TRANSCANADA HYDRO NORTHEAST INC.

VERNON HYDROELECTRIC PROJECT

FERC PROJECT NO. 1904

PRE-APPLICATION DOCUMENT

Project Location, Facilities, and Operation
18 C.F.R. § 5.6(d)(2)

Description of Existing Environment and Resources Impacts
18 C.F.R. § 5.6(d)(3)

Preliminary Issues and Studies List
18 C.F.R. § 5.6(d)(4)

October 30, 2012

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TERMS, ACRONYMS, AND ABBREVIATIONS

APE	area of potential effects
BCC	Birds of Conservation Concern
CEII	Critical Energy Infrastructure Information
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
CPUE	catch per unit effort
CRASC	Connecticut River Atlantic Salmon Commission
CRJC	Connecticut River Joint Commissions
CSO	combined sewer overflow
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission (the Commission)
FPA	Federal Power Act
FWS	U.S. Fish and Wildlife Service
HPMP	Historic Properties Management Plan
IBI	Index of Biotic Integrity
ILP	Integrated Licensing Process
IPANE	Invasive Plant Atlas of New England
ISO-NE	New England Independent System Operator
ITA	Indian Trust Assets
LBG	Louis Berger Group, Inc.
mg/L	milligrams per liter
MIwb	Modified Index of Well-Being
msl	mean sea level
MW	megawatt
MWh	megawatt-hour
NAC	Northeast Aquatic Connectivity
National Register	National Register of Historic Places
NEP	New England Power Company
New Hampshire DES	New Hampshire Department of Environmental Services
New Hampshire DHR	New Hampshire Department of Historic Resources
New Hampshire Fish & Game	New Hampshire Fish and Game Department
New Hampshire NHB	New Hampshire Natural Heritage Bureau
NGO	Non-Governmental Organization
NHPA	National Historic Preservation Act
NOI	Notice of Intent

Normandeau	Normandeau Associates, Inc.
NPDES	National Pollution Discharge Elimination System
NWI	National Wetlands Inventory
PAD	Pre-Application Document
PAL	Public Archaeology Laboratory
PM&E measures	protection, mitigation, and enhancement measures
QHEI	Qualitative Habitat Evaluation Index
RM	river mile
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SHPO	State Historic Preservation Office
SWRPC	Southwest Regional Planning Commission
TCP	Traditional Cultural Property
TMDL	Total Maximum Daily Load
TransCanada	TransCanada Hydro Northeast Inc.
Tribes	Native American (FERC term is Indian) tribes
TWI	Targeted Watershed Initiative
USACE	U.S. Army Corps of Engineers
USASAC	U.S. Atlantic Salmon Assessment Committee
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UVLSRPC	Upper Valley Lake Sunapee Regional Planning Commission
Vermont DEC	Vermont Department of Environmental Conservation
Vermont DHP	Vermont Division for Historic Preservation
Vermont Fish & Wildlife	Vermont Fish and Wildlife Department
Vermont NHIP	Vermont Natural Heritage Information Project
Vermont Yankee	Vermont Yankee Nuclear Power Plant
WAP	Wildlife Action Plan

INTRODUCTION

The Licensee, TransCanada Hydro Northeast Inc. (TransCanada) hereby files with the Federal Energy Regulatory Commission (FERC) the required Pre-Application Document (PAD) for the relicensing of the existing Vernon Hydroelectric Project (Project), FERC No. 1904. Power generated by the Project is sold through bilateral contracts or into the wholesale market administered by ISO New England and delivered to the grid via an interconnection to the regional transmission system.

The Vernon Project is located on the Connecticut River at river mile (RM) 141.9, about 2 miles upstream of the Ashuelot River and 7.4 miles downstream of the West River, in the town of Vernon, Vermont, and the town of Hinsdale, New Hampshire. The Project area extends about 26 miles upstream terminating at the Walpole Bridge (Route 123) at Westminster Station, Vermont, about 4 miles downstream of the Bellows Falls Project (FERC No. 1855). The downstream Project boundary is the downstream side of Vernon dam because the upstream boundary of the Turners Falls Project (FERC No. 1889) impoundment at normal reservoir elevation abuts the downstream face of the Vernon dam.

The Project consists of (1) a concrete gravity dam 956 feet long and 58 feet high, and consists of the integral powerhouse with a sluice gate block section that is about 356 feet long, and a concrete overflow spillway section about 600 feet long with 6 tainter gates, 2 hydraulic flashboard bays, 3 stanchion bays, and a sluice; (2) the Vernon reservoir, extending 26 miles upstream, having a surface area of 2,550 acres at normal full pond elevation of 220.13 feet mean sea level (msl); (3) a powerhouse containing ten generating units, with Unit Nos. 1 – 4 rated at 2,000 kW, Unit Nos. 5 – 8 rated at 4,000 kW and unit Nos. 9 – 10 rated at 4,200 kW; (4) transmission interconnection facilities; (5) fish passage facilities; and (6) appurtenant facilities.

The current license for the Project was issued by FERC in 1979 for a term of 40 years. On February 27, 1998, FERC approved the transfer of the license from New England Power Company to USGen New England, Inc. On January 24, 2005, FERC approved the transfer of the license to TransCanada Hydro Northeast Inc., the current Licensee. The current license expires on April 30, 2018.

The Licensee is using FERC's Integrated Licensing Process (ILP) as set forth in Title 18 of the US Code of Federal Regulations (C.F.R.), Part 5. This PAD accompanies the Licensee's Notice of Intent to File a License Application (NOI) to seek a new license for the Project. The Licensee is distributing the PAD and NOI simultaneously to federal and state resource agencies, local governments, Native American (FERC term is Indian) tribes (tribes), non-governmental organizations (NGOs), members of the public, and other parties potentially interested in the relicensing proceeding. The PAD provides FERC and the entities listed above with summaries of existing, relevant, and reasonably available information related to the Project that was in the Licensee's possession as supplemented by a due diligence search. The information required in the PAD is specified in 18 C.F.R. § 5.6 (c) and (d).

The Licensee exercised due diligence in preparation of this PAD by contacting appropriate governmental agencies, tribes and others potentially having relevant information and by conducting extensive searches of publically available databases and its own records. In addition, the Licensee performed studies as described in section 3 of this PAD to augment readily available information on issues of concern to our stakeholders.

The existing, relevant, and reasonably available information presented in this PAD provides Interested Parties in this relicensing proceeding the information necessary to identify issues and related information needs and develop study requests preceding the Licensee's Application for a New License (License Application), which must be filed with FERC on or before April 30, 2016.

The PAD is also a precursor to the environmental analysis section of the License Application and to the FERC's Scoping Documents and Environmental Impact Statement, or Environmental Assessment, under the National Environmental Policy Act. Filing the PAD concurrently with the NOI enables those who plan to participate in the relicensing to familiarize themselves with the Project at the start of the proceeding. This familiarity is intended to enhance the FERC scoping process that follows issuance of the PAD.

1.0 PROCESS PLAN, SCHEDULE, AND PROTOCOLS

1.1 OVERALL PROCESS PLAN AND SCHEDULE

TransCanada developed this process plan and schedule in accordance with the timeframes established in 18 C.F.R. Part 5 based on a NOI filing date of October 30, 2012. The process plan and schedule in table 1.1-1 outline the specific timeframes, deadlines, and responsibilities of FERC, TransCanada, and other stakeholders in the ILP from the filing of the NOI and PAD through filing of the application for license. By regulation, TransCanada, resource agencies, tribes, and FERC must adhere to this regulatory schedule. TransCanada is committed to working with all stakeholders to ensure the expeditious resolution of any issues.

1.2 SCOPING MEETINGS AND SITE VISIT

Pursuant to 18 C.F.R. § 5.8 (b), FERC will hold a site visit and scoping meetings. Although FERC typically conducts an environmental site review at approximately the same time as the scoping meetings, in this instance FERC conducted a publicly noticed environmental site review at the Vernon Project on October 3, 2012, due to the potential for inclement weather and winter conditions restricting viewing opportunities of the reservoir at the time of the scheduled scoping meetings. Typically, FERC conducts two scoping meetings with one meeting held during the day to focus on the solicitation of comments and information from resource agencies and tribes and the second meeting held in the evening to facilitate participation from the public and NGOs. FERC will provide a public notice of the scoping meetings. All interested parties are invited to participate in the meetings. Additional information regarding the scoping meetings may also be obtained by contacting:

Mr. Kenneth Hogan
Federal Energy Regulatory Commission
(202) 502-8434
Kenneth.Hogan@ferc.gov

1.3 PROCESS PLAN AND SCHEDULE

TransCanada intends to follow the process plan and schedule provided in table 1.1-1, consistent with the ILP process (18 C.F.R. §5).

Table 1.1-1. Proposed process plan and schedule.

18 C.F.R.	Lead	Activity	Timeframe	Deadline[a]
§ 5.5 (a)	TransCanada	Deadline to File NOI		10/30/2012[b]
§ 5.6 (a)	TransCanada	Deadline to File PAD		10/30/2012
§ 5.7	FERC	Initial Tribal Consultation Meeting	Within 30 Days of filing NOI and PAD	12/3/2012

18 C.F.R.	Lead	Activity	Timeframe	Deadline[a]
§5.8(a) b(2)	FERC	FERC Issues Notice of Commencement of Proceeding and Scoping Document (SD1) and requests to Initiate Informal Consultation under Section 7 of the ESA Consultation and section 106 of the NHPA	Within 60 days of filing NOI and PAD	12/29/2012
§5.8 (b)(3) (viii)	FERC / Stakeholders	Public Scoping Meeting	Within 30 days of NOI and PAD notice and issuance of SD1	1/30/2013
§ 5.9	Stakeholders	File Comments on PAD, SD1, and Study Requests	Within 60 days of NOI and PAD notice and issuance of SD1	2/27/2013
§5.10	FERC	FERC Issues Scoping Document 2 (SD2) (if necessary)	Within 45 days of deadline for filing comments on SD1	4/13/2013
§5.11(a)	TransCanada	File Proposed Study Plans	Within 45 days of deadline for filing comments on SD1	4/13/2013
§5.11 (e)	TransCanada / Stakeholders	Study Plan Meetings	Within 30 days of deadline for filing proposed Study Plans	5/13/2013
§5.12	Stakeholders	File Comments on Proposed Study Plan	Within 90 days after proposed study plan is filed	7/12/2013
§5.13 (a)	TransCanada	File Revised Study Plan (if necessary)	Within 30 days following the deadline for filing comments on proposed Study Plan	8/11/2013
§5.13 (b)	Stakeholders	File Comments on Revised Study Plan (if necessary)	Within 15 days following Revised Study Plan	8/26/2013
§5.13 (c)	FERC	FERC Issues Study Plan Determination	Within 30 days following Revised Study Plan	9/10/2013
§5.14 (a)	Stakeholders/ FERC	Formal Study Dispute Resolution Process (if necessary)	Within 20 days of Study Plan determination	9/30/2013
§5.14(l)	FERC	Study Dispute Determination	Within 70 days from notice of study dispute	12/9/2013

18 C.F.R.	Lead	Activity	Timeframe	Deadline[a]
§5.15 (a)	TransCanada	Conduct First Season Field Studies	Spring/summer 2014	
§5.15 (b)	TransCanada	File Study Progress Reports	Spring/summer 2014	
§5.15 (c)(1)	TransCanada	File Initial Study Reports	No later than one year from Study Plan approval	9/10/2014
§5.15 c)(2)	TransCanada	Initial Study Results Meeting	Within 15 days of Initial Study Report	9/25/2014
§5.15 (c)(3)	TransCanada	File Study Results Meeting Summary	Within 15 days of Study Results Meeting	10/10/2014
§5.15 (c)(4)	Stakeholders/ FERC	File Meeting Summary –Dispute/Modifications to Study/Propose New Studies (if necessary)	Within 30 days of filing Meeting Summary	11/9/2014
§5.15 (c)(5)	TransCanada	File Responses to Disputes (if necessary)	Within 30 days of disputes	12/9/2014
§5.15	FERC	Dispute Resolution (if necessary)	Within 30 days of filing responses to disputes	1/8/2015
§5.15	TransCanada	Conduct Second Season Field Studies	Spring/summer 2015	
§5.15 (f)	TransCanada	File Updated Study Reports	No later than two years from Study Plan approval	9/10/2015
§5.15 (f)	TransCanada	Second Study Results Meeting	Within 15 days of Updated Study Report	9/25/2015
§5.15 (f)	TransCanada	File Study Results Meeting Summary	With 15 days of Study Results Meeting	10/10/2015
§5.15 (f)	Stakeholders / FERC	File Meeting Summary Disputes/ Modifications to Study/Propose New Studies (if necessary)	Within 30 days of filing Meeting Summary	11/9/2015
§5.15 (f)	TransCanada / Stakeholders	File Responses to Disputes (if necessary)	Within 30 days of disputes	12/9/2015
§5.16 (a)	TransCanada	File Preliminary Licensing Proposal (or Draft License Application) with the FERC and distribute to Stakeholders	Not later than 150 days before final application is filed	12/2/2015

18 C.F.R.	Lead	Activity	Timeframe	Deadline[a]
§5.16 (e)	FERC / Stakeholders	Comments on TransCanada Preliminary Licensing Proposal, Additional Information Request (if necessary)	Within 90 days of filing Preliminary Licensing Proposal (or Draft License Application)	3/1/2016
§5.17 (a)	TransCanada	License Application Filed		4/30/2016

[a] This schedule may adjust based upon filing dates of required documents. When a regulatory deadline falls on a weekend or federally recognized holiday, the actual due date will be on by the close of the next business day.

[b] The earliest date that TransCanada can file the NOI/PAD.

1.4 PROPOSED COMMUNICATION PROTOCOL

TransCanada is proposing a Communication Protocol (Protocol) to provide guidelines for effective participation and communication in the Project relicensing process. The Protocol pertains to TransCanada, governmental agencies, NGOs, tribes, and unaffiliated members of the public who participate in the proceedings. The primary means of communication will be meetings, formal documents, email, and telephone. To establish the formal consultation record, all formal correspondence requires adequate documentation. This Protocol provides a flexible framework for dissemination of information and documenting consultation among all Project relicensing participants. This document may be revised from time to time, in consultation with the participants' active in the relicensing process, and will be posted to the relicensing web site. The Protocol remains in effect until FERC issues a new license for the Project.

1.4.1 Participants

TransCanada Relicensing Team – The Relicensing Team will consist of staff and consultants of TransCanada who are responsible for the conduct of relicensing activities within the scope of their authority. TransCanada will assume the lead role in most matters for the purposes of contact, communication, and management of relicensing activities. Consultants cannot speak for or bind TransCanada in any matter. TransCanada's relicensing manager and primary contact for this Project is Mr. John Ragonese:

Mr. John Ragonese
Relicensing Project Manager
TransCanada Hydro Northeast Inc.
4 Park Street, Suite 402
Concord NH 03301
(603) 498-2851
john_ragonese@transcanada.com

FERC –Mr. Kenneth Hogan will serve as the team leader for the FERC team assigned to this initiative. Both FERC staff and contracted consultants for FERC will be referred to as FERC throughout the process. FERC team members will be identified on the relicensing website www.transcanada-relicensing.com. Mr. Hogan will participate in relicensing meetings and provide guidance during the process. FERC's role will be in accordance with the rules and regulations for the ILP (see the FERC website for details http://www.ferc.gov/industries/hydropower.asp). For any questions related to FERC communications, contact Mr. Hogan at kenneth.hogan@ferc.gov or at 202-502-8434.

