.75	4.47	4.54

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10.09	T	1050.72	234.42	230.79	4.48	4.55
10.1	T	1053.03	234.47	230.83	4.49	4.56
10.11	T	1055.34	234.51	230.87	4.5	4.57
10.12	T	1057.65	234.56	230.91	4.51	4.58
10.13	T	1059.95	234.6	230.96	4.52	4.59
10.14	T	1062.27	234.65	231	4.53	4.6
10.15	T	1064.58	234.7	231.04	4.54	4.61
10.16	T	1066.89	234.74	231.08	4.54	4.62
10.17	T	1069.2	234.79	231.12	4.55	4.63
10.18	T	1071.51	234.83	231.16	4.56	4.64
10.19	T	1073.82	234.88	231.2	4.57	4.64
10.2	T	1076.14	234.93	231.24	4.58	4.65
10.21	T	1078.45	234.97	231.29	4.59	4.66
10.22	T	1080.76	235.02	231.33	4.6	4.67
10.23	T	1083.08	235.06	231.37	4.61	4.68
10.24	T	1085.39	235.11	231.41	4.62	4.69
10.25	T	1087.71	235.15	231.45	4.63	4.7
10.26	T	1090.02	235.2	231.49	4.63	4.71
10.27	T	1092.34	235.25	231.53	4.64	4.72
10.28	T	1094.65	235.29	231.57	4.65	4.73
10.29	T	1096.97	235.34	231.61	4.66	4.74
10.3	T	1099.29	235.38	231.66	4.67	4.75
10.31	T	1101.6	235.43	231.7	4.68	4.75
10.32	T	1103.92	235.47	231.74	4.69	4.76
10.33	T	1106.24	235.52	231.78	4.7	4.77
10.34	T	1108.56	235.57	231.82	4.71	4.78
10.35	T	1110.88	235.61	231.86	4.71	4.79
10.36	T	1113.2	235.66	231.9	4.72	4.8
10.37	T	1115.51	235.7	231.94	4.73	4.81
10.38	T	1117.83	235.75	231.99	4.74	4.82
10.39	T	1120.16	235.8	232.03	4.75	4.83
10.4	T	1122.48	235.84	232.07	4.76	4.84
10.41	T	1124.8	235.89	232.11	4.77	4.85
10.42	T	1127.12	235.93	232.15	4.78	4.86
10.43	T	1129.44	235.98	232.19	4.79	4.86
10.44	T	1131.76	236.03	232.23	4.8	4.87
10.45	T	1134.09	236.07	232.28	4.8	4.88
10.46	T	1136.41	236.12	232.32	4.81	4.89
10.47	T	1138.73	236.16	232.36	4.82	4.9
10.48	T	1141.06	236.21	232.4	4.83	4.91
10.49	T	1143.38	236.26	232.44	4.84	4.92
10.5	T	1145.71	236.3	232.48	4.85	4.93
10.51	T	1148.03	236.35	232.52	4.86	4.94
10.52	T	1150.36	236.39	232.57	4.87	4.95
10.53	T	1152.69	236.44	232.61	4.88	4.96

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10.54	T	1155.01	236.49	232.65	4.88	4.96
10.55	T	1157.34	236.53	232.69	4.89	4.97
10.56	T	1159.67	236.58	232.73	4.9	4.98
10.57	T	1162	236.62	232.77	4.91	4.99
10.58	T	1164.32	236.67	232.81	4.92	5
10.59	T	1166.65	236.72	232.86	4.93	5.01
10.6	T	1168.98	236.76	232.9	4.94	5.02
10.61	T	1171.31	236.81	232.94	4.95	5.03
10.62	T	1173.64	236.85	232.98	4.96	5.04
10.63	T	1175.97	236.9	233.02	4.96	5.05
10.64	T	1178.3	236.95	233.06	4.97	5.06
10.65	T	1180.64	236.99	233.1	4.98	5.06
10.66	T	1182.97	237.04	233.15	4.99	5.07
10.67	T	1185.3	237.08	233.19	5	5.08
10.68	T	1187.63	237.13	233.23	5.01	5.09
10.69	T	1189.96	237.18	233.27	5.02	5.1
10.7	T	1192.3	237.22	233.31	5.03	5.11
10.71	T	1194.63	237.27	233.35	5.03	5.12
10.72	T	1196.97	237.31	233.39	5.04	5.13
10.73	T	1199.3	237.36	233.44	5.05	5.14
10.74	T	1201.64	237.41	233.48	5.06	5.15
10.75	T	1203.97	237.45	233.52	5.07	5.16
10.76	T	1206.31	237.5	233.56	5.08	5.16
10.77	T	1208.64	237.55	233.6	5.09	5.17
10.78	T	1210.98	237.59	233.64	5.1	5.18
10.79	T	1213.32	237.64	233.68	5.11	5.19
10.8	T	1215.66	237.68	233.73	5.11	5.2
10.81	T	1217.99	237.73	233.77	5.12	5.21
10.82	T	1220.33	237.78	233.81	5.13	5.22
10.83	T	1222.67	237.82	233.85	5.14	5.23
10.84	T	1225.01	237.87	233.89	5.15	5.24
10.85	T	1227.35	237.91	233.93	5.16	5.25
10.86	T	1229.69	237.96	233.97	5.17	5.26
10.87	T	1232.03	238.01	234.02	5.18	5.26
10.88	T	1234.37	238.05	234.06	5.19	5.27
10.89	T	1236.71	238.1	234.1	5.19	5.28
10.9	T	1239.05	238.14	234.14	5.2	5.29
10.91	T	1241.4	238.19	234.18	5.21	5.3
10.92	T	1243.74	238.24	234.22	5.22	5.31
10.93	T	1246.08	238.28	234.26	5.23	5.32
10.94	T	1248.42	238.33	234.31	5.24	5.33
10.95	T	1250.77	238.37	234.35	5.25	5.34
10.96	T	1253.11	238.42	234.39	5.26	5.35
10.97	T	1255.46	238.5	234.46	5.26	5.35
10.98	T	1257.8	238.57	234.53	5.27	5.36

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10.99	T	1260.15	238.65	234.61	5.28	5.37
11	T	1262.5	238.72	234.68	5.29	5.38
11.01	T	1264.84	238.8	234.75	5.3	5.39
11.02	T	1267.19	238.87	234.82	5.3	5.4
11.03	T	1269.54	238.95	234.89	5.31	5.4
11.04	T	1271.89	239.02	234.97	5.32	5.41
11.05	T	1274.24	239.1	235.04	5.33	5.42
11.06	T	1276.59	239.17	235.11	5.34	5.43
11.07	T	1278.94	239.25	235.18	5.35	5.44
11.08	T	1281.3	239.32	235.25	5.35	5.45
11.09	T	1283.65	239.4	235.32	5.36	5.45
11.1	T	1286	239.47	235.4	5.37	5.46
11.11	T	1288.36	239.55	235.47	5.38	5.47
11.12	T	1290.71	239.63	235.54	5.39	5.48
11.13	T	1293.07	239.7	235.61	5.39	5.49
11.14	T	1295.43	239.78	235.68	5.4	5.5
11.15	T	1297.79	239.85	235.76	5.41	5.5
11.16	T	1300.14	239.93	235.83	5.42	5.51
11.17	T	1302.5	240	235.9	5.43	5.52
11.18	T	1304.86	240.08	235.97	5.44	5.53
11.19	T	1307.22	240.15	236.04	5.44	5.54
11.2	T	1309.59	240.23	236.11	5.45	5.55
11.21	T	1311.95	240.3	236.19	5.46	5.55
11.22	T	1314.31	240.38	236.26	5.47	5.56
11.23	T	1316.67	240.45	236.33	5.48	5.57
11.24	T	1319.04	240.53	236.4	5.48	5.58
11.25	T	1321.4	240.6	236.47	5.49	5.59
11.26	T	1323.77	240.68	236.55	5.5	5.6
11.27	T	1326.13	240.75	236.62	5.51	5.6
11.28	T	1328.5	240.83	236.69	5.52	5.61
11.29	T	1330.87	240.9	236.76	5.52	5.62
11.3	T	1333.24	240.98	236.83	5.53	5.63
11.31	T	1335.61	241.05	236.9	5.54	5.64
11.32	T	1337.98	241.13	236.98	5.55	5.65
11.33	T	1340.35	241.2	237.05	5.56	5.65
11.34	T	1342.72	241.28	237.12	5.56	5.66
11.35	T	1345.09	241.35	237.19	5.57	5.67
11.36	T	1347.46	241.43	237.26	5.58	5.68
11.37	T	1349.84	241.51	237.34	5.59	5.69
11.38	T	1352.21	241.58	237.41	5.6	5.7
11.39	T	1354.59	241.66	237.48	5.61	5.7
11.4	T	1356.96	241.73	237.55	5.61	5.71
11.41	T	1359.34	241.81	237.62	5.62	5.72
11.42	T	1361.72	241.88	237.69	5.63	5.73
11.43	T	1364.09	241.96	237.77	5.64	5.74

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
11.44	T	1366.47	242.03	237.84	5.65	5.75
11.45	T	1368.85	242.11	237.91	5.65	5.75
11.46	T	1371.23	242.18	237.98	5.66	5.76
11.47	T	1373.61	242.26	238.05	5.67	5.77
11.48	T	1375.99	242.33	238.13	5.68	5.78
11.49	T	1378.37	242.41	238.2	5.69	5.79
11.5	T	1380.76	242.48	238.27	5.69	5.79
11.51	T	1383.14	242.66	238.44	5.7	5.8
11.52	T	1385.53	243.73	239.51	5.68	5.78
11.53	T	1387.93	244.8	240.57	5.67	5.77
11.54	T	1390.34	245.86	241.64	5.65	5.75
11.55	T	1392.77	246.93	242.7	5.64	5.74
11.56	T	1395.2	248	243.77	5.63	5.72
11.57	T	1397.64	249.07	244.83	5.61	5.71
11.58	T	1400.1	250.14	245.89	5.6	5.69
11.59	T	1402.56	251.21	246.96	5.58	5.68
11.6	T	1405.04	252.27	248.02	5.57	5.66
11.61	T	1407.52	253.25	249	5.56	5.65
11.62	T	1410.01	253.47	249.2	5.56	5.66
11.63	T	1412.51	253.69	249.41	5.57	5.66
11.64	T	1415	253.91	249.61	5.57	5.67
11.65	T	1417.5	254.13	249.81	5.58	5.67
11.66	T	1420	254.34	250.02	5.58	5.68
11.67	T	1422.5	254.56	250.22	5.59	5.68
11.68	T	1425.01	254.78	250.43	5.59	5.69
11.69	T	1427.51	255	250.63	5.6	5.7
11.7	T	1430.02	255.22	250.84	5.6	5.7
11.71	T	1432.53	255.43	251.04	5.61	5.71
11.72	T	1435.04	255.65	251.24	5.61	5.71
11.73	T	1437.56	255.87	251.45	5.62	5.72
11.74	T	1440.07	256.09	251.65	5.62	5.72
11.75	T	1442.59	256.31	251.86	5.63	5.73
11.76	T	1445.11	256.52	252.06	5.63	5.73
11.77	T	1447.63	256.74	252.27	5.64	5.74
11.78	T	1450.16	256.96	252.47	5.64	5.74
11.79	T	1452.68	257.18	252.68	5.65	5.75
11.8	T	1455.21	257.4	252.88	5.65	5.75
11.81	T	1457.74	257.62	253.09	5.66	5.76
11.82	T	1460.27	257.84	253.3	5.66	5.77
11.83	T	1462.81	258.06	253.51	5.67	5.77
11.84	T	1465.35	258.29	253.71	5.67	5.78
11.85	T	1467.88	258.51	253.92	5.68	5.78
11.86	T	1470.43	258.73	254.13	5.68	5.79
11.87	T	1472.97	258.95	254.34	5.69	5.79
11.88	T	1475.51	259.18	254.55	5.69	5.8

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
11.89	T	1478.06	259.4	254.76	5.7	5.8

******************************WinXSPRO********************************
C:\WinXSPro\MidPool2.out
Input File: C:\WinXSPro\MidPool.sec
Run Date: 10/17/14
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 9/08/14

Subsections/Dividing positions

Resistance Method: Manning's n
SECTION A
Low Stage n 0.035
High Stage n 0.035

Unadjusted horizontal distances used

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
4.7	T	431.75	183.79	182.52	2.35	2.37
4.71	T	433.58	184.02	182.73	2.36	2.37
4.72	T	435.41	184.24	182.95	2.36	2.38
4.73	T	437.24	184.47	183.16	2.37	2.39
4.74	T	439.07	184.7	183.38	2.38	2.39
4.75	T	440.9	184.95	183.62	2.38	2.4
4.76	T	442.74	185.13	183.8	2.39	2.41
4.77	T	444.58	185.32	183.98	2.4	2.42
4.78	T	446.42	185.5	184.16	2.41	2.42
4.79	T	448.27	185.68	184.35	2.41	2.43
4.8	T	450.11	185.87	184.53	2.42	2.44
4.81	T	451.96	186.03	184.69	2.43	2.45
4.82	T	453.8	186.2	184.85	2.44	2.45
4.83	T	455.65	186.36	185.02	2.45	2.46
4.84	T	457.51	186.53	185.18	2.45	2.47
4.85	T	459.36	186.69	185.35	2.46	2.48
4.86	T	461.21	186.86	185.51	2.47	2.49
4.87	T	463.07	187.02	185.67	2.48	2.49
4.88	T	464.93	187.18	185.84	2.48	2.5
4.89	T	466.79	187.35	186	2.49	2.51
4.9	T	468.65	187.51	186.16	2.5	2.52
4.91	T	470.51	187.68	186.33	2.51	2.53
4.92	T	472.38	187.84	186.49	2.51	2.53
4.93	T	474.24	188.01	186.65	2.52	2.54
4.94	T	476.11	188.17	186.82	2.53	2.55

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
4.95	T	477.98	188.34	186.98	2.54	2.56
4.96	T	479.85	188.5	187.15	2.55	2.56
4.97	T	481.72	188.67	187.31	2.55	2.57
4.98	T	483.6	188.83	187.47	2.56	2.58
4.99	T	485.47	189	187.64	2.57	2.59
5	T	487.35	189.16	187.8	2.58	2.6
5.01	T	489.23	189.33	187.96	2.58	2.6
5.02	T	491.11	189.49	188.13	2.59	2.61
5.03	T	492.99	189.66	188.29	2.6	2.62
5.04	T	494.88	189.82	188.45	2.61	2.63
5.05	T	496.76	189.99	188.62	2.61	2.63
5.06	T	498.65	190.15	188.78	2.62	2.64
5.07	T	500.54	190.32	188.95	2.63	2.65
5.08	T	502.43	190.48	189.11	2.64	2.66
5.09	T	504.32	190.65	189.27	2.65	2.66
5.1	T	506.22	190.81	189.44	2.65	2.67
5.11	T	508.11	190.98	189.6	2.66	2.68
5.12	T	510.01	191.14	189.76	2.67	2.69
5.13	T	511.91	191.31	189.93	2.68	2.7
5.14	T	513.81	191.47	190.09	2.68	2.7
5.15	T	515.71	191.64	190.25	2.69	2.71
5.16	T	517.61	191.8	190.42	2.7	2.72
5.17	T	519.52	191.97	190.58	2.71	2.73
5.18	T	521.43	192.13	190.75	2.71	2.73
5.19	T	523.34	192.3	190.91	2.72	2.74
5.2	T	525.25	192.46	191.07	2.73	2.75
5.21	T	527.16	192.63	191.24	2.74	2.76
5.22	T	529.07	192.79	191.4	2.74	2.76
5.23	T	530.99	192.96	191.56	2.75	2.77
5.24	T	532.9	193.12	191.73	2.76	2.78
5.25	T	534.82	193.29	191.89	2.77	2.79
5.26	T	536.74	193.45	192.05	2.77	2.79
5.27	T	538.66	193.61	192.21	2.78	2.8
5.28	T	540.59	193.77	192.37	2.79	2.81
5.29	T	542.51	193.93	192.53	2.8	2.82
5.3	T	544.44	194.09	192.68	2.81	2.83
5.31	T	546.37	194.24	192.84	2.81	2.83
5.32	T	548.3	194.4	193	2.82	2.84
5.33	T	550.23	194.56	193.16	2.83	2.85
5.34	T	552.16	194.72	193.31	2.84	2.86
5.35	T	554.09	194.88	193.47	2.84	2.86
5.36	T	556.03	195.04	193.63	2.85	2.87
5.37	T	557.97	195.2	193.79	2.86	2.88
5.38	T	559.91	195.36	193.94	2.87	2.89
5.39	T	561.85	195.52	194.1	2.87	2.89

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
5.4	T	563.79	195.68	194.26	2.88	2.9
5.41	T	565.73	195.83	194.42	2.89	2.91
5.42	T	567.68	195.99	194.58	2.9	2.92
5.43	T	569.63	196.15	194.73	2.9	2.93
5.44	T	571.57	196.31	194.89	2.91	2.93
5.45	T	573.53	196.47	195.05	2.92	2.94
5.46	T	575.48	196.63	195.21	2.93	2.95
5.47	T	577.43	196.79	195.36	2.93	2.96
5.48	T	579.38	196.95	195.52	2.94	2.96
5.49	T	581.34	197.11	195.68	2.95	2.97
5.5	T	583.3	197.27	195.84	2.96	2.98
5.51	T	585.26	197.42	196	2.96	2.99
5.52	T	587.22	197.58	196.15	2.97	2.99
5.53	T	589.18	197.74	196.31	2.98	3
5.54	T	591.15	197.9	196.47	2.99	3.01
5.55	T	593.11	198.06	196.63	2.99	3.02
5.56	T	595.08	198.22	196.78	3	3.02
5.57	T	597.05	198.38	196.94	3.01	3.03
5.58	T	599.02	198.54	197.1	3.02	3.04
5.59	T	600.99	198.7	197.26	3.02	3.05
5.6	T	602.97	198.86	197.41	3.03	3.05
5.61	T	604.94	199.02	197.57	3.04	3.06
5.62	T	606.92	199.17	197.73	3.05	3.07
5.63	T	608.9	199.33	197.89	3.05	3.08
5.64	T	610.88	199.49	198.05	3.06	3.08
5.65	T	612.86	199.65	198.2	3.07	3.09
5.66	T	614.84	199.81	198.36	3.08	3.1
5.67	T	616.83	199.97	198.52	3.08	3.11
5.68	T	618.81	200.13	198.68	3.09	3.11
5.69	T	620.8	200.29	198.83	3.1	3.12
5.7	T	622.79	200.45	198.99	3.11	3.13
5.71	T	624.78	200.61	199.15	3.11	3.14
5.72	T	626.77	200.76	199.31	3.12	3.14
5.73	T	628.77	200.92	199.47	3.13	3.15
5.74	T	630.76	201.08	199.62	3.14	3.16
5.75	T	632.76	201.24	199.78	3.14	3.17
5.76	T	634.76	201.4	199.94	3.15	3.17
5.77	T	636.76	201.56	200.1	3.16	3.18
5.78	T	638.76	201.72	200.25	3.17	3.19
5.79	T	640.77	201.88	200.41	3.17	3.2
5.8	T	642.77	202.04	200.57	3.18	3.2
5.81	T	644.78	202.2	200.73	3.19	3.21
5.82	T	646.79	202.35	200.88	3.2	3.22
5.83	T	648.8	202.51	201.04	3.2	3.23
5.84	T	650.81	202.67	201.2	3.21	3.23

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
5.85	T	652.82	202.83	201.36	3.22	3.24
5.86	T	654.84	202.99	201.52	3.23	3.25
5.87	T	656.85	203.15	201.67	3.23	3.26
5.88	T	658.87	203.31	201.83	3.24	3.26
5.89	T	660.89	203.47	201.99	3.25	3.27
5.9	T	662.91	203.63	202.15	3.26	3.28
5.91	T	664.94	203.79	202.3	3.26	3.29
5.92	T	666.96	203.95	202.46	3.27	3.29
5.93	T	668.99	204.1	202.62	3.28	3.3
5.94	T	671.01	204.26	202.78	3.29	3.31
5.95	T	673.04	204.42	202.93	3.29	3.32
5.96	T	675.07	204.58	203.09	3.3	3.32
5.97	T	677.1	204.74	203.25	3.31	3.33
5.98	T	679.14	204.9	203.41	3.31	3.34
5.99	T	681.17	205.06	203.57	3.32	3.35
6	T	683.21	205.22	203.72	3.33	3.35
6.01	T	685.25	205.38	203.88	3.34	3.36
6.02	T	687.29	205.54	204.04	3.34	3.37
6.03	T	689.33	205.69	204.2	3.35	3.38
6.04	T	691.37	205.85	204.35	3.36	3.38
6.05	T	693.42	206.01	204.51	3.37	3.39
6.06	T	695.47	206.17	204.67	3.37	3.4
6.07	T	697.51	206.33	204.83	3.38	3.41
6.08	T	699.56	206.49	204.99	3.39	3.41
6.09	T	701.61	206.65	205.14	3.4	3.42
6.1	T	703.67	206.81	205.3	3.4	3.43
6.11	T	705.72	206.97	205.46	3.41	3.43
6.12	T	707.78	207.13	205.62	3.42	3.44
6.13	T	709.83	207.28	205.77	3.42	3.45
6.14	T	711.89	207.44	205.93	3.43	3.46
6.15	T	713.95	207.6	206.09	3.44	3.46
6.16	T	716.02	207.76	206.25	3.45	3.47
6.17	T	718.08	207.92	206.4	3.45	3.48
6.18	T	720.14	208.08	206.56	3.46	3.49
6.19	T	722.21	208.24	206.72	3.47	3.49
6.2	T	724.28	208.4	206.88	3.48	3.5
6.21	T	726.35	208.56	207.04	3.48	3.51
6.22	T	728.42	208.72	207.19	3.49	3.52
6.23	T	730.49	208.87	207.35	3.5	3.52
6.24	T	732.57	209.03	207.51	3.5	3.53
6.25	T	734.65	209.19	207.67	3.51	3.54
6.26	T	736.72	209.35	207.82	3.52	3.54
6.27	T	738.8	209.51	207.98	3.53	3.55
6.28	T	740.88	209.73	208.2	3.53	3.56
6.29	T	742.97	209.94	208.41	3.54	3.56

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
6.3	T	745.05	210.15	208.62	3.55	3.57
6.31	T	747.14	210.35	208.81	3.55	3.58
6.32	T	749.23	210.52	208.99	3.56	3.59
6.33	T	751.32	210.7	209.16	3.57	3.59
6.34	T	753.41	210.87	209.34	3.57	3.6
6.35	T	755.51	211.05	209.51	3.58	3.61
6.36	T	757.61	211.22	209.68	3.59	3.61
6.37	T	759.7	211.4	209.86	3.59	3.62
6.38	T	761.8	211.57	210.03	3.6	3.63
6.39	T	763.91	211.75	210.21	3.61	3.63
6.4	T	766.01	211.92	210.38	3.61	3.64
6.41	T	768.11	212.1	210.55	3.62	3.65
6.42	T	770.22	212.28	210.73	3.63	3.66
6.43	T	772.33	212.45	210.9	3.64	3.66
6.44	T	774.44	212.63	211.08	3.64	3.67
6.45	T	776.55	212.8	211.25	3.65	3.68
6.46	T	778.67	212.98	211.42	3.66	3.68
6.47	T	780.78	213.15	211.6	3.66	3.69
6.48	T	782.9	213.33	211.77	3.67	3.7
6.49	T	785.02	213.5	211.95	3.68	3.7
6.5	T	787.14	213.68	212.12	3.68	3.71
6.51	T	789.26	213.85	212.29	3.69	3.72
6.52	T	791.39	214.03	212.47	3.7	3.72
6.53	T	793.51	214.2	212.64	3.7	3.73
6.54	T	795.64	214.38	212.82	3.71	3.74
6.55	T	797.77	214.55	212.99	3.72	3.75
6.56	T	799.9	214.73	213.16	3.73	3.75
6.57	T	802.03	214.91	213.34	3.73	3.76
6.58	T	804.17	215.08	213.51	3.74	3.77
6.59	T	806.3	215.26	213.69	3.75	3.77
6.6	T	808.44	215.43	213.86	3.75	3.78
6.61	T	810.58	215.61	214.03	3.76	3.79
6.62	T	812.72	215.78	214.21	3.77	3.79
6.63	T	814.87	215.96	214.38	3.77	3.8
6.64	T	817.01	216.13	214.56	3.78	3.81
6.65	T	819.16	216.31	214.73	3.79	3.81
6.66	T	821.31	216.48	214.9	3.79	3.82
6.67	T	823.46	216.66	215.08	3.8	3.83
6.68	T	825.61	216.83	215.25	3.81	3.84
6.69	T	827.76	217.01	215.43	3.81	3.84
6.7	T	829.92	217.18	215.6	3.82	3.85
6.71	T	832.08	217.36	215.77	3.83	3.86
6.72	T	834.24	217.54	215.95	3.83	3.86
6.73	T	836.4	217.71	216.12	3.84	3.87
6.74	T	838.56	217.89	216.3	3.85	3.88

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
6.75	T	840.72	218.06	216.47	3.86	3.88
6.76	T	842.89	218.24	216.64	3.86	3.89
6.77	T	845.06	218.41	216.82	3.87	3.9
6.78	T	847.23	218.59	216.99	3.88	3.9
6.79	T	849.4	218.76	217.17	3.88	3.91
6.8	T	851.57	218.94	217.34	3.89	3.92
6.81	T	853.75	219.11	217.51	3.9	3.93
6.82	T	855.92	219.29	217.69	3.9	3.93
6.83	T	858.1	219.46	217.86	3.91	3.94
6.84	T	860.28	219.64	218.04	3.92	3.95
6.85	T	862.46	219.81	218.21	3.92	3.95
6.86	T	864.65	219.99	218.38	3.93	3.96
6.87	T	866.83	220.17	218.56	3.94	3.97
6.88	T	869.02	220.34	218.73	3.94	3.97
6.89	T	871.21	220.52	218.91	3.95	3.98
6.9	T	873.4	220.69	219.08	3.96	3.99
6.91	T	875.59	220.87	219.25	3.96	3.99
6.92	T	877.78	221.04	219.43	3.97	4
6.93	T	879.98	221.22	219.6	3.98	4.01
6.94	T	882.18	221.39	219.78	3.98	4.01
6.95	T	884.37	221.57	219.95	3.99	4.02
6.96	T	886.58	221.74	220.12	4	4.03
6.97	T	888.78	221.92	220.3	4	4.03
6.98	T	890.98	222.09	220.47	4.01	4.04
6.99	T	893.19	222.27	220.65	4.02	4.05
7	T	895.4	222.44	220.82	4.03	4.05
7.01	T	897.61	222.62	220.99	4.03	4.06
7.02	T	899.82	222.79	221.17	4.04	4.07
7.03	T	902.03	222.97	221.34	4.05	4.08
7.04	T	904.24	223.15	221.52	4.05	4.08
7.05	T	906.46	223.32	221.69	4.06	4.09
7.06	T	908.68	223.49	221.86	4.07	4.1
7.07	T	910.9	223.6	221.96	4.07	4.1
7.08	T	913.12	223.71	222.07	4.08	4.11
7.09	T	915.34	223.81	222.17	4.09	4.12
7.1	T	917.56	223.92	222.28	4.1	4.13
7.11	T	919.79	224.02	222.38	4.11	4.14
7.12	T	922.01	224.13	222.49	4.11	4.14
7.13	T	924.24	224.24	222.59	4.12	4.15
7.14	T	926.47	224.34	222.69	4.13	4.16
7.15	T	928.69	224.45	222.8	4.14	4.17
7.16	T	930.92	224.56	222.9	4.15	4.18
7.17	T	933.15	224.66	223.01	4.15	4.18
7.18	T	935.38	224.77	223.11	4.16	4.19
7.19	T	937.62	224.87	223.22	4.17	4.2

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
7.2	T	939.85	224.98	223.32	4.18	4.21
7.21	T	942.08	225.09	223.43	4.19	4.22
7.22	T	944.32	225.19	223.53	4.19	4.22
7.23	T	946.55	225.3	223.63	4.2	4.23
7.24	T	948.79	225.41	223.74	4.21	4.24
7.25	T	951.03	225.51	223.84	4.22	4.25
7.26	T	953.27	225.62	223.95	4.23	4.26
7.27	T	955.51	225.72	224.05	4.23	4.26
7.28	T	957.75	225.83	224.16	4.24	4.27
7.29	T	959.99	225.94	224.26	4.25	4.28
7.3	T	962.24	226.04	224.37	4.26	4.29
7.31	T	964.48	226.15	224.47	4.26	4.3
7.32	T	966.73	226.26	224.57	4.27	4.3
7.33	T	968.97	226.36	224.68	4.28	4.31
7.34	T	971.22	226.47	224.78	4.29	4.32
7.35	T	973.47	226.58	224.89	4.3	4.33
7.36	T	975.72	226.68	224.99	4.3	4.34
7.37	T	977.97	226.79	225.1	4.31	4.34
7.38	T	980.22	226.89	225.2	4.32	4.35
7.39	T	982.48	227	225.3	4.33	4.36
7.4	T	984.73	227.11	225.41	4.34	4.37
7.41	T	986.99	227.21	225.51	4.34	4.38
7.42	T	989.24	227.32	225.62	4.35	4.38
7.43	T	991.5	227.43	225.72	4.36	4.39
7.44	T	993.76	227.53	225.83	4.37	4.4
7.45	T	996.02	227.64	225.93	4.38	4.41
7.46	T	998.28	227.74	226.04	4.38	4.42
7.47	T	1000.54	227.85	226.14	4.39	4.42
7.48	T	1002.8	227.96	226.24	4.4	4.43
7.49	T	1005.06	228.06	226.35	4.41	4.44
7.5	T	1007.33	228.17	226.45	4.41	4.45
7.51	T	1009.59	228.28	226.56	4.42	4.46
7.52	T	1011.86	228.38	226.66	4.43	4.46
7.53	T	1014.13	228.49	226.77	4.44	4.47
7.54	T	1016.4	228.59	226.87	4.45	4.48
7.55	T	1018.67	228.7	226.98	4.45	4.49
7.56	T	1020.94	228.81	227.08	4.46	4.5
7.57	T	1023.21	228.91	227.18	4.47	4.5
7.58	T	1025.48	229.02	227.29	4.48	4.51
7.59	T	1027.76	229.13	227.39	4.49	4.52
7.6	T	1030.03	229.23	227.5	4.49	4.53
7.61	T	1032.31	229.34	227.6	4.5	4.54
7.62	T	1034.58	229.45	227.71	4.51	4.54
7.63	T	1036.86	229.55	227.81	4.52	4.55
7.64	T	1039.14	229.66	227.91	4.52	4.56

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
7.65	T	1041.42	229.76	228.02	4.53	4.57
7.66	T	1043.7	229.87	228.12	4.54	4.58
7.67	T	1045.99	229.98	228.23	4.55	4.58
7.68	T	1048.27	230.08	228.33	4.56	4.59
7.69	T	1050.55	230.19	228.44	4.56	4.6
7.7	T	1052.84	230.3	228.54	4.57	4.61
7.71	T	1055.12	230.4	228.65	4.58	4.61
7.72	T	1057.41	230.51	228.75	4.59	4.62
7.73	T	1059.7	230.61	228.85	4.6	4.63
7.74	T	1061.99	230.72	228.96	4.6	4.64
7.75	T	1064.28	230.83	229.06	4.61	4.65
7.76	T	1066.57	230.93	229.17	4.62	4.65
7.77	T	1068.87	231.04	229.27	4.63	4.66
7.78	T	1071.16	231.15	229.38	4.63	4.67
7.79	T	1073.45	231.25	229.48	4.64	4.68
7.8	T	1075.75	231.36	229.59	4.65	4.69
7.81	T	1078.05	231.46	229.69	4.66	4.69
7.82	T	1080.34	231.57	229.79	4.67	4.7
7.83	T	1082.64	231.68	229.9	4.67	4.71
7.84	T	1084.94	231.78	230	4.68	4.72
7.85	T	1087.24	231.89	230.11	4.69	4.72
7.86	T	1089.55	232	230.21	4.7	4.73
7.87	T	1091.85	232.1	230.32	4.7	4.74
7.88	T	1094.15	232.21	230.42	4.71	4.75
7.89	T	1096.46	232.31	230.52	4.72	4.76
7.9	T	1098.77	232.42	230.63	4.73	4.76
7.91	T	1101.07	232.53	230.73	4.74	4.77
7.92	T	1103.38	232.63	230.84	4.74	4.78
7.93	T	1105.69	232.74	230.94	4.75	4.79
7.94	T	1108	232.85	231.05	4.76	4.8
7.95	T	1110.31	232.95	231.15	4.77	4.8
7.96	T	1112.62	233.06	231.26	4.77	4.81
7.97	T	1114.94	233.17	231.36	4.78	4.82
7.98	T	1117.25	233.27	231.46	4.79	4.83
7.99	T	1119.57	233.38	231.57	4.8	4.83
8	T	1121.89	233.48	231.67	4.8	4.84
8.01	T	1124.2	233.59	231.78	4.81	4.85
8.02	T	1126.52	233.7	231.88	4.82	4.86
8.03	T	1128.84	233.8	231.99	4.83	4.87
8.04	T	1131.16	233.91	232.09	4.84	4.87
8.05	T	1133.48	234.02	232.2	4.84	4.88
8.06	T	1135.81	234.12	232.3	4.85	4.89
8.07	T	1138.13	234.23	232.4	4.86	4.9
8.08	T	1140.46	234.33	232.51	4.87	4.91
8.09	T	1142.78	234.44	232.61	4.87	4.91

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
8.1	T	1145.11	234.55	232.72	4.88	4.92
8.11	T	1147.44	234.65	232.82	4.89	4.93
8.12	T	1149.77	234.76	232.93	4.9	4.94
8.13	T	1152.1	234.87	233.03	4.91	4.94
8.14	T	1154.43	234.97	233.13	4.91	4.95
8.15	T	1156.76	235.08	233.24	4.92	4.96
8.16	T	1159.09	235.18	233.34	4.93	4.97
8.17	T	1161.43	235.29	233.45	4.94	4.98
8.18	T	1163.76	235.4	233.55	4.94	4.98
8.19	T	1166.1	235.5	233.66	4.95	4.99
8.2	T	1168.44	235.61	233.76	4.96	5
8.21	T	1170.78	235.72	233.87	4.97	5.01
8.22	T	1173.12	235.82	233.97	4.97	5.01
8.23	T	1175.46	235.93	234.07	4.98	5.02
8.24	T	1177.8	236.04	234.18	4.99	5.03
8.25	T	1180.14	236.14	234.28	5	5.04
8.26	T	1182.49	236.25	234.39	5.01	5.05
8.27	T	1184.83	236.35	234.49	5.01	5.05
8.28	T	1187.18	236.46	234.6	5.02	5.06
8.29	T	1189.52	236.57	234.7	5.03	5.07
8.3	T	1191.87	236.67	234.81	5.04	5.08
8.31	T	1194.22	236.78	234.91	5.04	5.08
8.32	T	1196.57	236.89	235.01	5.05	5.09
8.33	T	1198.92	236.99	235.12	5.06	5.1
8.34	T	1201.27	237.08	235.2	5.07	5.11
8.35	T	1203.63	237.16	235.28	5.08	5.12
8.36	T	1205.98	237.23	235.35	5.08	5.12
8.37	T	1208.34	237.31	235.42	5.09	5.13
8.38	T	1210.69	237.38	235.49	5.1	5.14
8.39	T	1213.05	237.46	235.56	5.11	5.15

******************************WinXSPRO********************************
C:\WinXSPro\MidRun2.out
Input File: C:\WinXSPro\MidRun.sec
Run Date: 10/17/14
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 9/08/14

Subsections/Dividing positions

Resistance Method: Manning's n
SECTION A
Low Stage n 0.035
High Stage n 0.035

Unadjusted horizontal distances used

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
2.8	T	251.45	140.9	140.26	1.78	1.79
2.81	T	252.86	140.99	140.34	1.79	1.8
2.82	T	254.26	141.09	140.43	1.8	1.81
2.83	T	255.67	141.18	140.51	1.81	1.82
2.84	T	257.07	141.28	140.6	1.82	1.83
2.85	T	258.48	141.37	140.68	1.83	1.84
2.86	T	259.89	141.47	140.76	1.84	1.85
2.87	T	261.29	141.56	140.85	1.85	1.86
2.88	T	262.7	141.68	140.96	1.85	1.86
2.89	T	264.11	141.8	141.08	1.86	1.87
2.9	T	265.53	141.92	141.19	1.87	1.88
2.91	T	266.94	142.03	141.31	1.88	1.89
2.92	T	268.35	142.15	141.42	1.89	1.9
2.93	T	269.77	142.27	141.54	1.9	1.91
2.94	T	271.18	142.39	141.66	1.9	1.91
2.95	T	272.6	142.5	141.77	1.91	1.92
2.96	T	274.02	142.62	141.89	1.92	1.93
2.97	T	275.44	142.74	142	1.93	1.94
2.98	T	276.86	142.86	142.12	1.94	1.95
2.99	T	278.28	142.97	142.23	1.95	1.96
3	T	279.71	143.09	142.35	1.95	1.96
3.01	T	281.13	143.21	142.46	1.96	1.97
3.02	T	282.56	143.33	142.58	1.97	1.98
3.03	T	283.98	143.44	142.69	1.98	1.99
3.04	T	285.41	143.56	142.81	1.99	2

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
3.05	T	286.84	143.68	142.93	2	2.01
3.06	T	288.27	143.8	143.04	2	2.02
3.07	T	289.7	143.91	143.16	2.01	2.02
3.08	T	291.13	144.03	143.27	2.02	2.03
3.09	T	292.57	144.15	143.39	2.03	2.04
3.1	T	294	144.27	143.5	2.04	2.05
3.11	T	295.44	144.38	143.62	2.05	2.06
3.12	T	296.87	144.5	143.73	2.05	2.07
3.13	T	298.31	144.62	143.85	2.06	2.07
3.14	T	299.75	144.74	143.96	2.07	2.08
3.15	T	301.19	144.85	144.08	2.08	2.09
3.16	T	302.63	144.97	144.19	2.09	2.1
3.17	T	304.08	145.09	144.31	2.1	2.11
3.18	T	305.52	145.21	144.43	2.1	2.12
3.19	T	306.97	145.32	144.54	2.11	2.12
3.2	T	308.41	145.44	144.66	2.12	2.13
3.21	T	309.86	145.56	144.77	2.13	2.14
3.22	T	311.31	145.68	144.89	2.14	2.15
3.23	T	312.76	145.79	145	2.15	2.16
3.24	T	314.21	145.91	145.12	2.15	2.17
3.25	T	315.66	146.03	145.23	2.16	2.17
3.26	T	317.11	146.15	145.35	2.17	2.18
3.27	T	318.57	146.27	145.46	2.18	2.19
3.28	T	320.02	146.38	145.58	2.19	2.2
3.29	T	321.48	146.5	145.7	2.19	2.21
3.3	T	322.94	146.62	145.81	2.2	2.21
3.31	T	324.4	146.74	145.93	2.21	2.22
3.32	T	325.86	146.85	146.04	2.22	2.23
3.33	T	327.32	146.97	146.16	2.23	2.24
3.34	T	328.78	147.09	146.27	2.24	2.25
3.35	T	330.24	147.21	146.39	2.24	2.26
3.36	T	331.71	147.32	146.5	2.25	2.26
3.37	T	333.18	147.44	146.62	2.26	2.27
3.38	T	334.64	147.56	146.73	2.27	2.28
3.39	T	336.11	147.68	146.85	2.28	2.29
3.4	T	337.58	147.79	146.97	2.28	2.3
3.41	T	339.05	147.91	147.08	2.29	2.31
3.42	T	340.52	148.03	147.2	2.3	2.31
3.43	T	342	148.15	147.31	2.31	2.32
3.44	T	343.47	148.26	147.43	2.32	2.33
3.45	T	344.94	148.38	147.54	2.32	2.34
3.46	T	346.42	148.5	147.66	2.33	2.35
3.47	T	347.9	148.62	147.77	2.34	2.35
3.48	T	349.38	148.73	147.89	2.35	2.36
3.49	T	350.86	148.85	148	2.36	2.37

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
3.5	T	352.34	148.97	148.12	2.37	2.38
3.51	T	353.82	149.09	148.23	2.37	2.39
3.52	T	355.3	149.2	148.35	2.38	2.4
3.53	T	356.79	149.32	148.47	2.39	2.4
3.54	T	358.27	149.44	148.58	2.4	2.41
3.55	T	359.76	149.56	148.7	2.41	2.42
3.56	T	361.25	149.67	148.81	2.41	2.43
3.57	T	362.74	149.79	148.93	2.42	2.44
3.58	T	364.23	149.91	149.04	2.43	2.44
3.59	T	365.72	150.03	149.16	2.44	2.45
3.6	T	367.21	150.14	149.27	2.45	2.46
3.61	T	368.7	150.26	149.39	2.45	2.47
3.62	T	370.2	150.38	149.5	2.46	2.48
3.63	T	371.69	150.5	149.62	2.47	2.48
3.64	T	373.19	150.62	149.74	2.48	2.49
3.65	T	374.69	150.73	149.85	2.49	2.5
3.66	T	376.19	150.85	149.97	2.49	2.51
3.67	T	377.69	150.97	150.08	2.5	2.52
3.68	T	379.19	151.09	150.2	2.51	2.52
3.69	T	380.69	151.2	150.31	2.52	2.53
3.7	T	382.2	151.32	150.43	2.53	2.54
3.71	T	383.7	151.44	150.54	2.53	2.55
3.72	T	385.21	151.56	150.66	2.54	2.56
3.73	T	386.72	151.67	150.77	2.55	2.56
3.74	T	388.23	151.79	150.89	2.56	2.57
3.75	T	389.74	151.91	151.01	2.57	2.58
3.76	T	391.25	152.03	151.12	2.57	2.59
3.77	T	392.76	152.14	151.24	2.58	2.6
3.78	T	394.27	152.26	151.35	2.59	2.61
3.79	T	395.79	152.38	151.47	2.6	2.61
3.8	T	397.3	152.5	151.58	2.61	2.62
3.81	T	398.82	152.61	151.7	2.61	2.63
3.82	T	400.34	152.73	151.81	2.62	2.64
3.83	T	401.86	152.85	151.93	2.63	2.65
3.84	T	403.38	152.97	152.04	2.64	2.65
3.85	T	404.9	153.08	152.16	2.64	2.66
3.86	T	406.42	153.2	152.27	2.65	2.67
3.87	T	407.94	153.32	152.39	2.66	2.68
3.88	T	409.47	153.44	152.51	2.67	2.68
3.89	T	410.99	153.55	152.62	2.68	2.69
3.9	T	412.52	153.67	152.74	2.68	2.7
3.91	T	414.05	153.79	152.85	2.69	2.71
3.92	T	415.58	153.91	152.97	2.7	2.72
3.93	T	417.11	154.02	153.08	2.71	2.72
3.94	T	418.64	154.14	153.2	2.72	2.73

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
3.95	T	420.17	154.26	153.31	2.72	2.74
3.96	T	421.71	154.38	153.43	2.73	2.75
3.97	T	423.24	154.49	153.54	2.74	2.76
3.98	T	424.78	154.61	153.66	2.75	2.76
3.99	T	426.32	154.73	153.78	2.76	2.77
4	T	427.86	154.85	153.89	2.76	2.78
4.01	T	429.4	154.97	154.01	2.77	2.79
4.02	T	430.94	155.08	154.12	2.78	2.8
4.03	T	432.48	155.17	154.21	2.79	2.8
4.04	T	434.02	155.26	154.3	2.8	2.81
4.05	T	435.57	155.35	154.39	2.8	2.82
4.06	T	437.11	155.44	154.47	2.81	2.83
4.07	T	438.66	155.53	154.56	2.82	2.84
4.08	T	440.2	155.62	154.65	2.83	2.85
4.09	T	441.75	155.71	154.74	2.84	2.85
4.1	T	443.3	155.81	154.83	2.85	2.86
4.11	T	444.85	155.9	154.91	2.85	2.87
4.12	T	446.4	155.99	155	2.86	2.88
4.13	T	447.95	156.08	155.09	2.87	2.89
4.14	T	449.5	156.18	155.19	2.88	2.9
4.15	T	451.05	156.77	155.78	2.88	2.9
4.16	T	452.62	157.36	156.36	2.88	2.89
4.17	T	454.18	157.94	156.94	2.88	2.89
4.18	T	455.75	158.53	157.53	2.87	2.89
4.19	T	457.33	159.12	158.11	2.87	2.89
4.2	T	458.92	159.71	158.7	2.87	2.89
4.21	T	460.51	160.29	159.28	2.87	2.89
4.22	T	462.1	160.88	159.87	2.87	2.89
4.23	T	463.71	161.47	160.45	2.87	2.89
4.24	T	465.31	162.05	161.03	2.87	2.89
4.25	T	466.93	162.64	161.62	2.87	2.89
4.26	T	468.55	163.23	162.2	2.87	2.89
4.27	T	470.17	163.82	162.79	2.87	2.89
4.28	T	471.8	164.4	163.37	2.87	2.89
4.29	T	473.44	164.99	163.96	2.87	2.89
4.3	T	475.08	165.56	164.53	2.87	2.89
4.31	T	476.73	165.73	164.69	2.88	2.89
4.32	T	478.38	165.9	164.86	2.88	2.9
4.33	T	480.03	166.06	165.02	2.89	2.91
4.34	T	481.68	166.23	165.19	2.9	2.92
4.35	T	483.33	166.4	165.35	2.9	2.92
4.36	T	484.99	166.56	165.52	2.91	2.93
4.37	T	486.64	166.73	165.68	2.92	2.94
4.38	T	488.3	166.9	165.85	2.93	2.94
4.39	T	489.96	167.06	166.01	2.93	2.95

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
4.4	T	491.62	167.23	166.18	2.94	2.96
4.41	T	493.28	167.4	166.34	2.95	2.97
4.42	T	494.95	167.56	166.51	2.95	2.97
4.43	T	496.62	167.73	166.68	2.96	2.98
4.44	T	498.28	167.9	166.84	2.97	2.99
4.45	T	499.95	168.06	167.01	2.97	2.99
4.46	T	501.62	168.23	167.17	2.98	3
4.47	T	503.3	168.4	167.34	2.99	3.01
4.48	T	504.97	168.56	167.5	3	3.01
4.49	T	506.65	168.73	167.67	3	3.02
4.5	T	508.33	168.9	167.83	3.01	3.03
4.51	T	510.01	169.06	168	3.02	3.04
4.52	T	511.69	169.23	168.16	3.02	3.04
4.53	T	513.37	169.4	168.33	3.03	3.05
4.54	T	515.05	169.56	168.49	3.04	3.06
4.55	T	516.74	169.73	168.66	3.04	3.06
4.56	T	518.43	169.9	168.82	3.05	3.07
4.57	T	520.12	170.06	168.99	3.06	3.08
4.58	T	521.81	170.23	169.15	3.07	3.08
4.59	T	523.5	170.4	169.32	3.07	3.09
4.6	T	525.2	170.56	169.48	3.08	3.1
4.61	T	526.89	170.73	169.65	3.09	3.11
4.62	T	528.59	170.9	169.82	3.09	3.11
4.63	T	530.29	171.06	169.98	3.1	3.12
4.64	T	531.99	171.23	170.15	3.11	3.13
4.65	T	533.69	171.4	170.31	3.11	3.13
4.66	T	535.4	171.56	170.48	3.12	3.14
4.67	T	537.1	171.73	170.64	3.13	3.15
4.68	T	538.81	171.89	170.81	3.13	3.15
4.69	T	540.52	172.06	170.97	3.14	3.16
4.7	T	542.23	172.23	171.14	3.15	3.17
4.71	T	543.94	172.39	171.3	3.16	3.18
4.72	T	545.66	172.56	171.47	3.16	3.18
4.73	T	547.37	172.73	171.63	3.17	3.19
4.74	T	549.09	172.89	171.8	3.18	3.2
4.75	T	550.81	173.06	171.96	3.18	3.2
4.76	T	552.53	173.23	172.13	3.19	3.21
4.77	T	554.25	173.39	172.29	3.2	3.22
4.78	T	555.98	173.56	172.46	3.2	3.22
4.79	T	557.7	173.73	172.62	3.21	3.23
4.8	T	559.43	173.89	172.79	3.22	3.24
4.81	T	561.16	174.06	172.95	3.22	3.24
4.82	T	562.89	174.23	173.12	3.23	3.25
4.83	T	564.62	174.39	173.29	3.24	3.26
4.84	T	566.36	174.56	173.45	3.24	3.27

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
4.85	T	568.09	174.73	173.62	3.25	3.27
4.86	T	569.83	174.89	173.78	3.26	3.28
4.87	T	571.57	175.06	173.95	3.26	3.29
4.88	T	573.31	175.23	174.11	3.27	3.29
4.89	T	575.05	175.39	174.28	3.28	3.3
4.9	T	576.8	175.56	174.44	3.29	3.31
4.91	T	578.54	175.73	174.61	3.29	3.31
4.92	T	580.29	175.89	174.77	3.3	3.32
4.93	T	582.04	176.06	174.94	3.31	3.33
4.94	T	583.79	176.23	175.1	3.31	3.33
4.95	T	585.54	176.39	175.27	3.32	3.34
4.96	T	587.29	176.56	175.43	3.33	3.35
4.97	T	589.05	176.73	175.6	3.33	3.35
4.98	T	590.81	176.89	175.76	3.34	3.36
4.99	T	592.57	177.06	175.93	3.35	3.37
5	T	594.33	177.23	176.09	3.35	3.38
5.01	T	596.09	177.39	176.26	3.36	3.38
5.02	T	597.85	177.56	176.43	3.37	3.39
5.03	T	599.62	177.73	176.59	3.37	3.4
5.04	T	601.38	177.89	176.76	3.38	3.4
5.05	T	603.15	178.06	176.92	3.39	3.41
5.06	T	604.92	178.22	177.09	3.39	3.42
5.07	T	606.7	178.39	177.25	3.4	3.42
5.08	T	608.47	178.56	177.42	3.41	3.43
5.09	T	610.24	178.72	177.58	3.41	3.44
5.1	T	612.02	178.89	177.75	3.42	3.44
5.11	T	613.8	179.06	177.91	3.43	3.45
5.12	T	615.58	179.22	178.08	3.43	3.46
5.13	T	617.36	179.39	178.24	3.44	3.46
5.14	T	619.15	179.56	178.41	3.45	3.47
5.15	T	620.93	179.72	178.57	3.45	3.48
5.16	T	622.72	179.89	178.74	3.46	3.48
5.17	T	624.51	180.06	178.9	3.47	3.49
5.18	T	626.3	180.22	179.07	3.48	3.5
5.19	T	628.09	180.39	179.23	3.48	3.5
5.2	T	629.88	180.56	179.4	3.49	3.51
5.21	T	631.68	180.72	179.56	3.5	3.52
5.22	T	633.48	180.89	179.73	3.5	3.52
5.23	T	635.27	181.06	179.9	3.51	3.53
5.24	T	637.07	181.22	180.06	3.52	3.54
5.25	T	638.88	181.39	180.23	3.52	3.54
5.26	T	640.68	181.56	180.39	3.53	3.55
5.27	T	642.48	181.72	180.56	3.54	3.56
5.28	T	644.29	181.89	180.72	3.54	3.57
5.29	T	646.1	182.06	180.89	3.55	3.57

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
5.3	T	647.91	182.22	181.05	3.56	3.58
5.31	T	649.72	182.39	181.22	3.56	3.59
5.32	T	651.53	182.56	181.38	3.57	3.59
5.33	T	653.35	189.32	188.15	3.45	3.47
5.34	T	655.24	189.47	188.3	3.46	3.48
5.35	T	657.12	189.63	188.45	3.47	3.49
5.36	T	659.01	189.78	188.6	3.47	3.49
5.37	T	660.89	189.93	188.75	3.48	3.5
5.38	T	662.78	190.09	188.9	3.49	3.51
5.39	T	664.67	190.24	189.05	3.49	3.52

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Lower Reach Flow Data

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Project	**Ellsworth Flow Study**					
Transect Name	**Lower Reach Riffle**	Date	**9/9/2014**			
Purpose / Project	**Verification flow measurement reportedly 150 cfs**	Time	**Begin**	**8:00**		
			End			
Conditions / Test	**Minimum flow**					
Transect Location	**Adjacent to Shore Road**					
Zero Station Location						
Verification Team	Gagnon/Sears/MacVane	**Total Flow =**	333.4	**cfs**		

Data

Field Measurements					Calculations				
Personnel / Method	**Node**	**Station Distance (ft)** (tag line)	**Station Depth (ft)**	**Mean Station Velocity (ft/sec)**	**Incremental Nodal Area (ft^2)**	**Incremental Mean Nodal Velocity (ft/sec)**	**Incremental Nodal Flow (cfs)**	**Total Accumulated Flow (cfs)**	**Comment**
Manual	0	31.7	0.00	0.000	0.00	0.00	0.00	0.00	LEW Bedrock
Manual	1	37.0	0.60	0.010	1.59	0.01	0.01	0.01	Bedrock slope
Manual	2	50.0	0.90	0.510	9.75	0.26	2.54	2.54	
Manual	3	55.0	0.90	1.220	4.50	0.87	3.89	6.44	
Manual	4	60.0	0.70	1.190	4.00	1.21	4.82	11.26	
Manual	5	65.0	1.20	1.520	4.75	1.36	6.44	17.69	
Manual	6	70.0	2.20	1.660	8.50	1.59	13.52	31.21	
Manual	7	75.0	1.80	1.140	10.00	1.40	14.00	45.21	Boulders/bedrock outcrop
Manual	8	83.0	5.30	0.870	28.40	1.01	28.54	73.75	
Manual	9	90.0	5.00	1.815	36.05	1.34	48.40	122.15	TWG
Manual	10	100.0	5.80	0.810	54.00	1.31	70.88	193.02	Large boulders; US eddie
Manual	11	104.0	3.20	0.200	18.00	0.51	9.09	202.11	measurement on a rock, D>6ft
Manual	12	109.0	4.00	0.035	18.00	0.12	2.12	204.23	Large boulders; US eddie
Manual	13	114.0	5.50	0.110	23.75	0.07	1.72	205.95	Large boulders; US eddie
Manual	14	119.0	6.00	0.045	28.75	0.08	2.23	208.18	Large boulders; US eddie
Manual	15	124.0	6.00	0.245	30.00	0.15	4.35	212.53	Large boulders; US eddie
Manual	16	129.0	6.50	0.440	31.25	0.34	10.70	223.23	Channel through US boulders
Manual	17	134.0	5.6	0.155	30.25	0.30	9.00	232.23	Large boulders; US eddie
Manual	18	139.0	3	0.06	21.50	0.11	2.31	234.54	Large boulders; US eddie
Manual	19	144.0	1.8	0.04	12.00	0.05	0.60	235.14	Large boulders; US eddie
Manual	20	149.0	2.8	0.03	11.50	0.04	0.40	235.54	Large boulders; US eddie
Manual	21	154.0	3.5	0.885	15.75	0.46	7.21	242.75	channel to right of US boulders, on bedrock
Manual	22	159.0	2.5	0.1	15.00	0.49	7.39	250.14	bedrock
Manual	23	164.0	2.5	0.37	12.50	0.24	2.94	253.07	bedrock
Manual	24	169.0	2.5	0.85	12.50	0.61	7.63	260.70	bedrock
Manual	25	174.0	2.2	0.78	11.75	0.82	9.58	270.27	bedrock
Manual	26	182.0	3.6	1.13	23.20	0.96	22.16	292.43	bedrock near large boulder
Manual	27	187.0	3.2	0.965	17.00	1.05	17.81	310.24	TWG of right minor channel
Manual	28	192.0	2	1.2	13.00	1.08	14.07	324.31	bedrock
Manual	29	197.0	1.3	0.56	8.25	0.88	7.26	331.57	bedrock
Manual	30	203.5	0.7	0.01	6.50	0.29	1.85	333.42	bedrock
Manual	31	204.7	0	0	0.42	0.01	0.00	333.42	REW
Manual	32				0.00	0.00	0.00	333.42	
Manual	33				0.00	0.00	0.00	333.42	
Manual	34				0.00	0.00	0.00	333.42	
Manual	35				0.00	0.00	0.00	333.42	
Manual	36				0.00	0.00	0.00	333.42	
Manual	37				0.00	0.00	0.00	333.42	
Manual	38				0.00	0.00	0.00	333.42	
Manual	39				0.00	0.00	0.00	333.42	
Manual	40				0.00	0.00	0.00	333.42	
Manual	41				0.00	0.00	0.00	333.42	
Manual	42				0.00	0.00	0.00	333.42	
Manual	43				0.00	0.00	0.00	333.42	
Manual	44				0.00	0.00	0.00	333.42	
Manual	45				0.00	0.00	0.00	333.42	
Manual	46				0.00	0.00	0.00	333.42	
Manual	47				0.00	0.00	0.00	333.42	
Manual	48				0.00	0.00	0.00	333.42	
Manual	49				0.00	0.00	0.00	333.42	
Manual	50				0.00	0.00	0.00	333.42	
Manual	51				0.00	0.00	0.00	333.42	

Project	**Ellsworth Flow Study**			
Transect Name	**Lower Reach Pool**	Date	**9/9/2014**	
Purpose / Project	**Verification flow measurement reportedly 150 cfs**	Time	**Begin**	**11:00**
			End	
Conditions / Test	**Minimum flow**			
Transect Location	**Adjacent to Shore Road**			
Zero Station Location				
Verification Team	Gagnon/Sears/MacVane	**Total Flow =**	315.2	**cfs**

Data

Field Measurements					**Calculations**				
Personnel / Method	**Node**	**Station Distance (ft)** (tag line)	**Station Depth (ft)**	**Mean Station Velocity (ft/sec)**	**Incremental Nodal Area (ft^2)**	**Incremental Mean Nodal Velocity (ft/sec)**	**Incremental Nodal Flow (cfs)**	**Total Accumulated Flow (cfs)**	**Comment**
Manual	0	7.6	0.00	0.000	0.00	0.00	0.00	0.00	LEW
Manual	1	11.0	0.90	0.000	1.53	0.00	0.00	0.00	Cove/rock outcrop US and DS
Manual	2	16.0	0.90	0.000	4.50	0.00	0.00	0.00	Cove/rock outcrop US and DS
Manual	3	21.0	1.40	0.000	5.75	0.00	0.00	0.00	Cove/rock outcrop US and DS
Manual	4	26.0	1.70	0.000	7.75	0.00	0.00	0.00	Cove/rock outcrop US and DS
Manual	5	31.0	2.20	0.000	9.75	0.00	0.00	0.00	Cove/rock outcrop US and DS
Manual	6	36.0	2.00	0.000	10.50	0.00	0.00	0.00	Cove/rock outcrop US and DS
Manual	7	41.0	2.80	0.000	12.00	0.00	0.00	0.00	
Manual	8	46.0	6.00	0.000	22.00	0.00	0.00	0.00	
Manual	9	51.0	8.00	-0.135	35.00	-0.07	-2.36	-2.36	Flow is US Eddy
Manual	10	56.0	8.30	-0.110	40.75	-0.12	-4.99	-7.35	Flow is US Eddy
Manual	11	61.0	11.00	0.050	48.25	-0.03	-1.45	-8.80	
Manual	12	66.0	10.00	0.065	52.50	0.06	3.02	-5.78	
Manual	13	71.0	10.00	0.040	50.00	0.05	2.63	-3.16	
Manual	14	76.0	9.90	0.085	49.75	0.06	3.11	-0.05	
Manual	15	81.0	10.50	0.195	51.00	0.14	7.14	7.09	
Manual	16	87.0	10.60	0.145	63.30	0.17	10.76	17.85	
Manual	17	92.0	8.7	0.24	48.25	0.19	9.29	27.14	
Manual	18	97.0	8.7	0.265	43.50	0.25	10.98	38.12	
Manual	19	102.0	9.4	0.345	45.25	0.31	13.80	51.93	
Manual	20	107.0	11.1	0.53	51.25	0.44	22.42	74.35	
Manual	21	112.0	10.3	0.53	53.50	0.53	28.36	102.70	TWG
Manual	22	117.0	10.9	0.63	53.00	0.58	30.74	133.44	
Manual	23	122.0	10	0.75	52.25	0.69	36.05	169.49	
Manual	24	127.0	9	0.97	47.50	0.86	40.85	210.34	
Manual	25	132.0	9.8	0.96	47.00	0.97	45.36	255.70	
Manual	26	137.0	7.7	0.855	43.75	0.91	39.70	295.40	
Manual	27	142.0	2.5	0.56	25.50	0.71	18.04	313.44	
Manual	28	146.9	0	0	6.13	0.28	1.72	315.16	REW
Manual	29				0.00	0.00	0.00	315.16	
Manual	30				0.00	0.00	0.00	315.16	
Manual	31				0.00	0.00	0.00	315.16	
Manual	32				0.00	0.00	0.00	315.16	
Manual	33				0.00	0.00	0.00	315.16	
Manual	34				0.00	0.00	0.00	315.16	
Manual	35				0.00	0.00	0.00	315.16	
Manual	36				0.00	0.00	0.00	315.16	
Manual	37				0.00	0.00	0.00	315.16	
Manual	38				0.00	0.00	0.00	315.16	
Manual	39				0.00	0.00	0.00	315.16	
Manual	40				0.00	0.00	0.00	315.16	
Manual	41				0.00	0.00	0.00	315.16	
Manual	42				0.00	0.00	0.00	315.16	
Manual	43				0.00	0.00	0.00	315.16	
Manual	44				0.00	0.00	0.00	315.16	
Manual	45				0.00	0.00	0.00	315.16	
Manual	46				0.00	0.00	0.00	315.16	
Manual	47				0.00	0.00	0.00	315.16	
Manual	48				0.00	0.00	0.00	315.16	
Manual	49				0.00	0.00	0.00	315.16	
Manual	50				0.00	0.00	0.00	315.16	
Manual	51				0.00	0.00	0.00	315.16	

Ellsworth
Lower Reach

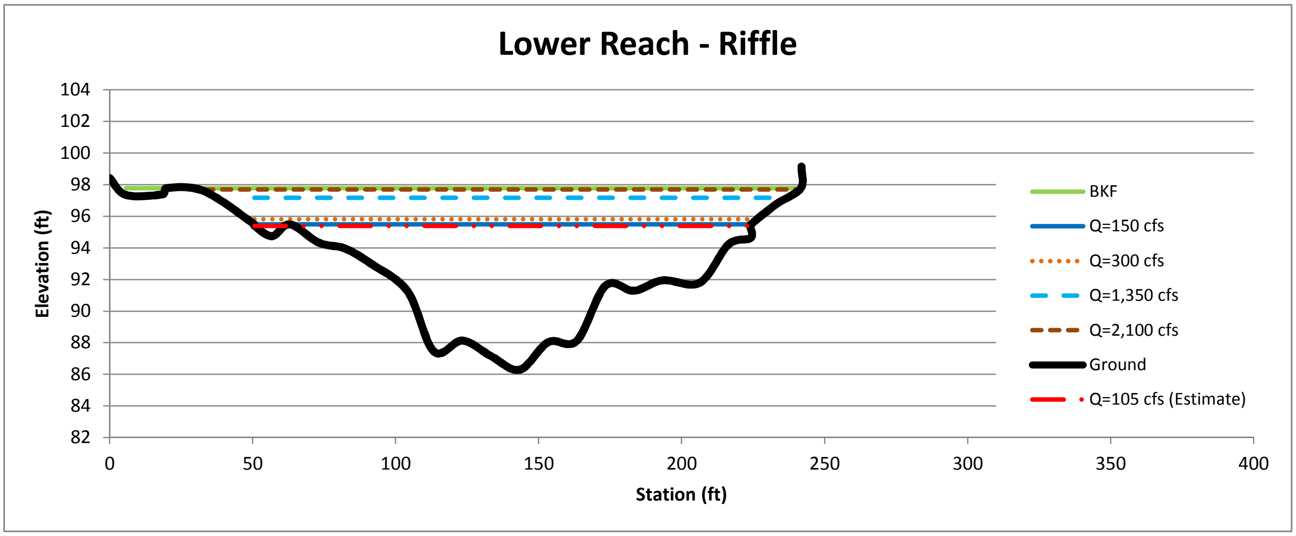
Survey Date: 9/9/2014

	BM1	100							
Riffle	HI1	102.1		9/9/2014	9/10/2014	9/11/2014	9/11/2014		Plot
Station (ft)	FS	El	Notes	SG Reading (cm)					Station (ft)
				9.5	19.6	60.7	77		
-19.4	3.68	98.42	Rock BM G	Q=150 cfs	Q=300 cfs	Q=1,350 cfs	Q=2,100 cfs	BKF	0
-13.6	4.75	97.35	BKF						**5.8**
-0.9	4.71	97.39	LT Boulders						18.5
0.6	4.31	97.79							20
13.7	4.51	97.59	EV/Bedrock						33.1
31.2	**6.61**	95.49	LEW WS						50.6
31.2	6.685	95.415	LEW CG						50.6
37.3	7.36	94.74	CG Bedrock						56.7
43.7	6.61	95.49	CG Bedrock						63.1
53.8	7.77	94.33	CG Bedrock						73.2
63	8.14	93.96	CG Bedrock						82.4
71.9	9.09	93.01	CG						91.3
84.8	10.85	91.25	TW						104.2
94	14.66	87.44	CG						113.4
104	13.96	88.14	CG						123.4
114	14.95	87.15	CG						133.4
124	15.81	86.29	CG						143.4
134	14.06	88.04	CG						153.4
144	13.97	88.13	CG						163.4
154	10.49	91.61	CG						173.4
164	10.81	91.29	CG						183.4
174	10.15	91.95	CG						193.4
187	10.3	91.8	CG						206.4
197	7.88	94.22	CG Bedrock						216.4
204.7	7.48	94.62	REW CG						224.1
204.7	**6.79**	95.31	REW WS						224.1
204.8	6.62	95.48	EV/ LT						224.2
213.8	5.32	96.78	LT						233.2
222.3	4.32	97.78	Toe BKF Slope						241.7
222.5	4.27	99.14	BKF RP G						**241.9**
222.5	2.96	97.83	RP Top						241.9

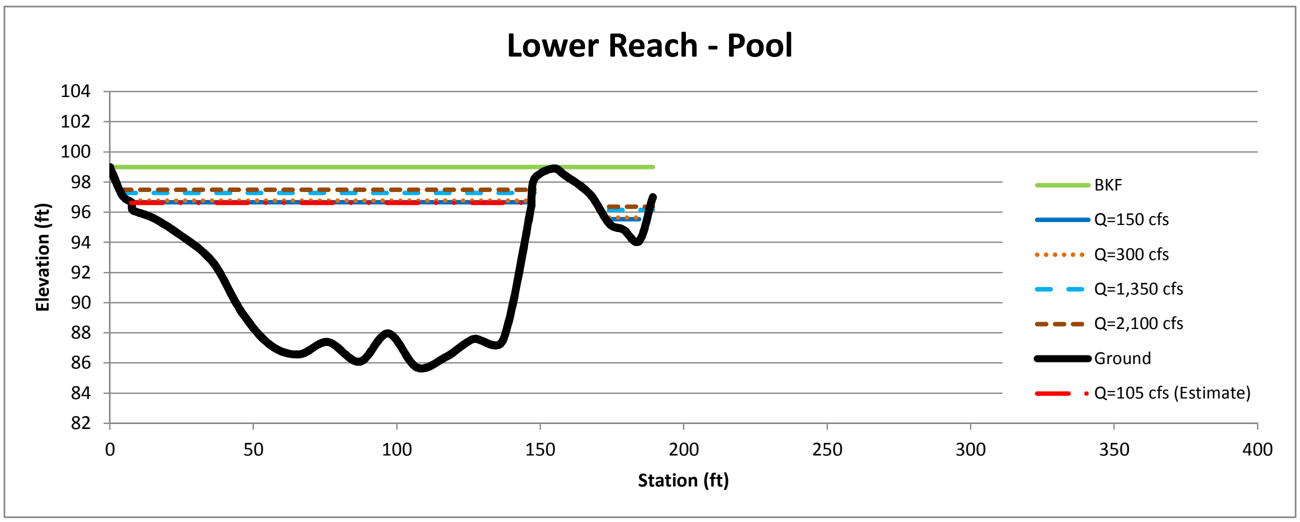
Ellsworth
Lower Reach

Survey Date: 9/9/2014

Pool	HI3	100.81		9/9/2014	9/10/2014	9/11/2014	9/11/2014	
Station (ft)	FS	El	Notes	SG Reading (cm)				
				8	11.05	26.6	33	
				Q=150 cfs	Q=300 cfs	Q=1,350 cfs	Q=2,100 cfs	BKF
0	3.11	98.99	BKF at Tree					
4.3	4.98	97.12	Toe LT					
7.5	**5.44**	96.66	LEW WS					
7.6	5.72	96.38	LEW CG					
8.2	6	96.1	CG at SG					
15	6.48	95.62	CG					
25.1	7.69	94.41	CG					
36	9.45	92.65	CG					
46	12.75	89.35	CG					
56	14.93	87.17	CG					
66	15.53	86.57	CG					
76	14.71	87.39	CG					
87	16.02	86.08	CG					
97	14.14	87.96	CG					
107	16.4	85.7	CG					
117	15.72	86.38	CG					
127	14.5	87.6	CG					
137	14.59	87.51	CG					
146.9	5.66	96.44	REW CG					
146.9	**5.4**	96.7	REW WS					
148	3.87	98.23	LT Rocks					
154.6	3.2	98.9	Rocks					
158.6	3.66	98.44	Rocks					
167.3	4.9	97.2	Rocks Midslope					
174	**6.85**	95.25	EW Rock toe					
179	7.26	94.84	Puddle G					
184.5	6.72	94.09	EW					
189.2	3.81	97	BKF RP G					
189.2	3.36	97.45	RP Top					



Lower Reach - Riffle
Elevation (ft)
104
102
100
98
96
94
92
90
88
86
84
82
0
50
100
150
200
250
300
350
400
Station (ft)
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)



Lower Reach - Pool
Elevation (ft)
104
102
100
98
96
94
92
90
88
86
84
82
0
50
100
150
200
250
300
350
400
Station (ft)
BKF
Q=150 cfs
Q=300 cfs
Q=1,350 cfs
Q=2,100 cfs
Ground
Q=105 cfs (Estimate)

******************************WinXSPRO********************************
C:\WinXSPro\LowRif2.out
Input File: C:\WinXSPro\LowRif.sec
Run Date: 10/17/14
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 9/08/14

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
9.1	T	739.4	174.58	171.6	4.24	4.31
9.11	T	741.11	174.86	171.87	4.24	4.31
9.12	T	742.83	175.13	172.13	4.24	4.32
9.13	T	744.56	175.37	172.36	4.25	4.32
9.14	T	746.28	175.56	172.54	4.25	4.33
9.15	T	748.01	175.76	172.71	4.26	4.33
9.16	T	749.74	175.95	172.89	4.26	4.34
9.17	T	751.47	176.15	173.07	4.27	4.34
9.18	T	753.2	176.34	173.25	4.27	4.35
9.19	T	754.93	176.54	173.43	4.28	4.35
9.2	T	756.67	176.79	173.67	4.28	4.36
9.21	T	758.41	176.95	173.82	4.29	4.36
9.22	T	760.15	177.1	173.97	4.29	4.37
9.23	T	761.89	177.25	174.13	4.3	4.38
9.24	T	763.63	177.41	174.28	4.3	4.38
9.25	T	765.37	177.56	174.43	4.31	4.39
9.26	T	767.12	177.72	174.59	4.32	4.39
9.27	T	768.87	177.87	174.74	4.32	4.4
9.28	T	770.61	178.02	174.89	4.33	4.41
9.29	T	772.36	178.18	175.04	4.33	4.41
9.3	T	774.12	178.33	175.2	4.34	4.42
9.31	T	775.87	178.49	175.35	4.35	4.42
9.32	T	777.62	178.64	175.5	4.35	4.43
9.33	T	779.38	178.79	175.65	4.36	4.44
9.34	T	781.14	178.95	175.81	4.37	4.44

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
9.35	T	782.9	179.1	175.96	4.37	4.45
9.36	T	784.66	179.26	176.11	4.38	4.46
9.37	T	786.42	179.41	176.26	4.38	4.46
9.38	T	788.18	179.56	176.42	4.39	4.47
9.39	T	789.95	179.72	176.57	4.4	4.47
9.4	T	791.72	179.87	176.72	4.4	4.48
9.41	T	793.48	180.02	176.87	4.41	4.49
9.42	T	795.25	180.18	177.03	4.41	4.49
9.43	T	797.02	180.33	177.18	4.42	4.5
9.44	T	798.8	180.49	177.33	4.43	4.5
9.45	T	800.57	180.64	177.48	4.43	4.51
9.46	T	802.35	180.79	177.64	4.44	4.52
9.47	T	804.13	180.95	177.79	4.44	4.52
9.48	T	805.9	181.1	177.94	4.45	4.53
9.49	T	807.69	181.26	178.09	4.46	4.54
9.5	T	809.47	181.41	178.25	4.46	4.54
9.51	T	811.25	181.56	178.4	4.47	4.55
9.52	T	813.04	181.72	178.55	4.47	4.55
9.53	T	814.82	181.87	178.71	4.48	4.56
9.54	T	816.61	182.03	178.86	4.49	4.57
9.55	T	818.4	182.18	179.01	4.49	4.57
9.56	T	820.19	182.33	179.16	4.5	4.58
9.57	T	821.98	182.49	179.32	4.5	4.58
9.58	T	823.78	182.64	179.47	4.51	4.59
9.59	T	825.58	182.8	179.62	4.52	4.6
9.6	T	827.37	182.95	179.77	4.52	4.6
9.61	T	829.17	183.1	179.93	4.53	4.61
9.62	T	830.97	183.26	180.08	4.53	4.61
9.63	T	832.77	183.41	180.23	4.54	4.62
9.64	T	834.58	183.56	180.38	4.55	4.63
9.65	T	836.38	183.72	180.54	4.55	4.63
9.66	T	838.19	183.87	180.69	4.56	4.64
9.67	T	840	184.03	180.84	4.56	4.64
9.68	T	841.81	184.18	180.99	4.57	4.65
9.69	T	843.62	184.33	181.15	4.58	4.66
9.7	T	845.43	184.49	181.3	4.58	4.66
9.71	T	847.24	184.64	181.45	4.59	4.67
9.72	T	849.06	184.8	181.6	4.59	4.68
9.73	T	850.88	184.95	181.76	4.6	4.68
9.74	T	852.7	185.1	181.91	4.61	4.69
9.75	T	854.52	185.26	182.06	4.61	4.69
9.76	T	856.34	185.41	182.21	4.62	4.7
9.77	T	858.16	185.57	182.37	4.62	4.71
9.78	T	859.99	185.72	182.52	4.63	4.71
9.79	T	861.81	185.87	182.67	4.64	4.72

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
9.8	T	863.64	186.03	182.83	4.64	4.72
9.81	T	865.47	186.18	182.98	4.65	4.73
9.82	T	867.3	186.34	183.13	4.65	4.74
9.83	T	869.13	186.49	183.28	4.66	4.74
9.84	T	870.97	186.64	183.44	4.67	4.75
9.85	T	872.8	186.8	183.59	4.67	4.75
9.86	T	874.64	186.95	183.74	4.68	4.76
9.87	T	876.48	187.1	183.89	4.68	4.77
9.88	T	878.32	187.26	184.05	4.69	4.77
9.89	T	880.16	187.41	184.2	4.7	4.78
9.9	T	882	187.57	184.35	4.7	4.78
9.91	T	883.85	187.72	184.5	4.71	4.79
9.92	T	885.69	187.87	184.66	4.71	4.8
9.93	T	887.54	188.03	184.81	4.72	4.8
9.94	T	889.39	188.18	184.96	4.73	4.81
9.95	T	891.24	188.34	185.11	4.73	4.81
9.96	T	893.09	188.49	185.27	4.74	4.82
9.97	T	894.95	188.64	185.42	4.74	4.83
9.98	T	896.8	188.8	185.57	4.75	4.83
9.99	T	898.66	188.95	185.72	4.76	4.84
10	T	900.52	189.11	185.88	4.76	4.84
10.01	T	902.38	189.26	186.03	4.77	4.85
10.02	T	904.24	189.41	186.18	4.77	4.86
10.03	T	906.1	189.57	186.33	4.78	4.86
10.04	T	907.97	189.72	186.49	4.79	4.87
10.05	T	909.83	189.88	186.64	4.79	4.87
10.06	T	911.7	190.03	186.79	4.8	4.88
10.07	T	913.57	190.18	186.95	4.8	4.89
10.08	T	915.44	190.34	187.1	4.81	4.89
10.09	T	917.31	190.49	187.25	4.82	4.9
10.1	T	919.19	190.64	187.4	4.82	4.9
10.11	T	921.06	190.8	187.56	4.83	4.91
10.12	T	922.94	190.95	187.71	4.83	4.92
10.13	T	924.82	191.11	187.86	4.84	4.92
10.14	T	926.7	191.26	188.01	4.85	4.93
10.15	T	928.58	191.41	188.17	4.85	4.93
10.16	T	930.46	191.57	188.32	4.86	4.94
10.17	T	932.34	191.72	188.47	4.86	4.95
10.18	T	934.23	191.88	188.62	4.87	4.95
10.19	T	936.12	192.03	188.78	4.87	4.96
10.2	T	938.01	192.18	188.93	4.88	4.96
10.21	T	939.9	192.34	189.08	4.89	4.97
10.22	T	941.79	192.49	189.23	4.89	4.98
10.23	T	943.68	192.65	189.39	4.9	4.98
10.24	T	945.58	192.8	189.54	4.9	4.99

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10.25	T	947.47	192.95	189.69	4.91	4.99
10.26	T	949.37	193.11	189.84	4.92	5
10.27	T	951.27	193.26	190	4.92	5.01
10.28	T	953.17	193.42	190.15	4.93	5.01
10.29	T	955.08	193.57	190.3	4.93	5.02
10.3	T	956.98	193.72	190.46	4.94	5.02
10.31	T	958.89	193.88	190.61	4.95	5.03
10.32	T	960.79	194.03	190.76	4.95	5.04
10.33	T	962.7	194.19	190.91	4.96	5.04
10.34	T	964.61	194.34	191.07	4.96	5.05
10.35	T	966.52	194.49	191.22	4.97	5.05
10.36	T	968.44	194.65	191.37	4.98	5.06
10.37	T	970.35	194.8	191.52	4.98	5.07
10.38	T	972.27	194.95	191.68	4.99	5.07
10.39	T	974.19	195.11	191.83	4.99	5.08
10.4	T	976.11	195.26	191.98	5	5.08
10.41	T	978.03	195.42	192.13	5	5.09
10.42	T	979.95	195.57	192.29	5.01	5.1
10.43	T	981.87	195.72	192.44	5.02	5.1
10.44	T	983.8	195.88	192.59	5.02	5.11
10.45	T	985.73	196.03	192.74	5.03	5.11
10.46	T	987.65	196.19	192.9	5.03	5.12
10.47	T	989.58	196.34	193.05	5.04	5.13
10.48	T	991.52	196.49	193.2	5.05	5.13
10.49	T	993.45	196.65	193.36	5.05	5.14
10.5	T	995.38	196.82	193.52	5.06	5.14
10.51	T	997.32	196.99	193.69	5.06	5.15
10.52	T	999.26	197.16	193.86	5.07	5.15
10.53	T	1001.2	197.33	194.03	5.07	5.16
10.54	T	1003.14	197.5	194.2	5.08	5.17
10.55	T	1005.08	197.67	194.37	5.08	5.17
10.56	T	1007.03	197.84	194.53	5.09	5.18
10.57	T	1008.97	198	194.7	5.1	5.18
10.58	T	1010.92	198.17	194.87	5.1	5.19
10.59	T	1012.87	198.34	195.04	5.11	5.19
10.6	T	1014.82	198.51	195.21	5.11	5.2
10.61	T	1016.78	198.68	195.38	5.12	5.2
10.62	T	1018.73	198.85	195.54	5.12	5.21
10.63	T	1020.69	199.02	195.71	5.13	5.22
10.64	T	1022.65	199.19	195.88	5.13	5.22
10.65	T	1024.61	199.36	196.05	5.14	5.23
10.66	T	1026.57	199.53	196.22	5.14	5.23
10.67	T	1028.53	199.7	196.39	5.15	5.24
10.68	T	1030.5	199.87	196.55	5.16	5.24
10.69	T	1032.47	200.04	196.72	5.16	5.25

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10.7	T	1034.43	200.21	196.89	5.17	5.25
10.71	T	1036.4	200.38	197.06	5.17	5.26
10.72	T	1038.38	200.55	197.23	5.18	5.26
10.73	T	1040.35	200.72	197.4	5.18	5.27
10.74	T	1042.32	200.89	197.56	5.19	5.28
10.75	T	1044.3	201.06	197.73	5.19	5.28
10.76	T	1046.28	201.23	197.9	5.2	5.29
10.77	T	1048.26	201.4	198.07	5.2	5.29
10.78	T	1050.24	201.57	198.24	5.21	5.3
10.79	T	1052.23	201.74	198.41	5.22	5.3
10.8	T	1054.21	201.9	198.57	5.22	5.31
10.81	T	1056.2	202.07	198.74	5.23	5.31
10.82	T	1058.19	202.24	198.91	5.23	5.32
10.83	T	1060.18	202.41	199.08	5.24	5.33
10.84	T	1062.17	202.58	199.25	5.24	5.33
10.85	T	1064.16	202.75	199.42	5.25	5.34
10.86	T	1066.16	202.92	199.58	5.25	5.34
10.87	T	1068.16	203.09	199.75	5.26	5.35
10.88	T	1070.15	203.26	199.92	5.26	5.35
10.89	T	1072.15	203.43	200.09	5.27	5.36
10.9	T	1074.16	203.6	200.26	5.28	5.36
10.91	T	1076.16	203.77	200.43	5.28	5.37
10.92	T	1078.17	203.94	200.6	5.29	5.37
10.93	T	1080.17	204.11	200.76	5.29	5.38
10.94	T	1082.18	204.28	200.93	5.3	5.39
10.95	T	1084.19	204.45	201.1	5.3	5.39
10.96	T	1086.21	204.62	201.27	5.31	5.4
10.97	T	1088.22	204.79	201.44	5.31	5.4
10.98	T	1090.23	204.96	201.61	5.32	5.41
10.99	T	1092.25	205.13	201.77	5.32	5.41
11	T	1094.27	205.3	201.94	5.33	5.42
11.01	T	1096.29	205.47	202.11	5.34	5.42
11.02	T	1098.31	205.63	202.28	5.34	5.43
11.03	T	1100.34	205.8	202.45	5.35	5.44
11.04	T	1102.36	205.97	202.62	5.35	5.44
11.05	T	1104.39	206.14	202.78	5.36	5.45
11.06	T	1106.42	206.45	203.09	5.36	5.45
11.07	T	1108.47	209.85	206.49	5.28	5.37
11.08	T	1110.55	213.25	209.88	5.21	5.29
11.09	T	1112.67	216.65	213.28	5.14	5.22
11.1	T	1114.82	219.92	216.55	5.07	5.15
11.11	T	1116.99	220.18	216.81	5.07	5.15
11.12	T	1119.16	220.44	217.07	5.08	5.16
11.13	T	1121.33	220.71	217.33	5.08	5.16
11.14	T	1123.5	220.97	217.59	5.08	5.16

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
11.15	T	1125.68	221.23	217.85	5.09	5.17
11.16	T	1127.86	221.5	218.11	5.09	5.17
11.17	T	1130.04	221.76	218.37	5.1	5.17
11.18	T	1132.23	222.02	218.63	5.1	5.18
11.19	T	1134.42	222.29	218.89	5.1	5.18
11.2	T	1136.61	222.55	219.15	5.11	5.19
11.21	T	1138.8	222.81	219.41	5.11	5.19
11.22	T	1141	223.08	219.67	5.11	5.19
11.23	T	1143.19	223.34	219.93	5.12	5.2
11.24	T	1145.4	223.61	220.19	5.12	5.2
11.25	T	1147.6	223.87	220.45	5.13	5.21
11.26	T	1149.81	224.13	220.71	5.13	5.21
11.27	T	1152.01	224.4	220.97	5.13	5.21
11.28	T	1154.23	224.66	221.23	5.14	5.22
11.29	T	1156.44	224.92	221.49	5.14	5.22
11.3	T	1158.66	225.21	221.78	5.14	5.22
11.31	T	1160.88	226.05	222.61	5.14	5.21
11.32	T	1163.11	226.88	223.44	5.13	5.21
11.33	T	1165.35	227.72	224.27	5.12	5.2
11.34	T	1167.6	228.55	225.1	5.11	5.19
11.35	T	1169.85	229.39	225.93	5.1	5.18
11.36	T	1172.12	230.22	226.77	5.09	5.17
11.37	T	1174.39	231.06	227.6	5.08	5.16
11.38	T	1176.67	231.89	228.43	5.07	5.15
11.39	T	1178.96	232.73	229.26	5.07	5.14
11.4	T	1181.26	233.56	230.09	5.06	5.13
11.41	T	1183.56	234.4	230.93	5.05	5.13
11.42	T	1185.87	235.23	231.76	5.04	5.12
11.43	T	1188.2	236.06	232.59	5.03	5.11
11.44	T	1190.53	236.9	233.42	5.03	5.1
11.45	T	1192.87	237.73	234.25	5.02	5.09
11.46	T	1195.21	238.57	235.09	5.01	5.08
11.47	T	1197.57	239.4	235.92	5	5.08
11.48	T	1199.93	240.24	236.75	4.99	5.07
11.49	T	1202.3	241.07	237.58	4.99	5.06
11.5	T	1204.68	241.79	238.29	4.98	5.06
11.51	T	1207.07	241.86	238.35	4.99	5.06
11.52	T	1209.45	241.92	238.4	5	5.07
11.53	T	1211.84	241.99	238.46	5.01	5.08
11.54	T	1214.22	242.05	238.51	5.02	5.09
11.55	T	1216.61	242.12	238.57	5.02	5.1
11.56	T	1219	242.18	238.62	5.03	5.11
11.57	T	1221.38	242.25	238.68	5.04	5.12
11.58	T	1223.77	242.32	238.73	5.05	5.13
11.59	T	1226.16	242.38	238.79	5.06	5.13