Parties interested in the Vernon Project relicensing have various options for identifying themselves and their interest based upon level of participation and formal status. Identification of these parties can either be through lists maintained by TransCanada or FERC. TransCanada will have an interested parties list and a relicensing participants list. The distinction between the two is as follows:

- ***Interested Parties*** is the broad group of individuals and entities that have identified themselves to TransCanada or FERC either prior to or following the issuance of the NOI as interested in the relicensing proceedings. They include tribes, state and federal agencies, local governments, NGOs, and private citizens. The initial list to whom the NOI was distributed pursuant to the FERC regulations in Section 5.5(c) was derived from a combination of the FERC mailing lists, the FERC service lists, parties identified through previous consultation or outreach, municipal officials, and abutters or parties with land within the Project boundary.

  Any party that desires to be added to or removed from the interested parties list should either return the prepaid postcard accompanying the NOI, indicating they wish to be removed, send an email to info@transcanada-relicensing.com or send a written request to Mr. John Ragonese at the address or email above. Parties requesting to be added to the interested parties list should provide the following contact information: name, e-mail, mailing address, phone, affiliation if appropriate, and resource area of interest. A current list of interested parties (excluding for privacy reasons, abutting landowners) will be maintained and updated on the TransCanada relicensing website (www.transcanada-relicensing.com).

- ***Relicensing Participants*** is a subset of interested parties and consists of individuals and entities who will actively participate in the relicensing proceeding, working meetings, consultation, collaboration and negotiations.

FERC maintains several lists that identify parties interested in relicensing of the Vernon Project. They include the formal service list, a subscription list, and a mailing list.

- ***Service List***–The FERC establishes an official Service List specific to the Vernon Project for parties who formally intervene (Intervener) in the proceeding. Additional information may be found on FERC's Website at www.ferc.gov. Once FERC establishes a Service List, any written documents filed with FERC must also be sent to the Service List. A Certificate of Service must be included with the document filed with FERC. The official service list is available on the FERC website.

- ***Mailing List*** – A list of names and addresses of contacts on the Service List and contacts that are non-Interveners but who may have communicated with the FERC specific to the project or a docket associated with the project.
- ***eSubscription*** – this is an undisclosed list of parties that wish to be alerted to filings made to the FERC specific to the project or a docket associated with the project. Parties on this list receive email notifications of filings posted to the eLibrary (the searchable electronic document database maintained by the FERC) including a link to the subject document itself.

Any party requesting to be added to the service list should also register for eSubscription of filings associated with the Vernon Project.

1.4.2 Relicensing Websites

TransCanada has established a publicly accessible internet website as a means of making relicensing information and resource information readily available to participants. It will serve as the Public Information or Document Room. It is available at www.transcanada-relicensing.com. A publicly accessible computer terminal for accessing the website will also be available during business hours at TransCanada's office located at 2 Killeen Street, North Walpole, New Hampshire. See section 1.4.5 for more information on access to that facility.

Pertinent information posted to the website will include the process plan and schedule and communication protocol, TransCanada and FERC contacts, calendar, meeting agendas and summaries, reports, and relicensing documents (e.g., PAD, NOI, study plans, preliminary licensing proposal or draft license application, and study reports). Additional information on the website will include operational and background information, the ILP relicensing timeline and how the process works, a list of interested parties who are involved, a project library, and a photo gallery. A library of pertinent historic studies will also be available on the website.

The FERC website is also a valuable resource for relicensing documents, it is located at: www.ferc.gov. Documents related to the Vernon Project relicensing can be accessed by clicking on the eLibrary link and conducting a general search on the Project docket number (P-1904).

1.4.3 General Communications

TransCanada's goal is to keep the lines of communication open during the relicensing process and make it easy for participants in the relicensing process to ask for and receive information related to the relicensing. All participants will informally communicate with each other; however, participants are encouraged to share relevant communications among all participants working on specific resource issues.

Verbal communications at meetings and e-mail will be the primary means of formal communication among participants. TransCanada anticipates that individual and conferencing telephone calls among participates will be treated informally, with no specific documentation unless specifically agreed upon in the discussion or as part of formal agency consultation proceedings.

1.4.3.1 FERC Communication

All written communications to FERC regarding project relicensing must reference the "Vernon Hydroelectric Project FERC No. P-1904 - Application for New License." The sub-docket number assigned by FERC after TransCanada files the NOI should also be included. Comments filed with FERC prior to TransCanada's submission of a final license application for the Vernon Project should be copied to TransCanada and interested parties. After FERC issues a formal notice of acceptance of TransCanada's application, and notice that the application is ready for environmental analysis, intervenors submitting comments to FERC about Project relicensing are required to serve said comments to each person on the official service list as well as to TransCanada (18 C.F.R. §385.2010 (a)). FERC will issue a notice when it is soliciting motions to intervene on a specific proceeding. The official service list is available on the FERC website (see section 1.4.1).

FERC strongly encourages paperless electronic filing of comments and interventions. To eFile comments and/or interventions, interested parties must have an eRegistration account. After preparing the comment or motion to intervene, go to www.ferc.gov, and select the eFiling link. Select the new user option, and follow the prompts. Users are required to validate their account by accessing the site through a hyperlink sent to the registered email account.

An additional method to eFile comments is through the "Quick Comment" system available via a hyperlink on the FERC homepage. "Quick Comments" do not require the users to be registered; the comments are limited to 6,000 characters; and all information must be public. Commenters are required to enter their names and email addresses. They will then receive an email with detailed instructions on how to submit "Quick Comments."

Stakeholders without internet access may request to be added to the mailing list and/or submit comments via hard copy. Send the request or comments to the address below. Official motions to intervene require sending the original and three copies to the address below.

> Honorable Kimberly D. Bose, Secretary
> Federal Energy Regulatory Commission
> 888 First Street, NE
> Washington, D.C. 20426

1.4.4 Meetings

Public participation in the ILP is encouraged. Meetings will generally fall into three categories: Public Information Meetings sponsored by TransCanada; FERC Public Meetings to meet its obligations under the National Environmental Policy Act (NEPA); and Working Group meetings between TransCanada, FERC, and relicensing participants working on or discussing issues and studies specific to a particular resource, issue or interest.

Under the ILP, FERC will hold a public scoping meeting within 30 days of FERC issuing its Scoping Document 1 and notice of commencement of relicensing proceeding corresponding with its acceptance of the NOI and PAD. It is anticipated that any meeting required by FERC to meet its obligations under NEPA or applicable regulation will be scheduled and noticed by FERC staff. In accordance with 18 C.F.R. §5.8 (e), the FERC scoping meetings will be publicly noticed by FERC in the *Federal Register* and in the daily or weekly local newspapers. TransCanada will include notice of these scoping meetings on the public relicensing website.

TransCanada may hold periodic Public Information Meetings thereafter to review and provide opportunities for consultation with members of the public on such matters as the proposed study plan, study review and reporting, the preliminary licensing proposal and the draft environmental analysis. TransCanada will incorporate these additional meetings and schedules into the ILP schedule in a manner that will work to avoid scheduling conflicts and try to minimize any conflicts. TransCanada will provide written notification (email or U.S. Postal Service as available) to the current list of interested parties at least 15 days prior to the meeting date for all meetings unless extraordinary circumstances prevent 15 days advance notice. TransCanada will also post the Public Information Meeting dates on the public relicensing website.

In addition, TransCanada may schedule periodic Working Group Meetings among entities and persons with interests in a specific resource area to address specific issues, develop study plans, or negotiate terms and conditions. Working meetings will be scheduled with the members of these technical working groups, and posted to the public relicensing website.

TransCanada will distribute a full agenda at the meetings, and participants may suggest changes to the agenda at the meeting. TransCanada will post draft meeting summaries for the study plan and study results meetings on the public relicensing website within two weeks following each meeting. The summary will include the participant list, discussion points, decisions, action items, and location and date of the next meeting. Meeting participants are asked to provide redlined comments to the draft meeting summaries within two weeks of the notification. TransCanada will incorporate the comments received and post a final meeting summary to the website. Any comments received along with the final version of the respective meeting summaries will be included in the consultation record submitted with the license application.

Discussion may be closed to the public when matters under review contain information, which if disclosed could endanger sensitive cultural resource sites, or species protected under the Endangered Species Act.

1.4.4.1 Conduct of Meetings

Meetings will generally be held in an accessible location to all those attending. Meeting participants may at any time request short breaks for the purpose of a caucus. Relicensing participants are encouraged to caucus outside the regularly scheduled meetings.

1.4.5 Public Reference File

Until FERC issues a new license for the Project, TransCanada will maintain a Virtual Public Reference Room through the website www.transcanada-relicensing.com where copies of the NOI, PAD, PAD supporting materials, unrestricted published studies will be kept. Access to these materials will be open except for sensitive information as described in section 1.4.5.1. There will be no charge for viewing the documents online. A computer terminal accessing the website and Virtual Public Information Room will be maintained at the TransCanada office located at 2 Killeen Street, North Walpole, New Hampshire. Access to the facility is controlled and requires an escort and advance notice by contacting Mr. John Ragonese at the phone, email, or address provided in section 1.0.

All requests for public records should clearly indicate the document name, publication date (if known), and FERC Project No. 1904. A reproduction charge and postage costs may be assessed for hard copies requested by the public. Federal, state, and tribal entities will not be subject to document-processing or postage fees.

In addition, public reference files will be filed with the FERC and will be available on the FERC website at the eLibrary link and can be searched for by the FERC project docket number (P-1904). In addition, all materials in the public reference files will be available for review and copying at the FERC offices in Washington, DC:

Federal Energy Regulatory Commission
Public Reference Room, Room 2-A
Attn: Secretary
888 First Street, N.E.
Washington, DC 20426

1.4.5.1 Sensitive Information

Certain Project related documents are restricted from public viewing in accordance with FERC regulations. Critical Energy Infrastructure Information (CEII) (18C.F.R. 388.113) related to the design and safety of dams and appurtenant facilities, and that is necessary to protect national security and public safety are restricted. Anyone seeking CEII information from FERC must file a CEII request. FERC's website at www.ferc.gov/help/how-to/file-ceii.asp contains additional details related to CEII.

Information related to protecting sensitive archaeological or other culturally important information is also restricted under section 106 of the National Historic Preservation Act. Anyone seeking this information from FERC must file a Freedom of Information Act request. Instructions for Freedom of Information Act are available on FERC's website at www.ferc.gov/legal/ceii-foia/foia.asp.

In addition, information that may reveal the locations of rare, threatened, and endangered species is protected under section 7 of the Endangered Species Act and/or state regulations. This includes all species (plant and animal) listed, proposed for listing, or candidates for listing under the federal and state endangered species acts.

Participants may also submit data requests for sensitive information to john_ragonese@transcanada.com. Requests for access to this information will be evaluated under TransCanada's policies, relevant FERC regulations, and applicable laws. Parties requesting sensitive information may be required to sign a non-disclosure agreement pertaining to the specific material requested.

1.4.6 Document Distribution

TransCanada will distribute, whenever possible, all documents electronically in standard Microsoft Office formats (.doc, .xls, .ppt) or portable document format (PDF), image (jpeg) or as GIS shapefiles (.shp) or published map files (.pmf) either via email or on CD, and will post all relevant relicensing documents on the TransCanada relicensing website. TransCanada may distribute hard copies of some documents for convenience or by request (copy fees may be requested). Unless otherwise specified, the following procedures will be used for document distribution:

Document	Distribution Path	Participant
Public meeting notices	By website, email, and/or newspaper.	Interested parties, FERC service list
Meeting summaries	Website, email	Relicensing participants
Major documents[a]: FERC scoping documents, proposed study plans, study reports, draft license application, etc.	Website. FERC eLibrary, email and normal or express mail	Notice of availability by email to interested parties
Study plan comments / summary	Website	Notice of availability by email to interested parties
General correspondence	Email	Interested parties or as applicable
Progress/status report	Website	Notice of availability by email to interested parties

[a] TransCanada expects to distribute the final license application on CDs via U.S. Postal Service mail or overnight mail.

TransCanada will also provide a copy of the NOI, PAD, proposed study plan, final study plan, preliminary license proposal or draft license application, and final license application to public libraries located near the Project. These libraries, their addresses, and their phone numbers are as follows:

Towns	Public Library
Hinsdale NH	Hinsdale Public Library 122 Brattleboro Road PO Box 6 Hinsdale, NH 03451-0006 (603-336-5713)
Chesterfield NH	Chesterfield Public Library 524 Route 63 Chesterfield, NH 03443-3607 (603-363-4621)
Westmoreland NH	Westmoreland Public Library 33 South Village Road Westmoreland, NH 03467-4514 (603-399-7750)
Walpole NH	Walpole Town Library 48 Main Street PO Box 487 Walpole, NH 03608-0487 (603-756-9806)
Vernon VT	Vernon Free Library 567 Governor Hunt Road Vernon, VT 05354-0094 (802-257-0150)
Brattleboro VT	Brooks Memorial Library 224 Main Street Brattleboro, VT 05301 (802-254-5290)
Dummerston VT	Lydia Taft Pratt Library 156 West Street PO Box 70 West Dummerston, VT 05357-0070 (802-254-2703)
Putney VT	Putney Public Library 55 Main Street Putney, VT 05346-0193 (802-387-4407)
Westminster VT	Butterfield Library Main Street PO Box 123 Westminster, VT 05158-0123 (802-722-4891)

1.5 STUDY REQUESTS

As part of early consultation and collaboration efforts, TransCanada will work with interested parties and relicensing participants to identify areas where there is little or no information relevant to issues of potential concern for project effects to the human and natural environments. To facilitate compliance within the ILP process, draft study requests should use the following format;

As specified by C.F.R. 18, § 5.9(b) of FERC's ILP regulations, any study request must:

- Describe the goals and objectives of each study proposal and the information to be obtained.
- If applicable, explain the relevant resource management goals of the agencies or tribes with jurisdiction over the resource to be studied.
- If the requestor is a not resource agency, explain any relevant public interest considerations in regard to the proposed study.
- Describe existing information concerning the subject of the study proposal, and themed for additional information.
- Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would complement the development of license requirements.
- Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.
- Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The requestor should also describe any available cost-share funds or in-kind services that the sponsor of the request may contribute towards the study effort. Email completed draft study requests in Microsoft Word or PDF format to John Ragonese at john_ragonese@transcanada.com.

2.0 PROJECT LOCATION, FACILITIES, AND OPERATIONS

2.1 PROJECT LOCATION

The Project's dam and powerhouse are located on the Connecticut River at river mile (RM) 141.9, about 2 miles upstream of the Ashuelot River and 7.4 miles downstream of the West River, in the town of Vernon, Vermont, and the town of Hinsdale, New Hampshire. The Project area extends upstream about 26 miles upstream terminating at the Walpole Bridge (Route 123) at Westminster Station, Vermont, about 6 miles downstream of the Bellows Falls Project (FERC No. 1855). The downstream Project boundary is the downstream side of Vernon dam because the upstream boundary of the Turners Falls Project (FERC No. 1889) impoundment at normal reservoir elevation abuts the downstream face of the Vernon dam.

Interstate Route 91, U.S. Route 5, and Vermont Route 142 run in a north-south direction along the Vermont side of the river, and New Hampshire Routes 119 and 63 run along the New Hampshire side. The Boston and Maine Railroad runs along the New Hampshire side, crossing into Vermont at Brattleboro. The Central Vermont Railroad runs along the Vermont side. The 540-megawatt (MW) Vermont Yankee Nuclear Power Plant (Vermont Yankee) is also located on the Vermont shore just upstream from Vernon dam. The Project lies within nine communities - Hinsdale, Chesterfield, Westmoreland, and Walpole (Cheshire County) in New Hampshire; and Vernon, Brattleboro, Dummerston, Putney, and Westminster (Windham County) in Vermont.

Figure 2.1-1 illustrates the primary Project facilities, figure 2.1-2 shows the Project constructed works layout, and table 2.1-1 summarizes Project information.

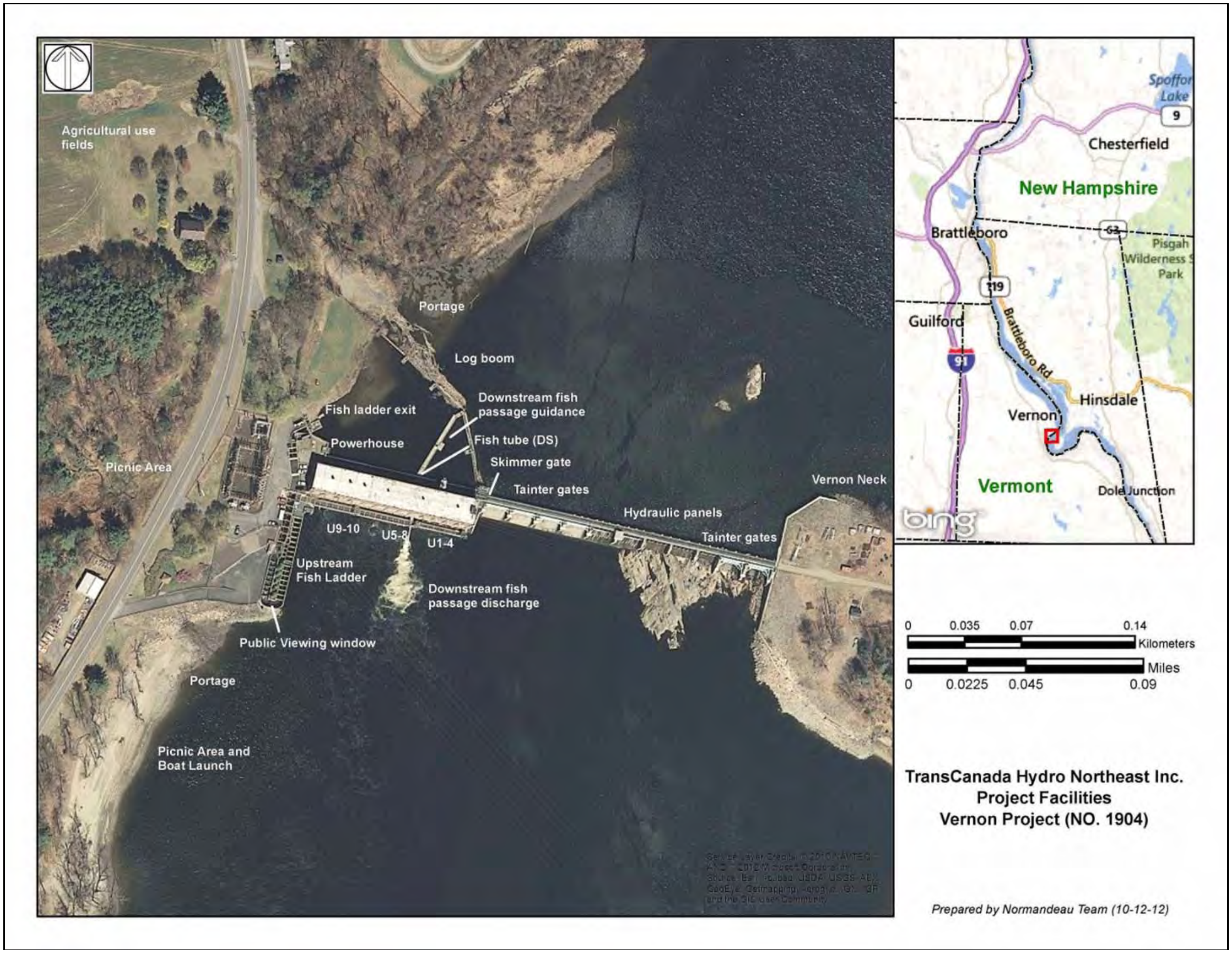

Figure 2.1-1. Primary Project facilities.

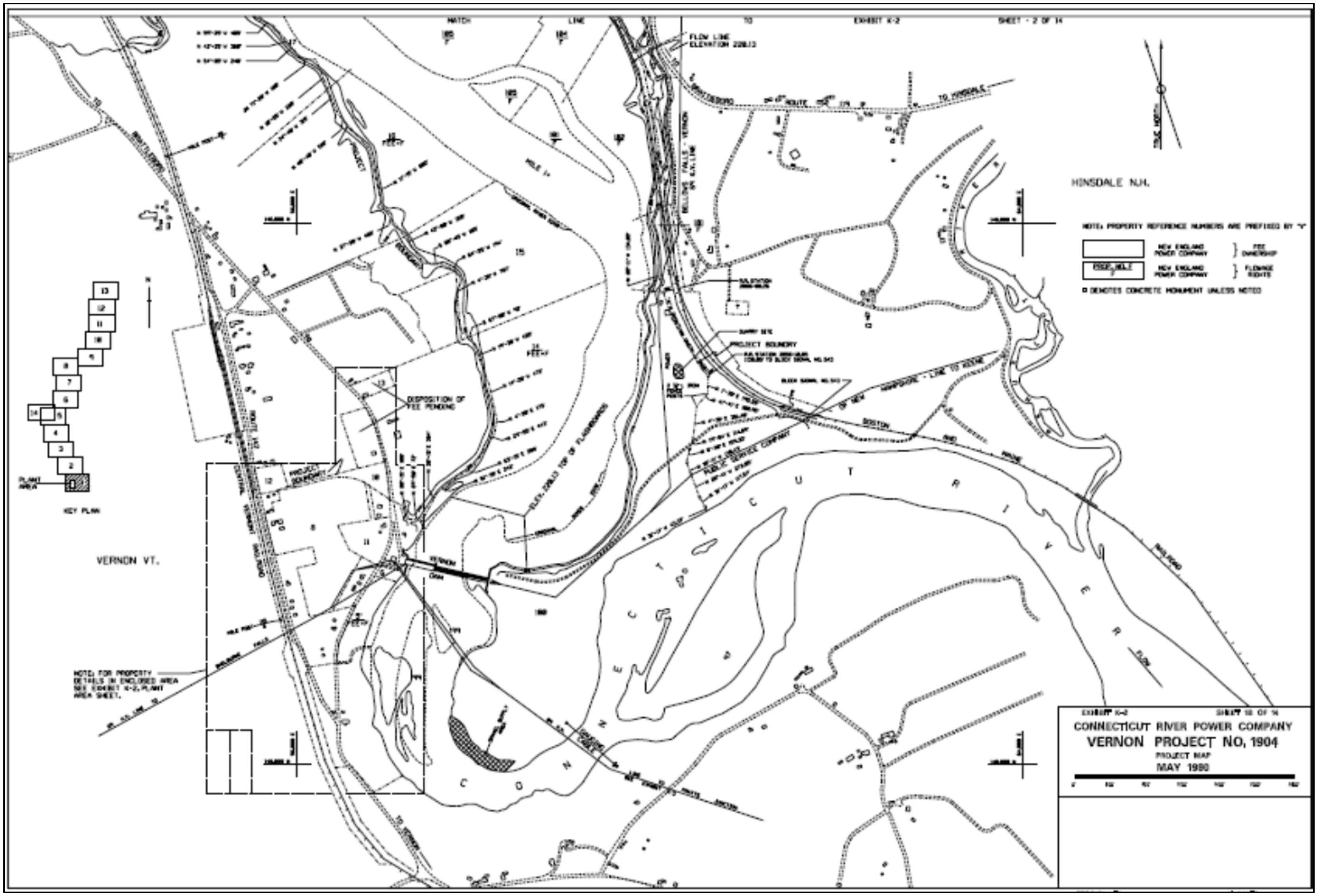

Figure 2.1-2. Project constructed works layout.

Table 2.1-1. Project summary.

General Information	
Owner	TransCanada Hydro Northeast Inc.
FERC Project Number	P-1904
Current License Term	June 25, 1979 – April 30, 2018
Authorized Generating Capacity	32.4 MW
Vernon Project	
Location of Dam	Connecticut River at river mile 141.9
Nearest Towns / Counties	Vernon, Windham Count, Vermont Hinsdale, Cheshire County, New Hampshire
Drainage Area	6,266 square miles
Major Tributaries	NH – Cold River VT – Saxtons and West Rivers
Operating Range Elevation	212.0 – 220.0
Normal Range Elevation[a]	218.6 – 219.8
Normal Tailwater Elevation	184.63
Impoundment Length	26 miles (Walpole NH/Westminster VT)
Gross Storage	40,000 acre-feet
Useable Storage	18,300 acre-feet (at 8-foot drawdown)
Surface Area at Normal Full Pond	2,550 acres
Average Annual Inflow at the Project	Approximately 12,200 cfs
Required Minimum Flow	1,250 cfs or inflow, whichever is less
Generated Minimum Flow[a]	1,600 cfs
Major Structures and Equipment	
Original Construction	1909
Dam	Composite overflow and non-overflow ogee type concrete gravity structure, 956 feet long with a maximum height of 58 feet and net head of 33.5 feet.
Spillway Gates	6 tainter gates, 2 hydraulic panel bays, 8 hydraulic flood gates, 3 stanchion bays, 1 sluice gate

Powerhouse	Reinforced concrete substructure with a structural steel and brick superstructure, 336 feet long by 55 feet wide
Turbine/Generator Units	10
Turbine Manufacturer/Type	Units 1-2: Birdsboro / vertical Francis Units 3-4: S. Morgan Smith / vertical Francis Units 5-8: Litostroj / vertical Kaplan Units 9-10: S. Morgan Smith / vertical Francis
Turbine Capacities	Units 1-4: 2.5 MW / 4,190 hp / 1,465 cfs @ 35 ft head Units 5-8: 4.0 MW / 9,276 hp / 1,800 cfs @ 32 ft head Units 9-10: 4.2 MW / 6,000 hp / 2,035 cfs @ 34 ft head
Generator Manufacturer	Units 1-4: General Electric Units 5-8: Koncar Units 9-10: General Electric
Generator Capacities	Units 1-4: 2,500 KVA/ 2,000 KW with 0.8 power factor Units 5-8: 5,000 KVA / 4,000 KW with 0.9 power factor Units 9-10: 6,000 KVA / 4,200 KW with 0.7 power factor
Total Discharge Capacity	119,785 cfs
Fish Ladder	Reinforced concrete: overflow weir lower section comprised of 26 pools (12” rise), collection facility; viewing window; serpentine vertical slot upper section with 25 pools (6” rise).
Upgrades	Fish ladder completed in 1981. Spillway crest control reconstructed in 1986 including the addition of a skimmer gate, 6 tainter gates, 2 50' hydraulic panel bays. New rack raking system along powerhouse forebay. Downstream diversion barrier completed 1995. Station automated with remote control capability in 1998. Units 5–8 repowered and operational in the spring of 2008.

[a] Reflects typical non-spill, non-emergency operation

2.1.1 Project Authorized Agents

The following persons are authorized to act as agent for the Licensee pursuant to 18 C.F.R. § 5.6(d)(2)(i):

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erin_odea@transcanada.com

2.2 PROJECT LICENSE HISTORY AND AMENDMENTS

The original license for the Project was issued by the Commission on March 26, 1945 and in 1955 the Project was purchased by New England Power Company. The original license expired on June 30, 1970 and the Project operated under annual licenses until the license was renewed on June 25, 1979. The license had been amended on July 31, 1970 for the use of the Project as a cooling water source for the Vermont Yankee Nuclear located just upstream. The 1979 license (as amended) remains in effect and expires on April 30, 2018.

On October 5, 1978, the Commission approved a settlement agreement concerning fish passage facilities for American shad and Atlantic salmon at the Project, and at two other projects - Wilder (Project No. 1892) and Bellows Falls, both located upstream. The settlement was executed on December 30, 1977 among the Licensee, the States of Massachusetts, Connecticut, New Hampshire and Vermont, U.S. Fish and Wildlife Service (FWS), and four non-governmental organizations (the Environmental Defense Fund, the Massachusetts Public Interest Research Group, Inc., For Land's Sake, and Trout Unlimited). The settlement called for staged design, construction and operation of passage facilities at the three Projects, with

Vernon's construction being the first in the series. The upstream fishway was subsequently completed and commenced operation in 1981.

In 1986, a major reconstruction of the spillway crest water control mechanisms was completed and included the addition of a trash sluice (skimmer) gate, 6 tainter gates and 2 50-foot bays of hydraulic panels in the spillway section. A new rack raking system was constructed along the powerhouse forebay at that time.

On July 26, 1990, the Licensee entered into a Memorandum of Agreement with the Connecticut River Atlantic Salmon Commission (CRASC) for permanent downstream fish passage facilities for the Wilder, Bellows Falls and Vernon Projects. Downstream passage facilities were constructed in 1995 and consist of a "fishpipe" and louver array as well as a "fish bypass" as described in section 2.3.3 below.

On June 12, 1992, The Commission issued an order amending the license for the proposed replacement of four existing 2.0 MW turbine/generator units (Units Nos. 5 through 8) with two 14.0 MW turbine/generator units (Unit Nos. 11 and 12). As required by Article 403 of the 1992 license amendment, downstream fish passage facilities at the Project were completed in 1995. However, after several time extensions the replacement of the four existing generating units never occurred. The license was subsequently amended on July 28, 2006 for the proposed replacement of the same four existing units with four new 4.0-MW units. That replacement did occur and the new units became operational in 2008.

On February 27, 1998, FERC approved the transfer of the license from New England Power Company to USGen New England, Inc. At that time, the station was automated and began operations via remote control from the Connecticut River Control Center in Wilder, Vermont.

On January 24, 2005, FERC approved the transfer of the license to TransCanada Hydro Northeast Inc., the current Licensee.

2.3 PROJECT FACILITIES

2.3.1 Dam and Spillway Features

The dam is a composite overflow and non-overflow ogee type concrete gravity structure extending across the Connecticut River between Hinsdale, New Hampshire, and Vernon, Vermont. It is 956 feet long with a maximum height of 58 feet, and consists of the integral powerhouse with a sluice gate block section that is about 356 feet long, and a concrete overflow spillway section about 600 feet long. The maximum dam height is 58 feet. Figures 2.3-1 and 2.3-2 and table 2.3-1 provide additional detail.

Figure 2.3-1 Powerhouse and dam looking upstream (fish ladder is not apparent).

The spillway portion of the dam is divided into 12 bays containing, from west to east, a trash sluice, 4 tainter gates, 2 hydraulic flashboard bays, 3 stanchion bays, and 2 tainter gates. The various bays are separated by concrete piers supporting a steel and concrete bridge. A steel bridge runs the length of the dam for access and for operation of flashboards.