******************************WinXSPRO********************************
C:\WinXSPro\LowPool2.out
Input File: C:\WinXSPro\LowPool.sec
Run Date: 10/17/14
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 9/08/14

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
10.9	T	1056.94	165.55	158.57	6.38	6.67
10.91	T	1058.53	165.62	158.63	6.39	6.67
10.92	T	1060.11	165.7	158.68	6.4	6.68
10.93	T	1061.7	165.77	158.73	6.4	6.69
10.94	T	1063.29	165.85	158.79	6.41	6.7
10.95	T	1064.88	165.92	158.84	6.42	6.7
10.96	T	1066.47	166	158.9	6.42	6.71
10.97	T	1068.05	166.13	159.02	6.43	6.72
10.98	T	1069.65	166.27	159.14	6.43	6.72
10.99	T	1071.24	166.4	159.26	6.44	6.73
11	T	1072.83	166.54	159.38	6.44	6.73
11.01	T	1074.43	166.68	159.5	6.45	6.74
11.02	T	1076.02	166.81	159.63	6.45	6.74
11.03	T	1077.62	166.95	159.76	6.45	6.75
11.04	T	1079.22	167.09	159.89	6.46	6.75
11.05	T	1080.82	167.23	160.01	6.46	6.75
11.06	T	1082.42	167.36	160.14	6.47	6.76
11.07	T	1084.02	167.5	160.27	6.47	6.76
11.08	T	1085.63	167.64	160.39	6.48	6.77
11.09	T	1087.23	167.78	160.52	6.48	6.77
11.1	T	1088.84	167.91	160.65	6.48	6.78
11.11	T	1090.44	168.05	160.78	6.49	6.78
11.12	T	1092.05	168.19	160.9	6.49	6.79
11.13	T	1093.66	168.33	161.03	6.5	6.79
11.14	T	1095.27	168.46	161.16	6.5	6.8

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
11.15	T	1096.89	168.6	161.29	6.51	6.8
11.16	T	1098.5	168.74	161.41	6.51	6.81
11.17	T	1100.12	168.88	161.54	6.51	6.81
11.18	T	1101.73	169.01	161.67	6.52	6.81
11.19	T	1103.35	169.15	161.79	6.52	6.82
11.2	T	1104.97	169.29	161.92	6.53	6.82
11.21	T	1106.59	169.42	162.05	6.53	6.83
11.22	T	1108.21	169.56	162.18	6.54	6.83
11.23	T	1109.83	169.7	162.3	6.54	6.84
11.24	T	1111.46	169.84	162.43	6.54	6.84
11.25	T	1113.08	169.97	162.56	6.55	6.85
11.26	T	1114.71	170.11	162.69	6.55	6.85
11.27	T	1116.34	170.25	162.81	6.56	6.86
11.28	T	1117.97	170.39	162.94	6.56	6.86
11.29	T	1119.6	170.52	163.07	6.57	6.87
11.3	T	1121.23	170.66	163.19	6.57	6.87
11.31	T	1122.86	170.79	163.31	6.57	6.88
11.32	T	1124.49	170.92	163.42	6.58	6.88
11.33	T	1126.13	171.05	163.53	6.58	6.89
11.34	T	1127.77	171.17	163.64	6.59	6.89
11.35	T	1129.4	171.3	163.75	6.59	6.9
11.36	T	1131.04	171.43	163.86	6.6	6.9
11.37	T	1132.68	171.56	163.97	6.6	6.91
11.38	T	1134.32	171.69	164.08	6.61	6.91
11.39	T	1135.96	171.82	164.19	6.61	6.92
11.4	T	1137.61	171.95	164.31	6.62	6.92
11.41	T	1139.25	172.07	164.42	6.62	6.93
11.42	T	1140.9	172.2	164.53	6.63	6.93
11.43	T	1142.54	172.28	164.59	6.63	6.94
11.44	T	1144.19	172.37	164.66	6.64	6.95
11.45	T	1145.84	172.45	164.72	6.64	6.96
11.46	T	1147.48	172.53	164.79	6.65	6.96
11.47	T	1149.13	172.62	164.85	6.66	6.97
11.48	T	1150.78	172.7	164.92	6.66	6.98
11.49	T	1152.43	172.78	164.98	6.67	6.99
11.5	T	1154.08	172.87	165.04	6.68	6.99
11.51	T	1155.73	172.99	165.14	6.68	7
11.52	T	1157.38	173.1	165.25	6.69	7
11.53	T	1159.04	173.22	165.35	6.69	7.01
11.54	T	1160.69	173.34	165.45	6.7	7.02
11.55	T	1162.35	173.46	165.55	6.7	7.02
11.56	T	1164	173.58	165.65	6.71	7.03
11.57	T	1165.66	173.7	165.75	6.71	7.03
11.58	T	1167.32	173.81	165.85	6.72	7.04
11.59	T	1168.98	173.93	165.95	6.72	7.04

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
11.6	T	1170.64	174.05	166.05	6.73	7.05
11.61	T	1172.3	174.17	166.15	6.73	7.06
11.62	T	1173.96	174.29	166.25	6.74	7.06
11.63	T	1175.63	174.41	166.35	6.74	7.07
11.64	T	1177.29	174.52	166.45	6.75	7.07
11.65	T	1178.96	174.64	166.55	6.75	7.08
11.66	T	1180.62	174.76	166.65	6.76	7.08
11.67	T	1182.29	174.88	166.75	6.76	7.09
11.68	T	1183.96	175	166.85	6.77	7.1
11.69	T	1185.63	175.12	166.95	6.77	7.1
11.7	T	1187.3	175.23	167.05	6.78	7.11
11.71	T	1188.97	175.35	167.15	6.78	7.11
11.72	T	1190.64	175.47	167.25	6.79	7.12
11.73	T	1192.32	175.59	167.35	6.79	7.12
11.74	T	1193.99	175.71	167.45	6.8	7.13
11.75	T	1195.66	175.82	167.55	6.8	7.14
11.76	T	1197.34	175.94	167.65	6.81	7.14
11.77	T	1199.02	176.06	167.75	6.81	7.15
11.78	T	1200.7	176.18	167.85	6.82	7.15
11.79	T	1202.38	176.3	167.96	6.82	7.16
11.8	T	1204.06	176.42	168.06	6.83	7.16
11.81	T	1205.74	176.53	168.16	6.83	7.17
11.82	T	1207.42	176.65	168.26	6.83	7.18
11.83	T	1209.1	176.77	168.36	6.84	7.18
11.84	T	1210.79	176.89	168.46	6.84	7.19
11.85	T	1212.47	177.01	168.56	6.85	7.19
11.86	T	1214.16	177.13	168.66	6.85	7.2
11.87	T	1215.85	177.24	168.76	6.86	7.2
11.88	T	1217.54	177.36	168.86	6.86	7.21
11.89	T	1219.23	177.48	168.96	6.87	7.22
11.9	T	1220.92	177.6	169.06	6.87	7.22
11.91	T	1222.61	177.72	169.16	6.88	7.23
11.92	T	1224.3	177.84	169.26	6.88	7.23
11.93	T	1225.99	177.95	169.36	6.89	7.24
11.94	T	1227.69	178.07	169.46	6.89	7.24
11.95	T	1229.38	178.19	169.56	6.9	7.25
11.96	T	1231.08	178.31	169.66	6.9	7.26
11.97	T	1232.78	178.43	169.76	6.91	7.26
11.98	T	1234.48	178.55	169.86	6.91	7.27
11.99	T	1236.18	178.66	169.96	6.92	7.27
12	T	1237.88	178.78	170.06	6.92	7.28
12.01	T	1239.58	178.9	170.16	6.93	7.28
12.02	T	1241.28	179.02	170.26	6.93	7.29
12.03	T	1242.98	179.14	170.36	6.94	7.3
12.04	T	1244.69	179.26	170.46	6.94	7.3

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
12.05	T	1246.39	179.37	170.56	6.95	7.31
12.06	T	1248.1	179.49	170.67	6.95	7.31
12.07	T	1249.81	179.61	170.77	6.96	7.32
12.08	T	1251.52	179.73	170.87	6.96	7.32
12.09	T	1253.23	179.85	170.97	6.97	7.33
12.1	T	1254.94	179.96	171.07	6.97	7.34
12.11	T	1256.65	180.08	171.17	6.98	7.34
12.12	T	1258.36	180.2	171.27	6.98	7.35
12.13	T	1260.07	180.32	171.37	6.99	7.35
12.14	T	1261.79	180.44	171.47	6.99	7.36
12.15	T	1263.5	180.56	171.57	7	7.36
12.16	T	1265.22	180.67	171.67	7	7.37
12.17	T	1266.94	180.79	171.77	7.01	7.38
12.18	T	1268.66	180.91	171.87	7.01	7.38
12.19	T	1270.38	181.03	171.97	7.02	7.39
12.2	T	1272.1	181.15	172.07	7.02	7.39
12.21	T	1273.82	181.27	172.17	7.03	7.4
12.22	T	1275.54	181.38	172.27	7.03	7.4
12.23	T	1277.26	181.5	172.37	7.04	7.41
12.24	T	1278.99	181.62	172.47	7.04	7.42
12.25	T	1280.71	181.74	172.57	7.05	7.42
12.26	T	1282.44	181.86	172.67	7.05	7.43
12.27	T	1284.17	181.98	172.77	7.06	7.43
12.28	T	1285.9	182.09	172.87	7.06	7.44
12.29	T	1287.63	182.21	172.97	7.07	7.44
12.3	T	1289.36	182.33	173.07	7.07	7.45
12.31	T	1291.09	182.45	173.17	7.08	7.46
12.32	T	1292.82	182.57	173.27	7.08	7.46
12.33	T	1294.56	182.69	173.38	7.09	7.47
12.34	T	1296.29	182.8	173.48	7.09	7.47
12.35	T	1298.03	182.92	173.58	7.1	7.48
12.36	T	1299.76	183.04	173.68	7.1	7.48
12.37	T	1301.5	183.16	173.78	7.11	7.49
12.38	T	1303.24	183.28	173.88	7.11	7.5
12.39	T	1304.98	183.4	173.98	7.12	7.5
12.4	T	1306.72	183.51	174.08	7.12	7.51
12.41	T	1308.46	183.63	174.18	7.13	7.51
12.42	T	1310.2	183.75	174.28	7.13	7.52
12.43	T	1311.95	183.87	174.38	7.14	7.52
12.44	T	1313.69	183.99	174.48	7.14	7.53
12.45	T	1315.44	184.1	174.58	7.15	7.53
12.46	T	1317.18	184.22	174.68	7.15	7.54
12.47	T	1318.93	184.34	174.78	7.15	7.55
12.48	T	1320.68	184.46	174.88	7.16	7.55
12.49	T	1322.43	184.58	174.98	7.16	7.56

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
12.5	T	1324.18	184.7	175.08	7.17	7.56
12.51	T	1325.93	184.81	175.18	7.17	7.57
12.52	T	1327.68	184.93	175.28	7.18	7.57
12.53	T	1329.44	185.05	175.39	7.18	7.58
12.54	T	1331.19	185.26	175.58	7.19	7.58
12.55	T	1332.95	185.46	175.77	7.19	7.58
12.56	T	1334.71	185.67	175.96	7.19	7.59
12.57	T	1336.47	185.87	176.15	7.19	7.59
12.58	T	1338.23	186.08	176.34	7.19	7.59
12.59	T	1340	186.28	176.54	7.19	7.59
12.6	T	1341.77	186.49	176.73	7.19	7.59
12.61	T	1343.53	186.69	176.92	7.2	7.59
12.62	T	1345.3	186.9	177.11	7.2	7.6
12.63	T	1347.08	187.1	177.3	7.2	7.6
12.64	T	1348.85	187.31	177.49	7.2	7.6
12.65	T	1350.63	187.51	177.69	7.2	7.6
12.66	T	1352.41	187.72	177.88	7.2	7.6
12.67	T	1354.19	187.92	178.07	7.21	7.6
12.68	T	1355.97	188.13	178.26	7.21	7.61
12.69	T	1357.75	188.33	178.45	7.21	7.61
12.7	T	1359.54	188.54	178.64	7.21	7.61
12.71	T	1361.33	188.74	178.84	7.21	7.61
12.72	T	1363.11	188.95	179.03	7.21	7.61
12.73	T	1364.91	189.15	179.22	7.22	7.62
12.74	T	1366.7	189.36	179.41	7.22	7.62
12.75	T	1368.5	189.58	179.62	7.22	7.62
12.76	T	1370.29	189.8	179.83	7.22	7.62
12.77	T	1372.09	190.03	180.04	7.22	7.62
12.78	T	1373.89	190.25	180.25	7.22	7.62
12.79	T	1375.7	190.47	180.45	7.22	7.62
12.8	T	1377.5	190.69	180.66	7.22	7.62
12.81	T	1379.31	190.91	180.87	7.22	7.63
12.82	T	1381.12	191.13	181.08	7.23	7.63
12.83	T	1382.94	191.36	181.29	7.23	7.63
12.84	T	1384.75	191.58	181.5	7.23	7.63
12.85	T	1386.57	191.8	181.71	7.23	7.63
12.86	T	1388.38	192.02	181.91	7.23	7.63
12.87	T	1390.2	192.24	182.12	7.23	7.63
12.88	T	1392.03	192.46	182.33	7.23	7.63
12.89	T	1393.85	192.69	182.54	7.23	7.64
12.9	T	1395.68	192.91	182.75	7.23	7.64
12.91	T	1397.51	193.13	182.96	7.24	7.64
12.92	T	1399.34	193.35	183.17	7.24	7.64
12.93	T	1401.17	193.57	183.37	7.24	7.64
12.94	T	1403.01	193.79	183.58	7.24	7.64

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)
12.95	T	1404.84	194.02	183.79	7.24	7.64
12.96	T	1406.68	194.24	184	7.24	7.65
12.97	T	1408.53	194.46	184.21	7.24	7.65
12.98	T	1410.37	194.68	184.42	7.24	7.65
12.99	T	1412.21	194.9	184.62	7.25	7.65
13	T	1414.06	195.12	184.83	7.25	7.65
13.01	T	1415.91	195.35	185.04	7.25	7.65
13.02	T	1417.76	195.57	185.25	7.25	7.65
13.03	T	1419.62	195.79	185.46	7.25	7.65
13.04	T	1421.47	196.01	185.67	7.25	7.66
13.05	T	1423.33	196.23	185.88	7.25	7.66
13.06	T	1425.19	196.45	186.08	7.25	7.66
13.07	T	1427.05	196.68	186.29	7.26	7.66
13.08	T	1428.92	196.9	186.5	7.26	7.66
13.09	T	1430.79	197.12	186.71	7.26	7.66
13.1	T	1432.65	197.34	186.92	7.26	7.66
13.11	T	1434.52	197.56	187.13	7.26	7.67
13.12	T	1436.4	197.78	187.34	7.26	7.67
13.13	T	1438.27	198.01	187.54	7.26	7.67
13.14	T	1440.15	198.23	187.75	7.27	7.67
13.15	T	1442.03	198.45	187.96	7.27	7.67
13.16	T	1443.91	198.67	188.17	7.27	7.67
13.17	T	1445.79	198.89	188.38	7.27	7.67
13.18	T	1447.68	199.11	188.59	7.27	7.68
13.19	T	1449.56	199.34	188.79	7.27	7.68
13.2	T	1451.45	199.55	188.99	7.27	7.68
13.21	T	1453.34	199.58	189.02	7.28	7.69
13.22	T	1455.23	199.62	189.04	7.29	7.7
13.23	T	1457.13	199.65	189.06	7.3	7.71
13.24	T	1459.02	199.69	189.09	7.31	7.72
13.25	T	1460.91	199.72	189.11	7.31	7.73
13.26	T	1462.8	199.76	189.13	7.32	7.73
13.27	T	1464.69	199.79	189.16	7.33	7.74
13.28	T	1466.58	199.83	189.18	7.34	7.75
13.29	T	1468.48	199.86	189.2	7.35	7.76
13.3	T	1470.37	199.88	189.2	7.36	7.77
13.31	T	1472.26	199.9	189.2	7.36	7.78
13.32	T	1474.15	199.92	189.2	7.37	7.79
13.33	T	1476.05	199.94	189.2	7.38	7.8
13.34	T	1477.94	199.96	189.2	7.39	7.81
13.35	T	1479.83	199.98	189.2	7.4	7.82
13.36	T	1481.72	200	189.2	7.41	7.83
13.37	T	1483.62	200.02	189.2	7.42	7.84
13.38	T	1485.51	200.04	189.2	7.43	7.85
13.39	T	1487.4	200.06	189.2	7.43	7.86

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Gilpatrick Photographs

September 8, 2014

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Riffle (Alternative 1)
Riffle (Alternative 2)
Pool
Pool (Additional Option)
Riffle (Additional Option)
Run (Additional Option)
Run
Riffle
Pool


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Greys Photographs

September 8, 2014

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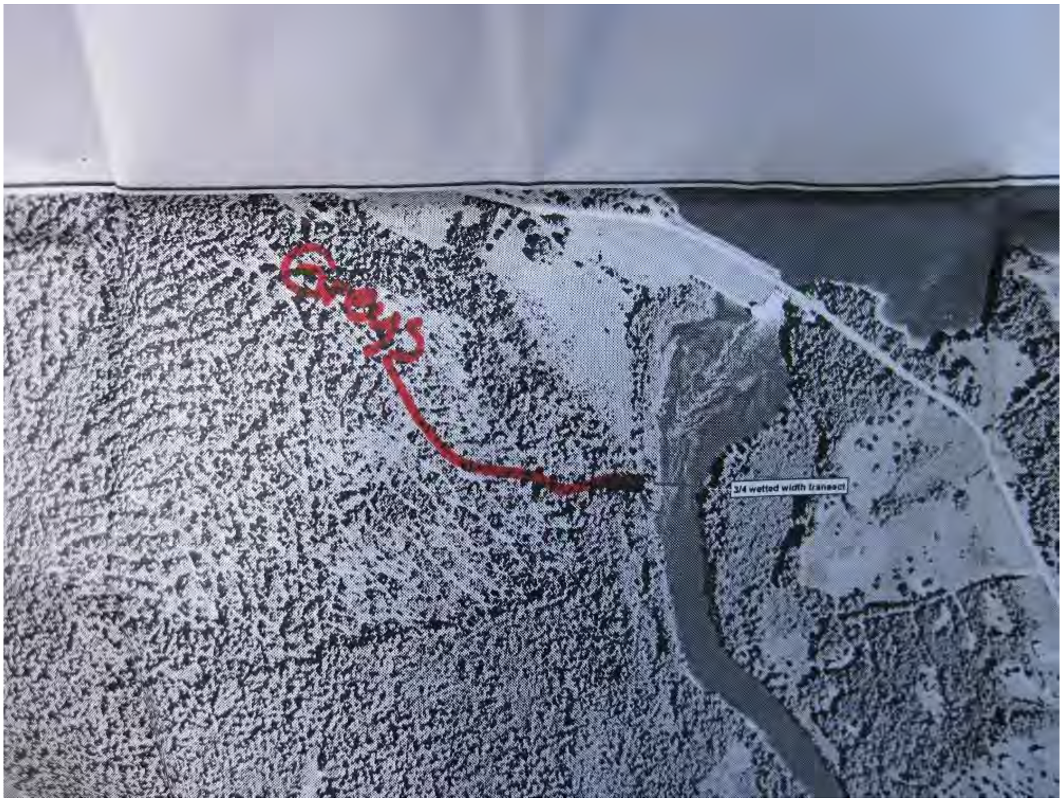
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Moore Photographs

September 8, 2014

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Moore


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Shackford Photographs

September 8, 2014

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APPENDIX E-5

TURBINE INTAKE AND FISHWAY ENTRANCE WATER VELOCITY MEASUREMENTS

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MEMORANDUM	
TO:	Frank Dunlap, Licensing Specialist, Black Bear Hydro Partners LLC
FROM:	Jesse Wechsler, Fish and Aquatic Scientist, Kleinschmidt
DATE:	December 24, 2015
RE:	Turbine Intake and Downstream Fishway Entrance Water Velocity Measurements Ellsworth Hydroelectric Project (FERC No. 2727), Ellsworth, Maine

INTRODUCTION

The Ellsworth Project is located on the Union River in Maine, approximately 5 river kilometers (3.1 miles) upstream of Union River Bay and the Atlantic Ocean. Black Bear Hydro Partners LLC (Black Bear), an affiliate of the Brookfield Renewable Energy Group, operates the Ellsworth Project pursuant to the license issued by the Federal Energy Regulatory Commission (FERC) in 1987. The license expires on December 31, 2017; therefore, Black Bear is filing an application to FERC to relicense the Ellsworth Project. The Ellsworth Project consists of the Ellsworth dam, which forms Lake Leonard, and Graham Lake dam, which forms Graham Lake. Black Bear generates clean, renewable hydroelectric energy at the Ellsworth dam with four turbine/generator units with a total licensed nameplate capacity of 8.9 megawatts (MW).

Several migratory fish species currently occur in the Union River, including American eel and sea-run alewives; Atlantic salmon also occur but are uncommon. Black Bear provides downstream fish passage at the Ellsworth dam through three 3-foot-wide surface-weirs. Two of the weirs are located at the west powerhouse intake to Units 2, 3, and 4; the third entrance is located at the east powerhouse intake near Unit 1 (Figure 1). Fish that enter the two weirs at the west powerhouse intake are conveyed within an 18-inch-diameter pipe that crosses the downstream face of the non-overflow section of dam and powerhouse and discharges into a flume just below the dam crest elevation; the flume discharges in the tailrace (Figure 1). Each weir is opened approximately 21 inches and passes approximately 20 cubic feet a second (cfs) during the downstream fish passage season.

As part of the Initial Study Report (ISR),[1] Black Bear compared estimates of intake velocity in front of the trashracks to the swimming speed of American eel, Atlantic salmon, and river herring to evaluate the risk of entrainment through the intakes and impingement. Black Bear estimated the intake velocity by dividing the hydraulic capacity of each turbine by the gross area of each trashrack. This is a standard method for estimating intake velocity. In their December 30, 2014, Study Plan Determination, FERC noted that variation in trashrack spacing in combination with flows through the downstream fish bypass entrances could create an intake velocity field that may not be calculated accurately using turbine flow capacity and gross intake dimensions.[2] To verify the velocity of the water in front of the intakes, FERC requested that Black Bear conduct field measurements across the intake surfaces and at the three entrances of the Ellsworth dam downstream fish bypass. The National Marine Fisheries Service (NMFS) also recommended in its November 3, 2014, filing that Black Bear collect empirical measurements of velocities in front of the intakes to help understand entrainment risk at the Ellsworth Project.[3]

[1] Submitted to FERC on September 4, 2014.
[2] December 30, 2014 Determination on Requests for Study Modifications and New Studies for the Ellsworth Hydroelectric Project.
[3] November 3, 2014 Comments, Request for Study Clarification, and Modification regarding Black Bear Hydro Partners September 4, 2014 Initial Study Report for the Ellsworth Hydroelectric Project.

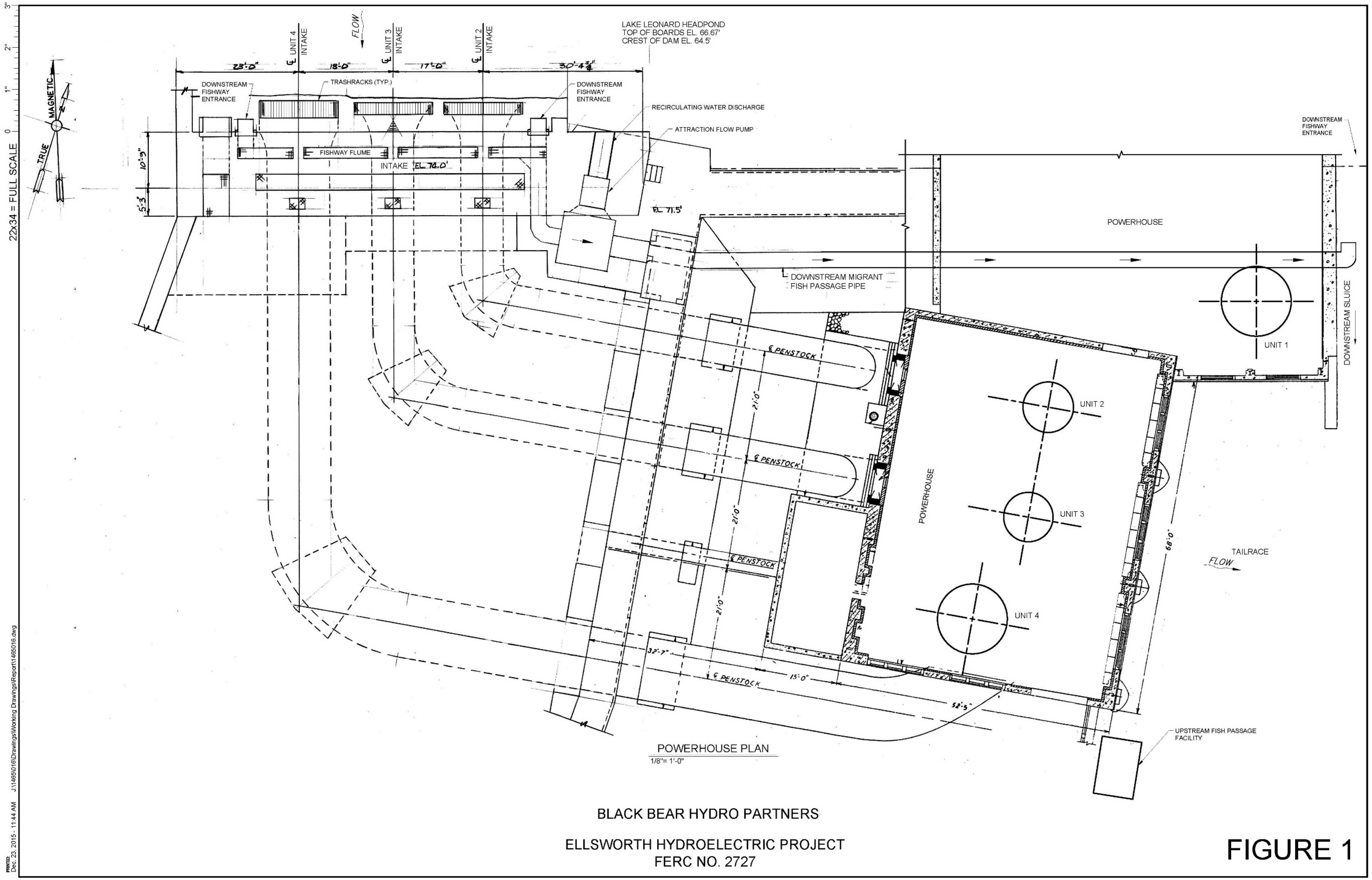

FIGURE 1 **PLAN VIEW OF THE ELLSWORTH INTAKES AND DOWNSTREAM FISH BYPASS ENTRANCES, UNION RIVER, ELLSWORTH, MAINE**

The top of the trashracks at the Ellsworth dam start at an elevation of approximately 60.7', approximately 6.0' below the normal full pond elevation of Leonard Lake, elevation 66.7'. (Figure 2). The bottom of the trashracks for unit 4 is at approximately 45.0' (Figure 2). The clear-bar rack spacing of the trashracks differs amongst the four turbine intakes at the Ellsworth dam.[4] The vertical bars of the trashrack in front of Unit 1 are spaced at 2.44 inches; the vertical bars in front of Units 2, 3, and 4 are spaced at 1 inch in the upper section and then increase to 2.37 inches at 14.0' of water depth (compared to a normal head pond elevation of 66.7'). Black Bear cleans debris from the trashracks in front of Units 2, 3, and 4 with a rail-mounted hydraulic trashrake. In the ISR, Black Bear calculated the average velocity in front of the trashracks to be 2.97 feet per second (fps) in front of Unit 2 and Unit 3; 2.79 fps in front of Unit 4, and 1.16 fps in front of Unit 1.

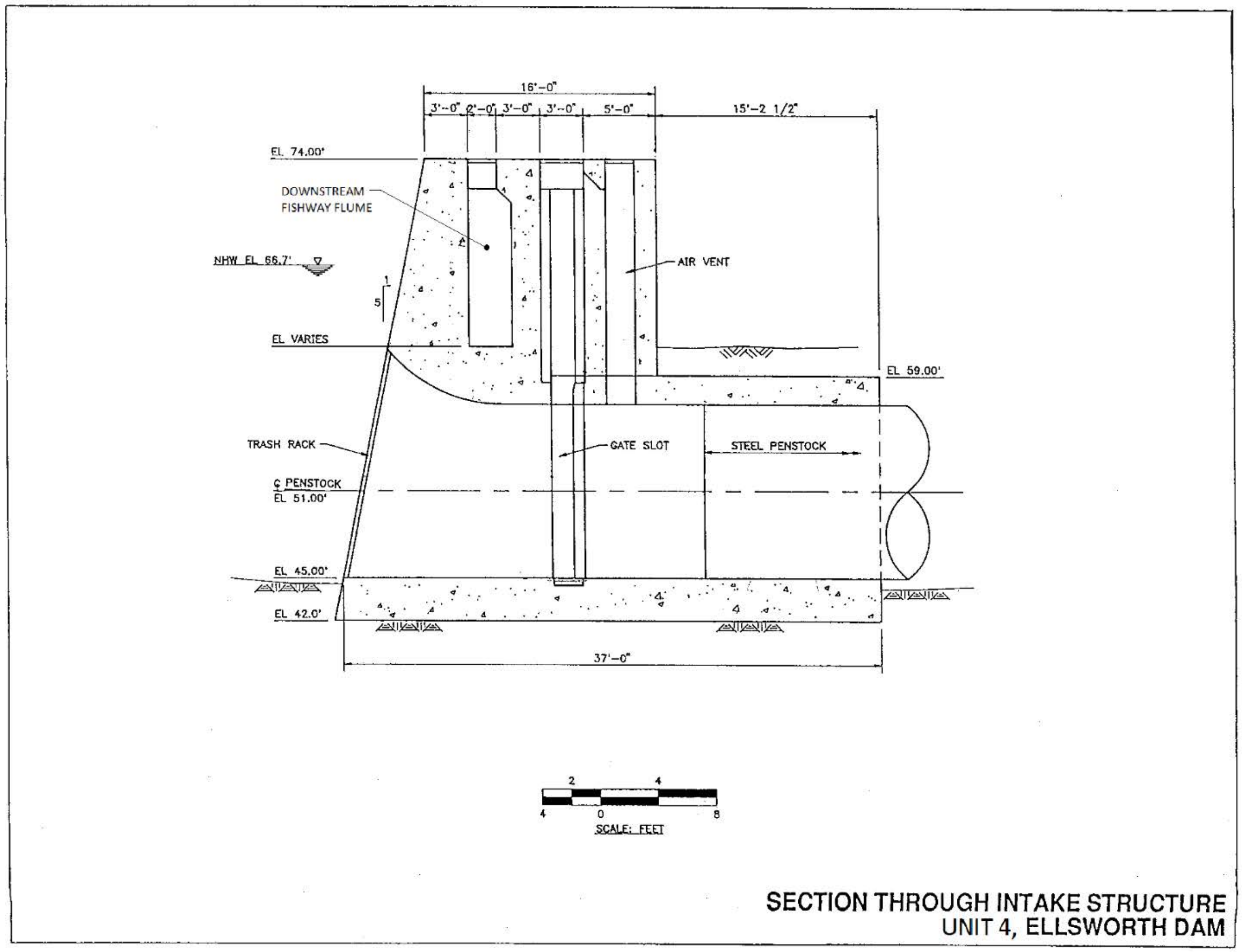

FIGURE 2 CROSS-SECTION THROUGH THE UNIT 4 INTAKE AT THE ELLSWORTH DAM

[4] All references to the spacing between the trashrack bars are to the "clear" space between the bars.

METHODS

Researchers mounted a Marsh McBirney digital flow meter to the trashrake at the Ellsworth dam to measure water velocity in front of Units 2, 3, and 4. The sensor probe was attached to a small frame mounted directly to the trashrake (Photo 1). The trashrake was lowered vertically in the water column and moved horizontally across the rack face during data collection. This method has been used successfully at other FERC-licensed hydroelectric projects in recent years to measure water velocity in front of the intakes of hydropower facilities (e.g., Anson Project, FERC No. 2365; Grandfather Falls Project, FERC No. 1966). The sensor was positioned approximately 3 feet upstream of the trashrack.

PHOTO 1 TRASHRAKE AT ELLSWORTH DAM WITH MOUNTED VELOCITY PROBE, OCTOBER 2015

Researchers measured water velocity at 2.5-foot intervals from a water depth of 5.0 feet to a water depth of approximately 20.0 feet. These measurements were then repeated at approximately 3.0-foot intervals across the horizontal faces of the trashracks at Units 2, 3, and 4. Researchers also measured water velocity with a pole-mounted Marsh McBirney flow meter at six positions in each entrance of the three downstream fish bypass weirs. Velocity measurements were taken at least twice at each position along the face of the trashrack and in the fishway entrances. Each single velocity measurement was equivalent to the composite average over 15 seconds. Measurements were then averaged to arrive at a single value. Black Bear operated all three units at or near maximum generation during the measurements (Table 1).

TABLE 1 GENERATION AND FLOW THROUGH THE UNITS DURING VELOCITY MEASUREMENTS, ELLSWORTH PROJECT

UNIT NUMBER	GENERATION (MEGAWATTS)	GATE OPENING (PERCENT)	APPROXIMATE FLOW (CFS)
2	2.10	86.6	480
3	1.95	94.3	430
4	2.70	95.0	640

Researchers did not measure water velocity in front of the Unit 1 intake because it is only accessible by diving. Velocity measurements at Unit 4 are considered to be representative of the velocity in front of Unit 1 because of the similarity between the units; both are fixed-propeller units of equal size. Researchers did not take measurements across the last 6 feet of the Unit 2 intake because a head pond transducer mounted there prevents access by the rack rake; therefore, the velocity probe could not be deployed in that area.

RESULTS

Researchers took 240 water velocity measurements at 93 discrete positions in front of the trashracks at Units 2, 3, and 4. Average water velocity ranged from -0.13 to 2.43 fps (Figure 3 and Table 2). The maximum average water velocity measurement ranged from 2.08 fps (Unit 3) to 2.43 fps (Unit 4) (Table 2). The minimum average water velocity measurement in front of the trashracks ranged from -0.13 fps (Unit 3) to 0.49 fps (Unit 4) (Table 2). These low values were recorded near the interface of the upper sections of the trashracks and the submerged concrete wall, where a noticeable backwater occurs. Figure 3 shows the velocity measurements and the positions where the measurements were taken across the face of the racks.

TABLE 2 SUMMARY OF INTAKE WATER VELOCITY MEASUREMENTS, ELLSWORTH PROJECT

UNIT NUMBER	2	3	4	ALL 3
Number of positions on rack face	22	36	35	93
Minimum average velocity measurement (fps)	0.10	-0.13	0.49	-0.13
Maximum average velocity measurement (fps)	2.27	2.08	2.43	2.43

The average water velocity measurements were less than 2.49 fps at all positions in front of the trashracks (Table 3). Most average water velocity values were between 1.50 and 1.99 fps (n=29, or 31.2 percent), followed by values between 1.00 and 1.49 fps (n=20, or 21.5 percent), values between 0.5 and 0.99 fps (n=19, or 20.4 percent), values less than 0.49 fps (n=13, or 14.0 percent), and values between 2.00 and 2.49 fps (n=12, or 12.9 percent). Table 3 shows the count, relative percentage, cumulative count, and cumulative percentage of all 93 average water velocity values.

TABLE 3 FREQUENCY DISTRIBUTION OF VELOCITY MEASUREMENTS AT THE TURBINE INTAKES, ELLSWORTH PROJECT

RANGE OF VELOCITY MEASUREMENTS (FPS)	TOTAL COUNT	RELATIVE PERCENTAGE	CUMULATIVE COUNT	CUMULATIVE PERCENTAGE
< 0.49	13	14.0%	13	14.0%
0.5 to 0.99	19	20.4%	32	34.4%
1.00 to 1.49	20	21.5%	52	55.9%
1.50 to 1.99	29	31.2%	81	87.1%
2.00 to 2.49	12	12.9%	93	100.0%
> 2.49	0	0.0%	-	-
Total	93	100.0%		

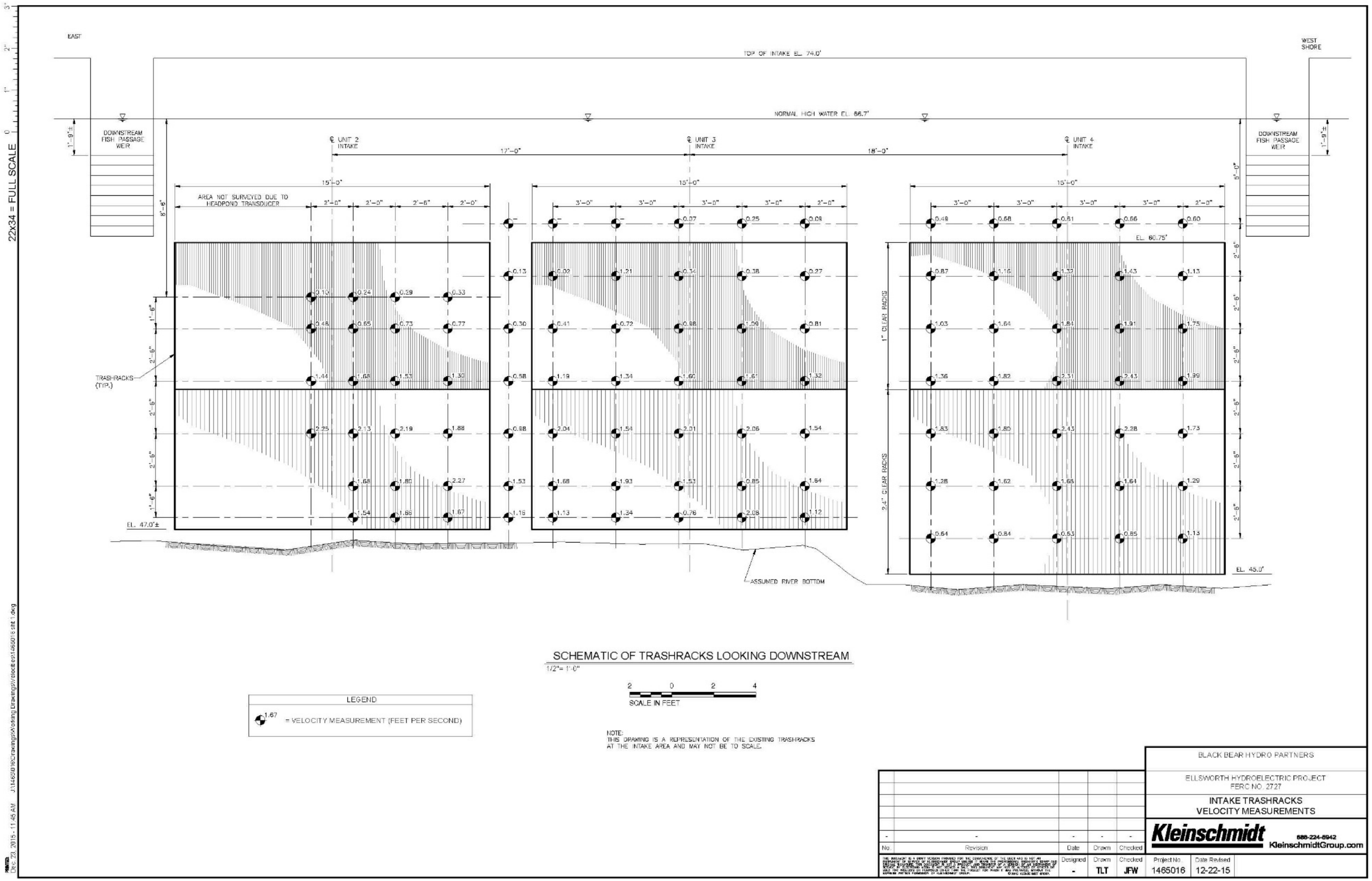

FIGURE 3 **INTAKE VELOCITY MEASUREMENTS AT THE ELLSWORTH DAM, ELLSWORTH, MAINE**

Researchers also measured water velocity at 18 discrete positions in or near the entrances of the three downstream fishway weirs. Water velocity ranged from 0.9 to 3.8 fps; water velocities were notably faster at the entrance near Unit 1 (Table 4). The depth of the measurements ranged from 6 to 24 inches (Table 4).

TABLE 4 WATER VELOCITY MEASUREMENTS IN THE FISH BYPASS ENTRANCES, ELLSWORTH PROJECT

FISHWAY ENTRANCE 1 (NEAR UNIT 1)				
	Depth(ft)	***Velocity(fps)***	***Depth(ft)***	***Velocity(fps)***
Left Side	0.5	3.8	1.5	2.31
Middle	0.5	3.7	1.5	2.34
Right Side	0.5	3.6	1.5	2.41
Average	**-**	**3.7**	**-**	**2.35**
FISHWAY ENTRANCE 2 (NEAR UNIT 2)				
	Depth(ft)	***Velocity(fps)***	***Depth(ft)***	***Velocity(fps)***
Left Side	0.5	1.1	2.0	1.0
Middle	0.5	0.9	2.0	0.9
Right Side	0.5	1.3	2.0	0.7
Average	**-**	**1.1**	**-**	**0.8**
FISHWAY ENTRANCE 3 (NEAR UNIT 4)				
	Depth(ft)	***Velocity(fps)***	***Depth(ft)***	***Velocity(fps)***
Left Side	0.5	2.0	2.0	1.3
Middle	0.5	1.5	2.0	1.4
Right Side	0.5	2.2	2.0	1.4
Average	**-**	**1.9**	**-**	**1.4**

SUMMARY

Water velocity across the face of the racks was fairly consistent, demonstrating that the variation in trashrack spacing combined with flows through the downstream fish bypass entrances does not create abnormal flow vectors in the intake area. Few intake velocity values were faster than 2 fps, which is sometimes identified as an important threshold for evaluating entrainment risk for some fish species. Most of the higher velocity values (10 of 12, or 83 percent; Table 3) were at a water depths of 15 feet or more, below where most surface oriented fish would pass. The remaining two values were at a water depth of 12.5 feet. Water velocity around the fishway entrances near Units 2, 3, and 4 was similar to the velocity measurements across the intake. Water velocity in the fishway entrance near Unit 1 (average of 3.7 fps at surface; average of 2.35 at bottom) was higher than all other velocity measurements.

The field measurements of intake approach velocity were taken from the trash rake, approximately 3 feet in front of the trashracks, while the calculated approach velocities were estimated at the trashrack face. Since approach velocity decreases with increasing distance from the racks, the difference between calculated and field measured velocity is reasonable and suggests consistency between methods.

J:\1465\016\Docs\Velocity Study\Final Report\20151224 001 Ellsworth Project 2015 Intake Velocity Measurements-Summary Memo-FINAL.docx

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APPENDIX E-6

UPSTREAM ATLANTIC SALMON PASSAGE STUDY 2015

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ELLSWORTH HYDROELECTRIC PROJECT

FERC NO. 2727

Upstream Atlantic Salmon Passage Study

2015 Daily Log Summary

Prepared by:

Black Bear Hydro Partners LLC

Lewiston, ME

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Ellsworth Project

Upstream Atlantic Salmon Passage Study

2015 Daily Log Summary

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Ellsworth Project

Upstream Atlantic Salmon Passage Study

2015 Daily Log Summary

1.0 - INTRODUCTION

During the 2015 upstream fish passage season, between May 1st and October 31st, seasonal fishway technicians operated the Ellsworth upstream fish passage facilities daily from sunrise to sunset. During this time, technicians managed fish passage attraction pumps, controlled the entrance attraction gate level, and monitored tailwater levels below the dam. Additionally, technicians checked the fishway trap four times a day (approximately once every 3 hours), during which time they monitored water temperature, tidal stage, river flows (cfs), number of units discharging, and made note of any spill conditions on the dam face. If any migratory fish were present in the trap during a lift, the species, number, condition, and any marks or characteristics indicating wild, hatchery, or aquaculture escapes were documented. The techs were all properly trained by the Maine Department of Marine Resources (MDMR) on salmon identification, handling, and transport. Throughout the day, techs also visually surveyed the fishway trap and the river below the dam for any fish activity (i.e. species observed, approximate number of river herring in the trap, density of river herring in front of the fishway, any fish behavior occurring in the trap or the river, and any predatory species present).

During the season, technicians performed routine weekly inspections on fish transportation trailers, oxygen systems, and aeration systems. Technicians were also responsible for gathering catch data and trap operations during the City of Ellsworth's annual alewife harvest. The harvesters use the upstream fish passage facilities as a trap and harvest facility during the months of May and June during daylight hours, Monday through Friday. During harvest time, a private contractor is hired to truck alewives to Graham Lake on Saturdays and Sundays (MDMR regulation). Technicians were responsible for recording and reporting stocking numbers during this time. During any harvest or stocking operation trap lift, technicians visually inspected the trap (while three feet of water remained in the trap) for any Atlantic salmon prior to removing the trap fully from the water.

2.0 - DESCRIPTION OF FISH PASSAGE FACILITIES

The upstream fish passage at the Project is a vertical slot design with a 3-foot-wide entrance and a trapping hopper located at the end of the passage. The entrance is located on the west side of the powerhouse and capable of passing up to 50 cubic feet per second (cfs). The entrance gate is adjusted, when water levels warrant, maintaining a wave ripple effect that extends as far as possible out into the tailrace. This usually requires about an 18 inch differential between the fishway and tailrace water levels. (The tailwater of the Ellsworth dam is influenced by tidewater). The entrance gate is manually adjusted with a hand wheel or with an electric actuator with local controls. The entrance runs into a single gallery that runs along the driveway of the powerhouse. The first attraction pump is a Worthington Model 20KLD24 attraction water pump that is capable of passing up to 28 cfs through a pipe to the diffusion chamber above the trap. The second attraction pump, Flygt Model 4451, takes water from the tailrace and pumps it into the fishway just above the entrance gate area through a diffuser system with a capacity of approximately 22 cfs. This simulates more flow in the fishway for attracting fish to the entrance areas. The fishway flow is approximately 50 cfs under normal operating conditions. There are two fish trap hoppers used. The stocking hopper is constructed with solid aluminum sides, which allows water to remain in the hopper tank when lifted for stocking. The second hopper is constructed with metal screen material which allows for the water to drain off when the hopper is lifted from the hopper pit during the City of Ellsworth's alewife harvest. The stocking hopper was used on Saturdays and Sundays during the harvest operations and seven days a week during non-harvest operation.

When stocking or transporting, fish are lifted out of the hopper pit, in the metal hopper tank, and then transferred into one of two different transport tank types. Two round tanks used for river herring and a rectangular tank used for salmon. The round transport tanks have a volume of 99.5 cubic feet and the rectangular tank has a volume of 66 cubic feet. The river herring transport tanks are used in tandem as necessary, thereby allowing one to be enroute to Graham Lake while the other is available at all times for fish entering the fishway.

3.0 – DAILY LOG REVIEW (Organized by Month)

May 1st – May 31st

On May 7th, the first river herring of the season were seen holding in the current at the entrance to the upstream fish passage (50-100 fish seen). At this time, the water temperature was 11 degrees Celsius. On May 10th, the density of river herring in the river increased, river herring began entering the fishway, and upstream trucking of river herring began for the season. Water temperature at this time was 12 degrees Celsius. By May 31st, 446,513 river herring had been moved through the Ellsworth upstream fish passage facility. 297,270 of these fish were trucked to Graham Lake, while the remaining 149,243 were sold as lobster bait by the City of Ellsworth. On May 31st, the water temperature had reached 18 degrees Celsius (warmest temperature of the season) and river herring densities were the highest seen all season.

During observations of the river, it was noted that the river herring tended to run strongest in the evenings and moved stronger during an incoming tide. Increasing river temperature was also noted to increase river herring densities during warm sunny days. It was also noted that, on most evenings, river herring stopped entering the fishway and began dropping downriver around sunset. River flows did not seem to have as strong of a correlation to river herring densities as the previously mentioned environmental factors, however, when plant operations increased the amount of water moving through the units, there was a subsequent increase in river herring densities occasionally noted by the technicians. During the month of May, river flows fluctuated between 271 cfs and 1,262 cfs. During all flows, the river herring tended to migrate upstream on the fishway side of the river (deeper water is present here) and hold in front of the fishway entrance. During spill events, the river herring did not appear to migrate towards the dam face.

At no point during the month of May was an Atlantic salmon observed by the fishway technicians. Osprey, bald eagles, harbor seals, cormorants, blue herons, and a number of gull species, were seen feeding on the river herring below the dam during the month of May.

June 1st – June 30th

On June 1st, 40,905 river herring were passed through the upstream fish passage facility. During the following days, heavy rain and cold temperatures dropped the river temperature from 18 degrees Celsius to 15 degrees Celsius. This drop in river temperature appeared to slow the river herring migration substantially. Throughout the month of June, river temperatures slowly increased to a high temperature of 19 degrees Celsius on June 29th. By June 30th, 102,927 river herring had been moved through the Ellsworth upstream fish passage facility. 26,315 of these fish were trucked to Graham Lake, while the remaining 76,612 were sold as lobster bait by the City of Ellsworth. On June 30th, water temps were 18 degrees Celsius and river herring densities were the lowest seen since the beginning of the migration.

During observations of the river, it was again noted that the river herring tended to run strongest in the evenings and moved stronger during an incoming tide. Increasing river temperature was again noted to increase river herring densities during warm sunny days. Decreasing river temperatures were also noted to decrease densities of river herring seen below the dam. It was again noted that, on most evenings, river herring stopped entering the fishway and began dropping downriver around sunset. River flows did not seem to have as strong of a correlation to river herring densities as the previously mentioned environmental factors. During the month of June, river flows fluctuated between 196 cfs and 1,262 cfs. During all flows, the river herring again tended to migrate upstream on the fishway side of the river and hold in front of the fishway entrance. During spill events, the river herring did not appear to migrate towards the dam face.

During the month of June, large numbers of post spawn adult river herring could be seen dropping through the downstream fish passage facilities.

At no point during the month of June was an Atlantic salmon observed by the fishway technicians. Osprey, bald eagles, harbor seals, cormorants, blue herons, and a number of gull species, were seen feeding on the river herring below the dam during the month of June.

July 1st – July 31st

During the month of July, 5,575 river herring were passed through the upstream fish passage facility. These fish were all trucked to Graham Lake. During the month of July, river temperatures surpassed 23.0 degrees Celsius on thirteen different days. Per the operations procedures outlined in the "Atlantic Salmon Trap Operating and Fish-Handling Protocols" provided by MDMR, operation of the upstream fishway was stopped when temperatures exceeded 23.0 degrees Celsius. Observations of the fishway entrance area and tailwaters continued on a routine basis, even when the fishway was not operating, with observations being made approximately once every three hours.

During observations of the river, it was again noted that the river herring tended to run strongest in the evenings and moved stronger during an incoming tide. It was again noted that, on most evenings, river herring stopped entering the fishway and began dropping downriver around sunset. On July 7th, flows through the plant were brought to minimum flow, after technicians noted injured YOY (young of the year) river herring in the tailrace. On July 28th, the plant was brought off of minimum flow, however, at this point in the season the adult river herring run had stopped and no impact on upstream migration could be noted.

At no point during the month of July was an Atlantic salmon observed by the fishway technicians. Osprey, bald eagles, harbor seals, cormorants, blue herons, and a number of gull species, were seen feeding on the river herring below the dam during the month of July.

August 1st – August 31st

During the month of August, no migratory fish were passed through the upstream fish passage facility. During this time, river temperatures surpassed 23.0 degrees Celsius on twenty-eight different days. Per the operations procedures outlined in the "Atlantic Salmon Trap Operating and Fish-Handling Protocols" provided by MDMR, operation of the upstream fishway was stopped when temperatures exceeded 23.0 degrees Celsius. Observations of the fishway entrance area and tailwaters continued on a routine basis, even when the fishway was not operating, with observations being made approximately once every three hours.

During observations of the river, YOY river herring could be seen using the downstream fish passage facility.

At no point during the month of August was an Atlantic salmon observed by the fishway technicians. Osprey, bald eagles, cormorants, blue herons, and a number of gull species, were seen feeding on the YOY river herring below the dam during the month of August.

September 1st – September 30th

During the month of September, no migratory fish were passed through the upstream fish passage facility. During this time, river temperatures surpassed 23.0 degrees Celsius on eleven different days. Per the operations procedures outlined in the "Atlantic Salmon Trap Operating and Fish-Handling Protocols" provided by MDMR, operation of the upstream fishway was stopped when temperatures exceeded 23.0 degrees Celsius. Observations of the fishway entrance area and tailwaters continued on a routine basis, even when the fishway was not operating, with observations being made approximately once every three hours.

During observations of the river, YOY river herring could be seen using the downstream fish passage facility.

At no point during the month of September was an Atlantic salmon observed by the fishway technicians. Osprey, bald eagles, cormorants, blue herons, and a number of gull species, were seen feeding on the YOY river herring below the dam during the month of September.

October 1st – October 31st

During the month of October, no migratory fish were passed through the upstream fish passage facility. Observations of the fishway entrance area and tailwaters continued on a routine basis, even when the fishway was not operating, with observations being made approximately once every three hours.

During observations of the river, YOY river herring could be seen using the downstream fish passage facility.

At no point during the month of October was an Atlantic salmon observed by the fishway technicians. Osprey, bald eagles, cormorants, blue herons, and a number of gull species, were seen feeding on the YOY river herring below the dam during the month of October.

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APPENDIX E-7

UPSTREAM FISH PASSAGE ALTERNATIVES STUDY - REVISED

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ELLSWORTH HYDROELECTRIC PROJECT
FERC No. 2727

UPSTREAM FISH PASSAGE ALTERNATIVES STUDY

Prepared for:
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DECEMBER 2015

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ELLSWORTH HYDROELECTRIC PROJECT
UPSTREAM FISH PASSAGE ALTERNATIVES STUDY

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1.0 INTRODUCTION

1.1 Study Purpose

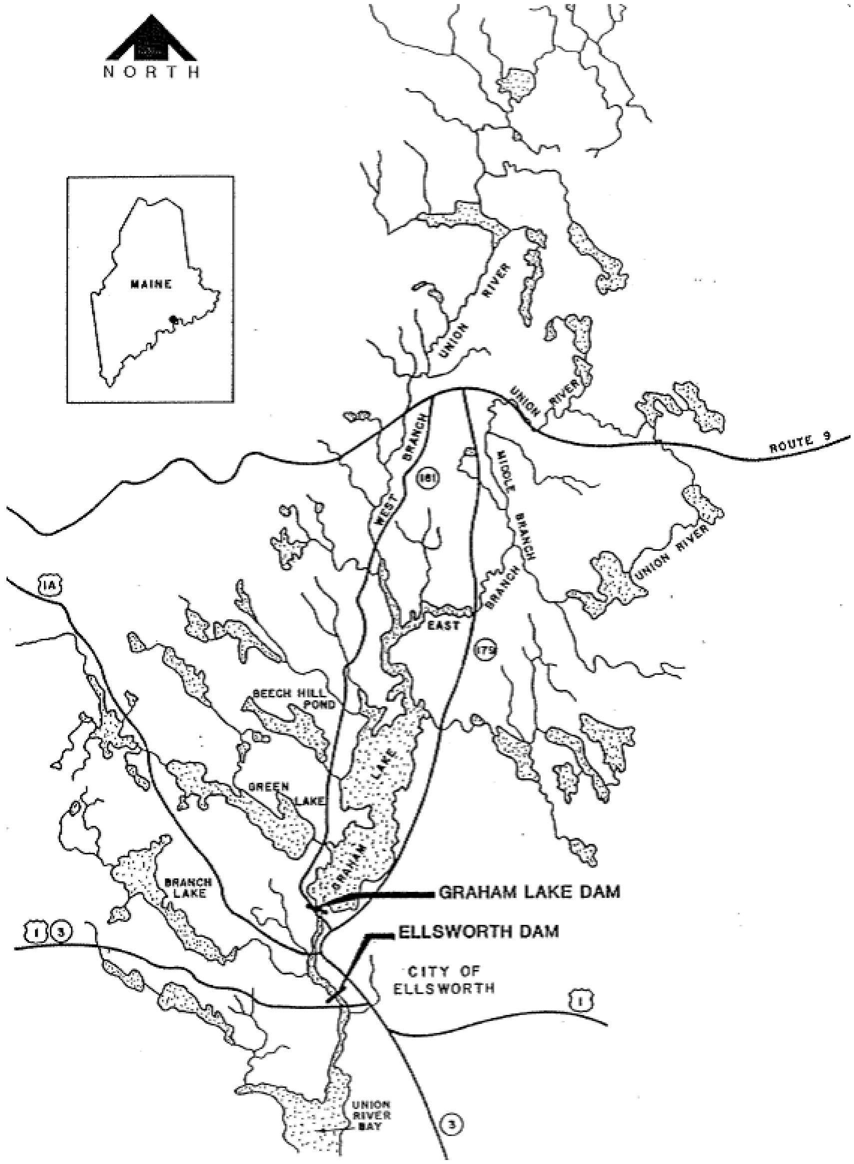
As part of the relicensing process of the Ellsworth Project (FERC No. 2727), Black Bear conducted a study to investigate the feasibility of an expanded upstream fish passage program in the Union River at Ellsworth and Graham Lake Dams. This included the identification of feasible upstream passage alternatives at both dams, including dam removal and developing estimates of the capital, operational, and maintenance costs of each alternative. This effort involved reviewing previously developed fish passage design concepts considered for the Ellsworth Project in the past and updating them, as well as an assessment of any newer fish passage technologies that may be appropriate for the site. The review was a broad-brush treatment of the topic for screening at the conceptual level of design with “order-of-magnitude” costs associated with each design.

The study results were reported in the Updated Study Report (USR), which was submitted to FERC on August 27, 2015. The report has been revised to address comments received during the USR meeting held on September 23, 2015, and in subsequent comment letters from FERC and stakeholders.

1.2 Ellsworth Project Site Description

The Ellsworth Project consists of the Ellsworth Dam, the Graham Lake Dam, and appurtenant facilities. The Ellsworth Dam has an integral intake structure and powerhouse and creates the impoundment, Lake Leonard. Graham Lake Dam is located on the Union River about 4 miles upstream of Ellsworth Dam, creating the water storage reservoir known as Graham Lake (Figure 1).

FIGURE 1
PROJECT LOCATION MAP



<u>Ellsworth Dam and Lake Leonard</u>

Construction of the Ellsworth Dam was completed in 1907. The Ellsworth Development has a concrete dam 65 feet high and 377 feet long (with a 275-foot long section of spillway). Ellsworth Dam was modified in 1991 to enhance stability by filling the interior of the dam with mass concrete. Post-tensioned anchors were also installed to gain additional sliding resistance in several of the bays where space was limited. The dam forms Lake Leonard, which extends approximately 1 mile above Ellsworth Dam and has a surface area of 90 acres at a normal water surface elevation 66.7'. The powerhouse is a reinforced concrete and concrete block masonry powerhouse containing four turbine-generator units, which have a total rated capacity of 8,900 kilowatts (kW) (Table 1), with gross annual energy production of about 30,333,000 kilowatt-hours (kWH).

TABLE 1
CHARACTERISTICS OF THE ELLSWORTH PROJECT

Facility Characteristics	Ellsworth Dam	Graham Lake Dam
Reservoir Surface Length	1 mile	10 miles
Reservoir Surface Area	90 acres	10,000 acres
Reservoir Normal Surface Water Elevation	66.7' (includes 1.7-foot flashboards)	104.2'
Length of Dam	377 feet	750 feet
Height of Dam	65 feet	30 feet
Total Rated Capacity	8,900 kW (4 units) • Unit 1 – 2,500 kW unit (vertical shaft propeller) • Unit 2 – 2,000 kW unit (Kaplan) • Unit 3 – 2,000 kW unit (Kaplan) • Unit 4 – 2,400 kW unit (vertical shaft propeller)	NA
Trashrack Spacing	Variable – Typical configuration based on normal pond elevation: Top 6-8 feet is concrete Unit 1 – 2.44 in. Units 2-4 – 1.00 in.(top)/2.37 in. (bottom)	NA

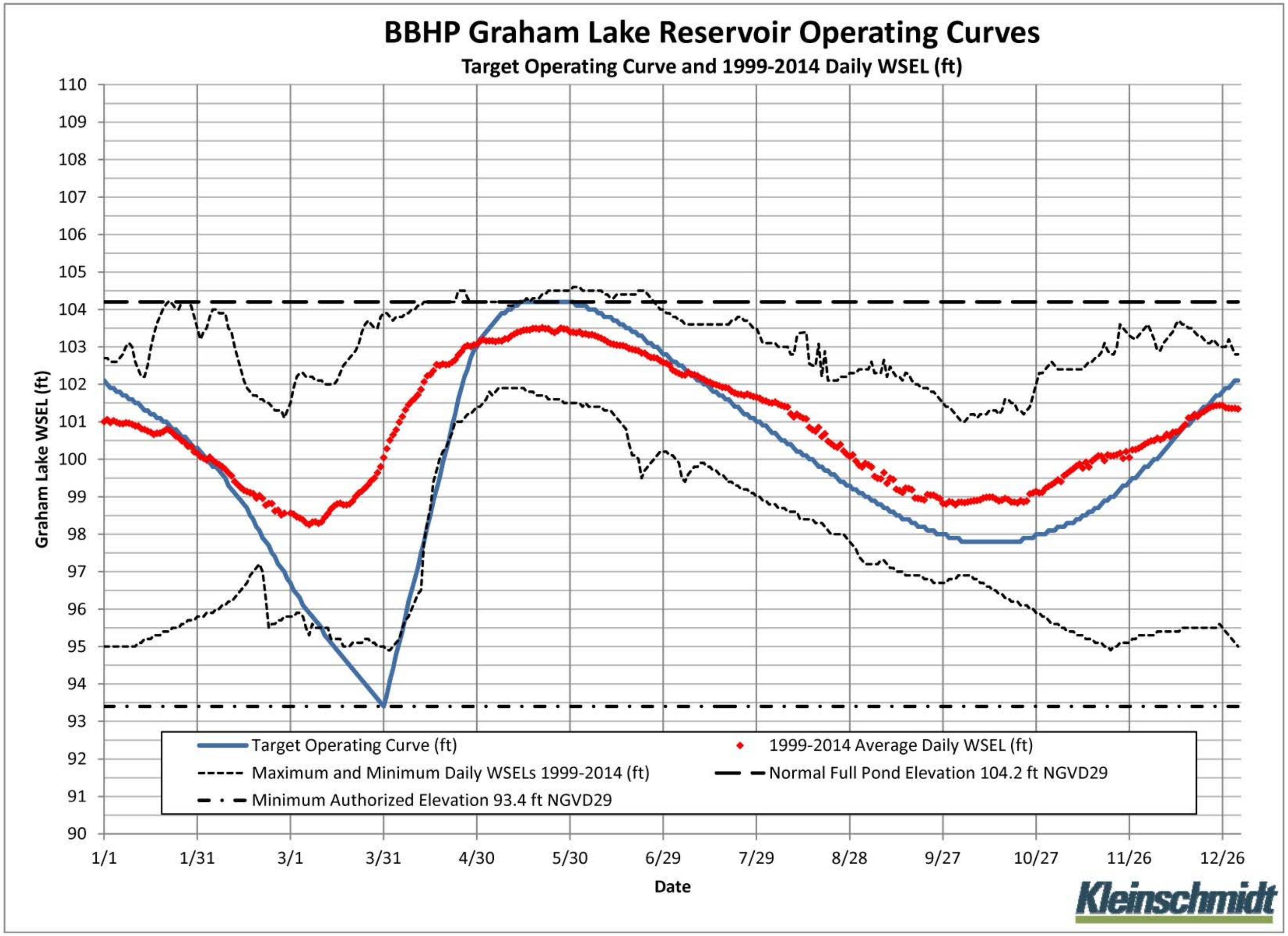
<u>Graham Lake Dam and Graham Lake</u>

The Graham Lake Dam was completed in 1924 and is located about four miles upstream from the Ellsworth Dam. Graham Lake Dam is 30 feet high and consists of a 670-foot-long earth dike and an 80-foot-long concrete gate structure. The concrete gate structure contains three 20-foot-wide radial (Tainter) gates and an eight-foot-wide sluice that is used for downstream fish passage. This dam was modified in 1992, adding flood control structures on the downstream side of the original dam to address stabilization concerns. The flood control structure consists of an approximately 720-foot long flood wall, which is is connected to the existing Graham Lake Dam outlet gates by a wing wall extension and a permanent cofferdam cell t. The Graham Lake reservoir is approximately 10 miles long with a surface area of approximately 10,000 acres at maximum water surface elevation of 104.2’ (Table 1). There are no generating facilities at the Graham Lake Development.

Project Operations

The Ellsworth Project operates as both a water storage facility and as a peaking generation facility, depending on available inflows, while maintaining minimum flows. Timed releases at Graham Lake are used at Ellsworth Dam for power production. The releases may result in minor (approximately 1 foot) surface elevation changes in Lake Leonard. During high-flow conditions, primarily in the spring and fall, the Project may operate at full load up to 24 hours a day. Graham Lake generally follows an operating guide curve that can result in fluctuations approaching 11 feet over the course of a year (Figure 2). As per Articles 401 and 402 of the 1987 Order Issuing New License, minimum flows and water levels are required and maintained by Black Bear. Article 401 specifies a continuous minimum flow release of 105 cubic feet per second (cfs) from the Ellsworth Dam and Graham Dam from July 1 through April 30 and a continuous minimum flow release of 250 cfs from May 1 through June 30 for the protection of fishery resources. Article 402 of the FERC license specifies that the licensee operates the Ellsworth Project so that the following water levels are maintained: Lake Leonard 1-foot fluctuation (el. 65.7 to 66.7 feet) and Graham Lake 10.8-foot fluctuation (el. 93.4 to 104.2 feet msl).

FIGURE 2
HISTORIC OPERATING CURVES, GRAHAM LAKE



Project Downstream Passage

Black Bear operates downstream passage facilities at both Ellsworth Dam (Figures 3 and 4) and Graham Lake Dam (Figure 5). Downstream measures at the Ellsworth Dam consist of two stoplog-controlled surface weirs above Units 2 through 4 and a transport pipe leading to a plunge pool immediately downstream of the dam, as well as a third surface weir adjacent to the Unit 1 intake that discharges directly to the same plunge pool. In addition, a permanent stainless steel inlet screen was installed over the intake of the cooling water system at the Ellsworth Dam on May 26, 2015, as a downstream passage protection measure, following review and consultation with the resources agencies, including guidance provided by the USFWS and the National Marine Fisheries Service (NMFS).

In addition to the activities associated with operation and maintenance of the fish passage facilities at the Ellsworth Dam, Black Bear operates a surface weir (located in a former log sluice bay) suitable to provide downstream passage of out-migrating Atlantic salmon and river herring (alewife and blueback herring) on the west end of the Graham Lake Dam gate structure. The development of this passage route was completed in 2003, coinciding with an increase in upstream stocking of river herring. The weir is similar to the downstream passage system at the Ellsworth Dam in that it is a surface weir that contains stoplogs, which enables Black Bear to adjust the opening as necessary. The opening empties into a downstream plunge pool and provides migrants with another route of passage in addition to the existing gates, which are operated to pass water used for generation purposes at the Ellsworth Dam (Figure 4). It further enhances existing passage at the site by providing out-migrating fish constant uninhibited passage, in addition to passage opportunities through water releases using the gates during normal Project operations. The downstream fishways are operated from April 1 to December 31 annually, as river conditions allow.

FIGURE 3
VIEW OF COLLECTION CHAMBER AND ENTRANCE TO DOWNSTREAM FISH PASSAGE PIPE AT THE ELLSWORTH DAM

FIGURE 4
VIEW OF DISCHARGE FROM DOWNSTREAM FISH PASSAGE PIPE (ARROW) AT THE ELLSWORTH DAM

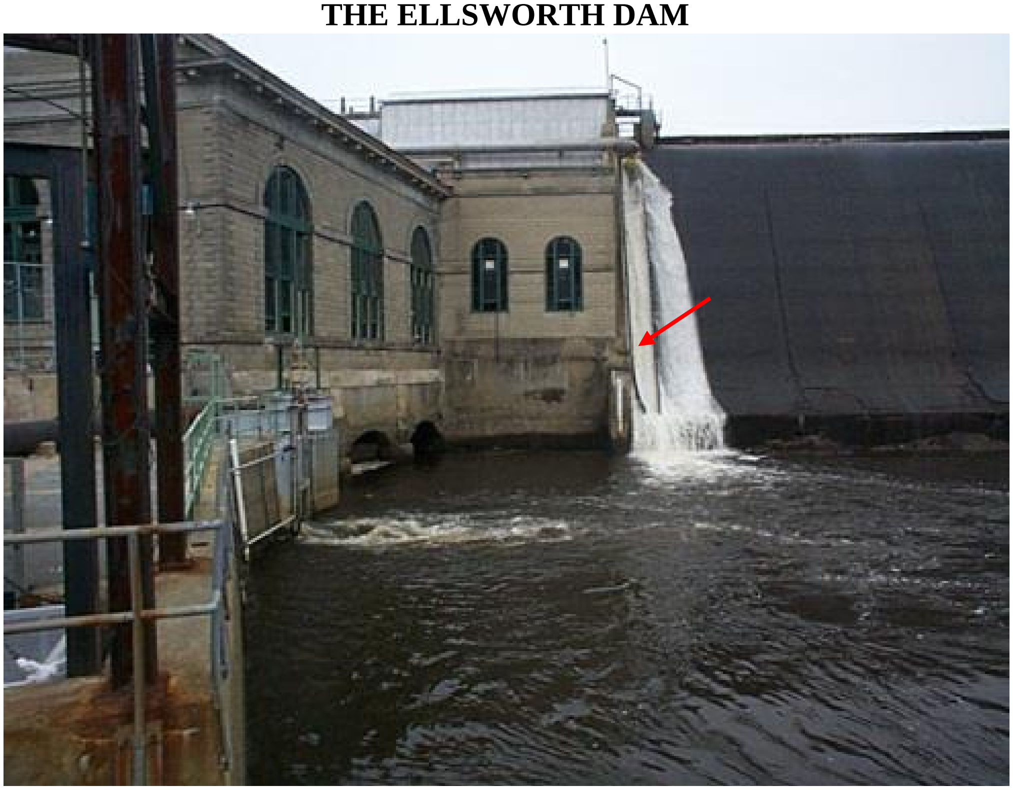


FIGURE 5
VIEW OF DOWNSTREAM SIDE OF THE GRAHAM LAKE DAM, WHERE THE DOWNSTREAM BYPASS IS INTEGRAL WITH THE RELEASE GATES (ARROW)

Project Upstream Passage

The Ellsworth Dam trap and transport facility is equipped with a four-baffle vertical slot upstream fishway leading to a trap fitted with a hopper and hoisting structure to facilitate fish transport in circular transport tanks (Figures 6 and 7). The fishway entrance is immediately adjacent to the powerhouse tailrace with a pumped attraction flow of up to 50 cfs. The upstream fishway and fish trapping facility were originally constructed at the Ellsworth Dam (Lake Leonard) in 1974 to provide a supplemental source of Atlantic salmon broodstock for use in the restoration of populations to the Penobscot and other Maine rivers (Baum 1982). Atlantic salmon broodstock collection was discontinued at Ellsworth in 1991, and since that time the upstream fishway is now used primarily during the river herring migration, but also to collect any salmon that might use the facility for potential upriver transport (depending on origin of fish) in the Union River. Between 2006 and 2011, no salmon returned to the Union River. Since then, three hatchery origin salmon (not ESA protected) were captured in 2012, one salmon (wild) returned in 2013, two (one wild and one hatchery) in 2014 (URFCC 2015), and no salmon returns in 2015. Adult Atlantic salmon that are captured in the fishway are examined to determine origin, and the Maine Department of Marine Resources (MaineDMR) determines whether Atlantic salmon caught in the fishway are released downstream of the Ellsworth Dam, upstream of the Graham Lake Dam, or, if of aquaculture origin, removed by Maine DMR.

FIGURE 6
VIEW OF FISHWAY HOPPER IN OPERATION USED FOR TRANSFERRING FISH TO THE HOLDING TANK AT THE ELLSWORTH DAM

Graham Lake Dam does not have an upstream fishway because fish are transported from the Ellsworth trap and transport facility to locations above the Graham Lake Dam. Black Bear manages the upstream passage facility at Ellsworth Dam in consultation with the agencies through the Union River Management Plan. River herring are trapped and transported to Lake Leonard and Graham Lake. Lake Leonard and Graham Lake are the primary stocking locations for river herring in the Union River drainage and contain the majority of potential spawning habitat. In 2014, the upstream fishway was operated for river herring stocking and harvesting beginning in early May through mid-June, and then Black Bear continued to operate the fishway through November 4 for Atlantic salmon (URFCC 2015). In 2015, Black Bear conducted an upstream Atlantic salmon passage evaluation and operated the fishway from May 1 through

FIGURE 7
OVERVIEW OF FISHWAY TRAP AND TRANSFER FACILITY AT THE ELLSWORTH POWERHOUSE TAILRACE

October 31[1]. According to the fishway operator, the presence of river herring near the fishway is typically sporadic after early June as the migration slows to an end.

Under current operations, the trap facility is also used for commercial harvest of river herring and, therefore, handles more fish than the required spawning escapement. This is currently accomplished by temporal separation of trap and truck operations and commercial harvest on different days. Also, the priority of trapping operations is to first transport a majority of the escapement to upstream spawning habitat before initiating harvest of river herring. After stocking approximately 2/3 of the required river herring escapement, the fishway operations are adjusted for harvest operations, and a different fishway hopper system is installed to provide for harvesting. Fish trap and transport for stocking is then continued on Saturdays and weekdays as

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[1] Consistent with Maine DMR protocols, the fishway is not operated when temperatures exceed 23^0C (73^0F, which occurred sporadically in July and September and the majority of August. However, observations of the fishway entrance and tailwater areas were conducted routinely.

needed (at which time the hopper system used for stocking is reinstalled), until the total target spawning escapement of river herring is reached. This protocol ensures that the majority of fish are stocked prior to harvesting activities, while also providing that a substantial amount (about 1/3) of river herring are transported throughout various portions of the entire migration season.

The Project's fish passage facilities are managed in consultation with the agencies[2] through the *Comprehensive Fishery Management Plan for the Union River Drainage 2000-2005*, which is updated every five years. The current plan covers the three-year period of 2015-2017 due to the expiration of the Project license in December 2017 (URFCC 2015). In 2014, the upstream fishway was operated for river herring (alewife and blueback herring) stocking and harvesting beginning in early May through mid-June, and then Black Bear continued to operate the fishway through November 4 for Atlantic salmon (URFCC 2015). In 2015, Black Bear conducted an upstream Atlantic salmon passage evaluation and operated the fishway from May 1 through October 31. The downstream fishways are operated from April 1 to December 31 annually, as river conditions allow. Also in 2015, Black Bear developed a site specific operation and maintenance plan for the fishways for the Project and hired dedicated staff to operate the project fish passage facilities; these staff members were dedicated to fishway operations, oversight, fish trap tending, and transporting the fish upriver.

One operational issue for the current Ellsworth fishway is the appropriate action to take if an Atlantic salmon is captured when ambient water temperature exceeds 73° F. The current Maine DMR protocol is to not handle Atlantic salmon at fish passage facilities when the river temperature exceeds 73°F. While there is a low probability of salmon captures when water temperature exceeds 73°F (few salmon have been collected in the Union River at or above this temperature historically), Black Bear plans to modify its operational and handling procedures in case such a situation occurs in the future.

In 2015, the *Comprehensive Fishery Management Plan for the Union River Drainage 2015-2017* (URFCC 2015) increased the targeted spawning escapement from 150,000 to 315,000 river herring. To accomplish this increase in spawning escapement, trap and transport operations have been modified. Beginning in 2015, the first 150,000 river herring were transported upstream to

[2] Includes NMFS, USFWS, and Maine DMR

Graham Lake and other upper basin lakes (as determined by the URFCC) before commercial harvest commenced. At that time, commercial harvest began on weekdays and upstream passage only (live transport and stocking) continued on Saturdays and Sundays through June 10. Beginning on June 10, commercial harvest ended and all river herring captured (up to 1,600 fish) are transported to Lake Leonard where the late run blueback herring spawning habitat is more suitable than the larger lakes upstream.

Commercial Harvest Operations

Alewives and blueback herring, collectively referred to and managed as river herring, supports an active commercial fishery at Ellsworth Dam. The commercial fishery is managed by the Maine DMR in cooperation with the City of Ellsworth. The City of Ellsworth holds the commercial fishing rights for river herring harvest on the Union River and historically assumed responsibility for stocking adult fish in upstream spawning habitat to maintain the fishery under a cooperative agreement with the Maine DMR. The licensee is now responsible for the transport of the spawning escapement upstream while the City continues to operate the commercial harvest. The annual commercial harvest, which occurs at the Ellsworth Dam trap and transport facility, has ranged from 5,000 to 1,066,297 fish since 1974 (URFCC 2010, 2015), with the catch being sold as bait for the lobster fishery.

Operation of the current Ellsworth fish trap and transport fishway facility has successfully developed and maintained a self-sustained river herring population and commercial fishery, which is among the largest in the country. Further, the Atlantic States Marine Fisheries Commission (ASMFC) assessed the status of populations of river herring along the Atlantic Coast and concluded that the population of alewife in the Union River has increased between 1975 to the early 2000s. The ASMFC also concluded that the Union River has exhibited a stable population of alewife for the past 10 years (ASMFC 2012 *cited in* FERC's September 4, 2013 Study Plan Determination).

1.3 Upstream Fishway Design Parameters

A baseline plan view of the Ellsworth Dam, powerhouse, and tailwater is shown in Figure 8.

Design species, populations, and seasons

Targeted species for passage under the current management plan (URFCC 2015) are river herring and Atlantic salmon.

Design Population:

- Atlantic salmon: 750
- River herring: 2,315,000 (315,000 escapement, 2,000,000 harvest)

Season:

- Atlantic salmon: May 1 through October 31, daily, dawn to dusk
- River herring: May 1 through June 10, daily, dawn to dusk
    - All river herring transported upstream until 150,000 have passed, then Saturday and Sunday only while commercial harvest is allowed Monday – Friday, through June 10 to achieve a total spawning escapement of 315,000. Beginning June 10, all river herring transported to Lake Leonard up to 1,600 fish.

Site hydraulics:

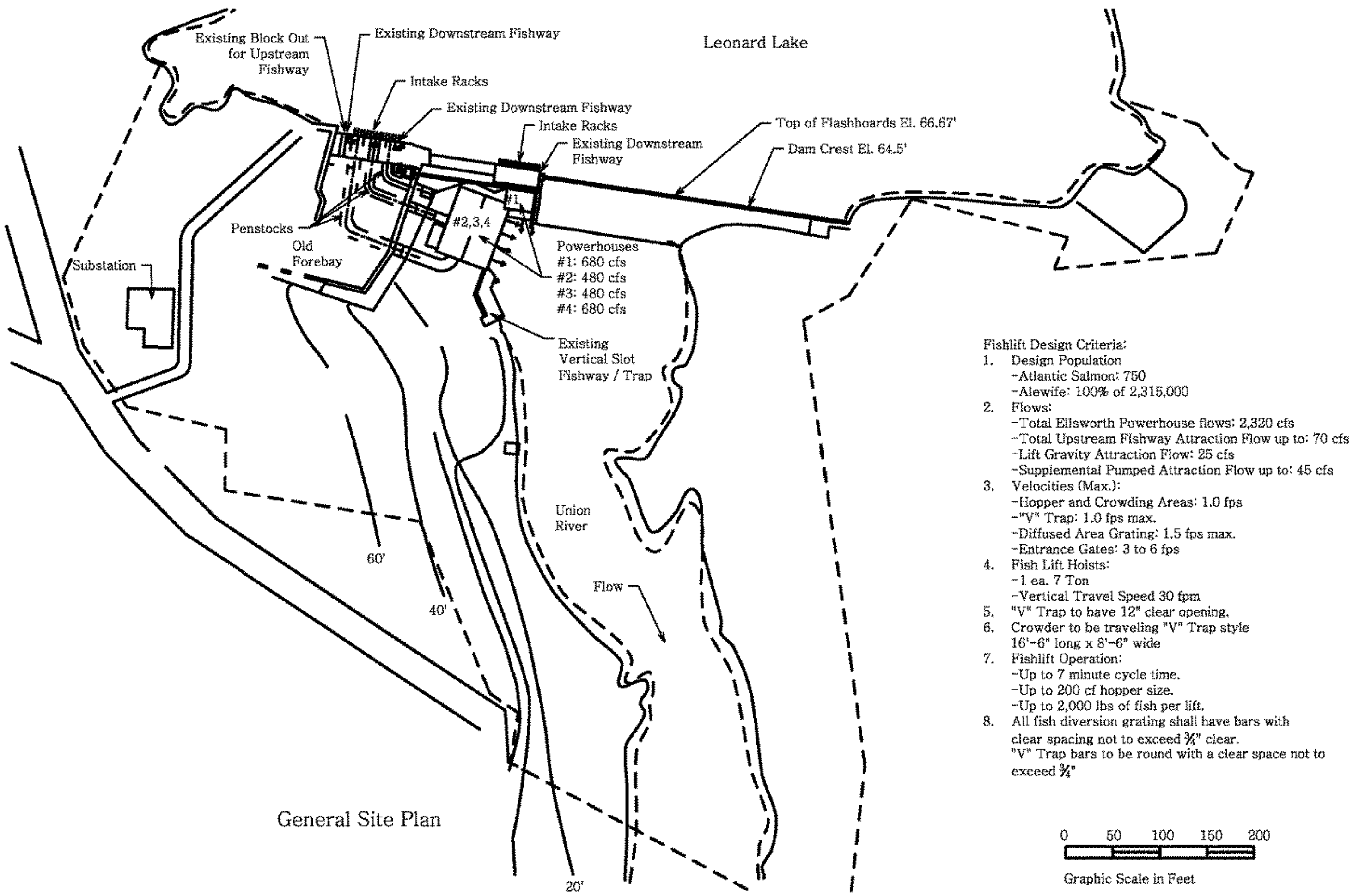
- Both Graham and Ellsworth Dams minimum flow is 250 cfs from May 1 through June 30, and 105 cfs July 1 through April 30.
- Ellsworth powerhouse hydraulic capacity is 2,460 cfs.

  Current fishway pumped attraction flow is up to 45 to 50 cfs, depending on tailwater elevation.

Maximum Fishway Velocities (as applicable):

- Hopper and crowder areas – 1.0 foot per second (fps)
- V–trap – 1.0 fps
- Diffused attraction flow grating – 0.5 to 1.5 fps
- Entrance gate – 3 to 6 fps

FIGURE 8
BASELINE PLAN VIEW OF ELLSWORTH DAM



2.0 TRAP AND TRANSPORT ALTERNATIVES

2.1 Concerns with Existing Facility

Agency-expressed concerns with the current Ellsworth trap and transport fishway have centered on two issues: (1) the overall capacity of the fishway to safely handle the full escapement/harvest design populations of river herring and Atlantic salmon; and, (2) the safe, timely, and effective handling and passage of Atlantic salmon. The first issue relates to how the harvestable surplus of river herring (up to 2,000,000 fish) are handled and whether the trap and transport facility must be sized to accommodate the harvestable run in addition to the spawning escapement of 315,000 fish. As presented in the Initial Study Report (ISR), the existing trap and transport facility is of sufficient size to pass the USFWS design criteria peak hourly rate of 4,725 river herring per hour (315,000 escapement only) with a 12-minute cycle time with a hopper capacity of only 61 cubic feet during lifting. Empirical data from the 2014 passage season demonstrated that up to 26,000 fish could be transported in a 5-hour day or approximately 5,200 fish per hour. Additionally, a post-transport survival study demonstrated that 24 hour survival of the transported river herring was greater than 97.5%. Under current operational protocol, separation of the upstream passage of the spawning escapement and the commercial harvest is accomplished temporally with harvest and transport conducted on different days. In 2015, the spawning escapement target was more than doubled from 150,000 to 315,000 river herring, and in this first year, the new escapement goal was accomplished with 329,160 fish transported upstream and a commercial harvest of 225,855 fish was also achieved for a total run size of approximately 555,015 river herring. While the 2015 season experience clearly demonstrated the capacity to handle over a half million river herring and the doubled spawning escapement, the hopper volume may also be physically expanded in length, width, and height within the existing fish trap footprint to provide additional capacity as discussed below.

Regarding the safe, timely, and effective passage of Atlantic salmon at Ellsworth, the primary concern is the safe handling of trapped salmon, especially during harvest operations and the potential for migration delay due to fishway crowding or infrequent trap and transport operation. Under current operations, the trap and hopper are visually inspected for Atlantic salmon and if one is spotted, the hopper is left in the water and the salmon is dip-netted out and placed in a holding tank. The salmon is then measured, examined for fin clips, fin wear, or other markings, a scale sample is taken, and the magnified scale image and fish photo is digitally captured. This information is transmitted to the MDMR who will then determine whether the Atlantic salmon caught in the fishway is to be released downstream of the Ellsworth Dam (hatchery or aquaculture escapees), moved via transport tank truck upstream (wild origin) and released in the West Branch of the Union River, approximately 17 miles upstream, or removed. Generally this process takes one to two hours, and in the case of wild Atlantic salmon, they arrive in upstream habitat more quickly than if they had passed volitionally and swam the entire distance.