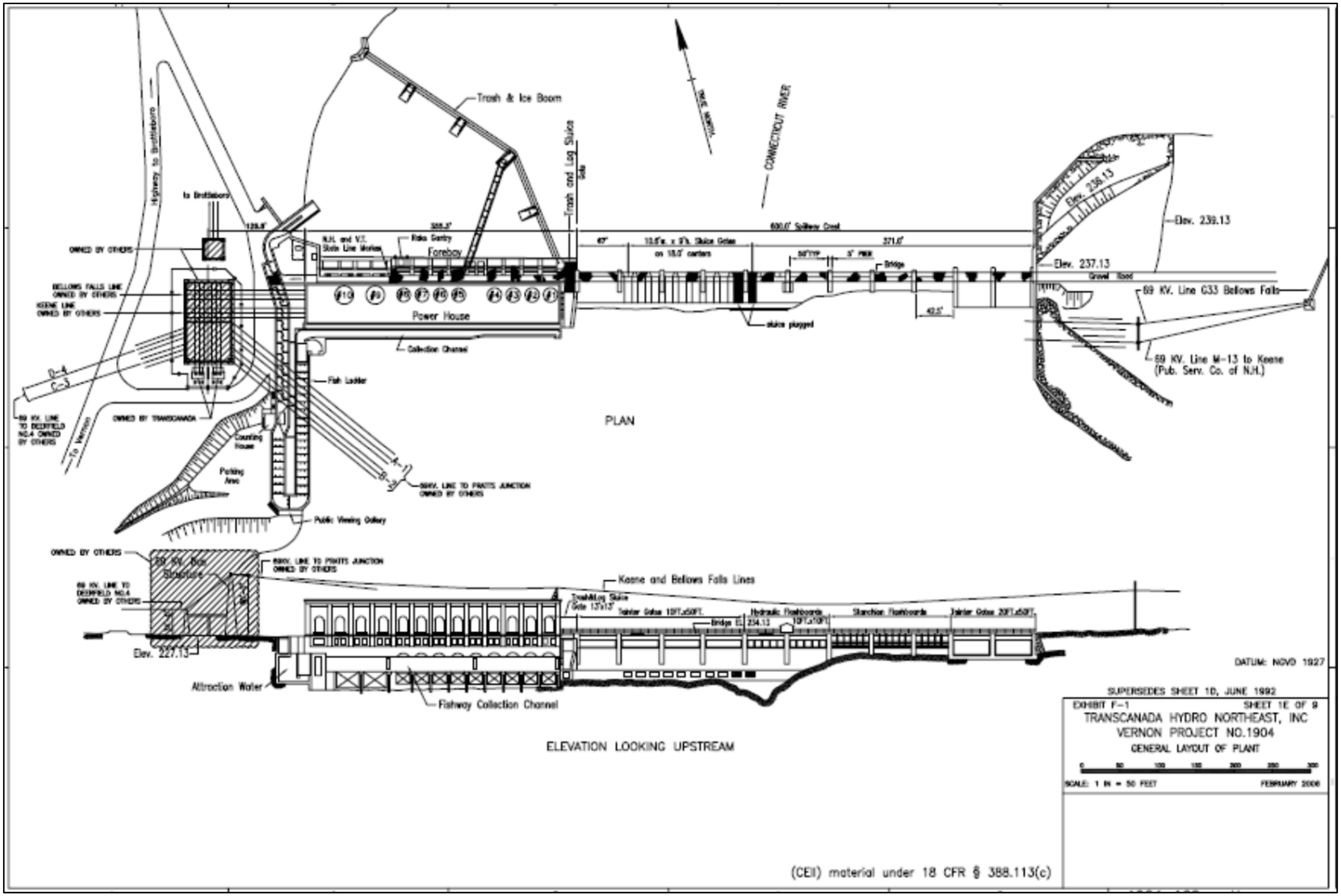

Figure 2.3-2. Project layout and spillway cross section.

Table 2.3-1. Spillway features.

Gate Type	Number	Size (height or width, by length in feet)	Elevation
Fishway sluice	1	9 x 6 (inlet end) 4 x 5 (discharge end)	210.13 194.33
Trash sluice	1	13 x 13	209.13 (sill)
Tainter gates	2	20 x 50	202.13 (crest)
Tainter gates	4	10 x 50	212.13 (crest)
Hydraulic panel bays	2	10 x 50	212.13 (crest)
Stanchion bays	2	10 x 50	212.13 (crest)
Stanchion bay	1	10 x 42.5	212.13 (crest)
Hydraulic floodgates	8	7 x 9 (invert)	173.13 (sill)

The trash sluice is a skimmer gate which passes logs and other debris deflected away from the powerhouse by a log and ice boom in the station forebay. On the western abutment the fishway sluice provides 50 cubic feet per second (cfs) of attraction flow to the upstream fish ladder. It has a hydraulically operated upward opening gate and bar racks to keep out debris.

2.3.2 Powerhouse Features

The powerhouse is integral to the dam and contains ten turbine/generators, electrical equipment, machine shop, excitation equipment, emergency generator, air compressor, an overhead crane, offices and storage rooms. The powerhouse is approximately 356 feet long by 55 feet wide by 45 feet high, and is a reinforced concrete substructure with a structural steel and brick superstructure.

The concrete gravity intake is integral with the powerhouse structure with two water passages for No. 9 and No. 10 units and a single water passage for No. 1 - No. 8 units. Water enters directly from the forebay intake and into the scroll or wheel cases. The draft tubes discharge into a short tailrace excavated partly in the bank (for Units No. 9 and No. 10) and partly in the bed of the river. The scroll cases and draft tubes are formed in the concrete of the substructure which was poured on bedrock.

The water passages for Units No. 9 and No. 10 units have trash racks (4-inch on center) and head gates consisting of two concrete gates with an electrically driven fixed hoist. Units No. 1 – No. 8 have a rack spacing of 2 inches on center. Units No. 1 - No. 4 head gates consist of a single steel-hinge gate, one for each unit. Units No. 5 - No. 8 have one steel slide gate for each unit equipped with an electrically driven fixed hoist. A hydraulic “rack rake” is used to pull river debris away from the unit intakes. It is manually operated and is driven to the trash racks in front of each unit on a set of tracks that are located on top of the forebay intake structure. The rake head is lowered to the bottom of the racks and is then retracted riding up the rack removing the debris. The debris is then conveyed into a trailer for removal.

The powerhouse substructure is of reinforced concrete construction. The only units that have draft tube gates are Units No. 5 – No. 8. These gates are operated with a common electrical hoist that can be positioned in any bay via an overhead monorail.

A trash sluice/skimmer gate is located on the east side of the forebay and is 13 feet wide by 13 feet high. The fishway sluice is located on the west side of the forebay. Backwater from the Turners Falls impoundment located about 20 miles downstream reaches up to Vernon dam. Figures 2.3-2, 2.3-3, and 2.3-4 and table 2.3-2 provide additional details.

Figure 2.3-3. Generator Unit No. 10.

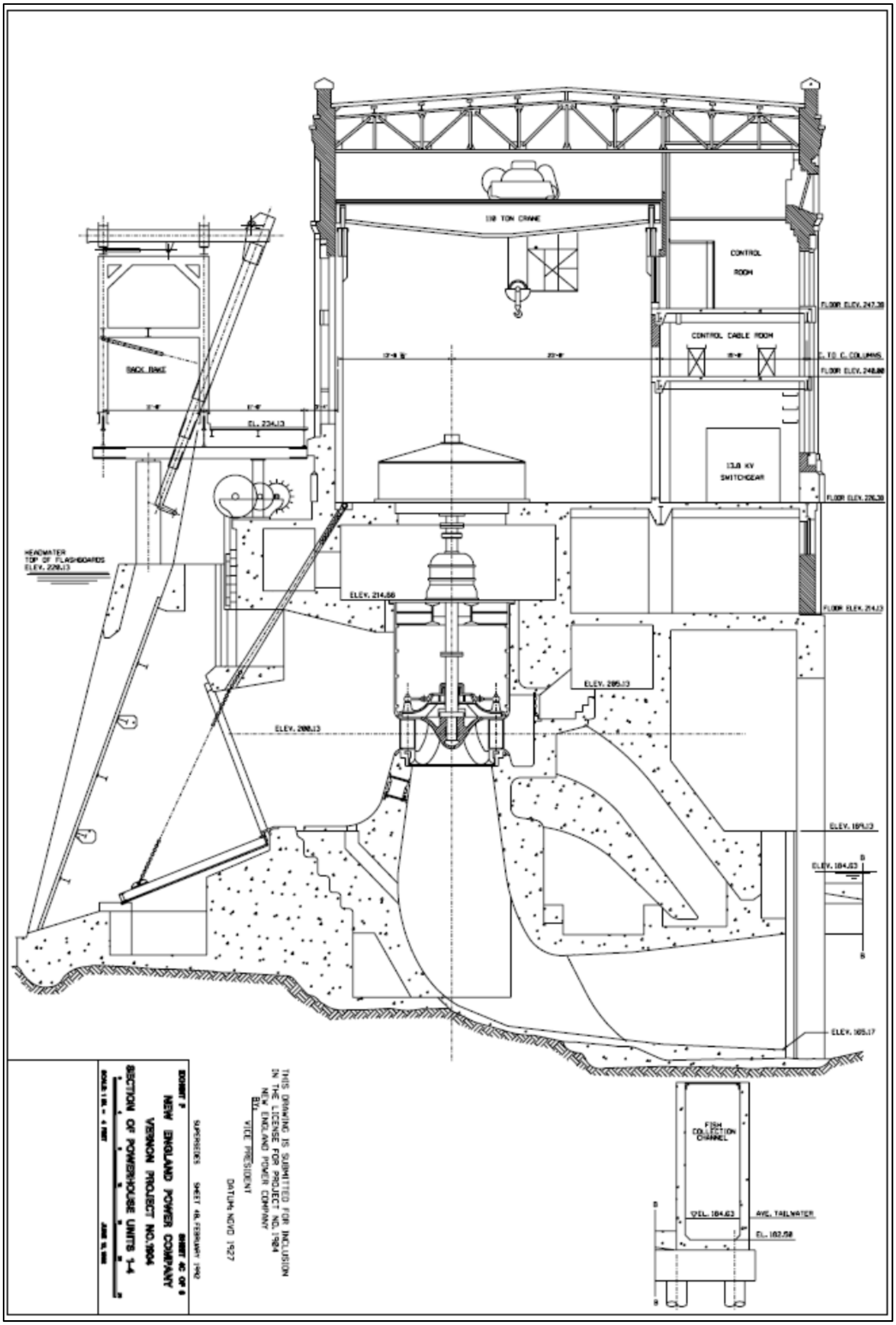

Figure 2.3-4. Powerhouse cross section (Units No. 1- No. 4).

Table 2.3-2. Turbines and generators.

Unit Nos.	**1 - 4**	**5 - 8**	**9 - 10**
Turbines			
Type	Single runner vertical Francis	Vertical axial flow Kaplan	Single runner vertical Francis
Design Head (feet)	35	32	34
HP Rating at Design Head	4,190	5,898	6,000
RPM	133.3	144	75
Min. Hydraulic Capacity (cfs)	0	900	900
Max. Hydraulic Capacity at Design Head (cfs)	1,465	1,800 cfs	2,035
Intake Trashrack Size	2-inch on center	2-inch on center	4-inch on center
Generators			
Nameplate KVA	2,500	5,000	6,000
Nameplate KW	2,000	4,000	4,200
Power Factor	0.80	0.90	0.70
Phase/Frequency	3/60	3/60	3/60
Voltage	2,300	13,800	13,800

Unit Nos. 1 – 4, 9 and 10 have electronic Cutler Hammer/ Westinghouse exciters and Unit Nos. 5 – 8 have electronic Basler exciters. The powerhouse also contains a switchboard but it is only used as a backup facility to the Connecticut River Control Center located at a separate facility at the Wilder Project.

Project electrical facilities include the generators, four step-up transformers, bus structures, switching equipment and switchboard, generator terminals and a 13.8-KV interconnection that runs underneath the station to two outdoor 13.8 to 69-KV step-up transformers located in an outdoor substation west of the powerhouse. Switchgear, bus work and two step-up transformers are located in the substation along with a 69 KV interconnection that provides power to one of the regional transmission companies, New England Power Company (NEP), d/b/a as National Grid. National Grid equipment is also located in the substation, as well as in a smaller 13.2 KV switchyard located just north of the substation and within the Project boundary. Figure 2.3-5 illustrates the separation of electrical facilities between the Project and the regional transmission system.

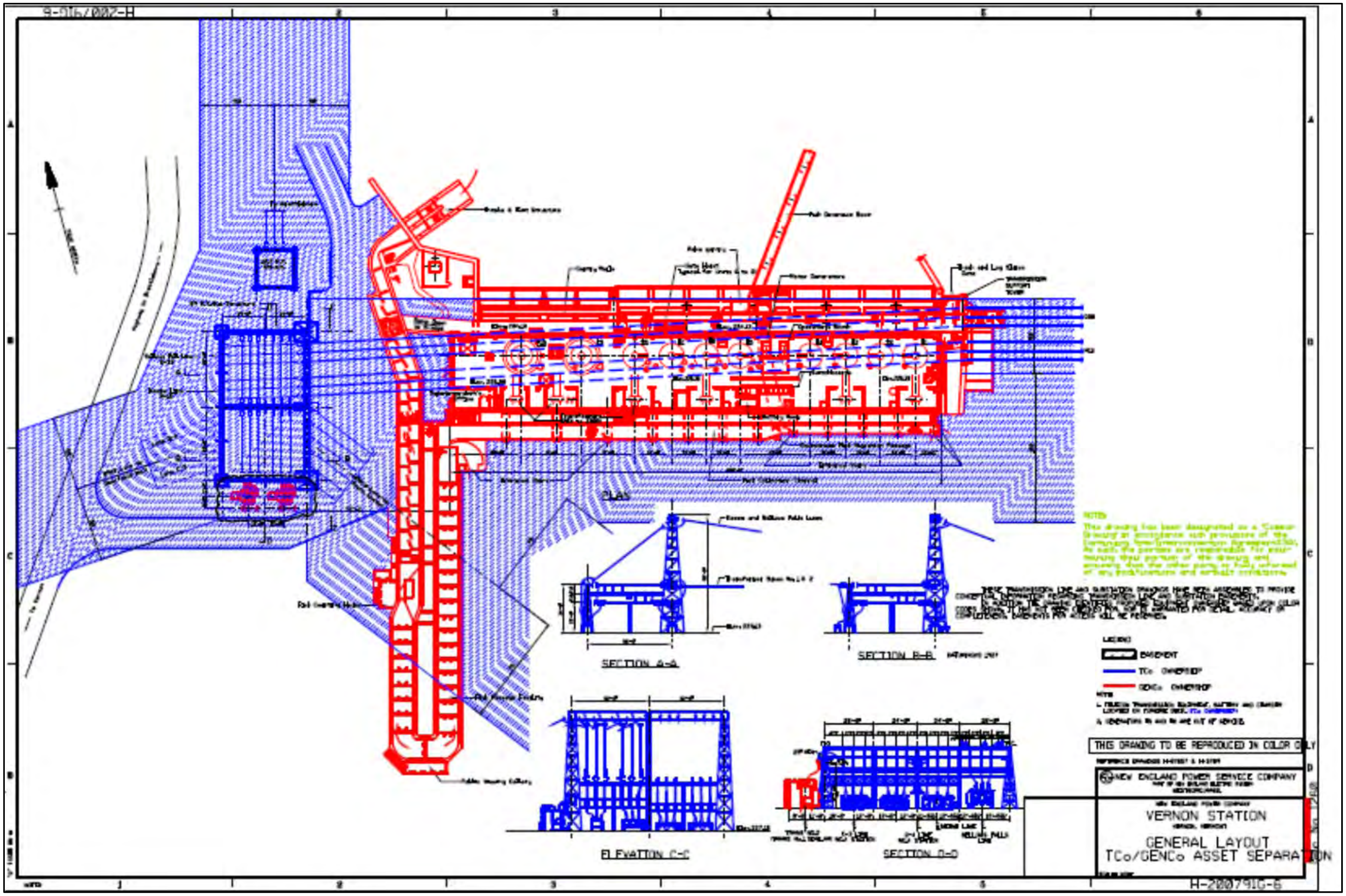

Figure 2.3-5. Project transmission interconnection with non-project transmission grid (red is project facilities).