The current trap and transport facilities and operating protocols at Ellsworth have proven to be reliabe and functional by handling river herring runs from 190,000 to 1,200,000 river herring and 0 to 8 Atlantic salmon annually from 2000 to 2015. Historically, this facility has handled up to 263 adult Atlantic salmon broodstock in a year. However, fishery resource agency concerns over the adequacy of the existing fishway facility to handle design populations remain. These concerns are addressed in the subsections below.

2.2 Hopper Improvements and Fish Trap Capacity

Since its original construction in 1974, different hoppers have been used at the Ellsworth fish trap for different purposes including: Atlantic salmon hatchery broodstock collections, trap and transport of river herring to Graham Lake, trap and transport of Atlantic salmon to the West Branch Union River, and commercial harvest of river herring. Since commercial harvest and trap and transport occur at the same location, fisheries resource managers have determined that the entire run, (escapement and harvested fish), must be included in the fishway capacity sizing. NMFS in their November 4, 2014 comments on the ISR, provided fish trap capacity calculations for the Ellsworth design population of river herring that was prepared by the USFWS Region 5 fishway hydraulic engineer. The capacity calculations included not only hopper sizing criteria, but also holding pool and vertical slot fishway sizing criteria as follows:

USFWS capacity criteria for 2,315,000 river herring, assuming 15-minute lift cycle

- Fishway Pool = 222 cubic feet
- Holding Pool = 416 cubic feet
- Hopper = 166 cubic feet

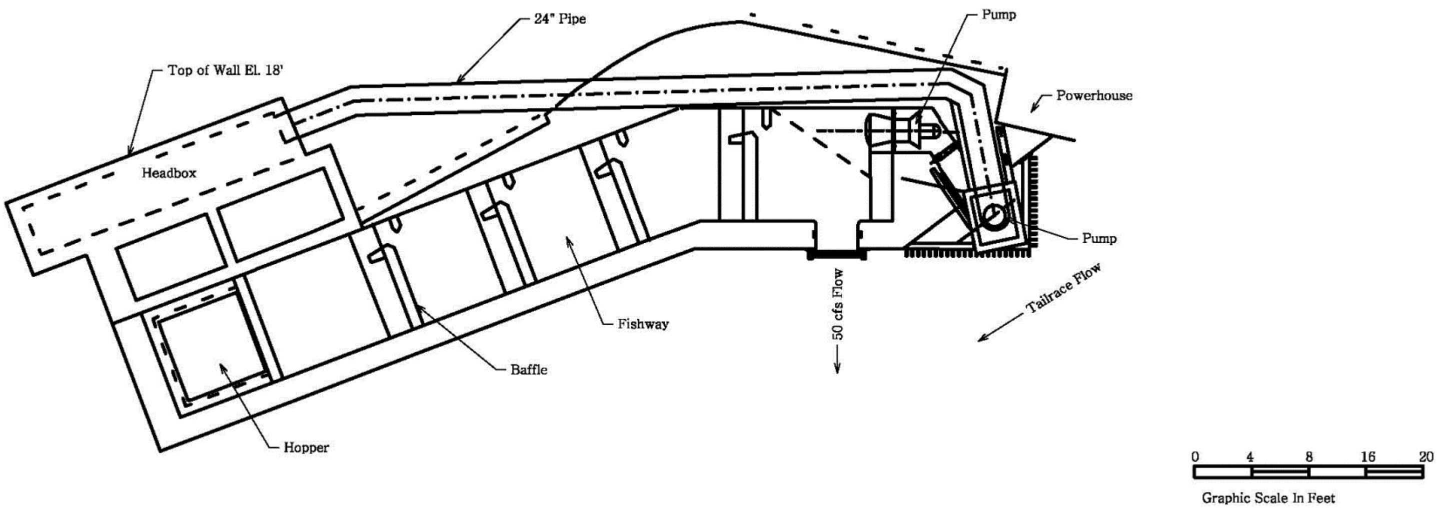
To determine whether the Ellsworth trap and transport facility is compatible with the USFWS criteria above, the existing fish trap dimensions (Figure 9) were determined for the fishway pools, holding pool, and hopper pool (to determine the largest hopper size that would fit in the pool). These dimensions were field verified, including water depth measurements under normal operating flows. The capacity of the existing Ellsworth fish trap was calculated as follows:

Ellsworth fish trap capacity

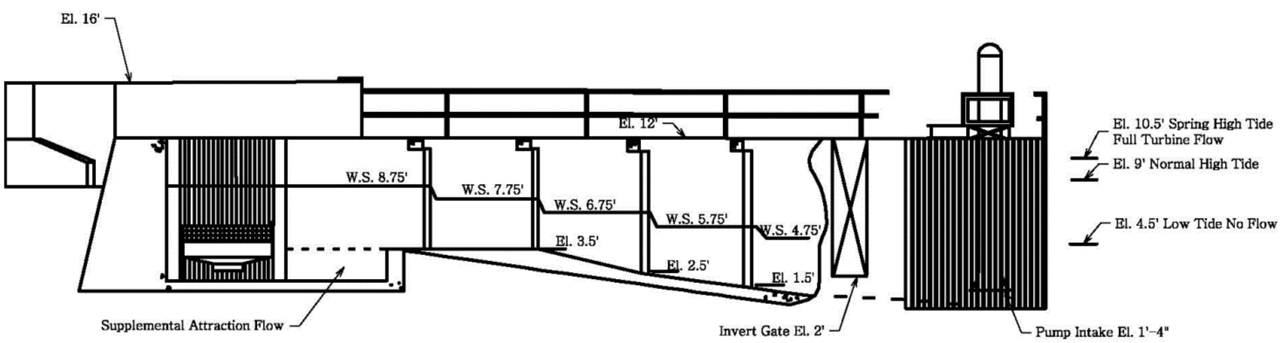
- Fishway Pool = 8.0 (l) x 8.0 (w) x 4.25 (d) = 272 cubic feet
- Holding Pool = 10.0 (l) x 8.0 (w) x 5.25 (d) = 420 cubic feet
- Hopper = 7.0 (l) x 8.0 (w) x 5.25 (d) = 294 cubic feet

While the hopper currently in use at Ellsworth (61 cubic feet during lifting) is smaller than the calculated capacity above, a larger hopper (and a larger hoist) could be fabricated and installed at the existing facility that would meet the 166 cubic foot criteria. These capacities meet or exceed USFWS criteria for the river herring design population of 2,315,000 fish with surplus capacity available for the Atlantic salmon 750 fish design population during the time when the two species' upstream migration periods overlap. Since these criteria are based on the projected single peak hour of abundance of the entire passage season, during the remainder of the season there will be even more surplus capacity for Atlantic salmon.

FIGURE 9
ELLSWORTH EXISTING FISH TRAP DIMENSIONS



Plan View of Existing Union River Fishtrap



Elevation through Centerline (from River Side)
of the Existing Union River Fishtrap

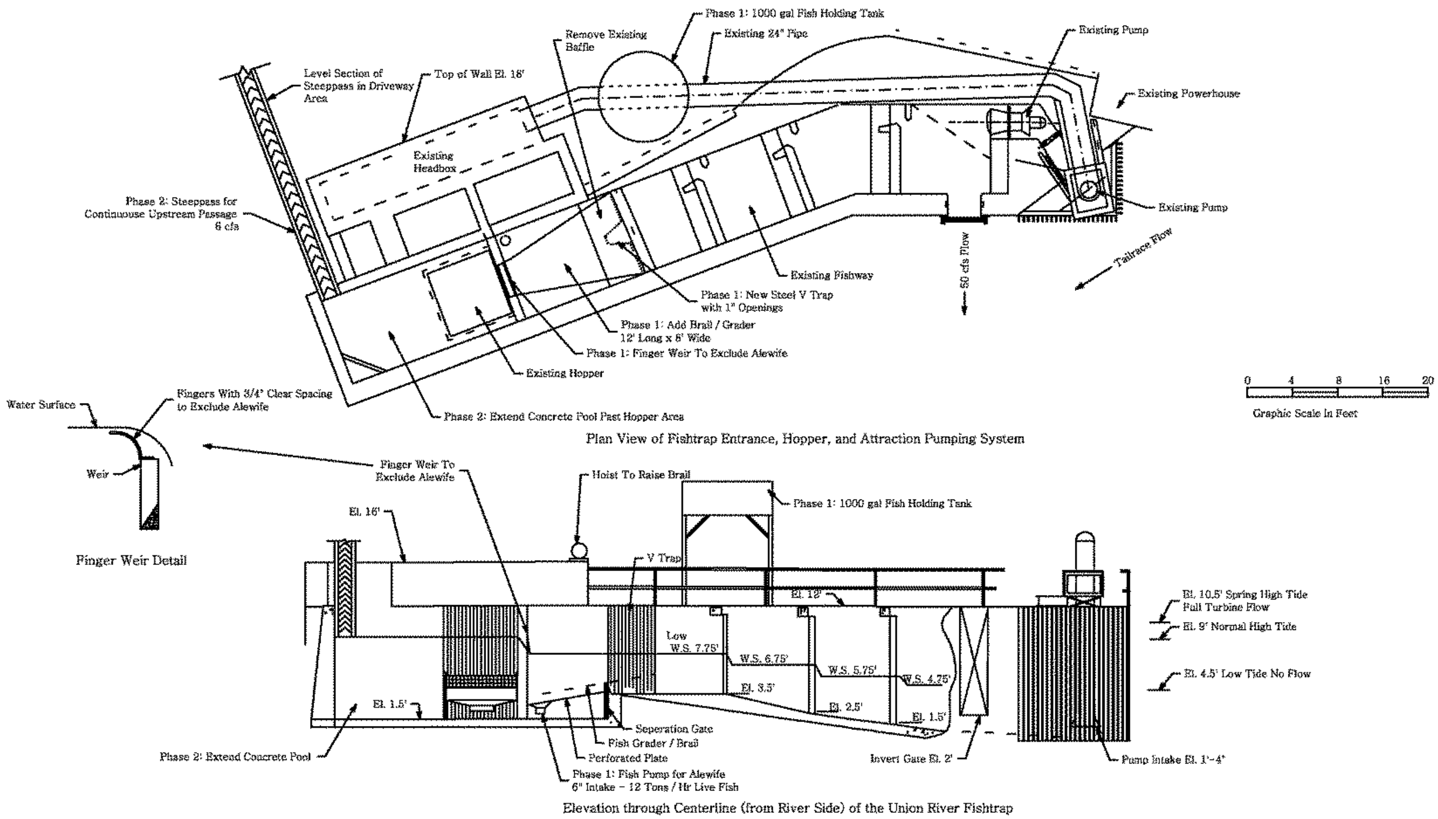
2.3 Separation of River Herring from Atlantic Salmon Passage

Separation of river herring transport and harvest activities from Atlantic salmon passage is thought to be a way of reducing potential harm or delay to Atlantic salmon upstream passage. Figure 10 illustrates a two-phased approach to accomplishing this species separation based on fish size and swimming ability. In Phase 1, the separation of Atlantic salmon and river herring is accomplished and both species are transported by vehicle in tanks to upstream habitat. In Phase 2, the trap is enlarged and modified to accommodate a fish ladder entrance allowing Atlantic salmon to volitionally swim upstream following separation from river herring.

2.3.1 Phase 1 – Exclude river herring from hopper and pump from holding pool

The system sketched on Figure 10 modifies the upper fish trap pools to have a 12-foot-long x 8-foot-wide x 4.25-foot-deep fish-holding pool. To accomplish this, the upper vertical slot baffle is removed and replaced with a “V” trap to capture both river herring and Atlantic salmon. The hopper entrance is also replaced with weir flow from the hopper pool by installing a finger weir (Clay 1995; Bell 1986) to restrict river herring from the hopper. The finger weir was originally designed to keep adult salmon from dropping out of a trap. When used at Ellsworth, river herring would be restricted by the close spacing of the finger weir bars and weir height; however, Atlantic salmon will easily pass over the weir. Thus with a finger weir, salmon can go into the hopper area but not river herring. The floor of the holding pool also has grader bars spaced to restrict salmon, but allow river herring to pass through. As the floor brail is lifted, alewife pass through the bars and any reluctant salmon are raised to the surface to pass the weir or can be dip netted. Atlantic salmon may then be lifted out in the hopper for examination and subsequent transfer to a tank vehicle for transport to a designated stocking location.

FIGURE 10
ELLSWORTH MODIFIED TRAP TO SEPARATE RIVER HERRING AND ATLANTIC SALMON



River herring remaining in the holding pool pass into a fish pump intake at the bottom of the pool. A 6-inch-diameter, 5 horsepower (hp) Aqua-Life, fish-friendly pump with a capacity of 12 tons of 1.5-pound live fish per hour (or 48,000 smaller river herring) is used to pass the live fish into a 1,000 gallon holding tank. From the holding tank, the river herring can be loaded into transport tanks for upstream stocking or may be harvested. The fish pump capacity is above the 21,000 river herring vertical slot capacity so it's possible to cycle the brail and fish pumping. Therefore, fish can be held alive when a truck is not available.

2.3.2 Phase 2 – Add Volitional Fish Ladder to Expanded Hopper Pool

Phase 2 modifications shown on Figure 10 would involve removal of the hopper and expansion of the hopper pool with construction of a fish ladder entrance at the end of the pool. This would accommodate either a steeppass or standard Denil ladder entrance for volitional upstream passage of Atlantic salmon to Lake Leonard as described below in Section 3.1.

3.0 FISH LADDER ALTERNATIVES

Two fish ladder alternatives are evaluated for both Ellsworth Dam and Graham Lake Dam: steeppass Denil and standard Denil ladders. A third alternative, a pool and weir fishway was considered, but determined not to be a viable alternative for the Ellsworth Project as discussed below.[3]

In response to the Updated Study Report the NMFS commented that an Ice Harbor or similar pool and weir fishway be considered in this evaluation because of their proven success passing salmon on the West Coast and the potential for similar success passing Atlantic salmon in the Northeast. However, in the Northeast, where multi-species passage goals are typical, Ice Harbor or pool & weir fishways at small high head dams are uncommon. Those that do exist (Turners

[3] The initial Alternatives Study as included in the August 2015 Updated Study Report evaluated two ladder alternatives, steeppass Denil and standard Denil ladders. In its comments on the USR the NMFS recommended that the Alternatives Study should include an evaluation of an Ice Harbor or other pool and weir fishway. The FERC determination on requested study modifications issued December 8, 2015, discussed the request and recommended that Black Bear either provide a conceptual design and associated cost estimate for an Ice Harbor or other pool and weir fishway, or specifically describe the issues that would make such a fishway infeasible or ineffective at the Ellsworth Project.

Falls and Amoskeag) have experienced poor passage effectiveness results for non-salmonid species, or are located upstream of shad and river herring historical range (Vernon, and Wilder). The modified Ice Harbor ladder at Turners Falls Cabot Station has been studied, modified, and restudied extensively during the last 20-plus years, yet shad passage effectiveness remains poor at only 10 to 20%. During the period of record when river herring were abundant in the Connecticut River (100,000 to 600,000 per year at Holyoke - 1983 to 1993), passage at the Cabot Ice Harbor fishway was less than 1.5% of those available fish (106 to 7,091 river herring per year). This has led the CRASC Technical Subcommittee for River Herring to limit their short term river herring restoration efforts to areas downstream of Turners Fall due in part to "existing fish passage concerns at Turners Falls Dam fishways" (February 10, 2015 status report). While studied less intensely, the pool & weir fishway at Amoskeag Dam on the Merrimack River is experiencing similar problems. 2015 fish passage statistics indicate 17,310 American shad and 31,668 river herring were passed at the downstream dam at Lowell, yet none of these fish were passed at the Amoskeag pool & weir fishway.

In addition to poor performance for passage of non-salmonid species, site specific conditions and operations of the Ellsworth Project limit the feasibility of Ice Harbor or pool & weir fishways. These fishways do not operate well under large fluctuations of headwater or tailwater elevations. A design solution for the fluctuating tailwater at the Ellsworth dam would be to incorporate a section of vertical slot fishway that spans the fluctuation range similar to the existing trap and transfer facility entrance in the Ellsworth Dam tailwater. The 11foot seasonal headwater range at Graham Lake Dam would present a formidable design challenge for an Ice Harbor or pool and weir fishway exit structure. The design would need to incorporate some way of adding or removing weirs as the water levels change. Black Bear Hydro is not aware of any existing pool and weir fishway that has been constructed under such a large headwater range, suggesting that the Ice Harbor or pool & weir design is not feasible at Graham Lake Dam. At best, a design solution would be extremely expensive, likely increasing costs 50% to 100% over comparable Denil or fish lift designs.

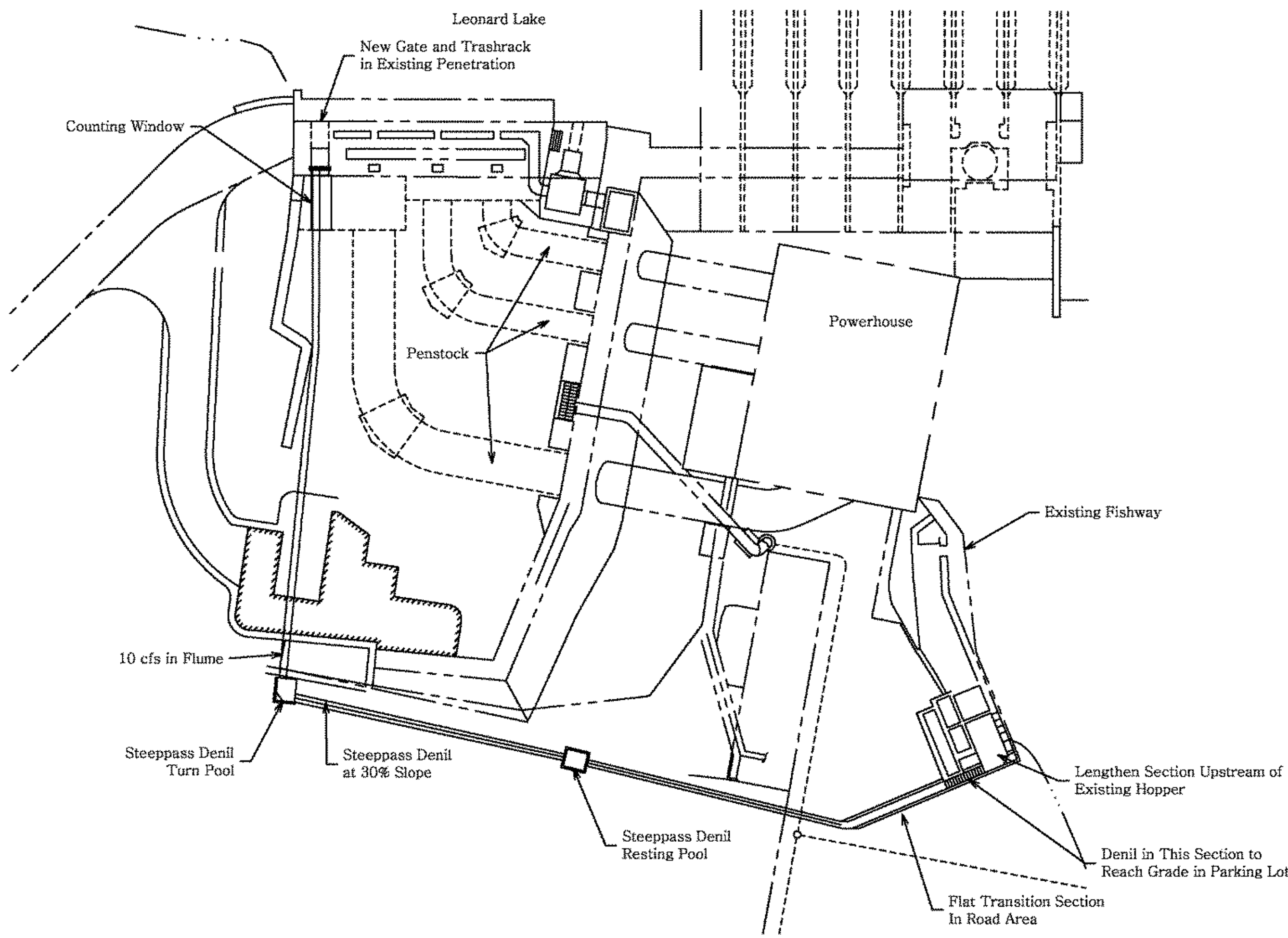
In summary, an Ice Harbor or similar pool & weir fishway may perform well for Atlantic salmon passage, but this design has a poor record for non-salmonid fish passage effectiveness. An Ice Harbor or pool & weir design could be used at Ellsworth Dam to provide volitional passage to Lake Leonard for Atlantic salmon only, similar to the steeppass and Denil designs discussed below; however, Ice Harbor or pool & weir design fishways do not perform well with large headwater or tailwater variation and would be excessively expensive to design and construct. Therefore, Ice Harbor and pool & weir fishway designs have not been evaluated further for the Ellsworth Project.

3.1 Ellsworth

Steeppass Denil

The steeppass Denil ladder alternative is intended to provide volitional passage to Lake Leonard for Atlantic salmon only. A plan view layout concept for a steeppass Denil ladder is shown in Figure 11. The ladder entrance is located at the back of the extended hopper pool described above in Section 2.3. In this alternative, the hopper is removed from the trap and river herring are excluded by the finger weir and pumped out of the holding pool for transport or harvest. Just inside the ladder entrance there is a short section of steeppass to reach the appropriate grade for the sluice crossing under the entrance road. From the road, a 170-foot-long steeppass on a 30% slope ascends the steep bank just southwest of the powerhouse. There is one resting pool half way up the ladder and a turning pool at the top, transitioning into a sluice that runs across the old forebay fill area, to a counting window, and then exit through an existing knock-out penetration in the intake structure into Lake Leonard. The hydraulic capacity of the steeppass and sluiceway is 5 to 10 cfs depending on the level of Lake Leonard at the sluiceway exit.

FIGURE 11
ELLSWORTH STEEPPASS DENIL LADDER ALTERNATIVE



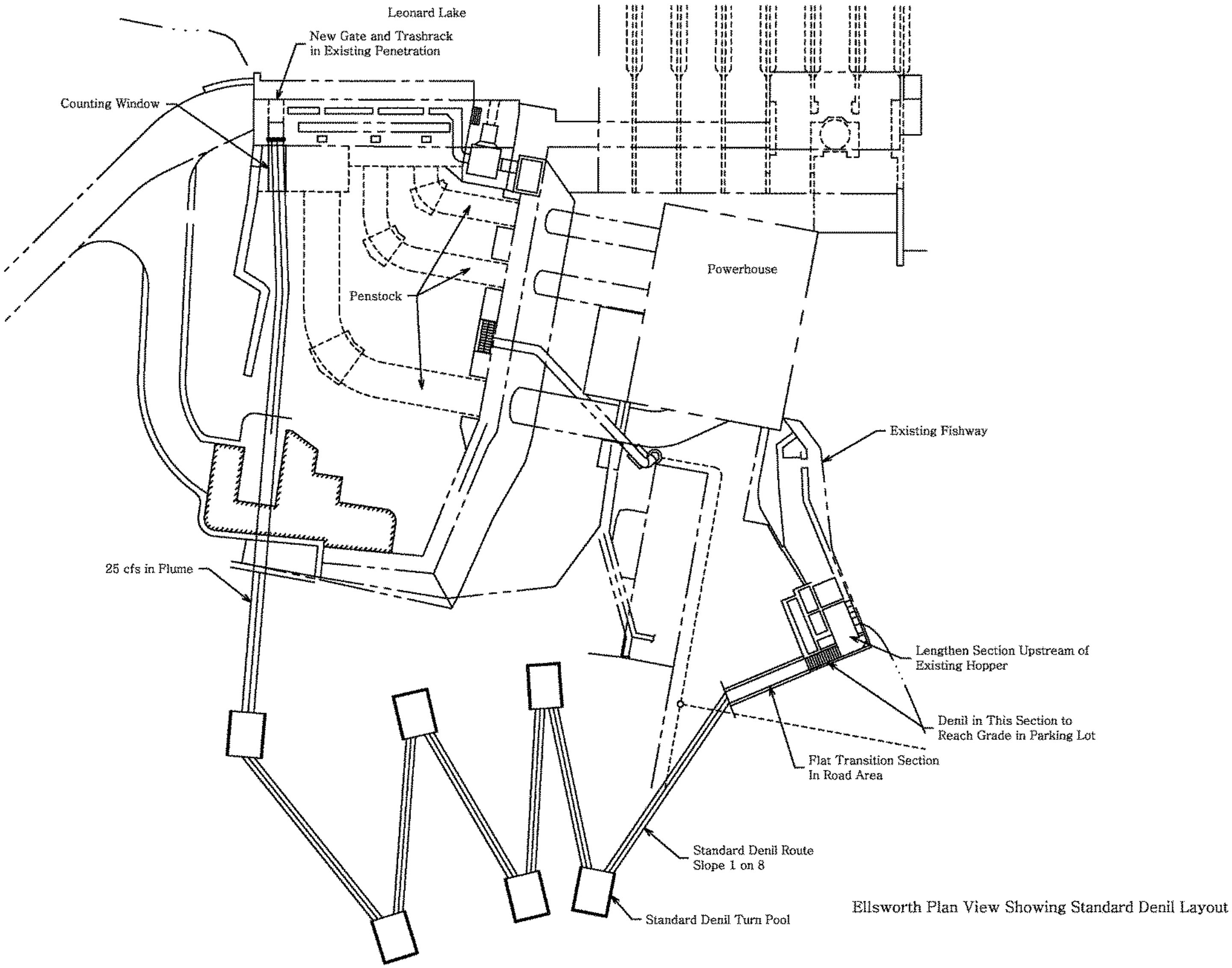
Ellsworth Plan View Showing Steeppass Denil Layout at 30% Slope

Standard Denil

The standard Denil ladder alternative is similar to the steeppass except that the ladder is much longer due to a more gradual slope of 1 on 8 (12.5%) and a much higher hydraulic capacity of 25 to 30 cfs. A plan view layout concept for a standard Denil ladder is shown in Figure 12. The ladder entrance is located at the back of the extended hopper pool described above in Section 2.3. In this alternative, the hopper is removed from the trap, and river herring are excluded by the finger weir and pumped out of the holding pool for transport or harvest. Just inside the ladder entrance there is a short section of standard Denil to reach the appropriate grade for the sluice crossing under the entrance road. From the road, the Denil ladder runs 385 linear feet through six turning / resting pools at 8 feet vertical / 64 feet horizontal intervals resulting in a "W" shape layout, ascending the steep bank just southwest of the powerhouse. At the top elevation, the ladder transitions into a sluice carrying 25 to 30 cfs that runs across the old forebay fill area, to a counting window, and then exits through an existing knock-out penetration in the intake structure into Lake Leonard.

With the standard Denil conceptual design described above, river herring are removed from the fishway in what was the original trap holding pool via a fish-friendly pump for both transport of the required spawning escapement (315,000 fish) upstream and for commercial harvest of the remaining surplus fish. In theory, however, the standard Denil could volitionally pass the spawning escapement upstream, eliminating the need for the fish pump system and subsequent transport of fish. The USFWS recommends a standard Denil capacity limit of 200,000 river herring; however, there is empirical data for a similar standard Denil at Woodland Dam on the St. Croix River that passed over 1,000,000 river herring in a single season two times, once in 1986 and a second time in 1988. This data strongly suggests that a standard Denil at Ellsworth could easily pass the required 315,000 spawning escapement upstream, in addition to the 750 design population of Atlantic salmon.

FIGURE 12
ELLSWORTH STANDARD DENIL LADDER ALTERNATIVE



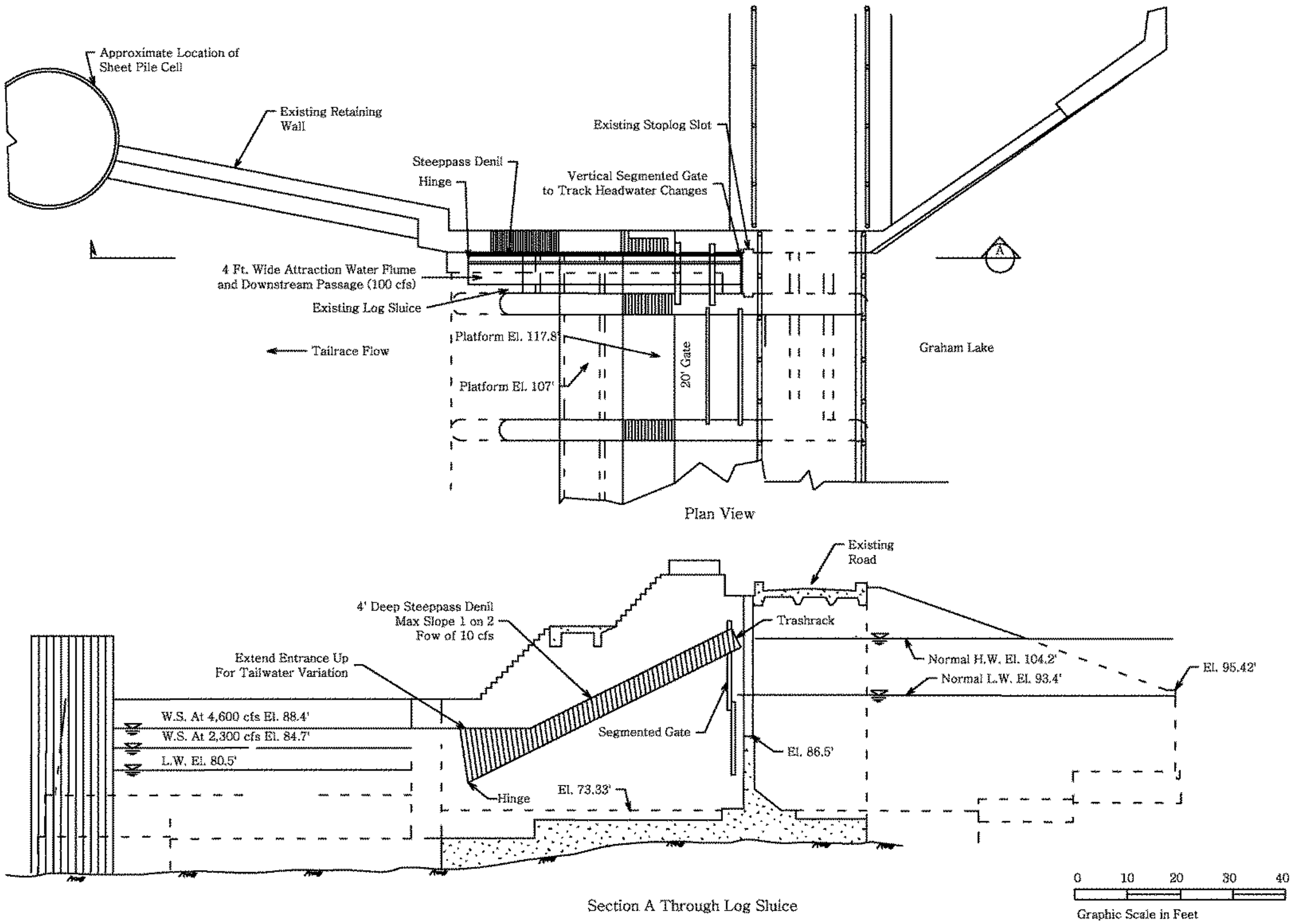
3.2 Graham Lake

One of the benefits of trap and transport from Ellsworth Dam is that anadromous fish can be returned to the Union River above both Ellsworth and Graham Lake Dams quickly and with nearly 100% passage efficiency. With the provision of volitional passage via fish ladders at Ellsworth Dam comes the requirement of volitional passage at Graham Lake Dam to get anadromous species to their spawning and rearing habitat. The two subsections below discuss concepts for a steeppass Denil and standard Denil fishway at Graham Lake Dam. The biggest challenge for both of these fishway designs is the headwater fluctuation in Graham Lake that can vary up to 11 feet below full pond elevation. While both Denil designs below are able to accommodate the full headwater range of 11 feet by adjusting fishway slope to follow headwater variation, they are also designed to be at near optimal slope at the target headwater elevations of 104 to 98 feet for May 1 through October 31 (Figure 2).

3.2.1 Steeppass Denil

The steeppass Denil would be located in the log sluice bay of the Graham Lake Dam gate structure, where the current minimum flow and downstream passage are released through a surface weir notch in the stoplogs near the top of the log sluice. The conceptual layout of the steeppass is shown in Figure 13. The steeppass itself is 22 inches wide, 48 inches deep, and 60 feet long with a hinged foundation at the downstream entrance, and the top is built into a segmented gate installed just downstream of the stoplogs. The side walls of the steeppass are built up at the lower end to maintain function at high tailwater elevations. While the steeppass is designed to adjust over the full operational range of 5 to 24 feet of head (8% to 40% slope) during the vast majority of the fish passage season, Graham Lake will be between elevation 98 and 104 feet and the steeppass slope will be between 22% and 33%. The steeppass only passes 5 to 10 cfs, and in order to supplement this flow, a 4-foot-wide flume that will pass 100 cfs would run parallel to the steeppass. This flume will provide a fishway attraction flow, minimum instream flow, and serve to pass downstream migrant fish. Flow into the flume would be controlled by a bottom drop gate. This system is not a traditional supplemental attraction flow system, but should draw fish to the area where they can enter the adjacent steeppass.

FIGURE 13
GRAHAM STEEPPASS DENIL PLAN

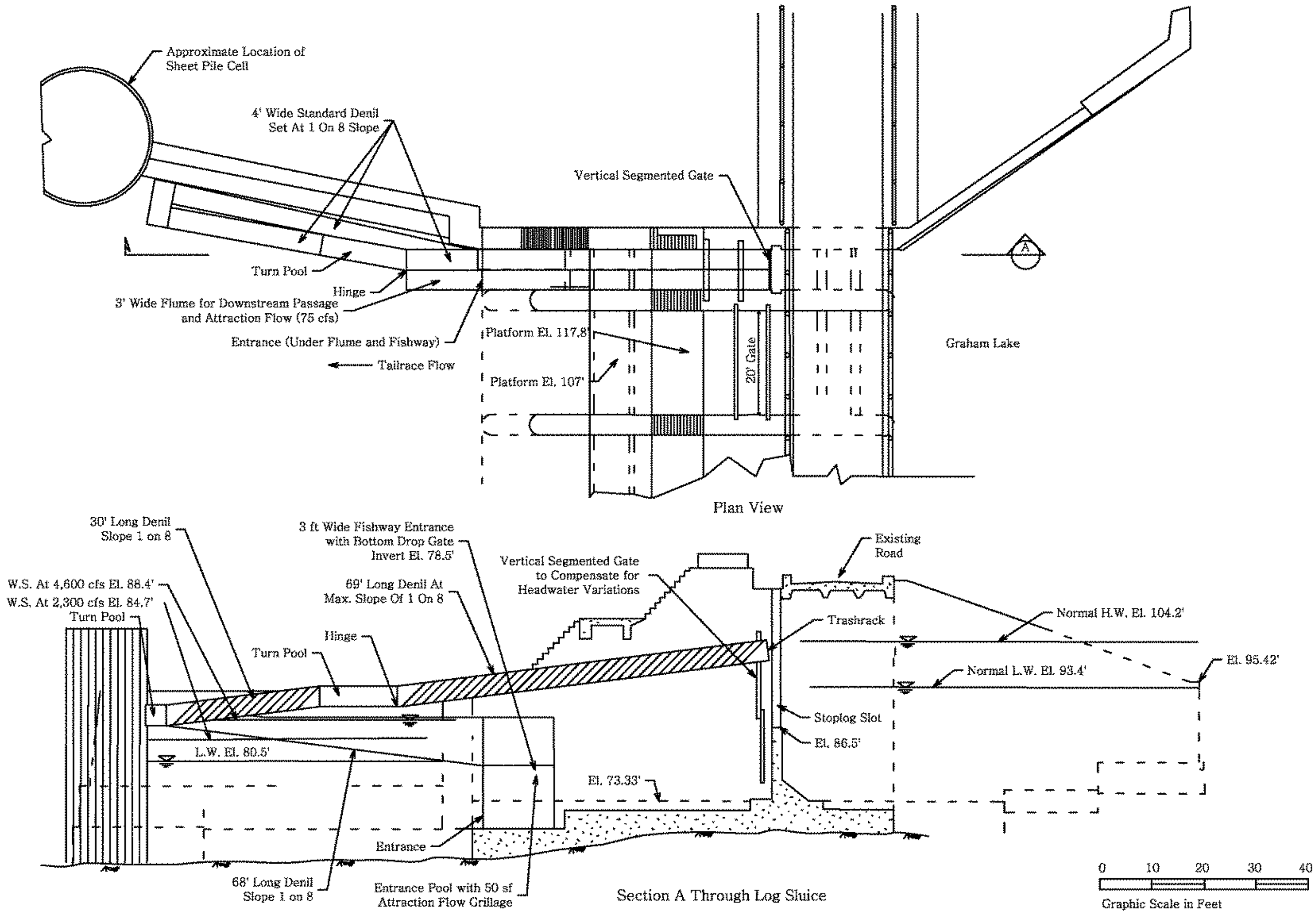


3.2.2 Standard Denil

The standard 4-foot-wide, 6-foot-deep Denil fishway conceptual layout in the log sluice bay at Graham Lake is illustrated in Figure 14. The Denil is designed with a slope not to exceed 1 on 8 and has resting pools at 8-foot-head intervals. The site head varies from a maximum head of 24 feet to a minimum of 5 feet. In order to accommodate the changing headwater elevation in Graham Lake, the upper 70 linear feet of Denil is hinged at the lower end with the upper exit of the Denil sitting on a segmented gate installed just downstream of the stoplogs. This permits the Denil to match the potential 11 foot headwater change. At full pond elevation, the slope of this hinged section is 1 on 8 and at minimum pond elevation it is almost flat with a 1 on 70 slope. In the normal lake level operating range during fish passage season, the slope varies from 1 on 8 at elevation 104 feet to approximately 1 on 25 at elevation 98 feet.

The Denil passes only 25 to 35 cfs. To supplement this flow for fish attraction, downstream passage, and minimum flow requirements, a 3-foot-wide flume with capacity to pass 75 cfs has been added to the log sluice, running parallel to the upper section of the Denil discharging in the vicinity of the entrance to the ladder. This system would screen off approximately 50 cfs supplemental attraction flow for the fishway entrance chamber to achieve a total attraction flow of 75 cfs. The Denil has a traditional entrance structure with an automatic entrance gate and supplemental attraction flow to accommodate tailwater changes.

FIGURE 14
GRAHAM STANDARD DENIL PLAN



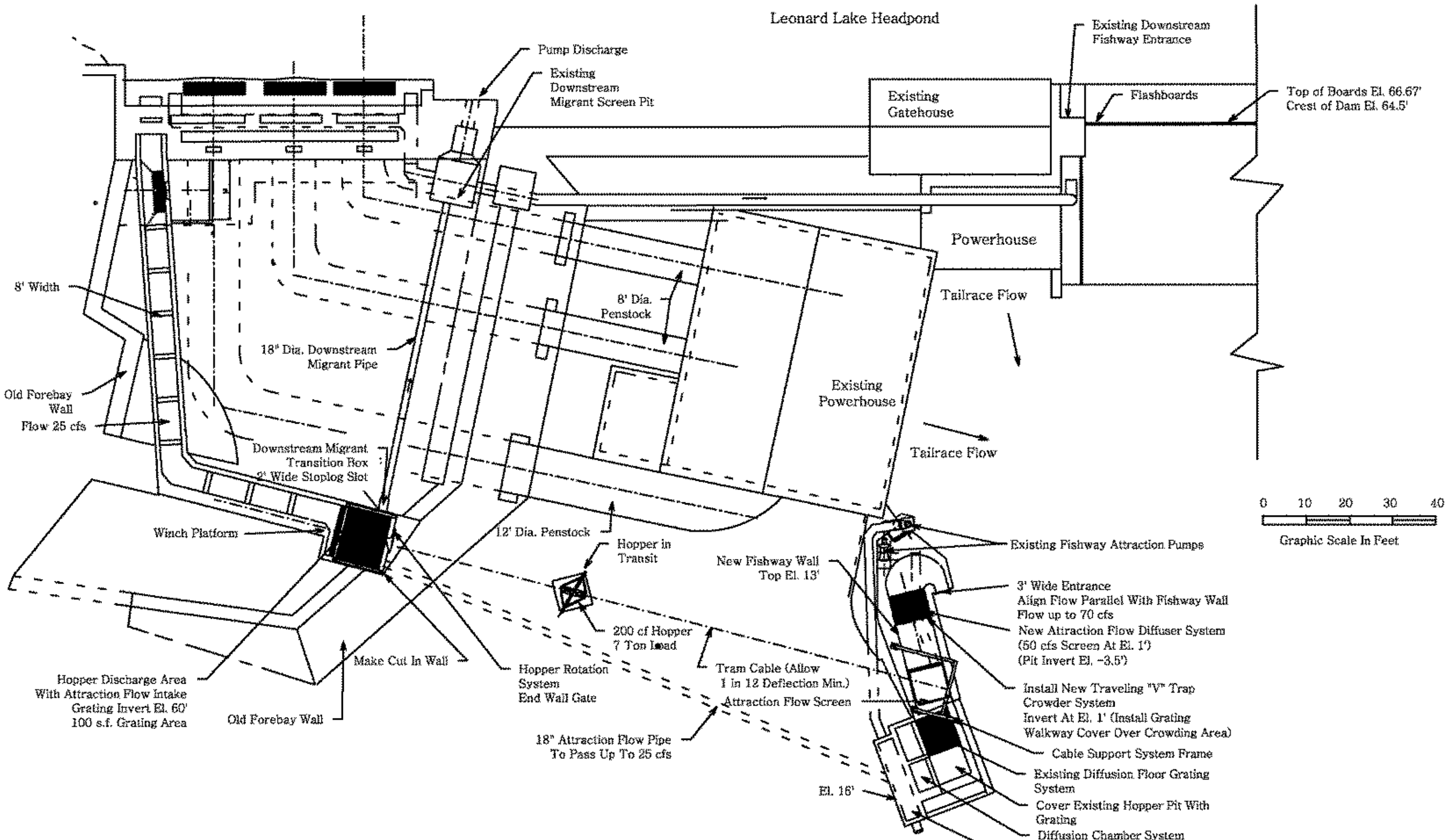
4.0 LIFT ALTERNATIVES

The following two fish lift concepts are nearly identical to the designs that were developed for the Ellsworth Project in 1994 and 1995 in consultation with resource agencies and ultimately approved by FERC in an order issued on January 26, 1996. However, the FERC order was subsequently challenged by the licensee and reversed in court and the fishway was not built.

4.1 Ellsworth Fish Lift with Cable Car Hopper

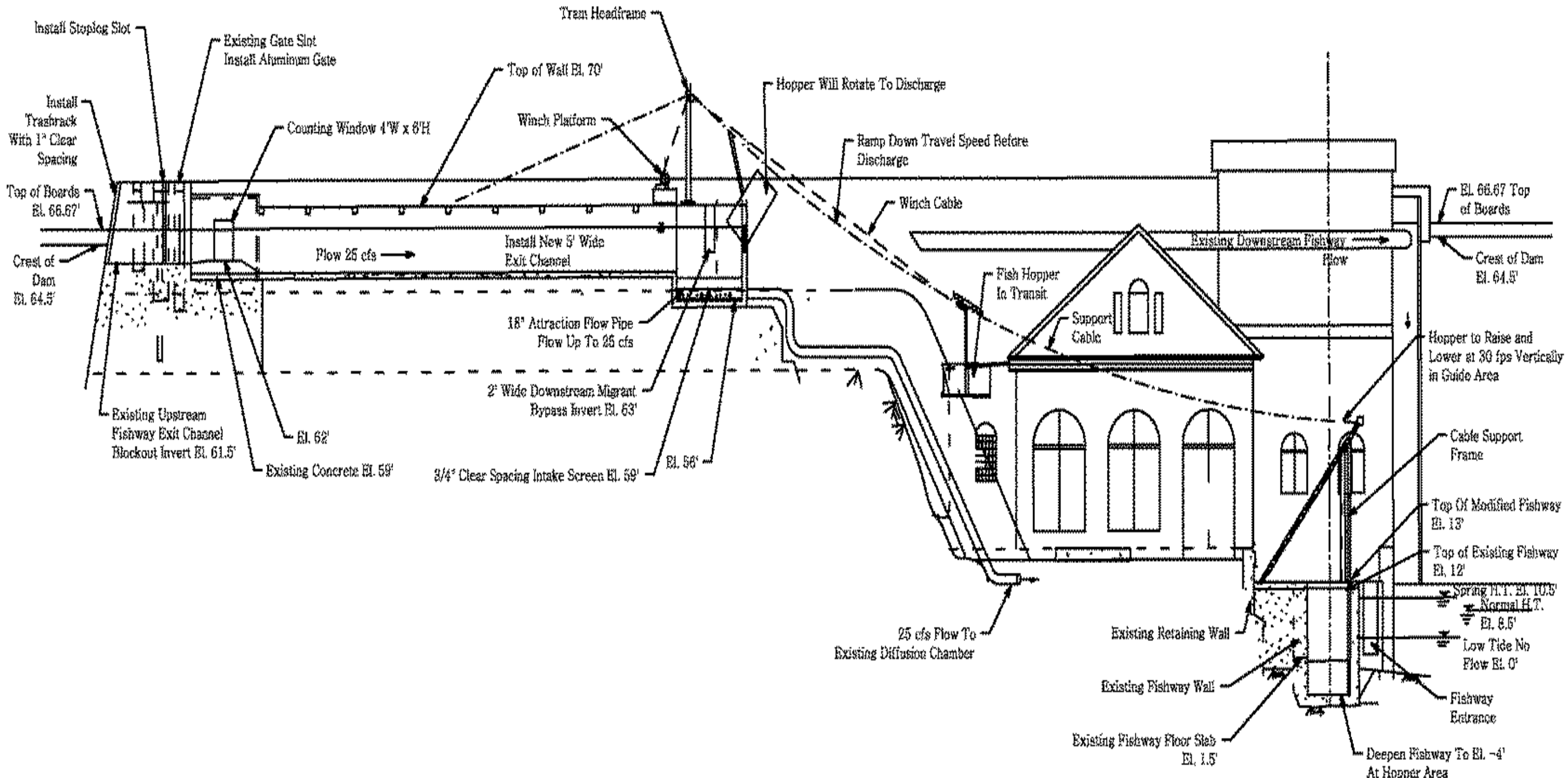
The fish lift design concept at Ellsworth Dam is illustrated in Figures 15 and 16. Contrary to the other fishway concepts developed for Ellsworth (Denil, steeppass, and trap/transport) that utilized the same fish trap entrance and vertical slot baffles leading to the holding and hopper pools, this fish lift concept involves a substantial redesign of the fishway entrance and trap area. The fishway entrance gate is reoriented to discharge downstream parallel to the fishway wall and increased to 3 feet wide allowing a 70 to 75 cfs attraction flow (approximately 3% of powerhouse hydraulic capacity). Additionally, the vertical slot baffles, outer wall, and floor of the existing trap entryway will be demolished to widen the channel to 10 feet, level the floor, and add new attraction flow diffusers and traveling V-trap crowder system leading to a new 200-cubic-foot hopper. The current lift structure would be removed and a new 7-ton hoist and tram tower would be constructed to provide the lower support for a 7-ton industrial tramway adapted from a mining industry design. Near the top of the hill, southwest of the powerhouse, the second tram tower and receiving platform would be constructed just below Lake Leonard surface elevation to receive the hopper and fish. From the upper platform, the hopper is discharged into an 8-foot-wide sluiceway conveying 25 cfs from the fishway exit at a penetration through the intake structure. A counting window is located on the sluiceway just before the exit into Lake Leonard. An 18-inch pipe running from the downstream end of the sluice to the diffusion chamber at the lower hopper pool would receive the 25 cfs flow from the sluice as attraction flow. The existing supplemental attraction flow pumps would provide the 50 cfs balance of the required 75 cfs attraction flow at the fishway entrance.

FIGURE 15
ELLSWORTH FISH LIFT CONCEPT PLAN



Ellsworth Upstream Fishway Entrance Structure Modification
Tramway System, Exit Channel, and Counting Station
General Plan View

FIGURE 16
ELLSWORTH FISH LIFT CONCEPT SECTION



Section Through Forebay Fish Tram System

4.2 Graham Lake Fish Lift

The Graham Lake Dam fish lift concept shown in Figures 17 and 18 is designed to be constructed in the existing log sluice bay. This log sluice is presently being used for downstream fish passage, so a new structure for downstream fish passage is illustrated to be built in the adjacent Tainter gate bay.

For construction, the existing upstream timber stoplogs would be replaced with aluminum logs for an upstream dewatering barrier. A downstream cofferdam would be constructed on the existing concrete gate apron. There is a structural concern with the walls when they are dewatered, so internal bracing would have to be installed. To accommodate general maintenance, a head gate would be installed just downstream of the stoplogs.

The fish lift entrance gate is a typical segmented bottom drop gate with an electric actuator. The gate is designed to pass 70 cfs attraction flow. Just downstream of the fish lift entrance gate there is a stoplog slot to allow for maintenance of the gate. The lift utilizes a brail-type crowder with a 180-cubic-foot hopper. The lift adjusts fish discharge elevations to accommodate the 11-foot headwater fluctuation range. This lift is sized to accommodate up to a design population of 1,700,000 river herring (75% of the Ellsworth lift) and 750 Atlantic salmon. There is no counting station at the Graham Lake fish lift. Estimates of fishway effectiveness would be achieved by PIT tagging fish at Ellsworth and monitoring for PIT tags at Graham.

FIGURE 17
GRAHAM FISH LIFT CONCEPT

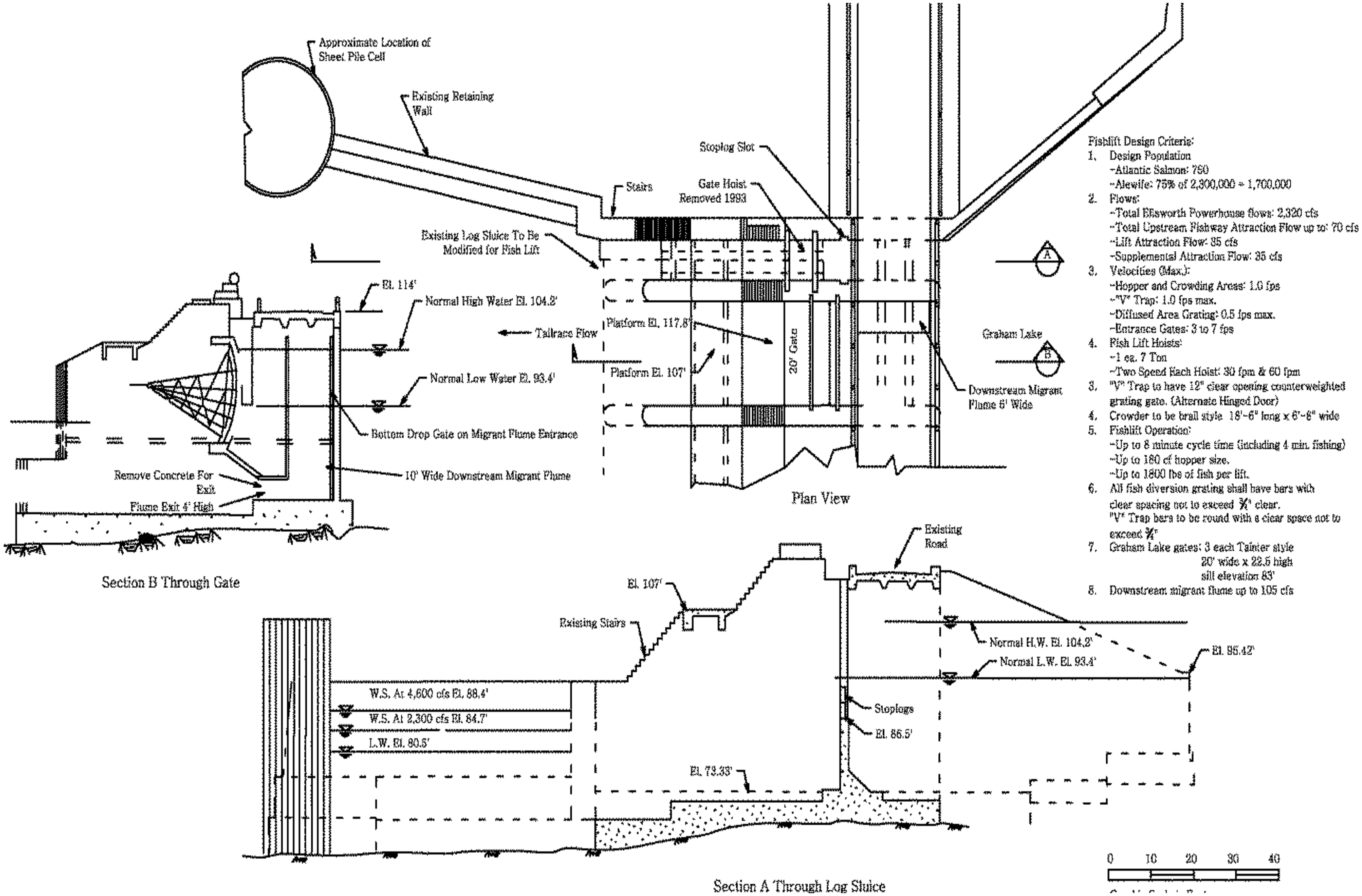
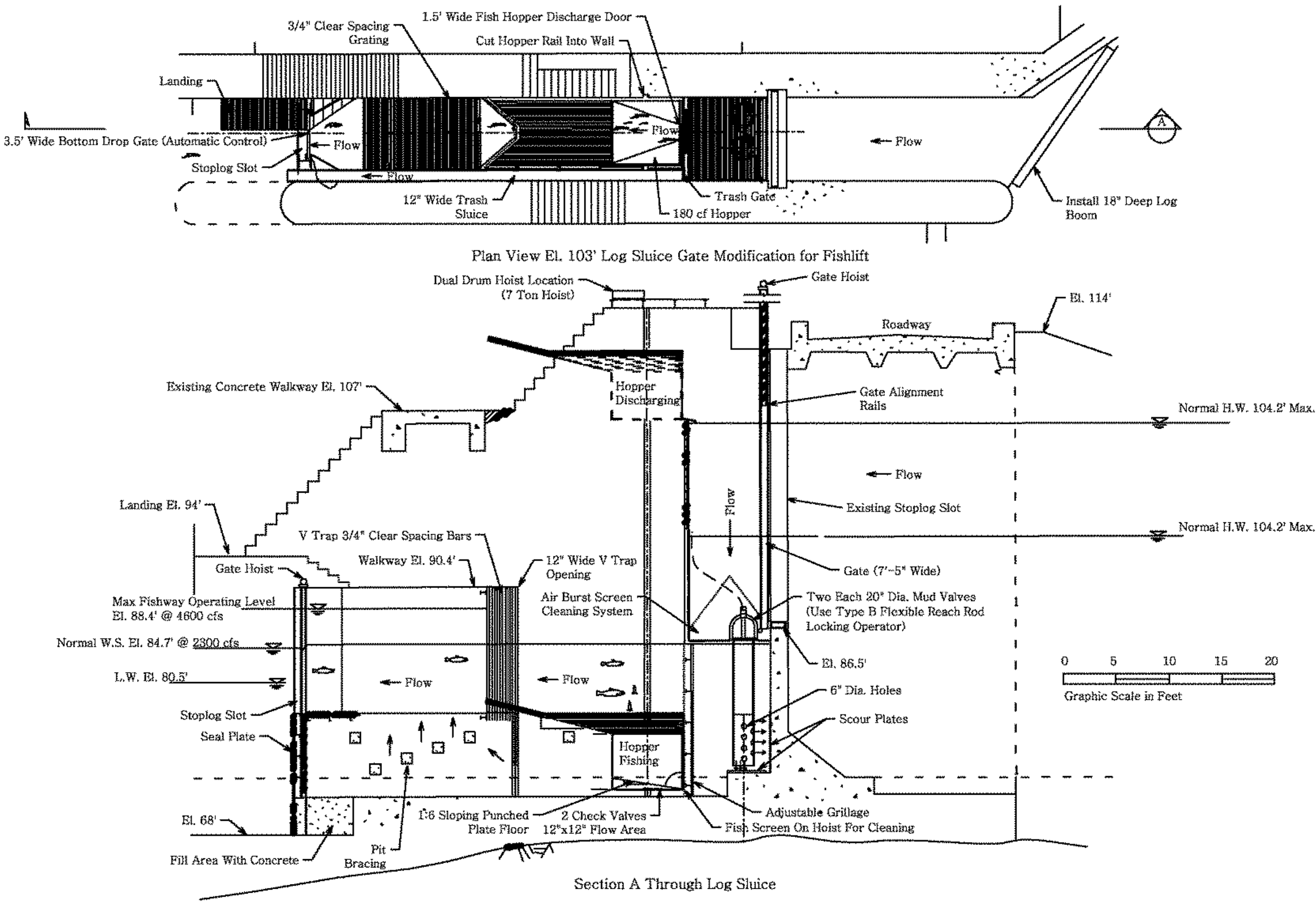


FIGURE 18
GRAHAM FISH LIFT CONCEPT



5.0 DECOMMISSIONING

5.1 Ellsworth Dam

The Ellsworth Dam is an Ambursen dam, constructed by the Ambursen Hydraulic Construction Company under direction from the Chief Engineer, James A. Leonard, with construction beginning in February 1907 and completed on November 14, 1907[4]. Construction of the project involved excavation of over 3,000 cubic yards of bedrock for use as aggregate in the concrete. Three low-level sluices were constructed in bays 14 through 16, and river flow was diverted during construction through the buttresses in the dam and ultimately through the three low-level sluices.

In the early 1990s, a majority of the Ambursen dam was filled with concrete to comply with FERC stability guidelines specific to Ambursen dams to address sliding stability and lateral earthquake stability. All the bays of the dam received concrete fill, with some bays also receiving post-tensioned rock anchors. The low-level sluices were also filled with concrete.

5.1.1 Full Dam Removal

A conceptual cost estimate was prepared to estimate the costs of full dam removal at the Ellsworth Hydro project, including all appurtenances. The costs for removal include:

- Main dam removal;
- Powerhouse removal;
- Fishway removal;
- Penstock removal;
- Forebay wall and intake wall removal;
- Forebay fill removal;
- Substation removal; and
- River bank restoration.

The demolition costs include water handling during construction, which was estimated to be managed by releases through the existing hydro equipment flow passages, operation of the

[4] Ambursen Hydraulic Company report on the Bar Harbor and Union River Power Company dam, undated.

upstream storage project, and the installation and operation of siphons during construction. The siphons were required, as the project has no low-level outlets and is incapable of passing flow lower than the invert of the hydro intake structures. Costs were included for removal of the turbine equipment and modifications to the turbine head cover to be able to pass flow without unit braking or unit runaway. The siphons were required to be reset multiple times during the demolition of the dam for flow diversion, due the head limitation of the operation of siphons. A temporary 120-foot-long bridge across the powerhouse tailrace and gravel road along the toe of the dam was planned to provide access to the dam for the removal of concrete demolition debris. The powerhouse, penstocks, old forebay walls, intake wall, fishway, and miscellaneous concrete walls were estimated to be removed and the debris hauled off-site to an approved disposal facility.

The cost opinion for this alternative does not include any sediment dredging post-demolition work along the dewatered reservoir or recreational access to the site. The potential cost of providing a temporary means of fish passage during demolition was also not included.

5.1.2 Partial Dam Removal

The conceptual costs for the partial dam removal of the Ellsworth Dam were estimated to include:

- Removal of a portion of the main dam, bays 8 through 22, leaving a portion of the east abutment in place and the balance of the dam, intake, penstocks, and powerhouse. Demolition and water handling is the same as in the full removal.
- The generating equipment would be removed as in the full removal, primarily for safe discharge capacity during dewatering.
- The intake structure and appurtenances, including the old forebay walls, would be left in place with portions of the penstocks plugged and filled with concrete for safety.
- The fishway facilities would be removed and the area restored, as in the full removal.
- The substation equipment and appurtenances would be removed and restored, similar to the full removal.
- Security fencing of the intake and forebay would remain.

The cost opinion for this alternative does not include any sediment dredging post-demolition work along the dewatered reservoir or recreational access to the site. The potential cost of providing a temporary means of fish passage during demolition was also not included.

5.2 Graham Lake Dam

Graham Lake Dam is an earthen embankment dam constructed as a storage project to augment flows to the downstream Ellsworth Hydro project. The project consists of an earthen embankment and a gated discharge structure. The original gated structure failed in 1923 during high flows and was rebuilt and extended to a bedrock foundation. In the early 1990s concerns about the stability of the earthen embankment and the potential for liquefaction of the embankment materials led to the construction of a downstream gravity dam and modifications to the existing embankment dam in 1992 to comply with updated FERC stability criteria. The downstream gravity dam includes a permanent cellular cofferdam segment.

5.2.1 Full Dam Removal

The full removal of the Graham Lake Dam includes:

- Removal of the embankment fill material;
- Removal of the concrete gated structure;
- Removal of the downstream gravity dam and permanent cellular cofferdam; and
- Removal of the concrete connector wall between the gated structure and the permanent cellular cofferdam.

The demolition costs include the water handling during demolition to dewater Graham Lake through operation of the three Tainter gates and subsequent removal of the Tainter gates to facilitate diversion of flows. Following lowering of the reservoir, the earthen embankment would be excavated with a section of the excavation deep enough to use for flow diversion to dewater, demolish, and remove the concrete gated structure and foundations. The concrete gravity section would be excavated to provide access to demolish and remove the remaining concrete structure, including the permanent cellular cofferdam and closure wall. Costs include grading and loam and seed for the site, but no additional costs were included for landscaping.

The cost opinion for this alternative does not include any sediment dredging post-demolition work along the dewatered reservoir or recreational access to the site. The potential cost of providing a temporary means of fish passage during demolition was also not included.

5.2.2 Partial Dam Removal

The conceptual cost estimate for the partial removal of the Graham Lake Dam includes costs for:

- Removal of the concrete gated discharge structure and three radial gates;
- Removal of a portion of the embankment dam and riprapping of the sloped face of the remaining earthen embankment; and
- Removal of the concrete connection wall between the gated structure and the permanent cellular cofferdam.

The partial removal concept includes removal of a portion of the earthen embankment which abuts the concrete gated discharge structure and the permanent cellular cofferdam. This section of the removed earthen dam will provide flow diversion during the demolition and removal of the concrete gated section and foundation. The demolition of the concrete gated section and foundation will require the construction of temporary upstream and downstream cofferdams to dewater the gate section and foundations.

The cost opinion for this alternative does not include any sediment dredging post-demolition work along the dewatered reservoir or recreational access to the site. The potential cost of providing a temporary means of fish passage during demolition was also not included.

6.0 ESTIMATED COSTS OF ALTERNATIVES

6.1 Capital Costs

Estimated capital costs for each fish passage alternative are summarized in Table 2. The direct costs are based on experience with similar projects to develop estimates of unit costs and labor.

Indirect costs were estimated at:

30% Conceptual design level contingency
10% Mobilization and demobilization
5% Permitting
15% Engineering
10% Contractor profit
2% Brookfield project management

Annual O&M costs at Ellsworth would be expected to be similar to what it cost to run the existing trap and transport facility in 2015, which was approximately $90,000. Graham Lake O&M costs would be approximately 50% of Ellsworth or approximately $45,000 depending on the final design alternative selected.

TABLE 2
ESTIMATED CONCEPTUAL LEVEL COST OPINIONS FOR EACH FISH PASSAGE ALTERNATIVE

Fish Passage alternative	Ellsworth Dam	Graham Lake Dam
Trap & Truck – Separation of Alewife and Salmon	$225,000	N/A
Steeppass Denil	$1,500,000	$1,500,000
Standard Denil	$1,800,000	$2,200,000
Fish Lift	$3,700,000	$2,300,000
Decommissioning and Full Removal	$12,300,000	$10,400,000
Decommissioning and Partial Removal	$8,000,000	$3,200,000

6.2 Renewable Energy Costs

The Ellsworth Project has a total rated capacity of 8,900 kW, with gross annual energy production of about 30,333,000 kWH. Project decommissioning would mean the loss of this clean, reliable, and renewable hydropower energy source. All other passage alternatives considered would have negligible impacts on the current level of renewable energy production.

7.0 FISH PASSAGE EFFECTIVENESS AND EFFECTS ON OTHER ANADROMOUS SPECIES

This section evaluates the effectiveness of the fish passage alternatives on the target species, Atlantic salmon and river herring, as well as potential effects on other anadromous species known to frequent the Union River or rivers in the vicinity of Ellsworth, such as American shad, Atlantic and shortnose sturgeon, sea lamprey, rainbow smelt, tomcod, and striped bass. Historic use of the Union River above the Ellsworth Project is unknown for many of these species due to the higher gradient of the river at the dam site, which may have naturally inhibited migrations for weaker swimming species, and sparse historical data. Regardless of historic presence, each of these fishway alternatives offers the potential for future access to waters above Ellsworth Dam on a selective basis, due to the maintenance of trapping and transport operations on all but the fully volitional lift option. It is important to note that for all the Ellsworth fishway alternatives evaluated except the fish lift, a short section of 3 or 4 vertical slot baffles in the entrance must be passed before reaching the subsequent hopper, ladder, or transport/harvest station.

For the two primary target species, Atlantic salmon and river herring, passage effectiveness should be high. Atlantic salmon and river herring will readily pass the vertical slot entrance baffles as demonstrated over the operating history of the current facility. Lifts with optional sorting and transport facilities are common in Maine because of their proven effectiveness at fishways such as Cataract and Skelton on the Saco River, Lockwood on the Kennebec River, and Milford on the Penobscot River. With use of the finger weir to isolate salmon from all other species, upstream passage via either a steeppass or Denil ladder will work well for salmon. In the Maine DMR inventory of fishways in Maine shown in Table 3, it can be seen that Denil ladders are currently in use at the first dam on seven rivers. While the table ranks American shad passage effectiveness as moderate to low, these ladders were typically installed for the primary purpose of passing Atlantic salmon (and/or river herring) as these species readily pass a Denil ladder with high efficiency.

TABLE 3
MAINE DMR FISHWAY INVENTORY

River/Watershed	Distance to first mainstem dam (km)	First Mainstem Dam Name	Fish Passage Type	Shad Passage Potential	Dam Ownership	FERC License	FERC License Renewal
Salmon Falls/ Piscataqua River	26.8	South Berwick Dam	Denil	Moderate	Consolidated Hydro New Hampshire, Inc	Yes	11/30/2037
Salmon Falls/ Piscataqua River	26.6	Great Works Pond Dam	None	None	Great Works Hyrdo Co.	No	
Webhanet River	None						
Little River	3.3	Skinners Mill Dam	None	None	Not listed	No	
Mousam River	6.8	Kessler Dam	None	None	Kennebunk Light and Power District	Yes (3 dams)	3/31/22
Kennebunk River	27.9	Days Mill	None	None	Private	No	
Saco River	9.3	Cataract Project	Fish Lift, Denil, 2 fish locks	Low to Moderate	Brookfield Renewable Energy	Yes (4 dams)	11/30/29
Scarborough Marsh/ Nonesuch R.	None						
Presumpscot River	12.6	Cumberland Mills	Denil Fishway	Moderate	S. D. Warren	No	
Royal River	4.9	Bridge Street Dam	Denil Fishway	Low	Town of Falmouth	No	
Androscoggin River	48.2	Brunswick Project	Vertical slot	Low (Documented)	Brookfield Renewable Energy	Yes	2/28/29
Kennebec River	140.8	Lockwood Project	Fish Lift	Low	Brookfield Renewable Energy	Yes	10/31/36
Sebasticook River	173.6	Benton Falls	Fish Lift	Moderate	Essex Hydro Associates	Yes	2/28/34
Sheepscot River	44.0	Head Tide Dam	Slots	Moderate	Town of Alna	No	
St. George River	48.3	Sennebec Pond Dam	Rock Ramp	High	Sennebec Lake Assoc.	No	
Ducktrap River	17.9	Dickey Mill Dam	None	None	Not listed	No	
Penobscot Watershed	68.5	Milford Dam	Fish Lift	Low to Moderate	Bangor Hydro Electric Co.	Yes	4/1/38
Union River	7.3	Ellsworth Dam	Denil,Trap and Truck	Not Passed Upstream	Black Bear Hydro	Yes	12/31/18 (consulting)
Tunk Stream	None						
Narraguagus River	10.6	Cherryfield Dam	Denil Fishway	Moderate	Town of Cherryfield	No	
Pleasant River	None						
East Machias River	None						
Dennys River	None						
Pennamaquan River	2.9	Pembroke Cottage Dam	Denil Fishway	Moderate	Private	No	
St. Croix River	30.8	Milltown Power Station Dam	Denil Fishway	Moderate	New Brunswick Electric Co.	No	

Source: Maine DMR 2013. American Shad Habitat Plan, Prepared September 16, 2013, submitted to the Atlantic States Marine Fisheries Commission as a requirement of Amendment 3 to the Interstate Management Plan for Shad and River Herring, approved by ASMFC February 6, 2014.

Steeppass experience for Atlantic salmon passage in Maine is rare; however, this ladder design was specifically developed for salmon in Alaska where they are widely used and very successful, including use at barriers in excess of 60 feet high. As discussed earlier, river herring would be passed via transport trucks for the two ladder alternatives. For the volitional lift option, the vertical slot entrance is removed in favor of a deeper and larger standard lift entrance, a method frequently used to pass salmon and river herring successfully throughout the Northeast.

For American shad, the existing fishway, as well as the two salmon ladder alternatives with separation of sorting and transportation upstream, would function with low to moderate effectiveness. The vertical slot baffles will readily pass American shad, however a 0.75-foot-head differential between pools will typically pass shad more effectively as opposed to the 1.0-foot-head differential currently in place. For the volitional lift option, with proper entrance hydraulics, American shad passage effectiveness would be high. It should be noted, however, that according to the Maine DMR's shad habitat management plan (Maine DMR 2013) only 2 miles of river above Ellsworth Dam (to the top of Lake Leonard) is currently suitable for American shad, and there is no information provided on historical use of the river by shad. Therefore, the appropriate number of shad to be passed at Ellsworth Dam has not been determined.

For the remaining species - Atlantic and shortnose sturgeon, sea lamprey, rainbow smelt, tomcod, and striped bass, historic use of the Union River above the Ellsworth Project is largely unknown. Therefore, the potential benefits or risks, or need for upstream passage would need to be carefully considered. Atlantic sturgeon, shortnose sturgeon, striped bass, and sea lamprey are all known to pass through vertical slot fishways; however, the relative effectiveness for these species is generally unknown. Both rainbow smelt and tomcod are primarily tidewater estuarine species, they are relatively weak swimmers and passage effectiveness through a vertical slot fishway is likely poor. It is not known if these species even reach the base of Ellsworth Dam or if upstream passage would be appropriate from a fisheries management perspective. The volitional fish lift would likely pass these species because the vertical slot entrance is removed in favor of a deeper and larger standard lift entrance if they are able to negotiate the entrance hydraulics.

Dam removal passage effectiveness and environmental effects are considered separately in Section 8.0 below.

8.0 ENVIRONMENTAL BENEFITS AND IMPACTS

This section evaluates the potential benefits and impacts associated with dam removal alternatives in relation to the following resource areas:

- River herring production;
- Resident fisheries;
- Fish passage;
- Recreation;
- Sedimentation and water quality;
- Wetlands;
- Cultural resources; and
- Socioeconomic resources.

Each of these resource areas is considered in the subsections below.

8.1 River Herring Production

Current river herring management goals are intertwined with the amount of available spawning and rearing habitat upstream of the Ellsworth Dam, which would be greatly impacted by the removal of Graham Lake and Ellsworth Dams. According to the Comprehensive Fisheries Management Plan for the Union River Drainage (Management Plan) there are eight lakes totaling 10,204 acres in surface area under active river herring management in the Union River drainage. Lake Leonard and Graham Lake comprise 7,983 surface acres (78%) of this total. The Management Plan estimates that the full river herring production capability of the seven Phase I lakes is approximately 2,398,011 fish of which 2,040,860 are harvestable surplus. River herring production estimates for Lake Leonard and Graham Lake is 1,875,958 fish (based on lake area), and is also 78% of the total river basin potential (URFCC 2015).

The current acreage of Graham Lake at full pond is approximately 10,000 acres; however, during the spring and summer rearing period for river herring, the lake is being drawn down approximately 6 feet. For the purposes of estimating river herring production potential, an intermediate surface area of 7,865 acres is used (URFCC 2015). Using GIS and historical mapping (Figure 19), the surface water area of Graham Lake would decrease to 367 acres after dam removal, reducing the potential production of river herring to 86,245, which is approximately a 95% reduction in river herring production in Graham Lake. Similarly for Lake Leonard (Figure 20), which is currently estimated at 118 acres in size in the Management Plan (URFCC 2015), dam removal would reduce the acreage to about 14 acres, resulting in a potential river herring production of only 3,290 fish. This is an 88% reduction from the current production estimate for Lake Leonard of 27,730 fish, based on 235 fish per acre (URFCC 2015). Considering both lakes, Project decommissioning would result in the loss of 1,875,958 river herring for a 78% overall reduction in the seven Phase I lakes of the Union River Basin.

8.2 Resident Fisheries

In the Ellsworth Project area, warmwater species such as smallmouth bass, chain pickerel, and white perch are resident species in Graham Lake and Lake Leonard that provide sport fishing opportunities (Black Bear 2012). Largemouth bass were introduced illegally into Graham Lake in 2009 or 2010 and are expanding rapidly (personal communication with Greg Burr, Maine Department of Inland Fisheries and Wildlife [Maine DIFW] July 3, 2014). Good white perch fishing exists at Graham Lake, which also has a productive pickerel fishery (URFCC 2010), as well as a brown bullhead fishery (personal communication with Dick Fennelly, July 23, 2014). Removal of the two dams would transform this current lacustrine habitat to strictly lotic habitat and dramatically change the characteristics of the current resident fish community. Over all, decommissioning would convert 10,118 acres of lacustrine habitat to 381 acres of lotic habitat, a 95% reduction in surface area.

The benefits of dam removal include expanding the connectivity of habitat between the former sites of Graham Lake and Lake Leonard, as well as eliminating mortality risks due to turbine entrainment, and this section of the Union River would be restored to a free-flowing reach. Although suitable habitat for resident species exists both upstream and downstream from the Project, dam removal may allow for some species to locate new spawning and resident habitats that are currently inaccessible.

FIGURE 19
1911 USGS MAP OF GRAHAM LAKE VICINITY PRIOR TO DAM CONSTRUCTION

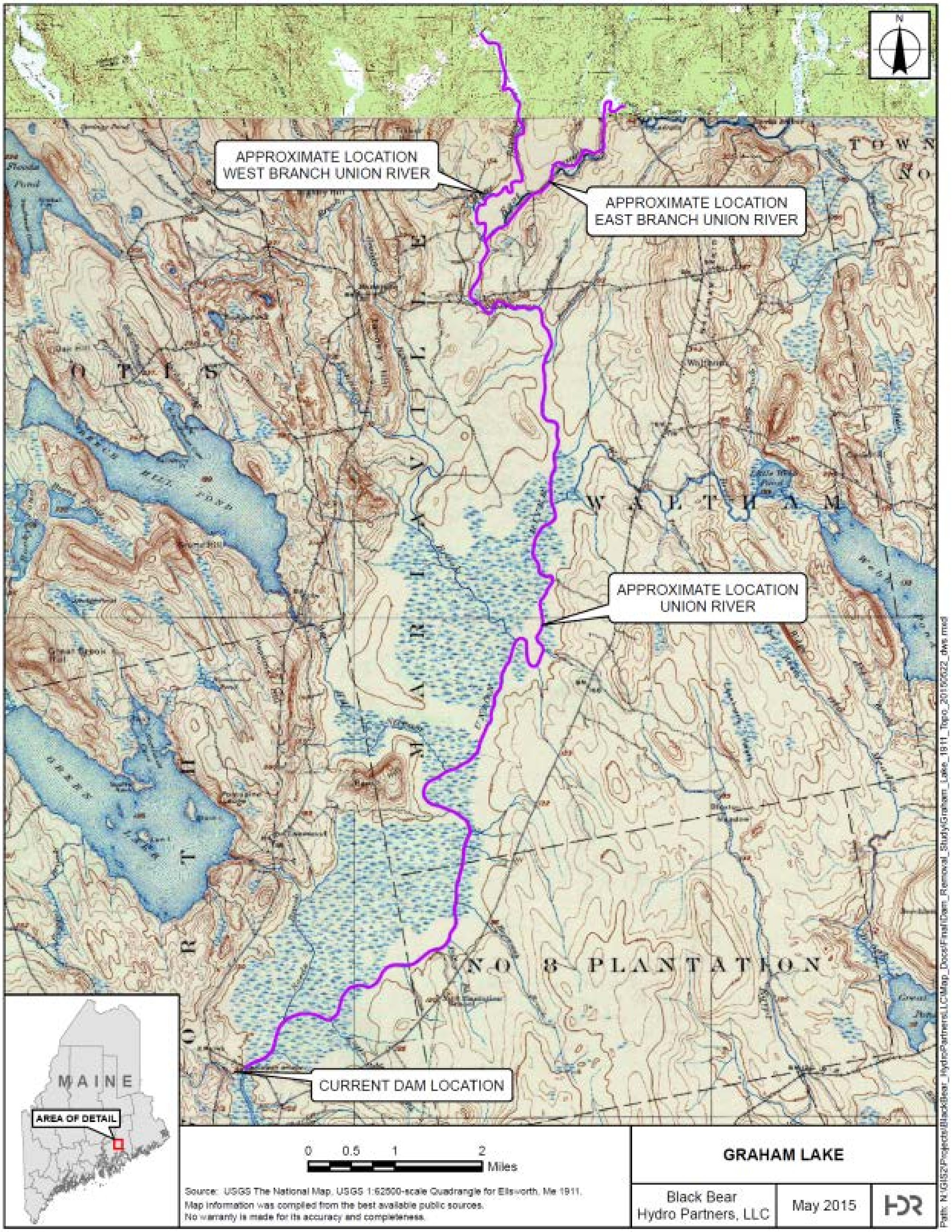
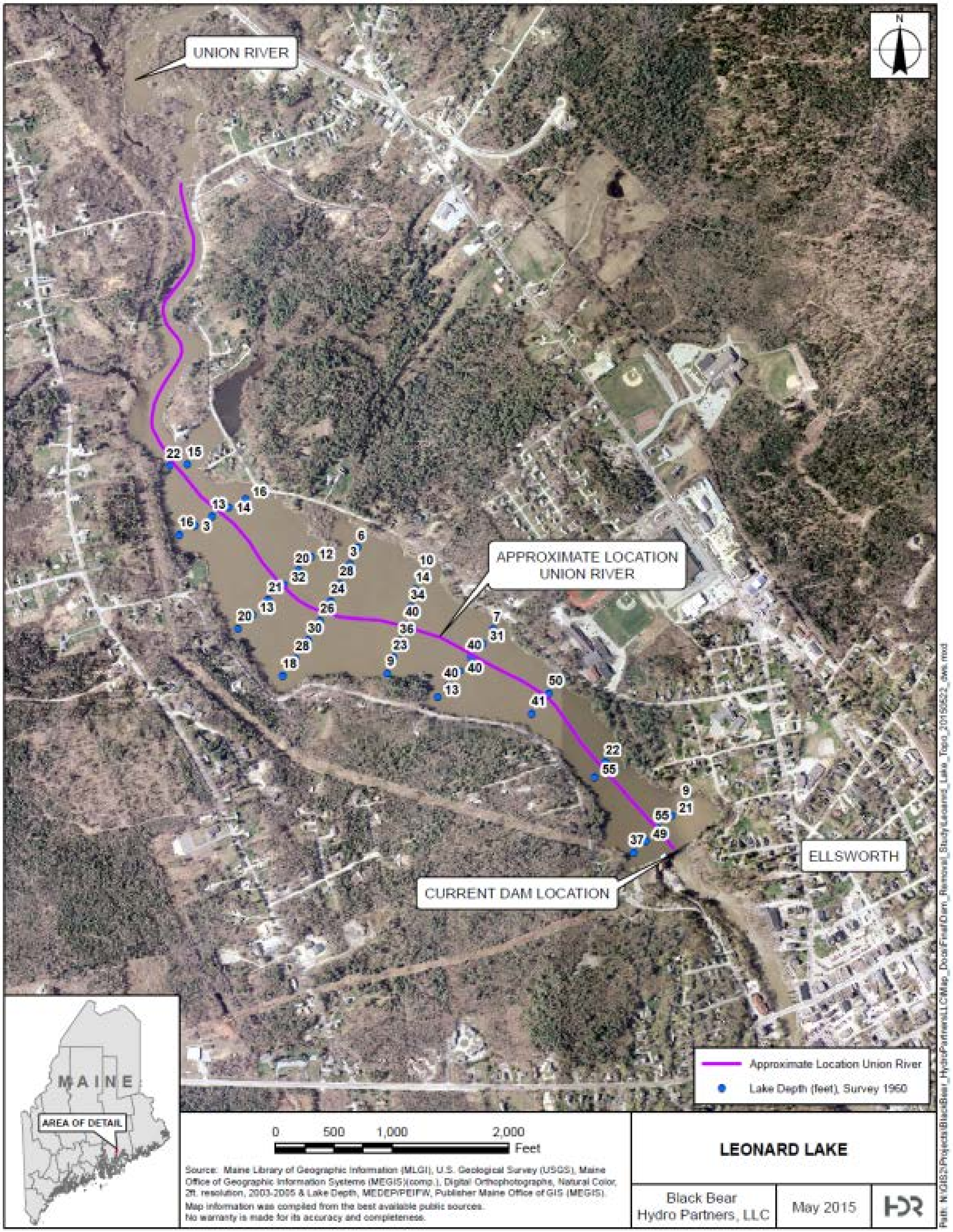


FIGURE 20
AERIAL PHOTOGRAPH OF LAKE LEONARD SHOWING BATHYMETRY SOUNDINGS AND APPROXIMATE RIVER CHANNEL LOCATION



8.3 Fish Passage

Decommissioning of the Ellsworth Project and removal of the Graham Lake and Ellsworth Dams would restore volitional accessibility and fish passage to historical habitat ranges for several diadromous and other migratory fish species, including sea-run Atlantic salmon, river herring, American eel, and possibly American shad. Atlantic and shortnose sturgeon, sea lamprey, rainbow smelt, tomcod, and striped bass are also know to frequent rivers in the vicinity of Ellsworth; however, their historic or potential future use of the Union River above the Ellsworth Project is unknown due to the higher gradient of the river at the dam site which may have naturally inhibited migrations for weaker swimming species. Dam removal would also facilitate downstream migration of these species back to the Atlantic Ocean by avoiding any potential injury or mortality from impingement or turbine entrainment.

8.4 Recreation

The Ellsworth Project provides a variety of public recreation opportunities. The area surrounding the Project is a mixture of year-round and seasonal residential development and undeveloped forest land. The Project is easily accessible from US Route 1 to the south and State Route 9 to the north via Route 179 along the easterly side of the Project and Route 180/181 on the westerly side of the Project. Public access to the Project is available over a combination of public highways, city streets, and private roads, as well as by boat from several launching areas on the impoundments. Black Bear provides public recreation access at several locations for motorized and non-motorized boating and shoreline fishing. Project recreation facilities owned and managed by Black Bear include: a carry-in boat launch off Shore Road on the Lake Leonard impoundment; the Graham Lake Dam boat launch on Graham Lake; and a canoe portage trail around Graham Lake Dam. The existing canoe portage trail also serves as an angler access trail to the Union River downstream of Graham Lake Dam. Municipal, state, and private lands provide additional recreation access to the Project. These include: a picnic area/day use site (municipal) on Shore Road on the east shore of Lake Leonard opposite the Middle School; Infant Street access (municipal) on both sides of the Union River; Fletcher’s Landing (State), an unimproved boat launch on Graham Lake; Mariaville carry-in boat launch (municipal) on the west side of Graham Lake; and a carry-in (private) on the West Branch of the Union River. At present, canoeists or kayakers can portage around the Graham Lake Dam at a Project portage trail, and at Ellsworth Dam using an informal portage route. Bass fishing tournaments are hosted in Graham Lake, also indicating that there are abundant bass, and MAINE DIFW (2015) reports that Graham Lake has good action for medium-size bass.

Opportunities for boating, kayaking, fishing, water sports, snowmobiling, ice skating, ice fishing, and other water-related recreational activities exist at Lake Leonard and Graham Lake. Although these recreational opportunities may still be available if the dams are removed, they would be changed significantly and would be at a much smaller scale, decreasing the total amount of recreational opportunities in the area. One recreational benefit from removal of the dams would be the increase of river-based canoe and kayak opportunities.

Fishing is the most popular recreational activity observed in the Project's vicinity. Removal of the dams would create a shallow, riverine habitat in Graham Lake and Lake Leonard, characterized by a riffle/run complex and higher flow velocities in some locations. Based on the historic topographical map of the Graham Lake area (Figure 19), this section of the Union River would likely revert to a flat water meandering stream through wetlands. Popular game fish species such as smallmouth bass, chain pickerel, lake trout, splake, and white perch would likely be displaced to elsewhere in the river system, or greatly reduced in number due to habitat loss. While smallmouth bass would still persist in the river habitat their numbers would substantially diminish due to the loss of 95% of their current habitat area. Fishing from larger power boats and bass tournament fishing would be eliminated. While removal of the dams may displace some game fish, this alternative would create additional habitat for other species such as salmon, brook trout, and white sucker.