2.3.3 Fish Passage Facilities

Upstream Fish Passage - Ladder Operation

The fishway (see figures 2.3-6, 2.3-7 and 2.3-8) is a reinforced concrete structure (ice harbor and vertical slot design) 984 feet long with accessory electrical, mechanical, and pneumatic equipment that was designed to provide passage for migrating Atlantic salmon and American shad past the dam, a vertical distance of about 35 feet.

Upstream migrating fish enter the tailrace area where they are attracted to entrance weirs at the west end of the powerhouse. Attraction water to the channel entrance weirs consists of 64 cfs from the fishway flow and up to 254 cfs through a floor diffuser supplied by a 48-inch diameter pipe from the attraction water intake at the fishway exit. Fish are attracted into the fishway and "climb" by swimming through a series of 51 pools created by a sequence of overflow weirs in the lower section and by a series of vertical slot pools in the upper section.

After passing the first 26 overflow weir pools, each 15 feet wide by10 feet long, and 12 inches higher than the last, fish enter the counting/trapping area and a regulating pool. A constant water surface elevation of about 208 feet is maintained in the regulating pool and a steady 64 cfs flow is provided. Flow in the regulating pool can be supplemented as needed by a floor diffuser supplied by a 30-inch diameter pipe from the attraction water intake at the fishway exit. Fish are guided by flow and crowder screens through a narrow opening, passing two underwater viewing windows (one public), where they can be observed and counted. They can also be trapped and diverted to a holding pool by means of manually activated pneumatic trapping gates.

From the counting/trapping area, fish continue to climb through the vertical slot section of the fishway, consisting of an additional 25 pools each about 6 inches higher than the last. At the upper end of the fishway, fish pass through a flume, past screens protecting the attraction water intake, through at 12-foot wide exit channel, and into the forebay. The exit channel is divided by a concrete center pier and includes pairs of motor-driven headgates, trash racks with 12 inch spacing, and slots for wooden stop logs.

A total of 260 cfs of attraction flow is required for the fishway. The entrance weir attraction water flows are dependent upon tailwater elevation and are set by an automated supply gate to regulate fishway elevation between 0.9 and 1.4 feet higher than the tailwater elevation. Attraction water to the entrance weir consists of about 64 cfs from fishway flow with the balance introduced through a floor diffuser just upstream of the entrance channel. About 136 cfs of supplemental flow is required when tailwater elevations are between 180 and 185 feet, and 254 cfs is required to supplement the fishway flow when tailwater elevation is between 185 and 192 feet. This supplemental flow is supplied to a gate valve regulated chamber in the entrance weir floor diffuser, from the 48-inch supply pipe.

Flow into the upper fishway vertical slot section is maintained at 64 cfs. This flow is a function of headwater elevation. When the reservoir is very low (below elevation[El.] 218), make up water is supplied proportionally based on headwater elevation, from 8 to 46 cfs corresponding to El. 217 down to El. 212. Makeup water is supplied to the floor makeup diffuser by an automated butterfly valve regulated 30-inch pipe from the attraction water intake.

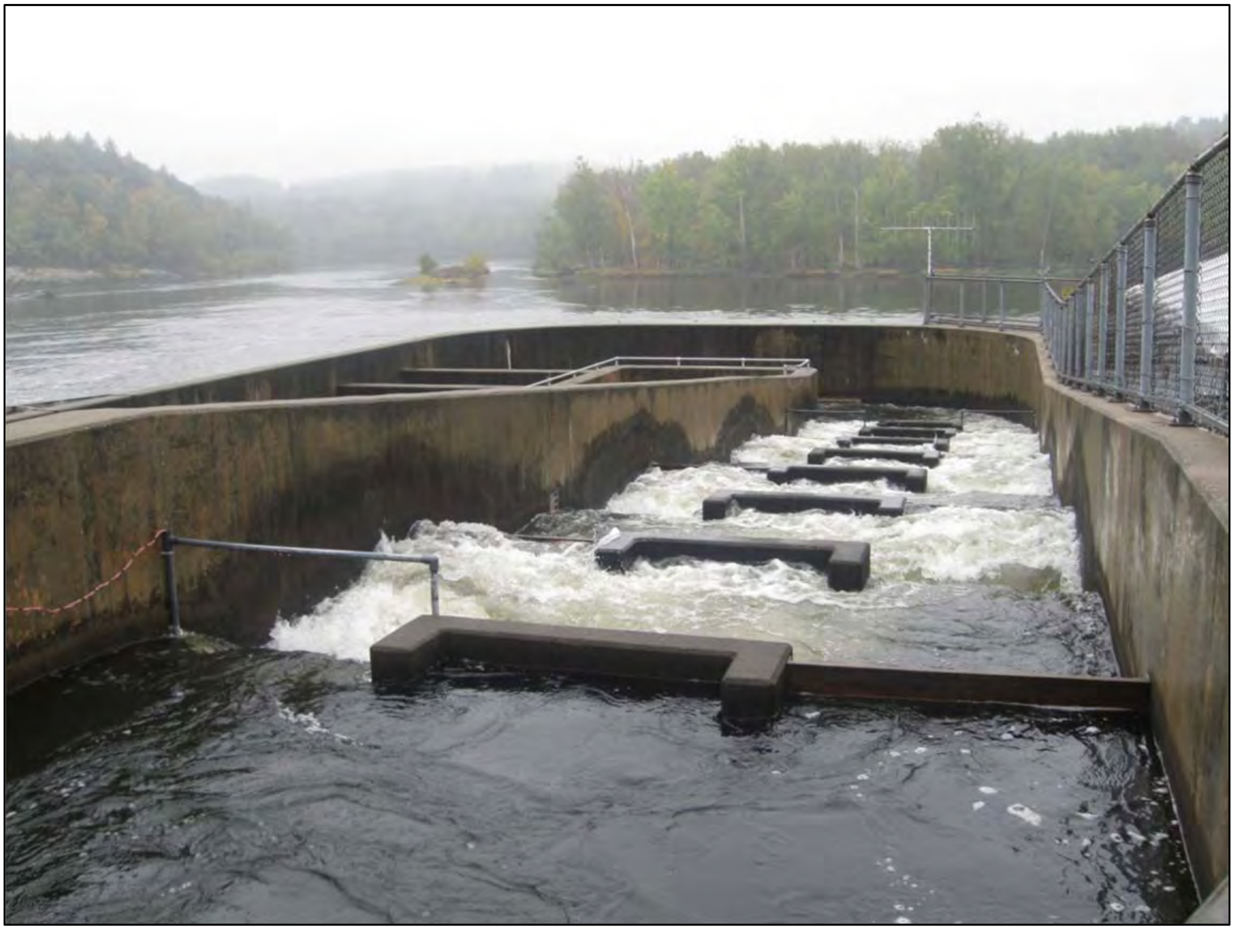

Figure 2.3-6. Fish ladder.

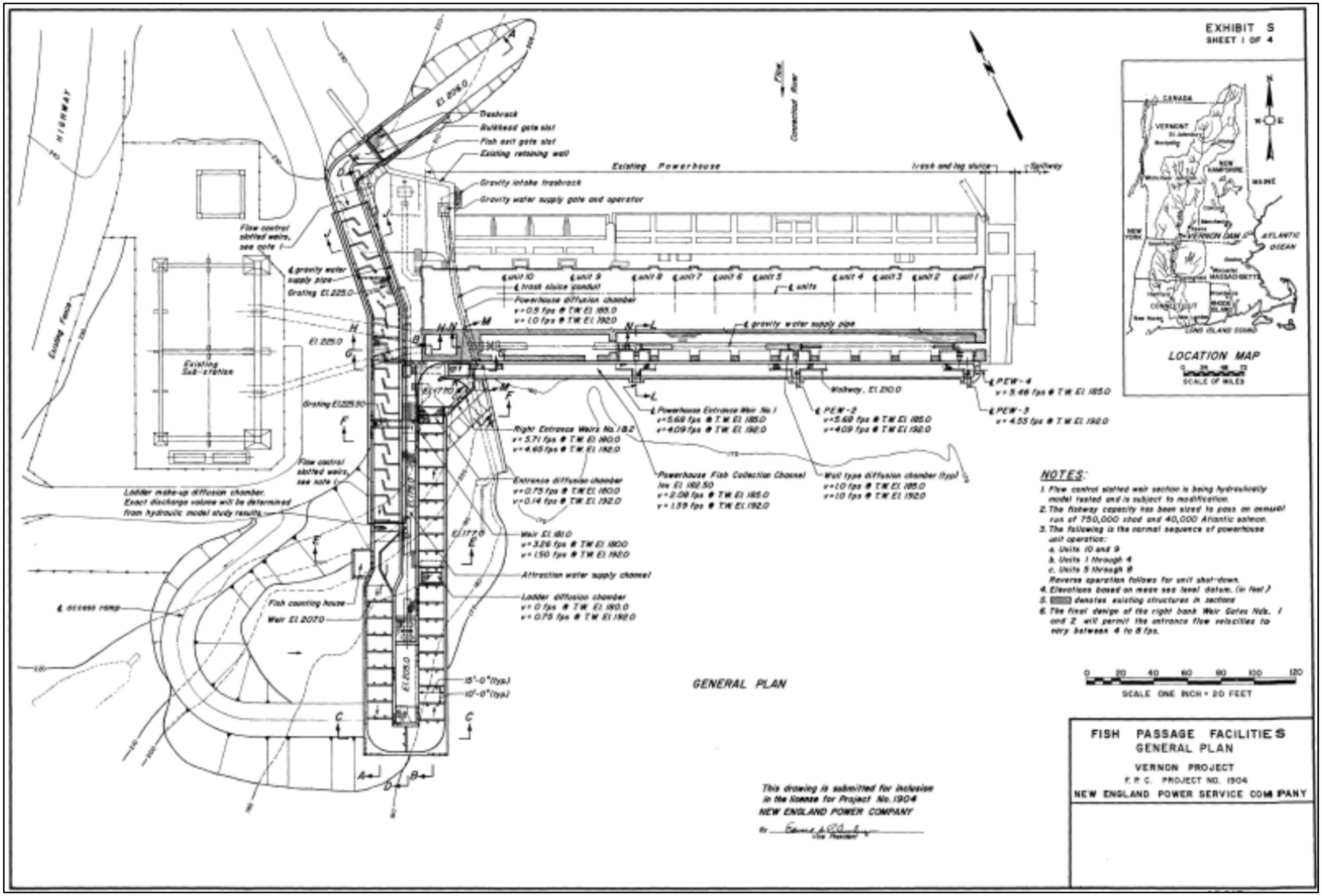

Figure 2.3-7 Fish ladder layout.

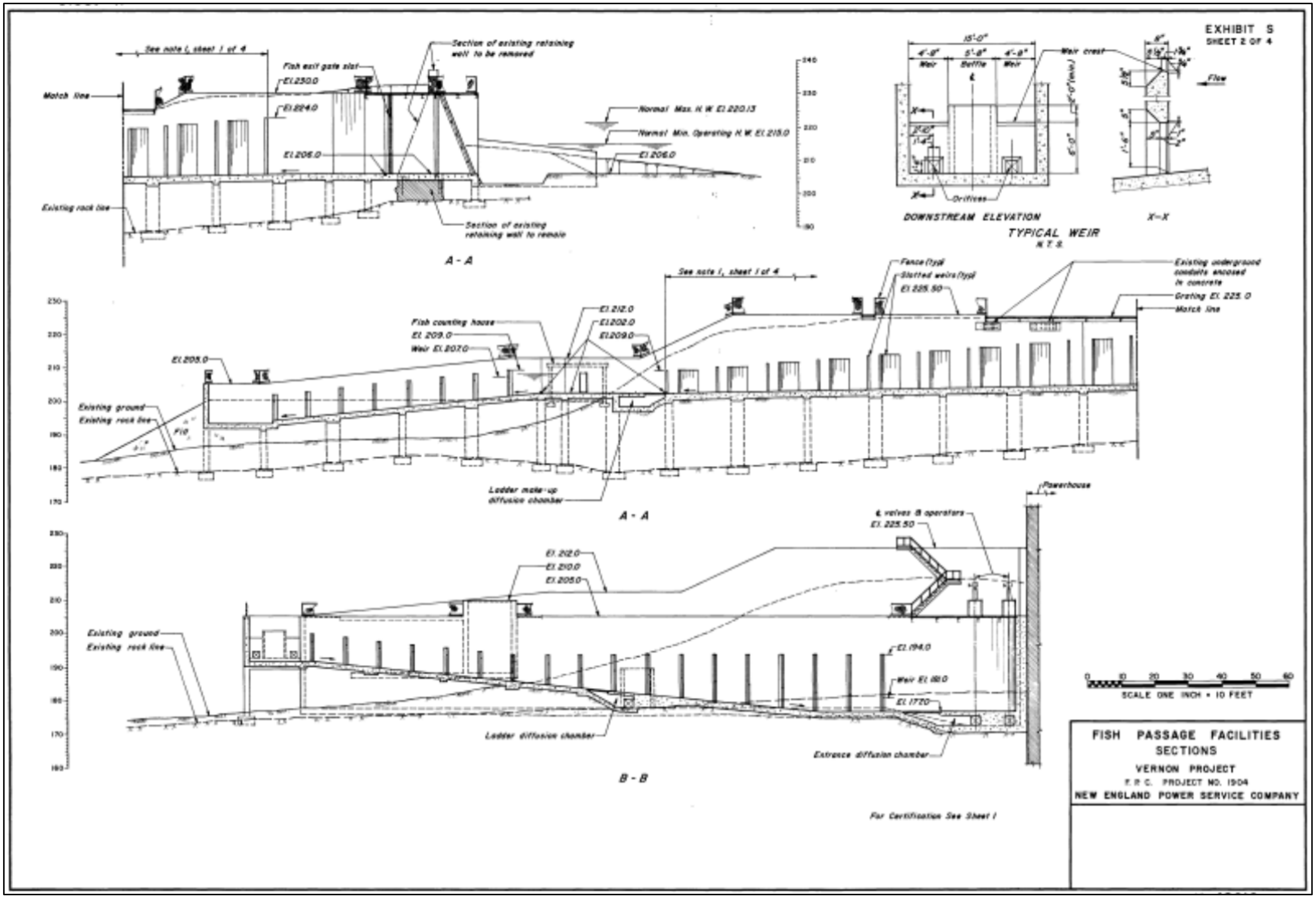

Figure 2.3-8. Fish ladder cross section.

A public viewing area and underwater window are located at the fish ladder's counting/trapping area just below the powerhouse parking lot.