8.5 Sedimentation and Water Quality

Complete removal of Graham Lake and Lake Leonard Dams would likely have limited effects on water quality in the Union River. Water quality in rivers is influenced by a variety of factors including the flow regime. Sampling conducted in 2013 revealed that Graham Lake weakly stratifies during the summer months, but due to the shallowness of the lake and long fetch from multiple directions, the stratification often breaks down during windy periods that prevail on the lake. The results of the 2013 sampling for Graham Lake are consistent with previous sampling efforts dating back to the 1970s. Sampling conducted in Lake Leonard revealed that the lake did stratify over much of the summer. Removal of the dams would mean that the free-flowing Union River would not stratify and would likely have lower water temperatures and somewhat higher dissolved oxygen levels. One factor that could adversely affect water quality is the potential release of sediments currently trapped in the lakebeds of the impoundments, especially the larger Graham Lake. Removal of the dams could suspend these sediments into the water column and wash them downstream and into the estuary and harbor.

8.6 Wetlands

Wetland types found within the Project boundary include Lacustrine, Riverine, Estuarine, Palustrine Unconsolidated Bottom (PUB), Palustrine Aquatic Bed (PAB), Palustrine Emergent (PEM), Palustrine Scrub-Shrub (PSS), and Palustrine Forested (PFO). The vast majority of palustrine wetlands within the Project boundary are associated with Graham Lake, and the various types are generally found together as wetland complexes. There are also several islands in Graham Lake consisting of PEM, PSS, and PFO wetland types. Many of the wetlands associated with Graham Lake are narrow fringes along the lake itself or along tributary streams; some areas comprised of numerous wetland classes are more extensive. Narrow fringes of wetland are located along Lake Leonard and the Union River in some areas; these areas are classified as PAB, PEM, and PSS (Black Bear 2014).

The wetland types observed in the Project vicinity were observed to reflect the natural community expectations for this area and in an impoundment environment in the northeastern United States. Removal of the two dams would essentially convert the reservoir into a riverine and riparian habitat. Under this scenario, riverine species may increase at the expense of reservoir taxa. Dewatering and elimination of a reservoir results in dramatic changes soon after dam removal, as extensive areas of sediment and previously submerged structures are exposed. Organisms present in the reservoir prior to removal may be washed downstream or stranded during surface water drawdown. Mortality rates of virtually all reservoir populations, except fish, would likely be high if dewatering of the reservoir is rapid. When a dam is removed, the river begins to recreate a channel by cutting into the mound of accumulated sediment and transporting it downstream. Exposed sediment lateral to the forming channel dries and, over time, becomes more physically stable as vegetation grows in, giving rise to a new floodplain (Stanley and Doyle 2003).

Since much of the Graham Lake impounded area was historically a flat heath bog-type habitat (Figure 19), the hydrology would revert back to a similar regime. However, it is uncertain what type of vegetation and soil characteristics would evolve in the lake bed as sediment accumulation over the years of impoundment would likely have changed the topography and soil conditions from the pre-impoundment condition.

8.7 Cultural Resources

During the summer and fall of 2013, Black Bear conducted a Phase I archaeological survey of the Ellsworth Project. As part of the initial survey, Black Bear conducted background research and identified a number of previously known Precontact sites located at the Project vicinity. In addition, at the request of the Maine State Historic Preservation Officer (SHPO), Black Bear reviewed select existing archaeological reports and amateur artifact collections from the Project area. A desktop sensitivity analysis followed by field inspection and survey work led to the identification of three new Precontact sites. The sites range in age from the Late Archaic to Contact periods. All three sites were recommended for further evaluation (Phase II) to determine their potential eligibility for listing to the National Register of Historic Places (NRHP). Phase II investigation of the three new sites took place in the summer of 2015 and two of the sites were recommended as eligible for listing.

Decommissioning considered in this study report could have an adverse effect on the cultural resources present in the Project area by changing the land use and hydrology. Equally likely is the possibility of exposing undiscovered cultural resources that have been inundated since the impoundments were built.

8.8 Socioeconomic Resources

The Project is currently utilized by the City of Ellsworth, fishermen, and recreationists. Existing shoreline development is currently limited almost exclusively to private residences and seasonal cottages. Other than recreation, private waterfront real estate development, and the seasonal harvesting of alewives for lobster bait and American eel elvers for export, there are no significant non-Project socioeconomic resources or uses of the Ellsworth Project.

The Project provides a positive economic benefit to the City of Ellsworth each spring as alewives are harvested below the Ellsworth Dam on the Union River. Alewives have been harvested in Maine for economic purposes for many years. There is high demand for alewives for use as lobster bait. The City of Ellsworth holds a license for harvesting alewives in the Union River and in turn issues permits to fish alewives for commercial purposes, earning 40% of the license holder's revenue as a permit fee (College of the Atlantic 2004). The following table shows annual revenue to the city from the alewife harvest for the past 10 years.

TABLE 4
CITY OF ELLSWORTH REVENUE FROM ALEWIFE HARVEST

Year	Revenue
2005	$9,500
2006	$2,778
2007	$21,053
2008	$20,287
2009	$12,355
2010	$13,306
2011	$11,700
2012	$58,799
2013	$31,816
2014	$35,872
Total	$217,466

*Data supplied by City of Ellsworth

Migrating American juvenile eel, also known as elvers, are also harvested by licensed fishermen on the Union River (Bangor Daily News 2012). The 2015 Maine elver harvest season, which ended May 31, was valued at over $11 million for the season, according to Maine DMR (2015). The recreational opportunities in the Project vicinity attract visitors for camping, birding, wildlife viewing, boating, and fishing.

Removal of the dams would result in a loss of socioeconomic value to the area due mainly to the loss of recreational opportunities, water front real estate, and the loss of alewife harvesting at the Ellsworth Dam. The loss of property values on Graham Lake and Lake Leonard would likely have the greatest socioeconomic impact to the area, as these properties would lose lake front views and access when the lakes are drained and restored to a riverine environment.

9.0 REFERENCES CITED

Bangor Daily News. 2012. Elvers fetching more than $2,000 per pound. [Online] URL:http://bangordailynews.com/2012/03/23/news/hancock/elvers-fetching-more-than-2000-per-pound/.

Baum, E. T. 1982. The Union River: An Atlantic salmon management plan. Atlantic Sea Run Salmon Commission. Bangor, Maine. 27 pp.

Bell, Milo. 1986. Fisheries Handbook of Engineering Requirements and Biological Criteria. US Army Corps of Engineers, Portland, OR.

Black Bear Hydro Partners, LLC (Black Bear). 2012. Pre-Application Document for the Ellsworth Hydroelectric Project (FERC No. 2727).

_____. 2014. Initial Study Report (ISR), Ellsworth Hydroelectric Project, FERC No. 2727. September 2014.

Burr, Greg, MAINE DIFW, Personal Communication, July 3 and 23, 2014; July 18, 2013; March 7, 2013.

Clay, Charles. 1995. Design of Fishways and Other Fish Facilities. Lewis Publishers, Boca Raton, FL.

College of the Atlantic. 2004. Alewife Restoration in the Union River Watershed.

Federal Energy Regulatory Commission (FERC) 2013. Study Plan Determination for the Ellsworth Hydroelectric Project. September 4, 2013. Issued to Black Bear Hydro Partners, LLC.

Fennelly, Dick, Retired Maine Guide. Personal Communication, July 23, 2014.

Maine Department of Inland Fish and Wildlife (MAINE DIFW). 2015. Regional Fishing Information - Region C (The Downeast Region). [Online] URL: http://www.maine.gov/ifw/ fishing/regional_information/region_c.htm. Accessed April 2015.

Maine Department of Marine Resources (Maine DMR). 2013. American Shad Habitat Plan, Prepared September 16, 2013, submitted to the Atlantic States Marine Fisheries Commission as a requirement of Amendment 3 to the Interstate Management Plan for Shad and River Herring, approved by ASMFC February 6, 2014.

Maine Department of Marine Resources (Maine DMR). 2015. Maine's Elver Fishery Increases in Value by Nearly $3 Million. Online. http://www.maine.gov/dmr/news/2015/ 2015ElverSeason.htm. June 2, 2015.

Stanley, E.H. and M.W. Doyle. 2003. Trading Off: The Ecological Effects of Dam Removal. *Frontiers in Ecology and the Environment* 1: 15-22.

Union River Fisheries Coordinating Committee (URFCC). 2010. Comprehensive fishery management plan for the Union River drainage: 2011-2014. 31pp.

_____. 2015. Comprehensive fishery management plan for the Union River drainage: 2015-2017. 35 pp.

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APPENDIX E-8

2015 ADULT AMERICAN EEL DOWNSTREAM PASSAGE STUDY

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2015 ADULT AMERICAN EEL DOWNSTREAM PASSAGE STUDY

PRELIMINARY REPORT

ELLSWORTH HYDROELECTRIC PROJECT

(FERC No. 2727)

Prepared for:

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December 2015

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2015 ADULT AMERICAN EEL DOWNSTREAM PASSAGE STUDY
PRELIMINARY REPORT
ELLSWORTH HYDROELECTRIC PROJECT

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1.0 INTRODUCTION

The Ellsworth Project is on the Union River in Maine, approximately 5 river kilometers (3.1 miles) upstream of Union River Bay and the Atlantic Ocean (Figure 1). Black Bear Hydro Partners LLC (Black Bear), an affiliate of the Brookfield Renewable Energy Group, operates the Ellsworth Project pursuant to the license issued by the Federal Energy Regulatory Commission (FERC) in 1987. The license expires on December 31, 2017; therefore, Black Bear is filing an application to FERC in December 2015 to relicense the Ellsworth Project.

The Ellsworth Project consists of the Ellsworth dam, which forms Lake Leonard, and Graham Lake dam, which forms Graham Lake (Figure 1). Black Bear generates clean, renewable hydroelectric energy at the Ellsworth dam with four turbine-generator units with a total authorized nameplate capacity of 8.9 megawatts (MW). There are no turbines at Graham Lake dam; three Tainter gates are used to regulate downstream river flows to support generation at the Ellsworth development in accordance with the existing license conditions; water is also passed through a 4-foot-wide weir that serves as the downstream fish bypass.

American eel, a migratory species, is present in the Union River. Juvenile eels return to rivers in Maine in the spring and summer, mature in freshwater for 5 to 40 years (Haro 2003), and then migrate to the Sargasso Sea as silver-phased adults. The peak silver eel outmigration in Maine is in the late summer and fall. American eel is an important commercial fish species in Maine, and the Atlantic States Marine Fisheries Commission considers the stock to be depleted (ASMFC 2014). Although the American eel stock hit a low in 1997, it is reported to have increased 41 percent since that time (AESA 2015). The U.S. Fish and Wildlife Service (USFWS) recently determined that American eels did not warrant protection under the Endangered Species Act (80 FR 60834).

Path: G:\A_Client_Data\Black Bear Hydro\Ellsworth\A_MXD\2015 Downstream Eel\Location Map.mxd

Source: ESRI, Kleinschmidt

FIGURE 1. LOCATION OF THE ELLSWORTH HYDROELECTRIC PROJECT, UNION RIVER, ELLSWORTH, MAINE.

Black Bear provides downstream fish passage at the Ellsworth dam through three, 3-foot-wide surface-weirs. Two of the weirs are located at the powerhouse intake to Units 2, 3, and 4; the third entrance is located at the powerhouse intake near Unit 1. Black Bear normally opens each entrance to the fishway 21 inches, which provides approximately 20 cfs through each opening. Downstream passage at Graham Lake dam consists of a 4-foot-wide surface weir. The weir structure is 7.5 feet deep and contains stoplogs that can be adjusted to accommodate the varying lake levels; the weir can pass up to 50 cfs. The downstream fishways are operated from April 1 to December 31 annually, as river conditions allow.

FERC and the National Marine Fisheries Service (NMFS) requested that Black Bear study the downstream passage of adult silver American eels at the Ellsworth Project as part of the relicensing effort.[1] Black Bear submitted a draft study plan to the Maine Department of Marine Resources, USFWS, and NMFS on August 4, 2015. Black Bear modified the study plan based on the comments received and filed the final study plan with FERC on September 14, 2015. On behalf of Black Bear and pursuant to the study plan, Kleinschmidt used radio telemetry to study the downstream passage of silver American eels in the fall of 2015. The objective of the 2015 study was to identify the routes that American eels use to pass downstream at the Graham Lake dam and Ellsworth dam and to determine whether they survive passage at each dam.

The September 2015 Study Plan anticipates that the study will be conducted in two phases. This preliminary report describes the results of the first phase of the study. The objectives and methodology of the second phase of the study, either to evaluate eel injury by passage route at the Ellsworth dam development, or to further evaluate passage routes and survival at the Ellsworth dam development, will be finalized after review of the phase 1 study results and agency consultation regarding study needs.

[1] See FERC's Determination on Requests for Study Modifications and New Studies for the Ellsworth Hydroelectric Project (issued 12/30/2014); see NMFS's Comments, Request for Study Clarification, and Modification regarding Black Bear's September 4, 2014 Initial Study Report for the Ellsworth Hydroelectric Project (filed 11/03/2014).

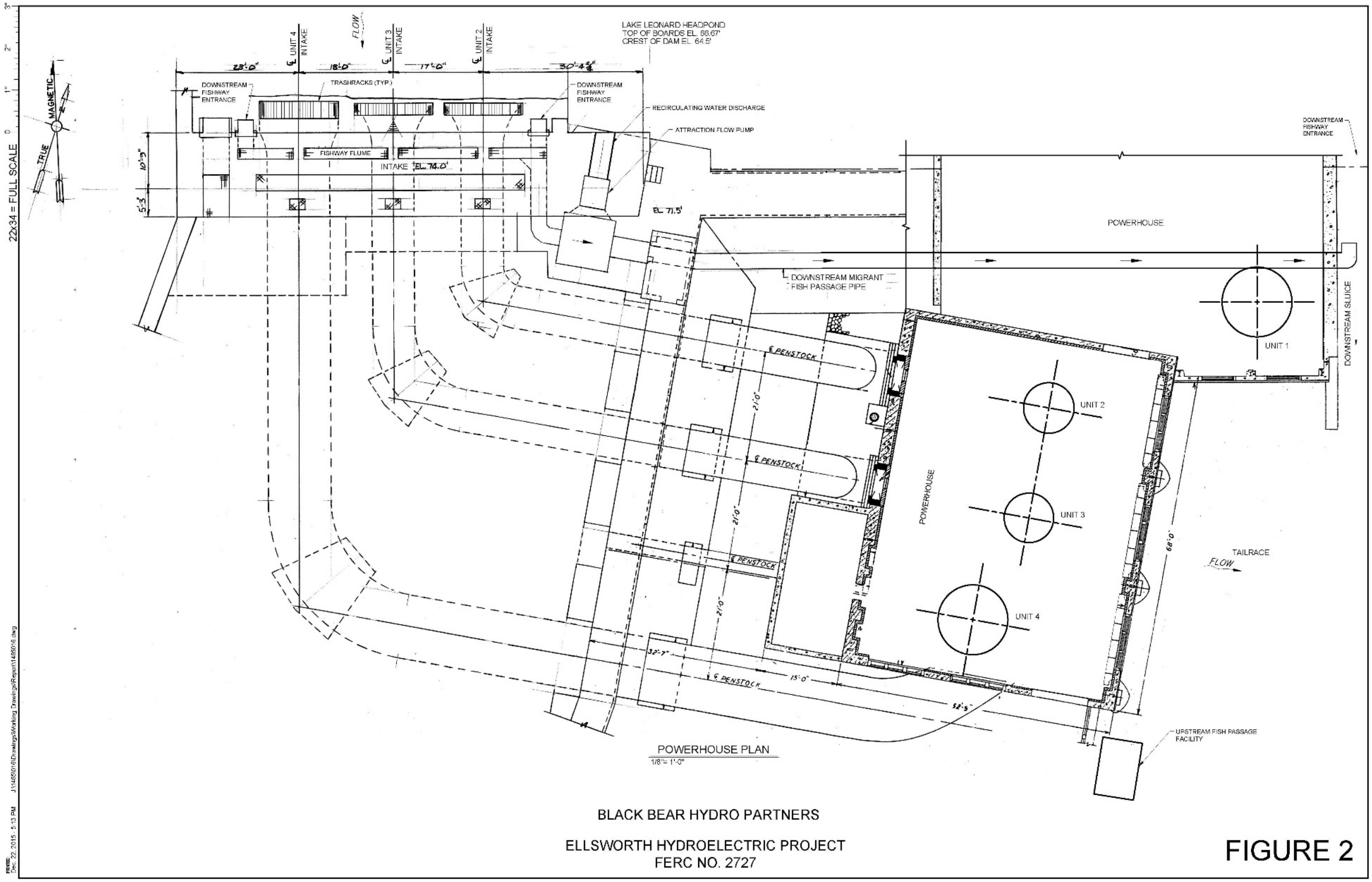


FIGURE 2. ELLSWORTH DEVELOPMENT INTAKES AND DOWNSTREAM FISH BYPASS ENTRANCES, UNION RIVER, ELLSWORTH, MAINE.

2.0 METHODS

2.1 SAMPLE SIZE AND SOURCE OF EELS

Researchers tagged and tracked the movements of 50 adult American eels within the study area. The sample size of 50 aligned with NMFS's recommendations in its November 3, 2014 letter requesting the study. The sample size of 50 is also comparable to that used in downstream eel passage studies completed at hydroelectric facilities in Maine in recent years (Kleinschmidt 2011, Kleinschmidt 2013) and with fish passage studies of other adult fish species in Maine (Brookfield 2015). An additional 10 eels were held as controls to evaluate the effects of transporting, handling, and tagging the eels. Eels were collected in mid-September by deploying a trap in the St. Croix River near Baileyville, Maine, which is approximately 100 kilometers (62 miles) northeast of the Ellsworth Project. The Maine Department of Inland Fish and Wildlife issued a scientific collectors permit authorizing the collection and transport of the eels.

2.2 HOLDING, TAGGING, AND RELEASING EELS

Researchers transported adult eels from Baileyville to the Ellsworth Project in a 190-gallon insulated transport tank prior to tagging. Once on site, eels were transferred from the transport tank to several 30-gallon perforated holding bins that were submerged in a 300-gallon holding tank filled with water pumped continuously from the Union River. Eels were held overnight in Union River water and tagged the next day.

In preparation for surgery to implant the tags, individual eels were anesthetized with MS-222[2] for approximately 5 minutes. Following sedation, total length, weight, and the horizontal and vertical diameter of the eyes were measured. Body length and eye diameter were used to calculate a Pankhurst Index value for each eel to provide an indication of migratory status; the Pankhurst Index is a ratio that is based on the diameter of the eyes in relation to total body length. A value of 6.5 or greater typically indicates a mature silver eel (Pankhurst 1982).

[2] Tricaine-S (tricaine methanesulfonate) is an FDA-approved fish anesthetic used for temporarily immobilizing fish, amphibians, and other aquatic cold-blooded animals.

Telemetry tags were surgically implanted through a ¾-inch incision in the ventral-abdominal region, approximately 1.5 inches anterior to the vent and slightly off the mid-line. The incision was closed with two or three surgical sutures by instrument tie. Following surgery, researchers flushed the MS-222 from the gills with fresh river water and placed eels back into the holding bins for recovery. All eels fully recovered within approximately 5 to 10 minutes. Tagged eels were then held for a minimum of 24 hours before being released to assess whether tag insertion and handling caused any short-term adverse effects and to allow eels to recover adequately. Two control groups of five adult eels were tagged and held for approximately 10 days to assess whether tag insertion and handling caused any longer-term effects. All tags were checked for functionality during the surgical procedure. Eels were tagged and released in three groups, starting on September 29; the last release was made on October 15 (Table 1). Each group of eels was released by boat approximately 0.8 kilometers (0.5 miles) upstream of Graham Lake dam at around sunset (Figure 3).

TABLE 1. SUMMARY OF EEL RELEASES, 2015 DOWNSTREAM EEL PASSAGE STUDY, ELLSWORTH PROJECT.

GROUP NO.	TAG DATE	RELEASE DATE (TIME)	NO. RELEASED	WEATHER CONDITIONS
1	9/29	10/1 (1953)	15	rainy/overcast
2	10/7	10/8 (1856)	20	clear and cool
3	10/14	10/15 (1817)	15	clear and cool

2.3 MONITORING DOWNSTREAM PASSAGE OF TAGGED EELS

Researchers used 16 automated radio-telemetry receiver and antenna arrays (i.e., stations) to monitor the downstream passage and survival of American eels at the Graham Lake and Ellsworth dams. Receivers were positioned to document eel passage through the existing downstream fish bypasses, the Ellsworth turbine units, the minimum flow gate at Graham Lake dam, and the spillways or spill gates at both dams. Specifically, researchers installed receivers and antennas at the following stations (Figure 3 and Figure 4):

- Station 1 – an aerial Yagi antenna located immediately upstream of the Graham Lake dam; the antenna was pointed upstream to detect eels approaching Graham Lake dam;

- Station 2 – stripped, coaxial-wire dropper antenna located within the Graham Lake downstream fish passage weir;
- Station 3 – stripped, coaxial-wire dropper antenna located immediately downstream of Tainter gate No. 3 at the Graham Lake dam, which is used to pass minimum flows;
- Station 4 – stripped, coaxial-wire dropper antenna located immediately downstream of Tainter gate No. 2 at the Graham Lake dam, which is used to pass flood flows or to provide water for generation at the Ellsworth dam;
- Station 5 (Downstream Station 1) – an aerial Yagi antenna located approximately 4.8 river kilometers downstream of Graham Lake dam and 1.75 river kilometers upstream of the Ellsworth dam to confirm eel passage and survival via any route at Graham Lake;
- Station 6 – approximately 260 meters upstream of the Ellsworth dam to detect approaching eels;
- Station 7 – within the entrance to the downstream fish bypass entrance near the Unit 1 intake at Ellsworth dam;
- Station 8 – within the downstream fish bypass near the Unit 2, 3, and 4 intakes at Ellsworth dam;
- Station 9 – within the intake air vent of turbine Unit 1;[3]
- Station 10 – within the intake air vent of turbine Unit 2;
- Station 11 – within the intake air vent of turbine Unit 3;
- Station 12 – within the intake air vent of turbine Unit 4;
- Station 13 – an aerial Yagi antenna at the Ellsworth powerhouse tailrace to detect eels that passed through the turbines;
- Station 14 (Downstream Station 2) – an aerial Yagi antenna approximately 160 meters downstream of the Ellsworth dam to detect eels that passed downstream by any route, including spill over the dam;
- Station 15 (Downstream Station 3) – an aerial Yagi antenna approximately 415 meters downstream of the Ellsworth dam to detect eels that passed downstream by any route;
- Station 16 (Downstream Station 4) – an aerial Yagi antenna approximately 700 meters downstream of the Ellsworth dam to confirm downstream passage and survival.

Monitoring of tagged eels in the Union River occurred from October 1 through November 12.

[3] The air vents are located approximately 15 feet downstream of the trash racks for each turbine unit.

Path: G:_Client_Data\BlackBearHydro\Ellsworth_MXD\2015 Downstream Eel\Graham Lake dam antenna locations.mxd

Source: ESRI, Kleinschmidt

FIGURE 3. LOCATION OF RADIO-TELEMETRY RECEIVERS AROUND GRAHAM LAKE DAM, UNION RIVER, ELLSWORTH, MAINE.

Source: ESRI, Kleinschmidt

FIGURE 4. LOCATION OF RADIO-TELEMETRY RECEIVERS IN LAKE LEONARD AND AROUND ELLSWORTH DAM, UNION RIVER, ELLSWORTH, MAINE.

2.4 MANUAL TRACKING

Researchers completed frequent boat and pedestrian tracking surveys to locate tagged eels and verify whether they survived passage past the dams (Figure 4). The manual tracking survey area included (1) the lowermost 800 meters of Graham Lake; (2) Lake Leonard; (3) the Ellsworth tailwater; (4) the 700-meter reach of the Union River between the Ellsworth dam and Downstream Station 4; (5) the Union River near the Ellsworth marina, which is approximately 1.2 river kilometers (0.75 miles) downstream of the Ellsworth dam; and (6) the 3.5-river kilometer (2.2 mile) reach downstream from Downstream Station 4 (Figure 5). Manual surveys between the dam and the marina were completed by foot two or three times a week during the study (Table 2). Boat tracking surveys in the Union River downstream of the marina and in Lake Leonard and Graham Lake were completed periodically, as conditions allowed. During each manual tracking event, biologists recorded the location and status (alive/mortality) of tagged fish.

TABLE 2. DATES AND LOCATIONS OF MANUAL TRACKING SURVEYS DURING THE DOWNSTREAM EEL PASSAGE STUDY, UNION RIVER, ELLSWORTH, MAINE.

DATE	SURVEY LOCATION
10/07/15	Perimeter of Lake Leonard
10/09/15	Tailrace to marina
10/12/15	Tailrace to marina
10/14/15	Lower Graham Lake to DS1 Ellsworth approach Tailrace to DS4
10/15/15	Graham Lake Lake Leonard Between Graham Lake approach and DS1
10/16/15	Tailrace to marina
10/19/15	DS4 to marina
10/21/15	DS4 to marina
10/23/15	Tailrace to marina Lake Leonard
10/26/15	lower most 3.5 kilometers of Union River
10/28/15	Tailrace to marina
10/30/15	Tailrace to marina
11/02/15	Tailrace to marina lower most 3.5 kilometers of Union River Lower Graham Lake to DS1
11/05/15	Tailrace to marina
11/12/15	Tailrace to marina

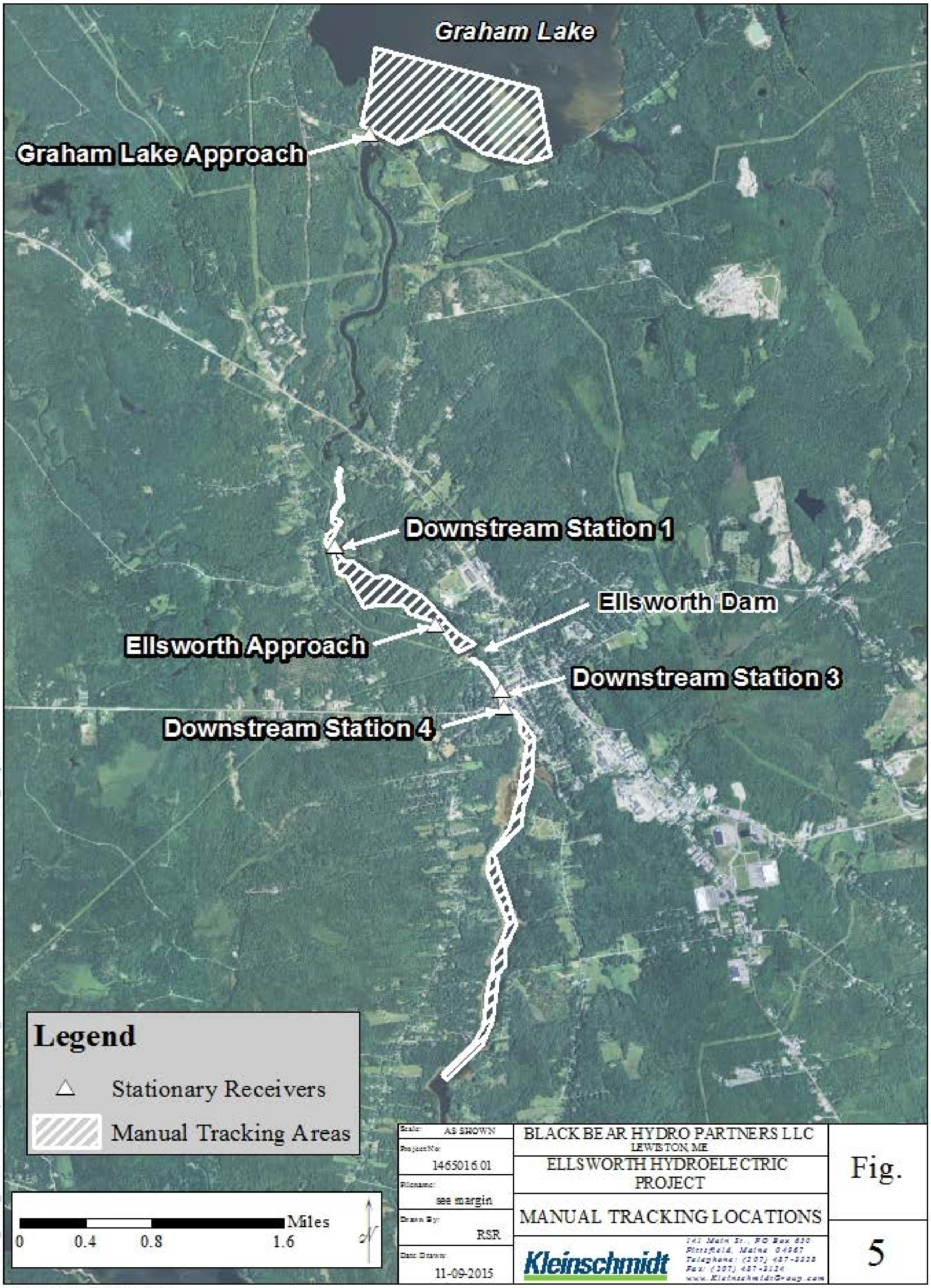
2.5 Equipment Specifications and Range Testing

Researchers used 14 Sigma Eight Orion and two Lotek radio-telemetry receivers for the study. The Sigma Eight receivers are broadband receivers that can simultaneously monitor all radio frequencies in use. This feature results in high detection efficiency, particularly in zones where passage may be rapid, because the receivers do not have to switch frequencies when scanning. Lotek SRX 600 receivers were used at Downstream Stations 3 and 4 and during manual tracking surveys; these receivers were programmed to switch between individual frequencies. All receivers were: field-tested prior to the release of tagged eels to validate detection and verify receiver coverage; powered by 12-volt, deep-cycle marine batteries; and time-synchronized so that detections at multiple receivers could be compared chronologically. Dissolved ions in the water can reduce the range of radio-telemetry tags. Researchers measured water conductivity at Downstream Stations 3 and 4 (stations in the tidal zone) during the set up and testing. Values ranged from 30 to 1,200 microsiemens/centimeter. Although some of these values were higher than expected (i.e., at high-tide), tags were consistently detected throughout the study and at high-tide with Lotek SRX 600 receivers at Downstream Stations 3 and 4 and during manual tracking efforts from Ellsworth dam to the Union River Bay.

Researchers used Sigma Eight Pisces sensor radio-telemetry tags that were approximately 12 millimeters (mm) in diameter by 45 mm long with a trailing whip antenna. Estimated battery life was approximately 100 days. Five radio frequencies with unique number codes on each frequency were used to identify individual eels. Tags were programmed to transmit a radio signal at 1-second intervals to increase the likelihood of detecting eels in high velocity areas (i.e., Graham Lake gates, the downstream fish bypasses, and turbine units). Each tag was equipped with a motion sensor, and the tag was programmed to transmit a signal once every 10 seconds if eels became immobile for more than 36 hours. For purposes of this study, eels that became immobile were classified as mortalities. Motion for these sensor tags is identified with a non-mercury based “tilt switch” consisting of a ball bearing within a canister containing two electrodes. A change of state is defined as making or breaking an electrical connection between the two electrodes through the ball bearing, which occurs when the tagged animal moves. Raw motion activity signals from the sensor are processed based upon laboratory experiments with fish to remove effects of noise and represent real fish activity. Although false-positives can occur using sensor tags (i.e., an immobile tag can transmit as an active tag if the tag is moved), this feature allowed for a better understanding of the fate of tagged eels as they moved downstream through the Ellsworth Project.

2.6 DATA ANALYSIS

Researchers downloaded data from each receiver two to three times a week. Data for individual detections included date, time, location, frequency, code, and power (signal strength). Data processing and analysis were completed with MS Access, which allowed for filtering and data sorting by individual eel. Route-of-passage determinations were based on sequential and chronological detections through the receiver arrays. If the last detection of an eel was a string of sequential immobility codes (i.e., 10 second interval burst rate), the eel was considered to have expired. A tally of eel passage through available routes (e.g., downstream fish bypasses, minimum flow gates, spill gates, spillways, and turbine passage) and information pertaining to the fate of tagged fish (e.g., passage survival) was developed to summarize the study results.



Source: ESRI, Kleinschmidt

FIGURE 5. AREAS SURVEYED DURING MANUAL TRACKING, UNION RIVER, ELLSWORTH, MAINE.

2.7 PROJECT OPERATIONS DURING THE STUDY AND DESCRIPTION OF TURBINE UNITS

The Ellsworth Project has four turbine-units; Units 1 and 4 are fixed-propeller units, and Units 2 and 3 are adjustable Kaplan units (Table 3). Units 1 and 4 rotate at 200 revolutions per minute (rpm), which is considerably less than the speeds of Units 2 and 3 (360 rpm) (Table 3). Units 1 and 4 are rated for 685 cfs each, and Units 2 and 3 are rated for up to 545 cfs each for a total station flow of 2,460 cfs (Table 3). During the late-summer and fall, river flow is typically less than the flow needed to run the Ellsworth Project at its full capacity of 8.9 MW. Accordingly, Black Bear generates power at the Ellsworth dam by using a combination of turbine-generator units, depending on river flow and available storage.

TABLE 3. SUMMARY OF TURBINE ATTRIBUTES, ELLSWORTH PROJECT.

VARIABLE	UNIT 1	UNIT 2	UNIT 3	UNIT 4
Unit type	Propeller	Kaplan	Kaplan	Propeller
Gross head (feet)	62.5	62.5	62.5	62.5
Rated head (feet)	60	60	60	60
Maximum flow (cfs)	685	545	545	685
Runner diameter (feet)	4.65	5	5	4.65
Runner speed (rpm)	200	360	360	200
Number of turbine blades	4	4	4	4

Black Bear evaluated downstream eel passage during three nighttime (i.e., 6 PM to 6 AM) scenarios representative of typical river conditions and operations during the late summer and fall (Table 4). Each of the three eel releases was coordinated with a change in operations. Black Bear adjusted the gate settings of Tainter gate No. 2 at Graham Lake to provide water for operations at Ellsworth dam during the three operational scenarios. Tainter gate No. 3 was opened approximately 5 inches to provide the seasonal minimum flow of 105 cfs from Graham Lake, and the surface fish bypass weir at Graham Lake was open during the study.

Just prior to the first release, 6 inches of rain fell in the study area; consequently, the Ellsworth Project was operated at maximum capacity with all four units running and no spill (i.e., operational scenario No. 1). On October 23, Black Bear returned the Ellsworth Project to normal, low-flow operations typical for the time of year. Generation during the study ranged from 1.7 to

8.7 MW (Table 4). The average opening for Tainter gate No. 2 at Graham Lake ranged from 0.6 to 3.7 feet. Appendix A provides a listing of daily operations of the Ellsworth Project during the study.

TABLE 4. SUMMARY OF OPERATIONS DURING THE 2015 DOWNSTREAM AMERICAN EEL PASSAGE STUDY, ELLSWORTH PROJECT.

OPERATIONAL SCENARIO	EEL RELEASE	DATES OF OPERATION	UNITS OPERATING	AVERAGE GENERATION (MW)	PERCENT OF MAXIMUM GENERATION*	GRAHAM LAKE GATE NO. 2 OPENING (FT)
1	10/1	10/1 – 10/6	1, 2, 3, 4	8.7	97.0%	3.7
2	10/8	10/7 – 10/12	2, 3, 4	5.7	64.5%	2.6
3	10/15	10/13 – 10/23	2, 3	3.6	40.7%	1.7
LOW FLOW	–	10/23 – 11/01	3**	1.7	19.1%	0.6

* Average nightly generation from 6 PM – 6AM.
** Unit 4 also operated for two days (Oct. 31 and Nov 1).

3.0 RESULTS

3.1 EEL LENGTH, WEIGHT, AND EYE DIAMETER

Tagged adult eels ranged in length from 700 mm (27.5 inches) to 1,041 mm (41.0 inches), with an average length of 828 mm (32.5 inches). Tagged eels ranged in weight from 500 grams (1.1 pounds) to 2,100 grams (4.6 pounds), with an average weight of 1,114 grams (2.5 pounds). The Pankhurst Index value for 5 eels was less than 6.5 (Table 5), indicating a non-migratory phase; however, these 5 eels moved downstream through Graham Lake dam and passed the Ellsworth dam. Table 5 lists length, weight, eye diameter, Pankhurst Index value, and tag information for each eel.

3.2 EFFECTIVE SAMPLE SIZE

Two of the 50 tagged eels did not migrate out of Graham Lake after being released, and one escaped from the holding tanks; therefore, the effective sample size for the evaluation of route selection and passage survival was 47 eels.

3.3 CONTROL FISH

All 10 control fish were healthy and active at the end of the 10-day holding period. These eels were released into the Union River 300 feet downstream of the Ellsworth dam. Upon release, all control eels immediately swam away or found cover under large boulders. No signs of adverse effects of transporting, handling, or tagging the eels were observed.

3.4 MIGRATORY BEHAVIOR

The majority of tagged eels released into Graham Lake were detected approaching Graham Lake dam within 12 hours of release (n=30, or 63.8 percent), indicating that they began their downstream migration quickly after release (Table 6). Cumulatively, 44 of 47 eels (93.6 percent) migrated out of Graham Lake within 72 hours of being released (Table 6). The remaining three eels moved after 3 or more days.

TABLE 5. MORPHOLOGICAL AND TAG INFORMATION FOR ADULT SILVER EELS.

Release No.	Eel No.	Frequency	Code	Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst index
Release 1 (10/1)	1	149.320	50	900	1480	12	10	10.6
	2	149.320	51	850	1200	9	10	8.3
	3	149.320	60	965	1600	11	11	9.8
	4	149.340	65	900	1100	9	10	7.9
	5	149.340	70	750	1150	7	8	5.9*
	6	149.340	75	750	1650	10	10	10.5
	7	149.480	80	800	900	9	7	6.3*
	8	149.480	85	810	1000	9	10	8.7
	9	149.480	90	750	900	9	9	8.5
	10	149.400	95	857	1100	10	10	9.2
	11	149.400	100	965	1700	10	10	8.1
	12	149.400	105	711	800	11	10	12.2
	13	149.460	110	787	1200	9	10	9.0
	14	149.460	115	735	700	8	8	6.8
	15	149.460	120	889	1300	11	11	10.7
Release 2 (10/8)	16	149.320	125	816	1000	10	10	9.6
	17	149.320	130	835	1150	10	10	9.4
	18	149.320	135	863	1350	10	10	9.1
	19	149.320	140	774	900	9	9	8.2
	20	149.340	145	875	1300	10	11	9.9
	21	149.340	150	784	890	9	9	8.1
	22	149.340	155	830	1100	10	10	9.5
	23	149.340	160	1041	1300	10	10	7.5
	24	149.400	165	792	900	10	11	10.9
	25	149.400	170	885	1300	10	10	8.9
	26	149.400	175	725	820	9	9	8.8
	27	149.400	180	825	1100	9	9	7.7
	28	149.460	185	830	1000	10	9	8.5
	29	149.460	190	892	1430	11	11	10.6
	30	149.460	195	860	1400	10	9	8.2
	31	149.460	200	845	1000	10	9	8.4
	32	149.480	205	735	900	9	9	8.7
	33	149.480	210	840	1350	10	10	9.3
	34	149.480	212	875	1500	11	11	10.9
	35	149.480	207	795	900	9	9	8.0
Release 3 (10/15)	36	149.320	92	700	650	7	6	4.7*
	37	149.320	102	997	2100	14	13	14.3
	38	149.320	203	735	900	9	10	9.6
	39	149.340	62	767	700	8	9	7.4
	40	149.340	72	740	1100	9	10	9.6
	41	149.340	123	790	800	8	8	6.4*
	42	149.400	97	838	900	10	10	9.4
	43	149.400	118	805	1000	10	9	8.8
	44	149.400	113	770	1000	10	10	10.2
	45	149.460	133	880	1150	9	9	7.2
	46	149.460	157	734	600	7	7	5.2*
	47	149.460	163	900	1600	11	11	10.6
	48	149.480	178	840	1050	10	9	8.4
	49	149.480	167	770	500	9	9	8.3
	50	149.480	184	1000	1300	10	11	8.7
			Average	**828**	**1114**	-	-	-
			Minimum	**700**	**500**	-	-	-
			Maximum	**1041**	**2100**	-	-	-

* Although the Pankhurst Index value was less than 6.5, all 5 eels migrated downstream.

TABLE 6. INITIATION OF MIGRATORY MOVEMENTS BY ADULT SILVER AMERICAN EELS AFTER RELEASE IN THE UNION RIVER.

MIGRATORY TIMING	NUMBER OF EELS	CUMULATIVE NUMBER OF EELS	PERCENTAGE OF EELS	CUMULATIVE PERCENTAGE OF EELS
0.25 to 12 hours	30	30	63.8%	63.8%
13 to 24 hours	2	32	4.3%	68.1%
25 to 48 hours	10	42	21.3%	89.4%
49 to 72 hours	2	44	4.3%	93.6%
> 72 hours	3	100	6.4%	100.0%
TOTAL	**47**	**-**	**100.0%**	**-**

3.5 PASSAGE ROUTE AND SURVIVAL

3.5.1 GRAHAM LAKE DAM

Adult eels used the downstream fish bypass weir, Tainter gate No. 2, and Tainter gate No. 3 to pass Graham Lake dam (Tainter gate No. 1 was closed during the entire study period). Fourteen passed through Tainter gate No. 2, which was open for the entire study; 14 passed through Tainter gate No. 3, which was open for approximately 90 percent of the study period; and 7 passed through the surface fish bypass weir (Table 7), which was open for the entire study. Twelve eels passed through the Graham Lake dam undetected by the telemetry receivers at the dam; however, given the velocity of the water passing through the Tainter gates (estimated in excess of 20 feet per second), it is not surprising that some eels passed without being detected at the dam. All 47 eels (100 percent) migrated through Graham Lake dam, survived passage, and moved downstream to the Ellsworth dam, a distance of approximately 7 river kilometers (4.3 miles).

TABLE 7. ROUTE OF PASSAGE SELECTION BY ADULT AMERICAN EELS, GRAHAM LAKE DAM, UNION RIVER.

ROUTE OF PASSAGE	NUMBER DETECTED	PERCENT DETECTED	PERCENT PASSAGE SURVIVAL
Tainter gate No. 2	14	30%	100%
Tainter gate No. 3	14	30%	100%
Fish bypass weir	7	15%	100%
Unidentified route	12	26%	100%
TOTAL	**47**	**100%**	**100%**

3.5.2 ELLSWORTH DAM

All 47 eels migrating downstream from Graham Lake also passed through the Ellsworth development; 43 of these were documented passing through the turbines (Table 8). Most eels passed through Unit 3 (n=17, or 36.2%). Slightly fewer eels passed through Unit 4 (n=14, 29.8 percent), and 12 passed through Unit 2 (n=12, or 25.5 percent). Four eels were not detected as they moved through the Ellsworth development; however, they were detected at stations downstream. Researchers documented no eels using the downstream fish bypass. Using a combination of manual and automated tracking (i.e., detections on the receivers positioned downstream of the Ellsworth dam), researchers documented 21 eels that had not survived passage through the turbines. Based on the data from the stationary receivers and from manual tracking, turbine passage survival was 25 percent for Unit 2, 47 percent for Unit 3, and 86 percent for Unit 4 (Table 8). Overall, 53 percent of the tagged eels survived passage at the Ellsworth development (Table 8). Eighty-eight percent of the eels migrated through the Ellsworth development between the hours of 6 PM and 6 AM (n=38) (Table 9).

TABLE 8. ROUTE OF PASSAGE SELECTION AND PASSAGE SURVIVAL FOR SILVER EELS, ELLSWORTH DAM, UNION RIVER.

ROUTE OF PASSAGE	NUMBER OF EELS	PERCENT OF EELS	PASSAGE SURVIVAL	PERCENT PASSAGE SURVIVAL
Unit 1	0	0%	–	–
Unit 2	12	25.5%	3 of 12	25%
Unit 3	17	36.2%	8 of 17	47%
Unit 4	14	29.8%	12 of 14	86%
Unidentified	4	8.5%	1 of 2*	50%
TOTAL	**47**	**100%**	**24 of 45**	**53%**

* Turbine passage survival determined for 2 of 4 eels only. Fate of two eels in the tailrace at study termination undetermined.

TABLE 9. PASSAGE TIMING OF TAGGED AMERICAN EELS AT THE ELLSWORTH DAM, UNION RIVER.

TIME OF DAY	NUMBER OF EELS	PERCENTAGE OF EELS	CUMULATIVE PERCENTAGE OF EELS
18:00-21:00	10	23.3%	23.3%
21:01-00:00	11	25.6%	48.9%
00:01-03:00	12	27.9%	76.8%
03:01-06:00	5	11.6%	88.4%
Other	5	11.6%	100.0%
TOTAL	**43***	**100.0%**	**-**

*** Four (4) eels were not detected as they passed the Ellsworth development, so time of passage is unknown.**

On October 26 and November 2, researchers manually tracked the lowermost 3.5 river kilometers (2.2 miles) of the Union River by boat. The October 26 survey was conducted during low tide, and the November 2 survey took place during high tide. In total, nine eels were detected during these two surveys; three survivors and six mortalities. The fate of two eels that were still in the tailrace area on November 12, which was the final tracking survey, is unknown. These two eels were first detected in the tailrace on October 20 and October 25.

Eels passed through the turbines somewhat uniformly during each of the three different operational scenarios: 14 passed with all units running; 12 passed with Units 2, 3, and 4 running; 14 passed with Units 2 and 3 running; and 3 passed after Black Bear returned to its normal low-flow operating scenario (Table 10). With all four units running (i.e., operational scenario No. 1), 10 of 14 eels passed through Unit 4, and 9 of 10 survived passage. Appendix B provides a summary of passage route and survival of individual silver eels at Graham Lake and Ellsworth dams. Appendix C provides passage summaries for all 47 eels that passed the Ellsworth Project.

TABLE 10. DOWNSTREAM EEL PASSAGE COMPARED TO OPERATIONS, ELLSWORTH PROJECT.

OPERATIONAL SCENARIO	UNITS OPERATING	AVERAGE GENERATION (MW)	UNIT 1	UNIT 2	UNIT 3	UNIT 4	TOTAL
1	1, 2, 3, 4	8.7	0	3	1	10	14
2	2, 3, 4	5.7	0	4	5	3	12
3	2, 3	3.6	0	5	9	0	14
LOW FLOW	3	1.7	0	0	2	1	3
TOTAL			**0**	**12**	**17**	**14**	**43***

*** Four (4) eels were not detected as they passed the Ellsworth development, so their route is unknown.**

4.0 REFERENCES

American Eel Sustainability Association (AESA). 2015. Rebuilding of Eel Stocks. Available online [URL]: http://americaneel.org/understand-the-issues/eel-science/rebuilding-of-eel-stocks/. Accessed November 10, 2015.

Brookfield Renewable Energy Group. 2015. Final Atlantic Salmon Passage Study Report for the Lower Penobscot River, submitted to FERC March 2015.

Haro, A. 2003. Downstream migration of silver-phase anguillid eels. Pages 215-222 in: Aida, K., K. Tsukamoto, and K. Yamauchi, eds. Eel Biology. Springer, Tokyo.

Kleinschmidt. 2011. Final Interim Downstream Bypass Eel Passage Effectiveness Study Report, Anson Hydroelectric Project (FERC No. 2365) and Abenaki Hydroelectric Project (FERC No. 2364). Final Report, Submitted to FERC June 2011.

Kleinschmidt. 2013. Final Downstream Eel Passage Study Report, Anson Hydroelectric Project (FERC No. 2365) and Abenaki Hydroelectric Project (FERC No. 2364) Final Report, Submitted to FERC May 2013.

Pankhurst, N. W.1982. Relation of visual changes to the onset of sexual maturation in the European eel, *Anguilla anguilla*, Journal of Fish Biology 21:127-140.

APPENDIX A

SUMMARY OF NIGHTLY AVERAGE GENERATION, OCTOBER 1 – NOVEMBER 1

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		Unit 1			Unit 2		
Operational Scenario	**Date**	**Gen (MW)**	**Flow (cfs)**	**Percent gate**	**Gen (MW)**	**Flow (cfs)**	**Percent gate**
All 4 units (full gate)	10/1-10/2	2.2	520	88.8	1.8	406	91.4
	10/2-10/3	2.2	520	95.8	2.0	432	95.6
	10/3-10/4	2.2	514	95.8	2.1	473	97.1
	10/4-10/5	2.2	517	95.7	2.1	477	85.3
	10/5-10/6	2.2	514	89.5	2.1	477	77.4
	Average	**2.2**	**517**	**94.2**	**2.1**	**465**	**88.9**
Units 2, 3, and 4 (reduced flow)	10/6-10/7	0.0	0	0.0	0.0	0	2.8
	10/7-10/8	0.0	0	0.0	0.0	0	-1.0
	10/8-10/9	0.0	0	0.0	2.0	446	72.9
	10/9-10/10	0.0	0	0.0	2.2	493	78.5
	10/10-10/11	0.0	0	0.0	2.2	489	80.2
	10/11-10/12	0.0	0	0.0	1.7	375	62.6
	Average	**0.0**	**0**	**0.0**	**2.0**	**451**	**73.5**
Unit 2 and Unit 3 only	10/12-10/13	0.0	0	0.0	2.2	492	79.0
	10/13-10/14	0.0	0	0.0	2.1	484	72.6
	10/14-10/15	0.0	0	0.0	2.1	484	71.4
	10/15-10/16	0.0	0	0.0	2.1	469	71.3
	10/16-10/17	0.0	0	0.0	2.1	469	70.6
	10/17-10/18	0.0	0	0.0	2.1	466	71.4
	10/18-10/19	0.0	0	0.0	2.1	462	69.6
	10/19-10/20	0.0	0	0.0	2.1	465	78.0
	10/20-10/21	0.0	0	0.0	2.1	464	73.9
	10/21-10/22	0.0	0	0.0	2.1	486	74.4
	Average	**0.0**	**0**	**0.0**	**2.1**	**474**	**73.2**
Unit 3 only	10/22-10/23	0.0	0	0.0	0.0	0	1.9
	10/23-10/24	0.0	0	0.0	0.0	0	-0.4
	10/24-10/25	0.0	0	0.0	0.0	0	-0.6
	10/25-10/26	0.0	0	0.0	0.0	0	-0.2
	10/26-10/27	0.0	0	0.0	0.0	0	-0.1
	10/27-10/28	0.0	0	0.0	0.0	0	1.1
	10/28-10/29	0.0	0	0.0	0.0	0	1.0
	10/29-10/30	0.0	0	0.0	0.0	0	1.6
	10/30-10/31	0.0	0	0.0	0.0	0	1.6
	10/31-11/01	0.0	0	0.0	0.0	0	1.4
	Average	**0.0**	**0**	**0.0**	**0.0**	**0**	**0.7**

*** Tainter Gate No. 3 (minimum flow gate) was opened (5 inches) during the study.**

*** Downstream fish bypass at Graham Lake opened during the study.**

		Unit 3			Unit 4		
Operational Scenario	Date	Gen (MW)	Flow (cfs)	Percent gate	Gen (MW)	Flow (cfs)	Percent gate
All 4 units (full gate)	10/1-10/2	1.9	416	92.2	2.5	589	89.3
	10/2-10/3	1.9	425	98.8	2.5	577	97.4
	10/3-10/4	1.9	425	98.8	2.4	575	97.4
	10/4-10/5	1.9	426	98.6	2.5	578	97.5
	10/5-10/6	1.9	425	98.8	2.5	579	97.7
	Average	**1.9**	**425**	**98.7**	**2.5**	**577**	**97.5**
Units 2, 3, and 4 (reduced flow)	10/6-10/7	1.3	300	59.5	0.0	0	0.2
	10/7-10/8	0.6	154	37.1	0.0	0	0.2
	10/8-10/9	1.6	363	73.1	2.2	515	66.9
	10/9-10/10	1.9	419	89.2	1.5	351	45.6
	10/10-10/11	1.8	401	74.1	1.8	413	53.6
	10/11-10/12	1.9	425	88.0	2.3	551	72.4
	Average	**1.5**	**344**	**70.2**	**1.9**	**457**	**59.6**
Unit 2 and Unit 3 only	10/12-10/13	1.7	370	71.1	0.0	0	0.2
	10/13-10/14	1.7	388	73.0	0.0	0	0.2
	10/14-10/15	1.6	351	64.1	0.0	0	0.2
	10/15-10/16	1.5	332	63.3	0.0	0	0.2
	10/16-10/17	1.2	266	53.0	0.0	0	0.1
	10/17-10/18	1.3	284	55.9	0.0	0	0.1
	10/18-10/19	1.5	336	62.2	0.0	0	0.0
	10/19-10/20	1.5	329	59.6	0.0	0	0.1
	10/20-10/21	1.6	360	66.8	0.2	37	6.4
	10/21-10/22	1.2	275	56.5	0.3	74	10.9
	Average	**1.5**	**329**	**62.6**	**0.1**	**11**	**1.8**
Unit 3 only	10/22-10/23	0.8	194	43.2	0.0	0	0.1
	10/23-10/24	1.2	268	51.9	0.0	0	0.1
	10/24-10/25	1.2	264	50.8	0.0	0	0.1
	10/25-10/26	1.2	265	51.3	0.0	0	0.1
	10/26-10/27	0.8	187	41.6	0.0	0	0.0
	10/27-10/28	0.8	186	41.3	0.0	0	0.0
	10/28-10/29	1.1	249	50.2	0.0	0	0.1
	10/29-10/30	2.1	485	96.0	0.0	0	0.1
	10/30-10/31	1.8	410	80.0	2.1	498	62.7
	10/31-11/01	1.8	392	68.0	2.1	499	62.7
	Average	**1.3**	**290**	**57.4**	**0.4**	**100**	**12.6**

*** Tainter Gate No. 3 (minimu**

*** Downstream fish bypass at**

		All Units Combined			Graham Lake
Operational Scenario	**Date**	**Gen (MW)**	**Percent total generation (%)**	**Flow (cfs)**	**Tainter Gate No. 2 Opening (ft.)***
All 4 units (full gate)	10/1-10/2	8.4	94.9%	1967	3.1
	10/2-10/3	8.6	96.1%	1964	3.5
	10/3-10/4	8.7	97.4%	1997	3.7
	10/4-10/5	8.7	97.9%	2009	3.7
	10/5-10/6	8.7	97.7%	2006	4.0
	Average	**8.7**	**97.3%**	**1994**	**3.7**
Units 2, 3, and 4 (reduced flow)	10/6-10/7	1.3	14.7%	317	0.0
	10/7-10/8	0.6	7.3%	164	0.0
	10/8-10/9	5.8	65.1%	1336	2.8
	10/9-10/10	5.5	62.1%	1280	2.5
	10/10-10/11	5.7	64.3%	1313	2.5
	10/11-10/12	5.9	66.5%	1362	2.7
	Average	**5.7**	**64.5%**	**1322**	**2.6**
Unit 2 and Unit 3 only	10/12-10/13	3.8	42.9%	872	1.7
	10/13-10/14	3.9	43.7%	883	1.7
	10/14-10/15	3.7	41.8%	846	1.7
	10/15-10/16	3.6	40.1%	811	1.6
	10/16-10/17	3.2	36.5%	745	1.6
	10/17-10/18	3.3	37.4%	760	1.6
	10/18-10/19	3.6	40.1%	808	1.7
	10/19-10/20	3.5	39.8%	804	1.7
	10/20-10/21	3.8	43.2%	883	1.8
	10/21-10/22	3.7	41.2%	865	1.8
	Average	**3.6**	**40.7%**	**828**	**1.7**
Unit 3 only	10/22-10/23	0.8	9.3%	205	0.5
	10/23-10/24	1.2	13.2%	279	0.6
	10/24-10/25	1.2	13.0%	274	0.6
	10/25-10/26	1.2	13.0%	276	0.6
	10/26-10/27	0.8	8.9%	198	0.5
	10/27-10/28	0.8	8.8%	197	0.5
	10/28-10/29	1.1	12.2%	259	0.5
	10/29-10/30	2.1	24.1%	671	0.0
	10/30-10/31	3.9	44.3%	919	1.3
	10/31-11/01	3.9	43.8%	902	1.3
	Average	**1.7**	**19.1%**	**418**	**0.6**

*** Tainter Gate No. 3 (minimu**

*** Downstream fish bypass at (**

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APPENDIX B

ROUTE OF PASSAGE AND SURVIVAL OF TAGGED ADULT EELS AT THE ELLSWORTH PROJECT

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APPENDIX B. DOWNSTREAM AMERICAN EEL PASSAGE AND SURVIVAL RESULTS, ELLSWORTH PROJECT, OCTOBER 2015.

	Eel No.	Code	Graham Lake Passage Route	Graham Lake Passage Route Time	Ellsworth Passage Route	Ellsworth Passage Route Time	Passage Survival?	Migration Time from GL1 to DS4 (hours)
Release 1	1	50	Gate 2	10/2/2015 2:55	Unit 4	10/3/2015 1:40	Successful passage (10/4 7:40)	59.5
	2	51	Unidentified	Unidentified	Unit 4	10/2/2015 0:08	Successful passage (10/2 0:18)	4.5
	3	60	Gate 2	10/1/2015 11:36	Unit 2	10/2/2015 20:23	Mortality (marina 10/12)	-
	4	65	Gate 2	10/1/2015 20:30	Unit 2	10/10/2015 23:09	Mortality (marina 10/26)	-
	5	70	Gate 2	10/1/2015 20:50	Unit 4	10/2/2015 1:56	Successful passage (10/2 5:00)	8.5
	6	75	Gate 2	10/2/2015 5:26	Unit 2	10/2/2015 8:37	Successful passage (10/2 8:47)	3.5
	7	80	Gate 2	10/1/2015 20:56	Unit 4	10/1/2015 23:42	Successful passage (10/1 23:43)	3.5
	8	85	Gate 2	10/2/2015 0:50	Unit 4	10/2/2015 11:41	Successful passage (10/2 18:43)	18
	9	90	Gate 2	10/2/2015 4:38	Unit 4	10/2/2015 19:53	Successful passage 10/4 13:00)	58
	10	95	Gate 2	10/2/2015 1:05	Unit 4	10/2/2015 20:47	Successful passage (10/2 21:01)	20
	11	100	Gate 2	10/1/2015 22:59	Unit 4	10/2/2015 22:05	Successful passage (10/2 22:14)	23.5
	12	105	Unidentified	10/2/2015 0:42	Unit 3	10/2/2015 3:54	Mortality (marina 10/26)	-
	13	110	Gate 3	10/1/2015 20:52	Unit 4	10/1/2015 23:44	Mortality (tailrace 10/12)	-
	14	115	Gate 2	10/1/2015 22:05	Unit 2	10/2/2015 1:26	Mortality (marina 10/21)	-
	15	120	Gate 2	10/2/2015 1:20	Unit 4	10/2/2015 21:18	Successful passage (10/2 21:26)	20
Release 2	16	125	Escaped prior to release					
	17	130	Gate 3	10/8/2015 20:38	Unit 3	10/10/2015 1:01	Mortality (marina 10/26)	-
	18	135	Gate 3	10/8/2015 21:50	Unit 4	10/9/2015 1:25	Successful passage (10/9 1:38)	4
	19	140	Unidentified	Unidentified	Unit 3	10/14/2015 23:25	Successful passage (10/14 23:37)	19
	20	145	Unidentified	Unidentified	Unit 3	10/10/2015 4:47	Mortality (marina 10/16)	-
	21	150	Unidentified	Unidentified	Unit 4	10/11/2015 18:14	Successful passage (10/11 18:29)	13
	22	155	Did not migrate from Graham Lake					
	23	160	Gate 2	10/9/2015 20:18	Unit 3	10/24/2015 19:14	Mortality (tailrace 11/12)	-
	24	165	Unidentified	Unidentified	Unit 2	10/16/2015 17:42	Mortality (marina 11/5)	-
	25	170	Gate 3	10/9/2015 1:22	Unit 2	10/9/2015 19:42	Mortality (tailrace 11/1)	-
	26	175	Gate 3	10/10/2015 3:28	Unit 3	10/10/2015 19:01	Successful passage (10/11 14:49)	36
	27	180	Gate 3	10/9/2015 21:03	Unit 3	10/10/2015 0:11	Mortality (Unit 3 10/10)	-
	28	185	Gate 2	10/10/2015 3:19	Unidentified	Unidentified	Successful passage (10/25 20:40)	378
	29	190	Unidentified	Unidentified	Unit 3	10/16/2015 3:09	Mortality (marina 10/21)	-
	30	195	Fish Bypass	10/9/2015 21:21	Unit 4	10/10/2015 0:23	Mortality (marina 10/21)	-
	31	200	Fish Bypass	10/9/2015 20:44	Unit 2	10/10/2015 1:11	Successful passage (10/10 1:27)	5
	32	205	Unidentified	Undetected	Unit 2	10/10/2015 4:12	Mortality (marina 10/16)	-
	33	210	Did not migrate from Graham Lake					
	34	212	Unidentified	Unidentified	Unit 3	10/9/2015 2:27	Successful passage (10/9 2:52)	5
	35	207	Fish Bypass	10/10/2015 7:49	Unit 3	10/18/2015 22:22	Successful passage (10/19 3:05)	248
Release 3	36	92	Gate 3	10/16/2015 19:56	Unit 2	10/18/2015 4:09	Successful passage (10/18 4:58)	46
	37	102	Gate 3	10/15/2015 21:38	Unidentified	Unidentified	Mortality (DS4 11/2)	-
	38	**203**	**Fish Bypass**	**10/15/2015 20:02**	**Unit 3**	**10/25/2015 20:07**	**Last detected in tailrace (10/25-11/12)**	-
	39	62	Gate 3	10/16/2015 15:32	Unit 3	10/16/2015 22:23	Successful passage (10/16 22:31)	20
	40	72	Gate 3	10/15/2015 19:15	Unit 2	10/15/2015 23:44	Mortality (DS3 11/12)	-
	41	123	Unidentified	Unidentified	Unit 3	10/16/2015 21:55	Mortality (tailrace 11/2)	-
	42	97	Unidentified	Unidentified	Unidentified	Unidentified	Successful passage (10/17 10:39)	17
	43	118	Gate 3	10/16/2015 8:17	Unit 3	10/16/2015 21:03	Successful passage (10/16 23:06)	25
	44	**113**	**Gate 3**	**10/19/2015 12:03**	**Unidentified**	**Unidentified**	**Last detected in tailrace (10/2-11/12)**	-
	45	133	Fish Bypass	10/16/2015 23:29	Unit 2	10/17/2015 16:00	Mortality (tailrace 10/20)	-
	46	157	Unidentified	10/16/2015 0:50	Unit 3	10/16/2015 19:53	Mortality (tailrace 10/23)	-
	47	163	Fish Bypass	10/16/2015 19:10	Unit 3	10/17/2015 1:34	Mortality (marina 10/21)	-
	48	178	Fish Bypass	10/31/2015 4:14	Unit 4	10/31/2015 9:16	Successful passage (10/31 17:22)	13
	49	167	Gate 3	10/17/2015 1:48	Unit 2	10/17/2015 20:45	Mortality (DS2 10/23)	-
	50	184	Gate 3	10/17/15 19:07	Unit 3	10/18/15 0:10	Successful passage (10/18 00:21)	5.5

APPENDIX C

DATA EXCERPTS OF DOWNSTREAM EEL PASSAGE

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TABLE C1. PASSAGE SUMMARY FOR EEL 149.320 50

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/2/2015 2:54:33	1	Graham Lake Approach	-83	Released 10/1/2015 19:53
10/2/2015 2:54:34	1	Graham Lake Approach	-82	
10/2/2015 2:54:35	1	Graham Lake Approach	-83	
10/2/2015 2:54:36	1	Graham Lake Approach	-84	
10/2/2015 2:54:37	1	Graham Lake Approach	-87	
10/2/2015 2:55:28	4	Graham Lake Gate 2	-62	Graham Lake Passage
10/2/2015 19:07:24	5	Downstream Station #1	-93	
10/2/2015 19:07:25	5	Downstream Station #1	-89	
10/2/2015 19:07:26	5	Downstream Station #1	-93	
10/2/2015 19:07:27	5	Downstream Station #1	-88	
10/2/2015 19:07:28	5	Downstream Station #1	-87	
10/3/2015 0:53:47	6	Ellsworth Approach	-66	
10/3/2015 0:53:48	6	Ellsworth Approach	-65	
10/3/2015 0:53:49	6	Ellsworth Approach	-63	
10/3/2015 0:53:50	6	Ellsworth Approach	-65	
10/3/2015 1:41:03	12	Ellsworth Unit 4	-59	Ellsworth Dam Passage
10/3/2015 1:41:04	12	Ellsworth Unit 4	-59	
10/3/2015 1:41:05	12	Ellsworth Unit 4	-59	
10/3/2015 1:41:06	12	Ellsworth Unit 4	-60	
10/3/2015 1:43:12	13	Ellsworth Tailrace	-60	
10/3/2015 1:43:13	13	Ellsworth Tailrace	-60	
10/3/2015 1:43:14	13	Ellsworth Tailrace	-60	
10/3/2015 1:43:15	13	Ellsworth Tailrace	-62	
10/3/2015 1:49:52	14	Downstream Station #2	-78	
10/3/2015 1:49:53	14	Downstream Station #2	-75	
10/3/2015 1:50:00	14	Downstream Station #2	-79	
10/4/2015 7:13:26	15	Downstream Station #3	128	
10/4/2015 7:13:36	15	Downstream Station #3	123	
10/4/2015 7:13:43	15	Downstream Station #3	118	
10/4/2015 7:45:55	16	Downstream Station #4	164	
10/4/2015 7:46:05	16	Downstream Station #4	154	
10/4/2015 7:46:06	16	Downstream Station #4	155	Successful Passage
10/4/2015 7:46:14	16	Downstream Station #4	151	
10/4/2015 7:46:24	16	Downstream Station #4	157	
10/4/2015 7:46:32	16	Downstream Station #4	122	

Table C2. Passage Summary for Eel 149.320 51

Date and Time	Site #	Site Name	Power	Notes
10/1/2015 19:33:41	1	Graham Lake Approach	-89	Released 10/1/2015 19:53
10/1/2015 19:33:42	1	Graham Lake Approach	-90	
10/1/2015 19:33:44	1	Graham Lake Approach	-88	
10/1/2015 19:33:45	1	Graham Lake Approach	-87	
10/1/2015 19:33:46	1	Graham Lake Approach	-88	
10/1/2015 19:33:48	1	Graham Lake Approach	-90	
10/1/2015 22:11:51	5	Downstream #1	-81	Passage – Unknown Route
10/1/2015 22:11:52	5	Downstream #1	-79	
10/1/2015 22:11:53	5	Downstream #1	-79	
10/1/2015 22:11:55	5	Downstream #1	-79	
10/1/2015 22:11:56	5	Downstream #1	-80	
10/1/2015 22:11:57	5	Downstream #1	-78	
10/1/2015 22:11:58	5	Downstream #1	-80	
10/2/2015 0:02:12	6	Ellsworth Approach	-96	
10/2/2015 0:02:13	6	Ellsworth Approach	-85	
10/2/2015 0:02:14	6	Ellsworth Approach	-90	
10/2/2015 0:02:15	6	Ellsworth Approach	-90	
10/2/2015 0:08:32	12	Ellsworth Unit 4	-61	Ellsworth Dam Passage
10/2/2015 0:08:33	12	Ellsworth Unit 4	-60	
10/2/2015 0:08:34	12	Ellsworth Unit 4	-60	
10/2/2015 0:09:24	13	Ellsworth Tailrace	-74	
10/2/2015 0:09:25	13	Ellsworth Tailrace	-62	
10/2/2015 0:09:26	13	Ellsworth Tailrace	-61	
10/2/2015 0:09:28	13	Ellsworth Tailrace	-71	
10/2/2015 0:17:54	14	Downstream #2	-68	
10/2/2015 0:17:56	14	Downstream #2	-68	
10/2/2015 0:17:57	14	Downstream #2	-62	
10/2/2015 0:17:58	14	Downstream #2	-65	
10/2/2015 0:20:52	15	Downstream #3	119	
10/2/2015 0:21:13	15	Downstream #3	137	
10/2/2015 0:21:22	15	Downstream #3	140	
10/2/2015 0:21:31	15	Downstream #3	135	
10/2/2015 0:21:39	15	Downstream #3	127	
10/2/2015 0:21:52	16	Downstream #4	72	Successful Passage
10/2/2015 0:23:32	16	Downstream #4	74	

TABLE C3. PASSAGE SUMMARY FOR EEL 149.320 60

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/1/2015 23:33:35	1	Graham Lake Approach	-62	Released 10/1/2015 19:53
10/1/2015 23:33:36	1	Graham Lake Approach	-60	
10/1/2015 23:33:37	1	Graham Lake Approach	-63	
10/1/2015 23:33:40	1	Graham Lake Approach	-61	
10/1/2015 23:33:42	1	Graham Lake Approach	-67	
10/1/2015 23:37:11	4	Graham Lake Gate 2	-66	Graham Lake Passage
10/1/2015 23:37:16	4	Graham Lake Gate 2	-73	
10/2/2015 6:27:31	5	Downstream #1	-84	
10/2/2015 6:27:32	5	Downstream #1	-81	
10/2/2015 6:27:33	5	Downstream #1	-80	
10/2/2015 6:27:35	5	Downstream #1	-79	
10/2/2015 6:27:36	5	Downstream #1	-81	
10/2/2015 20:17:33	6	Ellsworth Approach	-86	
10/2/2015 20:17:34	6	Ellsworth Approach	-86	
10/2/2015 20:17:35	6	Ellsworth Approach	-86	
10/2/2015 20:17:36	6	Ellsworth Approach	-87	
10/2/2015 20:17:37	6	Ellsworth Approach	-86	
10/2/2015 20:23:50	10	Ellsworth Unit 2	-62	Ellsworth Dam Passage
10/2/2015 20:23:51	10	Ellsworth Unit 2	-57	
10/2/2015 20:23:53	10	Ellsworth Unit 2	-66	
10/2/2015 20:24:12	13	Ellsworth Tailrace	-61	
10/2/2015 20:24:13	13	Ellsworth Tailrace	-73	
10/2/2015 20:24:16	13	Ellsworth Tailrace	-62	
10/2/2015 20:24:18	13	Ellsworth Tailrace	-65	
10/2/2015 20:24:19	13	Ellsworth Tailrace	-62	
10/2/2015 20:25:51	14	Downstream #2	-78	
10/2/2015 20:25:52	14	Downstream #2	-76	
10/2/2015 20:25:57	14	Downstream #2	-79	
10/2/2015 20:25:59	14	Downstream #2	-78	
10/2/2015 20:37:33	15	Downstream #3	175	
10/2/2015 20:37:44	15	Downstream #3	170	
10/2/2015 20:37:53	15	Downstream #3	176	
10/2/2015 20:38:02	15	Downstream #3	188	
10/2/2015 20:38:10	15	Downstream #3	185	
10/2/2015 20:43:11	16	Downstream #4	187	
10/2/2015 20:43:12	16	Downstream #4	129	
10/2/2015 20:43:38	16	Downstream #4	213	
10/2/2015 20:43:47	16	Downstream #4	235	
10/12/2015		Marina – manual tracking		Mortality

TABLE C4. PASSAGE SUMMARY FOR EEL 149.340 65

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/1/2015 20:25:57	1	Graham Lake Approach	-78	Released 10/1/2015 19:53
10/1/2015 20:25:58	1	Graham Lake Approach	-76	
10/1/2015 20:26:00	1	Graham Lake Approach	-74	
10/1/2015 20:26:01	1	Graham Lake Approach	-73	
10/1/2015 20:26:02	1	Graham Lake Approach	-76	
10/1/2015 20:26:04	1	Graham Lake Approach	-75	
10/1/2015 20:26:05	1	Graham Lake Approach	-79	
10/1/2015 20:28:57	4	Graham Lake Gate 2	-62	Graham Lake Passage
10/1/2015 20:29:01	4	Graham Lake Gate 2	-67	
10/1/2015 20:29:02	4	Graham Lake Gate 2	-69	
10/1/2015 20:29:05	4	Graham Lake Gate 2	-69	
10/5/2015 7:13:41	5	Downstream #1	-84	
10/5/2015 7:13:42	5	Downstream #1	-86	
10/5/2015 7:13:43	5	Downstream #1	-87	
10/5/2015 7:13:44	5	Downstream #1	-86	
10/5/2015 7:13:45	5	Downstream #1	-85	
10/5/2015 7:13:46	5	Downstream #1	-84	
10/10/2015 22:58:15	6	Ellsworth Approach	-91	
10/10/2015 22:58:17	6	Ellsworth Approach	-93	
10/10/2015 22:58:18	6	Ellsworth Approach	-93	
10/10/2015 23:09:16	10	Ellsworth Unit 2	-59	Ellsworth Dam Passage
10/10/2015 23:09:17	10	Ellsworth Unit 2	-57	
10/10/2015 23:10:03	13	Ellsworth Tailrace	-72	
10/10/2015 23:10:05	13	Ellsworth Tailrace	-63	
10/10/2015 23:10:06	13	Ellsworth Tailrace	-67	
10/10/2015 23:10:07	13	Ellsworth Tailrace	-70	
10/10/2015 23:10:09	13	Ellsworth Tailrace	-70	
10/10/2015 23:13:09	14	Downstream #2	-71	
10/10/2015 23:13:10	14	Downstream #2	-77	
10/10/2015 23:13:18	14	Downstream #2	-79	
10/10/2015 23:28:33	16	Downstream #4	235	
10/10/2015 23:28:42	16	Downstream #4	254	
10/10/2015 23:29:09	16	Downstream #4	255	
10/10/2015 23:29:26	16	Downstream #4	254	
10/12/2015		Marina – manual tracking		Mortality

Table C5. Passage Summary for Eel 149.340 70

Date and Time	Site #	Site Name	Power	Notes
10/1/2015 20:47:57	1	Graham Lake Approach	-79	Released 10/1/2015 19:53
10/1/2015 20:47:58	1	Graham Lake Approach	-80	
10/1/2015 20:47:59	1	Graham Lake Approach	-78	
10/1/2015 20:48:00	1	Graham Lake Approach	-77	
10/1/2015 20:48:02	1	Graham Lake Approach	-80	
10/1/2015 20:48:03	1	Graham Lake Approach	-81	
10/1/2015 20:50:50	4	Graham Lake Gate 2	-73	Graham Lake Passage
10/1/2015 22:50:19	5	Downstream #1	-83	
10/1/2015 22:50:20	5	Downstream #1	-83	
10/1/2015 22:50:21	5	Downstream #1	-84	
10/1/2015 22:50:22	5	Downstream #1	-82	
10/1/2015 22:50:23	5	Downstream #1	-80	
10/2/2015 0:55:00	6	Ellsworth Approach	-81	
10/2/2015 0:55:01	6	Ellsworth Approach	-81	
10/2/2015 0:55:02	6	Ellsworth Approach	-80	
10/2/2015 0:55:03	6	Ellsworth Approach	-83	
10/2/2015 0:55:04	6	Ellsworth Approach	-80	
10/2/2015 1:56:52	12	Ellsworth Unit 4	-59	Ellsworth Dam Passage
10/2/2015 1:56:53	12	Ellsworth Unit 4	-59	
10/2/2015 1:56:55	12	Ellsworth Unit 4	-60	
10/2/2015 1:57:34	13	Ellsworth Tailrace	-60	
10/2/2015 1:57:37	13	Ellsworth Tailrace	-62	
10/2/2015 1:57:40	13	Ellsworth Tailrace	-77	
10/2/2015 4:55:27	14	Downstream #2	-77	
10/2/2015 4:55:33	14	Downstream #2	-80	
10/2/2015 4:55:42	14	Downstream #2	-80	
10/2/2015 4:57:26	15	Downstream #3	150	
10/2/2015 4:57:35	15	Downstream #3	138	
10/2/2015 4:57:53	15	Downstream #3	137	
10/2/2015 5:01:15	16	Downstream #4	224	
10/2/2015 5:01:24	16	Downstream #4	232	Successful Passage
10/2/2015 5:01:34	16	Downstream #4	228	
10/2/2015 5:01:42	16	Downstream #4	247	

TABLE C6. PASSAGE SUMMARY FOR EEL 149.340 75

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/2/2015 5:23:18	1	Graham Lake Approach	-92	Released 10/1/2015 19:53
10/2/2015 5:23:19	1	Graham Lake Approach	-94	
10/2/2015 5:23:20	1	Graham Lake Approach	-93	
10/2/2015 5:23:22	1	Graham Lake Approach	-95	
10/2/2015 5:23:23	1	Graham Lake Approach	-94	
10/2/2015 5:26:22	4	Graham Lake Gate 2	-70	Graham Lake Passage
10/2/2015 5:26:23	4	Graham Lake Gate 2	-69	
10/2/2015 5:26:24	4	Graham Lake Gate 2	-69	
10/2/2015 7:08:54	5	Downstream Station #1	-83	
10/2/2015 7:08:55	5	Downstream Station #1	-84	
10/2/2015 7:08:56	5	Downstream Station #1	-82	
10/2/2015 7:08:57	5	Downstream Station #1	-83	
10/2/2015 8:26:21	6	Ellsworth Approach	-97	
10/2/2015 8:26:22	6	Ellsworth Approach	-87	
10/2/2015 8:26:23	6	Ellsworth Approach	-86	
10/2/2015 8:26:24	6	Ellsworth Approach	-86	
10/2/2015 8:26:25	6	Ellsworth Approach	-85	
10/2/2015 8:36:57	10	Ellsworth Unit 2	-76	
10/2/2015 8:36:58	10	Ellsworth Unit 2	-62	
10/2/2015 8:36:59	10	Ellsworth Unit 2	-63	
10/2/2015 8:37:01	10	Ellsworth Unit 2	-56	
10/2/2015 8:37:02	10	Ellsworth Unit 2	-57	Ellsworth Dam Passage
10/2/2015 8:37:03	10	Ellsworth Unit 2	-66	
10/2/2015 8:37:05	10	Ellsworth Unit 2	-71	
10/2/2015 8:37:32	13	Ellsworth Tailrace	-68	
10/2/2015 8:37:33	13	Ellsworth Tailrace	-68	
10/2/2015 8:37:36	13	Ellsworth Tailrace	-75	
10/2/2015 8:37:38	13	Ellsworth Tailrace	-63	
10/2/2015 8:37:39	13	Ellsworth Tailrace	-69	
10/2/2015 8:39:16	14	Downstream Station #2	-78	
10/2/2015 8:39:17	14	Downstream Station #2	-69	
10/2/2015 8:39:19	14	Downstream Station #2	-73	
10/2/2015 8:39:20	14	Downstream Station #2	-80	
10/2/2015 8:41:58	15	Downstream Station #3	117	
10/2/2015 8:42:08	15	Downstream Station #3	161	
10/2/2015 8:42:15	15	Downstream Station #3	153	
10/2/2015 8:42:25	15	Downstream Station #3	140	
10/2/2015 8:42:26	16	Downstream Station #4	150	Successful Passage
10/2/2015 8:42:44	16	Downstream Station #4	103	
10/2/2015 8:43:02	16	Downstream Station #4	116	
10/2/2015 8:43:38	16	Downstream Station #4	79	
10/2/2015 8:44:14	16	Downstream Station #4	97	

TABLE C7. PASSAGE SUMMARY FOR EEL 149.480 80

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/1/2015 20:50:07	1	Graham Lake Approach	-82	Released 10/1/2015 19:53
10/1/2015 20:50:08	1	Graham Lake Approach	-82	
10/1/2015 20:50:09	1	Graham Lake Approach	-82	
10/1/2015 20:50:10	1	Graham Lake Approach	-87	
10/1/2015 20:50:12	1	Graham Lake Approach	-88	
10/1/2015 20:50:13	1	Graham Lake Approach	-79	
10/1/2015 20:56:06	4	Graham Lake Gate 2	-66	Graham Lake Passage
10/1/2015 20:56:08	4	Graham Lake Gate 2	-67	
10/1/2015 20:56:15	4	Graham Lake Gate 2	-70	
10/1/2015 22:39:57	5	Downstream #1	-83	
10/1/2015 22:39:58	5	Downstream #1	-78	
10/1/2015 22:39:59	5	Downstream #1	-79	
10/1/2015 22:40:00	5	Downstream #1	-78	
10/1/2015 22:40:02	5	Downstream #1	-79	
10/1/2015 23:35:24	6	Ellsworth Approach	-84	
10/1/2015 23:35:25	6	Ellsworth Approach	-81	
10/1/2015 23:35:26	6	Ellsworth Approach	-85	
10/1/2015 23:35:27	6	Ellsworth Approach	-91	
10/1/2015 23:42:11	12	Ellsworth Unit 4	-67	Ellsworth Dam Passage
10/1/2015 23:42:12	12	Ellsworth Unit 4	-58	
10/1/2015 23:42:14	12	Ellsworth Unit 4	-68	
10/1/2015 23:43:01	13	Ellsworth Tailrace	-62	
10/1/2015 23:43:02	13	Ellsworth Tailrace	-60	
10/1/2015 23:43:04	13	Ellsworth Tailrace	-79	
10/1/2015 23:43:05	13	Ellsworth Tailrace	-78	
10/1/2015 23:45:00	14	Downstream #2	-80	
10/1/2015 23:45:08	14	Downstream #2	-78	
10/1/2015 23:45:09	14	Downstream #2	-80	
10/1/2015 23:46:49	15	Downstream #3	124	
10/1/2015 23:46:58	15	Downstream #3	137	
10/1/2015 23:47:15	15	Downstream #3	119	
10/1/2015 23:49:00	16	Downstream #4	55	
10/2/2015 12:48:45	16	Downstream #4	49	Successful Passage
10/2/2015 12:49:02	16	Downstream #4	55	
10/2/2015 12:49:11	16	Downstream #4	53	

Table C8. Passage Summary for Eel 149.480 85

Date and Time	Site #	Site Name	Power	Notes
10/2/2015 0:48:14	1	Graham Lake Approach	-91	Released 10/1/2015 19:53
10/2/2015 0:48:16	1	Graham Lake Approach	-92	
10/2/2015 0:48:17	1	Graham Lake Approach	-89	
10/2/2015 0:48:18	1	Graham Lake Approach	-92	
10/2/2015 0:48:19	1	Graham Lake Approach	-88	
10/2/2015 0:50:46	4	Graham Lake Gate 2	-64	Graham Lake Passage
10/2/2015 0:51:01	4	Graham Lake Gate 2	-74	
10/2/2015 2:39:06	5	Downstream #1	-82	
10/2/2015 2:39:07	5	Downstream #1	-85	
10/2/2015 2:39:08	5	Downstream #1	-85	
10/2/2015 2:39:09	5	Downstream #1	-82	
10/2/2015 2:39:10	5	Downstream #1	-81	
10/2/2015 6:23:59	6	Ellsworth Approach	-87	
10/2/2015 6:24:00	6	Ellsworth Approach	-87	
10/2/2015 6:24:01	6	Ellsworth Approach	-86	
10/2/2015 6:24:02	6	Ellsworth Approach	-93	
10/2/2015 11:41:04	12	Ellsworth Unit 4	-64	Ellsworth Dam Passage
10/2/2015 11:41:05	12	Ellsworth Unit 4	-68	
10/2/2015 11:41:06	12	Ellsworth Unit 4	-60	
10/2/2015 11:41:07	12	Ellsworth Unit 4	-60	
10/2/2015 11:41:58	13	Ellsworth Tailrace	-80	
10/2/2015 11:42:00	13	Ellsworth Tailrace	-75	
10/2/2015 11:42:01	13	Ellsworth Tailrace	-73	
10/2/2015 11:42:02	13	Ellsworth Tailrace	-79	
10/2/2015 11:43:45	14	Downstream #2	-75	
10/2/2015 11:43:46	14	Downstream #2	-74	
10/2/2015 11:43:48	14	Downstream #2	-77	
10/2/2015 18:41:10	15	Downstream #3	120	
10/2/2015 18:41:28	15	Downstream #3	121	
10/2/2015 18:41:38	15	Downstream #3	143	
10/2/2015 18:41:46	15	Downstream #3	127	
10/2/2015 18:43:19	16	Downstream #4	182	
10/2/2015 18:43:28	16	Downstream #4	121	Successful Passage
10/2/2015 18:43:46	16	Downstream #4	224	
10/2/2015 18:43:56	16	Downstream #4	255	

TABLE C9. PASSAGE SUMMARY FOR EEL 149.480 90

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/2/2015 4:30:40	1	Graham Lake Approach	-77	Released 10/1/2015 19:53
10/2/2015 4:30:42	1	Graham Lake Approach	-75	
10/2/2015 4:30:43	1	Graham Lake Approach	-79	
10/2/2015 4:30:44	1	Graham Lake Approach	-76	
10/2/2015 4:30:45	1	Graham Lake Approach	-79	
10/2/2015 4:38:44	4	Graham Lake Gate 2	-71	Graham Lake Passage
10/2/2015 4:38:45	4	Graham Lake Gate 2	-73	
10/2/2015 4:38:48	4	Graham Lake Gate 2	-71	
10/2/2015 6:21:37	5	Downstream Station #1	-87	
10/2/2015 6:21:38	5	Downstream Station #1	-86	
10/2/2015 6:21:39	5	Downstream Station #1	-87	
10/2/2015 6:21:40	5	Downstream Station #1	-87	
10/2/2015 6:21:41	5	Downstream Station #1	-86	
10/2/2015 19:45:36	6	Ellsworth Approach	-91	
10/2/2015 19:45:37	6	Ellsworth Approach	-92	
10/2/2015 19:45:38	6	Ellsworth Approach	-93	
10/2/2015 19:45:39	6	Ellsworth Approach	-92	
10/2/2015 19:53:43	12	Ellsworth Unit 4	-59	Ellsworth Dam Passage
10/2/2015 19:53:44	12	Ellsworth Unit 4	-58	
10/2/2015 19:53:45	12	Ellsworth Unit 4	-58	
10/4/2015 12:30:05	14	Downstream Station #2	-80	
10/4/2015 12:30:11	14	Downstream Station #2	-79	
10/4/2015 12:30:13	14	Downstream Station #2	-79	
10/4/2015 12:30:17	14	Downstream Station #2	-79	
10/4/2015 12:39:14	15	Downstream Station #3	136	
10/4/2015 12:39:16	15	Downstream Station #3	141	
10/4/2015 12:39:24	15	Downstream Station #3	131	
10/4/2015 12:39:33	15	Downstream Station #3	145	
10/4/2015 12:39:42	15	Downstream Station #3	144	
10/4/2015 13:00:06	16	Downstream Station #4	169	
10/4/2015 13:00:08	16	Downstream Station #4	101	
10/4/2015 13:00:16	16	Downstream Station #4	221	Successful Passage
10/4/2015 13:00:25	16	Downstream Station #4	247	
10/4/2015 13:00:34	16	Downstream Station #4	252	
10/4/2015 13:00:43	16	Downstream Station #4	254	

TABLE C10. PASSAGE SUMMARY FOR EEL 149.400 95

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/2/2015 1:01:54	1	Graham Lake Approach	-83	Released 10/1/2015 19:53
10/2/2015 1:01:55	1	Graham Lake Approach	-85	
10/2/2015 1:01:56	1	Graham Lake Approach	-86	
10/2/2015 1:01:57	1	Graham Lake Approach	-86	
10/2/2015 1:01:58	1	Graham Lake Approach	-89	
10/2/2015 1:05:33	4	Graham Lake Gate 2	-67	Graham Lake Passage
10/2/2015 1:05:34	4	Graham Lake Gate 2	-70	
10/2/2015 1:05:39	4	Graham Lake Gate 2	-70	
10/2/2015 19:05:38	5	Downstream #1	-82	
10/2/2015 19:05:39	5	Downstream #1	-82	
10/2/2015 19:05:40	5	Downstream #1	-80	
10/2/2015 19:05:41	5	Downstream #1	-81	
10/2/2015 19:05:42	5	Downstream #1	-82	
10/2/2015 19:05:43	5	Downstream #1	-82	
10/2/2015 20:34:55	6	Ellsworth Approach	-99	
10/2/2015 20:34:56	6	Ellsworth Approach	-96	
10/2/2015 20:34:57	6	Ellsworth Approach	-95	
10/2/2015 20:34:58	6	Ellsworth Approach	-90	
10/2/2015 20:47:11	12	Ellsworth Unit 4	-61	Ellsworth Dam Passage
10/2/2015 20:47:12	12	Ellsworth Unit 4	-59	
10/2/2015 20:47:13	12	Ellsworth Unit 4	-60	
10/2/2015 20:48:05	13	Ellsworth Tailrace	-66	
10/2/2015 20:48:06	13	Ellsworth Tailrace	-71	
10/2/2015 20:48:07	13	Ellsworth Tailrace	-76	
10/2/2015 20:48:10	13	Ellsworth Tailrace	-77	
10/2/2015 20:52:25	14	Downstream #2	-76	
10/2/2015 20:52:29	14	Downstream #2	-79	
10/2/2015 20:52:35	14	Downstream #2	-79	
10/2/2015 20:56:24	15	Downstream #3	127	
10/2/2015 20:56:25	15	Downstream #3	128	
10/6/2015 17:28:42	16	Downstream #4	253	
10/6/2015 17:28:52	16	Downstream #4	181	
10/6/2015 17:29:00	16	Downstream #4	255	Successful Passage
10/6/2015 17:29:09	16	Downstream #4	254	
10/6/2015 17:29:18	16	Downstream #4	251	

TABLE C11. PASSAGE SUMMARY FOR EEL 149.400 100

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/1/2015 22:51:25	1	Graham Lake Approach	-89	Released 10/1/2015 19:53
10/1/2015 22:51:26	1	Graham Lake Approach	-92	
10/1/2015 22:51:27	1	Graham Lake Approach	-90	
10/1/2015 22:51:28	1	Graham Lake Approach	-90	
10/1/2015 22:52:00	1	Graham Lake Approach	-84	
10/1/2015 22:52:01	1	Graham Lake Approach	-83	
10/1/2015 22:52:02	1	Graham Lake Approach	-86	
10/1/2015 22:52:03	1	Graham Lake Approach	-80	
10/1/2015 22:52:04	1	Graham Lake Approach	-89	
10/1/2015 22:59:36	4	Graham Lake Gate 2	-74	Graham Lake Passage
10/1/2015 22:59:37	4	Graham Lake Gate 2	-75	
10/1/2015 22:59:38	4	Graham Lake Gate 2	-74	
10/1/2015 22:59:39	4	Graham Lake Gate 2	-66	
10/2/2015 21:00:41	5	Downstream Station #1	-81	
10/2/2015 21:00:43	5	Downstream Station #1	-81	
10/2/2015 21:00:44	5	Downstream Station #1	-84	
10/2/2015 21:00:45	5	Downstream Station #1	-83	
10/2/2015 21:50:35	6	Ellsworth Approach	-96	
10/2/2015 21:50:36	6	Ellsworth Approach	-91	
10/2/2015 21:50:37	6	Ellsworth Approach	-88	
10/2/2015 21:50:38	6	Ellsworth Approach	-89	
10/2/2015 22:05:35	12	Ellsworth Unit 4	-60	Ellsworth Dam Passage
10/2/2015 22:05:36	12	Ellsworth Unit 4	-59	
10/2/2015 22:05:37	12	Ellsworth Unit 4	-59	
10/2/2015 22:06:30	13	Ellsworth Tailrace	-61	
10/2/2015 22:06:31	13	Ellsworth Tailrace	-72	
10/2/2015 22:06:32	13	Ellsworth Tailrace	-71	
10/2/2015 22:06:33	13	Ellsworth Tailrace	-77	
10/2/2015 22:09:38	14	Downstream Station #2	-72	
10/2/2015 22:09:39	14	Downstream Station #2	-77	
10/2/2015 22:09:40	14	Downstream Station #2	-77	
10/2/2015 22:11:01	15	Downstream Station #3	139	
10/2/2015 22:11:10	15	Downstream Station #3	150	
10/2/2015 22:11:19	15	Downstream Station #3	151	
10/2/2015 22:15:55	16	Downstream Station #4	107	
10/2/2015 22:16:13	16	Downstream Station #4	110	Successful Passage
10/2/2015 22:16:31	16	Downstream Station #4	124	
10/2/2015 22:16:41	16	Downstream Station #4	111	

TABLE C12. PASSAGE SUMMARY FOR EEL 149.400 105

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/2/2015 0:38:36	1	Graham Lake Approach	-83	Released 10/1/2015 19:53
10/2/2015 0:38:37	1	Graham Lake Approach	-79	
10/2/2015 0:38:38	1	Graham Lake Approach	-79	
10/2/2015 0:40:44	3	Graham Lake Gate 3	-93	Passage – Unknown Route
10/2/2015 0:40:45	3	Graham Lake Gate 3	-95	
10/2/2015 0:42:36	2	Graham Lake Fishway Weir	-70	
10/2/2015 0:42:53	4	Graham Lake Gate 2	-72	
10/2/2015 0:44:54	3	Graham Lake Gate 3	-94	
10/2/2015 0:53:26	3	Graham Lake Gate 3	-88	
10/2/2015 2:41:31	5	Downstream Station #1	-91	
10/2/2015 2:41:32	5	Downstream Station #1	-89	
10/2/2015 2:41:33	5	Downstream Station #1	-88	
10/2/2015 2:41:34	5	Downstream Station #1	-87	
10/2/2015 3:36:27	6	Ellsworth Approach	-73	
10/2/2015 3:36:28	6	Ellsworth Approach	-66	
10/2/2015 3:36:29	6	Ellsworth Approach	-84	
10/2/2015 3:36:30	6	Ellsworth Approach	-83	
10/2/2015 3:54:17	11	Ellsworth Unit 3	-57	Ellsworth Dam Passage
10/2/2015 3:54:18	11	Ellsworth Unit 3	-57	
10/2/2015 3:54:19	11	Ellsworth Unit 3	-57	
10/2/2015 3:54:20	11	Ellsworth Unit 3	-58	
10/2/2015 3:54:47	13	Ellsworth Tailrace	-65	
10/2/2015 3:54:48	13	Ellsworth Tailrace	-59	
10/2/2015 3:54:49	13	Ellsworth Tailrace	-64	
10/2/2015 3:54:51	13	Ellsworth Tailrace	-72	
10/2/2015 3:56:56	14	Downstream Station #2	-77	
10/2/2015 3:56:58	14	Downstream Station #2	-72	
10/2/2015 3:56:59	14	Downstream Station #2	-77	
10/2/2015 4:00:11	15	Downstream Station #3	126	
10/2/2015 4:00:21	15	Downstream Station #3	145	
10/2/2015 4:00:30	15	Downstream Station #3	131	
10/2/2015 4:02:35	16	Downstream Station #4	211	
10/2/2015 4:02:44	16	Downstream Station #4	190	Successful Passage
10/2/2015 4:02:52	16	Downstream Station #4	206	
10/2/2015 4:03:01	16	Downstream Station #4	211	
11/02/2015		1 KM from marina – manual tracking		Mortality

TABLE C13. PASSAGE SUMMARY FOR EEL 149.460 110

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/1/2015 20:49:21	1	Graham Lake Approach	-71	Released 10/1/2015 19:53
10/1/2015 20:49:22	1	Graham Lake Approach	-70	
10/1/2015 20:49:23	1	Graham Lake Approach	-76	
10/1/2015 20:49:25	1	Graham Lake Approach	-74	
10/1/2015 20:49:26	1	Graham Lake Approach	-69	
10/1/2015 20:49:27	1	Graham Lake Approach	-76	
10/1/2015 20:51:59	3	Graham Lake Gate 3	-76	Graham Lake Passage
10/1/2015 20:52:00	3	Graham Lake Gate 3	-72	
10/1/2015 20:52:01	3	Graham Lake Gate 3	-80	
10/1/2015 20:52:02	3	Graham Lake Gate 3	-80	
10/1/2015 20:52:03	3	Graham Lake Gate 3	-87	
10/1/2015 22:46:01	5	Downstream Station #1	-77	
10/1/2015 22:46:02	5	Downstream Station #1	-77	
10/1/2015 22:46:03	5	Downstream Station #1	-77	
10/1/2015 22:46:05	5	Downstream Station #1	-79	
10/1/2015 22:46:06	5	Downstream Station #1	-88	
10/1/2015 22:46:07	5	Downstream Station #1	-93	
10/1/2015 23:37:57	6	Ellsworth Approach	-86	
10/1/2015 23:37:58	6	Ellsworth Approach	-88	
10/1/2015 23:37:59	6	Ellsworth Approach	-85	
10/1/2015 23:38:00	6	Ellsworth Approach	-84	
10/1/2015 23:38:01	6	Ellsworth Approach	-87	
10/1/2015 23:38:02	6	Ellsworth Approach	-87	
10/1/2015 23:44:44	12	Ellsworth Unit 4	-75	
10/1/2015 23:44:45	12	Ellsworth Unit 4	-71	Ellsworth Dam Passage
10/1/2015 23:44:46	12	Ellsworth Unit 4	-66	
10/1/2015 23:44:47	12	Ellsworth Unit 4	-70	
10/1/2015 23:44:48	12	Ellsworth Unit 4	-58	
10/2/2015 4:34:28	13	Ellsworth Tailrace	-59	
10/2/2015 4:34:29	13	Ellsworth Tailrace	-64	
10/2/2015 4:34:30	13	Ellsworth Tailrace	-62	
10/2/2015 4:34:31	13	Ellsworth Tailrace	-63	
10/2/2015 4:34:33	13	Ellsworth Tailrace	-61	
10/12/2015 10:00:09	13	Ellsworth Tailrace	86	Mortality in Tailrace
10/12/2015 10:00:19	13	Ellsworth Tailrace	80	
10/12/2015 10:00:29	13	Ellsworth Tailrace	133	
10/12/2015 10:00:39	13	Ellsworth Tailrace	131	
10/12/2015 10:00:49	13	Ellsworth Tailrace	156	

TABLE C14. PASSAGE SUMMARY FOR EEL 149.460 115

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/1/2015 22:02:27	1	Graham Lake Approach	-92	Released 10/1/2015 19:53
10/1/2015 22:02:28	1	Graham Lake Approach	-92	
10/1/2015 22:02:30	1	Graham Lake Approach	-90	
10/1/2015 22:02:31	1	Graham Lake Approach	-91	
10/1/2015 22:05:24	4	Graham Lake Gate 2	-73	Graham Lake Passage
10/1/2015 22:05:25	4	Graham Lake Gate 2	-72	
10/1/2015 22:05:27	4	Graham Lake Gate 2	-59	
10/1/2015 22:05:28	4	Graham Lake Gate 2	-75	
10/2/2015 0:09:04	5	Downstream Station #1	-76	
10/2/2015 0:09:05	5	Downstream Station #1	-75	
10/2/2015 0:09:06	5	Downstream Station #1	-76	
10/2/2015 0:09:07	5	Downstream Station #1	-76	
10/2/2015 1:12:21	6	Ellsworth Approach	-85	
10/2/2015 1:12:22	6	Ellsworth Approach	-87	
10/2/2015 1:12:23	6	Ellsworth Approach	-88	
10/2/2015 1:12:25	6	Ellsworth Approach	-93	
10/2/2015 1:26:11	10	Ellsworth Unit 2	-57	Ellsworth Dam Passage
10/2/2015 1:26:12	10	Ellsworth Unit 2	-57	
10/2/2015 1:26:13	10	Ellsworth Unit 2	-56	
10/2/2015 1:26:14	10	Ellsworth Unit 2	-60	
10/2/2015 1:26:40	13	Ellsworth Tailrace	-63	
10/2/2015 1:26:41	13	Ellsworth Tailrace	-61	
10/2/2015 1:26:43	13	Ellsworth Tailrace	-64	
10/2/2015 1:26:44	13	Ellsworth Tailrace	-61	
10/6/2015 12:33:01	14	Downstream Station #2	-77	
10/6/2015 12:33:02	14	Downstream Station #2	-75	
10/6/2015 12:33:03	14	Downstream Station #2	-80	
10/6/2015 12:33:04	14	Downstream Station #2	-78	
10/6/2015 12:40:12	15	Downstream Station #3	151	
10/6/2015 12:40:22	15	Downstream Station #3	151	
10/6/2015 12:40:29	15	Downstream Station #3	151	
10/6/2015 12:40:39	15	Downstream Station #3	156	
10/6/2015 12:56:11	16	Downstream Station #4	193	
10/6/2015 12:56:20	16	Downstream Station #4	189	
10/6/2015 12:56:29	16	Downstream Station #4	171	Successful Passage
10/6/2015 12:56:38	16	Downstream Station #4	254	
10/6/2015 12:56:46	16	Downstream Station #4	253	
10/21/2015		Marina – manual tracking		Mortality

TABLE C15. PASSAGE SUMMARY FOR EEL 149.460 120

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/2/2015 1:16:40	1	Graham Lake Approach	-93	Released 10/1/2015 19:53
10/2/2015 1:16:41	1	Graham Lake Approach	-92	
10/2/2015 1:16:42	1	Graham Lake Approach	-94	
10/2/2015 1:16:44	1	Graham Lake Approach	-90	
10/2/2015 1:20:43	4	Graham Lake Gate 2	-71	Graham Lake Passage
10/2/2015 1:20:45	4	Graham Lake Gate 2	-71	
10/2/2015 1:20:47	4	Graham Lake Gate 2	-71	
10/2/2015 1:20:48	4	Graham Lake Gate 2	-72	
10/2/2015 3:00:51	5	Downstream Station #1	-75	
10/2/2015 3:00:52	5	Downstream Station #1	-75	
10/2/2015 3:00:53	5	Downstream Station #1	-75	
10/2/2015 3:00:54	5	Downstream Station #1	-75	
10/2/2015 3:00:55	5	Downstream Station #1	-75	
10/2/2015 20:59:18	6	Ellsworth Approach	-86	
10/2/2015 20:59:19	6	Ellsworth Approach	-84	
10/2/2015 20:59:20	6	Ellsworth Approach	-83	
10/2/2015 20:59:21	6	Ellsworth Approach	-82	
10/2/2015 21:18:06	12	Ellsworth Unit 4	-60	Ellsworth Dam Passage
10/2/2015 21:18:07	12	Ellsworth Unit 4	-58	
10/2/2015 21:18:08	12	Ellsworth Unit 4	-72	
10/2/2015 21:18:47	13	Ellsworth Tailrace	-72	
10/2/2015 21:18:50	13	Ellsworth Tailrace	-78	
10/2/2015 21:20:38	14	Downstream Station #2	-79	
10/2/2015 21:20:41	14	Downstream Station #2	-77	
10/2/2015 21:20:42	14	Downstream Station #2	-79	
10/2/2015 21:20:43	14	Downstream Station #2	-79	
10/2/2015 21:22:45	15	Downstream Station #3	117	
10/2/2015 21:22:53	15	Downstream Station #3	130	
10/2/2015 21:23:03	15	Downstream Station #3	139	
10/2/2015 21:23:11	15	Downstream Station #3	156	
10/2/2015 21:23:21	15	Downstream Station #3	150	
10/2/2015 21:27:22	16	Downstream Station #4	198	
10/2/2015 21:27:30	16	Downstream Station #4	243	Successful Passage
10/2/2015 21:27:39	16	Downstream Station #4	197	
10/2/2015 21:27:48	16	Downstream Station #4	138	

TABLE C16. PASSAGE SUMMARY FOR EEL 149.320 130

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/8/2015 20:36:32	1	Graham Lake Approach	-87	Released 10/8/2015 18:56
10/8/2015 20:36:33	1	Graham Lake Approach	-87	
10/8/2015 20:36:34	1	Graham Lake Approach	-87	
10/8/2015 20:36:35	1	Graham Lake Approach	-86	
10/8/2015 20:38:42	3	Graham Lake Min Flow Gate 3	-94	Graham Lake Passage
10/8/2015 20:38:46	3	Graham Lake Min Flow Gate 3	-92	
10/8/2015 22:44:18	5	Downstream Station #1	-89	
10/8/2015 22:44:19	5	Downstream Station #1	-88	
10/8/2015 22:44:20	5	Downstream Station #1	-88	
10/8/2015 22:44:21	5	Downstream Station #1	-88	
10/10/2015 0:52:06	6	Ellsworth Approach	-95	
10/10/2015 0:52:07	6	Ellsworth Approach	-90	
10/10/2015 0:52:09	6	Ellsworth Approach	-91	
10/10/2015 0:52:10	6	Ellsworth Approach	-84	
10/10/2015 1:01:48	11	Ellsworth Unit 3	-57	Ellsworth Dam Passage
10/10/2015 1:01:49	11	Ellsworth Unit 3	-57	
10/10/2015 1:02:11	13	Ellsworth Tailrace	-60	
10/10/2015 1:02:12	13	Ellsworth Tailrace	-60	
10/10/2015 1:02:13	13	Ellsworth Tailrace	-60	
10/10/2015 1:02:14	13	Ellsworth Tailrace	-64	
10/10/2015 1:04:31	14	Downstream Station #2	-70	
10/10/2015 1:04:32	14	Downstream Station #2	-76	
10/10/2015 1:04:35	14	Downstream Station #2	-80	
10/10/2015 1:04:42	14	Downstream Station #2	-69	
10/10/2015 1:04:49	14	Downstream Station #2	-75	
10/10/2015 1:04:50	14	Downstream Station #2	-75	
10/10/2015 1:06:38	15	Downstream Station #3	131	
10/10/2015 1:06:56	15	Downstream Station #3	117	
10/10/2015 1:07:13	15	Downstream Station #3	145	
10/10/2015 1:09:42	16	Downstream Station #4	117	
10/10/2015 1:09:49	16	Downstream Station #4	151	
10/10/2015 1:09:59	16	Downstream Station #4	255	
10/10/2015 1:10:07	16	Downstream Station #4	254	
10/10/26/2015		Marina – manual tracking		Mortality

TABLE C17. PASSAGE SUMMARY FOR EEL 149.320 135

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/8/2015 21:48:39	1	Graham Lake Approach	-80	Released 10/8/2015 18:56
10/8/2015 21:48:40	1	Graham Lake Approach	-79	
10/8/2015 21:48:41	1	Graham Lake Approach	-79	
10/8/2015 21:48:42	1	Graham Lake Approach	-80	
10/8/2015 21:50:18	3	Graham Lake Gate 3	-93	Graham Lake Passage
10/8/2015 21:50:26	3	Graham Lake Gate 3	-89	
10/8/2015 23:42:23	5	Downstream Station #1	-82	
10/8/2015 23:42:24	5	Downstream Station #1	-82	
10/8/2015 23:42:26	5	Downstream Station #1	-84	
10/8/2015 23:42:27	5	Downstream Station #1	-82	
10/9/2015 1:19:13	6	Ellsworth Approach	-82	
10/9/2015 1:19:14	6	Ellsworth Approach	-84	
10/9/2015 1:19:15	6	Ellsworth Approach	-82	
10/9/2015 1:19:16	6	Ellsworth Approach	-83	
10/9/2015 1:25:40	12	Ellsworth Unit 4	-64	Ellsworth Dam Passage
10/9/2015 1:25:41	12	Ellsworth Unit 4	-59	
10/9/2015 1:25:42	12	Ellsworth Unit 4	-59	
10/9/2015 1:25:43	12	Ellsworth Unit 4	-60	
10/9/2015 1:26:55	13	Ellsworth Tailrace	-77	
10/9/2015 1:26:56	13	Ellsworth Tailrace	-68	
10/9/2015 1:26:57	13	Ellsworth Tailrace	-67	
10/9/2015 1:26:59	13	Ellsworth Tailrace	-69	
10/9/2015 1:29:15	14	Downstream Station #2	-80	
10/9/2015 1:29:19	14	Downstream Station #2	-77	
10/9/2015 1:29:20	14	Downstream Station #2	-70	
10/9/2015 1:29:23	14	Downstream Station #2	-74	
10/9/2015 1:34:02	15	Downstream Station #3	140	
10/9/2015 1:34:12	15	Downstream Station #3	149	
10/9/2015 1:34:20	15	Downstream Station #3	150	
10/9/2015 1:34:29	15	Downstream Station #3	136	
10/9/2015 1:40:10	16	Downstream Station #4	192	
10/9/2015 1:40:28	16	Downstream Station #4	135	
10/9/2015 1:40:37	16	Downstream Station #4	159	Successful Passage
10/9/2015 1:40:46	16	Downstream Station #4	119	
10/9/2015 1:40:54	16	Downstream Station #4	132	

TABLE C18. PASSAGE SUMMARY FOR EEL 149.320 140

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/14/2015 19:33:35	1	Graham Lake Approach	-85	Released 10/8/2015 18:56
10/14/2015 19:33:36	1	Graham Lake Approach	-85	
10/14/2015 19:33:38	1	Graham Lake Approach	-85	
10/14/2015 19:33:39	1	Graham Lake Approach	-84	
10/14/2015 19:33:40	1	Graham Lake Approach	-84	
10/14/2015 22:02:42	5	Downstream Station #1	-79	Passage – Unknown Route
10/14/2015 22:02:43	5	Downstream Station #1	-79	
10/14/2015 22:02:44	5	Downstream Station #1	-82	
10/14/2015 22:02:45	5	Downstream Station #1	-84	
10/14/2015 23:14:29	6	Ellsworth Approach	-76	
10/14/2015 23:14:30	6	Ellsworth Approach	-79	
10/14/2015 23:14:31	6	Ellsworth Approach	-76	
10/14/2015 23:14:32	6	Ellsworth Approach	-64	
10/14/2015 23:14:34	6	Ellsworth Approach	-71	
10/14/2015 23:25:47	11	Ellsworth Unit 3	-57	Ellsworth Dam Passage
10/14/2015 23:25:49	11	Ellsworth Unit 3	-58	
10/14/2015 23:25:50	11	Ellsworth Unit 3	-57	
10/14/2015 23:28:10	14	Downstream Station #2	-77	
10/14/2015 23:28:11	14	Downstream Station #2	-76	
10/14/2015 23:28:13	14	Downstream Station #2	-73	
10/14/2015 23:28:14	14	Downstream Station #2	-73	
10/14/2015 23:31:27	15	Downstream Station #3	143	
10/14/2015 23:31:36	15	Downstream Station #3	138	
10/14/2015 23:31:45	15	Downstream Station #3	139	
10/14/2015 23:31:54	15	Downstream Station #3	149	
10/14/2015 23:32:04	15	Downstream Station #3	139	
10/14/2015 23:36:35	16	Downstream Station #4	174	
10/14/2015 23:36:44	16	Downstream Station #4	164	
10/14/2015 23:36:53	16	Downstream Station #4	191	Successful Passage
10/14/2015 23:36:54	16	Downstream Station #4	216	
10/14/2015 23:37:03	16	Downstream Station #4	161	
10/14/2015 23:37:11	16	Downstream Station #4	255	

TABLE C19. PASSAGE SUMMARY FOR EEL 149.340 145

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/8/2015 21:01:09	1	Graham Lake Approach	-78	Released 10/8/2015 18:56
10/8/2015 21:01:10	1	Graham Lake Approach	-77	
10/8/2015 21:01:11	1	Graham Lake Approach	-77	
10/8/2015 21:01:12	1	Graham Lake Approach	-77	
10/8/2015 21:01:13	1	Graham Lake Approach	-77	
10/8/2015 21:01:14	1	Graham Lake Approach	-78	
10/8/2015 23:16:02	5	Downstream Station #1	-86	Passage – Unknown Route
10/8/2015 23:16:03	5	Downstream Station #1	-87	
10/8/2015 23:16:04	5	Downstream Station #1	-86	
10/8/2015 23:16:06	5	Downstream Station #1	-86	
10/9/2015 2:43:54	6	Ellsworth Approach	-64	
10/9/2015 2:43:55	6	Ellsworth Approach	-63	
10/9/2015 2:43:56	6	Ellsworth Approach	-62	
10/9/2015 2:43:57	6	Ellsworth Approach	-62	
10/9/2015 2:43:58	6	Ellsworth Approach	-63	
10/9/2015 2:43:59	6	Ellsworth Approach	-64	
10/10/2015 4:47:18	11	Ellsworth Unit 3	-57	
10/10/2015 4:47:42	13	Ellsworth Tailrace	-67	Ellsworth Dam Passage
10/10/2015 4:47:43	13	Ellsworth Tailrace	-67	
10/10/2015 4:47:44	13	Ellsworth Tailrace	-63	
10/10/2015 4:47:45	13	Ellsworth Tailrace	-64	
10/10/2015 12:14:18	14	Downstream Station #2	-77	
10/10/2015 12:14:19	14	Downstream Station #2	-79	
10/10/2015 12:14:21	14	Downstream Station #2	-76	
10/10/2015 19:53:37	15	Downstream Station #3	134	
10/10/2015 19:53:45	15	Downstream Station #3	135	
10/10/2015 19:53:55	15	Downstream Station #3	138	
10/10/2015 19:53:56	15	Downstream Station #3	160	
10/11/2015 2:09:17	16	Downstream Station #4	235	
10/11/2015 2:09:18	16	Downstream Station #4	224	
10/11/2015 2:09:28	16	Downstream Station #4	252	
10/11/2015 2:09:35	16	Downstream Station #4	246	
10/11/2015 2:09:45	16	Downstream Station #4	238	
10/16/2015		Marina – manual tracking		Mortality

TABLE C20. PASSAGE SUMMARY FOR EEL 149.340 150

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/11/2015 5:15:06	1	Graham Lake Approach	-83	Released 10/8/2015 18:56
10/11/2015 5:15:07	1	Graham Lake Approach	-84	
10/11/2015 5:15:08	1	Graham Lake Approach	-86	
10/11/2015 5:15:09	1	Graham Lake Approach	-85	
10/11/2015 7:41:32	5	Downstream Station #1	-83	Passage – Unknown Route
10/11/2015 7:41:33	5	Downstream Station #1	-81	
10/11/2015 7:41:34	5	Downstream Station #1	-80	
10/11/2015 7:41:35	5	Downstream Station #1	-80	
10/11/2015 7:41:36	5	Downstream Station #1	-80	
10/11/2015 9:22:51	6	Ellsworth Approach	-98	
10/11/2015 9:22:54	6	Ellsworth Approach	-98	
10/11/2015 9:23:02	6	Ellsworth Approach	-95	
10/11/2015 9:23:10	6	Ellsworth Approach	-100	
10/11/2015 18:14:51	12	Ellsworth Unit 4	-61	Ellsworth Dam Passage
10/11/2015 18:14:52	12	Ellsworth Unit 4	-59	
10/11/2015 18:14:53	12	Ellsworth Unit 4	-60	
10/11/2015 18:14:54	12	Ellsworth Unit 4	-61	
10/11/2015 18:15:41	13	Ellsworth Tailrace	-64	
10/11/2015 18:15:42	13	Ellsworth Tailrace	-63	
10/11/2015 18:15:43	13	Ellsworth Tailrace	-67	
10/11/2015 18:15:44	13	Ellsworth Tailrace	-66	
10/11/2015 18:22:37	14	Downstream Station #2	-64	
10/11/2015 18:22:38	14	Downstream Station #2	-67	
10/11/2015 18:22:39	14	Downstream Station #2	-72	
10/11/2015 18:22:40	14	Downstream Station #2	-70	
10/11/2015 18:22:41	14	Downstream Station #2	-67	
10/11/2015 18:25:41	15	Downstream Station #3	130	
10/11/2015 18:25:51	15	Downstream Station #3	131	
10/11/2015 18:26:00	15	Downstream Station #3	150	
10/11/2015 18:26:10	15	Downstream Station #3	140	
10/11/2015 18:26:18	15	Downstream Station #3	138	
10/11/2015 18:29:05	16	Downstream Station #4	159	
10/11/2015 18:29:14	16	Downstream Station #4	154	Successful Passage
10/11/2015 18:29:23	16	Downstream Station #4	129	
10/11/2015 18:29:33	16	Downstream Station #4	135	

TABLE C21. PASSAGE SUMMARY FOR EEL 149.340 160

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/9/2015 20:15:49	1	Graham Lake Approach	-93	Released 10/8/2015 18:56
10/9/2015 20:15:50	1	Graham Lake Approach	-93	
10/9/2015 20:15:51	1	Graham Lake Approach	-90	
10/9/2015 20:15:52	1	Graham Lake Approach	-90	
10/9/2015 20:15:54	1	Graham Lake Approach	-86	
10/9/2015 20:18:42	4	Graham Lake Gate 2	-69	Graham Lake Passage
10/9/2015 20:18:43	4	Graham Lake Gate 2	-70	
10/9/2015 22:29:33	5	Downstream Station #1	-89	
10/9/2015 22:29:34	5	Downstream Station #1	-91	
10/9/2015 22:29:35	5	Downstream Station #1	-94	
10/9/2015 22:29:36	5	Downstream Station #1	-95	
10/11/2015 19:26:33	6	Ellsworth Approach	-89	
10/11/2015 19:26:34	6	Ellsworth Approach	-90	
10/11/2015 19:26:35	6	Ellsworth Approach	-86	
10/11/2015 19:26:36	6	Ellsworth Approach	-84	
10/11/2015 19:26:37	6	Ellsworth Approach	-85	
10/24/2015 19:14:57	11	Ellsworth Unit 3	-70	Ellsworth Dam Passage
10/24/2015 19:14:59	11	Ellsworth Unit 3	-57	
10/24/2015 19:15:00	11	Ellsworth Unit 3	-57	
10/24/2015 19:15:02	11	Ellsworth Unit 3	-57	
10/24/2015 19:15:04	11	Ellsworth Unit 3	-65	
10/24/2015 19:15:50	13	Ellsworth Tailrace	-72	
10/24/2015 19:15:51	13	Ellsworth Tailrace	-68	
10/24/2015 19:15:52	13	Ellsworth Tailrace	-76	
10/24/2015 19:15:55	13	Ellsworth Tailrace	-64	
10/24/2015 19:15:56	13	Ellsworth Tailrace	-67	
10/24/2015 19:15:57	13	Ellsworth Tailrace	-65	
11/12/2015 11:30:14		Manual Tracking Near Tailrace	205	Mortality
11/12/2015 11:30:24		Manual Tracking Near Tailrace	254	
11/12/2015 11:30:34		Manual Tracking Near Tailrace	255	
11/12/2015 11:30:44		Manual Tracking Near Tailrace	204	
11/12/2015 11:30:54		Manual Tracking Near Tailrace	203	

TABLE C22. PASSAGE SUMMARY FOR EEL 149.400 165

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/9/2015 22:26:18	1	Graham Lake Approach	-86	Released 10/8/2015 18:56
10/9/2015 22:26:19	1	Graham Lake Approach	-83	
10/9/2015 22:26:20	1	Graham Lake Approach	-83	
10/9/2015 22:26:21	1	Graham Lake Approach	-83	
10/9/2015 22:26:22	1	Graham Lake Approach	-86	
10/10/2015 7:16:09	5	Downstream Station #1	-85	Passage – Unknown Route
10/10/2015 7:16:10	5	Downstream Station #1	-82	
10/10/2015 7:16:11	5	Downstream Station #1	-81	
10/10/2015 7:16:12	5	Downstream Station #1	-84	
10/10/2015 7:16:13	5	Downstream Station #1	-85	
10/12/2015 2:00:58	6	Ellsworth Approach	-83	
10/12/2015 2:00:59	6	Ellsworth Approach	-87	
10/12/2015 2:01:00	6	Ellsworth Approach	-79	
10/12/2015 2:01:01	6	Ellsworth Approach	-79	
10/12/2015 2:01:04	6	Ellsworth Approach	-68	
10/16/2015 17:42:20	10	Ellsworth Unit 2	-70	Ellsworth Dam Passage
10/16/2015 17:42:22	10	Ellsworth Unit 2	-57	
10/16/2015 17:42:43	13	Ellsworth Tailrace	-68	
10/16/2015 17:42:47	13	Ellsworth Tailrace	-62	
10/16/2015 17:42:50	13	Ellsworth Tailrace	-63	
10/16/2015 17:42:55	13	Ellsworth Tailrace	-65	
10/16/2015 17:42:56	13	Ellsworth Tailrace	-68	
10/16/2015 18:11:17	14	Downstream Station #2	-79	
10/16/2015 18:11:18	14	Downstream Station #2	-79	
10/16/2015 18:11:19	14	Downstream Station #2	-80	
10/16/2015 18:11:21	14	Downstream Station #2	-79	
10/16/2015 18:11:22	14	Downstream Station #2	-80	
10/17/2015 18:51:59	15	Downstream Station #3	130	
10/17/2015 18:52:08	15	Downstream Station #3	132	
10/17/2015 18:52:17	15	Downstream Station #3	138	
10/17/2015 18:52:26	15	Downstream Station #3	124	
10/17/2015 18:52:34	15	Downstream Station #3	136	
10/20/2015 13:17:38	16	Downstream Station #4	214	
10/20/2015 13:17:48	16	Downstream Station #4	118	
10/20/2015 13:17:55	16	Downstream Station #4	252	
10/20/2015 13:18:05	16	Downstream Station #4	225	
11/5/2015		Marina – manual tracking		Mortality

TABLE C23. PASSAGE SUMMARY FOR EEL 149.400 170

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/9/2015 1:19:35	1	Graham Lake Approach	-77	Released 10/8/2015 18:56
10/9/2015 1:19:36	1	Graham Lake Approach	-80	
10/9/2015 1:19:39	1	Graham Lake Approach	-92	
10/9/2015 1:19:41	1	Graham Lake Approach	-92	
10/9/2015 1:19:42	1	Graham Lake Approach	-90	
10/9/2015 1:21:25	3	Graham Lake Gate 3	-85	
10/9/2015 1:21:26	3	Graham Lake Gate 3	-82	Passage Graham Lake
10/9/2015 1:21:28	3	Graham Lake Gate 3	-83	
10/9/2015 1:21:34	3	Graham Lake Gate 3	-73	
10/9/2015 1:21:36	3	Graham Lake Gate 3	-91	
10/9/2015 1:21:37	3	Graham Lake Gate 3	-91	
10/9/2015 3:25:38	5	Downstream Station #1	-84	
10/9/2015 3:25:39	5	Downstream Station #1	-86	
10/9/2015 3:25:40	5	Downstream Station #1	-85	
10/9/2015 3:25:41	5	Downstream Station #1	-85	
10/9/2015 3:25:42	5	Downstream Station #1	-84	
10/9/2015 3:25:43	5	Downstream Station #1	-86	
10/9/2015 3:25:44	5	Downstream Station #1	-86	
10/9/2015 19:18:28	6	Ellsworth Approach	-93	
10/9/2015 19:18:29	6	Ellsworth Approach	-87	
10/9/2015 19:18:30	6	Ellsworth Approach	-85	
10/9/2015 19:18:31	6	Ellsworth Approach	-90	
10/9/2015 19:18:32	6	Ellsworth Approach	-90	
10/9/2015 19:18:33	6	Ellsworth Approach	-93	
10/9/2015 19:41:59	10	Ellsworth Unit 2	-74	
10/9/2015 19:42:01	10	Ellsworth Unit 2	-69	Passage Ellsworth Dam
10/9/2015 19:42:07	10	Ellsworth Unit 2	-59	
10/9/2015 22:41:34	13	Ellsworth Tailrace	-64	
10/9/2015 22:41:35	13	Ellsworth Tailrace	-64	
10/9/2015 22:41:37	13	Ellsworth Tailrace	-68	
10/9/2015 22:41:39	13	Ellsworth Tailrace	-64	
10/9/2015 22:41:40	13	Ellsworth Tailrace	-68	
10/9/2015 22:41:41	13	Ellsworth Tailrace	-69	
11/1/2015 11:03:06	13	Ellsworth Tailrace	-64	Mortality in Tailrace
11/1/2015 11:03:16	13	Ellsworth Tailrace	-66	
11/1/2015 11:03:26	13	Ellsworth Tailrace	-63	
11/1/2015 11:03:36	13	Ellsworth Tailrace	-64	
11/1/2015 11:03:46	13	Ellsworth Tailrace	-64	
11/1/2015 11:03:56	13	Ellsworth Tailrace	-63	

TABLE C24. PASSAGE SUMMARY FOR EEL 149.400 175

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/10/2015 3:22:08	1	Graham Lake Approach	-76	Released 10/8/2015 18:56
10/10/2015 3:22:09	1	Graham Lake Approach	-77	
10/10/2015 3:22:10	1	Graham Lake Approach	-73	
10/10/2015 3:22:11	1	Graham Lake Approach	-74	
10/10/2015 3:22:12	1	Graham Lake Approach	-74	
10/10/2015 3:28:07	3	Graham Lake Gate 3	-69	Graham Lake Passage
10/10/2015 5:05:31	5	Downstream Station #1	-86	
10/10/2015 5:05:32	5	Downstream Station #1	-87	
10/10/2015 5:05:33	5	Downstream Station #1	-85	
10/10/2015 5:05:34	5	Downstream Station #1	-85	
10/10/2015 5:05:35	5	Downstream Station #1	-88	
10/10/2015 5:44:22	6	Ellsworth Approach	-93	
10/10/2015 5:44:23	6	Ellsworth Approach	-95	
10/10/2015 5:44:24	6	Ellsworth Approach	-95	
10/10/2015 5:44:25	6	Ellsworth Approach	-91	
10/10/2015 5:44:26	6	Ellsworth Approach	-97	
10/10/2015 19:01:39	11	Ellsworth Unit 3	-58	Ellsworth Dam Passage
10/10/2015 19:01:40	11	Ellsworth Unit 3	-59	
10/10/2015 19:01:41	11	Ellsworth Unit 3	-58	
10/10/2015 19:02:05	13	Ellsworth Tailrace	-63	
10/10/2015 19:02:07	13	Ellsworth Tailrace	-68	
10/10/2015 19:02:08	13	Ellsworth Tailrace	-68	
10/10/2015 19:02:09	13	Ellsworth Tailrace	-64	
10/11/2015 13:10:51	14	Downstream Station #2	-64	
10/11/2015 13:10:52	14	Downstream Station #2	-79	
10/11/2015 13:10:53	14	Downstream Station #2	-75	
10/11/2015 13:10:55	14	Downstream Station #2	-60	
10/11/2015 13:22:50	15	Downstream Station #3	132	
10/11/2015 13:23:00	15	Downstream Station #3	145	
10/11/2015 13:23:25	15	Downstream Station #3	136	
10/11/2015 13:23:54	15	Downstream Station #3	142	
10/11/2015 13:24:02	15	Downstream Station #3	143	
10/11/2015 14:48:31	16	Downstream Station #4	169	
10/11/2015 14:48:40	16	Downstream Station #4	219	Successful Passage
10/11/2015 14:48:49	16	Downstream Station #4	251	
10/11/2015 14:48:50	16	Downstream Station #4	254	

TABLE C25. PASSAGE SUMMARY FOR EEL 149.400 180

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/9/2015 20:41:23	1	Graham Lake Approach	-88	Released 10/8/2015 18:56
10/9/2015 20:41:24	1	Graham Lake Approach	-89	
10/9/2015 20:41:26	1	Graham Lake Approach	-86	
10/9/2015 20:41:27	1	Graham Lake Approach	-88	
10/9/2015 20:41:28	1	Graham Lake Approach	-87	
10/9/2015 20:41:29	1	Graham Lake Approach	-87	
10/9/2015 20:41:30	1	Graham Lake Approach	-90	
10/9/2015 20:41:31	1	Graham Lake Approach	-89	
10/9/2015 20:41:32	1	Graham Lake Approach	-91	
10/9/2015 21:03:23	3	Graham Lake Gate 3	-64	Graham Lake Passage
10/9/2015 21:03:24	3	Graham Lake Gate 3	-72	
10/9/2015 21:03:31	3	Graham Lake Gate 3	-67	
10/9/2015 21:03:39	3	Graham Lake Gate 3	-68	
10/9/2015 23:22:20	5	Downstream Station #1	-92	
10/9/2015 23:22:21	5	Downstream Station #1	-92	
10/9/2015 23:22:22	5	Downstream Station #1	-90	
10/9/2015 23:22:23	5	Downstream Station #1	-86	
10/9/2015 23:22:24	5	Downstream Station #1	-87	
10/9/2015 23:22:26	5	Downstream Station #1	-86	
10/9/2015 23:22:27	5	Downstream Station #1	-84	
10/9/2015 23:58:21	6	Ellsworth Approach	-98	
10/9/2015 23:59:29	6	Ellsworth Approach	-84	
10/9/2015 23:59:30	6	Ellsworth Approach	-86	
10/9/2015 23:59:31	6	Ellsworth Approach	-91	
10/10/2015 0:11:25	11	Ellsworth Unit 3	-58	Ellsworth Dam Passage
10/10/2015 0:11:26	11	Ellsworth Unit 3	-58	
10/10/2015 0:11:27	11	Ellsworth Unit 3	-57	Last Detection - Mortality

TABLE C26. PASSAGE SUMMARY FOR EEL 149.460 185

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/10/2015 3:17:45	1	Graham Lake Approach	-92	Released 10/8/2015 18:56
10/10/2015 3:17:46	1	Graham Lake Approach	-89	
10/10/2015 3:17:47	1	Graham Lake Approach	-87	
10/10/2015 3:17:48	1	Graham Lake Approach	-89	
10/10/2015 3:17:49	1	Graham Lake Approach	-89	
10/10/2015 3:17:50	1	Graham Lake Approach	-89	
10/10/2015 3:19:29	4	Graham Lake Gate 2	-64	Graham Lake Passage
10/25/2015 18:44:18	5	Downstream Station #1	-91	
10/25/2015 18:44:28	5	Downstream Station #1	-80	
10/25/2015 18:44:38	5	Downstream Station #1	-79	
10/25/2015 18:44:48	5	Downstream Station #1	-80	
10/25/2015 18:44:58	5	Downstream Station #1	-83	
10/25/2015 20:03:48	6	Ellsworth Approach	-99	
10/25/2015 20:06:58	6	Ellsworth Approach	-95	
10/25/2015 20:17:06	13	Ellsworth Tailrace	-66	Passage – Unknown Route
10/25/2015 20:17:07	13	Ellsworth Tailrace	-70	
10/25/2015 20:17:08	13	Ellsworth Tailrace	-70	
10/25/2015 20:17:09	13	Ellsworth Tailrace	-67	
10/25/2015 20:17:12	13	Ellsworth Tailrace	-70	
10/25/2015 20:26:07	14	Downstream Station #2	-73	
10/25/2015 20:26:08	14	Downstream Station #2	-71	
10/25/2015 20:26:10	14	Downstream Station #2	-69	
10/25/2015 20:26:11	14	Downstream Station #2	-78	
10/25/2015 20:26:12	14	Downstream Station #2	-77	
10/25/2015 20:31:17	15	Downstream Station #3	129	
10/25/2015 20:31:35	15	Downstream Station #3	129	
10/25/2015 20:32:10	15	Downstream Station #3	122	
10/25/2015 20:32:37	15	Downstream Station #3	128	
10/25/2015 20:40:30	16	Downstream Station #4	248	
10/25/2015 20:40:39	16	Downstream Station #4	218	
10/25/2015 20:40:48	16	Downstream Station #4	184	Successful Passage
10/25/2015 20:40:58	16	Downstream Station #4	255	
10/25/2015 20:41:06	16	Downstream Station #4	239	

TABLE C27. PASSAGE SUMMARY FOR EEL 149.460 190

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/9/2015 5:32:02	1	Graham Lake Approach	-81	Released 10/8/2015 18:56
10/9/2015 5:32:03	1	Graham Lake Approach	-80	
10/9/2015 5:32:04	1	Graham Lake Approach	-80	
10/9/2015 5:32:05	1	Graham Lake Approach	-82	
10/9/2015 5:32:07	1	Graham Lake Approach	-82	
10/9/2015 20:08:29	5	Downstream Station #1	-86	Passage – Unknown Route
10/9/2015 20:08:30	5	Downstream Station #1	-90	
10/9/2015 20:08:31	5	Downstream Station #1	-94	
10/9/2015 20:08:32	5	Downstream Station #1	-89	
10/9/2015 20:08:33	5	Downstream Station #1	-93	
10/9/2015 22:47:09	6	Ellsworth Approach	-90	
10/9/2015 22:47:10	6	Ellsworth Approach	-90	
10/9/2015 22:47:11	6	Ellsworth Approach	-90	
10/9/2015 22:47:12	6	Ellsworth Approach	-92	
10/9/2015 22:47:13	6	Ellsworth Approach	-91	
10/16/2015 3:09:44	11	Ellsworth Unit 3	-58	Ellsworth Dam Passage
10/16/2015 3:09:47	11	Ellsworth Unit 3	-58	
10/16/2015 3:10:09	13	Ellsworth Tailrace	-70	
10/16/2015 3:10:10	13	Ellsworth Tailrace	-66	
10/16/2015 3:10:11	13	Ellsworth Tailrace	-76	
10/16/2015 3:10:14	13	Ellsworth Tailrace	-79	
10/16/2015 3:12:16	14	Downstream Station #2	-77	
10/16/2015 3:12:17	14	Downstream Station #2	-80	
10/16/2015 3:12:18	14	Downstream Station #2	-78	
10/16/2015 3:12:19	14	Downstream Station #2	-76	
10/16/2015 3:14:48	15	Downstream Station #3	146	
10/16/2015 3:14:57	15	Downstream Station #3	146	
10/16/2015 3:15:07	15	Downstream Station #3	165	
10/16/2015 3:15:15	15	Downstream Station #3	142	
10/16/2015 3:15:24	15	Downstream Station #3	170	
10/16/2015 3:56:54	16	Downstream Station #4	242	
10/16/2015 3:57:04	16	Downstream Station #4	239	
10/16/2015 3:57:12	16	Downstream Station #4	238	
10/16/2015 3:57:22	16	Downstream Station #4	240	
10/16/2015 3:57:29	16	Downstream Station #4	223	
10/21/2015		Marina – manual tracking		Mortality

TABLE C28. PASSAGE SUMMARY FOR EEL 149.460 195

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/9/2015 21:19:14	1	Graham Lake Approach	-73	Released 10/8/2015 18:56
10/9/2015 21:19:15	1	Graham Lake Approach	-73	
10/9/2015 21:19:16	1	Graham Lake Approach	-74	
10/9/2015 21:19:17	1	Graham Lake Approach	-74	
10/9/2015 21:21:28	2	Graham Lake Fishway Weir	-58	Graham Lake Passage
10/9/2015 21:21:31	2	Graham Lake Fishway Weir	-58	
10/9/2015 21:21:32	2	Graham Lake Fishway Weir	-57	
10/9/2015 23:25:19	5	Downstream Station #1	-88	
10/9/2015 23:25:20	5	Downstream Station #1	-94	
10/9/2015 23:25:22	5	Downstream Station #1	-86	
10/9/2015 23:25:23	5	Downstream Station #1	-90	
10/10/2015 0:13:07	6	Ellsworth Approach	-85	
10/10/2015 0:13:08	6	Ellsworth Approach	-75	
10/10/2015 0:13:09	6	Ellsworth Approach	-71	
10/10/2015 0:13:10	6	Ellsworth Approach	-73	
10/10/2015 0:23:09	12	Ellsworth Unit 4	-58	Ellsworth Dam Passage
10/10/2015 0:23:10	12	Ellsworth Unit 4	-58	
10/10/2015 0:23:13	12	Ellsworth Unit 4	-59	
10/10/2015 0:23:14	12	Ellsworth Unit 4	-62	
10/10/2015 0:24:12	13	Ellsworth Tailrace	-60	
10/10/2015 0:24:13	13	Ellsworth Tailrace	-67	
10/10/2015 0:24:18	13	Ellsworth Tailrace	-71	
10/10/2015 0:24:19	13	Ellsworth Tailrace	-64	
10/10/2015 0:26:09	14	Downstream Station #2	-77	
10/10/2015 0:26:10	14	Downstream Station #2	-78	
10/10/2015 0:26:17	14	Downstream Station #2	-80	
10/10/2015 0:26:18	14	Downstream Station #2	-80	
10/10/2015 0:28:51	15	Downstream Station #3	141	
10/10/2015 0:28:59	15	Downstream Station #3	153	
10/10/2015 0:29:07	15	Downstream Station #3	141	
10/10/2015 0:29:16	15	Downstream Station #3	140	
10/10/2015 0:29:25	15	Downstream Station #3	161	
10/10/2015 0:32:06	16	Downstream Station #4	175	
10/10/2015 0:32:25	16	Downstream Station #4	159	
10/10/2015 0:32:35	16	Downstream Station #4	199	
10/10/2015 0:32:43	16	Downstream Station #4	255	
10/10/2015 0:32:53	16	Downstream Station #4	255	
10/21/2015		Marina – manual tracking		Mortality

TABLE C29. PASSAGE SUMMARY FOR EEL 149.460 200

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/9/2015 20:42:49	1	Graham Lake Approach	-83	Released 10/8/2015 18:56
10/9/2015 20:42:50	1	Graham Lake Approach	-84	
10/9/2015 20:42:51	1	Graham Lake Approach	-84	
10/9/2015 20:42:53	1	Graham Lake Approach	-86	
10/9/2015 20:42:54	1	Graham Lake Approach	-92	
10/9/2015 20:42:55	1	Graham Lake Approach	-102	
10/9/2015 20:44:38	2	Graham Lake Fishway Weir	-58	Graham Lake Passage
10/9/2015 20:44:39	2	Graham Lake Fishway Weir	-58	
10/9/2015 20:44:40	2	Graham Lake Fishway Weir	-60	
10/9/2015 20:44:42	2	Graham Lake Fishway Weir	-63	
10/9/2015 20:44:43	2	Graham Lake Fishway Weir	-62	
10/9/2015 23:36:39	5	Downstream Station #1	-86	
10/9/2015 23:36:40	5	Downstream Station #1	-86	
10/9/2015 23:36:41	5	Downstream Station #1	-86	
10/9/2015 23:36:42	5	Downstream Station #1	-88	
10/9/2015 23:36:43	5	Downstream Station #1	-87	
10/10/2015 1:02:58	6	Ellsworth Approach	-97	
10/10/2015 1:02:59	6	Ellsworth Approach	-96	
10/10/2015 1:03:00	6	Ellsworth Approach	-98	
10/10/2015 1:03:01	6	Ellsworth Approach	-98	
10/10/2015 1:03:02	6	Ellsworth Approach	-97	
10/10/2015 1:03:03	6	Ellsworth Approach	-98	
10/10/2015 1:11:50	10	Ellsworth Unit 2	-62	Ellsworth Dam Passage
10/10/2015 1:11:52	10	Ellsworth Unit 2	-72	
10/10/2015 1:11:53	10	Ellsworth Unit 2	-62	
10/10/2015 1:11:54	10	Ellsworth Unit 2	-57	
10/10/2015 1:11:56	10	Ellsworth Unit 2	-56	
10/10/2015 1:12:20	13	Ellsworth Tailrace	-72	
10/10/2015 1:12:21	13	Ellsworth Tailrace	-77	
10/10/2015 1:12:22	13	Ellsworth Tailrace	-64	
10/10/2015 1:12:23	13	Ellsworth Tailrace	-68	
10/10/2015 1:12:27	13	Ellsworth Tailrace	-71	
10/10/2015 1:12:29	13	Ellsworth Tailrace	-69	
10/10/2015 1:15:04	14	Downstream Station #2	-78	
10/10/2015 1:15:05	14	Downstream Station #2	-76	
10/10/2015 1:15:08	14	Downstream Station #2	-78	
10/10/2015 1:15:10	14	Downstream Station #2	-72	
10/10/2015 1:15:11	14	Downstream Station #2	-71	
10/10/2015 1:15:12	14	Downstream Station #2	-75	
10/10/2015 1:17:50	15	Downstream Station #3	116	
10/10/2015 1:17:59	15	Downstream Station #3	130	
10/10/2015 1:18:08	15	Downstream Station #3	123	
10/10/2015 1:18:17	15	Downstream Station #3	142	
10/10/2015 1:18:27	15	Downstream Station #3	135	
10/10/2015 1:18:35	15	Downstream Station #3	134	
10/10/2015 1:18:44	15	Downstream Station #3	124	
10/10/2015 1:20:05	16	Downstream Station #4	136	
10/10/2015 1:20:16	16	Downstream Station #4	125	
10/10/2015 1:26:24	16	Downstream Station #4	185	Successful Passage
10/10/2015 1:26:33	16	Downstream Station #4	127	
10/10/2015 1:26:41	16	Downstream Station #4	201	

TABLE C30. PASSAGE SUMMARY FOR EEL 149.480 205

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/10/2015 0:54:41	1	Graham Lake Approach	-85	Released 10/8/2015 18:56
10/10/2015 0:54:42	1	Graham Lake Approach	-86	
10/10/2015 0:54:43	1	Graham Lake Approach	-87	
10/10/2015 0:54:44	1	Graham Lake Approach	-88	
10/10/2015 3:03:13	5	Downstream #1	-89	Passage – Unknown Route
10/10/2015 3:03:14	5	Downstream #1	-86	
10/10/2015 3:03:15	5	Downstream #1	-86	
10/10/2015 3:03:17	5	Downstream #1	-85	
10/10/2015 4:04:02	6	Ellsworth Approach	-75	
10/10/2015 4:04:03	6	Ellsworth Approach	-71	
10/10/2015 4:04:05	6	Ellsworth Approach	-70	
10/10/2015 4:04:06	6	Ellsworth Approach	-74	
10/10/2015 4:04:07	6	Ellsworth Approach	-70	
10/10/2015 4:12:43	10	Ellsworth Unit 2	-74	Ellsworth Dam Passage
10/10/2015 4:12:46	10	Ellsworth Unit 2	-58	
10/10/2015 4:12:47	10	Ellsworth Unit 2	-56	
10/10/2015 4:13:13	13	Ellsworth Tailrace	-66	
10/10/2015 4:13:14	13	Ellsworth Tailrace	-65	
10/10/2015 4:13:16	13	Ellsworth Tailrace	-71	
10/10/2015 4:13:18	13	Ellsworth Tailrace	-70	
10/10/2015 4:15:46	14	Downstream #2	-71	
10/10/2015 4:15:47	14	Downstream #2	-71	
10/10/2015 4:15:50	14	Downstream #2	-72	
10/10/2015 4:15:51	14	Downstream #2	-79	
10/10/2015 4:18:41	15	Downstream #3	118	
10/10/2015 4:18:50	15	Downstream #3	139	
10/10/2015 4:19:08	15	Downstream #3	156	
10/10/2015 4:19:17	15	Downstream #3	126	
10/10/2015 4:22:29	16	Downstream #4	157	
10/10/2015 4:22:37	16	Downstream #4	164	
10/10/2015 4:22:48	16	Downstream #4	202	
10/10/2015 4:22:56	16	Downstream #4	255	
10/10/2015 4:23:06	16	Downstream #4	250	
10/16/2015		Marina – manual tracking		Mortality

TABLE C31. PASSAGE SUMMARY FOR EEL 149.480 212

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/8/2015 22:00:19	1	Graham Lake Approach	-76	Released 10/8/2015 18:56
10/8/2015 22:00:20	1	Graham Lake Approach	-75	
10/8/2015 22:00:21	1	Graham Lake Approach	-76	
10/8/2015 22:00:22	1	Graham Lake Approach	-77	
10/8/2015 22:00:23	1	Graham Lake Approach	-77	
10/9/2015 0:15:17	5	Downstream #1	-87	Passage – Unknown Route
10/9/2015 0:15:18	5	Downstream #1	-86	
10/9/2015 0:15:19	5	Downstream #1	-85	
10/9/2015 0:15:20	5	Downstream #1	-86	
10/9/2015 2:12:44	6	Ellsworth Approach	-88	
10/9/2015 2:12:45	6	Ellsworth Approach	-88	
10/9/2015 2:12:46	6	Ellsworth Approach	-88	
10/9/2015 2:12:47	6	Ellsworth Approach	-88	
10/9/2015 2:12:48	6	Ellsworth Approach	-87	
10/9/2015 2:27:00	11	Ellsworth Unit 3	-70	Ellsworth Dam Passage
10/9/2015 2:27:02	11	Ellsworth Unit 3	-57	
10/9/2015 2:27:03	11	Ellsworth Unit 3	-57	
10/9/2015 2:27:04	11	Ellsworth Unit 3	-63	
10/9/2015 2:27:44	13	Ellsworth Tailrace	-67	
10/9/2015 2:27:45	13	Ellsworth Tailrace	-62	
10/9/2015 2:27:47	13	Ellsworth Tailrace	-62	
10/9/2015 2:27:48	13	Ellsworth Tailrace	-64	
10/9/2015 2:27:49	13	Ellsworth Tailrace	-64	
10/9/2015 2:30:18	14	Downstream #2	-80	
10/9/2015 2:30:19	14	Downstream #2	-69	
10/9/2015 2:30:20	14	Downstream #2	-68	
10/9/2015 2:30:23	14	Downstream #2	-75	
10/9/2015 2:46:33	15	Downstream #3	165	
10/9/2015 2:46:42	15	Downstream #3	154	
10/9/2015 2:46:50	15	Downstream #3	167	
10/9/2015 2:46:58	15	Downstream #3	176	
10/9/2015 2:47:08	15	Downstream #3	131	
10/9/2015 2:47:21	16	Downstream #4	88	
10/9/2015 2:52:28	16	Downstream #4	203	
10/9/2015 2:52:35	16	Downstream #4	175	Successful Passage
10/9/2015 2:52:44	16	Downstream #4	105	
10/9/2015 2:52:45	16	Downstream #4	255	

TABLE C32. PASSAGE SUMMARY FOR EEL 149.480 207

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/10/2015 7:34:14	1	Graham Lake Approach	-93	Released 10/8/2015 18:56
10/10/2015 7:34:24	1	Graham Lake Approach	-101	
10/10/2015 7:34:34	1	Graham Lake Approach	-94	
10/10/2015 7:34:44	1	Graham Lake Approach	-94	
10/10/2015 7:49:31	2	Graham Lake Fishway Weir	-58	Graham Lake Passage
10/10/2015 7:49:32	2	Graham Lake Fishway Weir	-59	
10/10/2015 7:49:33	2	Graham Lake Fishway Weir	-57	
10/11/2015 20:57:18	5	Downstream #1	-89	
10/11/2015 20:57:19	5	Downstream #1	-91	
10/11/2015 20:57:21	5	Downstream #1	-85	
10/11/2015 20:57:22	5	Downstream #1	-90	
10/16/2015 19:28:52	6	Ellsworth Approach	-87	
10/16/2015 19:28:53	6	Ellsworth Approach	-92	
10/16/2015 19:28:54	6	Ellsworth Approach	-78	
10/16/2015 19:28:55	6	Ellsworth Approach	-92	
10/16/2015 19:28:56	6	Ellsworth Approach	-91	
10/18/2015 22:22:17	11	Ellsworth Unit 3	-69	Ellsworth Dam Passage
10/18/2015 22:22:19	11	Ellsworth Unit 3	-58	
10/18/2015 22:22:20	11	Ellsworth Unit 3	-57	
10/18/2015 22:22:21	11	Ellsworth Unit 3	-58	
10/18/2015 22:25:53	14	Downstream #2	-75	
10/18/2015 22:25:54	14	Downstream #2	-69	
10/18/2015 22:25:55	14	Downstream #2	-71	
10/18/2015 22:25:58	14	Downstream #2	-72	
10/18/2015 22:25:59	14	Downstream #2	-71	
10/19/2015 2:58:12	15	Downstream #3	162	
10/19/2015 2:58:22	15	Downstream #3	166	
10/19/2015 2:58:29	15	Downstream #3	160	
10/19/2015 2:58:39	15	Downstream #3	188	
10/19/2015 2:58:47	15	Downstream #3	171	
10/19/2015 3:04:15	16	Downstream #4	139	
10/19/2015 3:04:33	16	Downstream #4	157	
10/19/2015 3:04:41	16	Downstream #4	254	Successful Passage
10/19/2015 3:04:51	16	Downstream #4	204	
10/19/2015 3:04:59	16	Downstream #4	253	
10/19/2015 3:05:10	16	Downstream #4	255	

TABLE C33. PASSAGE SUMMARY FOR EEL 149.320 92

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/17/2015 19:43:39	1	Graham Lake Approach	-87	Released 10/15/2015 18:17
10/17/2015 19:43:40	1	Graham Lake Approach	-86	
10/17/2015 19:43:42	1	Graham Lake Approach	-91	
10/17/2015 19:43:43	1	Graham Lake Approach	-90	
10/17/2015 19:43:44	1	Graham Lake Approach	-85	
10/17/2015 19:56:51	3	Graham Lake Gate 3	-71	Graham Lake Passage
10/17/2015 19:57:13	3	Graham Lake Gate 3	-74	
10/17/2015 22:29:28	5	Downstream #1	-83	
10/17/2015 22:29:29	5	Downstream #1	-83	
10/17/2015 22:29:30	5	Downstream #1	-83	
10/17/2015 22:29:31	5	Downstream #1	-82	
10/17/2015 22:29:32	5	Downstream #1	-81	
10/18/2015 3:43:14	6	Ellsworth Approach	-88	
10/18/2015 3:43:15	6	Ellsworth Approach	-88	
10/18/2015 3:43:16	6	Ellsworth Approach	-82	
10/18/2015 3:43:17	6	Ellsworth Approach	-89	
10/18/2015 3:43:18	6	Ellsworth Approach	-87	
10/18/2015 4:09:14	10	Ellsworth Unit 2	-57	Ellsworth Dam Passage
10/18/2015 4:09:35	13	Ellsworth Tailrace	-75	
10/18/2015 4:09:37	13	Ellsworth Tailrace	-65	
10/18/2015 4:09:39	13	Ellsworth Tailrace	-66	
10/18/2015 4:09:42	13	Ellsworth Tailrace	-68	
10/18/2015 4:09:44	13	Ellsworth Tailrace	-67	
10/18/2015 4:11:47	14	Downstream #2	-80	
10/18/2015 4:11:52	14	Downstream #2	-71	
10/18/2015 4:11:54	14	Downstream #2	-74	
10/18/2015 4:11:55	14	Downstream #2	-70	
10/18/2015 4:12:00	14	Downstream #2	-78	
10/18/2015 4:45:43	15	Downstream #3	181	
10/18/2015 4:45:44	15	Downstream #3	165	
10/18/2015 4:45:52	15	Downstream #3	177	
10/18/2015 4:46:01	15	Downstream #3	135	
10/18/2015 4:46:10	15	Downstream #3	172	
10/18/2015 5:00:53	16	Downstream #4	243	
10/18/2015 5:01:03	16	Downstream #4	254	Successful Passage
10/18/2015 5:01:11	16	Downstream #4	138	
10/18/2015 5:01:28	16	Downstream #4	231	

TABLE C34. PASSAGE SUMMARY FOR EEL 149.320 102

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/15/2015 21:32:34	1	Graham Lake Approach	-64	Released 10/15/2015 18:17
10/15/2015 21:32:35	1	Graham Lake Approach	-63	
10/15/2015 21:32:36	1	Graham Lake Approach	-63	
10/15/2015 21:32:37	1	Graham Lake Approach	-67	
10/15/2015 21:32:38	1	Graham Lake Approach	-64	
10/15/2015 21:38:26	3	Graham Lake Gate 3	-72	Graham Lake Passage
10/15/2015 21:38:30	3	Graham Lake Gate 3	-75	
10/15/2015 21:39:20	3	Graham Lake Gate 3	-75	
10/16/2015 21:55:04	5	Downstream #1	-86	
10/16/2015 21:55:05	5	Downstream #1	-86	
10/16/2015 21:55:06	5	Downstream #1	-85	
10/16/2015 21:55:07	5	Downstream #1	-86	
10/16/2015 21:55:08	5	Downstream #1	-89	
10/17/2015 0:02:12	6	Ellsworth Approach	-97	
10/17/2015 0:02:13	6	Ellsworth Approach	-96	
10/17/2015 0:02:14	6	Ellsworth Approach	-96	
10/17/2015 0:02:15	6	Ellsworth Approach	-94	
10/17/2015 0:02:16	6	Ellsworth Approach	-93	
10/17/2015 0:16:01	13	Ellsworth Tailrace	-65	Passage – Unknown Route
10/17/2015 0:16:03	13	Ellsworth Tailrace	-67	
10/17/2015 0:16:04	13	Ellsworth Tailrace	-71	
10/17/2015 0:16:05	13	Ellsworth Tailrace	-70	
10/17/2015 0:43:46	14	Downstream #2	-75	
10/17/2015 0:43:47	14	Downstream #2	-76	
10/17/2015 0:43:48	14	Downstream #2	-74	
10/17/2015 0:43:49	14	Downstream #2	-78	
10/17/2015 0:43:50	14	Downstream #2	-76	
10/17/2015 20:50:42	15	Downstream #3	120	
10/17/2015 20:50:50	15	Downstream #3	130	
10/17/2015 20:51:08	15	Downstream #3	131	
10/17/2015 20:51:17	15	Downstream #3	129	
10/17/2015 20:51:19	15	Downstream #3	122	
10/20/2015 15:11:48	16	Downstream #4	193	
10/20/2015 15:11:58	16	Downstream #4	207	
10/20/2015 15:12:06	16	Downstream #4	225	
10/20/2015 15:12:15	16	Downstream #4	207	
11/2/2015		Between Marina and tailrace – manual survey		Mortality

TABLE C35. PASSAGE SUMMARY FOR EEL 149.320 203

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/15/2015 19:59:04	1	Graham Lake Approach	-68	Released 10/15/2015 18:17
10/15/2015 19:59:05	1	Graham Lake Approach	-67	
10/15/2015 19:59:06	1	Graham Lake Approach	-68	
10/15/2015 19:59:07	1	Graham Lake Approach	-73	
10/15/2015 19:59:08	1	Graham Lake Approach	-73	
10/15/2015 20:02:34	2	Graham Lake Fishway Weir	-57	Graham Lake Passage
10/15/2015 20:02:35	2	Graham Lake Fishway Weir	-57	
10/15/2015 20:02:36	2	Graham Lake Fishway Weir	-57	
10/15/2015 20:02:37	2	Graham Lake Fishway Weir	-59	
10/21/2015 18:00:47	5	Downstream #1	-80	
10/21/2015 18:00:48	5	Downstream #1	-77	
10/21/2015 18:00:49	5	Downstream #1	-79	
10/21/2015 18:00:50	5	Downstream #1	-80	
10/21/2015 18:00:51	5	Downstream #1	-81	
10/21/2015 18:00:54	5	Downstream #1	-78	
10/25/2015 19:57:10	6	Ellsworth Approach	-88	
10/25/2015 19:57:11	6	Ellsworth Approach	-87	
10/25/2015 19:57:12	6	Ellsworth Approach	-84	
10/25/2015 19:57:13	6	Ellsworth Approach	-83	
10/25/2015 19:57:14	6	Ellsworth Approach	-83	
10/25/2015 20:07:08	11	Ellsworth Unit 3	-58	Ellsworth Dam Passage
10/25/2015 20:07:09	11	Ellsworth Unit 3	-57	
10/25/2015 20:07:10	11	Ellsworth Unit 3	-60	
10/25/2015 20:07:46	13	Ellsworth Tailrace	-69	
10/25/2015 20:07:47	13	Ellsworth Tailrace	-70	
10/25/2015 20:07:48	13	Ellsworth Tailrace	-70	
10/25/2015 20:07:49	13	Ellsworth Tailrace	-69	
10/25/2015 20:07:50	13	Ellsworth Tailrace	-70	
10/28/2015 11:56:46		Manual Tracking Near Tailrace	255	
10/28/2015 11:56:47		Manual Tracking Near Tailrace	255	In tailrace at end of study, 1 sec burst rate
10/28/2015 11:56:48		Manual Tracking Near Tailrace	211	

TABLE C36. PASSAGE SUMMARY FOR EEL 149.340 62

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/16/2015 3:03:34	1	Graham Lake Approach	-82	Released 10/15/2015 18:17
10/16/2015 3:03:35	1	Graham Lake Approach	-93	
10/16/2015 3:03:38	1	Graham Lake Approach	-87	
10/16/2015 3:03:39	1	Graham Lake Approach	-85	
10/16/2015 3:03:40	1	Graham Lake Approach	-85	
10/16/2015 15:37:27	3	Graham Lake Gate 3	-60	Graham Lake Passage
10/16/2015 15:37:28	3	Graham Lake Gate 3	-68	
10/16/2015 15:37:29	3	Graham Lake Gate 3	-58	
10/16/2015 20:06:30	5	Downstream #1	-83	
10/16/2015 20:06:31	5	Downstream #1	-83	
10/16/2015 20:06:32	5	Downstream #1	-81	
10/16/2015 20:06:33	5	Downstream #1	-80	
10/16/2015 20:06:34	5	Downstream #1	-79	
10/16/2015 20:06:35	5	Downstream #1	-80	
10/16/2015 22:16:07	6	Ellsworth Approach	-88	
10/16/2015 22:16:08	6	Ellsworth Approach	-89	
10/16/2015 22:16:09	6	Ellsworth Approach	-90	
10/16/2015 22:16:10	6	Ellsworth Approach	-89	
10/16/2015 22:16:12	6	Ellsworth Approach	-91	
10/16/2015 22:23:09	11	Ellsworth Unit 3	-57	Ellsworth Dam Passage
10/16/2015 22:23:10	11	Ellsworth Unit 3	-59	
10/16/2015 22:23:11	11	Ellsworth Unit 3	-57	
10/16/2015 22:25:14	14	Downstream #2	-76	
10/16/2015 22:25:16	14	Downstream #2	-73	
10/16/2015 22:25:20	14	Downstream #2	-73	
10/16/2015 22:25:31	14	Downstream #2	-79	
10/16/2015 22:27:12	15	Downstream #3	127	
10/16/2015 22:27:38	15	Downstream #3	140	
10/16/2015 22:27:47	15	Downstream #3	139	
10/16/2015 22:27:55	15	Downstream #3	127	
10/16/2015 22:28:06	15	Downstream #3	125	
10/16/2015 22:30:42	16	Downstream #4	128	
10/16/2015 22:30:43	16	Downstream #4	131	
10/16/2015 22:30:53	16	Downstream #4	221	Successful Passage
10/16/2015 22:31:11	16	Downstream #4	206	
10/16/2015 22:31:19	16	Downstream #4	242	

TABLE C37. PASSAGE SUMMARY FOR EEL 149.340 72

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/15/2015 19:10:19	1	Graham Lake Approach	-80	Released 10/15/2015 18:17
10/15/2015 19:10:20	1	Graham Lake Approach	-81	
10/15/2015 19:10:21	1	Graham Lake Approach	-81	
10/15/2015 19:10:22	1	Graham Lake Approach	-79	
10/15/2015 19:10:23	1	Graham Lake Approach	-80	
10/15/2015 19:15:13	3	Graham Lake Gate 3	-71	Graham Lake Passage
10/15/2015 19:15:30	3	Graham Lake Gate 3	-71	
10/15/2015 21:31:05	5	Downstream #1	-85	
10/15/2015 21:31:06	5	Downstream #1	-84	
10/15/2015 21:31:07	5	Downstream #1	-84	
10/15/2015 21:31:08	5	Downstream #1	-87	
10/15/2015 21:31:09	5	Downstream #1	-85	
10/15/2015 23:29:04	6	Ellsworth Approach	-90	
10/15/2015 23:29:05	6	Ellsworth Approach	-86	
10/15/2015 23:29:06	6	Ellsworth Approach	-87	
10/15/2015 23:29:07	6	Ellsworth Approach	-89	
10/15/2015 23:29:08	6	Ellsworth Approach	-95	
10/15/2015 23:44:16	10	Ellsworth Unit 2	-64	Ellsworth Dam Passage
10/15/2015 23:44:18	10	Ellsworth Unit 2	-58	
10/15/2015 23:44:19	10	Ellsworth Unit 2	-67	
10/15/2015 23:44:36	13	Ellsworth Tailrace	-67	
10/15/2015 23:44:39	13	Ellsworth Tailrace	-60	
10/15/2015 23:44:41	13	Ellsworth Tailrace	-65	
10/15/2015 23:44:47	13	Ellsworth Tailrace	-64	
10/15/2015 23:44:50	13	Ellsworth Tailrace	-71	
10/16/2015 19:16:19	14	Downstream #2	-69	
10/16/2015 19:16:20	14	Downstream #2	-67	
10/16/2015 19:16:22	14	Downstream #2	-67	
10/16/2015 19:16:23	14	Downstream #2	-75	
10/16/2015 19:16:24	14	Downstream #2	-74	
11/12/2015 12:18:14		Manual Tracking Near Downstream #3	125	
11/12/2015 12:18:24		Manual Tracking Near Downstream #3	112	Mortality
11/12/2015 12:18:34		Manual Tracking Near Downstream #3	108	

TABLE C38. PASSAGE SUMMARY FOR EEL 149.340 123

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/16/2015 1:59:01	1	Graham Lake Approach	-78	Released 10/15/2015 18:17
10/16/2015 1:59:02	1	Graham Lake Approach	-76	
10/16/2015 1:59:03	1	Graham Lake Approach	-75	
10/16/2015 1:59:04	1	Graham Lake Approach	-76	
10/16/2015 1:59:05	1	Graham Lake Approach	-75	
10/16/2015 1:59:06	1	Graham Lake Approach	-76	
10/16/2015 4:35:03	5	Downstream #1	-78	Passage – Unknown Route
10/16/2015 4:35:04	5	Downstream #1	-76	
10/16/2015 4:35:06	5	Downstream #1	-76	
10/16/2015 4:35:07	5	Downstream #1	-74	
10/16/2015 4:35:08	5	Downstream #1	-77	
10/16/2015 4:35:09	5	Downstream #1	-82	
10/16/2015 5:26:52	6	Ellsworth Approach	-77	
10/16/2015 5:26:53	6	Ellsworth Approach	-76	
10/16/2015 5:26:54	6	Ellsworth Approach	-75	
10/16/2015 5:26:55	6	Ellsworth Approach	-76	
10/16/2015 5:26:57	6	Ellsworth Approach	-76	
10/16/2015 5:26:58	6	Ellsworth Approach	-79	
10/16/2015 21:55:39	11	Ellsworth Unit 3	-57	Ellsworth Dam Passage
10/16/2015 21:55:40	11	Ellsworth Unit 3	-57	
10/16/2015 21:55:41	11	Ellsworth Unit 3	-58	
10/16/2015 21:55:42	11	Ellsworth Unit 3	-57	
10/16/2015 21:55:44	11	Ellsworth Unit 3	-66	
11/12/2015 11:41:27		Manual Tracking Near Tailrace	130	
11/12/2015 11:41:37		Manual Tracking Near Tailrace	95	Mortality
11/12/2015 11:41:47		Manual Tracking Near Tailrace	110	
11/12/2015 11:41:57		Manual Tracking Near Tailrace	158	

TABLE C39. PASSAGE SUMMARY FOR EEL 149.400 97

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/16/2015 19:02:01	1	Graham Lake Approach	-87	Released 10/15/2015 18:17
10/16/2015 19:02:02	1	Graham Lake Approach	-87	
10/16/2015 19:02:03	1	Graham Lake Approach	-87	
10/16/2015 19:02:04	1	Graham Lake Approach	-92	
10/16/2015 19:02:05	1	Graham Lake Approach	-88	
10/16/2015 21:13:07	5	Downstream #1	-88	Passage – Unknown Route
10/16/2015 21:13:09	5	Downstream #1	-88	
10/16/2015 21:13:10	5	Downstream #1	-89	
10/16/2015 21:13:11	5	Downstream #1	-87	
10/16/2015 21:13:12	5	Downstream #1	-85	
10/16/2015 21:13:14	5	Downstream #1	-89	
10/17/2015 1:14:28	6	Ellsworth Approach	-98	
10/17/2015 1:14:29	6	Ellsworth Approach	-87	
10/17/2015 1:14:30	6	Ellsworth Approach	-86	
10/17/2015 1:14:31	6	Ellsworth Approach	-90	
10/17/2015 1:14:48	6	Ellsworth Approach	-94	
10/17/2015 1:37:16	13	Ellsworth Tailrace	-77	Passage – Unknown Route
10/17/2015 1:37:17	13	Ellsworth Tailrace	-76	
10/17/2015 1:37:18	13	Ellsworth Tailrace	-78	
10/17/2015 1:37:19	13	Ellsworth Tailrace	-78	
10/17/2015 10:33:19	14	Downstream #2	-79	
10/17/2015 10:33:21	14	Downstream #2	-73	
10/17/2015 10:33:22	14	Downstream #2	-70	
10/17/2015 10:33:25	14	Downstream #2	-76	
10/17/2015 10:35:56	15	Downstream #3	131	
10/17/2015 10:36:06	15	Downstream #3	124	
10/17/2015 10:36:14	15	Downstream #3	127	
10/17/2015 10:36:42	15	Downstream #3	123	
10/17/2015 10:36:50	15	Downstream #3	121	
10/17/2015 10:38:56	16	Downstream #4	218	
10/17/2015 10:39:03	16	Downstream #4	106	
10/17/2015 10:39:04	16	Downstream #4	117	Successful Passage
10/17/2015 10:39:14	16	Downstream #4	196	
10/17/2015 10:39:22	16	Downstream #4	252	

TABLE C40. PASSAGE SUMMARY FOR EEL 149.400 118

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/16/2015 7:22:15	1	Graham Lake Approach	-77	Released 10/15/2015 18:17
10/16/2015 7:22:16	1	Graham Lake Approach	-77	
10/16/2015 7:22:18	1	Graham Lake Approach	-77	
10/16/2015 7:22:19	1	Graham Lake Approach	-78	
10/16/2015 7:22:20	1	Graham Lake Approach	-77	
10/16/2015 8:17:43	3	Graham Lake Gate 3	-73	
10/16/2015 8:17:52	3	Graham Lake Gate 3	-68	Graham Lake Passage
10/16/2015 8:17:54	3	Graham Lake Gate 3	-66	
10/16/2015 8:17:59	3	Graham Lake 3	-73	
10/16/2015 19:44:37	5	Downstream #1	-93	
10/16/2015 19:44:38	5	Downstream #1	-91	
10/16/2015 19:44:39	5	Downstream #1	-94	
10/16/2015 19:44:40	5	Downstream #1	-94	
10/16/2015 19:44:41	5	Downstream #1	-93	
10/16/2015 20:53:04	6	Ellsworth Approach	-70	
10/16/2015 20:53:06	6	Ellsworth Approach	-78	
10/16/2015 20:53:08	6	Ellsworth Approach	-78	
10/16/2015 20:53:09	6	Ellsworth Approach	-78	
10/16/2015 20:53:10	6	Ellsworth Approach	-79	
10/16/2015 21:03:24	11	Ellsworth Unit 3	-57	Ellsworth Dam Passage
10/16/2015 21:03:25	11	Ellsworth Unit 3	-57	
10/16/2015 21:03:27	11	Ellsworth Unit 3	-60	
10/16/2015 21:03:49	13	Ellsworth Tailrace	-61	
10/16/2015 21:03:51	13	Ellsworth Tailrace	-70	
10/16/2015 21:03:53	13	Ellsworth Tailrace	-66	
10/16/2015 21:03:56	13	Ellsworth Tailrace	-69	
10/16/2015 21:03:57	13	Ellsworth Tailrace	-65	
10/16/2015 21:20:26	15	Downstream #3	143	
10/16/2015 21:20:34	15	Downstream #3	140	
10/16/2015 21:20:43	15	Downstream #3	163	
10/16/2015 21:20:51	15	Downstream #3	173	
10/16/2015 23:05:48	16	Downstream #4	122	
10/16/2015 23:06:06	16	Downstream #4	159	
10/16/2015 23:06:14	16	Downstream #4	172	Successful Passage
10/16/2015 23:06:31	16	Downstream #4	220	
10/16/2015 23:06:32	16	Downstream #4	254	

TABLE C41. PASSAGE SUMMARY FOR EEL 149.400 113

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/19/2015 11:52:33	1	Graham Lake Approach	-73	Released 10/15/2015 18:17
10/19/2015 11:52:34	1	Graham Lake Approach	-67	
10/19/2015 11:52:35	1	Graham Lake Approach	-68	
10/19/2015 11:52:36	1	Graham Lake Approach	-69	
10/19/2015 11:52:37	1	Graham Lake Approach	-67	
10/19/2015 11:52:39	1	Graham Lake Approach	-71	
10/19/2015 12:02:12	3	Graham Lake Gate 3	-70	Graham Lake Passage
10/19/2015 12:03:20	3	Graham Lake Gate 3	-69	
10/19/2015 12:05:52	3	Graham Lake Gate 3	-75	
10/19/2015 19:50:57	5	Downstream #1	-92	
10/19/2015 19:50:58	5	Downstream #1	-91	
10/19/2015 19:50:59	5	Downstream #1	-88	
10/19/2015 19:51:00	5	Downstream #1	-91	
10/19/2015 19:51:01	5	Downstream #1	-92	
10/19/2015 20:59:33	6	Ellsworth Approach	-78	
10/19/2015 20:59:34	6	Ellsworth Approach	-79	
10/19/2015 20:59:35	6	Ellsworth Approach	-79	
10/19/2015 20:59:36	6	Ellsworth Approach	-91	
10/19/2015 20:59:38	6	Ellsworth Approach	-89	
10/20/2015 2:25:13	13	Ellsworth Tailrace	-80	Ellsworth Dam Passage Not Detected
10/20/2015 2:25:20	13	Ellsworth Tailrace	-80	
10/20/2015 2:25:22	13	Ellsworth Tailrace	-78	
10/20/2015 2:28:25	13	Ellsworth Tailrace	-78	
10/20/2015 2:31:30	13	Ellsworth Tailrace	-79	
11/12/2015 11:25:42		Manual Tracking Near Tailrace	227	
11/12/2015 11:25:43		Manual Tracking Near Tailrace	255	
11/12/2015 11:25:44		Manual Tracking Near Tailrace	230	
11/12/2015 11:25:45		Manual Tracking Near Tailrace	253	
11/12/2015 11:25:46		Manual Tracking Near Tailrace	255	
11/12/2015 11:25:48		Manual Tracking Near Tailrace	247	In tailrace at end of study, 1 sec burst rate

TABLE C42. PASSAGE SUMMARY FOR EEL 149.460 133

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/16/2015 23:26:05	1	Graham Lake Approach	-89	Released 10/15/2015 18:17
10/16/2015 23:26:06	1	Graham Lake Approach	-88	
10/16/2015 23:26:07	1	Graham Lake Approach	-90	
10/16/2015 23:26:08	1	Graham Lake Approach	-88	
10/16/2015 23:26:09	1	Graham Lake Approach	-91	
10/16/2015 23:29:23	2	Graham Lake Fishway Weir	-63	Graham Lake Passage
10/16/2015 23:29:25	2	Graham Lake Fishway Weir	-63	
10/16/2015 23:29:27	2	Graham Lake Fishway Weir	-62	
10/16/2015 23:29:40	2	Graham Lake Fishway Weir	-65	
10/17/2015 1:54:42	5	Downstream #1	-95	
10/17/2015 1:54:43	5	Downstream #1	-95	
10/17/2015 1:54:44	5	Downstream #1	-95	
10/17/2015 1:54:46	5	Downstream #1	-95	
10/17/2015 1:54:47	5	Downstream #1	-92	
10/17/2015 1:54:48	5	Downstream #1	-93	
10/17/2015 14:42:42	6	Ellsworth Approach	-76	
10/17/2015 14:42:44	6	Ellsworth Approach	-67	
10/17/2015 14:42:45	6	Ellsworth Approach	-74	
10/17/2015 14:42:46	6	Ellsworth Approach	-70	
10/17/2015 14:42:47	6	Ellsworth Approach	-72	
10/17/2015 16:00:11	10	Ellsworth Unit 2	-68	Ellsworth Dam Passage
10/17/2015 16:00:13	10	Ellsworth Unit 2	-58	
10/17/2015 16:00:14	10	Ellsworth Unit 2	-58	
10/17/2015 16:00:42	13	Ellsworth Tailrace	-66	
10/17/2015 16:00:45	13	Ellsworth Tailrace	-72	
10/17/2015 16:00:47	13	Ellsworth Tailrace	-80	
10/17/2015 16:00:48	13	Ellsworth Tailrace	-79	
10/17/2015 16:00:49	13	Ellsworth Tailrace	-75	
10/20/2015		Recovered In Tailrace		Mortality