The operating season of the fish ladder is determined by the schedule provided each year by CRASC. The ladder operates annually during the spring and fall seasons. In the spring, the ladder must be available to operate from April 15th through July 15 for Atlantic salmon, American shad and river herring. In the fall migration season, although generally specified as between Sept. 15th and Nov. 15th, the ladder has typically not operated until there is evidence that a salmon is located immediately below the Project. To date, all Atlantic salmon released into the Connecticut River at the Holyoke Project (FERC No. 2004) fish lift in Massachusetts have a radio tag implanted in them by TransCanada contractors with concurrence from state and federal agencies in order to track their migration in the river basin.

Upstream Fish Passage – Effectiveness Evaluations

No formal salmon effectiveness studies have been performed on the fish ladder due to in large part the lack of returning adult Atlantic salmon to the Connecticut River Basin overall, but in particular the relatively small number of adults passing the Turners Falls dam and arriving at the base of Vernon dam. In 2011 and 2012, TransCanada participated in a basin-wide FWS and U.S. Geological Survey (USGS) shad monitoring study that evaluated American shad use of the Vernon fish ladder and its passage effectiveness for American shad.

The Vermont Department of Fish & Wildlife (Vermont Fish & Wildlife) and Normandeau Associates, Inc. (Normandeau) have monitored adult Atlantic salmon utilization of the Vernon fish ladder since 1998. A small number (typically 10 fish per year) of the adult Atlantic salmon collected in the Holyoke dam fish lift are radio tagged and released into the Holyoke reservoir. The first radio tagged adult salmon to pass the Vernon Project was in 1998. Overall, 42 percent of all salmon tagged passed upstream of the Project, and 87 percent of all tagged salmon that passed Turners Falls also passed the Vernon Project (see section 3.6, *Fish and Aquatic Resources* for more information). Note that this is not an indication of passage effectiveness as Atlantic salmon that pass Vernon dam migrate up key tributaries, such as the West River.

Downstream Fish Passage Operation

Downstream fish passage facilities consist of a “fish pipe” that discharges about 350 cfs through the powerhouse, a second smaller “fish bypass" at the Vermont end of the powerhouse that discharges about 40 cfs, and a 156-foot-long louver array that extends from the forebay to the fish pipe entrance. The louver array consists of stainless steel louver panels with 3-inch spacing between louver vanes that extend to 15 feet depth at normal pond elevation. The louver intercepts and directs downstream-migrating fish that enter the forebay from mid-river and from the east (New Hampshire) shoreline into the fishpipe. The smaller fish bypass on the Vermont end of the powerhouse functions as a secondary passage route for fish that are not intercepted by the louver array and enter the western end of the forebay. Figure 2.3-9 illustrates the Project’s downstream passage facilities.

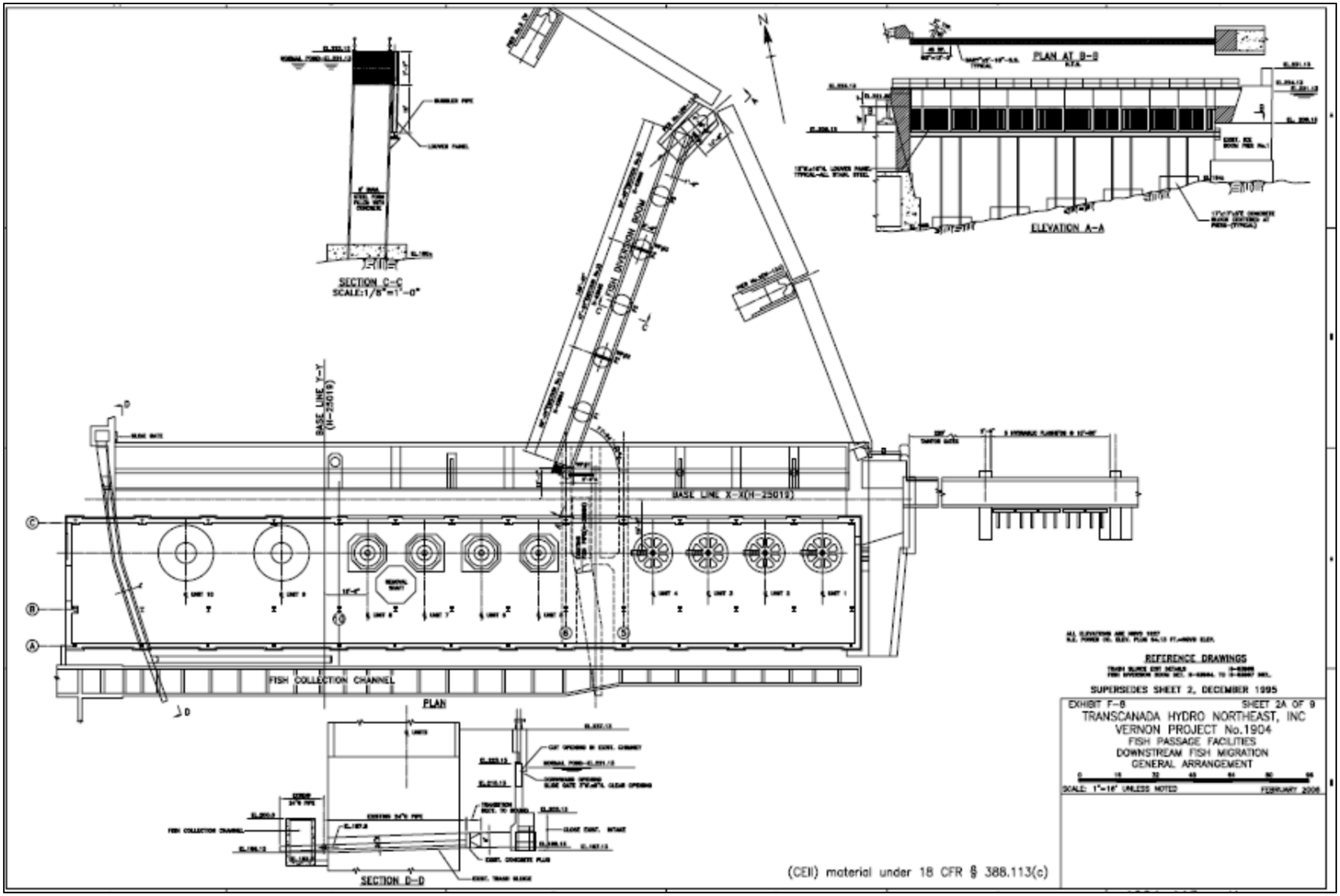

Figure 2.3-9. Downstream fish passage layout.

The operating season for downstream passage has been determined by the schedule provided each year by the CRASC. Downstream passage has generally operated annually from April 1 to December 31. The fishpipe and fish bypass have been operated primarily to facilitate downstream movement of juvenile Atlantic salmon smolts and juvenile and adult American shad. Antennas and receivers have been deployed each year above and below the dam to monitor the presence of tagged adult salmon and to confirm their passage.

Downstream Fish Passage – Effectiveness Evaluations

Studies were conducted in 1995 and 1996 to assess the effectiveness of the downstream fish passage facilities. These studies used radio telemetry to assess the efficiency of the louver array, fishpipe, and fish bypass at passing actively emigrating Atlantic salmon smolts. All salmon smolts passing downstream from several upriver tributaries in Vermont and New Hampshire (which are heavily stocked with salmon fry) must pass the Vernon Project.

Turbine and fishway survival studies were also conducted by Normandeau in 1995 and 1996 to develop estimates of total Project survival for downstream migrating salmon smolts. Survival through the fish bypass was 93.3 percent in 1995. Based on the passage routes that smolts used in 1996, the total estimated project survival was 95.5 percent. Estimated survival of smolts after 48 hours (delayed survival) through Unit 10 was 94.9 percent and through Unit 4 (a smaller capacity unit) was 85.1 percent.

Additional studies were conducted in 2008 to assess passage route selection and turbine passage survival after turbine Units No. 5-8 were replaced with 4MW units. Both immediate and delayed survival estimates for smolts passing a new turbine were very high (97 and 91 percent, respectively). In 2009, a radio telemetry study was conducted to observe behavior and passage of emigrating Atlantic salmon smolts at the Project. Results indicated that bypass efficiency was 58.3 percent and combined with survival estimates yielded >92 percent safe passage past the Project. See section 3.6, *Fish and Aquatic Resources* for more detail on passage studies.

2.3.4 Ancillary Buildings and Recreation Facilities

Warehouse

This structure is located across Governor Hunt Road from the powerhouse. It houses maintenance equipment necessary to maintain exterior components of the Project (i.e., mowing equipment, recreation area and public safety equipment).

Company House

This structure on Governor Hunt Road across from the powerhouse was formerly a residence for the onsite station superintendent. It is no longer used.

Storage Shed

A small storage shed is located on the east side of the dam. It houses flashboards and public safety equipment.

Recreational Facilities

- Vernon Glen Recreation Area
- Governor Hunt Recreation Area
- Fish ladder viewing area
- Wantastiquet - Hinsdale Canoe Rest Area (Hinsdale New Hampshire)
- Stebbins Island located in the Connecticut River (Hinsdale New Hampshire)

These facilities and other recreational opportunities in the Project vicinity are discussed in section 3.10, *Recreation and Land Use Resources*.

2.3.5 Project Boundary and Land

The Vernon Project extends 26 miles upstream on the Connecticut River in both New Hampshire and Vermont. The Project boundary includes the powerhouse and dam, the impounded portion of the river, a limited amount of fee-owned project land, and a significant quantity of private lands adjacent to the river upon which TransCanada retains adequate flowage rights to operate the Project. In general, flowage rights provide TransCanada with ability to flow on and otherwise affect as much of the lands and properties of others due to the construction, maintenance and operation of the Project to an elevation, not to exceeding 220.13 feet above sea level at Vernon dam. Flowage rights are tied to property and often are associated with entire parcels despite their reference to the water's edge. The Project boundary as described by TransCanada is the extent of the inundation limit at normal operation. The extent to which lands with flowage rights retained by TransCanada are affected by water due to Project operation or natural inflow is largely determined by the elevation of the land in relation to the elevation of the river (surface water elevation). Surface water elevation can be affected by three considerations: 1) surface water elevation at the dam; 2) the quantity of inflow from upstream and intermittent sources; and 3) the distance upstream of the dam.

TransCanada owns 287 acres of land in the Vernon Project. Of this, 16 acres are used for plant and related facilities, 34 acres are for public outdoor recreational use, 14 acres have been leased for agricultural and other uses, 223 acres have been set aside as natural lands. Detailed Project maps are provided in Attachment 1 to this PAD.

2.3.6 Proposed Facilities

No new facilities are proposed at the Project; however, as opportunities arise to examine upgrades and efficiency gains, TransCanada has and will continue to evaluate them in the ordinary course of its business.

2.4 PROJECT RESERVOIR

The Project includes a 26-mile impoundment which extends upstream to the Walpole Bridge (Route 123) at Westminster Station, Vermont. The reservoir has a surface area of 2,550 acres with a shoreline of approximately 69 miles. The reservoir has a total volume of about 40,000 acre-feet at full reservoir elevation of 220.13 feet at the top of the stanchions. Backwater effects raise the full reservoir level to about elevation 227 feet at the upstream end of the impoundment. Usable storage amounts to 11,950 acre-feet in five feet of normal drawdown; however, maximum drawdown is eight feet to El. 212.13 at the spillway crest, for a maximum usable storage capacity of 18,300 acre-feet. The typical reservoir operating range is 2 feet, between El. 220.1 and 218.1. Figures 2.4-1 and 2.4-2 illustrate reservoir conditions at different elevations. Note: the figure shows an outdated reference to “Normal Drawdown” which is now typically 2 feet.

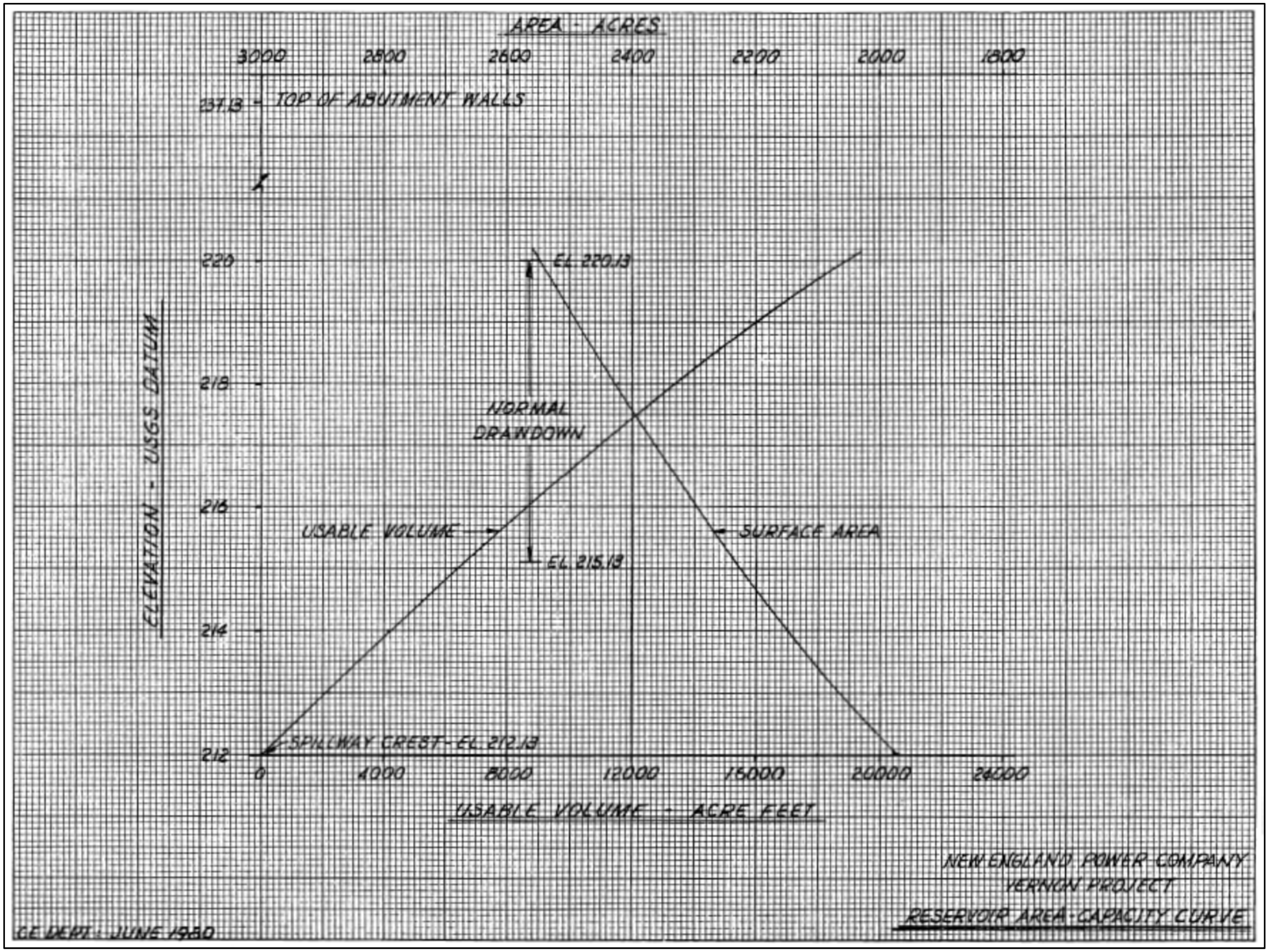

Figure 2.4-1. Reservoir capacity curve.