TABLE C43. PASSAGE SUMMARY FOR EEL 149.460 157

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/16/2015 0:41:46	1	Graham Lake Approach	-86	Released 10/15/2015 18:17
10/16/2015 0:41:47	1	Graham Lake Approach	-85	
10/16/2015 0:41:48	1	Graham Lake Approach	-86	
10/16/2015 0:41:49	1	Graham Lake Approach	-85	
10/16/2015 0:41:50	1	Graham Lake Approach	-87	
10/16/2015 0:48:23	4	Graham Lake Gate 2	-67	Passage – Route Unknown
10/16/2015 0:51:27	3	Graham Lake Gate 3	-74	
10/16/2015 0:51:40	3	Graham Lake Gate 3	-64	
10/16/2015 3:04:18	5	Downstream #1	-85	
10/16/2015 3:04:19	5	Downstream #1	-84	
10/16/2015 3:04:20	5	Downstream #1	-83	
10/16/2015 3:04:21	5	Downstream #1	-83	
10/16/2015 3:04:22	5	Downstream #1	-85	
10/16/2015 19:27:38	6	Ellsworth Approach	-82	
10/16/2015 19:27:39	6	Ellsworth Approach	-87	
10/16/2015 19:27:40	6	Ellsworth Approach	-83	
10/16/2015 19:27:41	6	Ellsworth Approach	-85	
10/16/2015 19:27:42	6	Ellsworth Approach	-86	
10/16/2015 19:53:13	11	Ellsworth Unit 3	-66	Ellsworth Dam Passage
10/16/2015 19:53:16	11	Ellsworth Unit 3	-57	
10/16/2015 19:53:17	11	Ellsworth Unit 3	-57	
10/16/2015 19:53:18	11	Ellsworth Unit 3	-57	
10/16/2015 20:00:01	13	Ellsworth Tailrace	-63	
10/16/2015 20:00:02	13	Ellsworth Tailrace	-67	
10/16/2015 20:00:04	13	Ellsworth Tailrace	-70	
10/16/2015 20:00:06	13	Ellsworth Tailrace	-64	
10/30/2015 13:39:50		Manual Tracking Near Tailrace	131	
10/30/2015 13:39:51		Manual Tracking Near Tailrace	127	Mortality
10/30/2015 13:39:52		Manual Tracking Near Tailrace	114	
10/30/2015 13:39:54		Manual Tracking Near Tailrace	106	

TABLE C44. PASSAGE SUMMARY FOR EEL 149.460 163

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/16/2015 2:45:39	1	Graham Lake Approach	-76	Released 10/15/2015 18:17
10/16/2015 2:45:40	1	Graham Lake Approach	-76	
10/16/2015 2:45:41	1	Graham Lake Approach	-79	
10/16/2015 2:45:42	1	Graham Lake Approach	-83	
10/16/2015 19:10:09	2	Graham Lake Fishway Weir	-58	Graham Lake Passage
10/16/2015 19:10:10	2	Graham Lake Fishway Weir	-57	
10/16/2015 19:10:11	2	Graham Lake Fishway Weir	-59	
10/16/2015 23:23:29	5	Downstream #1	-90	
10/16/2015 23:23:30	5	Downstream #1	-94	
10/16/2015 23:23:32	5	Downstream #1	-89	
10/16/2015 23:23:33	5	Downstream #1	-92	
10/17/2015 1:03:08	6	Ellsworth Approach	-85	
10/17/2015 1:03:09	6	Ellsworth Approach	-85	
10/17/2015 1:03:10	6	Ellsworth Approach	-93	
10/17/2015 1:03:11	6	Ellsworth Approach	-96	
10/17/2015 1:03:12	6	Ellsworth Approach	-96	
10/17/2015 1:34:54	11	Ellsworth Unit 3	-57	Ellsworth Dam Passage
10/17/2015 1:34:55	11	Ellsworth Unit 3	-58	
10/17/2015 1:34:56	11	Ellsworth Unit 3	-57	
10/17/2015 1:35:21	13	Ellsworth Tailrace	-69	
10/17/2015 1:35:22	13	Ellsworth Tailrace	-70	
10/17/2015 1:35:32	13	Ellsworth Tailrace	-77	
10/17/2015 1:35:33	13	Ellsworth Tailrace	-78	
10/17/2015 1:35:38	13	Ellsworth Tailrace	-77	
10/17/2015 1:47:26	14	Downstream #2	-78	
10/17/2015 1:47:27	14	Downstream #2	-77	
10/17/2015 1:47:29	14	Downstream #2	-70	
10/17/2015 1:47:30	14	Downstream #2	-64	
10/17/2015 1:47:31	14	Downstream #2	-70	
10/17/2015 3:20:30	15	Downstream #3	157	
10/17/2015 3:20:38	15	Downstream #3	141	
10/17/2015 3:20:49	15	Downstream #3	130	
10/17/2015 3:20:57	15	Downstream #3	126	
10/17/2015 3:59:47	16	Downstream #4	145	
10/17/2015 3:59:57	16	Downstream #4	186	
10/17/2015 4:00:05	16	Downstream #4	249	
10/17/2015 4:00:15	16	Downstream #4	255	
10/17/2015 4:00:22	16	Downstream #4	252	
10/21/2015		Marina – manual tracking		Mortality

TABLE C45. PASSAGE SUMMARY FOR EEL 149.480 178

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/31/2015 4:11:03	1	Graham Lake Approach	-83	Released 10/15/2015 18:17
10/31/2015 4:11:04	1	Graham Lake Approach	-89	
10/31/2015 4:11:05	1	Graham Lake Approach	-84	
10/31/2015 4:11:06	1	Graham Lake Approach	-90	
10/31/2015 4:11:07	1	Graham Lake Approach	-92	
10/31/2015 4:14:38	2	Graham Lake Fishway Weir	-60	Graham Lake Passage
10/31/2015 4:14:40	2	Graham Lake Fishway Weir	-57	
10/31/2015 4:14:41	2	Graham Lake Fishway Weir	-57	
10/31/2015 6:39:06	5	Downstream #1	-94	
10/31/2015 6:39:07	5	Downstream #1	-90	
10/31/2015 6:39:08	5	Downstream #1	-86	
10/31/2015 6:39:09	5	Downstream #1	-88	
10/31/2015 6:39:11	5	Downstream #1	-95	
10/31/2015 8:37:06	6	Ellsworth Approach	-81	
10/31/2015 8:37:07	6	Ellsworth Approach	-85	
10/31/2015 8:37:09	6	Ellsworth Approach	-87	
10/31/2015 8:37:10	6	Ellsworth Approach	-85	
10/31/2015 8:37:11	6	Ellsworth Approach	-91	
10/31/2015 9:16:10	12	Ellsworth Unit 4	-79	Ellsworth Dam Passage
10/31/2015 9:16:15	12	Ellsworth Unit 4	-58	
10/31/2015 9:16:16	12	Ellsworth Unit 4	-60	
10/31/2015 9:16:18	12	Ellsworth Unit 4	-70	
10/31/2015 9:17:14	13	Ellsworth Tailrace	-61	
10/31/2015 9:17:15	13	Ellsworth Tailrace	-58	
10/31/2015 9:17:17	13	Ellsworth Tailrace	-62	
10/31/2015 9:17:18	13	Ellsworth Tailrace	-64	
10/31/2015 9:17:20	13	Ellsworth Tailrace	-69	
10/31/2015 9:27:25	14	Downstream #2	-77	
10/31/2015 9:27:26	14	Downstream #2	-70	
10/31/2015 9:27:27	14	Downstream #2	-68	
10/31/2015 9:27:33	14	Downstream #2	-70	
10/31/2015 9:27:35	14	Downstream #2	-72	
10/31/2015 18:22:26	16	Downstream #4	149	
10/31/2015 18:22:44	16	Downstream #4	245	
10/31/2015 18:22:51	16	Downstream #4	250	Successful Passage
10/31/2015 18:22:52	16	Downstream #4	255	
10/31/2015 18:23:01	16	Downstream #4	255	

TABLE C46. PASSAGE SUMMARY FOR EEL 149.480 167

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/17/2015 1:40:15	1	Graham Lake Approach	-70	Released 10/15/2015 18:17
10/17/2015 1:40:16	1	Graham Lake Approach	-68	
10/17/2015 1:40:17	1	Graham Lake Approach	-69	
10/17/2015 1:40:19	1	Graham Lake Approach	-69	
10/17/2015 1:40:20	1	Graham Lake Approach	-69	
10/17/2015 1:48:11	3	Graham Lake Gate 3	-70	Graham Lake Passage
10/17/2015 4:31:24	5	Downstream #1	-85	
10/17/2015 4:31:25	5	Downstream #1	-84	
10/17/2015 4:31:26	5	Downstream #1	-86	
10/17/2015 4:31:28	5	Downstream #1	-86	
10/17/2015 4:31:29	5	Downstream #1	-88	
10/17/2015 20:35:49	6	Ellsworth Approach	-75	
10/17/2015 20:35:50	6	Ellsworth Approach	-87	
10/17/2015 20:35:51	6	Ellsworth Approach	-84	
10/17/2015 20:35:52	6	Ellsworth Approach	-84	
10/17/2015 20:35:54	6	Ellsworth Approach	-84	
10/17/2015 20:45:17	10	Ellsworth Unit 2	-61	Ellsworth Dam Passage
10/17/2015 20:45:18	10	Ellsworth Unit 2	-57	
10/17/2015 20:45:19	10	Ellsworth Unit 2	-57	
10/17/2015 20:45:20	10	Ellsworth Unit 2	-72	
10/17/2015 20:45:38	13	Ellsworth Tailrace	-64	
10/17/2015 20:45:39	13	Ellsworth Tailrace	-68	
10/17/2015 20:45:41	13	Ellsworth Tailrace	-65	
10/17/2015 20:45:48	13	Ellsworth Tailrace	-66	
10/20/2015 7:01:39	14	Downstream #2	-80	
10/20/2015 7:01:40	14	Downstream #2	-80	
10/20/2015 7:01:41	14	Downstream #2	-80	
10/20/2015 7:01:42	14	Downstream #2	-80	
10/23/2015 11:25:18		Manual Tracking Near Downstream #2	208	
10/23/2015 11:25:28		Manual Tracking Near Downstream #2	255	Mortality
10/23/2015 11:25:38		Manual Tracking Near Downstream #2	255	
10/23/2015 11:25:48		Manual Tracking Near Downstream #2	255	

TABLE C47. PASSAGE SUMMARY FOR EEL 149.480 184

DATE AND TIME	SITE #	SITE NAME	POWER	NOTES
10/17/2015 18:57:12	1	Graham Lake Approach	-87	Released 10/15/2015 18:17
10/17/2015 18:57:13	1	Graham Lake Approach	-87	
10/17/2015 18:57:15	1	Graham Lake Approach	-77	
10/17/2015 18:57:17	1	Graham Lake Approach	-79	
10/17/2015 18:57:18	1	Graham Lake Approach	-83	
10/17/2015 19:06:25	3	Graham Lake Gate 3	-72	
10/17/2015 19:06:26	3	Graham Lake Gate 3	-69	Graham Lake Passage
10/17/2015 19:07:00	3	Graham Lake Gate 3	-69	
10/17/2015 19:07:38	3	Graham Lake Gate 3	-65	
10/17/2015 19:07:54	3	Graham Lake Gate 3	-59	
10/17/2015 21:17:21	5	Downstream Station #1	-90	
10/17/2015 21:17:22	5	Downstream Station #1	-88	
10/17/2015 21:17:23	5	Downstream Station #1	-89	
10/17/2015 21:17:24	5	Downstream Station #1	-86	
10/17/2015 21:17:25	5	Downstream Station #1	-89	
10/17/2015 21:17:26	5	Downstream Station #1	-87	
10/17/2015 22:16:23	6	Ellsworth Approach	-97	
10/17/2015 22:16:24	6	Ellsworth Approach	-96	
10/17/2015 22:16:25	6	Ellsworth Approach	-96	
10/17/2015 22:16:26	6	Ellsworth Approach	-82	
10/17/2015 22:16:27	6	Ellsworth Approach	-83	
10/17/2015 22:16:28	6	Ellsworth Approach	-81	
10/17/2015 22:16:30	6	Ellsworth Approach	-96	
10/18/2015 0:10:01	11	Ellsworth Unit 3	-73	
10/18/2015 0:10:02	11	Ellsworth Unit 3	-74	Ellsworth Dam Passage
10/18/2015 0:10:04	11	Ellsworth Unit 3	-64	
10/18/2015 0:10:05	11	Ellsworth Unit 3	-57	
10/18/2015 0:10:06	11	Ellsworth Unit 3	-58	
10/18/2015 0:10:09	11	Ellsworth Unit 3	-60	
10/18/2015 0:10:43	13	Ellsworth Tailrace	-70	
10/18/2015 0:10:44	13	Ellsworth Tailrace	-66	
10/18/2015 0:10:45	13	Ellsworth Tailrace	-60	
10/18/2015 0:10:48	13	Ellsworth Tailrace	-60	
10/18/2015 0:10:49	13	Ellsworth Tailrace	-61	
10/18/2015 0:10:50	13	Ellsworth Tailrace	-62	
10/18/2015 0:14:42	14	Downstream Station #2	-77	
10/18/2015 0:14:43	14	Downstream Station #2	-76	
10/18/2015 0:14:54	14	Downstream Station #2	-78	
10/18/2015 0:14:55	14	Downstream Station #2	-80	
10/18/2015 0:14:56	14	Downstream Station #2	-75	
10/18/2015 0:18:02	15	Downstream Station #3	138	
10/18/2015 0:18:11	15	Downstream Station #3	145	
10/18/2015 0:18:38	15	Downstream Station #3	155	
10/18/2015 0:18:39	15	Downstream Station #3	162	
10/18/2015 0:18:47	15	Downstream Station #3	147	
10/18/2015 0:21:00	16	Downstream Station #4	112	
10/18/2015 0:21:10	16	Downstream Station #4	151	Successful Passage
10/18/2015 0:21:19	16	Downstream Station #4	112	
10/18/2015 0:21:27	16	Downstream Station #4	217	

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APPENDIX E-9

RECREATION FACILITIES MANAGEMENT PLAN

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

RECREATION FACILITIES MANAGEMENT PLAN

BLACK BEAR HYDRO PARTNERS, LLC

December 2015

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

RECREATION FACILITIES MANAGEMENT PLAN

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RECREATION FACILITIES MANAGEMENT PLAN

1.0 INTRODUCTION AND BACKGROUND

The Ellsworth Hydroelectric Project (Project) is licensed by the Federal Energy Regulatory Commission (FERC) as Project No. 2727. The Project is licensed to Black Bear Hydro Partners, LLC ("Black Bear" or "Licensee").

This Recreation Facilities Management Plan (Plan) describes the existing available public recreation facilities that provide access to Project lands and waters. This Plan also identifies proposed measures for enhancing public access to Project lands and waters that collectively, will maintain the existing recreation opportunities provided at the Ellsworth Project over the term of the new license.

2.0 CONSULTATION

The results of the Recreation Site/Facilities Inventory, conducted during the relicensing studies, are described in the Initial Study Report (ISR), which was provided to FERC and participating agencies, tribes, non-governmental organizations (NGOs), local governments, and the public for comment. A draft of this Recreation Facilities Management Plan was included in the Draft License Application. No comments regarding the recreation sites/facilities were received except that the Commission requested a map of the proposed canoe portage trail location.

3.0 PROJECT DESCRIPTION

The Project is located on the lower reach of the Union River in the City of Ellsworth, the towns of Waltham and Mariaville, and the township of Fletchers Landing in Hancock County, Maine. The Project consists of two developments, the Ellsworth Development and the Graham Lake Development. The Ellsworth Development consists of the Ellsworth Dam, which forms the 90-acre Lake Leonard, and the associated generating facilities having an authorized installed nameplate capacity of 8.9 MW. The Graham Lake Development consists of a dam with an approximately 10,000-acre storage reservoir (Graham Lake). There are no generating facilities at the Graham Lake Development.

In total, the Project boundary encompasses approximately 3,350 acres of land, and 10,099 acres of open water. Waters within the Project boundary include Lake Leonard (90 acres), Graham Lake (approximately 10,000 acres) and an intervening three mile riverine segment of the Union River. Black Bear owns or has rights to all lands within the Project boundary. The majority of lands surrounding the Project boundary are privately owned.

4.0 PROJECT-RELATED RECREATION AREAS AND FACILITIES

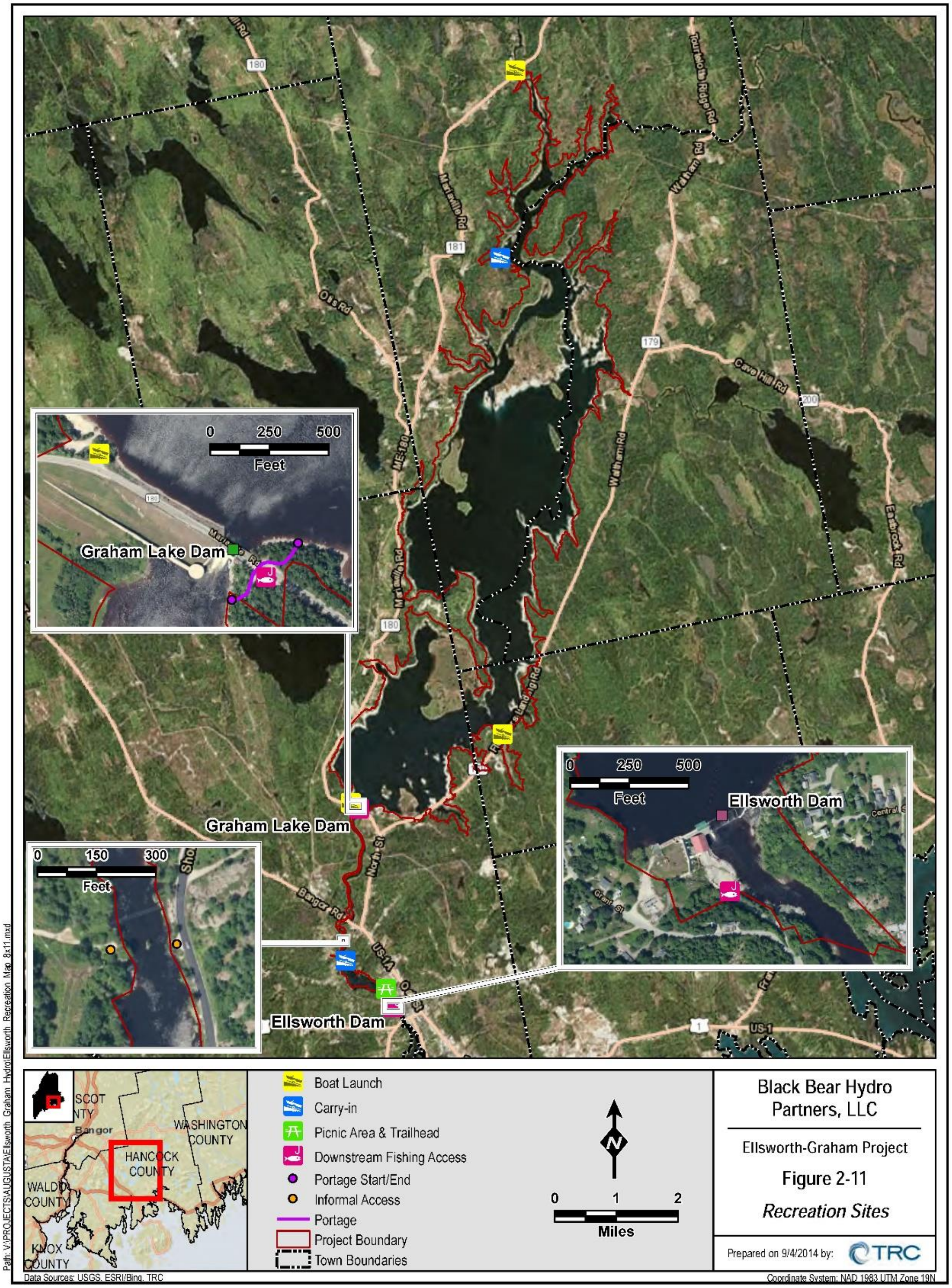
4.1 Existing Project Recreation Sites and Facilities

The Ellsworth Project has three existing public Project Recreation Sites that are maintained by Black Bear. These include a carry-in boat launch on Lake Leonard, a boat launch on Graham Lake, and a canoe portage/angler access trail around Graham Lake Dam (this trail will be limited to angler access only in the future and a new portage trail will be developed at the existing boat launch at the west end of the dam). Table 4-1 provides an overview of these sites and associated facilities. Detailed descriptions of each site follow.

Table 4-1: Commission Approved Recreation Facilities at Ellsworth Hydroelectric Project (FERC No. 2727)

Recreation Site Name	Recreation Facilities
Lake Leonard carry-in boat launch	a small gravel parking area and a six-foot wide hard surface carry-in ramp; additional parking occurs along the edge of the access road
Graham Lake boat launch	a 12-foot wide concrete plank boat ramp and gravel parking area that will accommodate approximately eight trailer rigs; the site is level with a gentle slope to the shoreline
Canoe portage and downstream angler access trail around Graham Lake	the downstream section of the trail is a well-worn footpath to the access points on the shore; parking areas are available on both sides of Patriot Road where the trail crosses; the northerly area will accommodate nine vehicles and the southerly area ten vehicles

Figure 4-1: Recreation Facilities Location Map



<u>Ellsworth Development</u>

Site Name: Lake Leonard Carry-in Boat Launch

Location: The Lake Leonard carry-in boat launch is located in Ellsworth, on the Shore Road on the east side of Lake Leonard.

Description of Facilities and Primary Recreational Activities[1]: The carry-in boat launch and associated parking area is located at the northern end of Lake Leonard and is accessed via the Shore Road which runs along the eastern shore of the lake. Black Bear owns and manages the boat launch.

Site Regulations: The multi-use parking area is intended for day use, and signage clearly indicated that overnight camping or parking are strictly prohibited.

Site Inventory: An inventory of site amenities for the carry-in boat launch is provided in Table 4-2.

Photo 4-1: Lake Leonard carry-in boat launch

[1] Primary recreational activities generally correspond to the types of facilities available.

Photo 4-2: Lake Leonard carry-in boat launch parking area

Photo 4-3: Lake Leonard carry-in boat launch ramp

Photo 4-4: Lake Leonard carry-in boat launch sign

Graham Lake Development

Site Name: Graham Lake Boat Launch

Location: The Graham Lake boat launch is located at the southern end of Graham Lake just west of Graham Lake Dam in Ellsworth. The site can be accessed via Eagle Road (formerly Route 180).

Description of Facilities and Primary Recreational Activities: The site occupies approximately 1 acre, including approximately 60 feet of shoreline frontage. The boat ramp is comprised of 12-foot wide concrete planks and the gravel parking area can accommodate eight vehicles with trailers.

The Graham Lake boat launch is used primarily for launching (or retrieving) trailered watercraft on the reservoir. Launching of personal and non-motorized watercraft also occurs. The boat launch and nearby shoreline areas are occasionally used by anglers. Black Bear owns and manages the Graham Lake boat launch site.

Site Regulations: The Graham Lake boat launch is intended for day use, and site signage clearly states the overnight camping or parking is prohibited.

Site Inventory: An inventory of site amenities for the Graham Lake boat launch is provided in Table 4-2. Photos of the site follow.

Photo 4-5: Graham Lake boat launch facility sign

Photo 4-6: Graham Lake boat launch ramp

Photo 4-7: Graham Lake boat launch parking area

<u>Graham Lake Development</u>

Site Name: Canoe Portage and Downstream Angler Access Trail

Location: The current Graham Lake canoe portage and downstream angler access trail is located on the east side of Graham Lake Dam in Ellsworth. The portal trail take-out is located on the south shore of Graham Lake near the easterly anchor point for the upstream boat barrier. The trail extends approximately 200 feet to the parking area on the north side of Patriot Road (former Route 180). The trail crosses the now dead end Patriot Road and the parking area on the south side of the road, and extends down the bank to the shoreline downstream of the dam. The trail forks and extends to two access points approximately 100 and 160 feet below the dam.

Description of Facilities and Primary Recreational Activities: Boaters traveling down Graham Lake in personal watercraft (i.e. kayaks or canoes) can take-out at the south end of the reservoir, portage their boats around the dam, and enter the Union River below the dam. The take-out is marked with a sign (posted on a tree at the water's edge) stating "canoe portage" and showing a portage symbol. Anglers can also use the trail for access to the Union River for shore fishing below the dam.

Based on observations made during recreation studies performed in 2013 - 2014 (i.e. site visit observations, and recreation use data), the canoe portage trail appears to be seldom used for full portage from the impoundment to the tailwater. The put-in is occasionally used for launching personal, non-motorized watercraft on the Project tailwater; however, the put-in location appears to be used most frequently by anglers to access the tailwater for fishing. The canoe portage trail was observed to be steep, with uneven footing in spots and also had areas of minor erosion.

Black Bear owns and manages the canoe portage trail.

Site Regulations: The canoe portage trail is intended for day use, however, no site regulations are posted.

Site Inventory: An inventory of site amenities for the canoe portage trail is provided in Table 4-4.

Photo 4-9: Graham Lake downstream canoe portage/angler access trail

Photo 4-10: Graham Lake upstream canoe portage trail

Photo 4-11: Graham Lake canoe portage/angler access trail parking area (south side)

Photo 4-12: Graham Lake canoe portage/angler access trail parking area (north side)

4.2 Proposed Project-Related Recreation Sites and Facilities

Black Bear is proposing to continue to operate and maintain the Project under the existing licensed regime. Black Bear proposes to continue to operate and maintain the Lake Leonard carry-in boat launch, and the Graham Lake boat launch and their associated facilities and amenities.

In order to enhance boater (personal watercraft) access to the Union River below Graham Lake Dam, and also to address safety concerns, Black Bear is proposing to relocate the east-side Graham Lake Dam canoe portage trail to the west side of the dam. The proposed canoe portage route is shown on Figure 4-2. The current canoe portage trail take-out location is in very close proximity to the Graham Lake Dam gate structure and the east end anchor point for the boat barrier floats. In addition, due to the difficulty in carrying personal watercraft down the steep and uneven woods/ledge trail down to the put-in locations below the dam, Black Bear determined that relocating the portage trail to the west side of the dam would be a significant improvement. The new portage trail take-out area will be co-located with the Graham Lake boat launch, though it would be designed to avoid interference with use of the trailered boat launch ramp. The new put-in location will be downstream of the Graham Lake flood control structure, an area that is currently used by some boaters as an informal put-in site. The existing east-side angler's access trail will continue to be used, and will be improved and maintained. Black Bear will also provide Part 8 and directional and safety signage at each Project recreational area.

Figure 4-2: Proposed Canoe Portage Route

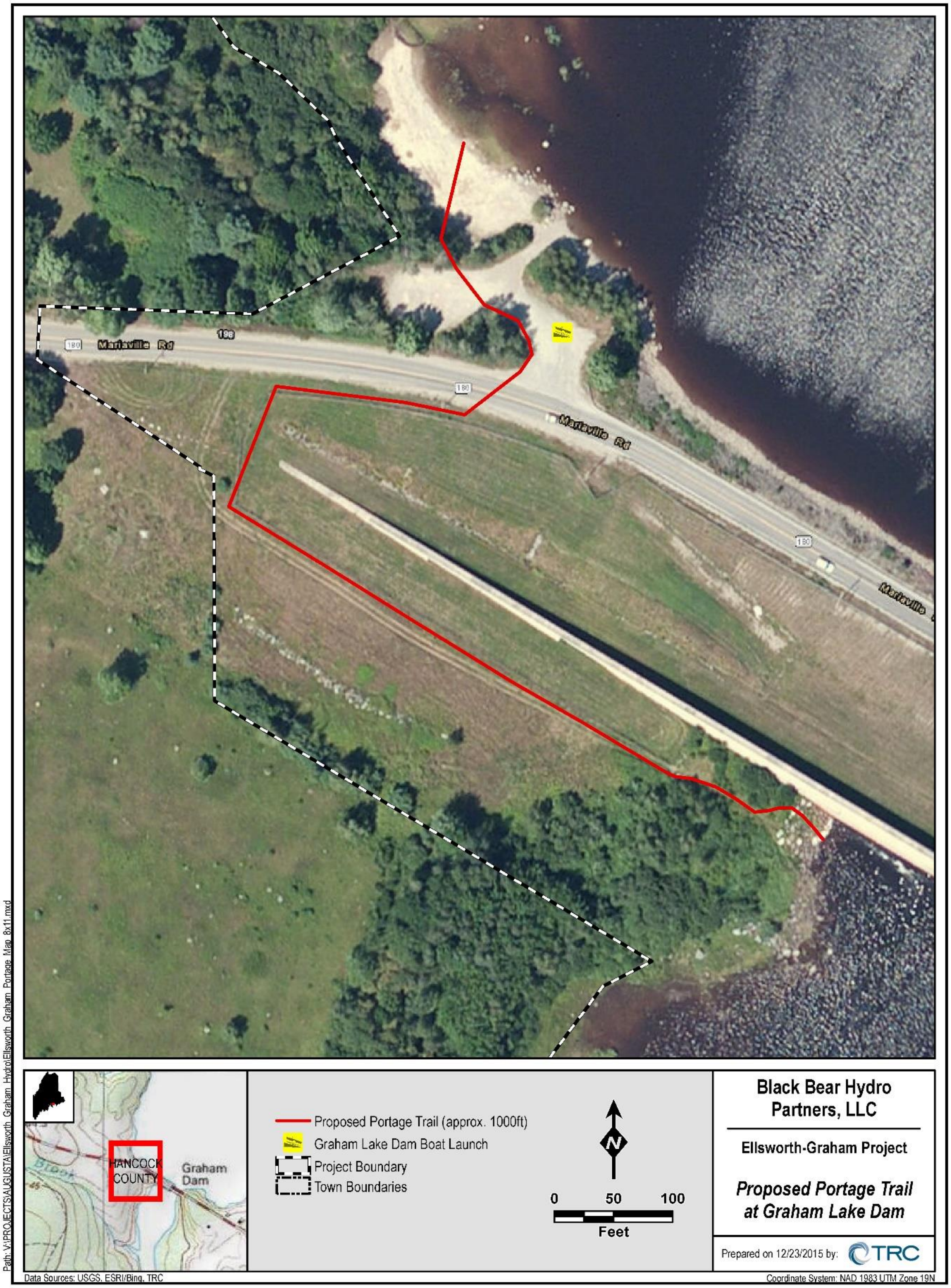


Table 4-2: Approved Recreation Amenities for the Ellsworth Hydroelectric Project FERC No. 2727

Project No.	Development Name	Recreation Amenity Name	Recreation Amenity Type	Amenity Status	Latitude*	Longitude*	FERC Citation & Date	Notes
P-2727	Lake Leonard	Lake Leonard boat launch	Carry-in boat launch	constructed	44.555049	-68.444943	68 FERC ¶62,240 09/14/1994	a six-foot wide hard surface carry-in ramp
P-2727	Graham Lake	Graham Lake Boat Launch	Boat Launch	constructed	44.592155	-68.442680		single lane, concrete planked ramp, approximately 12 feet wide
P-2727	Graham Lake	Downstream access trail	Downstream access trail	constructed	44.590857	-68.440227		forked path to two access points approximately 120 and 200 feet below the dam; the path is steep in spots with areas of erosion and irregular footing

*North American Datum (NAD) 1983 State Plane Coordinate System, Maine West, Feet

5.0 OTHER PUBLIC ACCESS

In addition to the Black Bear-owned and maintained facilities, there are several other public access sites associated with the Project. These sites are described below.

Ellsworth Elementary/Middle School Day Use Area:

The Ellsworth Elementary/Middle School day use area is located on the east shore of Lake Leonard in Ellsworth. The site is accessible by boat, foot, or by vehicle from the Shore Road. This site is owned and managed by the City of Ellsworth. Site improvements include three small open-sided shelters and informal trails to the shoreline. Vehicle parking for the site is provided at the school parking lot directly across the Shore Road. There is a footpath from Shore Road to the shelters. This site and facilities are outside the Project boundary, but the informal trails provide access to Project waters.

Photo 4-13: Day-use area shelters and path

Mariaville Carry-In Boat Launch:

The Mariaville carry-in is located on the west shore of Graham Lake off the Morrison Farm Road in Mariaville. The site is accessible by boat or by vehicle. The site has limited roadside parking for approximately six vehicles. The entrance road, parking areas and carry-in are compacted gravel on a gentle slope. The site is signed as a carry-in launch, although there is evidence that the site is used for trailered boat launching as well. The site is owned and managed by the Town of Mariaville and is outside the Project boundary, but provides access to Project waters.

Photo 4-14: Mariaville carry-in boat launch

Fletchers Landing:

Fletchers Landing is located on the east side of Graham Lake in Fletchers Landing Township (T8 SD). Access to the site is directly off Route 179. The site consists of a compacted gravel and grass parking area that will accommodate approximately ten trailer rigs. The boat launch area is approximately 15 feet wide and at one time had an asphalt surface. The asphalt ramp surface has degraded in some areas and has been repaired with gravel, stone, and concrete block. Local users appear to store boats on-site, both in the parking area and tied up to the shoreline. The site is owned by the State of Maine and outside the Project boundary, but provides access to Project waters.

Photo 4-15: Fletchers Landing boat launch and parking area

West Branch access site:

The West Branch Union River access site is located on the River Road in Mariaville. The site is accessible by boat and by vehicle from Route 181. A level gravel and grass parking area accommodates approximately seven vehicles and hand-carry watercraft can be launched into the West Branch via a short, steep, natural soil ramp. The site is privately-owned and outside the Project boundary, but provides access to Project waters. A dry hydrant for use of the local fire department is located on site.

Photo 4-16: West Branch Union River access site

Infant Street East Access

The Infant Street site is located off Shore Road on the east side of the Union River in Ellsworth. This is a discontinued City road that once crossed the Union River; the bridge has been removed. The site consists of a small (two vehicle) parking area (former road right-of-way) and a narrow informal footpath over the steep bank to the river. This site is owned by the City of Ellsworth and is outside the Project boundary, but provides access to Project waters.

Photo 4-17: Infant Street east access

Infant Street West Access

This site is located on the westerly side on Union River off Christian Ridge Road on the discontinued Infant Street in Ellsworth. The site consists of the discontinued road bed, which is accessible by vehicle, informal parking areas, and informal trails to the river. A trail leads to a large ledge outcrop on river's edge that is used for fishing, picnicking and other day use activities. The site is owned by the City and is located outside the Project boundary, but provides access to Project waters.

Photo 4-18: View upstream from ledge area of Infant Street west

6.0 MANAGEMENT MEASURES

6.1 Project Recreation Site Management and Maintenance

Black Bear will manage the proposed Project Recreation Sites, including the Leonard Lake carry-in boat access site, the Graham Lake boat launch, the fisherman access trail and parking area, and the canoe portage trail to provide safe and appropriate recreation access to the Project. Black Bear will ensure that the sites and facilities remain usable over the term of the new license.

Typical routine maintenance activities will include periodic mowing, litter clean-up, removal of fallen trees that hinder facility use, trimming overgrowth along the canoe portage trail, and checking that portage trail signage is in-place and readable. Black Bear will also conduct other improvements or repairs on an observed, as-needed basis.

Black Bear will complete the periodic FERC Form 80 process, as required by FERC.

6.2 Determining the Need for Additional Measures or Expansion of Existing Sites

In the event that the next FERC Form 80 process finds that an existing site has reached capacity, the need for additional access or improvements to existing sites will be further evaluated.

7.0 COST

Black Bear estimates the annual cost of inspecting and maintaining the existing recreation sites and facilities to be approximately $26,000 per year (2015 dollars), excluding capital replacements and improvements.

Black Bear estimates the cost of proposed improvements to the Graham Lake boat launch to be approximately $35,000.

Black Bear estimates the cost of proposed improvements to the fisherman access trail to be approximately $25,000.

Black Bear estimates the cost of developing a portage trail on the west side of Graham Lake Dam to be approximately $45,000.

Black Bear estimates the cost of developing Part 8, and directional and safety signage to be approximately $20,000.

8.0 SCHEDULE

Black Bear will conduct inspection and maintenance of the all the recreational sites and facilities described herein on an as-needed basis.

Development of the new Graham Lake canoe portage trail, improvements to the fisherman's downstream access trail at Graham Lake, improvements to the Graham Lake boat launch, and placement of the Part 8, and directional and safety signs will all be completed during the first full calendar year following issuance of a new license.

9.0 MODIFICATIONS TO PLAN

Any proposed modification to this Plan will be submitted to appropriate agencies for review and comment prior to submittal to FERC.

Prior to constructing any new structures or implementing major improvements to existing recreation facilities, design drawings will be submitted to FERC for approval. Any plans that may be developed for future recreational facilities will be provided to FERC for approval prior to construction. Any such plans will be provided along with drawings of facilities, documentation of consultation, cost estimates and schedule. The Maine Historic Preservation Commission will be included in the consultation process regarding the construction of new facilities or modifications to existing facilities that involve ground-disturbing activities.

10.0 REFERENCES

Black Bear Hydro Partners, LLC. 2014. Initial Study Report for the Ellsworth Hydroelectric Project (FERC No. 2727), filed with the Federal Energy Regulatory Commission on September 4, 2014.

APPENDIX E-10

PHASE II ARCHAEOLOGICAL INVESTIGATIONS AND DRAFT HISTORIC PROPERTIES MANAGEMENT PLAN

(FILED SEPARATELY AS PRIVILEGED)

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APPENDIX E-11

DRAFT OPERATIONS MONITORING PLAN

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Appendix E-11 - Operations Monitoring Plan

On December 20, 2012 the Black Bear Hydro Partners, LLC (BBHP or Licensee) formally initiated the relicensing process for the Ellsworth Hydroelectric Project (FERC No. 2727) with the filing of a Notice of Intent (NOI) and Pre-Application Document (PAD). In consultation with agencies, interested parties, and the Federal Energy Regulatory Commission (FERC or Commission), the Licensee conducted a number of resource studies, the results of which are incorporated in the Final License Application (FLA) for the Ellsworth Project. As a part of the FLA, the Licensee is filing a draft Project Operations Monitoring Plan. The plan will be finalized upon review by the FERC, and implemented in accordance with the issuance of a new license for the Project.

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DRAFT
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ELLSWORTH HYDROELECTRIC PROJECT
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1.0 BACKGROUND

The Ellsworth Hydroelectric Project (Project) is an existing hydroelectric project located on the lower reach of the Union River, in the City of Ellsworth, the towns of Waltham and Mariaville, and the Township of Fletchers Landing (an unincorporated township), in Hancock County, Maine. The Project is owned and operated by Black Bear Hydro Partners, LLC (Black Bear or Licensee). The Project consists of two developments, the Ellsworth Development and the Graham Lake Development.

The Federal Energy Regulatory Commission (FERC) issued a new license for the Project by Order dated [xxx] (xx_FERC ¶xx,xxx). Article xxx of the new license requires that Licensee develop and implement a Project Operations Monitoring Plan (Plan). The purpose of this Plan is to document how the licensee will monitor, record compliance with, and report deviations from the requisite minimum flow and impoundment level maintenance requirements described below.

2.0 PROJECT DESCRIPTION

The Ellsworth Project is located in Downeast Maine on the Union River, approximately 3 miles upstream of the Union River Bay, which flows into the Atlantic Ocean. The Project includes Graham Lake, Graham Lake Dam, a 3-mile stretch of the Union River, Lake Leonard, and Ellsworth Dam and powerhouse.

2.1 Project Works

Ellsworth Development

The Ellsworth Dam is an Ambursen-style dam that was filled in part with concrete in the early 1990s. The Ellsworth Dam is 65-feet high and 377-feet long including a 275-foot spillway. The overflow spillway and non-overflow section are comprised of a reinforced concrete buttress dam with 22 bays. The overflow spillway has a flashboard crest elevation of 66.7-feet. The non-overflow section includes a gatehouse; turbine-generator Unit No. 1 is served by a 10-foot diameter vertical penstock contained in the gatehouse. The non-overflow section is connected to an intake structure containing three additional penstocks: two 8-foot diameter penstocks serving turbine-generator Units No. 2 and 3, and one 12-foot diameter penstock serving turbine-generator Unit No. 4. The four units contained in the Ellsworth powerhouse have a total FERC-authorized nameplate capacity of 8.9 megawatts (MW).

An upstream fish passage facility consisting of a vertical slot fishway and trap is operated at the Ellsworth Dam providing for upstream fish passage and the commercial harvest of river herring by the City of Ellsworth under a cooperative management agreement with the Maine Department of Marine Resources. Downstream fish passage at each development is provide by dedicated surface weirs.

Graham Lake Development

Graham Lake Dam is a non-generating development located about four miles upstream from the Ellsworth Dam. The Graham Lake Dam is 30-feet high and consists of 670-foot long earth dike and an 80-foot long concrete gate structure plus abutments. The concrete gate structure contains three 20-foot wide radial gates and an 8-foot wide sluice that is used for downstream fish passage. There is a concrete flood control structure associated with the Graham Lake Dam. The flood control structure consists of a concrete flood wall approximately 720-feet long, a 65-foot diameter steel cell (formerly part of the construction coffer dam) and a 71-foot long wing wall extension that connects to the gate structure and serves as an emergency overflow spillway. No powerhouse is associated with the Graham Lake Dam and reservoir.

2.2 Impoundments

Ellsworth Development

The Ellsworth Project has a drainage area of approximately 547 square miles at the Ellsworth Dam. The lake impounded by the Ellsworth Dam, Lake Leonard, has a surface area of 90 acres at its normal maximum elevation of 66.7’ and a length of one mile. Normal water levels in Lake Leonard are maintained between elevation 65.7’ and 66.7’.

Graham Lake Development

The upper reservoir, Graham Lake, has a normal maximum surface area of approximately 10,000 acres and a maximum length of approximately 10 miles. Annual water levels in Graham Lake are managed between elevations 93.4’ and 104.2’. Drawdown of Graham Lake in the summer/fall and more extensively at the beginning of the year provides significant downstream flood control benefits.

2.3 License Requirements

Articles xxx and xxx of the new license for the Ellsworth Project read as follows:

Article xxx – Minimum Flows

> Except as temporarily modified by (1) approved maintenance activities, (2) extreme hydrologic conditions, as defined below, (3) emergency electrical system conditions, as defined below, or (4) agreement between the Licensee, the MDEP, and appropriate state and/or federal fisheries management agencies, the Licensee shall release a continuous minimum flow of 105 cubic feet per second (cfs) from the Graham Lake Development and the Ellsworth Development from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30, for the protection of fishery resources.

Article xxx – Impoundment Levels

> Except as temporarily modified by (1) approved maintenance activities, (2) extreme hydrologic conditions, as defined below, (3) emergency electrical system conditions, as defined below, or (4) agreement between the Licensee, the MDEP, and appropriate state and/or federal fisheries management agencies, the Licensee shall operate the project so that water levels in Lake Leonard are maintained between the elevations of 65.7’ and 66.7’ (flashboard crest) during normal operation, and water levels in Graham Lake are maintained between 104.2’ and 93.4’.
>
> "Extreme Hydrologic Conditions" means the occurrence of events beyond the Licensee's control such as, but not limited to, abnormal precipitation, extreme runoff, flood conditions, ice conditions or other hydrologic conditions such that the operational restrictions and requirements contained herein are impossible to achieve or are inconsistent with the safe operation of the Project.
>
> "Emergency Electrical System Conditions" means operating emergencies beyond the Licensee's control which require changes in flow regimes to eliminate such

emergencies which may in some circumstances include, but are not limited to, equipment failure or other temporary abnormal operating conditions, generating unit operation or third-party mandated interruptions under power supply emergencies, and orders from local, state, or federal law enforcement or public safety authorities.

In addition to the above station operating requirements the fish passage facilities (the planned upstream eel passage facility, the downstream fishway, and upstream fish passage facility) at the Ellsworth dam each require operating flows. The operating flows for these facilities are established through adaptive management practices and in consultation with the fishery resource agencies but are initially based on a percentage of station capacity (approximately 2,640 cfs), generally 2% to 4%. Estimated operating flows are:

- Flows for upstream ell passage; approximately 5 gpm,
- Flows for downstream anadromous fish passage; approximately 60 cfs, and
- Flows for upstream anadromous fish passage; approximately 50 to 100 cfs.

3.0 OPERATIONS MANAGEMENT

3.1 Typical Operations

The Ellsworth Dam operates in a run-of-river mode automatically via pond level control while the Graham Lake Dam provides storage and has no power facilities. Timed releases at Graham Lake are used at Ellsworth Dam for power production. Black Bear releases a continuous minimum flow of 105 cfs from the Graham Lake Development and the Ellsworth Development from July 1 through April 30 and 250 cfs from May 1 through June 30. The ability to store and release water at Graham Lake allows the Ellsworth plant to operate in a peaking mode during periods of high electric demand.

3.2 High Water Operations

The Ellsworth Project is normally operated as a peaking plant, with water being released from the Graham Lake reservoir and then used to generate electricity at the downstream Ellsworth powerhouse. In a potential flood situation, Black Bear dam operators work to manage water levels along the Union River in order to minimize risk and flood damage; the Project gates, spillways and generating units are operated based upon the High Water Guidelines which are incorporated into the Emergency Action Plan filed periodically with FERC.

3.3 Low Water Operations

The Ellsworth Project releases a continuous minimum flow of 105 cfs from July 1 through April 30 and 250 cfs from May 1 through June 30. Drawdown of Graham Lake provides important flow augmentation during dry inflow periods so that minimum flows can be maintained in the Union River below Graham Lake Dam.

3.4 Routine Maintenance Operations

The Ellsworth Project is remotely operated using a SCADA link to Brookfield Renewable Energy Group's North American System Control Center (NASCC) in Marlborough, Massachusetts.[1] A local operating crew is also available during weekdays and weekends as necessary to perform routine maintenance and operations of the facility. The dams are inspected routinely by Black Bear Engineering and Operations staff.

3.5 Scheduled Maintenance

3.5.1 Project Works

Periodic turbine-generator unit shutdowns will occur as necessary to perform maintenance activities. Under these circumstances the Licensee will maintain minimum downstream flow of 105 cfs from the Graham Lake Development and Ellsworth Lake Development from July 1 through April 30 and 250 cfs from May 1 through June 30 through the remaining turbines or spillways as necessary.

In addition to planned unit maintenance activities, there will be times when an operator has to clear accumulated debris (leaves, trees, branches, etc.) from the intake. This may require backing off the units to flush the debris away from the intake. The Licensee will maintain the required minimum flows as necessary during this activity.

[1] Black Bear Hydro Partners LLC is a member of the Brookfield Renewable Energy Group.

During planned maintenance activities where changes to the required minimum flows are necessary, Licensee will consult with Maine Department of Environmental Protection (MDEP), Maine Department of Inland Fisheries and Wildlife (MDIFW), U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) on temporary minimum flow limits.

3.5.2 Impoundments

Drawdown of the impoundments will be required from time to time to perform major maintenance on Project structures or to accommodate requests or orders from Federal or state agencies and entities concerned with public safety, construction/maintenance of downstream public works projects, and other similar activities. During sustained Project drawdowns within the normal operating parameters of the license, minimum flows will be maintained through the units or through the spillways as applicable. During planned drawdowns exceeding the normal operating parameters of the license, Licensee will consult with MDEP, MDIFW, USFWS and NMFS on minimum flows and impoundment level limits and refill.

3.5.3 Fish Passage Operations

The project fishways are operated, and records maintained, according to the Fish Passage Operations and Maintenance Plan that has been developed for the Project.

3.6 Unscheduled Operations

Project Works

The individual generating units, or the station, may occasionally trip off-line unexpectedly (i.e. line fault, equipment failure, etc.). Under these circumstances, the Licensee will maintain the required minimum flows from the Ellsworth Development through the remaining units or over the spillway. In the event that one unit is on line and trips, the NASCC will remotely start (or restart) a unit to meet the minimum flow. In the event that multiple units are on line and a unit trips, the NASCC will adjust the remaining unit flow to maintain the requisite minimum flow. NASCC can generally start a unit within 10 to 15 minutes of receiving an alarm of a unit or station trip. In the event that a unit or the station cannot be remotely restarted for any reason, a local operator will be dispatched to check the station and restart a unit if appropriate. The Ellsworth headpond is generally operated close to full pond elevation such that, during any extended outage, the pond will start to spill in a relatively short time and pass the inflow. If the Licensee is unable to restore or transition the minimum flow to a unit or to the spillway within 15 minutes, the Licensee will notify MDEP, MDIFW, USFWS and NMFS of the minimum flow excursion within 24 hours (see Section 5.0, Reporting).

Impoundments

There may be occasions where the Licensee will need to initiate an unplanned drawdown to respond to emergencies beyond its control such as dam safety, public safety, or impending electrical system blackout emergencies. The Licensee will notify the MDEP, MDIFW, USFWS and NMFS within 24 hours of such emergencies and include the date, time, and the reason for the emergency drawdown (see Section 5.0, Reporting).

4.0 OPERATIONS MONITORING

The Licensee will monitor generation at the Project continuously via SCADA, outflow is calculated from the generation readings using a conversion factor based on kw/cfs passed through the unit(s).[2] [The curves or calculations used to convert kw to cfs, and gate settings to cfs, will be included in the final plan.] Pressure-sensitive headwater sensors (transducer) are in place at both the Graham Lake Dam and the Ellsworth dam and provide real time impoundment levels.

Project generation/outflow, and impoundment levels, will be recorded electronically by the automated operations system every 15 minutes and archived for Licensee's record of compliance with the requirements of the new license. These records can be retrieved and be made available to verify compliance.

The Licensee will provide copies of monitoring data (i.e., flow and impoundment level conditions) to the FERC, MDEP, MDIFW, USFWS and the NMFS, upon written request.

[2] Flow statistics for the Project area are calculated from generation data for Ellsworth Dam collected at the facility, as there is no USGS Gage associated with the Project area.

5.0 REPORTING

The Licensee will notify the MDEP, MDIFW, USFWS and the NMFS within 24 hours of any deviation from minimum flow requirements (of greater than 15 minutes) or headpond elevations, as explained above. The agency notification will include a brief summary of the deviation and any observed adverse environmental or public safety impacts resulting from the incident. The minimum flow or headpond elevations may also be interrupted for short periods after consultation with the MDEP and appropriate fisheries management agencies.

The Licensee will notify the FERC within ten days of any deviation from minimum flow requirements (of greater than 15 minutes) or headpond elevations. The notification will contain, to the extent possible, the cause, severity and duration of the incident, and any observed or reported adverse environmental impacts resulting from the incident. The report will also provide pertinent Project data and a description of corrective measures and documentation of consultation with the agencies. A copy of the report will be provided to the resource agencies.

APPENDIX E-12

DRAFT BIOLOGICAL ASSESSMENT FOR ATLANTIC SALMON, ATLANTIC STURGEON, AND SHORTNOSE STURGEON

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ELLSWORTH HYDROELECTRIC PROJECT

FERC NO. 2727

DRAFT BIOLOGICAL ASSESSMENT

FOR

ATLANTIC SALMON, ATLANTIC STURGEON, AND SHORTNOSE STURGEON

Black Bear Hydro Partners LLC
Lewiston, Maine

HDR

December 2015

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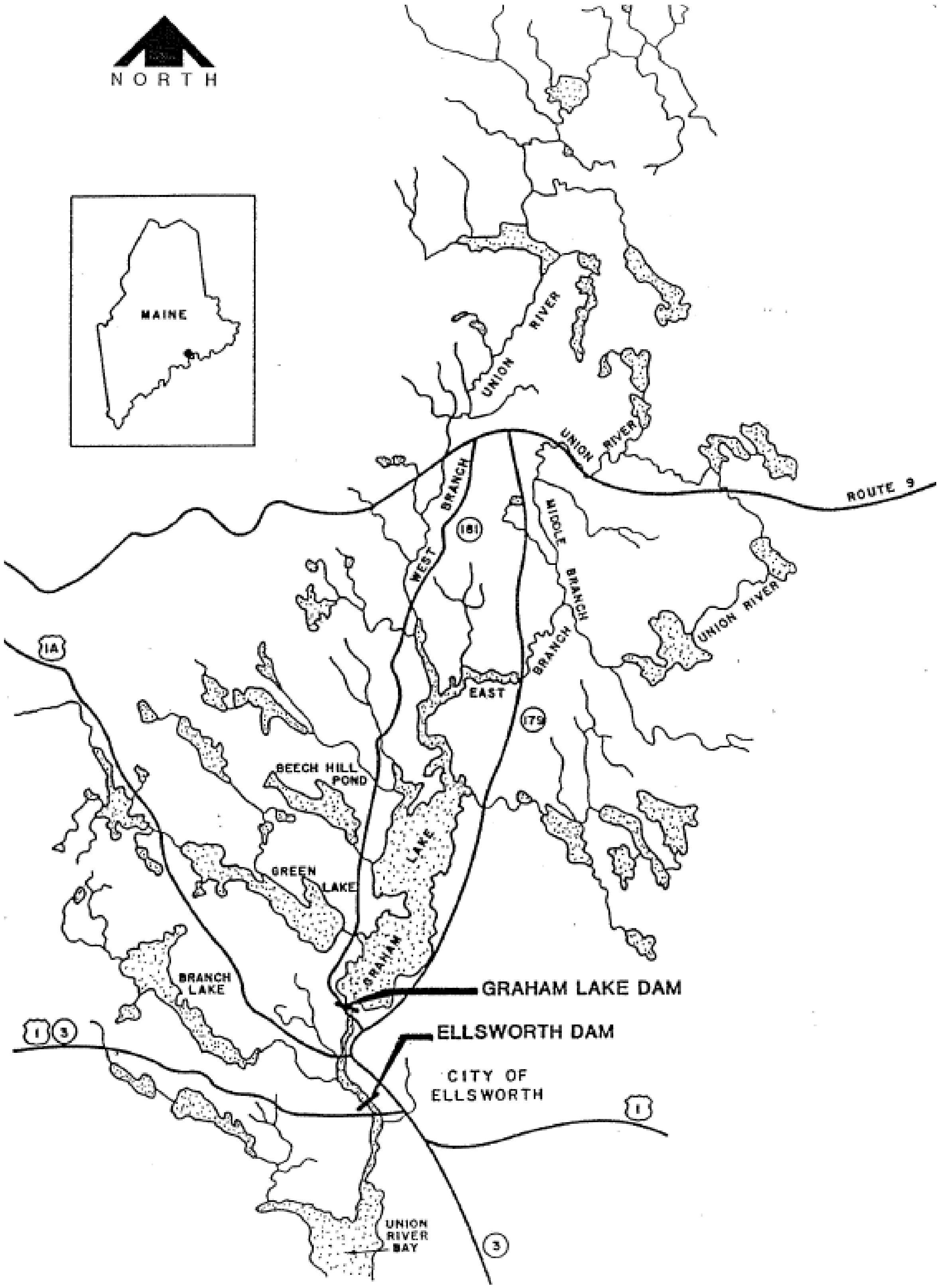
1.0 Background

Black Bear Hydro Partners LLC (Black Bear) is in the process of relicensing the Ellsworth Project (FERC No. 2727), an 8.9 megawatt (MW) hydroelectric facility located on the Union River in the City of Ellsworth, Hancock County, Maine. The existing license for the Ellsworth Project expires in 2017; Black Bear will submit an application for a new license to the Federal Energy Regulatory Commission (FERC) by December 31, 2015. FERC's issuance of a new license for the Ellsworth Project is a federal action and, therefore, requires consultation under Section 7 of the Endangered Species Act (ESA) to assess the potential effects of the action on federally protected species and determine whether incidental take is expected to occur. A federal agency may designate a non-federal representative to conduct informal consultation or prepare a biological assessment to assess the effects of a proposed federal action on listed species. On September 14, 2011, FERC designated Black Bear as its non-federal representative for ESA consultation for the licensing of the Ellsworth Project.

Consistent with its designation as FERC's non-federal representative for ESA consultation for the relicensing of the Ellsworth Project, Black Bear has developed this draft Biological Assessment (BA) for the federally endangered Gulf of Maine (GOM) Distinct Population Segment (DPS) of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon at the Ellsworth Project. The Ellsworth Project consists of the Ellsworth Development, the Graham Lake Development, and appurtenant facilities. The Ellsworth Dam has an integral intake structure and powerhouse. Graham Lake Dam is located on the Union River upstream of Ellsworth Dam, creating the water storage reservoir known as Graham Lake (Figure 1).

FIGURE 1
PROJECT LOCATION MAP



1.1 ESA Listing of Atlantic Salmon

The GOM DPS of Atlantic salmon was first listed as endangered by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (the Services) on November 17, 2000 (USFWS and NMFS 2000). The GOM DPS designation in 2000 included all naturally reproducing Atlantic salmon populations occurring in an area from the Kennebec River downstream of the former Edwards Dam site extending north to the international border between Canada and the United States at the mouth of the St. Croix River. This range includes the Union River. The listing in 2000 identified nine watersheds likely to contain naturally reproducing Atlantic salmon populations, including the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot Rivers, Cove Brook and Kenduskeag Stream. The GOM DPS also included river-specific hatchery fish that were being propagated at the Craig Brook Hatchery for release into the wild. The November 2000 final rule listing the GOM DPS did not include fish that inhabit the mainstem and tributaries of the Penobscot River above the site of the former Bangor Dam, the upper Kennebec River, or the Androscoggin River (USFWS and NMFS 2000).

The 2006 Status Review for anadromous Atlantic salmon in the U.S. (Fay et al. 2006) assessed genetic and life history information and concluded that the GOM DPS, as defined in 2000, should be redefined to encompass the Penobscot, Kennebec, and Androscoggin Rivers. On June 19, 2009, the Services published a final rule determining that naturally spawned and conservation hatchery populations of anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, including those that were already listed in November 2000, constitute a DPS and hence a “species” for listing as endangered under the ESA (USFWS and NMFS 2009). This range includes the Union River.

1.2 Downeast Coastal Salmon Habitat Recovery Unit

The GOM DPS of Atlantic salmon is divided into three salmon habitat recovery units (SHRUs) within the range of the GOM DPS and include the following: the Downeast Coastal SHRU, the Penobscot Bay SHRU, and the Merrymeeting Bay SHRU. The three SHRUs were created to ensure that Atlantic salmon were widely distributed across the DPS such that recovery of the GOM DPS is not limited to one river or one geographic location, because widely distributed species are less likely to become threatened or endangered by limited genetic variability and tend to be more stable over space and time (NOAA 2009).

The Downeast Coastal SHRU contains 61,395 units[1] of historically accessible spawning and rearing habitat for Atlantic salmon, of which 53,390 units are considered to be currently occupied, and 29,111 of these units are estimated to be functional units of spawning and rearing habitat (NMFS 2009a, NMFS 2009b). Within the Downeast Coastal SHRU, the Union River has about 12,000 units of historic spawning and rearing habitat, although NMFS concludes that dams reduce its equivalent functional habitat value to 4,062 units of habitat (NMFS 2009a). In addition to dams, a variety of issues and conditions affect Atlantic salmon recovery in the Union River, including agriculture, forestry, changing land use, hatcheries and stocking, roads and road crossings, mining, dredging, aquaculture, and introductions of non-native species such smallmouth bass (NMFS 2009a).

1.3 Critical Habitat Designation

As a result of the June 19, 2009 endangered species listing, NMFS was required to evaluate historical occupancy of the watershed for the process of designating critical habitat for the GOM DPS. Section 3 of the ESA defines critical habitat as the following:

1. Specific areas within the geographical area occupied by the species at the time of listing, in which are found those physical or biological features that are essential to the conservation of the listed species and that may require special management considerations or protection; and
2. Specific areas outside the geographical area occupied by the species at the time of listing that are essential for the conservation of a listed species.

As part of the critical habitat designation, NMFS described the known primary constituent elements (PCEs) that are deemed essential to the conservation of the GOM DPS, including (1) sites for spawning and rearing and (2) sites for migration (excluding marine migration[2]). The

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[1] One unit of habitat is $100m^2$ (NMFS 2009a)

2 NMFS was not able to identify the essential features of marine migration and feeding habitat or the specific locations of marine habitats at the time critical habitat was designated (NMFS 2009a).

physical and biological features of the two PCEs for Atlantic salmon critical habitat are as follows:

Physical and Biological Features of the Spawning and Rearing PCE

A1. Deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall.

A2. Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.

A3. Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.

A4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.

A5. Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.

A6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.

A7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Physical and Biological Features of the Migration PCE

B1. Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations.

B2. Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon.

B3. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.

B4. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

B5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.

B6. Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

On June 19, 2009, NMFS designated as critical habitat 45 specific areas occupied by GOM DPS Atlantic salmon at the time of listing. Critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line (33 C.F.R. 329.11). Critical habitat in estuaries is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater. Critical habitat is designated to include all perennial rivers, streams, and estuaries and lakes connected to the marine environment within the range of the GOM DPS, except for those particular areas within the range which are specifically excluded (NMFS 2009a).

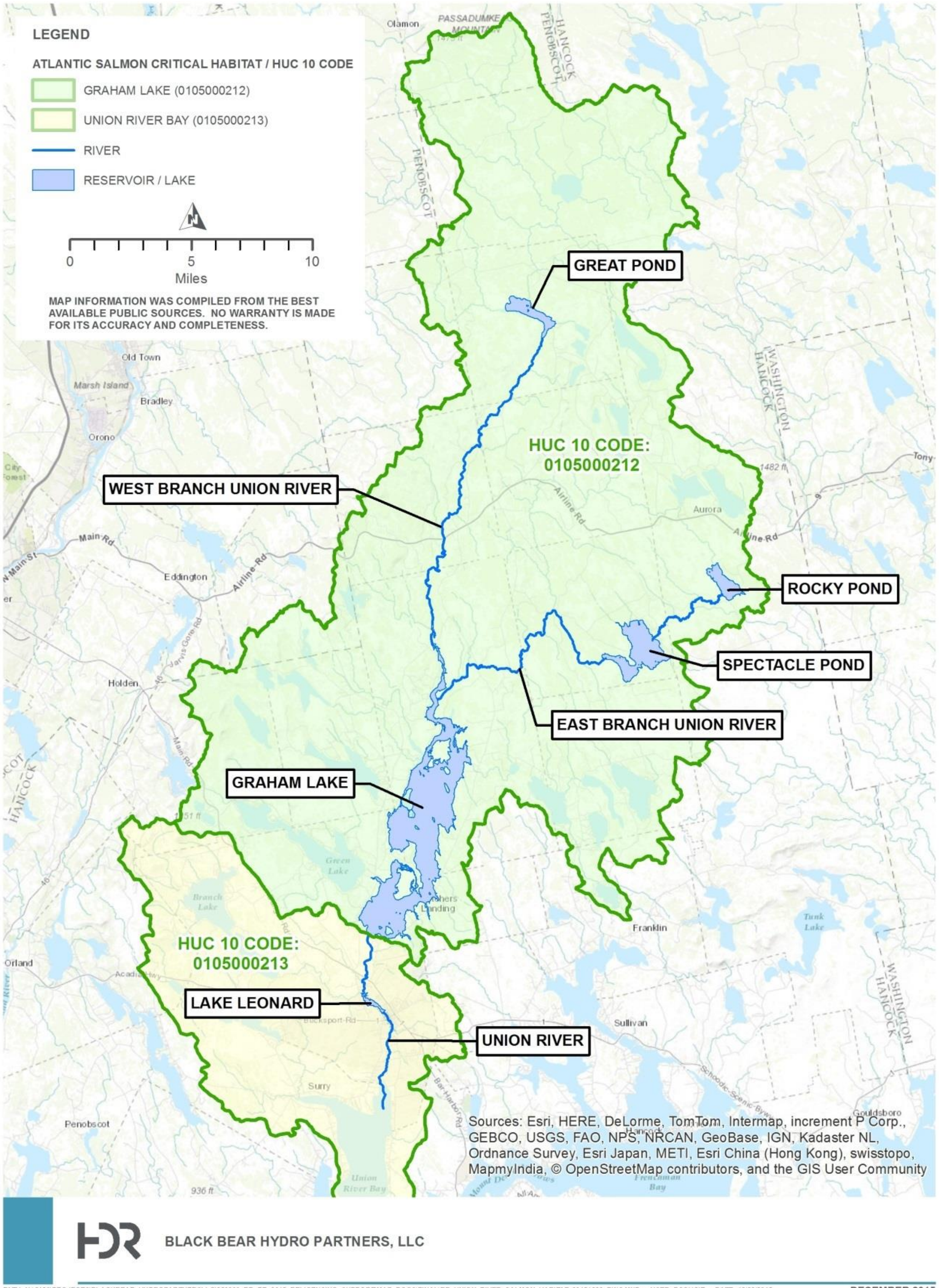
The Ellsworth Project falls within the designated critical habitat of the Downeast Coastal SHRU for Atlantic salmon. Critical Habitat is further delineated into HUC 10 watersheds. The Union River includes two HUC 10 watersheds listed as critical habitat, including the Graham Lake HUC 10 (code 0105000212) and the Union River Bay HUC 10 (code 0105000213). The entire Project area is within Atlantic salmon critical habitat as shown in Figure 2.

1.4 Other ESA Listed Species - Atlantic and Shortnose Sturgeon

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeon (*Acipenser brevirostrum*) have the potential to occur in the Union River downstream of the Ellsworth Project. On February 6, 2012, NOAA published notice in the Federal Register listing the Atlantic sturgeon as "endangered" in the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs, and as "threatened" in the Gulf of Maine DPS (77 FR 5880 and 77 FR 5914). The Ellsworth Project falls within the Gulf of Maine DPS.

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada; Maine; Massachusetts; Connecticut; New York; New Jersey/Delaware; Maryland and Virginia; North Carolina; South Carolina; Georgia; and Florida. Critical habitat has not been designated for Atlantic or shortnose sturgeon.

FIGURE 2
CRITICAL HABITAT, UNION RIVER WATERSHED



2.0 Overview of the Draft Biological Assessment and Agency Consultation

2.1 Purpose and Description of Draft Biological Assessment

The FERC license for the Ellsworth Project expires in 2017. Black Bear initiated the relicensing process for the Project in 2012 and submitted an application for new license to FERC in December of 2015. As part of the relicensing process, Black Bear is addressing the potential for continued operation of the Project to affect ESA listed species. Black Bear had previously requested to be designated FERC's non-federal representative for the purpose of conducting informal consultation with the Services pursuant to Section 7 of the ESA. FERC designated Black Bear as its non-federal representative in a letter dated September 14, 2011.

The Services have indicated that activities related to the listing of the GOM DPS Atlantic salmon in Maine will be jointly managed and administered; however, NMFS will have the lead on issues pertaining to hydroelectric operations and their effects on Atlantic salmon and their critical habitat. Section 9 of the ESA prohibits the take of endangered species, including the GOM DPS Atlantic salmon, unless the take is authorized under specific provisions of the ESA. "Take" is defined by the ESA as "to harass, harm, pursue, ban, shoot, wound, kill, trap, capture, or collect," or to attempt to engage in any such conduct.

Exemptions to the prohibitions of take under Section 9 of the ESA can be provided by the Services through Section 10 or Section 7 of the ESA. Under ESA Section 10(a)(1)(B), permits may be issued for taking that is incidental to the purposes of an otherwise lawful activity (incidental take permits). Under ESA Section 7(a)(2), incidental take statements may be issued to exempt from the prohibitions any take anticipated as an incidental result of an activity conducted, permitted, or funded by a federal agency provided this take would not be likely to result in jeopardy to the species or destruction of its critical habitat. Section 7 of the ESA mandates that all federal agencies consult with the Secretaries of Commerce (through NMFS) and Interior (through the USFWS) to determine whether a proposed action is likely to be categorized, with respect to listed species and designated critical habitat, as follows:

1. ***No Effect:*** No effects to the species and its critical habitat from the proposed action, either positive or negative, are expected.

2. ***May Affect, Not Likely to Adversely Affect:*** All effects of the proposed action to the species and its critical habitat are beneficial, insignificant, or discountable. Beneficial effects have positive effects to the species or its critical habitat. Insignificant effects relate to the size of the impact and should not reach the scale where incidental or unintentional take (harming or killing) occurs. Discountable effects are those that are extremely unlikely to occur. Determinations of "not likely to adversely affect" due to beneficial, insignificant, or discountable effects require written concurrence from the USFWS or NMFS.
3. ***May Affect, Likely to Adversely Affect:*** The action would have an adverse effect on the species or its critical habitat. Any action that may result in take of an endangered species is considered an adverse effect. A combination of beneficial and adverse effects is still considered "likely to adversely affect" even if the net effect is neutral or positive. Adverse effects are not considered discountable because they are expected to occur. This determination requires formal consultation with the USFWS or NMFS.

2.2 Consultation

Both prior to and after the June 19, 2009 ESA listing of GOM DPS Atlantic salmon, Black Bear held discussions with the Services to develop measures to protect the GOM DPS Atlantic salmon. Between 2009 and 2011, Black Bear had numerous discussions with the Services to develop a draft BA and a Draft Species Protection Plan (SPP) for the Ellsworth Project as part of the prospective documents also covering Black Bear's Penobscot River hydroelectric projects (Orono, Stillwater, Milford, West Enfield, and Medway projects). The SPP identified measures to avoid and minimize potential adverse effects on listed Atlantic salmon and designated critical habitat. In September 2011, NMFS requested that Black Bear remove the Ellsworth Project from the Penobscot draft BA and instead, develop a separate draft BA for the Ellsworth Project. This was done, and a draft BA for the Ellsworth Project was sent to the Services for their review on August 16, 2012. Black Bear held a meeting with NMFS to discuss development of the draft BA and SPP on November 13, 2012. NMFS provided comments on the draft BA on December 7, 2012. With the initiation of relicensing activities in late 2012, development of the draft BA has been coordinated with the schedule for developing the FERC license application. Based on further consultation with NMFS regarding potential protection measures and the lack of adequate information to inform the determination of suitable measures, an SPP has not yet been developed for the Ellsworth Project. Black Bear will continue to consult with NMFS regarding ongoing salmon passage studies to identify appropriate protection measures. Further, NMFS, Maine Department of Marine Resources (Maine DMR), and USFWS are currently developing a stock rebuilding and management plan for the Union River as part of the Atlantic salmon recovery objectives (NMFS 2015).

3.0 Project Description

3.1 Project Facilities

The Ellsworth Project consists of the Ellsworth Development, the Graham Lake Development, and appurtenant facilities. The Ellsworth Dam has an integral intake structure and powerhouse, and creates the impoundment, Lake Leonard. Graham Lake Dam is located on the Union River about 4 miles upstream of Ellsworth Dam, creating the water storage reservoir known as Graham Lake (Figure 1).

Construction of the Ellsworth Dam was completed in 1907. Ellsworth Dam is approximately 377 feet long and 65 feet high with 1.7-foot-high flashboards on the spillway. Lake Leonard extends approximately 1 mile above Ellsworth Dam and has a surface area of 90 acres at a normal full pond water surface elevation of 66.7' U.S. Geological Survey (USGS) datum. The powerhouse is a reinforced concrete and concrete block masonry powerhouse containing four turbine-generator units, which have a total FERC authorized nameplate capacity of 8,900 kW (Table 1) and a total combined maximum flow capacity of approximately 2,460 cfs.

The Graham Lake Dam is an earthfill dam with concrete core walls, about 750 feet long and 30 feet high and includes a gated concrete spillway. The Graham Lake reservoir is approximately 10 miles long with a surface area of approximately 10,000 acres at normal full pond water surface elevation of 104.2' (Table 1). There are no generating facilities at the Graham Lake Development.

TABLE 1
CHARACTERISTICS OF THE ELLSWORTH PROJECT

Facility Characteristics	Ellsworth Dam	Graham Lake Dam
Reservoir Length	1 mile	10 miles
Reservoir Surface Area	90 acres	Approximately 10,000 acres
Reservoir Normal Full Pond Elevation	66.7' (includes 1.7-foot flashboards)	104.2'
Length of Dam	377 feet	750 feet
Height of Dam	65 feet	30 feet
Turbine Rated Capacity*	• Unit 1 – 3,800 hp (2,850 kW) (vertical shaft propeller) • Unit 2 – 2,900 hp (2,175 kW) (Kaplan) • Unit 3 – 2,900 hp (2,175 kW) (Kaplan) • Unit 4 – 3,800 hp unit (2,850 kW) (vertical shaft propeller)	NA
Generator Rated Capacity**	• Unit 1 – 3,125 kVA @ power factor 0.8; 2,500 kW • Unit 2 – 2,500 kVA @ power factor 0.8; 2,000 kW • Unit 3 – 2,500 kVA @ power factor 0.8; 2,000 kW • Unit 4 – 3,000 kVA @ power factor 0.8; 2,400 kW	
Trash Rack Spacing	Variable – Typical configuration based on normal pond elevation: Top 6-8 feet is concrete Unit 1 – 2.44 in. Units 2-4 – 1.00 in.(top)/2.37 in. (bottom)	NA

*The total combined maximum hydraulic capacity of the turbines is estimated to be 2,460 cfs.
**The total FERC authorized capacity of the facility, based on the limiting unit components, is 8.9 MW.

The Ellsworth Dam trap and transport facility is equipped with a four-baffle vertical slot upstream fishway leading to a trap fitted with a hopper and hoisting structure to facilitate fish transport in circular transport tanks (Figure 3). The fishway entrance is immediately adjacent to the powerhouse tailrace with a pumped attraction flow of up to 50 cfs. The upstream fishway and fish trapping facility were constructed at the Ellsworth Dam (Lake Leonard) in 1974, originally to provide a supplemental source of Atlantic salmon broodstock for use in the restoration of populations to the Penobscot and other rivers (Baum 1982). Since Atlantic salmon broodstock collection has been discontinued, the upstream fishway is now used primarily during the river herring migration, but also to collect any salmon that might use the facility for potential upriver transport (depending on origin of fish) in the Union River. Adult Atlantic salmon that are captured in the fishway are examined to determine origin, and the Maine DMR determines whether Atlantic salmon caught in the fishway are released downstream of the Ellsworth Dam, upstream of the Graham Lake Dam, or, if an aquaculture escapee, removed by Maine DMR. Graham Lake Dam does not have an upstream fishway because fish are transported from the Ellsworth trap and transport facility to locations above the Graham Lake Dam.

Black Bear operates downstream passage facilities at both Ellsworth Dam (Figures 4 and 5) and Graham Lake Dam (Figure 6). Downstream measures at the Ellsworth Dam consist of two stop-log controlled surface weirs above Units 2 through 4 and a transport pipe leading to a plunge pool immediately downstream of the dam, as well as a third surface weir adjacent to the Unit 1 intake that discharges directly to the same plunge pool. In addition, a permanent stainless steel inlet screen was installed over the intake of the cooling water system at the Ellsworth Dam on May 26, 2015 as a downstream passage protection measure, following review and consultation with the resources agencies, including guidance provided by the USFWS and NMFS.

In addition to the activities associated with operation and maintenance of the fish passage facilities at the Ellsworth Dam, Black Bear operates a surface weir to provide downstream passage of out-migrating Atlantic salmon and river herring on the west end of the Graham Lake Dam gate structure. The development of this passage route was completed in 2003, coinciding with increased upstream stocking of alewives. The weir (Figure 6) is very similar to the downstream passage system at the Ellsworth Dam in that it is a surface weir that contains stoplogs, which enable Black Bear to adjust the opening as necessary. The opening empties into a downstream plunge pool and provides migrants with another route of passage in addition to the existing Tainter gates, which are operated to pass minimum flows and flows used for generation purposes at the Ellsworth Dam. The downstream fishways are operated from April 1 to December 31 annually, as river conditions allow.

FIGURE 3
VIEW OF FISHWAY LIFT IN OPERATION USED FOR TRANSFERRING FISH TO THE HOLDING TANK AT THE ELLSWORTH DAM

FIGURE 4
VIEW OF COLLECTION CHAMBER AND ENTRANCE TO DOWNSTREAM FISH PASSAGE PIPE AT THE ELLSWORTH DAM

FIGURE 5
VIEW OF DISCHARGE FROM DOWNSTREAM FISH PASSAGE PIPE AND SURFACE WEIR AT THE ELLSWORTH DAM

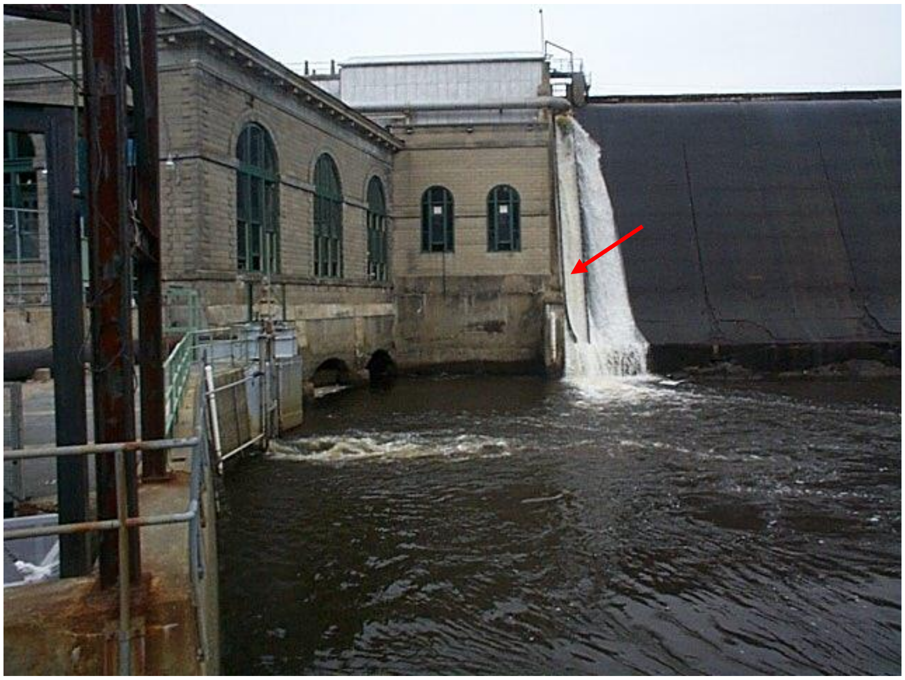
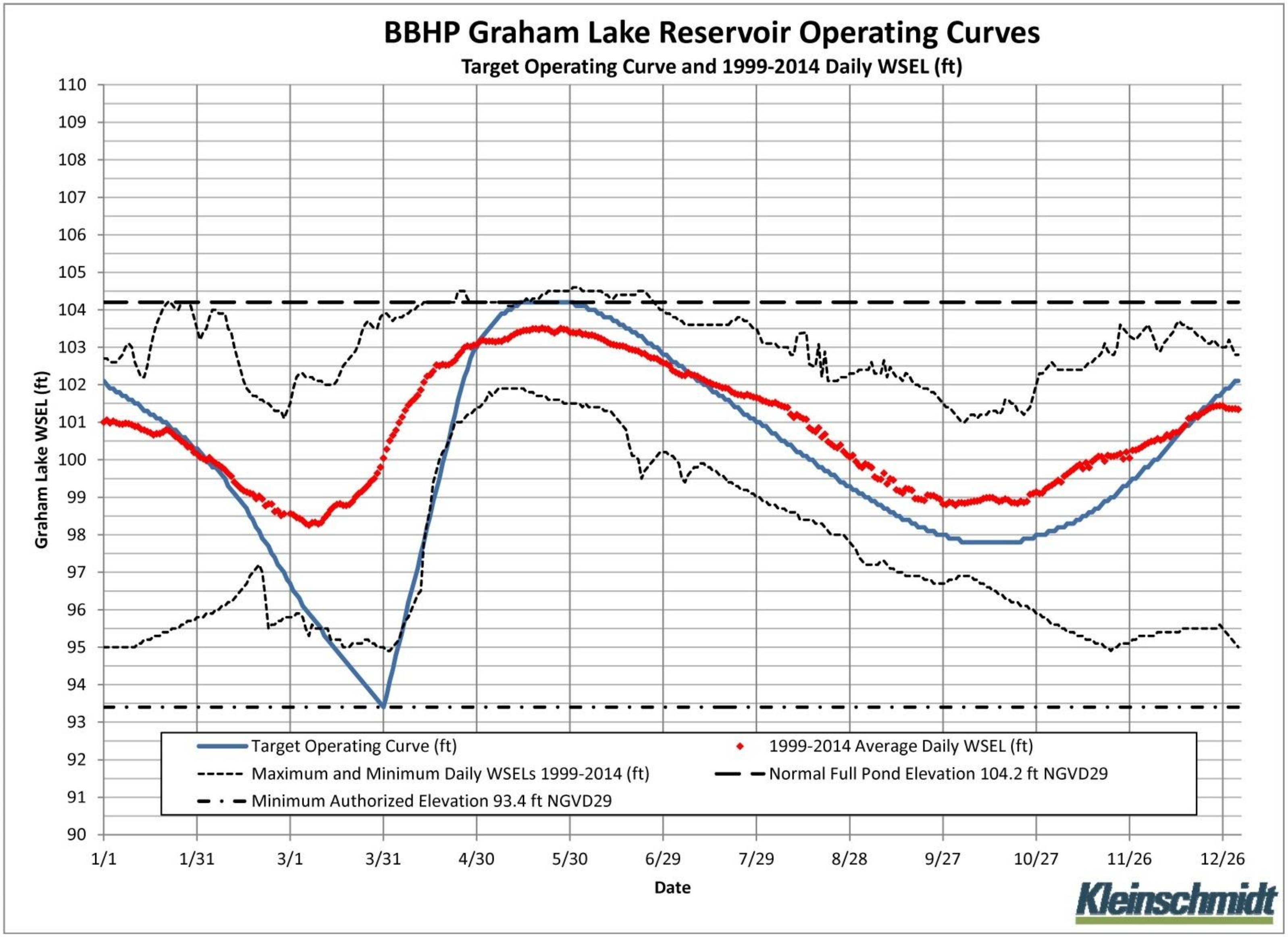


FIGURE 6
GRAHAM LAKE DAM FISH PASSAGE WEIR

3.2 Project Operations

The Ellsworth Project operates as both a water storage facility and as a peaking generation facility, depending on available inflows, while maintaining minimum flows. Timed releases at Graham Lake are used at Ellsworth Dam for power production. The releases may result in minor (approximately 1 foot) surface elevation variations in Lake Leonard. During high flow conditions, primarily in the spring and fall, the Project may operate at full load up to 24 hours a day. Graham Lake generally follows an operating curve that can result in fluctuations approaching 11 feet over the course of a year (Figure 7). As per Articles 401 and 402 of the 1987 Order Issuing New License, minimum flows and water levels are required and maintained by Black Bear. Article 401 specifies a continuous minimum flow release of 105 cfs from the Graham Lake Dam and Ellsworth Dam from July 1 through April 30 and a continuous minimum flow release of 250 cfs from May 1 through June 30 for the protection of fishery resources. Article 402 of the FERC license specifies that the licensee operates the Ellsworth Project so that the following water levels are maintained: Lake Leonard 1-foot fluctuation (65.7' to 66.7' msl) and Graham Lake 10.8-foot fluctuation (93.4' to 104.2' msl). Black Bear has proposed in the December 2015 application for new license to continue these fundamental operating parameters for the Ellsworth Project.

FIGURE 7
GRAHAM LAKE HISTORIC OPERATING CURVES



The Project's fish passage facilities are managed in consultation with the agencies[3] through the *Comprehensive Fishery Management Plan for the Union River Drainage 2000-2005*, which is updated every five years. The current plan covers the three year period of 2015-2017 due to the expiration of the Project license in December 2017 (URFCC 2015). In 2014, the upstream fishway was operated for river herring (alewife; blueback herring) stocking and harvesting beginning in early May through mid-June, and then Black Bear continued to operate the fishway through November 4 for Atlantic salmon (URFCC 2015). In 2015, Black Bear conducted an upstream Atlantic salmon passage evaluation and operated the fishway from May 1 through October 31[4]. The downstream fishways are operated from April 1 to December 31 annually, as river conditions allow. Also in 2015, Black Bear developed a site specific operation and maintenance plan for the fishways. The plan, which is consistent with the original design criteria for the fishways, includes a daily checklist that was instituted at the beginning of the 2015 season, and will be employed in future seasons to ensure that the upstream and downstream fishways are operating properly. The plan also includes both a list of spare parts critical to fishway operation and a checklist of proper fishway operating characteristics. In 2015, Black Bear hired dedicated staff to operate the project fish passage facilities; these staff were dedicated to fishway operations, oversight, fish trap tending, and transporting the fish upriver. These dedicated fishway staff completed the daily checklists and prepared weekly reports on fishway operations, which were provided to the fisheries management agencies throughout the fishway operational season.

3.3 Water Quality in the Project Area

The Union River watershed encompasses approximately 500 square miles in Hancock and Penobscot Counties and is Maine's 19th largest river (Baum 1982). The headwaters of the Union River are located in three principal tributaries, East, West and Middle Branches (see Figure 1). Of the three, the West Branch is the largest (175 mi^2) followed by the East (150 mi^2) and Middle

3 Includes NMFS, USFWS, and Maine DMR

4 Consistent with Maine DMR protocols, the fishway is not operated when temperatures exceed 23°C (73°F), which occurred sporadically in July and September and the majority of August. However, observations of the fishway entrance and tailwater areas were conducted routinely.

(45 mi^2) Branches. In total, there are approximately 484 miles of streams and 81 lakes and ponds within the watershed.

Maine statute 38 MRSA (§464-470) establishes the basis for the State's classification system of surface waters. The State has one water quality standard for lakes and great ponds (GPA) which includes inland bodies of water artificially formed or increased that have a surface area greater than 30 acres. Graham Lake is included in this classification. The Maine Department of Environmental Protection (Maine DEP) currently interprets the water quality statutes to classify Lake Leonard as a GPA water (K. Howatt, Maine DEP personal communication, June 16, 2015). There are four standards for the classification of fresh surface waters which are not classified as great ponds: Class AA, A, B, and C waters. The Union River from the outlet of Graham Lake to tidewater, excluding the impounded portion of Lake Leonard, is classified as Class B (38 M.R.S.A. §467.18.A (1)).

4.0 Listed Species Life History

4.1 Atlantic Salmon

Anadromous Atlantic salmon have a complex life history that includes spawning and rearing in freshwater rivers and streams, as well as extensive feeding migrations and sexual maturation in the marine environment (Fay et al. 2006). The freshwater juvenile stage of the life cycle can last from one to three years, after which juveniles undergo a physiological transformation (called smoltification) and migrate downstream to spend one to three years at sea, before returning to freshwater to spawn in their natal rivers. Unlike Pacific salmon, Atlantic salmon do not die after spawning, and can return to sea to repeat the migratory cycle.

Although spawning by Atlantic salmon does not occur until late October or November, most adult Atlantic salmon ascend rivers beginning in the spring. In the GOM rivers, the peak upstream migration occurs in June, but may persist until the fall (Fay et al. 2006). After fish enter the freshwater environment, they cease feeding and darken in coloration. Salmon that return early in the spring spend nearly five months in the river before spawning, seeking cool water refuges (e.g., deep pools, springs, and mouths of small cold-water tributaries) during the summer months (Fay et al. 2006). Following spawning, adults (referred to as "kelts") may move downstream in either the fall or the following spring, eventually reaching the estuary and ocean.

Once in the marine environment, these salmon resume feeding and a very small percentage may return as repeat spawners one to two years later.

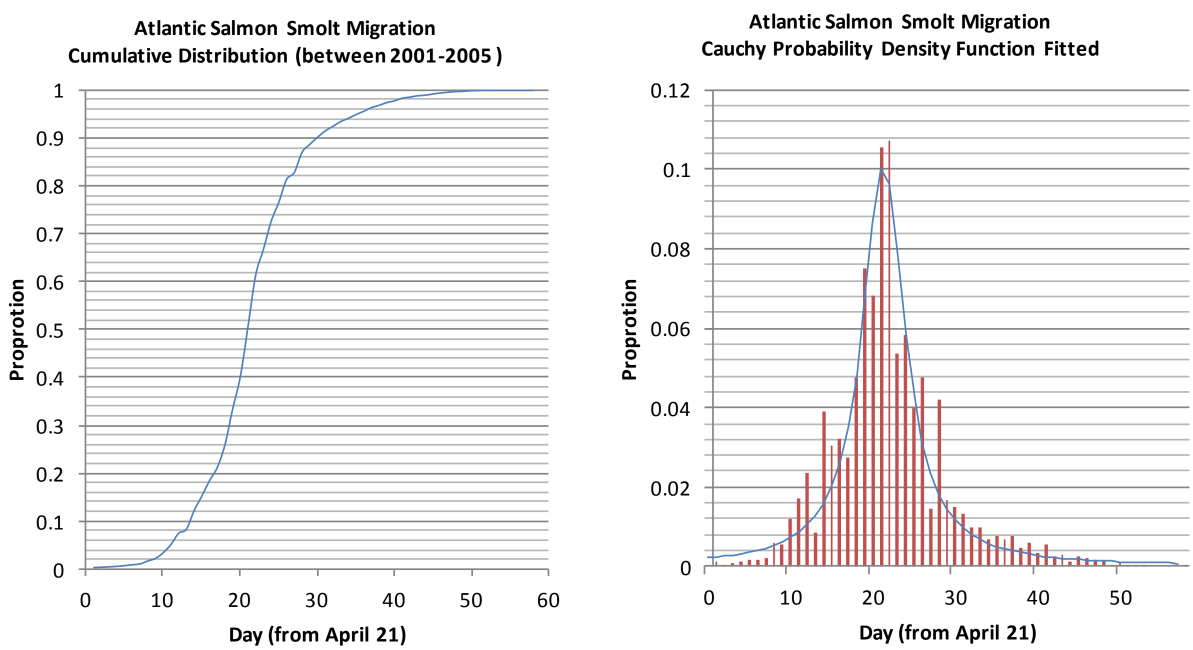
Preferred spawning habitat consists of gravel substrate with adequate water circulation to keep buried eggs well oxygenated. Water depth at spawning sites is typically 30 cm to 61 cm, and water velocity averages 60 cm per second (Fay et al. 2006). Spawning occurs from late October through November when water temperatures are roughly between 7.2°C to 10.0°C. The female uses its tail to scour or dig a series of nests in the gravel where the eggs are deposited; this series of nests is called a redd. One or more males fertilize the eggs as they are deposited in the redd. The female then continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel. A female salmon returning to spawn after spending two years at sea will produce approximately 7,500 eggs (Fay et al. 2006).

The eggs hatch in late March or April. At this stage, the young salmon are referred to as alevin or sac fry. Alevins remain in the redd for about six more weeks and are nourished by their yolk sac. Alevins emerge from the gravel in mid-May, and begin active feeding, at which time they are called fry (Fay et al. 2006). Within days, the salmon fry enter the parr stage, indicated by vertical bars (parr marks) visible on their sides. Parr prefer areas with adequate cover, water depths ranging from approximately 10 cm to 60 cm, water velocities between 30 cm and 92 cm per second, and water temperature near 16°C (Fay et al. 2006). Juvenile salmon are territorial and feed on a variety of aquatic invertebrates, including larvae of mayflies, stoneflies, chironomids, and caddis flies; aquatic annelids; mollusks; and numerous terrestrial invertebrate species that fall into the river (Fay et al. 2006). In fall as flows increase, and as temperature and day length decrease, parr often shelter in the substrate. Movement may be quite limited in the winter, but can occur, particularly if the formation of ice reduces available habitat (Fay et al. 2006).

After remaining in freshwater habitat for one to three years (typically two years in Maine), parr undergo a series of physiological, morphological and behavioral changes in a process called "smoltification." This transformation occurs in the spring and prepares the salmon "smolt" for its dramatic change in osmoregulatory needs that come with movement from a freshwater to marine environment (Fay et al. 2006). The smolt emigration period is rather short and lasts only two to three weeks for each individual (NMFS 2008). While not specifically assessed in the

Union River, naturally reared and wild smolts in Maine typically enter the sea during May to begin their ocean migration (Fay et al. 2006). In the Penobscot River, smolts migrate between late April and early June with a peak migration in early May (Fay et al. 2006). The majority of smolts migrate in a short period of time, as demonstrated by NMFS' Penobscot River smolt trapping studies conducted between 2000 and 2005. These data show that 74% of the downstream run occurs in 15 days in mid-May (Figure 8) and that the majority of the smolt migration appears to take place after water temperatures rise to 10°C (USFWS unpublished *cited in* Black Bear 2012). The USFWS conducted a review of literature regarding diurnal migration timing and found that a median of 80.7% of smolts migrated at night (USFWS unpublished *cited in* Black Bear 2012).

FIGURE 8
SMOLT MIGRATION TIMING IN THE PENOBSCOT RIVER, BASED ON NMFS SMOLT TRAPPING STUDIES BETWEEN 2001 AND 2005



Source: Review of NMFS' Penobscot River smolt trapping studies conducted between 2000 and 2005 - USFWS unpublished *cited in* Black Bear 2012.

Smolts have been documented to move through the Narraguagus River estuary (located in Downeast Maine) to the middle portion of the bay at 0.7 kilometers per hour (km/h) and 1.0 km/h in the outer Narraguagus Bay (Kocik et al. 2009). Overall, this study documented low survival between the estuary and open marine environment from 36% to 47% (Kocik et al. 2009).

Once in the ocean, Atlantic salmon become highly migratory, and undertake long migrations from their natal rivers (Fay et al. 2006). Major feeding areas in the ocean include the Davis Strait between Labrador and Greenland (USFWS and NMFS 2009). During their time at sea, Atlantic salmon undergo a period of rapid growth until they reach maturity and return to their natal river to complete the life cycle. Although the Gulf of Maine DPS yields the highest adult returns, millions of salmon are stocked annually, and these data indicate that freshwater and marine survival rates are extremely low (USFWS and NMFS 2009).

4.1.1 Recovery Plan Overview

Efforts aimed at restoring Atlantic salmon and their habitats in Maine have been underway for well over one hundred years. These efforts are supported by a number of federal, state, and local government agencies, as well as many non-governmental organizations. Major threats to Atlantic salmon "… continue to be impediments to fish passage; poor marine survival; water withdrawals; habitat degradation; poor water quality; recreational fishing mortality; disease and aquaculture impacts; and predation and competition" (Fay et al. 2006). The 2005 *Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon* for the originally listed GOM DPS (NMFS and USFWS 2005) presented a strategy for recovering Atlantic salmon and much of this strategy is carried over in the updated draft recovery plan (NMFS and USFWS 2015). This plan focused on reducing the most severe threats to the species and immediately halting the decline of the species to prevent extinction. The 2005 recovery program included the following elements:

- Protect and restore freshwater and estuarine habitats;
- Minimize potential for take in freshwater, estuarine, and marine fisheries;
- Reduce predation and competition for all life-stages of Atlantic salmon;
- Reduce risks from commercial aquaculture operations;
- Supplement wild populations with hatchery-reared DPS salmon;
- Conserve the genetic integrity of the DPS;
- Assess stock status of key life stages;
- Promote salmon recovery through increased public and government awareness; and
- Assess effectiveness of recovery actions and revise as appropriate (NMFS and USFWS 2005).

A wide variety of activities have focused on protecting and restoring GOM DPS Atlantic salmon. These activities include, but are not limited to:

- Hatchery supplementation;
- Removing unused dams or providing fish passage;
- Improving road crossings that block passage or degrade stream habitat;
- Protecting riparian corridors along rivers;
- Reducing the impact of irrigation water withdrawals;
- Limiting effects of recreational and commercial fishing;
- Reducing the effects of finfish aquaculture;
- Outreach and education activities; and
- Research focused on better understanding the threats to Atlantic salmon and developing effective restoration strategies (Trust 2008).

The interim recovery criteria from the critical habitat designation sets a minimum target of 500 wild adult returns and documented positive population growth (benchmark of threatened status) in each of the three SHRUs, which includes the utilization of critical habitat designated within Merrymeeting Bay, Penobscot Bay, and Downeast watersheds (NMFS 2009a). The longer-term recovery target is 2,000 wild adult salmon returns in each SHRU (NMFS 2009a). In light of the 2009 GOM DPS listing and designation of critical habitat, the Services have developed an updated recovery plan for the expanded GOM DPS of Atlantic salmon. The main objective of the draft 2011 *Atlantic Salmon Recovery Framework: Implementation Plan* is to increase the abundance and preserve genetic diversity of wild Atlantic salmon populations that demonstrate persistent growth in all three SHRUs (NMFS et al. 2011). The following Action Teams have been initiated to implement defined actions and assessments related to specific objectives of the draft recovery plan:

1. Marine and Estuary Action Team,
2. Connectivity Action Team,
3. Genetic Diversity Action Team,
4. Conservation Hatchery Action Team,
5. Freshwater Action Team,

6. Outreach and Education Action Team, and
7. Stock Assessment Action Team (NMFS et al. 2011).

The Stock Assessment Action Team was established to provide scientific review of action team actions and results. These teams were also carried forward under the new draft Recovery Plan (NMFS and USFWS 2015).

4.1.2 Union River Comprehensive Fisheries Management Plan

In 1997 a group of agencies and interested parties (Union River Stakeholders Group, including the USFWS and Maine DMR) signed an agreement for the purposes of addressing interim and long-term fisheries management in the Union River drainage, including the provision of fish passage at the Ellsworth Hydroelectric Project. The Stakeholders adopted the following Mission Statement:

> It is the goal of the Union River Stakeholders Group to achieve timely and effective restoration and/or management of populations of resident and self-sustaining diadromous fish in the Union River watershed, consistent with a comprehensive fishery management plan, and in a manner that balances the interests of the public, regulatory agencies, and the licensee of the Ellsworth Hydroelectric Project.

The Stakeholders agreed that they would develop a comprehensive, biologically-based plan, in order to support decisions on fishery management in the Union River.

The Union River Fisheries Coordinating Committee (URFCC), consisting of state and federal natural resource agencies and non-governmental conservation organizations[5]; as well as the City of Ellsworth; Black Bear; and interested members of the public, developed a comprehensive fishery management plan for the Union River. The plan consists of multi-year assessment cycles, beginning with 2000-2005. The most recent update to the plan (*Comprehensive Fishery Management Plan for the Union River Drainage, 2015-2017,* URFCC 2015) covers the period 2015-2017, due to the expiration of the Ellsworth Project license in December 2017. The current

5 The URFCC includes the USFWS, Maine DMR (former Maine Atlantic Salmon Commission), Maine Department of Inland Fisheries and Wildlife (Maine DIFW), City of Ellsworth, Union River Watershed Coalition, Union Salmon Association, the Maine Council of the Atlantic Salmon Federation, Black Bear, and interested members of the public.

plan identifies agency goals and objectives for diadromous and resident fish populations in the Union River drainage, and describes the various tasks and responsibilities related to the restoration and management of those resources, including stocking, habitat assessment, population monitoring, and fish passage.

4.2 Atlantic Sturgeon

The Atlantic sturgeon is a long-lived, late maturing, estuarine dependent, anadromous species. Information in the following subsections is taken from the 2007 Atlantic sturgeon status review (Atlantic Sturgeon Status Review Team 2007), unless otherwise noted. The species' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida. Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems. In some southern rivers, a fall spawning migration may also occur. A fall migration of ripening adults upriver in the Saint John River, New Brunswick is also observed; however, this fall migration is not considered a spawning run as adults do not spawn until the spring. Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers, where optimal flows are 46-76 cm/s and depths of 11-27 meters. Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18°C, respectively, and larvae assume a demersal existence. The yolksac larval stage is completed in about 8-12 days, during which time the larvae move downstream to rearing grounds over a 6-12 day period. During the first half of their migration downstream, movement is limited to night. During the day, larvae use benthic structure (e.g., gravel matrix) as refugia. During the latter half of migration when larvae are more fully developed, movement to rearing grounds occurs both day and night. Juvenile sturgeon continue to move further downstream into brackish waters, and eventually become residents in estuarine waters for months or years.

Upon reaching a size of approximately 76-92 cm, the subadults may move to coastal waters where populations may undertake long-range migrations. Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Subadult

Atlantic sturgeon transit between coastal and estuarine habitats, undergoing rapid growth. These migratory subadults, as well as adult sturgeon, are normally found in shallow (10-50 meters) near shore areas dominated by gravel and sand substrate. Coastal features or shorelines where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy, Massachusetts Bay, Rhode Island, New Jersey, Delaware, Delaware Bay, Chesapeake Bay, and North Carolina, which presumably provide better foraging opportunities. Despite extensive mixing in coastal waters, Atlantic sturgeon return to their natal river to spawn as indicated from tagging records and the relatively low rates of gene flow reported in population genetic studies. Males usually begin their spawning migration early and leave after the spawning season, while females make rapid spawning migrations upstream and quickly depart following spawning.

Atlantic sturgeon have been aged to 60 years, however, this should be taken as an approximation as the only age validation study conducted to date shows variations of ±5 years. Vital parameters of sturgeon populations show clinal variation with faster growth and earlier age at maturation in more southern systems, though not all data sets conform to this trend. For example, Atlantic sturgeon mature in South Carolina at 5-19 years, in the Hudson River at 11-21 years and in the Saint Lawrence River at 22-34 years. Atlantic sturgeon likely do not spawn every year. Multiple studies have shown that spawning intervals range from 1-5 years for males and 2-5 for females. Fecundity of Atlantic sturgeon has been correlated with age and body size (ranging from 400,000 - 8 million eggs). The average age at which 50% of maximum lifetime egg production is achieved is estimated to be 29 years, approximately 3-10 times longer than for other bony fish species examined (NOAA 2012a).

The GOM DPS includes all Atlantic sturgeon that are spawned in the watersheds from the Maine/Canadian border and extending southward to include all associated watersheds draining into the Gulf of Maine as far south as Chatham, Massachusetts (NOAA 2012a). Tagging and tracking data indicate that there is mixing of sturgeon from different DPSs throughout their marine range, and consequently, NMFS determined that the marine ranges for the five DPSs are the same: all marine waters, including coastal bays and estuaries, from Labrador Inlet, Labrador, Canada to Cape Canaveral, Florida (NOAA 2012a, 2012b).

4.3 Shortnose Sturgeon

The shortnose sturgeon is an endangered fish species that occurs in large coastal rivers of eastern North America. In the northern part of its range, the species is considered to be "freshwater amphidromous," meaning it spawns in freshwater, but regularly enters seawater during various stages of its life (NMFS 1998). Shortnose sturgeon are occasionally found near the mouths of rivers, and coastal migrations between the lower Penobscot River and the Androscoggin/Kennebec estuary (i.e., Merrymeeting Bay) have been documented (Zydlewski 2009, Fernandes et al. 2010). Juveniles typically move upstream in rivers in spring and summer, and downstream in fall and winter, but inhabit reaches above the freshwater - saltwater interface. Adults may move into higher salinity areas on a more regular basis (NMFS 1998).

Shortnose sturgeon are a long-lived species. The maximum documented age is 67 years for females, while males seldom exceed 30 years of age (NMFS 1987). In the northern part of their range, females do not spawn until about 18 years of age, while males spawn at about 12 years of age (NMFS 1987). Shortnose sturgeon females typically spawn every three to five years, while males may spawn as often as every one to three years (NMFS 1998). Spawning typically takes place in mid- to late spring when water temperatures reach 8-9°C; spawning ends when the water temperature reaches 12-15°C. Spawning may occur over a period of days to a few weeks. Overall spawning success can be negatively impacted if flows are unusually high during the spawning period (NMFS 1998).

Shortnose sturgeon typically seek the most accessible upstream areas for spawning, and may use a variety of micro-habitats. Channels appear to be important for spawning, which takes place over a variety of substrates (often gravel, rubble or boulders), in shallow to relatively deep water, and in moderate velocities (NMFS 1998).

Eggs are demersal and adhesive and remain near the spawning site. After eggs hatch, larval shortnose sturgeon are poor swimmers, and react negatively to light, instead seeking refuge among crevices and other cover on the bottom near the spawning site (NMFS 1998). After 9-12 days, the yolk sac is absorbed and the young sturgeon actively migrate downstream to locate suitable habitat. Young of year sturgeon typically inhabit deeper freshwater areas, and assume a more migratory behavior in the second summer of life (NMFS 1998).

Juvenile shortnose sturgeon (3 to 10 years old) typically inhabit the saltwater/freshwater interface in the lower reaches of rivers, foraging over fine-grained sand/silt/mud substrates. Juvenile and adult sturgeon can often use the same micro-habitats (NMFS 1998).

Adult shortnose sturgeon often inhabit short reaches of rivers, or concentration areas in summer and winter, where depth, velocity and substrate conditions combine to create favorable habitat for freshwater mussels, a preferred food item. Shortnose sturgeon will also forage in backwaters and in tidal channels under various levels of salinity (NMFS 1998).

Shortnose sturgeon are considered to be omnivorous. Juvenile sturgeon feed on a variety of benthic aquatic invertebrates (crustaceans, insects, worms, mollusks); adults show a preference for mollusks (NMFS 1998).

5.0 Presence of Listed Species in the Project Area

5.1 Atlantic Salmon

Runs of Atlantic salmon and other anadromous fish were once common in the Union River (Havey 1961), but disappeared in the late 1700s and early 1800s with the construction of dams in the lower portion of the river. Dams at outlets of many of the lakes and ponds in the drainage prevent full access of migratory fish to historical habitat (URFCC 2010).

Annual releases of hatchery-reared Atlantic salmon smolts (one- and two-year old fish) began in the Union River in 1971, and were continued until 1991, when stocking was suspended due to funding reductions and a redirected focus on wild salmon rivers and the Penobscot River (USASAC 1992). In the last 10 years of the broodstock program of that period, an average of approximately 36,000 smolts were stocked annually. Since 1993, there has been sporadic stocking of salmon fry and parr by the USFWS in the Union River in an effort to continue the restoration effort (Table 2).

In 2011, 19,000 fry and 282 excess brood stock (pre-spawn) were stocked in the West Branch Union River in Amherst (URFCC 2015). Spawning activity was assessed through redd counts near the release location, and over 200 redds were well distributed through the area (Figure 9). Fry stocking did not occur the next two years because of this natural reproduction. The Union

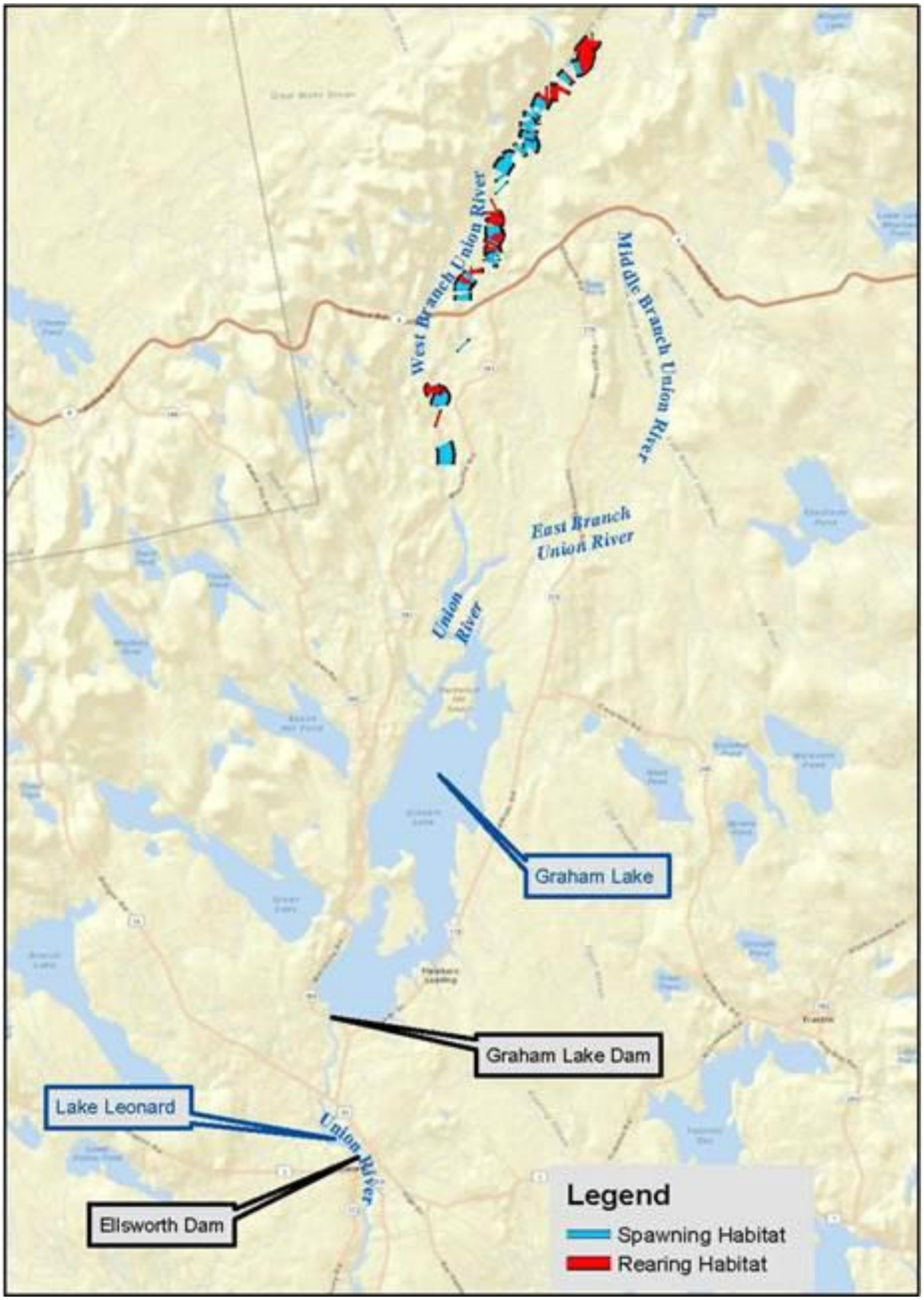
River Salmon Association resumed fry stocking in 2014, which will continue until at least 2017 (URFCC 2015).

TABLE 2
NUMBER OF ATLANTIC SALMON STOCKED
BY LIFE STAGE IN THE UNION RIVER

Year	Fry	0 Parr	1 Parr	2 Parr	1 Smolt	2 Smolt	Adult
1971-2001	425,000	371,400	0	0	379,700	251,000	0
2002	5,000	0	0	0	0	0	0
2003	3,000	0	0	0	0	0	0
2004	3,000	0	0	0	0	0	0
2005	2,000	0	0	0	0	0	0
2006	2,000	0	0	0	0	0	0
2007	22,000	0	0	0	0	0	0
2008	23,000	0	0	0	0	0	0
2009	28,000	0	0	0	0	0	0
2010	19,000	0	0	0	0	0	0
2011	19,000	0	0	0	0	0	282
2012	Natural recruitment from 282 adult spawners stocked in September, 2011 – no fry stocking						
2013	Natural recruitment from 282 adult spawners stocked in September, 2011 – no fry stocking						
2014	23,000	0	0	0	0	0	0

Source: URFCC 2015.

FIGURE 9
MAP SHOWING LOCATION OF SALMON REDDS
OBSERVED IN THE UNION RIVER IN 2011



Note: Red circles indicate location of redds, numbers to the right of circles indicate the number of redds at that location. Not all numbers are visible due to map scale. Source: URFCC 2012.

Completion of the fish trap at the Ellsworth Dam in 1974 aided in the collection of returning adult salmon; however, the effectiveness of the facility had initially been hampered by inadequate attraction flow and other operational problems, all of which have been improved in recent years (URFCC 2015). Adult Atlantic salmon returns to the Union River are shown in Table 3. Prior to aquaculture development in nearby marine areas, salmon origin was determined by fin condition and general appearance; however, this does not conclusively discriminate between aquaculture escapees and hatchery origin salmon. Large numbers of apparent aquaculture escapees were caught in 1996, but not verified with scale analyses.

Since 1999, the resource agencies have examined scale samples from each adult salmon returning to the Union River to determine origin. The assessments of salmon origin show that returns to the Union River since 1993 (i.e., following cessation of the broodstock program) consist of a few hatchery origin strays and a few wild or fry stocked salmon. The latter include salmon that originated from fry stocking, natural reproduction, or wild/fry stocked strays from other rivers. A few strays into the Union River that originated from the Penobscot River, or from the other eastern Maine rivers, is consistent with the homing and straying behavior of Atlantic salmon and the typical rate of straying described in the Status Review (i.e., 2% (Fay et al. 2006). The limited amount of stocking and natural spawning for a number of years has resulted in a near absence of sea-run salmon returns since 2003 (URFCC 2015). Between 2006 and 2011, no salmon returned to the Union River. Since then, three aquaculture escapees (non-GOM DPS salmon) were captured in 2012, one salmon (wild) returned in 2013, and two (one wild and one hatchery[6]) in 2014 (Table 3) (URFCC 2015). The 2014 suspected hatchery stray was released downstream of the Project. In 2015, the upstream fishway was operated four times per day for an extended period from May 1 to October 31; no Atlantic salmon were observed.

6 Wild and hatchery Atlantic salmon returning to the Union River are considered part of the GOM DPS.

TABLE 3
UNION RIVER SALMON RETURNS BY ORIGIN

Year	Aquaculture*	Hatchery	Wild	Total
1973 - 1986	0	1,892	4	1,896
1987	undetermined	63	0	63
1988	undetermined	45	2	47
1989	undetermined	30	0	30
1990	undetermined	21	0	21
1991	undetermined	2	6	8
1992	undetermined	4	0	4
1993	undetermined	0	0	0
1994	undetermined	0	0	0
1995	undetermined	0	0	0
1996	undetermined	68	1	69
1997	undetermined	8	0	8
1998	undetermined	13	0	13
1999	63	6	3	72
2000	3	2	0	5
2001	2	0	0	2
2002	6	5	0	11
2003	0	1	0	1
2004	0	1	1	2
2005	4	0	0	4
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	3	0	0	3
2013	0	0	1	1
2014	0	1	1	2
2015	0	0	0	0
TOTAL 1995 - 2015	81	105	7	193

Source: URFCC 2015 and Maine DMR 2015
Note: Salmon returns before 2000 included rod and trap captures..

The Union River has about 12,000 units of historic spawning and rearing habitat, of which 4,062 units are considered occupied and functional spawning and rearing habitat (NMFS 2009a). Most (67%) of the potential Atlantic salmon habitat is located in the West Branch of the Union River, based on surveys that were conducted in the late 1950s (Havey 1961; Baum 1982)[7]. The main stem of the river and tributaries (above Ellsworth Dam) account for 16% of the salmon habitat, with the balance occurring in the East Branch (13%) and Middle Branch (3%) of the system. Using an assumed production of 3.0 smolts/100 square yards of stream bottom, and a marine survival of 1-3%, the habitat in the Union River above Ellsworth could generate a self-sustaining run of about 250-750 salmon (Baum 1997). Additional production of adult salmon could result from fish spawning in three minor tributaries below the Ellsworth Dam (Meadow Stream, Patten Stream, and Card Brook).

5.2 Atlantic Sturgeon and Shortnose Sturgeon

Atlantic sturgeon have been observed in the Union River below Ellsworth Dam, according to state fishery personnel. The status of the population of Atlantic sturgeon and shortnose sturgeon, which may also occur in the river, is unknown at this time (URFCC 2010). In the Status Review of Atlantic sturgeon, it was noted that, "The geomorphology of most small coastal rivers in Maine is not sufficient to support Atlantic sturgeon spawning populations, except for the Penobscot and the estuarial complex of the Kennebec, Androscoggin, and Sheepscot Rivers", though subadults may use the estuaries of smaller coastal drainages during the summer months (Atlantic Sturgeon Status Review Team 2007). Zydlewski et al. (2011) found that shortnose sturgeon use small coastal rivers as they migrate between the Kennebec and Penobscot Rivers. However, only one shortnose sturgeon and no Atlantic sturgeon tagged at other locations have been detected by the acoustic receivers deployed in the lower Union River (Pers. Comm., G. Zydlewski, UMaine, July 9, 2014 and August 20, 2015). From review of the limited bathymetry data of the original river channel that has been inundated by Lake Leonard, there may be steep gradient reaches that would have historically kept Atlantic and shortnose sturgeon from accessing the Union River above the site of the Ellsworth Dam.

7 As noted, in 2011, 19,000 fry and 282 excess brood stock (pre-spawn) were stocked in the West Branch Union River in Amherst (URFCC 2015). Spawning activity was assessed through redd counts near the release location, and over 200 redds were well distributed through the area (Figure 8).

6.0 Potential Effects on Listed Species

6.1 Atlantic Salmon

The following sections discuss the relevant life stages potentially affected by the Ellsworth Project and evaluate what the potential Project effects are on those life stages of Atlantic salmon. As discussed above, regular stocking of Atlantic salmon smolts in the Union River was suspended in 1991, and since then, there has been only limited stocking of salmon fry or parr in the Union River. Also, in 2011 adult salmon (excess broodstock) were stocked in the river. A total of three GOM DPS Atlantic salmon have returned to the Union River in the last ten years, all of which were in 2013 and 2014 (URFCC 2015, Maine DMR 2015).

The following sections examine Project effects related to connectivity (i.e., upstream and downstream passage of adult and juvenile salmon), tributary access, and habitat suitability. The effects of predation on juvenile and adult salmon are also discussed.

6.1.1 Life Stage Assessments of Project Interactions

Very few Atlantic salmon have returned to the Union River in the last ten years, and little information is available on how Atlantic salmon have historically used the Union River habitat. Ellsworth Dam is located at the upper limit of tidal influence of the Union River, and there is no documented salmon spawning and rearing habitat downstream of the Project. The Union River in the Project area serves as a migration corridor to suitable habitat upstream of the Project. Thus, the life stages of Atlantic salmon that could be affected by the Project include adults migrating upstream to spawn and downstream migrating smolts and kelts (Fay et al. 2006). Potential effects to salmon are lessened at the Ellsworth Project, because the Project provides upstream fish passage (vertical slot upstream fish passage and trapping facility) and downstream fish passage (downstream fish bypass facility integral at each dam). The fish passage facilities are managed in consultation with the agencies through the *Comprehensive Fishery Management Plan for the Union River Drainage 2015-2017*.

6.1.2 Upstream Passage

The fish passage facility at the Ellsworth Project is designed to trap Atlantic salmon and other anadromous fish and to transport fish to suitable upstream habitat located above the Project dams. The fishway is managed in consultation with the agencies through the management plan, and historically, Maine DMR has annually directed Black Bear whether to transport any returning adult Atlantic salmon upstream of the Project. The vertical slot upstream fish passage and trapping facility at the Project has a positive effect on the Atlantic salmon GOM DPS, as it increases habitat connectivity in the event migrating adults seek to enter the Union River searching for access to suitable spawning habitats. Some potential negative effects from the trapping, trucking, and transporting of adult Atlantic salmon include migration delay/interruption, and handling and holding stress or injury. While specific empirical studies of the upstream passage effectiveness for adult Atlantic salmon at Ellsworth have not been conducted to date, primarily due to a lack of available study fish, an Upstream Atlantic Salmon Passage Study was conducted in 2015 to evaluate whether increased operations at the trapping facility may increase the capture of adult Atlantic salmon. The trap was operated from sunrise to sunset from May 1 to October 31 and checked at least four times a day. No Atlantic salmon were collected or observed.

Hydroelectric facilities may result in delays of upstream migration of Atlantic salmon. Several studies on the Penobscot River have evaluated upstream passage behavior, including the time needed for individual adult salmon to pass upstream of various dams once detected in the vicinity of a spillway or tailrace. These studies have documented certain migratory behaviors that may contribute to migration delays, including frequent upstream and downstream movement, periods of holding in fast water, seeking thermal refuge in tributaries, attraction to spillage at dams, reduced migratory behavior in late summer, and inhibited movement at temperature above 23°C (Power and McCleave 1980, Shepard 1995). However, upstream passage is site specific, and the findings from passage studies conducted in the Penobscot River or other rivers may not be applicable to the Ellsworth Project.

As part of the ongoing relicensing of the Project, Black Bear reviewed historic information relating to operations and environmental conditions during historic captures of Atlantic salmon to assist in evaluating the efficacy of the trap and truck facility and operations (Black Bear 2014). Recorded data on fishway operations when salmon were captured was available for years 2002 to 2005. There were no apparent trends in salmon captures and flow conditions, as salmon were collected over a wide range of river flows from summer flows as low as 48 cfs to the higher

June flow of 937 cfs. Salmon were also captured over a range in temperatures up to 74°F. The fish trap was not operated when water temperatures were at or exceeded 77°F as per direction from Atlantic Sea-Run Salmon Commission and Maine DMR protocol. Temperatures in the upper seventies are more typical of late summer when salmon are not expected to be entering the river, or would be expected to be holding in thermal refugia. The current Maine DMR protocol is to not handle Atlantic salmon at fish passage facilities when the river temperature exceeds 73°F. While there is a low probability of salmon captures when water temperature exceeds 73°F (few salmon have been collected in the Union River at or above this temperature historically), Black Bear plans to modify its operational and handling procedures in case such a situation occurs in the future.

Using an assumed production of 3.0 smolts/100 square yards of stream bottom, and a marine survival of 1 - 3 %, Baum (1997 *cited in* URFCC 2010) estimated the habitat in the Union River upstream of the Ellsworth Project could generate a self-sustaining run of about 250 - 750 Atlantic salmon. It should be noted however, current marine survival has been estimated to be lower, 0.09 to 1.02%, from 1995 to 2004 (ICES 2008 *cited in* USFWS and NMFS 2009), which would result in a run of approximately 250 or less fish, given that this survival range is on the lower end or less than Baum (1997) used.

Fisheries management agencies have expressed a concern for the safe, timely, and effective passage of Atlantic salmon, especially during river herring harvest operations, and the potential for migration delay due to fishway crowding or infrequent trap and transport operation. Under current operations, the trap and hopper are visually inspected for Atlantic salmon and if one is spotted, the hopper is left in the water and the salmon is dip-netted out and placed in a holding tank. The salmon is then measured, examined for fin clips, fin wear, or other markings, a scale sample is taken, and the magnified scale image and fish photo is digitally captured. This information is transmitted to the Maine DMR who then determines whether the Atlantic salmon caught in the fishway is to be released downstream of the Ellsworth Dam (hatchery or aquaculture escapees), moved via transport tank truck upstream (wild origin) and released in the West Branch of the Union River, approximately 17 miles upstream, or removed. Generally this process takes one to two hours, and in the case of wild Atlantic salmon, they arrive in upstream habitat more quickly than if they had passed volitionally and swam the entire distance.

The current trap and transport facilities and operating protocols at Ellsworth have provided for the handling of 190,000 to 1,200,000 river herring and 0 to 8 Atlantic salmon annually from 2000 to 2015. The Ellsworth trap and transport facility was originally designed and operated to pass Atlantic salmon. Historically, this facility has handled up to 263 adult Atlantic salmon broodstock in a year, including times concurrent with alewife harvesting. Black Bear examined the Ellsworth fishway hopper capacity for salmon with regard to the estimated maximum self sustained run size of 750 Atlantic salmon (Baum 1997 *cited in* URFCC 2010), and found that the Ellsworth lift hopper has more than four times the required capacity to pass a run of 750 Atlantic salmon (Black Bear 2014). Further, Black Bear conducted an Upstream Fish Passage Alternatives Analysis that evaluated the adequacy of the existing fishway facility to handle design populations of multiple species and potential fishway modifications and alternative designs (included as an appendix to the December 2015 License Application). Trap and transport systems have been used successfully to pass other species such as for the shad restoration on the Susquehanna River and the river herring restoration in the Sebasticook River. Sigourney et al. (2015) evaluated trap and transport of Atlantic salmon on the Penobscot River and found it was an effective means to increase migration success. Black Bear will continue to consult with fisheries management agencies on the need for and, if necessary, the design of upstream fish passage improvements based upon the results of the relicensing studies and future management plans to be published by the fisheries management agencies.

A concern was also expressed for peaking flow effects on aquatic habitat and upstream passage effectiveness downstream of the Ellsworth Dam. In regards to upstream passage effectiveness, the one consistent observation made throughout the upstream fish passage study (Black Bear 2014 and 2015) was that fish (river herring) occurrence and densities were higher in the afternoon and evening (prior to sunset) hours, and on incoming tides. A review of project operations/ river flow data did not suggest the fish migration or fishway numbers responded to changes in flow from the Project. Because river herring can access the river below Ellsworth Dam, it is expected that turbine discharge would not affect other diadromous fish from accessing Ellsworth Dam.

6.1.3 Downstream Passage - Smolts

The downstream fish passage facilities at each Ellsworth Project dam consist of stop-log controlled surface weirs, leading to a plunge pool immediately downstream of each dam. The downstream fish passage weirs have historically been operated from April 1 to December 31 each year, as river conditions allow.

The presence of dams can potentially result in downstream migration delays (discussed in a following section). Also, if salmon pass through the turbines, there is a risk of injury or mortality from blade strike or other factors. Because of the few salmon returns, the limited amount of juvenile stocking efforts, and the resulting low numbers of smolts that would be expected to occur in the river, no survival studies have yet been conducted in the Union River. In a 2014 relicensing study, Black Bear conducted a desktop fish entrainment and downstream passage assessment (referred to as the Downstream Fish Passage Study [Black Bear 2014]) to evaluate downstream passage at the Project for Atlantic salmon smolts and kelts (along with other species), including the potential for entrainment, turbine-induced mortality, migratory route selection, and whole station survival.

The results of the 2014 desktop entrainment study (Black Bear 2014) predicted that salmon smolts would not be excluded by, or impinged on, the trashracks, because their maximum reported sizes are smaller than the minimum estimated exclusion size; however, it is expected that the trashracks still provide some level of deterrence due to the presence of the structures (Fay et al. 2006; Alden 2012; Brown et al. 2009). Smolt burst speeds and average intake velocities at the trashracks at Ellsworth Dam were evaluated to predict the ability of smolts to avoid entrainment. Table 4 displays the calculated intake approach velocities in front of the traskracks for each unit at the Ellsworth Dam. Smolt burst speeds have been observed at around 6.0 feet per second (Peake et al. 1997), suggesting that smolts can easily avoid involuntary entrainment (Black Bear 2014). Sustained swim speeds of smolts have been observed at 1.6 feet per second (Booth et al. 1997).

TABLE 4
ELLSWORTH TRASHRACK SPACING AND CALCULATED INTAKE VELOCITIES

Parameter	Unit 1	Unit 2*	Unit 3	Unit 4
Trashrack Clear Spacing (in)	2.44	1.00 (top)/2.37(bottom)		
Approach Intake Velocity (feet/s)	1.16	2.97	2.97	2.79

* It is important to note that the Unit 2 and 3 trashracks start 7.8 feet below the normal full pond headwater elevation of 66.7 ft (first 7.8 feet is concrete), then has 1-in clear-space trashracks between 7.8 and 14.0 feet before the trashrack clear-spacing increases to 2.37 inches below 14.0 feet deep. The Unit 4 trashracks start 5.7 feet below the normal headwater elevation of 66.7 ft (first 5.7 feet is concrete), then has the same clear-spacing sizes at slightly different depths.

Black Bear collected field measurements in front of the trashracks at the Ellsworth Dam intakes to provide a more detailed understanding of intake velocities. Velocity measurements were also taken at the three entrances of the Ellsworth dam downstream fish bypass. Researchers took 240 water velocity measurements at 93 discrete positions in front of the trashracks at Units 2, 3, and 4 (Table 5). Measurements were not taken in front of the Unit 1 intake because it is only accessible by diving. Velocity measurements at Unit 4 are considered to be representative of the velocity in front of Unit 1 because of the similarity between the units. Average water velocity ranged from -0.13 to 2.43 feet per second (fps). All velocity values in the upper 14 feet (with 1-inch spacing) were below 2 fps and 87% of all intake velocity values were less than 2 fps. Most of the higher velocity values were at water depths of 15 feet or more, below where most surface oriented fish would pass. The measurements were fairly uniform across the face of the racks, demonstrating that the variation in trashrack spacing combined with flows through the downstream fish bypass entrances does not create abnormal flow vectors in the intake area which is sometimes identified as an important threshold for evaluating entrainment risk for some fish species.

TABLE 5
VELOCITIES MEASURED AT ELLSWORTH TRASHRACKS.

Unit Number	Unit 2	Unit 3	Unit 4	All Units
No. of positions on rack face	22	36	35	93
Minimum average velocity (fps)	0.10	-0.13	0.49	-0.13
Maximum average velocity (fps)	2.27	2.08	2.43	2.43

The field measurements of intake approach velocity were taken from the trash rake, which results in measurements at a position in front of the trash racks (approximately 3 feet in front of racks), while the calculated approach velocity was estimated at the trash rack face. Since approach velocity decreases with increasing distance from the racks the difference between calculated and field measured velocity is reasonable and suggests consistency between methods. The lower than estimated velocities in front of the 1-inch racks in the upper 14 feet of the intake are consistent with the reduced clear space for water to flow through the racks and should result in reduced entrainment levels for surface oriented fish.

The Downstream Fish Passage Study also estimated entrainment risk through the evaluation of species presence in the basin, outmigration periodicity, and downstream fish passage operations at the Project. There are currently very few salmon (smolts and kelts) expected to occur at the Project that would be at risk for entrainment. However, if the salmon run size increases, then smolts are predicted to have a moderate risk of entrainment due to their smaller size and ability to pass through the trashracks. Blade strike survival rates were estimated as part of this study, which were 96.1% for smolts entrained through Units 1 and 4, and 93.3% for smolts entrained through Units 3 and 4 (Black Bear 2014).

Spillway survival, as well as bypass survival and effectiveness, were also estimated as part of the Downstream Fish Passage Study. This was done by evaluating empirical data available from other hydropower projects with similar characteristics to make predictions at the Graham Lake Dam and Ellsworth Dam. Smolts were predicted to have high survival through the Graham Lake Dam taintor gates (99.6%) and surface weir (100%). High smolt survival rates were also predicted at the Ellsworth spillway (97.1%) and surface weir (99.0%). Whole station bypass effectiveness at Ellsworth was estimated to be 34.0%. Whole station survival for smolts was estimated to be 95.1 to 95.6% for smolts passing Ellsworth Dam, and 94.7 to 95.2% for smolts passing both Project dams (Table 6).

TABLE 6
ATLANTIC SALMON WHOLE STATION SURVIVAL ESTIMATES AT THE PROJECT

Target Species	Size Range (in)	Outmigration Months	Ellsworth Development Total Survival			Cumulative Total Project Survival[1]		
			Exceedance Flow (%)[2]			Exceedance Flow (%)[2]		
			75%	50%	25%	75%	50%	25%
Adult Salmon	25-32	April-May and October-November	99%	99.0%	99.0%	98.5%	98.5%	98.5%
Salmon Smolts	5-8	April-June	95.1%	95.1%	95.6%	94.7%	94.7%	95.2%

[1]Cumulative survival includes survival through the Graham Lake Dam Taintor gates and Ellsworth Development.
[2] Varying inflows representing a dry, wet, and normal year were applied to this evaluation, which translated into using the 75%, 50%, and 25% monthly exceedance flows.

Indirect survival, or delayed mortality, has been evaluated at some west coast projects. Alden (2012) used results from these studies that averaged 93% for indirect survival, and based on professional judgment, suggested that indirect survival would be 95% for Atlantic salmon passing the Penobscot River hydroelectric projects in Maine, due to the low head relative to the west coast projects where the studies were performed. There is considerable uncertainty regarding how to assess indirect survival, given the difficulty in measuring it (NMFS and USFWS 2015). NMFS noted this in its Biological Opinion for evaluating project effects to Atlantic salmon for Black Bear hydroelectric projects on the Penobscot River (NMFS did not attempt to quantify delayed mortality) (NMFS 2012). The results of some more recent studies conducted on the Penobscot River system have attempted to quantify differences in survival for smolts migrating through free-flowing river reaches and impounded river reaches (Holbrook et al. 2011, Stich et al. 2015a) and decreased estuarine survival for smolts migrating past multiple dams (Stich et al. 2015b). However, challenges remain in regards to quantifying delayed or indirect mortality and therefore neither was included as part of this analysis, rather only direct survival was evaluated past Ellsworth Dam, in addition to passage through Graham Lake Dam (Black Bear 2014).

In order to examine the effectiveness of the downstream passage facilities at Ellsworth, and in accordance with the December 30, 2014 Determination on Requests for Study Modifications and New Studies for the Ellsworth Hydroelectric Project by FERC, Black Bear developed a study plan in consultation with the agencies, to conduct a field study in 2016 to evaluate the effectiveness of downstream passage of Atlantic salmon smolts at the Ellsworth Project. The study plan was filed with FERC on March 31, 2015 and approved by Order from the FERC dated April 21, 2015. This study will monitor tagged salmon smolt passage through the Project area (from upstream of Graham Lake) using radio telemetry tags and monitoring gear, and passage survival at the Ellsworth Dam using acoustic tags and receivers maintained by NFMS downstream of the dam. The field study is planned for spring 2016, pending receipt of all required permits and approvals.

6.1.4 Downstream Passage - Kelts

No information on Atlantic salmon kelt presence is available for the Ellsworth Project, but based on evaluations on the Penobscot River, presented below, it is assumed that kelts at Ellsworth would pass over the spillways, through the downstream bypasses or, depending on trashrack spacing, through turbines during outmigrations. Kelt abundance at the Project is very low, given very few adult salmon have returned to the Union River in the last ten years, and only 288 adults (pre-spawn broodstock) have been stocked in the West Branch of the Union River, all in 2011.

Downstream passage success of kelts was assessed on the Penobscot River at Weldon Dam and several other sites in the lower Penobscot River (GNP 1989, Shepard 1989, Hall and Shepard 1990). The study fish were hatchery kelts that were tagged and released in the spring and the kelts tended to move downstream with high flows in early spring (mostly April through early May). Some of the adult salmon tagged at Weldon Dam during the fall upstream spawning migration returned downstream after spawning, and several of these pre-spawn tagged salmon returned downstream prior to spawning, indicating they may have been imprinted on other areas in the watershed and were trying to locate these areas (GNP 1989).

Kelt studies in the lower Penobscot River documented that most kelts passed the dams during high flow periods, typically over the spillways, but also through gates and sluices (Hall and Shepard 1990). The initial approach of kelts at the Veazie and Milford Dams reflected the distribution of flow, which means the proportion of kelts that approached spillways was highly correlated with spillway flow. Similarly, at the confluence of the Stillwater Branch and the main stem, kelts followed the routes in approximate proportion to flow in the two channels (Shepard 1989). Kelts that approached powerhouse intakes were deterred by trashracks and sought alternative routes of passage, typically passing via spillage after hours to days at the site (GNP 1989, Hall and Shepard 1990) and there were no mortalities in the two years of study (Hall and Shepard 1990).

In 2010, eight fish that migrated downstream of Veazie Dam were recaptured 17 days after being released in the Piscataquis River, and "appeared in excellent condition and showed no adverse effects from passing downstream over multiple (seven) dams" (Spencer et al. 2010, 2011). It should be noted that in normal flow years the Ellsworth Project spills about 11% of the time in May, while it spills about 21% of the time in April. In addition, the fish passage weirs are each passing approximately 50 cfs continuously during this period.

From the 2014 desktop Downstream Fish Passage Study (Black Bear 2014), Atlantic salmon kelts are expected to be fully excluded by trashrack spacing at the Project (2.44 inch clear space at Unit 1, and 1.0 inch on the top half, and 2.37 inches on the bottom half on Units 2, 3, and 4). This finding is supported by a downstream passage assessment conducted by Alden (2012), which suggests 100% kelt exclusion at Maine hydroelectric projects with trashrack clear-spacing less than 2.4 inches. Kelts could experience impingement on trash racks if hydraulic conditions exceed the kelt's swimming capabilities, however, according to observed burst swim speeds of adult salmon ranging from 16.5 to 19.7 feet per second (Wolter and Arlinghaus 2003), salmon kelts can easily avoid involuntary entrainment or impingement, and have no risk of entrainment due to their inability to pass through trashracks less than 2.4 inches (Alden 2012), and would likely have a 100% bypass effectiveness rate at the Project (via downstream bypass, or over the spillway if spill is occurring). Whole station survival estimates are presented above in Table 6.

6.1.5 Migration Delay

Smolt migration from freshwater to estuarine environments must be completed during a brief period of suitable environmental conditions—what researchers have termed a "smolt window"—or they may suffer irreversible effects that reduce their survival upon entering seawater (McCormick et al. 1999). Studies of Atlantic salmon smolt migration at other locations have documented certain migratory patterns, diel behaviors, responses to hydroelectric project structures, and effects of water temperature and river flow.

Smolt migration is primarily nocturnal in the early phases of the run (Ruggles 1980, Mudre and Saunders 1987, Shepard 1991). During the later phases of the smolt run, smolts exhibit movements throughout the day. During daylight, smolts generally cease migrating and hold station to avoid predators, most of which use vision to locate their prey. Daytime holding habitats tend to have characteristics similar to large parr habitats (i.e., moderate velocity, shallow depth and large substrates), when these habitats are available (BPHA 1994).

Barriers may affect the timing of the smolt migration. Migrating fish that do not reach the sea within the physiological smolt window may start reverting to the parr condition (Hoar 1988; Nielsen et al. 2001; Shrimpton et al. 2000). Thus, any significant delay of smolts may result in fish either becoming residents or reaching the estuary in sub-optimal physiological condition (McCormick et al. 1998; Shrimpton et al. 2000). Late migrants lose physiological smolt characteristics due to high water temperatures during spring migration (McCormick et al. 1999).

The onset of the smolt migration has often been linked to a thermal threshold of 10°C, although the rate of increase may be a more important environmental stimulus than the absolute temperature (Jonsson and Ruud-Hansen 1985). While not specifically assessed in the Union River, naturally-reared and wild smolts in Maine typically enter the sea during May to begin their ocean migration (Fay et al. 2006). In the Penobscot River, smolts migrate between late April and early June with a peak migration in early May (Fay et al. 2006). The peak of movement shifted from year to year in response to environmental conditions (Bakshtansky et al. 1976, Jonsson and Ruud-Hansen 1985). Smolt migratory movement is a combination of passive entrainment with flow, particularly in areas of high water velocity, and active swimming (Ruggles 1980). Active swimming speeds may exceed 1 meter per second for prolonged periods (Vanderpool 1992, Shepard 1993) and can include directed movement through very large lakes and reservoirs in the absence of rheotactic cues (Bourgeois and O'Connell 1986).

At the Ellsworth Project smolts may pass the project facilities through a combination of routes. At the Graham Lake dam smolts may pass either via the dedicated passage weir, or via the Tainter gates when they are open. At the Ellsworth dam smolts may pass via the three dedicated passage weirs, via spill depending on operations/river flow, or via the turbines. A Downstream Atlantic Salmon Smolt Passage Study will be conducted in the spring of 2016 to evaluate smolt passage through the project area and past the project facilities.

No information on Atlantic salmon kelt migration is available for the Ellsworth Project, but evaluations were conducted on the Penobscot River. Current Maine DMR research tracking tagged adult salmon (transported from Veazie Dam to spawning habitat in the Piscataquis River) has shown that adults can drop downstream quickly past many dams (Spencer et al. 2010, 2011). Researchers noted that "the presence of dams did not appear to impede downstream movement of motivated salmon and some fish passed seven dams in as many days." In two years of kelt telemetry studies at Veazie and Milford Dams, 35 of 49 kelts were delayed less than 2.0 hours (minimum – 0.1 hour, maximum – 155 hours) before finding a safe route of passage in spilled water.

Upstream migrating adults are caught and passed at the Ellsworth Dam fish trap and truck facility. Any significant delay in migration that occurs may increase adult salmon exposure to predation, such as from seals. An Upstream Atlantic Salmon Passage Study was conducted in 2015 to evaluate whether increased effort at the trapping facility resulted in an increase in the capture, or rate of capture, of adult Atlantic salmon. The trap was operated from sunrise to sunset from May 1 to October 31 in 2015, and was checked at least four times a day. No Atlantic salmon were collected or observed.

6.1.6 Habitat in Project Area

Within the range of the GOM DPS, the Union River contains two main stem dams (the Ellsworth and Graham Lake Dams) and numerous tributary dams, primarily at the outlets of lakes and ponds. The Project's upstream passage (trap and truck from the Ellsworth Dam) and downstream passage facilities (at both dams) allow access to spawning and rearing habitat, further reducing effects to salmon. While both the upstream and downstream facilities pass migrating fish, specific studies for the effectiveness of passing Atlantic salmon have not been conducted. In addition, very few salmon have returned to the river in the last ten years, and low level stocking has occurred in the Union River, consequently very few salmon smolts would be expected to be out-migrating. Black Bear will be conducting an Atlantic salmon downstream passage survival study at the Project in the spring of 2016 to collect empirical data.

In general, dam impoundments increase water depth, increase the water retention time (flushing rate) within a given river reach, and dampen daily fluctuations in water temperatures (FERC 1997). Large reservoirs with deep water that thermally stratify in summer may release water that is warmer or colder than ambient inflows, depending on the depth of withdrawal in relation to the depth of the thermocline, whereas run-of-the-river impoundments are typically shallow and have little effect on temperature (EPA modeling conducted on the Columbia River; Public Utility District No. 1 of Chelan County 2005). Impoundment conditions that result in reduced flow cues can result in migratory delay and result in habitat changes that are preferred by warmwater species that prey on juvenile Atlantic salmon such as largemouth and smallmouth bass and pike species (NMFS and USFWS 2015).

Project Impoundments

The Ellsworth Project results in up to approximately 11 miles of the Union River being impounded. Graham Lake is about 10 miles long with a surface area of approximately 10,000 acres; Graham Lake is relatively shallow, with an average depth of approximately 17 feet, and showed only weak short-term stratification during water quality studies conducted in 2013. The temperature in Graham Lake was fairly uniform through the water column on each of the summer sampling dates. Lake Leonard is about one mile long with a surface area of 90 acres; it averages 25 feet deep and is approximately 55 feet deep at its deepest point. Lake Leonard showed some stratification during the 2013 studies. Article 402 of the 1987 FERC license specifies that the licensee operates the Ellsworth Project so that the following normal water levels are maintained: Lake Leonard 1-foot fluctuation (65.7’ to 66.7’) and Graham Lake 10.8-foot fluctuation (93.4’ to 104.2’).

Graham Lake provides a majority of the spawning and rearing habitat for river herring in the Union River watershed, and Black Bear’s trap and transport efforts have allowed for development of one of the largest alewife runs in the country. NMFS has suggested that increased river herring populations may provide some predation buffer to Atlantic salmon (NOAA 2009). Atlantic salmon adults collected in the upstream fish trap are transported upstream of Graham Lake where they have access to suitable spawning habitat in the West Branch of the Union River and other tributaries.

Riverine Sections

The Ellsworth Project operates in a peaking mode while maintaining minimum flows and modest generation at all times. The Project license requires that Black Bear release a continuous minimum flow of 105 cfs from the Graham Lake Dam and the Ellsworth Dam from July 1 through April 30 and a continuous minimum flow of 250 cfs from May 1 through June 30 to protect fishery resources. Because the Ellsworth Project starts at the head of tide, there are no Project flow effects on juvenile salmon habitat below the dam. Observations below the Ellsworth dam indicate the river bed remains watered under minimum flow conditions with no evidence of areas of potential stranding.

Minimum flow releases from the project dams have protected and maintained the area fisheries. This was demonstrated in the relicensing study (Instream Flow and Union River Tributary Access Study [Black Bear 2014]) conducted in 2014. Flows analyzed included two low flows (150 and 300 cfs), a mid-range flow (1,230 cfs) and a high level (2,460 cfs) generating capacity flow. The study found aquatic habitat criteria for Atlantic salmon is sufficient at all flows analyzed. In addition, a zone of passage is provided throughout the Union River during the observed low flows.

Pursuant to Article 404 of the current FERC license, the Bangor Hydro-Electric Company (licensee prior to Black Bear) developed a minimum flow study plan in consultation with the USFWS, NMFS, Maine DMR, and Maine DEP to study the effectiveness of the 250 cfs minimum flow downstream of the project to determine if it was adequate to provide sufficient dissolved oxygen (DO) during the river herring migration. Study results, filed with FERC on September 4, 1990, indicated that DO concentrations were not significantly reduced under the operational conditions of the study. The agencies asserted that the study was not conducted during the worst case scenario and recommended that the licensee repeat the study when annual alewife runs were high to determine potential effects. The licensee repeated the study and found in a 2006 report that the required minimum flow provides sufficient dissolved oxygen and is protective of water quality for upstream migrant alewife, as well as other aquatic life. Resource agencies concurred with the conclusion and agreed that the current minimum flow should be maintained and that no additional DO sampling was needed (FERC Order dated October 13, 2006 Modifying Minimum Flow Study Plan Under Article 404).

Tributaries

As demonstrated in the 2014 Union River Tributary Access Study (Black Bear 2014), tributaries to the Union River between Graham Lake and Lake Leonard (Greys, Shackford, Moore, and

Gilpatrick brooks) maintained adequate connectivity for Atlantic salmon and other aquatic species during the flows observed. The study was conducted in September 2014 during managed low flow conditions. All tributary confluences had adequate depths (> 6 inches) during the observed low flows that would allow Atlantic salmon access. In addition, the tributary confluences had low velocities that would not preclude access by Atlantic salmon. Therefore, the confluence at each of the tributaries provide a zone of passage into the tributaries for Atlantic salmon to access any suitable spawning habitat that may be present upstream in these tributaries. Natural low flows within the tributaries themselves were observed during the study, suggesting that low flows within the tributaries could potentially be a limiting factor for migratory fish accessibility further up in the tributaries.

It should be noted that migratory species typically migrate upstream into tributaries during instances of high runoff following rain events, rather than during the low flow period observed in this study. This further suggests that accessibility to these tributaries is available during the Atlantic salmon migratory season.

Gilpatrick Brook likely has the most preferable salmon habitat at the confluence to the Union River than the other tributaries observed, as the lower portion of this stream contained adequate depth (>1.25 ft), flow (approximately 2 ft/s), substrate (cobble and gravel), and cover (large woody debris, shoreline vegetation, boulders) suitable for various life stages of Atlantic salmon (Fay et al. 2006) (Black Bear 2014).

Stakeholder comments on the USR suggested that the evaluation of accessibility to tributaries should be based upon more detailed criteria. To further address stakeholder comments on the USR, and in accord with FERC's December 8, 2015 Determination on Requested Study Modifications, Black Bear will consult with agencies and collect additional zone of passage information in 2016 for select tributaries to the Union River between Graham Lake and Lake Leonard. Black Bear will file the results of this study with FERC by December 31, 2016 as additional information to the FLA.

Juvenile Atlantic salmon, specifically parr, seek riffle habitat associated with diverse rough gravel substrate, as typically found in tributaries (Kircheis and Liebich 2007). Parr can also move great distances into or out of tributaries and main-stems to seek out habitat that is more conducive to growth and survival, such as areas of thermal refuge, resistance to dewatering, or increased prey abundance (McCormick et al. 1998). Atlantic salmon spawning and rearing areas have been identified in the West Branch of the Union River upstream of Graham Lake (USFWS 2011) (Figure 9).

6.1.7 Maintenance Activities

Maintenance activities affecting Atlantic salmon primarily pertain to periodic maintenance to the fishways. Black Bear has developed a site specific operation and maintenance plan for the fishways at this Project to ensure that the upstream and downstream fishways are operating properly. The plan also includes both a list of spare parts critical to fishway operation and a checklist of proper fishway operating characteristics. In 2015, Black Bear hired dedicated staff to operate the project fish passage facilities; these staff were dedicated to fishway operations, oversight, fish trap tending, and transporting the fish upriver. These dedicated fishway staff completed the daily checklists and prepared weekly reports on fishway operations, which were provided to the fisheries management agencies throughout the fishway operational season. The activities performed for upstream and downstream fishway maintenance have a positive effect on Atlantic salmon, as these activities ensure the fishways remain effective.

6.1.8 Predation

Atlantic salmon smolts face predation risk during their migration from freshwater to estuarine and marine environments. Anthropogenic factors may contribute to conditions that support known predators of Atlantic salmon, such as chain pickerel, smallmouth bass, and double crested cormorants (Fay et al., 2006). Dams may increase predation risk due to smolt disorientation, injuries, congregating behavior, and decreased abundance of other diadromous fishes that historically acted as a prey buffer by providing a robust alternative food source for predators (Northeast Salmon Team 2011). Dam passage may also affect predator detection and avoidance by salmonids (Raymond 1979, Mesa 1994).

The Union River drainage supports a variety of resident and migratory fish species. Principal resident sportfish include landlocked Atlantic salmon, brook trout, lake trout, brown trout, splake, landlocked arctic char, smallmouth bass, largemouth bass, chain pickerel, and white perch. Populations of resident fish are maintained through natural reproduction and stocking.

The Union River also contains migratory fish such as striped bass and American eel (URFCC 2010).

Fish species such as brook trout and American eel are native to all major drainages in Maine and likely feed on salmon eggs and small salmon. Introductions of top predator fish (e.g., smallmouth bass, chain pickerel, and brown trout are non-native fish species that occur in the Union River watershed) negatively affect resident fish communities by disrupting normal feeding behavior (Bystrom et al. 2007), decreasing prey abundance (He and Kitchell 1990, Findlay et al. 2005), and through extirpation of native species (Findlay et al. 2005, Bystrom et al. 2007). Striped bass are also known predators of Atlantic salmon smolts (Blackwell and Juanes 1998); however, their abundance in Maine is variable each year, indicating that predation by striped bass doesn't have an appreciable effect on Atlantic salmon populations (Beland et al. 2001).

Smallmouth bass are a warm-water species whose range now extends through north-central Maine and well into New Brunswick (Jackson 2002). Smallmouth bass are numerous in Graham Lake. Smallmouth bass likely feed on salmon fry and parr, though little quantitative information exists regarding the extent of bass predation. Smallmouth bass are predators of smolts in main stem habitats, and bioenergetics modeling indicates that bass predation is insignificant at 5°C, but increases with increasing water temperature during the smolt migration (Van den Ende 1993). Largemouth bass, another top predator species, were introduced illegally into Graham Lake about five years ago, and are expanding rapidly (pers. comm. Greg Burr, Maine Department of Inland Fisheries and Wildlife [Maine DIFW] July 3, 2014).

Chain pickerel, which are also common in Graham Lake, are known to feed upon salmon smolts within the range of the GOM DPS and certainly feed upon fry and parr, as well as smolts, given their piscivorous feeding habits (Van den Ende 1993). Chain pickerel feed actively in temperatures below 10°C (Van den Ende 1993, Maine DIFW 2002). Smolts were, by far, the most common item in the diet of chain pickerel observed by Barr (1962) and Van den Ende (1993). However, Van den Ende (1993) concluded that, "daily consumption was consistently lower for chain pickerel than that of smallmouth bass," apparently due to the much lower abundance of chain pickerel.

Birds known to prey upon Atlantic salmon throughout their life cycle include species such as mergansers, belted kingfisher, bald eagles, ospreys, double-crested cormorants, gulls, and gannets (Fay et al. 2006). The USFWS has concluded that avian predation poses a high-level threat to the survival and recovery of GOM DPS Atlantic salmon (NMFS and USFWS 2005). Blackwell et al. (1997) reported that salmon smolts were the most frequently occurring food items in cormorants sampled at main stem dam foraging sites. In a study in the Penobscot River, cormorants were present during the spring smolt migration as migrants, stopping to feed before resuming northward migrations, and as resident nesting birds using Penobscot Bay nesting islands (Blackwell 1996, Blackwell and Krohn 1997). Another study found Atlantic salmon comprised 26% of cormorant's diet during the smolt run (Hatch and Weseloh 1999). Meister and Gramlich (1967) studied salmon predation by cormorants in the Machias River estuary. The results of this study documented that cormorants consumed an estimated 8,000 tagged hatchery smolts during the period 1966-1967 in the Machias River. Predation rates on migrating hatchery-reared salmon smolts were found to be as high as 13.4% in the Machias River (Meister and Gramlich 1967).

Breeding pairs of double-crested cormorants in Maine have increased significantly since the late 1970s, and smolts are a frequent prey item (Northeast Salmon Team 2011). The abundance of alternative prey resources such as upstream migrating alewife, helps reduce the impacts of cormorant predation on GOM DPS Atlantic salmon (Northeast Salmon Team 2011). Common mergansers and belted kingfishers are likely the most important predators of Atlantic salmon fry and parr in freshwater environments, as well as seals that also predate upon adult salmon (Fay et al. 2006). Studies conducted in Canada found mergansers consumed more juvenile Atlantic salmon than cormorants (NMFS and USFWS 2005). These birds are common in Maine, including the Union River watershed (Cornell Lab of Ornithology 2012).

A restored run of river herring in the Union River drainage is expected to be beneficial to Atlantic salmon restoration efforts, because river herring provide a predation buffer, by providing predators with alternative, and potentially more abundant prey.

6.2 Atlantic Sturgeon and Shortnose Sturgeon

Because sturgeon only rarely occur in the Project tailwaters, normal Project operations should have minimal effect on shortnose and Atlantic sturgeon, or their habitat. There is a potential that sturgeon could be encountered during maintenance activities, for example, during planned dewatering of the draft tubes for turbine inspection or maintenance activities. There is also a possibility that sturgeon could be captured in the fish trap and handled during the sorting process. Black Bear has developed and will implement a sturgeon handling plan to provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered by personnel during fish lift operations, and in the event of stranding during periodic dewatering of the draft tubes.

6.3 Potential for Cumulative Effects

Cumulative effects are those effects of future state and private activities, not involving federal activities, that are reasonably certain to occur within the action area (50 C.F.R. § 402.02). Cumulative effects do not include future federal or federally authorized action, which would be subject to future ESA section 7(a)(2) consultations. Activities that occur now and are expected to continue in the future include recreational fishing and boating, which are regulated by the state of Maine.

Impacts to GOM DPS Atlantic salmon from non-federal activities are largely unknown in the Union River. It is possible that occasional recreational fishing could result in incidental takes of GOM DPS Atlantic salmon. There is no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past. The cumulative effects from forestry and agricultural practices will continue to occur in the watershed area, potentially affecting water quality and spawning and rearing habitat.

While not directly linked to Atlantic salmon, the Ellsworth Development will continue to have positive cumulative environmental effects by providing renewable energy, thus decreasing the nation's dependence on fossil fuels, and minimizing the substantial adverse cumulative effects that fossil fuels have on the environment. In addition, the Project's upstream and downstream fish passage facilities provide benefits to Atlantic salmon, specifically during periods of migration; however, the current Project effect to GOM DPS Atlantic salmon is negligible due to the lack of salmon in the river (e.g., only sporadic stocking over the years, very few returning adults during the last ten years, very few smolts expected to be out-migrating). Cumulative effects in the Union River watershed may occur from the need to pass numerous non-licensed small dams, if located within critical habitat.

7.0 Proposed Measures and Studies

This section describes measures proposed by Black Bear to evaluate existing salmon protection measures and to provide additional enhancements to Atlantic salmon. Table 7 provides an overview summary, and proposed measures are discussed further below.

TABLE 7
OVERVIEW OF PROPOSED PROTECTION MEASURES

2015	2016-2017
• Black Bear implemented site specific operations and management plan for fishways • Black Bear submitted Draft License Application in July • Black Bear conducted upstream passage study/observations for extended period (May 1 to October 31) • Black Bear conducted field measurements of intake velocities at the Ellsworth trashracks • Black Bear develops Draft BA • Black Bear meets with the Services to discuss Draft BA • Black Bear submits Final License Application and Draft BA in December	• FERC issues BA • NMFS issues Biological Opinion and Incidental Take Statement covering term of new license • Black Bear conducts downstream smolt passage study during 2016 Black Bear will work with the Services to develop appropriate protection measures based on results of the pending studies • FERC issues a new or annual license before December 31, 2017

7.1 Upstream Passage

In 2015, Black Bear conducted an upstream Atlantic salmon passage monitoring study. The goal of the study was to provide information about how the fishway operations influence the numbers of adult Atlantic salmon that are collected. Black Bear began operating and monitoring the trap and haul facility to provide passage for salmon on May 1, 2015 and operated the trap and haul facility daily from sunrise to sunset until October 31, 2015. Black Bear recorded information on water temperature, tidal stage, river flow, and the number of units generating each time the trap was checked. The trap was checked/lift operated at least four times daily. No Atlantic salmon were collected or observed in 2015.

If enhancement measures are appropriate to further protect GOM DPS Atlantic salmon, based on these study results and consultation with the agencies, Black Bear will work with the agencies to develop an SPP that incorporates the measures, as appropriate.

7.2 Downstream Passage

Black Bear will evaluate downstream smolt passage at the Project to determine the effectiveness of the downstream fishway and to evaluate survival for downstream migrating Atlantic salmon smolts. A detailed study plan was developed in consultation with NMFS, USFWS, and Maine DMR, and filed with FERC on March 31, 2015. FERC approved the study plan in a letter dated April 21, 2015. Proposed study methods involve use of radio and acoustic telemetry tagging of hatchery smolts to evaluate the effectiveness of the existing downstream fish passage facility at the Project. The study will evaluate migration routes and passage survival of tagged smolts within the Project area, including the Graham Lake and Ellsworth Dams and associated impoundments. As specified in the study plan, multiple release groups will be used, and the evaluation will occur during the peak smolt migration season in May. The study will be conducted in 2016.

If enhancement measures are appropriate to further protect GOM DPS Atlantic salmon, based on these study results and consultation with the agencies, Black Bear will work with the agencies to develop an SPP that incorporates the measures, as appropriate.

7.3 Fish Passage Facility Management

Black Bear has developed a site specific operation and maintenance plan for the fishways for the Ellsworth Project. The plan includes a daily check list that was employed throughout the 2015 season and will be continued in future seasons to ensure that the upstream and downstream fishways are operating properly. The site specific operation and maintenance plan for the fishways includes both a list of spare parts critical to fishway operation and a checklist of proper fishway operating characteristics. Black Bear is providing dedicated staff to implement the site specific operation and maintenance plan for the fishways each year. These staff are dedicated to fishway operations, oversight, fish trap tending, and trucking of fish upriver at the Project. Black Bear maintains a spare recovery pump, which provides 50 cfs of attraction flow into the two downstream bypass weirs in the main powerhouse intakes, to serve as a backup in the event of a pump failure.

7.4 Sturgeon Handling Plan

Black Bear has developed, and will implement, a sturgeon handling plan to provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered by personnel during fish lift operations, and in the event of stranding during periodic dewatering of the draft tubes (Attachment A).

8.0 Determination of Effect

Based on the analyses contained in this draft BA, the Determination of Effect of the Project for Atlantic salmon (and its designated critical habitat), shortnose sturgeon, and Atlantic sturgeon are provided below:

8.1 Atlantic Salmon

Based on the existence of the Project, and on information regarding the likely presence of GOM DPS Atlantic salmon, their biology and habitat requirements, this draft BA concludes that the action is likely to adversely affect (LAA) a small number of GOM DPS Atlantic salmon at the Project.

The LAA determination for the Ellsworth Project is based on the likelihood that despite efforts by Black Bear to implement fish passage measures and to provide mitigation measures, injury or mortality could occur to a small number of downstream migrating GOM DPS Atlantic salmon smolts. Black Bear will continue to manage the Project to avoid or minimize this effect through the continued implementation of fish protection and enhancement measures outlined in this document and will work with NMFS to develop an SPP.

Black Bear foresees no overall destruction or adverse modification of critical habitat, though there will be continued effects to the migratory primary constituent elements (PCEs) of the critical habitat designated for Atlantic salmon (see discussion in Section 1.3). The measures to promote restoration of GOM DPS Atlantic salmon in the Union River, as reflected in this document, have resulted in improvements to upstream and downstream fish passage facilities at the Project over the years. Continued consultation and refinements made from the results of future studies described in this document will lead to improvement of migratory PCEs for GOM DPS Atlantic salmon. In turn, PCEs for migrating adults and smolts will also be improved as a direct result of the relicensing of the Ellsworth Project.

The Proposed Action developed herein, including development of an SPP, is expected to minimize adverse effects to Atlantic salmon and its critical habitat.

8.2 Shortnose Sturgeon and Atlantic Sturgeon

Due to the uncommon occurrence of the species at the Project, normal operations would have minimal or no effect on shortnose sturgeon or Atlantic sturgeon. There is a possibility that sturgeon could be captured in the fish trap and handled during the sorting process, or during planned dewatering of the draft tubes for turbine inspection or maintenance activities. If this occurs, Black Bear staff would take the steps specified in the sturgeon handling plan (Attachment A) to return the sturgeon to the river downstream of the Project. Implementation of the sturgeon handling plan will provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered by personnel during fish lift operations or maintenance activities. The Proposed Action is not likely to adversely affect (NLAA) sturgeon at the Projects.

9.0 Literature Cited

Alden Research Laboratory (Alden). 2012. Atlantic salmon survival estimates at mainstem hydroelectric projects on the Penobscot River. Holden, Massachusetts.

Atlantic Sturgeon Status Review Team. 2007. Status review of Atlantic sturgeon (*Acipenser oxyrichus oxyrinchus*). National Marine Fisheries Service. February 23, 2007. 188 pp.

Bakshtansky, E.L., I.A. Barybina, and V.D. Nesterov. 1976. Changes in the intensity of downstream migration of Atlantic salmon smolts according to abiotic conditions. ICES Anadromous and Catadromous Fish Committee C.M.1976/M:4.

Bangor Pacific Hydro Associates (BPHA). 1994. 1994 Evaluation of Downstream Fish Passage Facilities at the West Enfield Hydroelectric Project. FERC #2600-029. Bangor-Pacific Hydro Associates. Bangor, ME. 18 pp. and appendices.

Barr, L.M. 1962. A life history of the chain pickerel, *Esox niger Lesueur*, in Beddington Lake, Maine. M.S. Thesis University of Maine, Orono, ME: 88 pp.

Baum, E.T. 1997. Maine Atlantic Salmon: A National Treasure. Atlantic Salmon Unlimited. Hermon, ME. 224 pp.

_____. 1982. The Union River: An Atlantic salmon management plan. Atlantic Sea Run Salmon Commission. Bangor, Maine. 27 p.

Beland, K.F., J.F. Kocik, J. VandeSande, and T.F. Sheehan. 2001. Striped Bass Predation Upon Atlantic Salmon Smolts in Maine. Northeastern Naturalist 8(3):267-274.

Black Bear Hydro Partners, LLC. (Black Bear). 2014. Initial Study Report (ISR), Ellsworth Hydroelectric Project, FERC No. 2727. Submitted by Black Bear Hydro Partners, LLC. September.

Black Bear Hydro Partners LLC (Black Bear). 2012. Draft Biological Assessment for Atlantic salmon, shortnose sturgeon, and Atlantic Sturgeon. Black Bear Hydro Projects - Orono Project, FERC No. 2710, Stillwater Project, FERC No. 2712, Milford Project, FERC No. 2534, West Enfield Project, FERC No. 2600, and Medway Project, FERC No. 2666. Prepared - March 2012.

Blackwell, B.F. 1996. Ecology of double-crested cormorants using the Penobscot River and Bay Maine. Doctoral dissertation, University of Maine.

Blackwell, B.F. and F. Juanes. 1998. Predation on Atlantic salmon smolts by striped bass after dam passage. North American Journal of Fisheries Management 18: 936-939.

Blackwell, B.F. and W.B. Krohn. 1997. Spring foraging distribution and habitat selection by double-crested cormorants on the Penobscot River, Maine, USA. Colonial Waterbirds 20(1): 66-76.

Blackwell, B.F., W.B. Krohn, N.R. Dube, and A.J. Godin. 1997. Spring prey use by double-crested cormorants on the Penobscot River, Maine, USA. Colonial Waterbirds 20(1): 77-86.

Booth, R.K., E.B. Bombardier, RS. McKinley, D.A. Scruton, and R.F. Goosney. 1997. Swimming Performance of Post Spawning Adult (Kelts) and Juvenile (Smolts) Atlantic Salmon, *Salma salar*. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2406: V + 18 p.

Bourgeois, C.E. and M.F. O'Connell. 1986. Observations on the seaward migration of Atlantic salmon (*Salmo salar L.*) smolts through a large lake as determined by radio telemetry and Carlin tagging. Canadian Journal of Zoology 66: 685-691.

Brown L.S., Haro A. and Castro-Santos T., 2009. Three-dimensional movements of silver-phase American eels in the forebay of a small hydroelectric facility. *In*: Casselman J.M. and Cairns D.K. (eds.), Eels at the edge: science, status and conservation concerns, *American Fisheries Society Symposium*, *58*, Bethesda, 277–291.

Bystrom P., J. Karlsson, P. Nilsson, T. Van Kooten, J. Ask, and F. Olofsson. 2007. Substitution of top predators: effects of pike invasion in a subarctic lake. Freshwater Biology 52(7): 1271-1280. *Cited in* Maine DMR and Maine DIFW 2009.

Cornell. 2012. Cornell Lab of Ornithology. All About Birds. Double-crested cormorant. Online [URL]: http://www.allaboutbirds.org/guide/search.aspx. (Accessed July 2012).

Fay C., M. Bartron, S. Craig, A. Hecht, J. Pruden, R. Saunders, T. Sheehan and J. Trial. 2006. Status review for anadromous Atlantic salmon (*Salmo salar*) in the United States. Report to the National Marine Fisheries Service and U.S. Fish and Wildlife Service. 294 pages.

Federal Energy Regulatory Commission (FERC). 1997. Final Environmental Impact Statement - Lower Penobscot River Basin, Maine (Basin Mills, Stillwater, and Milford Hydroelectric Projects - FERC Nos. 10981, 2712, and 2534, respectively). FERC, Washington, D.C.

Fernandes, S.J., G.B. Zydlewski, J.D. Zydlewski, G.S. Wippelhauser, and M.T. Kinnison. 2010. Seasonal distribution and movements of shortnose sturgeon and Atlantic sturgeon in the Penobscot River Estuary, Maine. Transactions of the American Fisheries Society 139: 1436-1449.

Findlay, D.L., M.J. Vanni, M. Patterson, K.H. Mills, S.E.M. Kasian, W.J. Findlay, and A.G

Salki. 2005. Dynamics of a boreal lake ecosystem during a long-term manipulation of top predators. Ecosystems (8):603-618. *Cited in* Maine DMR and Maine DIFW 2009.

Great Northern Paper Company (GNP). 1989. 1989 report on downstream passage of Atlantic salmon smolts and kelts at Weldon Dam. Great Northern Paper, Millinocket, Maine. 94 pages plus appendices.

Hall, S.D. and S.L. Shepard. 1990. 1989 Progress report of Atlantic salmon kelt radio telemetry investigations on the lower Penobscot River. Bangor Hydro-Electric Company. Bangor, Maine. 30 pages.

Hatch, J.J. and D.V. Weseloh. 1999. Double-crested Cormorant (*Phalacrocorax auritus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online [URL]: http://bna.birds.cornell.edu/bna/ species/441. Accessed April 2011.

Havey, K.A. 1961. Union River fish management and restoration. Maine Dept. of Inland Fish and Wildlife. Machias, Maine. 42 p.

He, X. and J.F. Kitchell. 1990. Direct and Indirect Effects of Predation on a Fish Community: A Whole-Lake Experiment. Transactions of the American Fisheries Society 119(5): 825-835. *Cited in* Maine DMR and Maine DIFW 2009.

Hoar, W.S. 1988. The physiology of smolting salmonids. In Fish physiology Vol. XIB (Hoar, W. S. & D. J., Randall eds.). London: Academic Press. *Cited in* Svendsen 2008.

Holbrook, C.M., M.T. Kinnison, and J. Zydlewski. 2011. Survival of migrating Atlantic salmon smolts through the Penobscot River, Maine: a prerestoration assessment. Trans. Am. Fish. Soc. 140:1255-1268.

Jackson, D.A. 2002. Ecological Effects of Micropterus Introductions: The Dark Side of Black Bass. In Black Bass: Ecology, Conservation, and Management. American Fisheries Society Symposium No. 31:221-232.

Jonsson, B. and J. Ruud-Hansen. 1985. Water temperature as the primary influence on timing of seaward migrations of Atlantic salmon (*Salmo salar*) smolts. Canadian Journal of Fisheries and Aquatic Sciences 42:593-595.

Kircheis, D., and T. Liebich. 2007. Draft habitat requirements and management considerations for Atlantic salmon (*Salmo salar*) in the Gulf of Maine Distinct Population Segment (GOM DPS). November 2007.

Kocik, J.F., J.P. Hawkes, T.F. Sheehan, P.A. Music, K.F. Beland. 2009. Assessing Estuarine and Coastal Migration and Survival of Wild Atlantic Salmon Smolts from the Narraguagus River, Maine Using Ultrasonic Telemetry. American Fisheries Society Symposium 69:293-310.

Maine Department of Inland Fisheries and Wildlife (Maine DIFW). 2002. Fishes of Maine. Augusta, ME. 38 pp.

Maine Department of Marine Resources (Maine DMR). 2015. Trap Count Statistics. [Online] URL: http://www.maine.gov/dmr/searunfish/trapcounts.shtml.

Maine Department of Marine Resources (Maine DMR) and Maine Department of Inland Fisheries and Wildlife (Maine DIFW). 2009. Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River. Prepared for the Atlantic Salmon Commission. April 10, 2009 draft. 293 pp.

McCormick, S.D., L.P. Hansen, T.P. Quinn, and R.L. Saunders. 1998. Movement, migration, and smolting of Atlantic salmon (*Salmo salar*). Canadian Journal of Fisheries and Aquatic Sciences 55, 77-92. *Cited in* Svendsen 2008 and Kircheis and Liebich 2007.

McCormick, S.D., R.A. Cunjack, B. Dempson, M.F. O'Dea and J.B. Carey. 1999. Temperature-related loss of smolt characteristics in Atlantic salmon (*Salmo salar*) in the wild. Canadian Journal of Fisheries and Aquatic Sciences 56:1649-1658.

Meister, A.L. and F. J. Gramlich. 1967. Cormorant predation on tagged Atlantic salmon smolts. Final report of the 1966-67 Cormorant - Salmon Smolt Study. Atlantic Sea Run Salmon Commission, Orono, Maine.

Mesa, M.G. 1994. Effects of multiple acute stressors on the predator avoidance ability and physiology of juvenile chinook salmon. Transactions of the American Fisheries Society 123(5): 786-793. *Cited in* USFWS and NMFS 2009.

Mudre, J.M. and W.P. Saunders. 1987. Radio telemetric investigation of downstream passage of Atlantic salmon smolts at Bellows Falls station. Prepared for New England Power and Northeast Utilities; 21 pages w/appn.

NMFS. 1987. (Draft) Status Review of shortnose sturgeon (*Acipenser brevirostrum* LeSueur 1818*)* Listed under the Endangered Species Act of 1973.

_____. 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland 104 pp.

_____. 2008. Endangered Species Act Section 7 formal consultation regarding proposed funding of fisheries sampling in the Penobscot River, Maine, to be funded by NMFS. Gloucester, MA. Biological Opinion, September 4.

_____. 2009a. Endangered and Threatened Species. Designation of critical habitat for Atlantic salmon (*Salmo salar*) Gulf of Maine Distinct Population Segment. Final rule. Federal Register, Vol. 74, No. 117. June 19, 2009.

_____. 2009b. Biological evaluation of Atlantic salmon habitat within the Gulf of Maine Distinct Population Segment.

_____. 2012. Dam Impact Assessment Model. Lab Reference Document. Northeast Fisheries Science Center, Woods Hole, MA.

National Marine Fisheries Service (NMFS), Maine Department of Marine Resources (Maine DMR), U.S. Fish and Wildlife Service (USFWS), and Penobscot Indian Nation (PIN). 2011. Atlantic Salmon Recovery Framework: Implementation Plan. March 2011.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2005. Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*). NMFS, Silver Spring, MD; USFWS, Hadley, MA. 325 pp.

_____. 2015. Atlantic Salmon Recover Plan (Draft). Online [URL]: http://atlanticsalmonrestoration.org/resources/documents/atlantic-salmon-recovery-plan-2015/atlantic-salmon-recovery-plan. Accessed December 8, 2015.

National Oceanic and Atmospheric Administration (NOAA). 2009. Draft Gulf of Maine Distinct Population Segment Management Guidance for Recovery.