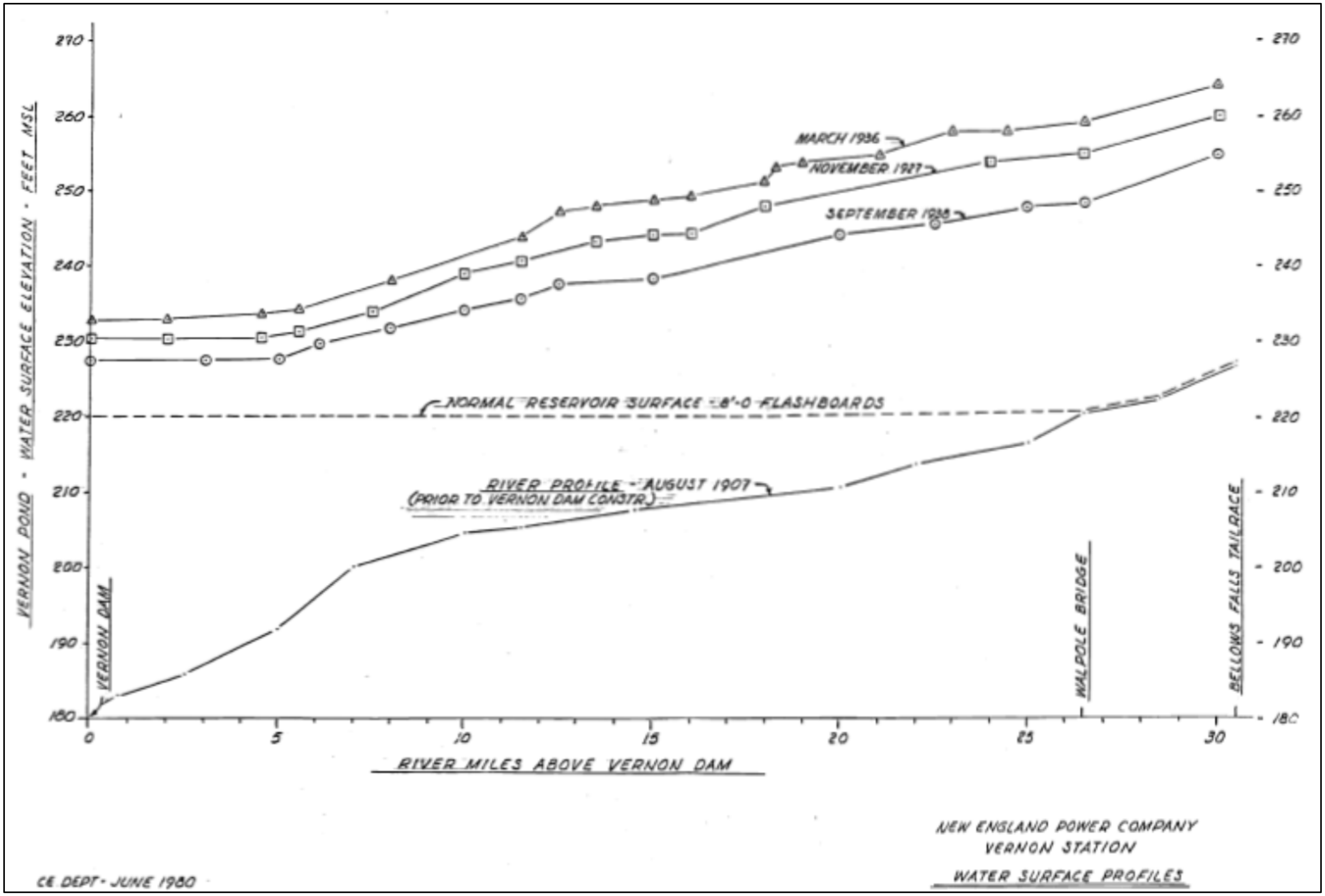

Figure 2.4-2. Water surface profiles.

Reservoir drawdown rates are typically less than one or two-tenths of a foot per hour and do not exceed 3-tenths per hour based upon a self-imposed restriction. There is approximately 3,000 cfs per hour per 0.1 foot of elevation.

Due to a number of factors including the overall length of the reservoir, the range of potential inflow in relation to the generation discharge capacity, the reservoir slope variability based upon inflow and constricted topography in particular locations the Project operates in a “river profile” manner once flows exceed station capacity. See section 2.5, *Project Operations* below.

During the summer recreation season beginning on the Friday before Memorial Day, through the last weekend in September TransCanada maintains a self-imposed minimum reservoir elevation of 218.6 feet from Fridays at 4 pm through Sundays at midnight and similar hours for holidays during this period.

2.5 CURRENT PROJECT OPERATIONS

2.5.1 Basin Information

The drainage area above the dam is 6,266 square miles. Flows in this reach of river are influenced by the upstream hydroelectric projects under normal flow conditions. Approximately 862 square miles of the intermediate drainage area provides natural inflow into the Project beyond what is released from the upstream Bellows Falls Project.

Three main tributaries (see section 3.3, *River Basin Description*), the West River, the Cold River, and the Saxtons River enter the Connecticut River between the Bellows Falls and Vernon dams.

2.5.2 Normal Operations

The Project is operated in conjunction with other TransCanada hydroelectric generating facilities on the Connecticut River, in a coordinated manner hydrologically, that takes into consideration variations in demand for electricity as well as natural flow variations due to seasonal snow-melt or precipitation events that occur within the Connecticut River watershed. The Project is operated primarily on a daily run-of-the-river basis whereby over the course of a day, its operation passes the average daily inflow. Figure 2.5-1 below illustrates the relationship between hydroelectric facilities on the river.

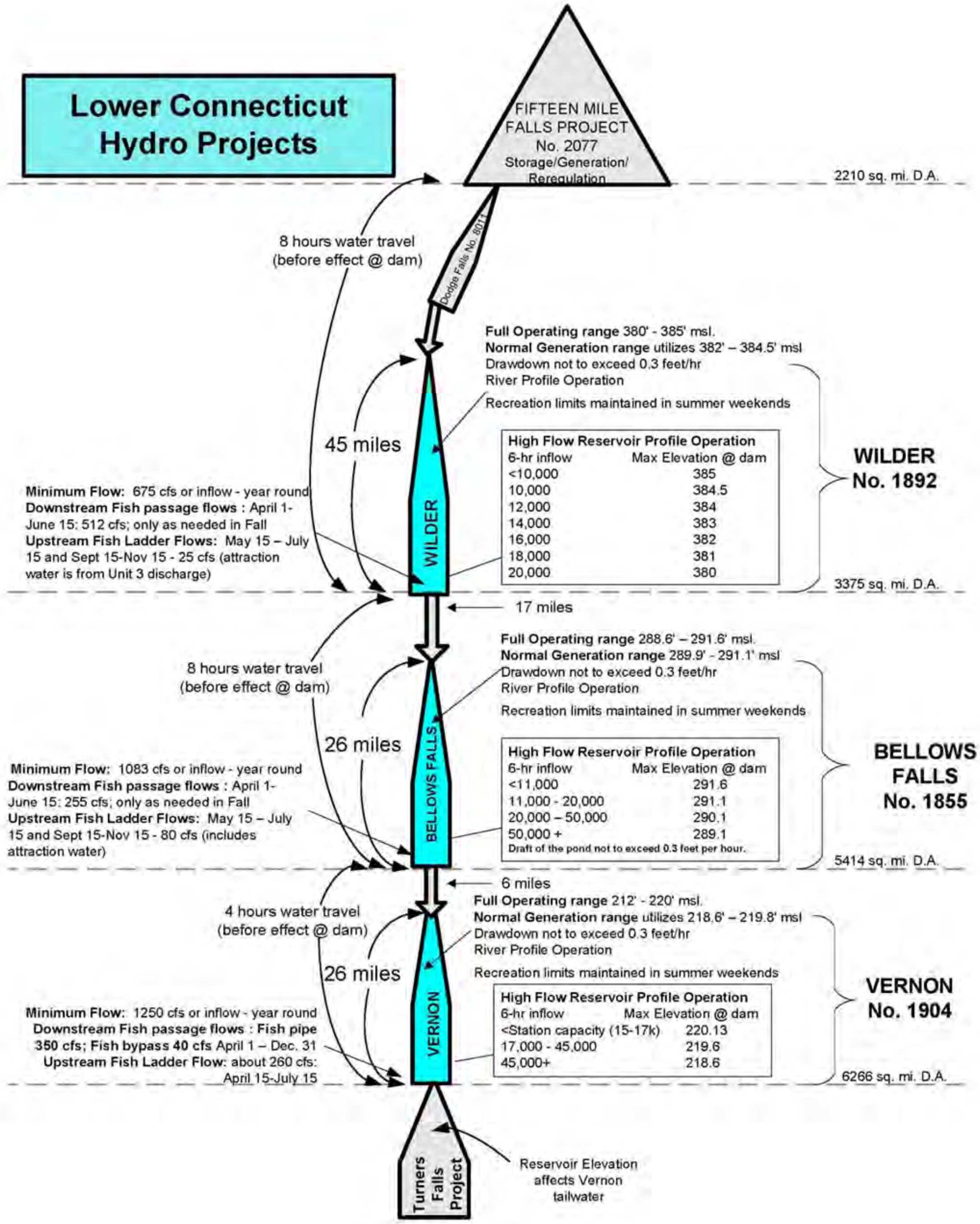

Figure 2.5-1. Connecticut River operations summary.

During periods when average daily flows are less than maximum station flow capacity, the Project uses the limited daily storage in the impoundment to dispatch generation as required to meet the generation schedule managed by the New England Independent System Operator (NE-ISO). Generation can vary during the course of any day between the required minimum flow and full capacity, if higher flows are available.

During periods of sustained high flows, Project generation is dispatched in a must-run status in order to utilize available water for generation.

A constant 1,250 cfs minimum flow (or inflow) is required. Minimum flow is provided primarily through generation at an efficient operating flow of about 1,600 cfs.

2.5.3 Inflow Calculation

Inflow into the Project is from two generalized sources: (1) discharge from the upstream Wilder and Bellows Falls Projects; and (2) natural inflow from the 852 square miles of intermediate drainage area below Bellows Falls dam. Estimated inflow is calculated and used to schedule operation of generators, predict and determine pond elevation, and determine gate and stanchion bay operation if required to pass excess flow.

Project inflow is estimated by combining the discharge from upstream hydro stations and tributary inflow. Inflows are typically calculated on an hourly basis. Inflow less than the required 1,250 cfs minimum is typically not determined since the generator(s) used are designed to operate efficiently at about 1,600 cfs.

The impoundment can be pre-drawn in advance of the inflow (between El. 220.1 and El. 218.61), but only to the extent that the inflow will utilize the limited storage made available without requiring spill. Operating impoundment elevation limits must be set for the reservoir in preparation for any spillway gate operation. Elevations at the dam are reduced as inflows increase above 17,000 cfs.

2.5.4 River Profile Reservoir Operation

When anticipated inflow into the Vernon impoundment increases above 17,000 cfs, TransCanada operators will initiate “river profile” operation by lowering the elevation at the dam. There are two stages to the river profile operation corresponding to inflows above 17,000 cfs that have been established in order to operate the reservoir at elevation 218.6 when inflows exceed 45,000 cfs, as shown in table 2.5-1.

Table 2.5-1. River profile operating stages.

Anticipated Inflow	Maximum Elevation at the Dam
< 17,000 CFS	220.13
17,000 – 45,000 CFS	219.6
> 45,000 CFS	218.6

2.5.5 High Flow Operation

High flows, flows above station capacity that require spill gate operation, occur at Vernon routinely throughout the year. Annually, flows at the dam exceed station capacity about 20 percent of the time. There is little flood storage capacity within the Project and pre-spilling to create storage capacity does not occur at Vernon. There may be instances where inflows are anticipated to peak at a level just above station capacity and the reservoir is drawn down ahead of these flows in order to capture the flow and avoid spilling but they are the exception. Drawdown is limited to no more than 0.3 feet per hour (about 9,000 cfs per hour) and is generally kept within the 0.1 - 0.2 foot per hour range. Pre-spilling to create storage capacity does not occur at Vernon. The timely anticipation of these events within operational constraints can minimize or eliminate spill, resulting in the best use of the water resource.

Operations at the far upstream Fifteen Mile Falls Project (FERC No. 2077) are coordinated to reduce spill at all three downstream Projects, Wilder, Bellows Falls and Vernon, by capturing inflow. High flows resulting in spilling at these three projects, collectively referred to as the Lower Connecticut projects, is typically independent of upstream hydroelectric operation and is a result of natural inflows below Fifteen Mile Falls.

Spring runoff on the Connecticut River typically occurs in phases based upon latitude. For example, normal spring runoff at Vernon occurs distinctly earlier than runoff above Bellows Falls and Wilder dams but below the Fifteen Mile Falls Project. The spring runoff from the Connecticut Lakes down to Fifteen Mile Falls occurs even later in the season. The seasonal storage capability of the Fifteen Mile Falls Project is limited in comparison to the total amount of inflow it receives. The storage capacity at that project is utilized during spring runoff to capture (and refill the project reservoirs) the anticipated peak inflow, reducing potential downstream high water conditions at Wilder and further downstream. The Lower Connecticut projects are typically spilling water as the upstream storage is capturing its peak inflow to the extent possible.

During periods of ice movement, frequent upstream observations and river elevation checks are made within the reservoir area. When there is an ice jam upstream of the dam, an increased or artificial inflow condition is created by a large swell of water in front of the jam as the water behind the jam pushes the ice and water in front of it. When this condition is observed, the station or gate discharges must be increased to pass this temporary situation and to keep the reservoir elevation within its operating pond limits since there is no reservoir storage capacity in this circumstance.

The Project spillway was designed to have a discharge capacity of approximately 127,600 cfs at normal full pond level, and it has successfully passed flows up to the maximum flood of record, 176,000 cfs in March 1936. Since the 1936 flood, the US Army Corps of Engineers (USACE) has constructed flood retention reservoirs throughout the Connecticut River Basin which substantially reduce the probability of floods of such magnitude. Station and spill capacity are provided in table 2.5-2.

Powerhouse discharge capacity is influenced in part by the tailwater elevation which is controlled by the reservoir associated with the downstream Turners Falls Project.

Table 2.5-2. Project discharge capacity.

Station Capacity (cfs)	No Spill	EL. 212.1	EL. 220.1	EL. 228.1 Maximum pond surcharge @ full spill
10 generators	17,100	16,500	21,000	0
1 trash sluice	0	220	1,570	2,770
2 larger tainter gates (No. 1 and No. 2)	0	4,300	23,590	40,950
4 smaller tainter gates (Nos. 3 – 6)	0	0	16,960	48,000
8 hydraulic floodgates	0	14,800	18,000	1,680 [a]
10 hydraulic panels	0	0	8,400	24,000
3 stanchion bays	0	0	2,610	10,200
Total Capacity	**17,100**	**26,320**	**83,230**	**127,600**

[a] Gates submerged by tailwater at this elevation.

Spillway discharge at the dam is regulated by the various gates, panels and stanchions as described in section 2.3.1 above. Different gates and panels can be used as regulating gates. The tainter gates can be operated by local or remote control, while the other gates are only operated locally. Operating experience has shown that the gates can receive considerable damage from ice and debris if operated at certain gate openings. For this reason gate operating limits have been set for remote control operation. The normal power source to operate the gates is from the station service supply. A back-up supply is provided by a diesel driven 125 KW generator located in the powerhouse to provide emergency power to the No. 1 and No. 2 tainter gates in case of power failure. The engine and generator are exercised weekly and used to open each of these gates prior to each spring freshet.