_____. 2012a. Endangered and Threatened wildlife and plants; threatened and endangered status for distinct population segments of Atlantic Sturgeon in the Northeast Region. Final rule. Federal Register, Vol. 77 No. 24 February 6, 2012.

_____. 2012b. Endangered and Threatened wildlife and plants; Final listing determination for two distinct population segments of Atlantic Sturgeon in the Southeast Region. Final rule. Federal Register, Vol. 77 No. 24 February 6, 2012.

Nielsen, C., G. Holdensgaard, H.C. Petersen, B.T. Björnsson and S.S. Madsen. 2001. Genetic differences in physiology, growth hormone levels and migratory behavior of Atlantic salmon smolts. Journal of Fish Biology 59, 28-44. *Cited in* Svendsen 2008.

Northeast Salmon Team. 2011. Managing the Impacts of Cormorant Predation on Smolts. NMFS. [Online] URL: http://www.nefsc.noaa.gov/salmon/Finalcormorantfactsheet.html. Accessed July 2011.

Penobscot River Restoration Trust (Trust). 2008. Applications to surrender licenses for the Veazie (FERC No. 2304), Great Works (FERC No. 2312), and Howland (FERC No. 2721) hydroelectric projects. Filed with the Federal Energy Regulatory Commission, Washington, D.C., November 2008.

Peake, S.J., McKinley, R.S. and Scruton, D.A. 1997. Swimming performance of various freshwater Newfoundland salmonids relative to habitat selection and fishway design. Journal of Fish Biology 51: 710-723.

Power, J.H. and J.D. McCleave. 1980. Riverine movements of hatchery reared Atlantic salmon (*Salmo salar*) upon return as adults. Environmental Biology of Fishes 5(1):3-13.

Raymond, H.L. 1979. Effects of dams and impoundments on migrations of juvenile chinook salmon and steelhead from the Snake River, 1966 to 1975. Transactions of the American Fisheries Society 108(6): 505-529. *Cited in* USFWS and NMFS 2009.

Ruggles, C.P. 1980. A review of downstream migration of Atlantic salmon. Canadian Technical Report of Fisheries and Aquatic Sciences No. 952. Freshwater and Anadromous Division.

Shepard, S.L. 1989. 1988 Progress Report of Atlantic Salmon Kelt Radio Telemetry Investigations in the Lower Penobscot River. Bangor Hydro-Electric Company. 30 pp.

_____. 1991. A radio telemetry investigation of Atlantic salmon smolt migration in the Penobscot River of Maine. Proceedings of the Atlantic salmon workshop, Rockport, Maine March 6-7, 1991. U.S. Fish and Wildlife Service. Pages 101-118.

_____. 1993. Survival and Timing of Atlantic Salmon Smolts Passing the West Enfield Hydroelectric Project. Bangor-Pacific Hydro Associates. 27 pp.

_____. 1995. Atlantic salmon spawning migrations in the Penobscot River, Maine: fishways, flows and high temperatures. MS Thesis. Univ. Maine. Orono, ME. 111 pp.

Shrimpton, J.M., B.T. Björnsson, and S.D. McCormick. 2000. Can Atlantic salmon smolt twice? Endocrine and biochemical changes during smolting. Canadian Journal of Fisheries and Aquatic Sciences 57, 1969 - 1976. *Cited in* Svendsen 2008.

Sigourney, D.B., and J.D. Zydlewski, E. Hughes, and O. Cox. 2015. Transport, dam passage, and size selection of adult Atlantic salmon in the Penobscot River, Maine. N. Am. J. Fish. Mgmt. 35:1164-1176.

Smith, C. L. 1985. The inland fishes of New York State. The New York State Department of Environmental Conservation, Albany, New York.

Spencer, R., K. Gallant, and D. Buckley. 2010. Migratory behavior and spawning activity of adult sea-run Atlantic salmon translocated to novel upriver habitat within the Penobscot Basin, Maine. A Progress Report to the West Enfield Fisheries Fund Committee. March

1, 2010.

_____. 2011. 2010 Progress Report. Migratory behavior and spawning activity of adult sea-run Atlantic salmon translocated to novel upriver habitat within the Penobscot Basin, Maine. A Report for the West Enfield Fisheries Fund Committee. April 25, 2011.

U.S. Atlantic Salmon Assessment Committee (USASAC). 1992. Annual Report of the U.S. Atlantic Salmon Assessment Committee. Report No. 4 – 1991 Activities.

U.S. Fish and Wildlife Service (USFWS). 2011. USFWS Gulf of Maine Coastal Program (GOMP), GIS data: (USFWS MEASHS) Maine Atlantic Salmon Habitat Surveys. Publication_Date: 20110621. Title: ashab3. Geospatial Data Presentation Form: vector digital data. Available at http://www.maine.gov/megis/catalog/.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2000. Endangered and Threatened Species. Gulf of Maine Distinct Population Segment of Atlantic salmon. Listing as endangered. Final rule. Federal Register, Vol. 65, No. 223. November 17, 2000.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2009. Endangered and Threatened Species. Determination of endangered status for the Gulf of Maine Distinct Population Segment of Atlantic salmon. Final rule. Federal Register, Vol. 74, No. 117. June 19, 2009.

Union River Fisheries Coordinating Committee (URFCC). 2015. Comprehensive Fishery Management Plan for the Union River Drainage, 2015-2017. February 2010.

_____. 2012. 2011 Annual Report, Union River Fisheries Coordinating Committee. Prepared by Black Bear Hydro partners, LLC on behalf of URFCC. February 2012.

_____. 2010. Comprehensive Fishery Management Plan for the Union River Drainage 2011-2014. 29 pp.

Van den Ende, O. 1993. Predation on Atlantic salmon smolts (*Salmo salar*) by smallmouth bass (*Micropterus dolomeiu*) and chain pickerel (*Esox niger*) in the Penobscot River, Maine. M.S. Thesis. University of Maine. Orono, ME. 95 pp.

Vanderpool, A.M. 1992. Migratory Patterns and Behavior of Atlantic Salmon Smolts in the Penobscot River, Maine. Thesis. University of Maine, Orono. 61pp.

Wolter and Arlinghaus. 2003. Navigation impacts on freshwater fish assemblages: the ecological relevance of swimming performance. Reviews in Fish Biology & Fisheries 13: 63-89.

Zydlewski, G. 2009. Cianbro Constructors, LLC Penobscot River Operations, Brewer, Maine Shortnose Sturgeon monitoring, July 2008 – October 2008. University of Maine. School of Marine Sciences.

Zydlewski, G. B., M. T. Kinnison, P. E. Dionne1, J. Zydlewski and G. S. Wippelhauser. 2011. Shortnose sturgeon use small coastal rivers: the importance of habitat connectivity. J. Appl. Ichthyol. 27 (Suppl. 2) (2011), 41–44 © 2011 Blackwell Verlag, Berlin. ISSN 0175–8659.

ATTACHMENT A

STURGEON HANDLING PLAN

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Sturgeon Handling Plan for the Ellsworth Development

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeon (*Acipenser brevirostrum*) have the potential to occur in the Union River downstream of the Project. Black Bear will implement the following sturgeon handling plan to provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered by personnel during operations of the fish trap or during maintenance of the project facilities.

<u>Fish Trap Operations</u>

If sturgeon are found in the Project's fish trap, the following procedures will be implemented:

- For each sturgeon detected, Black Bear shall record the weight, length, and condition of the fish. Fish should also be scanned for PIT tags. River flow, spillage, and water temperature will be recorded. All relevant information will be recorded on the reporting sheet (Sturgeon Reporting Sheet for the Ellsworth Project, a copy of which is attached).

- Black Bear shall follow the contact procedure outlined below that was developed in coordination with the National Oceanic and Atmospheric Administration (NOAA) to obtain a contact with the appropriate Endangered Species Act (ESA) representative for handling sturgeon.

- If alive and uninjured, the surgeon will be immediately returned downstream. A long handled net outfitted with non-abrasive knotless mesh will be used to place the sturgeon back into the river downstream of the dam. The fish should be properly supported during transport in the net to ensure that it is not injured.

- If any injured sturgeon are found, Black Bear shall report immediately to NOAA (see contact information below). Injured fish must be photographed and measured, if possible, and the reporting sheet must be submitted to NOAA within 24 hours. If the fish is badly injured, the fish should be retained by Black Bear, if possible, until obtained by a NOAA recommended facility for potential rehabilitation.

- If any dead sturgeon are found, Black Bear must report immediately to NOAA (see contact information below). Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded on the Salvage Form included below. Specimens should be stored in a refrigerator or freezer by Black Bear until they can be obtained by NOAA for analysis.

Unit Inspection and Maintenance

On occasion, the Ellsworth Development units are dewatered for inspection or for maintenance activities. Prior to dewatering, the headgate and tailwater gates are closed, and then water is pumped from the unit. Black Bear will follow the protocols outlined here:

- Designated Black Bear employees will conduct a visual check for the presence of any sturgeon in the draft tube area as soon as possible once the water levels allow. If sturgeon are observed in the draft tube, Black Bear will refill the draft tube as necessary and remove the sturgeon. The process of dewatering would be repeated, and a visual check would be conducted to see if any sturgeon remain in the draft tube as it is dewatered.

- If sturgeon are observed in the draft tubes, they will be removed by dip net or other appropriate equipment, and place in the river downstream of the powerhouse.

- Unit dewatering for annual inspections will not be scheduled during April and May unless there is an emergency, in which case consultation with the appropriate resources agencies will take place.

- For each fish removed, Black Bear will record the weight, length, and condition. Fish would also be scanned for PIT tags. All relevant information will be recorded on the reporting sheet (attached Sturgeon Reporting Sheet for the Ellsworth Development).

- If any injured sturgeon are found, Black Bear will report it immediately to NOAA (see contact information below). Injured fish must be photographed and measured, if possible, and the reporting sheet will be submitted to NOAA within 24 hours. If the fish is badly injured, the fish shall be retained by Black Bear, if possible, until obtained by a NOAA recommended facility for potential rehabilitation.

- Black Bear shall report any dead fish immediately to NOAA (see contact information below). Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information shall be recorded on the Salvage Form included below. Specimens should be stored in a refrigerator or freezer by Black Bear until they can be obtained by NOAA for analysis.

Contact Information

Points of contact will be developed with the appropriate resource agencies, and their names and contact information will be shared and updated on an as-needed basis. Black Bear anticipates that points of contact will be identified at Black Bear, Maine DMR, USFWS, and NOAA. Copies of all reporting sheets will be developed and submitted to USFWS/NOAA at the end of the season.

Contact information:

- If any sturgeon are detected – Bob Richter (207-242-5001) or the Operator (207-461-3619).
- If unavailable, contact – Gail Wippelhauser, Maine Department of Marine Resources (*207-624-6349*).
- Within 24 hours of any contact with an injured or dead sturgeon, contact NOAA Fisheries Northeast Regional Office –Protected Resources Division Main Number (978-282-9328) or Julie Crocker (978-282-8480) and fax any reporting sheets to 978-281-9394.

Reports at End of Season

- At the end of the season, copies of all reporting sheets will be send to:

    Jeff Murphy
    NOAA Fisheries
    17 Godfrey Drive, Suite 1
    Orono, ME 04976

Sturgeon Reporting Sheet for the Ellsworth Development

Date:________________________ Time:____________________

Physical conditions:
Is spill being released over the dam? YES NO
What is the approximate gaged river flow?_______________________ (in cfs)
Water temperature (°C): _______________________

Is the fishway operating? YES NO

Is project generating? YES NO

If yes, what units are currently being operating?

Location from where species was recovered (circle): FISH TRAP / DRAFT TUBES

OTHER ___________________________________
If fish trap, estimate condition of trap: EMPTY / FEW FISH / MODERATE FULL / VERY FULL

Species information:
Total length:__________________ Fork length:__________ Weight:______________

Condition of fish: ____

Does the sturgeon have visible injuries or abrasions: YES NO
If Yes, circle and code area of abrasions on sturgeon diagram on back side of sheet.

Comments/other: ____
____
____
____
____
____
____
____

Name of watch observer:____

Observer's Signature:____

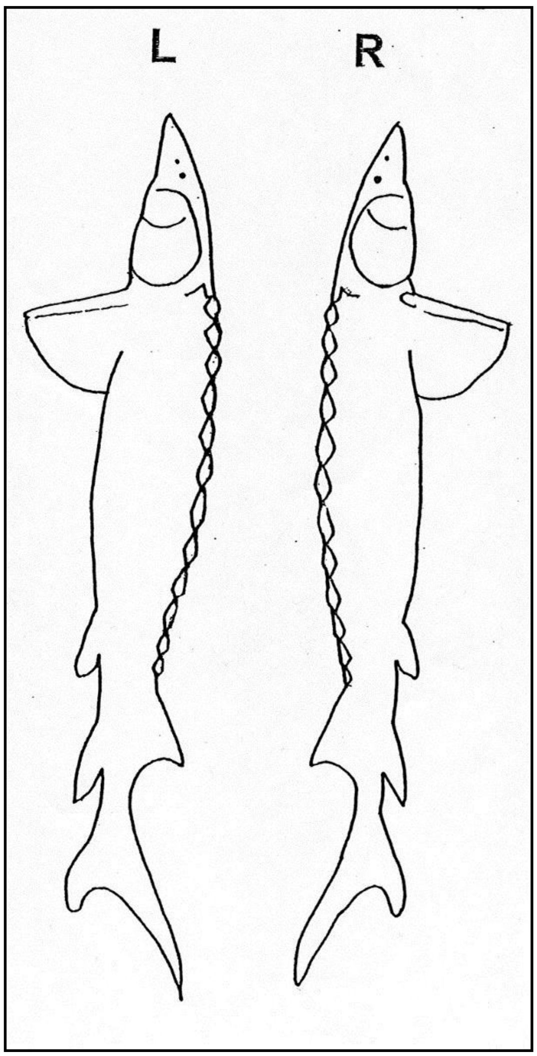
Abrasion Codes

None

Light Whitening or smoothed scutes,
Early sign of skin abrasion.

Moderate Early sign of redness on skin, scutes or fins, Erosion of skin over bony structures,
Loss of skin pigment

Heavy Large portion of skin red, scutes excessively worn,
Damaged, or missing; patches of skin missing,
Boney structures exposed; flaccid musculature.



For use in documenting dead sturgeon in the wild under ESA permit no. 1614 (version 07-20-2009)

NVESTIGATORS'S CONTACT INFORMATION
Name: First ________________ Last ________________________
Agency Affiliation ________________ Email________________________
Address ____
____
Area code/Phone number ______________________________________

UNIQUE IDENTIFIER (Assigned by NMFS)

DATE REPORTED:
Month ☐☐ Day☐☐ Year 20☐☐
DATE EXAMINED:
Month ☐☐ Day☐☐ Year 20☐☐

SPECIES: (check one)
☐ shortnose sturgeon
☐ Atlantic sturgeon
☐ Unidentified *Acipenser* species
Check "Unidentified" if uncertain .
See reverse side of this form for aid in identification.

LOCATION FOUND: ☐Offshore (Atlantic or Gulf beach) ☐Inshore (bay, river, sound, inlet, etc)
River/Body of Water________________ City________________________ State ____
Descriptive location (be specific)____
____
____
Latitude _______________N (Dec. Degrees) Longitude _______________ W (Dec. Degrees)

CARCASS CONDITION at time examined: (check one)
☐ 1 = Fresh dead
☐ 2 = Moderately decomposed
☐ 3 = Severely decomposed
☐ 4 = Dried carcass
☐ 5 = Skeletal, scutes & cartilage

SEX:
☐ Undetermined
☐ Female ☐ Male
How was sex determined?
☐ Necropsy
☐ Eggs/milt present when pressed
☐ Borescope

MEASUREMENTS: **Circle unit**
Fork length _________ cm / in
Total length _________ cm / in
Length ☐ actual ☐ estimate
Mouth width (inside lips, see reverse side) _________ cm / in
Interorbital width (see reverse side) _________ cm / in
Weight ☐ actual ☐ estimate _________ kg / lb

TAGS PRESENT? **Examined for external tags including fin clips?** ☐ **Yes** ☐ **No** **Scanned for PIT tags?** ☐ **Yes** ☐ **No**

Tag #	**Tag Type**	**Location of tag on carcass**
____________________	________________________	____________________________
____________________	________________________	____________________________

CARCASS DISPOSITION: (check one or more)
☐ 1 = Left where found
☐ 2 = Buried
☐ 3 = Collected for necropsy/salvage
☐ 4 = Frozen for later examination
☐ 5 = Other (describe) ____________________

Carcass Necropsied?
☐Yes ☐No
Date Necropsied:____________
Necropsy Lead:
____

PHOTODOCUMENTATION:
Photos/vide taken? ☐ Yes ☐ No
Disposition of Photos/Video:__________
____
____

SAMPLES COLLECTED? ☐ **Yes** ☐ **No**

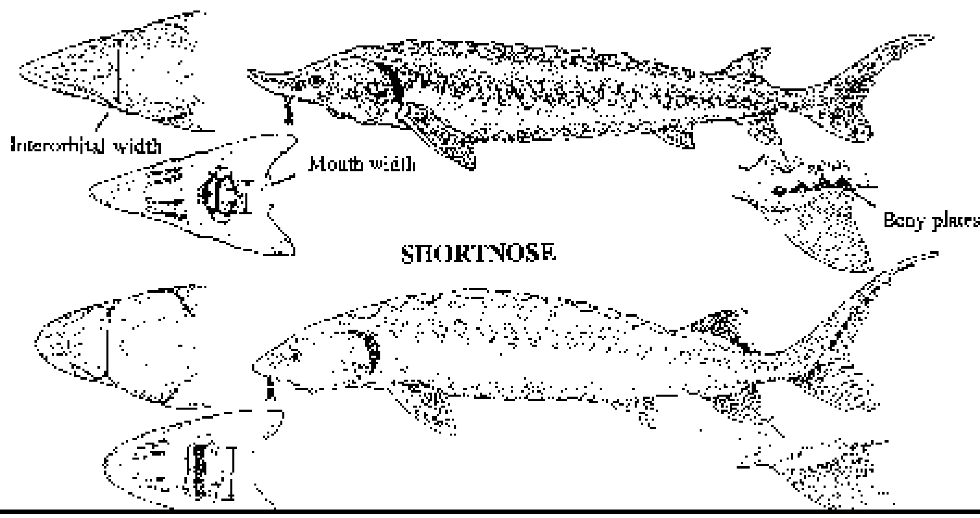
Sample	**How preserved**	**Disposition (person, affiliation, use)**
____________________	________________________	______________________________
____________________	________________________	______________________________
____________________	________________________	______________________________
____________________	________________________	______________________________
____________________	________________________	______________________________
____________________	________________________	______________________________
____________________	________________________	______________________________
____________________	________________________	______________________________

mments:
____

Distinguishing Characteristics of Atlantic and Shortnose Sturgeon (version 07-20-2009)

Characteristic	Atlantic Sturgeon, *Acipenser oxyrinchus*	Shortnose Sturgeon, *Acipenser brevirostrum*
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004



Describe any wounds / abnormalities (note tar or oil, gear or debris entanglement, propeller damage, etc.). **Please note if no wounds / abnormalities are found.**

____

____

____

____

____

Data Access Policy: Upon written request, information submitted to National Marine Fisheries Service (NOAA Fisheries) on this form will be released to the requestor provided that the requestor credit the collector of the information and NOAA Fisheries. NOAA Fisheries will notify the collector that these data have been requested and the intent of their use.

Submit completed forms (within 30 days of date of investigation) to: Jessica Pruden, Shortnose Sturgeon Recovery Coordinator, NOAA Fisheries Northeast Region, 55 Great Republic Drive, Gloucester, MA 01930 Phone: 978-282-8482; Fax: 978-281-9394; E-Mail Jessica.Pruden@noaa.gov

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EXHIBIT F

GENERAL DESIGN DRAWINGS
AND SUPPORTING DESIGN REPORT

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT F
GENERAL DESIGN DRAWINGS AND SUPPORTING DESIGN REPORT

The design drawings showing plan, elevations, and sections of the principal Project works are included as follows:

Sheet No.	Title
Sheet 1	Ellsworth Powerhouse and Dam Plan and Section
Sheet 2	Ellsworth Powerhouse Plan
Sheet 3	Ellsworth Powerhouse and Intake Section
Sheet 4	Ellsworth Powerhouse and Dam Sections
Sheet 5	Graham Lake Dam Site Plan and Section
Sheet 6	Graham Lake Dam Plan, Sections and Details

In accordance with Federal Energy Regulatory Commission (FERC or Commission) regulations, certain sensitive information related to this relicensing proceeding is being filed under separate cover with the Commission only. Special handling of this material is required to protect the security of critical energy infrastructure.

In order to protect critical energy infrastructure, the Commission has enacted regulations to govern public access to certain information. The Exhibit F drawings and Supporting Design Report referenced herein contain sensitive and detailed engineering information that, if used improperly, may compromise the safety of the Project and those responsible for its operation. Therefore, the Exhibit F drawings and Supporting Design Report have been labeled "Contains Critical Energy Infrastructure Information - Do Not Release." The drawings and Supporting Design Report have been submitted to FERC under separate cover. Agencies may file a CEII request under 18 CFR § 388.113 or a Freedom of Information Act (FOIA) request under 18 CFR § 388.108 to obtain the Exhibit F drawings.

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EXHIBIT G

PROJECT MAPS

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT G
PROJECT MAPS

The following maps show the location of the Ellsworth Hydroelectric Project, principal features, and Project boundary:

Sheet No.	Title
Sheet 1	Project Detail Map
Sheet 2	Project Detail Map
Sheet 3	Project Detail Map

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Traverse "A"			
FROM STA.	TO STA.	DIST.	BEARING
1	2	79.5	N 82° 10' W
2	3	80	N 05° 25' W
3	4	50	N 82° 10' W
4	5	99	N 05° 25' W
5	6	148.5	N 38° 05' W
6	7	282.9	S 86° 04' W
7	8	38	N 25° 01' 50" W
8	9	23.7	N 11° 09' 40" W
9	10	49.4	N 11° 30' 10" W
10	11	39.8	N 12° 49' 40" W
11	12	34.4	N 25° 10' 50" W
12	13	15.9	N 51° 46' 00" W
13	14	24.8	S 77° 53' 50" E
14	15	144.3	N 55° 24' 50" W
15	16	8.3	N 26° 23' 50" W
16	1	By Shore	

Traverse "B"			
FROM STA.	TO STA.	DIST.	BEARING
A	B	50	N 44° 22' E
B	C	130	S 51° 40' E
C	D	585	N 23° 14' W
D	E	231	N 16° 23' W
E	F	75	N 44° 22' E
F	G	83	N 07° 48' W
G	H	172.3	N 84° 00' E
H	I	To Shore	S 06° 50' W
I		By Shore	

NOTES:
EASEMENTS FOR, AND ACCESS RIGHTS-OF-WAY TO NON-PROJECT FACILITIES ARE EXCLUDED FROM THE PROJECT. ALL TRANSMISSION AND DISTRIBUTION LINES SHOWN WITHIN PROJECT BOUNDARY ARE EXCLUDED FROM THE PROJECT

Legend

- Recreation Amenity
- Reference Point (NAD83 State Plane, Maine East Zone, U.S. Survey Feet)
- Traverse Point
- Project Boundary
- Road
- Stream

Commission Approved Recreation Amenity Table			
#	Name	Northing	Easting
A	Carry-in Boat Launch	16186521	1785054
B	Boat Launch	16200057	1785508
C	Downstream Fishing Access	16199533	1786210

Reference Point Table NAD83 State Plane Maine West Zone U.S. Feet			
Sheet #	Reference Point #	Northing	Easting
1	1	320496.0	993822.0
1	2	333311.0	997964.0
1	3	325298.0	1002791.0
2	4	348299.0	1000410.0
2	5	335732.0	1014127.0
2	6	356720.0	1017132.0
3	7	382421.0	1011112.0
3	8	368961.0	1021908.0
3	9	393752.0	1027245.0

RICHARD E. OBERMAN, JR. LICENSED No.1148 STATE OF WEST VIRGINIA PROFESSIONAL SURVEYOR

I HEREBY CERTIFY TO THE FEDERAL ENERGY REGULATORY COMMISSION (FERC) THAT THIS PLAN MEETS THE CONDITIONS SET FOURTH BY FERC FOR ITS EXPRESSED PURPOSE. THE PURPOSE OF THIS MAP IS TO PROVIDE A GEOREFERENCED VISUAL DEPICTION OF THE LOCATION OF PROJECT FEATURES AND BOUNDARIES BASED ON THE BEST AVAILABLE HISTORICAL DRAWINGS INCORPORATED INTO THE GEOGRAPHIC INFORMATION SYSTEM (GIS). SOME LOCATIONS HAVE NOT BEEN VERIFIED BY PHYSICAL SURVEYS AND THIS DRAWING SHOULD NOT BE USED FOR PURPOSES OF DEVELOPING PROPERTY BOUNDARY DESCRIPTIONS.

EXHIBIT G — SHEET 1 OF 3

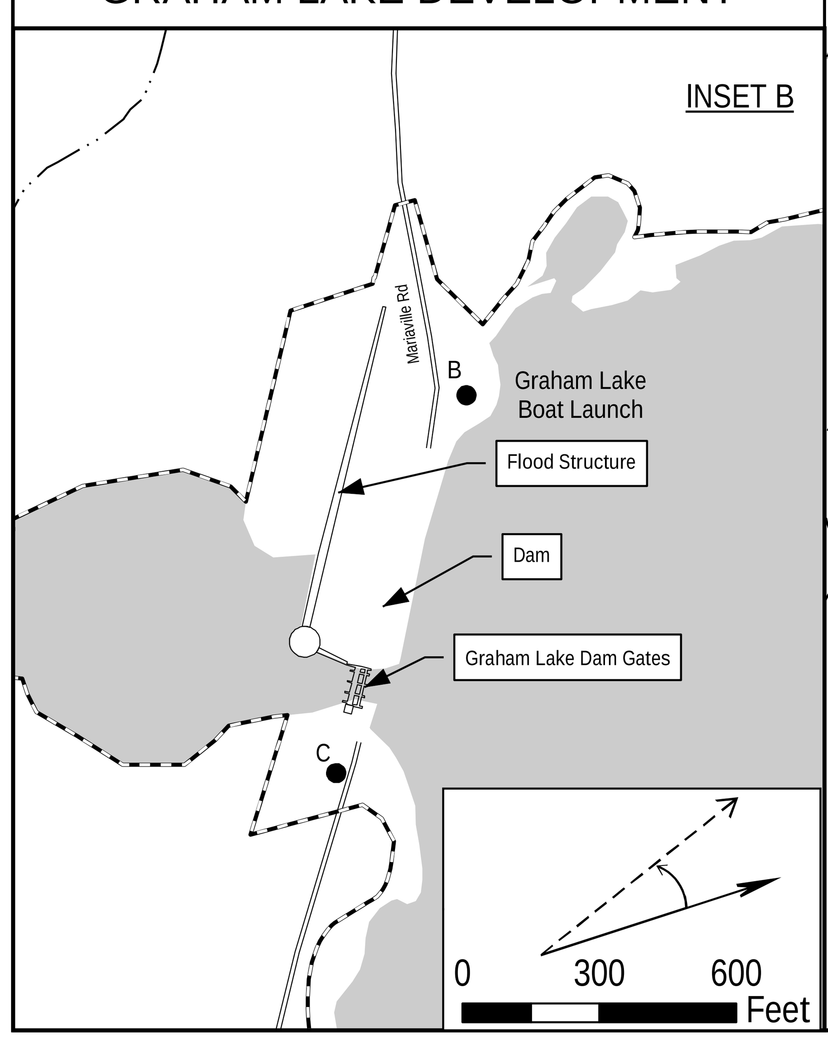
ELLSWORTH HYDROELECTRIC PROJECT
FERC NO. 2727

PROJECT DETAIL MAP

BLACK BEAR HYDRO PARTNERS, LLC

0 500 1,000 Feet — 1 inch = 500 feet

GRAHAM LAKE DEVELOPMENT



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2	6	356720.0	1017132.0
3	7	382421.0	1011112.0
3	8	368961.0	1021908.0
3	9	393752.0	1027245.0

Legend

- Recreation Amenity
- Reference Point (NAD83 State Plane, Maine East Zone, U.S. Survey Feet)
- Traverse Point
- Project Boundary
- Road
- Stream

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EXHIBIT G

SHEET 2 OF 3

ELLSWORTH HYDROELECTRIC PROJECT
FERC NO. 2727

PROJECT DETAIL MAP

BLACK BEAR HYDRO PARTNERS, LLC

0 1,000 2,000 Feet

1 inch = 1,000 feet

Legend

- Recreation Amenity
- Reference Point (NAD83 State Plane, Maine East Zone, U.S. Survey Feet)
- Traverse Point
- Project Boundary
- Road
- Stream

NOTES:
EASEMENTS FOR, AND ACCESS RIGHTS-OF-WAY TO NON-PROJECT FACILITIES ARE EXCLUDED FROM THE PROJECT. ALL TRANSMISSION AND DISTRIBUTION LINES SHOWN WITHIN PROJECT BOUNDARY ARE EXCLUDED FROM THE PROJECT

Commission Approved Recreation Amenity Table

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RICHARD E. OBERMAN, JR.
LICENSED
No.1148
STATE OF
WEST VIRGINIA
PROFESSIONAL SURVEYOR

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EXHIBIT G

SHEET 3 OF 3

ELLSWORTH HYDROELECTRIC PROJECT
FERC NO. 2727

PROJECT DETAIL MAP

BLACK BEAR HYDRO PARTNERS, LLC

0 1,000 2,000 Feet

1 inch = 1,000 feet

EXHIBIT H

DESCRIPTION OF PROJECT MANAGEMENT AND NEED FOR PROJECT POWER

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ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT H
DESCRIPTION OF PROJECT MANAGEMENT
AND NEED FOR PROJECT POWER

TABLE OF CONTENTS

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LIST OF FIGURES

ELLSWORTH HYDROELECTRIC PROJECT
(FERC NO. 2727)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT H
DESCRIPTION OF PROJECT MANAGEMENT
AND NEED FOR PROJECT POWER

1.0 INTRODUCTION

The Ellsworth Project (Project) is an existing hydroelectric project owned by, and licensed to, Black Bear Hydro Partners, LLC (Black Bear). Black Bear is an independent power producer and, as such, does not provide electric service to any particular group or class of customers. The Project generates renewable power that is currently sold into the New England wholesale market administered by the non-profit Independent System Operator (ISO) for New England (ISO New England). ISO New England administers all significant aspects of the New England Power Pool (NEPOOL) power market including: (i) the NEPOOL Open Access Transmission Tariff; (ii) the dispatch, billing and settlement system for interchange power in NEPOOL; (iii) NEPOOL energy and automatic generation control markets; and (iv) the NEPOOL installed capability market.

2.0 INFORMATION TO BE SUPPLIED BY ALL APPLICANTS

2.1 Plans and Ability of Owners of Ellsworth Dam to Operate and Maintain the Project

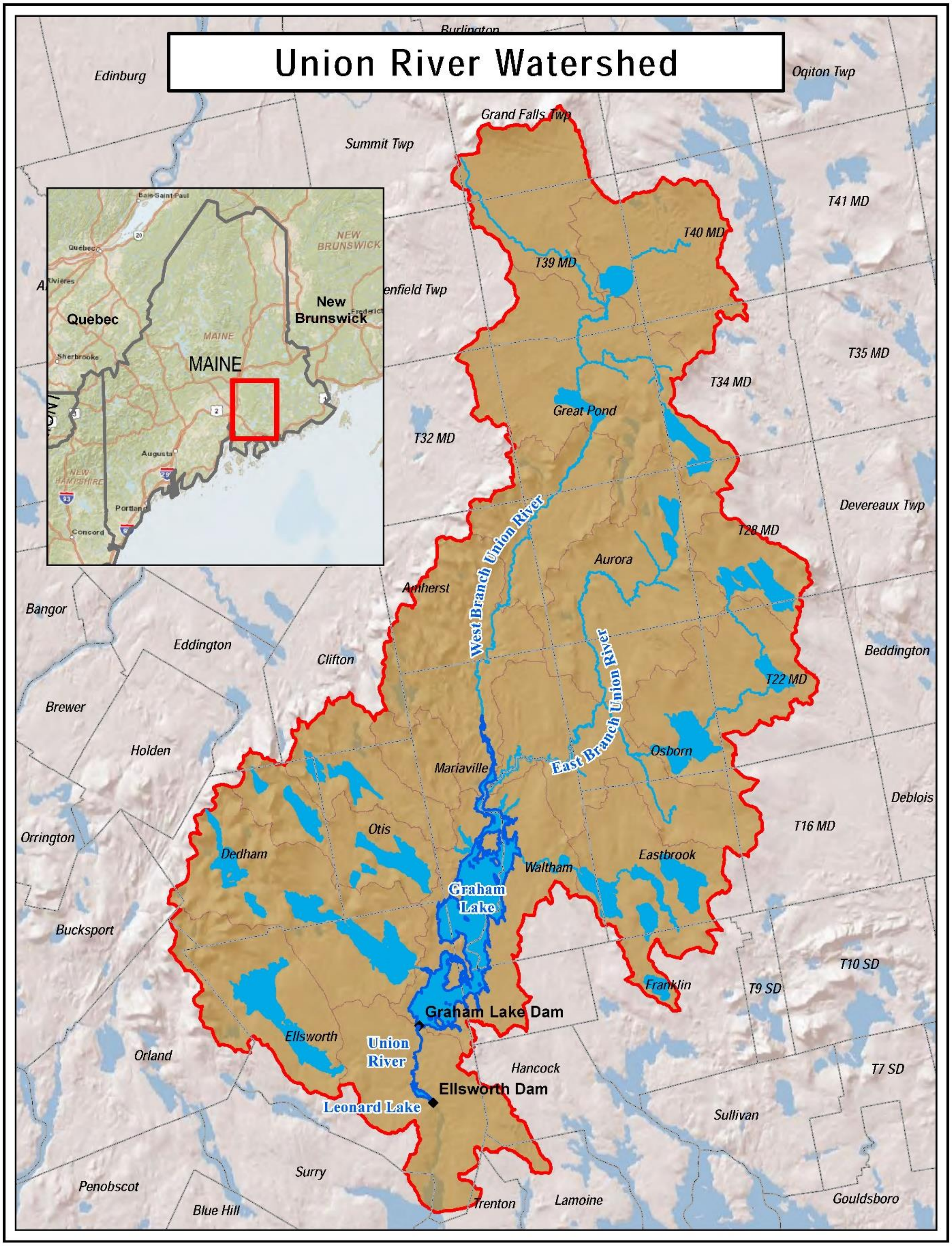
2.1.1 Plans to Increase Capacity or Generation

Black Bear has no current plans to increase the capacity or generation of the Project.

2.1.2 Plans to Coordinate the Operation of the Project with Other Water Resource Projects

The Project, owned by Black Bear is the only facility located on the Union River. The facility consists of two developments; Graham Lake development and Ellsworth development and their respective reservoirs typically operated for water storage and power generation. Operationally, the Project is typically run as a peaking plant, with water being released from the Graham Lake reservoir used to generate electricity at the downstream Ellsworth powerhouse to follow the electrical load of customers in the NEPOOL market.

Figure H-1: Union River Watershed



2.1.3 Plans to Coordinate the Operation of the Project with Other Electrical Systems

Black Bear is an independent power producer and member of NEPOOL that currently sells power from the Project wholesale to ISO New England. NEPOOL is a voluntary association whose members include not only traditional vertically integrated electric utilities, but independent power producers such as Black Bear that are participating in the competitive wholesale electricity marketplace. ISO New England serves as the independent system operator to operate the regional bulk power system and to administer the wholesale marketplace. ISO New England's primary responsibilities are to coordinate, monitor, and direct the operations of the major generating and transmission facilities in the region. The objective of ISO New England is to promote a competitive wholesale electricity marketplace while maintaining the electrical system's integrity and reliability. ISO New England seeks to assure both maximum reliability and economy of the bulk power supply for New England.

To this end, the electric facilities of NEPOOL member companies are operated as if they comprised a single power system. ISO New England accomplishes this by central dispatching of available power resources, and using the lowest cost generation and transmission equipment available at any given time consistent with meeting reliability requirements. As a result of this economic dispatch, utilities and their customers realize significant savings annually. NEPOOL participants also have strengthened the reliability of the bulk power system through shared operating reserves and coordinated maintenance scheduling.

The ISO New England staff constantly monitors and directs the operation of more than 300 generators and more than 7,600 miles of transmission lines in New England. ISO New England also is responsible for forecasting the various levels of daily electricity demand that will occur throughout the region and scheduling resources to meet the demand.

2.2 Need for the Electricity Generated by the Project

2.2.1 The Reasonable Costs and Availability of Alternative Sources of Power

The Project generates renewable power. The electrical output from the Project is sold wholesale into the ISO New England administered market.

The replacement of energy and capacity provided by the Project would be met through other sources, likely to be fossil-fired generating units, whose fuel and other variable costs would be significantly higher than those of the Project. As the lowest variable cost resource among power supply alternatives, hydroelectric assets such as the Project can bid energy into the ISO New England market at lower prices than alternative resources. Thus, loss of a low-variable cost resource such as the Project would result in upward pressure on the clearing prices in the NEPOOL market and ultimately paid by electric consumers in New England.

The Project provides renewable power, without the emissions of air pollutants or greenhouse gases that the marginal fossil fuel plants produce. This is an increasingly important fact in New England where all six New England states have enacted legislation to reduce the dependence on fossil fired generation through the introduction of Renewable Portfolio Standards (RPS), or similar legislation, that encourages and requires the use of renewable power sources in the state's total resource output. Many of these RPS programs include an annual escalating supply requirement to further encourage reliance on renewable power sources. Legislation that has been enacted is designed to increase the amount of renewable power supply in the region's mix of generation resources or, alternatively, reduce the amount of fossil fired generation as a percentage of the total resource output. The following are examples of actions in New England.

- In 1998, the Maine legislature enacted P.L. 1997, Chapter 31, "*An Act to Restructure the State's Electric Industry*". This Act requires that: as a condition of licensing pursuant to Section 3203, each competitive [retail] electricity provider in this State must demonstrate in a manner satisfactory to the Commission that no less than 30 percent of its portfolio of supply sources for retail electricity sales in this State is accounted for by renewable resources. 35-A M.R.S.A §3210(3).
- In Connecticut the General Assembly stated (*Act Concerning Electric Restructuring, Public Act 98-28*) that as a licensing condition effective in 2000, an electric supplier must demonstrate that: not less than one-half of one percent of its total electricity output shall be generated from Class I renewable energy sources and an additional 5.5 percent of the total output shall be from Class I or Class II renewable energy sources. These minimum requirements increased annually until 2009, at which time the minimum percentage for "Class I" renewable sources became 6 percent and the minimum total percentage for Class I and Class II renewables became seven percent. Class II renewables include hydroelectric facilities with a current or pending license.

As these statues and rules are implemented or adopted in New England, "clean" hydroelectric generation becomes an even more important and valuable part of the fuel mix for electric suppliers in the region.

2.2.2 Increase in Costs if the Licensee is not Granted a License

If Black Bear is not granted a license, this Project would cease to provide affordable and clean electricity to the New England Power Pool from its generation. An unquantified increase in costs would likely occur to the New England electric consumer if a license for continued operation of the Project was not granted. In addition, providing regulated, relatively stable downstream flows for downstream flood control benefits and flow augmentation during dry periods would not occur.

2.2.3 Effects of Alternative Sources of Power

Effects on Licensee's Customers

This section is not applicable to Black Bear, since Black Bear is a wholesale supplier.

Effect on Licensee's Operating and Load Characteristics

Black Bear is an independent power producer and, as such, does not maintain a separate transmission system which could be affected by replacement or alternative power sources.

Effect on Communities Served by the Project

Because Black Bear provides wholesale electricity to the regional system, the Project does not serve specific communities. It provides low cost, reliable capacity and energy for the regional electric customers. If ISO New England must replace the power benefits generated at the Project, the cost would be significantly more than the projected cost of operating the Project under the new license.

Because Black Bear cannot predict with any certainty the actual type or location of a potential alternative facility providing replacement power, it cannot specifically discuss potential effects on any particular community.

2.3 Need, Reasonable Cost, and Availability of Alternative Sources of Power

Black Bear is an independent power producer and, as such, does not have an obligation or need to prepare load and capability forecasts in reference to any particular group or class of customers. For the region, those obligations and tasks remain within the scope of services provided by ISO New England and NEPOOL.

2.4 Effect of Power on Licensee's Industrial Facility

This section is not applicable to Black Bear, which does not own industrial facilities.

2.5 Need of Indian Tribe Licensee for Electricity Generated by the Project

This section is not applicable to the Ellsworth Project.

2.6 Impacts on the Operations and Planning of Licensee's Transmission System

Because Black Bear is an independent power producer and does not own the local transmission system, this section is not applicable to Black Bear. Power generated by the Project is transmitted to the local utility transmission/distribution system.

2.7 Statement of Need for Modifications

Black Bear is not proposing any fundamental capacity changes to the Project facilities or operation. Black Bear conducted a standard redevelopment study of the Project in accordance with 18 CFR §5.18 (c)(1)(A)(1) to assess the feasibility of increasing power production including additional generation capacity, efficiency upgrades and increasing the impoundment level by up to one foot. The Project Redevelopment Study was conducted to evaluate potential generation and operations modifications, so that any feasible alternatives to increase or improve project generation, as well as any potential effects on natural resources, could be evaluated as part of the relicensing process. One part of the study assessed the potential for up to a 1 foot increase in the Graham Lake normal full pool reservoir elevation. The second part of the study examined the potential for adding additional generation capability. In addition, the potential for installing a unit to utilize available flows at Graham Lake was evaluated. Of the options evaluated, raising the normal maximum headpond level would present structural and project land issue considerations that would likely be cost prohibitive at this time. Based on those issues, a detailed, further, in-depth evaluation is not recommended. Therefore, Black Bear has no plans to add a generation unit at Graham Lake Dam at this time.

A review of system head losses and unit efficiencies at the Ellsworth Dam were investigated. In comparing calculated potential station capacity to actual historical generation, there may be some opportunity to increase Project generating capacity through efficiency upgrades (e.g., upgrade generators that limit turbine output). However, there is a factor of diminishing returns to consider given the potential equipment cost to achieve higher generation levels.

2.8 Consistency with Comprehensive Plans

Relicensing and continued operation of the Project will continue to be compatible with the comprehensive development and utilization of the waterway, and conform to the various comprehensive natural resource plans developed by resource management agencies, and approved by FERC, as discussed below.

Section 10(a)(2) of the Federal Power Act (FPA) requires the Federal Energy Regulatory Commission (FERC or Commission) to consider the extent to which a project is consistent with federal and state comprehensive plans for improving, developing, and conserving waterways affected by the project. In accordance with Section 10(a) (1) of the FPA, the list of Commission approved federal and state comprehensive plans was reviewed to determine applicability to the Ellsworth Project. The federal resource agencies, as well as the State of Maine, have prepared a number of comprehensive plans, which provide a general assessment of a variety of environmental conditions in Maine. In addition, the State of Maine's plans include policies related to ensuring that the State's energy needs are met and supporting hydropower, a renewable and indigenous source, as a valuable portion of the energy mix. These plans also address water quality, water pollution control, wetlands, recreation, and land management issues. The Ellsworth Project's consistency with pertinent state and federal comprehensive plans is discussed below.

2.8.1 FERC-Approved State of Maine Comprehensive Plans

In 1987, the State of Maine submitted to FERC a three-volume Comprehensive Rivers Management Plan. Volumes 1 and 2 of the plan were approved by FERC in October 1982. Volume 3 of the plan was included in the updated submittal in 1987 and contained hydro-related core laws, executive orders, and other plans. Subsequently, the State of Maine produced Volumes 4 and 5 of the Comprehensive Rivers Management Plan in 1992 and 1993, respectively (see separate discussion below). These volumes have also been approved by FERC.

State of Maine Comprehensive Rivers Management Plan, May 1987 – Volume 1

Volume 1 contains the Comprehensive Hydropower Plan issued by the Maine Office of Energy Resources (MOER) in October 1982[1]. The Comprehensive Hydropower Plan consists of three parts: Maine Rivers Policy, The Projected Contribution of Hydroelectric Generation to Meeting Maine's Electricity Needs in 1990 and 2000, and the Statewide Fisheries Plan, Summary.

"Maine Rivers Policy," Executive Order No. 1, FY 82/83

On July 6, 1982, Governor Joseph E. Brennan issued the above-captioned Executive Order designating certain river stretches as meriting special protection. The Governor ordered that no new dams shall be constructed on these stretches and that additional development or redevelopment of existing dams on these stretches be designed and executed in a manner that either enhances significant resources values or does not diminish them. This policy was adopted legislatively as part of the Maine Rivers Act.

The section of the Union River on which the Project is located is not one of the listed river segments meriting special protection. Therefore, the order is not applicable to the Project.

[1] The Office of Energy Resources has since been disbanded. The State Planning Office was responsible for oversight and development of Maine's comprehensive plans until it was disbanded in July 2012, although the Department of Agriculture, Conservation, and Forestry does provide municipal level assistance in municipal level comprehensive planning.

The Projected Contribution of Hydroelectric Generation to Meeting Maine's Electricity Needs in 1990 and 2000 (Maine Office of Energy Resources, October 1982)

Executive Order No. 1, FY82/83 directed MOER to prepare an estimate of the contribution that hydropower could make to meet the State's electricity needs in the years 1990 and 2000. The report was prepared in 1982; therefore, much of the information in the MOER report is outdated. However, the report does stress that Maine's energy policy "call for increased reliance on indigenous and renewable resources, such as hydro, in preference to imported and nonrenewable resources, such as oil."

The Project currently conforms with this portion of the Plan in that it contributes hydroelectric generation (an indigenous and renewable resource) in meeting Maine's electricity needs. The new license for the Project is projected to be issued in 2017 and the Project will continue to conform with this portion of the Plan.

Statewide Fisheries Plan, Summary (Maine Department of Inland Fisheries and Wildlife, June 1982)

The Statewide Fisheries Plan evaluates, by river basin, whether new or improved fish passage facilities may be needed at hydro development sites. It also specifies the fishery agencies' management goals, as they existed in 1982. This Plan represents the policies of the three author agencies (Maine Department of Inland Fisheries and Wildlife [MDIFW], Department of Marine Resources [DMR], and Atlantic Sea-Run Salmon Commission – now under the auspices of the Division of Sea-run Fisheries and Habitat within the Maine DMR) regarding conservation, management, and enhancement of river fishery resources in Maine. The Plan also identifies and evaluates significant river fisheries based upon several criteria. The Plan states that at the Ellsworth Project, "No fish passage is required at this time". Subsequent to adoption of the plan, fish passage measures have been provided at the Project.

State of Maine Comprehensive Rivers Management Plan, May 1987 – Volume 2

Volume 2 of the State of Maine Comprehensive Rivers Management Plan consists of the 1982 Maine Rivers Study. The Maine Rivers Study defines a list of unique and natural recreation rivers and classifies the rivers as A, B, C, or D. This study, prepared by the Maine Department of Conservation and National Park Service, identifies the main stem of the Union River from its outlet in Union Bay to Graham Lake, as Class C waters.

The reach of the Union River in the Project vicinity is identified as containing the following unique or significant resource values: Critical Ecologic, Undeveloped, and Anadromous Fishery.

Black Bear's proposals to continue operation of the Project essentially as it is operated now will help maintain or enhance the anadromous fishery in Graham Lake. The continued operation of the Project is consistent with the Plan.

State of Maine Comprehensive Rivers Management Plan, May 1987 – Volume 3

Volume 3 of the State of Maine Comprehensive Rivers Management Plan contains two parts. Part I is a compilation of laws which affect the construction, operation, maintenance, and licensing of hydro projects in Maine. Part II is a compilation of Executive Department Orders and other plans. (Note: A discussion of revised laws and Executive Department Orders implemented after the submittal of Volume 3 to the FERC in 1987 is contained in Volume 4 of the State of Maine Comprehensive Rivers Management Plan submitted to FERC in 1992, see discussion below.)

Volume 3, Part I – Core Laws

The applicability of these Core Laws to the Ellsworth Project are discussed below.

Maine Rivers Act

In the Maine Rivers Act 12 M.R.S.A.§401 et. seq., the Legislature expressly found:

> …..the state's rivers comprise one of its most important natural resources, historically vital to the state's commerce and industry; that the value of the state's rivers and streams has increased due to the growth in demand for hydropower; that the rivers and streams afford Maine people with major opportunities for economic expansion through the development of hydropower; and that "the best interests of the state's people are served by a policy which recognizes the importance that their rivers and streams have for meeting portions of several public needs, provides guidance for striking a balance among the various uses which affords the public the maximum benefit and seeks harmony rather than conflict among these uses." 38 M.R.S.A.§402(6).

Black Bear has consulted with and actively worked to resolve issues as they were raised by appropriate federal and state agencies, tribes, local governments, and non-governmental organizations (NGOs) during the relicensing process. This process has identified the importance of continued operation of the Project while identifying the relative importance of the river and its resources for various uses in providing public benefits. Where Black Bear has worked with the various interests to develop a proposal that balances the applicable needs, the Project conforms with these Core Laws.

Maine Waterway Development and Conservation Act (MWDCA) 38 M.R.S.A.§630 et. seq.

The MWDCA replaced several earlier laws and requires the developer to obtain one permit from the Maine Department of Environmental Protection (MDEP) or the Land Use Planning Commission (LUPC). The legislature emphasized the importance of hydropower to the State of Maine when it enacted the MWDCA.

> The legislature finds and declares that the surface waters of the State constitute a valuable indigenous and renewable energy resource; and that hydropower development utilizing these waters is unique in its benefits and impacts to the natural environment, and makes a significant contribution to the general welfare of the citizens of the State for the following reasons:
>
> - Hydropower is the State's only economically feasible, large-scale energy resource which does not rely on combustion of a fuel, thereby avoiding air pollution, solid waste disposal problems and hazards to human health from emissions, wastes and by-products. Hydropower can be developed at many sites with minimal environmental impacts, especially at sites with existing dams or where current type turbines can be used.
> - Like all energy generating facilities, hydropower projects can have adverse effects; in contrast with other energy sources, they may also have positive environmental effects. For example, hydropower dams can control floods and augment downstream flow to improve fish and wildlife habitats, water quality and recreation opportunities.
> - Hydropower is presently the State's most significant indigenous resource that can be used to free our citizens from their extreme dependence on foreign oil for peaking power.

Black Bear is proposing to continue to operate the Project to provide a source of renewable energy available to the people of Maine. Therefore, the continued operation of the Project is consistent with the policies expressed by the Maine legislature. By continuing to operate the Project as proposed, the energy-related benefits noted above will continue, as will the benefits to fish and wildlife habitat, water quality and recreation opportunities.

Black Bear is proposing the construction of recreational and environmental enhancements at the Project over the term of the new license; i.e. improve the boat launch, relocate the canoe portage, improve the fisherman access trail, and provide an upstream eel passage facility. Licensee will obtain MWDCA permits if necessary for the construction of these facilities.

An Act Concerning Fishways in Dams and Other Artificial Obstructions in Inland Waterways – 12 M.R.S.A.§7701-A

This act was enacted with the intent of conserving, developing, or restoring anadromous or migratory fish resources by requiring the construction or repair of fishways. The decision to require a fishway at a dam must, under the Act, be based on the restoration of one or more fish species of anadromous or migratory fish to the area upstream of the obstruction. In addition, the decision to require a fishway may be justified by the protection or enhancement of any rare, threatened, or endangered fish species.

The Project area contains both riverine and impoundment fisheries habitats. Fish passage facilities are in place in the tailwater area below the Ellsworth Dam. The facilities include a fishway with an integral trapping facility that captures river herring and Atlantic salmon. The fish are transported to the appropriate stocking areas upstream. Downstream passage at Graham Lake Dam consists of a surface weir. The Ellsworth Dam has a surface weir/collection box system with a flume. Black Bear proposes to continue the operation of fish passage facilities and fish trucking activities. Therefore, the Project conforms to this Act.

An Act Concerning Fishways in Dams and Other Artificial Obstructions in Coastal Waters – 12 M.R.S.A.§6121

This act states that the Commissioner of Inland Fisheries and Wildlife shall annually examine all dams and other artificial obstructions to fish passage within the coastal waters in order to determine whether fishways are necessary, sufficient or suitable for the passage of anadromous fish.

The Project area contains both riverine and impoundment fisheries habitats. Fish passage facilities are in place in the tailwater area below the Ellsworth Dam. The facilities include a fishway with an integral trapping facility that captures river herring and Atlantic salmon. They are transported to the appropriate stocking areas upstream. Downstream passage at Graham Lake Dam consists of a surface weir. The Ellsworth Dam has a surface weir/collection box system with a flume. Black Bear proposes to continue the operation of fish passage facilities and fish trucking activities. Therefore, the Project conforms to this Act.

The facility provides for upstream fish passage and is also used for the commercial harvest of river herring by the City of Ellsworth under a cooperative management agreement with the Maine Department of Marine Resources.

The Maine Dam Inspection, Registration, and Abandonment Act – 38 M.R.S.A.§815 et. seq.[2]

This law allows MDEP to establish water level regimes and minimum flow requirements for impoundments not within the jurisdiction of FERC.

This statute is not applicable to the Project since it is a FERC-licensed Project and is not subject to Maine DEP jurisdiction regarding establishment of water levels.

An Act to Amend the Classification System for Maine Waters and Change the Classification of Certain Waters – 38 M.R.S.A.§464 et. seq.

This Act was enacted to restore and maintain the chemical, physical, and biological integrity of the State's waters and to preserve certain pristine state waters. Water quality standards for fresh surface waters established by the Act that are pertinent to the Ellsworth Project consist of Class B, and Class GPA waters. The operation of the Project and its consistency with these standards is discussed in Exhibit E, Section 4.4.2.

Alteration of Rivers, Streams and Brooks – 38 M.R.S.A.§425 et. seq.

This article prohibited the alteration of a river, stream, or brook or areas adjacent to rivers, streams, or brooks due to dredging, filling, or construction such that any dredged spoil, fill or structure may fall or be washed into these waters without first obtaining a permit from the Commissioner. This act was replaced with the Natural Resources Protection Act (NRPA), 38 M.R.S.A.§480-A et. seq. which regulates similar activities along the State's waters. However, projects that are reviewed under the MWDCA are not subject to review under the Natural Resources Protection Act (NRPA).

The Licensee is not proposing any construction or redevelopment of the Project that would require an NRPA permit. If any construction is proposed in the future, the appropriate permits will be obtained.

Mandatory Shoreland Zoning and Subdivision Control – 38 M.R.S.A.§435 et. seq.

This article requires that lands within 250 feet of the normal high water mark of certain waters or wetlands be subjected to municipal zoning and subdivision control.

[2] Legislative actions in recent years have changed the scope of this act.

The City of Ellsworth, Town of Mariaville, Town of Waltham, and the Maine Land Use Planning Commission (which covers Fletchers Landing Township) currently have zoning requirements for those lands located within 250 feet of the normal high water mark of the Project impoundments. The Licensee is proposing the construction of several recreational and environmental enhancements at the Project over the term of the new license; Black Bear will obtain any required shoreland zoning permits prior to construction of any of the new facilities.

Land Subdivision – 30-A M.R.S.A.§4401-4407

This article grants special protection from land subdivisions to particular river reaches identified in the article. This article does not include any Project area lands. Black Bear is not proposing any construction that would be considered a subdivision. The Project conforms with this article.

Land Use Regulations – 12 M.R.S.A. §681 et. seq

This article requires the sound planning, zoning, and subdivision control of the unorganized and organized townships of the State.

The City of Ellsworth, Town of Mariaville, and Town of Waltham are located in an organized portion of the state that is subject to the jurisdiction of the Maine Department of Environmental Protection and local municipalities. Fletchers Landing Township is subject to LUPC regulations for the lands abutting the Project boundary include the Great Pond Protection Subdistrict. The purpose of this subdistrict is to regulate residential and recreational development on Great Ponds to protect water quality, recreation potential, fishery habitat, and scenic character. This subdistrict applies to areas within 250 feet of the normal high water mark of those bodies of standing water 10 acres or greater in size. Allowed uses without a permit include temporary docks, forest management activities, except for timber harvesting, primitive recreational uses and wildlife and fishery management practices (LURC, 2011). The Project conforms to this article for Fletchers Landing Township.

Special River Protection Zoning Map. Legend List (Maine Land Use Regulation Commission, 1987)

This map identifies river segments that have been designated by the Land Use Regulatory Commission[3] for "Special River Protection Zoning."

[3] The Land Use Regulatory Commission (LURC) is now the Land Use Planning Commission (LUPC).

The Project is mainly located in an organized portion of the state that is subject to the jurisdiction of the Maine Department of Environmental Protection and local municipalities. A small portion of the Project is located in Fletchers Landing Township, which is subject to LUPC regulations, this section of the Union River is not identified in the Special River Protection Zoning map.

Maine Rivers Access and Easement Plan (Joseph Handy, 1985)

Black Bear has consulted with stakeholders on access and other recreation issues in the Project area, and proposed recreation enhancements as detailed in Exhibit E, Section 4.4.7. The Project is in conformance with the strategies outlined in this Plan.

Designating the State Agencies Responsible for Water Quality Certification, Executive Order No. 5, FY85/86 Note: Updated Order No. 3, 96/97

This executive order identifies the state agencies responsible for reviewing and authorizing water quality certifications for hydropower projects. Maine DEP has jurisdiction for water quality certification for the licensing of the Ellsworth Project.

Black Bear will apply for water quality certification from Maine DEP in accordance with FERC's regulations. Project water quality and its consistency with these standards are discussed in Exhibit E, Section 4.4.2.

State of Maine Comprehensive River Management Plan – December 1992 – Volume 4

Volume 4 of the State of Maine Comprehensive River Management Plan consists of three sections. Part I is a summary of the revised Core Hydro Laws subsequent to those contained in Volume 3 which were approved in 1987. Part II is a compilation of Executive Orders and other plans including Maine resource agency policy regarding hydropower. Part III contains reports and studies regarding hydropower and relicensing.

Volume 4, Part I – Revised Core Hydro Laws

The revisions to the Core Hydro Laws contained in Volume 4 of the Plan are not all pertinent to the Ellsworth Project. The revised Core Hydro Laws that are pertinent to the Project are discussed below.

<u>Special Protection for Outstanding Rivers</u>

This law identifies river segments that are protected from further hydroelectric development in the State of Maine.

The Project is not located on an Outstanding River segment, and is therefore compliant with this law.

Hydropower Relicensing Standards

These standards require that existing hydropower impoundments be managed to protect habitat and aquatic life criteria commensurate with the appropriate water quality classifications. The Ellsworth area is subject to Class GPA water quality standards. Maine statute 38 M.R.S.A. subsection 464(9) clarifies that hydropower projects with impoundments must satisfy the aquatic life criteria contained in 38 M.R.S.A. subsection 464(4)(a) (i.e., Class C), which states that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community. The operation of the Project and its consistency with these standards is discussed in Exhibit E, Section 4.4.2.

Volume 4, Part II – Compilation of Executive Orders and Other Plans

Part II of Volume 4, Implementing Plans and Orders, contains State resource agency plans and policies regarding hydropower. The following plans and orders are discussed:

State of Maine Statewide River Fisheries Management Plan, June 1982

This plan is discussed previously under State of Maine Comprehensive Rivers Management Plan, May 1987 – Volume 1.

Addendum to the State of Maine Statewide Fisheries Management Plan, June 1982

This addendum includes a number of particular projects in the plan's target for anadromous fish restoration. The addendum includes the Union River, which it lists as having the potential for two million alewives.

Maine Comprehensive Hydropower Plan, July 1992

This plan assessed the then current and future demand for hydropower in the State of Maine. Hydropower is recognized as a significant resource available for use in meeting current and future energy needs. The plan also considers the potential for storage facilities to be developed as generating hydro facilities. Operation of the Ellsworth Project is consistent with this plan as it will continue to produce reliable, efficient indigenous energy from hydropower to meet the State of Maine energy needs.

Maine State Agency Hydropower Policy Statements

These policy statements provide the basis for agency comments on hydro-project license applications. These statements are not directly applicable to the Ellsworth Project as they set out the policy for State agencies to follow in commenting on hydro projects in general. Agency comments on the Project are addressed in the appropriate sections of Exhibit E.

Executive Order Designating the State Agencies Responsible for Water Quality Certification

This order identifies Maine DEP as the agency responsible for reviewing and providing water quality certification. Black Bear will apply for water quality certification from Maine DEP in accordance with FERC regulations. Project water quality and its consistency with these standards is discussed in Exhibit E, Section 4.4.2.

Feasibility Study of Maine's Small Hydropower Potential

This study was performed for the Maine Office of Energy Resources and examined the potential for development/expansion of hydropower development of Maine's low head dams.

This plan is not applicable to the Ellsworth Project.

Maine Hydropower Licensing and Relicensing Status Report 1989-91

These reports update hydropower licensing and relicensing activities in the State of Maine for 1989 through 1991. The Project relicensing began after this report was written and is not included in this summary of licensing activities.

Volume 4, Part III – Hydropower and Relicensing Reports and Studies

This section of Volume 4 of the State of Maine Comprehensive River Management Plan describes the current regulations for hydropower relicensing and reports the status of Maine projects with regard to the federal relicensing process.

The studies and reports contained in Part III of the State of Maine Comprehensive River Management Plan are not pertinent to the Ellsworth Project.

State of Maine Statewide River Fisheries Management Plan – June 1982 Maine Department of Inland Fisheries and Wildlife, Maine Department of Marine Resources, and Atlantic Sea-Run Salmon Commission

This plan is discussed previously under State of Maine Comprehensive Rivers Management Plan, May 1987 – Volume 1.

Management of Atlantic Salmon in the State of Maine: A Strategic Plan – July 1984, Maine Atlantic Sea-Run Salmon Commission

This plan lists as its objectives the maintenance of Atlantic salmon populations in rivers where they currently exist, and the restoration of Atlantic salmon populations in historical salmon rivers. The plan also identifies specific strategies to achieve the stated objectives, including fishway installation or improvement, increased hatchery capacity, and diversion of hatchery stocks once natural reproduction increases in stocked rivers.

The Ellsworth Project is not targeted by these restoration plans.

Maine State Comprehensive Outdoor Recreation Plan (SCORP) 2003-2008, Maine Department of Conservation, Bureau of Parks and Lands

This plan serves as the State's official policy document for statewide outdoor recreation planning and for acquisition and development of public outdoor recreation areas and facilities. The plan identifies outdoor recreation issues of Statewide importance based upon, but not limited to, input from the public participation program and also provides information about the demand for and supply of outdoor recreation resources and facilities in the state. The SCORP satisfies the requirements of the Land and Water Conservation Fund (LWCF) Act (P.I. 88-578) which dictates that each state have an approved SCORP available on file with the National Park Service in order to participate in the LWCF program. The SCORP contains an implementation program that identifies the State's strategies, priorities, and actions for the obligation of its LWCF apportionment. The SCORP also includes a wetlands priority component with Section 303 of the Emergency Wetlands Resources Act of 1986. This wetland component provides information on state wetland conservation planning efforts as reflected in the Maine State Wetlands Conservation Plan published in 2001.

The SCORP does not contain any recommendations or assessments that are specific to the Ellsworth Project area. Black Bear has consulted with stakeholders on access and other recreation issues in the Project area throughout the relicensing process. Black Bear is in compliance with the strategies outlined in this plan.

2.8.2 FERC-Approved Federal Comprehensive Plans

Atlantic Salmon Restoration in New England, Final Environmental Impact Statement 1989-2021. U.S. Fish and Wildlife Service, 1989

This document discusses the stated aim of the USFWS relative to Atlantic salmon (i.e., the restoration of self-sustaining populations of Atlantic salmon by the year 2021 to 11 rivers in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island. The Union River is not included.).

The Union River Fisheries Coordinating Committee (URFCC), consisting of state and federal natural resource agencies and non-governmental conservation organizations; as well as the City of Ellsworth; Black Bear Hydro Partners, LLC; and interested members of the public, developed a Comprehensive Fishery Management Plan (CFMP) for the Union River. The management plan consists of multi-year assessment cycles, beginning with 2000-2005. The most recent CFMP covers the period 2015-2017. With respect to Atlantic salmon, only three suspected aquaculture strays (2012) and two wild salmon (one in 2013 and one in 2014), and 1 hatchery (2014) have returned to the Ellsworth Project in the past nine years.

The state and federal natural resource agencies are signatories to the Comprehensive Fishery Management Plan, which is consistent with the objectives described in this document.

Fisheries USA: The Recreational Fisheries Policy of the U.S. Fish and Wildlife Service

This policy, under the auspices of the 1988 National Recreational Fisheries Policy (National Policy), encompasses the guiding principles, goals, and objectives set forth by the National Policy. The Policy, in short, defines the USFWS's stewardship role in management of the Nation’s recreational fishery resources, which include not only angling, but fish watching and photographing. With the Fisheries USA, USFWS committed to accomplish three goals:

- Usability – to optimize the opportunities for people to enjoy the Nation’s recreational fisheries.
- Sustainability – to ensure the future of quality and quantity of the Nation’s recreational fisheries; and
- Action – to work in partnership with other Federal governmental agencies, states, tribes, conservation organizations, and the public to effectively manage the Nation’s recreational fisheries.

Black Bear has consulted with USFWS and other applicable resource agencies and organizations on the topics of protection of fish resources and provisions of recreational fishing opportunities within the Project study area. Sections 4.4.3 and 4.4.7 of Exhibit E describe the existing fish resource and recreational opportunities the Project provides. The Project is in conformance with this policy.

Nationwide Rivers Inventory. National Park Service, January 1982, updated 1995

The Nationwide Rivers Inventory (NRI), completed in 1981 for the New England Region, is a survey of the nation’s rivers conducted to identify segments meeting the minimum criteria for further study and/or potential inclusion into the National Wild and Scenic Rivers System (NWSRS). Once included on the NRI, a river is protected to the extent that pursuant to Section f(d) of the Wild and Scenic Rivers Act, and in accordance with a Presidential Directive and guidance in the form of “Procedures for Interagency Consultation to Avoid or Mitigate Adverse Effects on Rivers in the Nationwide Inventory,” issued by the Council on Environmental Quality:

> “Each federal agency shall, as part of its normal planning and environmental review process, take care to avoid or mitigate adverse effects on Rivers identified in the Nationwide Inventory.” [Presidential Directive, August 2, 1979.]

This directive gives guidance to federal agencies on protecting the resources that cause the river to qualify for listing on the NRI.

According to the NRI, the West Branch of the Union River from the Route 181 bridge to Great Pond is listed for Fish. This segment of the river is a historic Atlantic Salmon Fishery (NPS, 2012). The Project boundary includes a small portion of this river segment. Black Bear has maintained the National Park Service on all distributions throughout the relicensing process and is not proposing any changes to the operation of the Project. The Project is in conformance with this directive.

North American Waterfowl Management Plan – 1986 U.S. Fish and Wildlife Service and Canadian Wildlife Service

This plan identifies waterfowl population goals and outlines the requirements of a waterfowl management and conservation program that would attain these goals. The plan addresses 37 species of the family *Anatidae*, (i.e., ducks, geese and swans) which occur in both the United States and Canada. The plan also discusses groups of similar species in terms of their ecological niche, distribution, abundance, breeding, population status and outlook, and causes of population declines or increases. The plan outlines a variety of initiatives and recommendations which will protect and enhance waterfowl resources, including: financial incentives for landowners for habitat maintenance; outright purchase of significant habitat; protective zoning; private land conservation promotion; financial participation of private conservation organizations; prioritization of public land management to enhance waterfowl resources; public works planning which considers and mitigates waterfowl resource impacts; and encouragement of joint ventures between private and public groups to enhance and preserve waterfowl habitat. Specific recommendations identify areas to be preserved, bag limits, and other hunting limitations for certain species and survey activities.

The majority of initiatives and recommendations contained in this plan are beyond the scope of Black Bear's operation of the Ellsworth Project. The most pertinent initiative of this Plan involves habitat protection and maintenance. The Project provides habitat for a number of the species discussed in this plan. The Project is located within the North Atlantic Flyway, and Project waters thus attract a variety of transient and migrating waterfowl species such as Canada goose, black duck, common merganser, and mallard duck. Continued operation of the Ellsworth Project, as proposed, will have no new effects to Project wildlife or their habitats, but will continue to provide waterfowl habitat for both nesting and migratory species. The Project is in conformance with the plan.

Final Amendment #11 to the Northeast Multi-species Fishery Management Plan; Amendment #1 to the Atlantic Salmon FMP; and Components of the Proposed Atlantic Herring FMP for Essential Fish Habitat. Volume 1. (USFWS, 1998)

In 1996 the U.S. Congress recognized the increasing pressure on marine resources in the country and addressed these problems in its reauthorization of the Magnuson Fishery Conservation and

Management Act, now known as the Magnuson-Stevens Act. This Act required the eight Regional Fishery Management Councils, in collaboration with National Oceanic and Atmospheric Administration (NOAA) Fisheries, to give heightened consideration to Essential Fish Habitat (EFH) in resource management decisions. Congress defined EFH as “those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity.” The designation and conservation of EFH seeks to minimize adverse effects on habitat caused by fishing and non-fishing activities.

The EFH designation for Atlantic represents all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut. Other species of fish incorporated under the NMFS amendments are not applicable to the Project.

Before a Federal agency proceeds with an activity that may adversely affect a designated EFH (e.g., relicensing of a hydro project), the agency must: 1) consult with NOAA Fisheries and, if requested, the appropriate Council for the recommended measures to conserve EFH and 2) reply within thirty days of receiving EFH recommendations. The agency response must include proposed measures to avoid or minimize adverse impacts on the habitat, or alternatively an explanation if the agency cannot adhere to the recommendation from NOAA Fisheries.

FERC will initiate consultation with NMFS regarding EFH for Atlantic salmon in the Project area following receipt of this application.

As mentioned previously, the CFMP addresses the need for fish passage facilities at the Project in a comprehensive fashion. The state and federal natural resource agencies are signatories to the CFMP, which is consistent with the objectives described in this document.

Final Recovery Plan for the Shortnose Sturgeon – 1998 National Marine Fisheries Service.

Congress passed the Endangered Species Act of 1973 (16 USC 1531 et seq., amended 1978, 1982, 1986, 1988) (ESA) to protect species of plants and animals endangered or threatened with extinction. NMFS and USFWS share responsibility for the administration of the Endangered Species Act. NMFS is responsible for most marine and anadromous species including the shortnose sturgeon. Section 4(f) of the ESA directs the responsible federal agency to develop and implement a recovery plan, unless such a plan would not promote the conservation of a species. NMFS determined that a recovery plan would promote conservation and recovery of shortnose sturgeon.

The NMFS recovery plan for shortnose sturgeon primarily addresses recovery of extant (i.e., existing) shortnose population segments. The plan does not specify the Union River in the

NMFS implementation schedule for recovery. Therefore, the plan is not applicable to the Project.

Fishery Management Report No. 24 of the Atlantic States Marine Fisheries Commission: Interstate Fisheries Management for Atlantic striped bass – 1995 National Marine Fisheries Service.

The Atlantic States Marine Fisheries Commission prepared a Fishery Management Plan for the striped bass fishery in order to protect and restore this popular recreational and commercial species. The goal of this amendment is to: perpetuate, through cooperative interstate fishery management, migratory stocks of Atlantic striped bass so as to allow a commercial and recreational harvest consistent with the long-term maintenance of self-sustaining spawning stocks and to provide for the restoration and maintenance of their critical habitat. .

The document describes the goals and objectives for the species, its current status, the ecological challenges affecting the species, and management options and actions needed to reach and maintain management goals.

Striped bass use the Union River estuary for feeding during the spring, summer and fall and are attracted into the river by the presence of migrating river herring, American shad and eels. They are not known to spawn in the Union River, but originate from other coastal migratory populations at major spawning rivers outside of the Gulf of Maine, including the Hudson and Delaware Rivers, and the tributaries to Chesapeake Bay. Striped bass are a popular sportfish in the Union River and are currently protected through the use of regulated minimum sizes, creel limits and seasonal angling restrictions (URFCC, 2014).

As mentioned previously, the CFMP addresses the need for fish passage facilities at the Project in a comprehensive fashion. The state and federal natural resource agencies are signatories to the CFMP, which is consistent with the objectives described in this document.

Fishery Management Report No. 31 of the Atlantic States Marine Fisheries Commission. Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon – 1998 National Marine Fisheries Service.

The Atlantic States Marine Fisheries Commission is a compact of fifteen Atlantic Coast states (including Maine) created to promote better utilization of the fisheries (marine, shell, and anadromous) along the Atlantic seaboard. The goal of the Amendment is to restore Atlantic sturgeon spawning stocks to population levels which will provide for sustainable fisheries and ensure viable spawning populations. The Amendment describes the life history of the species, including spawning locations where known, hatching requirements for eggs, and juvenile nursery area requirements and migrations. The document details a management plan intended to return the stocks to sustainable levels.

According to Amendment 1 of the NMFS Fisheries Management Plan for Atlantic sturgeon, only the estuarine complex of the Kennebec, Androscoggin, and Sheepscot Rivers in Maine currently support a spawning population of Atlantic sturgeon in New England. Amendment 1 requires each state to implement identification and protection of Atlantic sturgeon habitat within its jurisdiction in order to ensure the sustainability of that portion of the spawning stock. States must notify NMFS in writing of the locations of habitats used by Atlantic sturgeon. The State of Maine did not identify the Union River as having Atlantic sturgeon habitat. Therefore, the plan and its amendment are not applicable to the Project.

Fishery Management Report No. 35 of the Atlantic States Marine Fisheries Commission: Shad and River Herring – Amendment 1 to the Interstate Fishery Management Plan for Shad and River Herring – 1999 National Marine Fisheries Service; Technical Addendum 1 to Amendment 1 of the Interstate Fisheries Management Plan for Shad and River Herring – 2000 NMFS.

The Atlantic States Marine Fisheries Commission prepared a Fishery Management Plan for the shad and river herring fishery in order to protect and restore the species. The goal of this amendment is to: protect, enhance, and restore East Coast migratory spawning stocks of American shad, hickory shad, and river herrings in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass.

The document describes the goals and objectives for the species, its current status, the ecological challenges affecting the species, and management options and actions needed to reach and maintain management goals.

A trap and truck operation is run by Black Bear for the purposes of stocking river herring and Atlantic salmon. This operation was implemented in 1974; since 2000, the number of adults stocked upstream has exceeded 100,000 fish and returns have ranged from 9,260 to 1,219,927 fish. Despite annual stocking of hatchery-reared smolts from 1971-1990, sporadic stocking of salmon fry and parr from 1971-2011, and a one-time release of surplus broodstock in 2012, only three suspected aquaculture strays (2012), two wild (one in 2013 and one in 2014), and 1 hatchery (2014) Atlantic salmon have returned to the Ellsworth Project in the past nine years. The CFMP is consistent with the objectives described in this document and conforms with this plan.

Fishery Management Report No. 36 of the Atlantic States Marine Fisheries Commission: Interstate Fisheries Management for American Eel (*Anguilla rostrata*) – 2000 National Marine Fisheries Service.

The Atlantic States Marine Fisheries Commission prepared a Fisheries Management Plan for the American eel fishery in order to protect and restore the species. The Atlantic States Marine Fisheries Commission American Eel Fisheries Management Plan is a working document that describes the goals and objectives for the species, its current status, the ecological challenges affecting the species, and management options and actions needed to reach and maintain management goals. The stated goals of the Fisheries Management Plan are to: (1) protect and enhance the abundance of American eel in inland and territorial waters of the Atlantic States and jurisdictions and contribute to the viability of the American eel spawning population, and (2) provide for sustainable commercial and recreational fisheries preventing the over harvest of any eel life stage.

Although the report does not identify the Union River as eel habitat, Project studies have found that American eel are present in the Union River and Project waters. Following consultation with the Maine DMR, an American Eel Upstream Passage Study was conducted. Black Bear is proposing to develop in consultation with the fisheries agencies upstream passage measures for eel at the Project. Downstream eel passage studies are scheduled at the project during the fall of 2015 and 2016.

Interstate Fishery Management Plan for Atlantic Sturgeon: Amendment 1 - 1998 Atlantic States Marine Fisheries Commission.

Amendment 1 was designed to result in stock recovery, with consequent ecological and economic benefits to coastal ecosystems and fishermen. Amendment 1 describes the life history of Atlantic sturgeon, including spawning, hatching requirements, juvenile nursery area requirements and migration, as well as stock assessment.

Interstate Fishery Management Plan for Shad and River Herring Technical Addendum 1 - 2000 Atlantic States Marine Fisheries Commission.

Technical Addendum #1 (February 2000) was adopted to correct and clarify the monitoring requirements in Amendment 1, Tables 2 and 3.

Interstate Fishery Management Plan for Shad and River Herring Amendment 2 - 2009. Atlantic States Marine Fisheries Commission.

Amendment 2 was developed based on the concern that river herring are in decline coast-wide. Amendment 2 prohibits interstate commercial and recreational fisheries beginning January 1, 2012, unless a sustainable management plan was submitted for approval by a state or jurisdiction by January 1, 2010. Amendment 2 also required fishery independent and dependent monitoring from member states to conserve, restore, and protect critical river herring habitat.

Interstate Fishery Management Plan for Shad and River Herring Amendment 3 - 2010. Atlantic States Marine Fisheries Commission.

Amendment 3 establishes a coast wide commercial and recreational moratorium, with exceptions for sustainable systems, for shad and river herring. To improve data collection of shad and river herring, Amendment 3 implemented additional fisheries independent and dependent monitoring for some states or jurisdictions, such as, monitoring stocks, hatchery production, and commercial, recreational, and bycatch fisheries. Finally, Amendment 3 requires states and jurisdictions to submit a habitat plan regardless of whether their commercial fishery would remain open.

2.9 Financial and Personnel Resources

Black Bear has considerable experience operating not only the Ellsworth Project but several other licensed hydroelectric and water storage projects as well. Black Bear has operated the Project and multiple other hydroelectric and water storage projects since 2009. Black Bear has available a complete staff of engineers, biologists, operators, mechanics, and electricians that are trained and experienced in the operation of hydroelectric projects. In addition, Black Bear has available the administrative, licensing, and support personnel that are needed to maintain compliance with the terms of the license.

Information regarding the Project’s expected annual costs and value are provided in Exhibit D of the License Application.

2.10 Notification of Affected Land Owners

Black Bear does not propose to expand the Project to encompass additional lands of others. Therefore, notification of adjacent landowners is not applicable.

2.11 Applicant’s Electricity Consumption Efficiency Improvement Program

Because Black Bear is an independent power producer, this section is not applicable to the Project.

2.12 Identification of Indian Tribes Affected by the Project

There are no Indian tribes affected by the Project. The four federally-recognized Indian tribes having the potential to be interested in the relicensing are included on the distribution list for the Project.

3.0 INFORMATION TO BE PROVIDED BY AN APPLICANT WHO IS AN EXISTING LICENSEE

3.1 Measures Planned to Ensure Safe Management, Operation, and Maintenance of the Project

The Ellsworth Project is operated remotely from Brookfield Renewable Energy Group's North American System Control Center (NASCC) in Marlboro, MA[4]. An operator is available during weekdays and weekends as necessary to perform routine maintenance and operations at the Ellsworth Project. Daily logs of pond level, flow, and outages are maintained electronically for the Project.

The Project is subject to regular Part 12 Inspections by FERC. FERC's New York Regional Office conducts an environmental inspection every four to five years. Black Bear completes all necessary corrective actions to address comments and recommendations arising from FERC inspections in a timely manner.

The dam is inspected routinely by Black Bear's Engineering and Operations staff, as well as after local earthquakes of magnitude 3.0 or greater and floods in the Project vicinity. Black Bear conducts an annual field reconnaissance upstream and downstream of the Project to verify that no changes have occurred that would reasonably be expected to adversely affect public health, safety, or property in the event of a dam failure. Further, Black Bear maintains and annually verifies the accuracy of a contact list to be used in the event of a dam failure at the Project. An independent inspection by Black Bear's engineering staff is also conducted annually and routine repairs are performed as needed.

Black Bear has placed a copy of the Emergency Action Plan (EAP) at the Project and at its office in Lewiston, Maine. Local operations staff is on call 24 hours a day. Black Bear's staff reviews the EAP at least annually and there is an annual EAP training for Project personnel.

3.1.1 Existing and Planned Operation of the Project During Flood Conditions

The Ellsworth Project is operated as a peaking plant, with water being released from the Graham Lake reservoir and then used to generate electricity at the downstream Ellsworth powerhouse. During periods of high inflows, primarily in the spring and fall, the project may generate at full load up to 24 hours a day.

[4] Licensee Black Bear Hydro Partners, LLC is member of Brookfield Renewable Energy Group.

The ability to store large volumes of inflow in the spring is also valuable given the location of downtown Ellsworth just below the Ellsworth Dam. In a potential flood situation, Black Bear dam operators work to manage water levels along the Union River in order to minimize risk and flood damage.

Black Bear is proposing to operate the Ellsworth Project essentially as it has been operated in the past with some resource enhancements. There would be no significant changes to the fundamental operation of the Project to support downstream flows or the flow regime in the Union River. As a result, the Project will continue to provide important benefits of regulated, relatively stable downstream flows.

3.1.2 Warning Devices Used to Ensure Downstream Public Safety

There are numerous safety signs at the Project and along the Union River advising the public of the Project and safety considerations. These signs are in addition to the signs attached to the upstream safety barriers (installed during the summer boating season upstream of the spillway gates and intake to protect boaters using the impoundments) and the recreational and information signs posted in the vicinity of the Project. Black Bear's Public Safety Plan for the Project was filed with the Commission on November 23, 2015. Black Bear's High Water Guidelines for the Project are appended to the Project's Emergency Action Plan, which was filed with the Commission on December 7, 2015.

3.1.3 Proposed Changes Affecting the Existing Emergency Action Plan

There are no proposed changes that would affect the existing EAP. As noted above, Black Bear conducts an annual field reconnaissance upstream and downstream of the Project to verify that no changes have occurred that would reasonably be expected to adversely affect public health, safety, or property in the event of a dam failure. Further, Black Bear maintains and annually verifies the accuracy of a contact list to be used in the event of a dam failure at the Project.

3.1.4 Existing and Planned Monitoring Devices

See Exhibit F – Supporting Design Report of this application for a complete description of existing monitoring devices at the Project.

3.1.5 Project's Employee and Public Safety Record

Black Bear has an excellent record of operating in a work-safe environment. During the past 5 years[5], there have been no employee deaths or recordable injuries at the Project.

There have been no project-related deaths or serious injuries to members of the public within the Project boundary during the past 5 years.

Black Bear is committed to maintaining and operating its facilities in a manner that allows the public to safely enjoy recreational activities. Upstream safety barriers are installed during the summer boating season upstream of the spillway gates and intake to protect boaters using the impoundments, and warning signs are posted at numerous locations around the Project and on the Union River.

3.2 Current Operation of the Project

A full description of the Project operation is contained in Exhibit B of this License Application.

3.3 Project History

A description of the Project history is contained in Exhibit C of this License Application.

3.4 Lost Generation Due to Unscheduled Outages

Table H -1 lists the record of unscheduled outages and related lost generation during the last five years.

[5] Black Bear Hydro Partners, LLC became the Licensee for the Project by FERC Order Approving Transfer of License dated September 17, 2009 (128 FERC ¶ 62,212).

Table H-1: Ellsworth Project Unscheduled Outages and Lost Generation, 2010-2014

Unit	Date/Time Unavailable	Date/Time Available	Reason for Unit Unavailability	Estimated MW Hours Lost[1]
3	March 19, 2011	April 25, 2011	High vibration alarm	2
3	April 1, 2011	April 8, 2011	High vibration alarm	2
2	December 30 2011	March 19, 2011	Pilot exciter	2
4	September 3, 2013	October 4, 2013	Programmable component failure	0
4	May 14, 2014	May 19, 2014	Broken wicket gate link	0

3.5 Licensee's Record of Compliance

The Project has a good record of compliance with the terms and conditions of the existing license. The Licensee has received a single letter of violation. On January 27, 2015 the Commission notified Black Bear that, in relation to an October/November 2014 fisheries incident at the Project, it had failed to show due diligence in the operation of the downstream fish passage facilities as required by Article 406 of the license, which consequently resulted in a violation of Article 406. Licensee met with the Commission and responded to the various requests from the Commission regarding the incident, supplying information regarding the incident and measures undertaken to ensure safe and effective fish passage at the facility. By letter dated May 26, 2015, the Commission summarized its understanding of the incident and expressed its appreciation for Licensee's responses and for the measures that were being undertaken to improve fish passage. All of the measures proposed have been, or are currently being, implemented by Licensee.

3.6 Actions Affecting the Public

Operation of the Ellsworth Project provides regulated, relatively stable flow and water levels to the Union River from the Graham Lake Dam downstream through downtown Ellsworth.

Black Bear has always allowed public access to the Project impoundments and the surrounding Project lands. Recreation within the Project boundary is typically recreational fishing and boating. Other portions of the Union River offer opportunities for boating, picnicking, swimming, kayaking, and fishing. Black Bear provides public recreation access at several formal recreation sites that provide opportunities for bank fishing and motorized and non-motorized boating. A full description of these opportunities, associated recreational facilities provided by the Black Bear, and the recreational enhancement proposed are contained in Exhibit E of this application. Black Bear is proposing to implement a Recreation Facilities Management Plan for the Project.

Black Bear's regard for public safety is demonstrated by its active program of installing warning signs and safety devices at the Project. These are described in the Public Safety Plan which was most recently filed with the Commission on November 23, 2015.

3.7 Ownership and Operating Expenses That Would Be Reduced if the License Were Transferred

Black Bear is applying for a long-term license to continue to maintain and operate the Project. Additionally, there is no competing application to take over the Project. Because there is no proposal to transfer the Project license, this section is not applicable to the Project.

3.8 Annual Fees for Use of Federal or Native American Lands

This section is not applicable to the Project since it uses no federal or Native American lands.

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