Once the project starts spilling, the reservoir is lowered to El. 219.6. Once flows reach 45,000 cfs, the reservoir elevation is lowered more to control the elevation at 218.6 feet. Once flows reach 70,100 cfs, the reservoir is allowed to rise to El. 220.1 and portions of stanchion bays are removed. Complete stanchion removal does not take place until all gates and panels are committed and extremely high flows reach 105,000 cfs (El. 222.1). In advance of that, combinations of gates are used to control the reservoir at El. 220.1 as long as possible.

Stanchion beam removal is accomplished in accordance with the spillway operating procedure. A complete stanchion bay can be removed in 10 to 15 minutes, where the stanchion beams are released and later retrieved from the spillway channel area. Any portion of a bay (stanchion beams) can be released depending upon the flow conditions. At approximately 105,000 cfs there is no longer any control of flows through the Project. Table 2.5-3 provides a summary of the Vernon Project high flow operation based upon increasing inflow into the Project from upstream and tributary sources.

Table 2.5-3. High flow operations summary.

Inflow	Project Status
17,000 cfs or less	Flows in this range can be passed through the station using some or all of the 10 hydroelectric turbines depending upon the schedule for load requirements. The maximum pond limit is El. 220.1 for year round operation. License Article 34 requires a minimum flow release of 1,250 cfs or inflow if less and any of the Units 5 through 10 can be used to provide this flow. Typically, Units 5 thru 8 would be used first but during the upstream fish passage season Unit 10 would be the priority unit to ensure linear flow across the entrance to the fish ladder.
17,000 to 45,000 cfs Without Ice	For flows greater than station capacity (17,100 cfs) it is necessary to operate selected spillway gates to pass the excess. The first gate used is the trash sluice gate located in the spillway to keep debris away from the intake area. An operating limit at El. 219.6 is placed on the pond. No. 1 and 2 tainter gates (20' x 50') are used as needed up to a maximum opening of 7 feet on each gate. If additional gate capacity is needed, No. 1 tainter gate is taken out of water and No. 2 tainter gate is used to control the pond at El. 219.6. When using gates to lower the pond to a new pond limit, the rate of draw is normally 0.1 to 0.2 feet/hour; however, the rate is not to exceed 0.3 feet/hour, which is approximately 9,000 CFS. Pre-drawing the pond is in anticipation of higher expected flows to mitigate the peak flow.
17,000 to 45,000 cfs With Ice	When flows are in excess of station capacity with ice in the pond, it is necessary to operate the appropriate tainter gates to avoid stanchion panel damage from floating ice. An operating limit of El. 219.6 is placed on the pond. No. 1 tainter gate is used to control pond elevation up to a maximum of 7 feet open. When additional gate capacity is required, No. 4

Inflow	Project Status
	and 5 (10' x 50') tainter gates are used. Experience has shown these gates provide a smooth and more direct passage for ice flows. The submerged hydraulic floodgates would be the next gates used, if needed depending on the amount of ice flow or the time of day.
Expected to exceed 45,000 cfs Without Ice	When flows above 45,000 cfs are expected, an operating limit at Elevation 218.6 is placed on the pond. No. 1, 2, 3, 4, 5, and 6 tainter gates are used to lower the pond to the new operating limit at a rate of 0.1 to 0.2 feet/hour. Pre-drawing the pond is in anticipation of higher expected flows to mitigate the peak flow. When both No. 1 and 2 tainter gates have reached a gate opening of 7 feet, No. 1 gate is raised clear of the flow. No. 2 gate is then closed as needed to compensate for the increased flow. The submerged hydraulic floodgates are used next to pass increased flows. All hydraulic floodgates should be committed before the tailwater reaches El. 196.0 as tailwater elevation above that point can restrict safe access to the submerged gates. The ten (10' x 10') hydraulic panels can be lowered to the spillway crest (El. 212.1) to pass additional flow and the pond is then controlled by adjusting No.1 and No. 2 tainter gates.
Expected to exceed 45,000 cfs With Ice	When flows above 45,000 cfs are expected with ice on the pond, an operational limit of Elevation 218.6 is placed on the pond and selective gate operation is required to prevent damage to stanchion board sections. No. 1 tainter gate is used to a maximum opening of 7 feet to maintain the pond below El. 218.6. If additional gate capacity is needed, No. 4, 5, 6 and 3 tainter gates are opened. These gates will pass ice safely and not cause damage to stanchion sections. The submerged hydraulic floodgates should be used next. Past experience has shown ice passage through the dam usually occurs at flows between 25,000 to 45,000 cfs.
Expected to exceed 70,100 cfs	The pond is controlled at or below El. 218.6 using No. 1 or 2 tainter gate. The station crane is moved into position to pull stanchion bay boards and/or stanchion beams. At a flow of approximately 70,100 cfs, top sections of stanchion bay boards are pulled, and the pond is regulated to El. 218.6 using the No. 1 or 2 tainter gate.

Inflow	Project Status
	Once all gates and hydraulic panels are fully opened, the elevation is allowed to rise to 220.1. If the river continues to rise, a crane operator remains onsite to remove stanchion beams once elevation reaches 222.1. If river flows are continuing to rise, remove stanchion beams from bays as required to maintain El. 222.1 (approximate river flow of 105,000 cfs). If it appears the river will reach an extremely high flood stage of El. 224.1 or more over the dam, personnel will be posted round the clock at the east end of the dam. They will patrol the east abutment, Vernon neck, and No. 1 and 2 line tower footings to inspect for evidence of gullying and slope erosion; and if required, they will place sandbags to stop the erosion. At all times they keep in close contact with the Connecticut River Operator.

2.5.6 Flood Control Coordination and Navigation

The USACE operates and maintains two flood control dams on the West River, one at Townshend and one at Jamaica, Vermont. These projects can capture the stream flow from the 450 square mile of drainage area above them contributing to flood flows into this portion of the Connecticut River and Vernon reservoir.

Per Article 32 of the existing license, an agreement with the USACE provides for the coordinated operation of the Project with the USACE dams, in the interest of flood control and navigation on the Connecticut River. It specifically describes the operating protocol associated with periods of high inflow in which the elevation at the dam is lowered. This is known as "river profile" operation to maintain upstream elevations within a range that protects specific railroad grade embankments along the river as well as reduces potential for river flows to spill outside the normal operating range.

2.6 EXISTING LICENSE AND PROJECT OPERATIONS SUMMARY

2.6.1 Energy Production

Claimed capacity of the Project is 36.79 MW. Average annual gross energy production over the last 30 years (1982-2011) was 131,516 megawatt hour (MWh). Average monthly gross energy production over the same time period varies from a low of 6,267 MWh in September to a high of 14,533 MWh in May.

Project monthly and annual generation and discharge since 2000 is summarized in tables 2.6-1 and 2.6-2 below. It should be noted that precipitation was higher than normal during this period. Additional information is provided in section 3.5.2, *Hydrology*.

Table 2.6-1. Generation summary (MWH) 2000 – 2012 year-to-date.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	14,644	8,720	12,666	12,140	14,309	12,170	7,591	11,354	5,273	7,016	11,386	10,030	127,299
2001	11,332	9,411	9,735	9,393	13,334	10,668	6,780	3,040	2,622	2,602	4,797	7,209	90,923
2002	6,294	10,671	16,287	12,123	15,062	15,308	7,995	3,743	3,253	5,996	11,173	9,929	117,832
2003	9,186	6,604	8,441	13,800	14,631	10,080	5,490	10,430	7,884	11,988	14,012	12,412	124,956
2004	13,637	8,370	13,347	13,449	15,162	9,227	7,755	10,292	10,579	6,904	8,424	8,530	125,675
2005	8,749	8,133	10,367	9,322	13,911	12,535	9,545	4,577	5,535	7,851	10,043	10,767	111,336
2006	10,854	11,808	9,835	11,554	10,412	12,105	12,539	10,845	6,459	10,773	12,084	11,797	131,066
2007	13,421	8,985	10,628	10,342	9,819	9,438	8,667	6,023	5,090	5,912	12,045	12,743	113,113
2008	12,527	12,102	16,686	12,715	15,051	14,295	13,037	16,739	10,090	11,379	17,871	19,023	171,514
2009	15,040	11,633	20,870	19,116	20,997	14,613	19,919	15,818	6,359	11,874	18,453	17,873	192,564
2010	15,706	13,201	16,744	19,685	17,297	9,345	7,265	6,489	3,912	17,200	18,437	16,501	161,782
2011	13,049	9,392	16,992	12,533	19,571	17,366	7,737	9,077	12,342	19,960	14,232	18,691	170,941
2012	15,066	11,500	18,142	14,701	20,322	13,912	6,900	4,566	5,709				110,816
Average	12,269	10,041	13,903	13,144	15,375	12,389	9,325	8,692	6,547	9,955 [a]	12,746 [a]	12,959 [a]	137,344

[a] Average of 2000 – 2011 only.

Table 2.6-2. Discharge summary (cfs) 2000 – 2012 year-to-date.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
2000	9765	6233	23809	34028	23247	8930	5616	7162	3288	4429	7197	12150	12155
2001	6124	7057	14914	29886	18386	16093	5292	2233	2181	3812	8507	6457	10079
2002	3796	7057	14914	29886	18386	16093	5292	2233	2181	3812	8507	6457	9885
2003	5135	4313	17027	24268	15534	6698	3375	8467	5790	14858	22412	24665	12712
2004	10373	4827	11189	23586	14567	6868	4922	6340	10086	3965	6976	14651	9863
2005	11020	6057	8128	36709	16415	14889	5858	2662	4016	27148	23710	16123	14395
2006	22764	15685	11445	15917	22367	22596	14102	7940	3737	17294	21958	15253	15922
2007	16075	5310	14285	34773	18216	7030	6606	3254	3066	7893	13664	9696	11656
2008	15551	13259	20583	45483	13654	8892	12901	17910	5567	8620	11223	18710	16029
2009	8532	6812	19889	26319	13590	9490	15936	11551	3845	11382	12283	14378	12834
2010	10275	8346	24942	22366	10965	7147	4225	4204	2570	20934	14975	15566	12210
2011	6981	5546	20720	43183	28538	11913	4323	12732	19291	16876	8989	14341	16119
2012	9271	6749	16601	11431	16563	9915	3625	2674	3320				
Average	10436	7481	16804	29064	17725	11273	7083	6874	5303	11752 [a]	13367 [a]	14037 [a]	12821[a]

[a] Average of 2000 – 2011 only.

2.6.2 Net Investment

The Federal Power Act (FPA) generally defines a Licensee's net investment in a Project as the original cost of the Project, plus additions and betterments, minus depreciation and other amounts (16 USC §796(13)). TransCanada's net investment in the Vernon Project as of December 31, 2011, was $94,474,991. This amount is based on the allocated 2005 purchase price of the former USGen New England Inc. hydropower assets plus net investments in capital improvements from 2005 to 2011.

2.6.3 Current License and License Amendment Requirements

In addition to standard Articles 1 through 28 set forth in Form L-3 (Revised October 1975) entitled "Terms and Conditions of License for Constructed Major Project Affecting Navigable Waters of the United States," the Project license includes the requirements summarized in table 2.6-3.

Table 2.6-3. Summary of license and amendment requirements.

License Article	Summary of Requirement
29	Requires establishment and maintenance of amortization reserves based on a specified reasonable rate of return upon the net investment in the Project.
30	As revised June 16, 2007. Requires payment of annual charges to the Commission for the cost of administration of the license, based on the authorized installed capacity for that purpose of 32.4 MW.
31	Requires implementing and modifying when appropriate, the emergency action plan on file with the Commission designed to provide an early warning to upstream and downstream inhabitants and property owners if there should be an impending or actual sudden release of water caused by an accident to, or failure of, Project works.
32	Requires entering into an agreement with the USACE to provide for the coordinated operation of the Project, in the interest of flood control and navigation on the Connecticut River.
33	Required providing potable water at the Vernon Glen Recreation Area and the Governor Hunt Picnic Area, and completing all improvements to the Governor Hunt Boat Launching Area and all recreation facilities detailed in the license Exhibit R. The Vernon Neck Demonstration Forest Area shall be designated as a natural area, with only limited public use. The northern portion of the Vernon Glen Recreation Area may continue in existing agriculture use, subject to its reservation for future recreational development that may be determined necessary during the license period.
34	Requirement to maintain a continuous minimum flow of 1,250 cfs. This flow may be modified temporarily: (1) during and to

License Article	Summary of Requirement
	the extent required by operating emergencies beyond the control of the Licensee; and (2) in the interest of recreation and protection of the fisheries resources upon mutual agreement between the Licensee and the Fish and Game Departments of the States of New Hampshire and Vermont.
35	Requires undertaking consultation and cooperation with the appropriate State Historic Preservation Officer(s) (SHPO) prior to the commencement of any construction or development of any Project works or other facilities at the Project.
36	Requires installation and operation of signs, light, sirens, barriers, or other devices that may be reasonably needed to warn the public of fluctuations in flow from the Project and to protect the public in its recreational use of Project lands and waters.
37 (December 15, 1980 amendment)	Giving authority to the Licensee to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval.
38	Required to filing for approval a revised Exhibit K and (I) clearly delineating its flowage rights for Project lands, as well as fee ownership, and (2) incorporating all information denoted on Exhibit drawing K-2 Sheet 3A of 14 which was a part of the application for amendment of license filed May 31, 1968.
39	Required filing with the Commission a feasibility analysis of installing additional generating capacity at the Project.
40	Required filing a copy of a report with the Commission within 30 days after the USACE issues its final report on its study of erosion on the Connecticut River.
301, 302, 303 (June 12, 1992 amendment)	Required commencing construction of the revised project works within two years, and completing construction of the project within four years from the date of amendment; revising and submitting drawings, specifications and Exhibits.
304 (June 12, 1992 amendment)	Requires continuing to allow the New England Power Pool's regional central dispatching system (NEPEX) to coordinate operation of the Vernon Project with the Northfield Mountain Project (Project No. 2485) and Turners Falls Project for generation output. In the event that NEPEX will no longer continue to adequately coordinate the projects' operation, the Licensee must enter into a reasonable agreement with Northeast Utilities Service Company (NUSCO - then owner of Northfield Mountain and Turners Falls) to coordinate the operation of the three projects.

License Article	Summary of Requirement
401 (June 12, 1992 and July 28, 2006 amendments)	Required preparing and filing for Commission approval at least 90 days before commencing construction, a final plan and schedule to control erosion, slope stability, and fugitive dust, and to minimize the quantity of sediment resulting from project construction and operation. Further, the Licensee must implement its plan and schedule for minimizing impacts to migrating anadromous fish during excavation and construction.
402 (June 12, 1992 and July 28, 2006 amendments)	Required preparing and filing for Commission approval at least 90 days before commencing construction, a final plan and schedule for upstream fish passage and for monitoring the effectiveness of the passage of Atlantic salmon, American shad, and other anadromous fishes.
404 (June 12, 1992 amendment)	Required preparing National Register of Historic Places registration forms consistent with the Secretary of the Interior's Standards and Guidelines for Historic Preservation for the Vernon Station; and documenting the components proposed for replacement according to the standards of the Historic American Engineering Records (HAER) of the National Park Service (NPS), prior to commencing any project-related construction activities, that would affect the characteristics of the Vernon station that make it eligible for the National Register of Historic Places.
405 (July 28, 2006 amendment)	Requirement to comply with the conditions of the Water Quality Certificate, issued by the New Hampshire Department of Environmental Services, pursuant to Section 401 of the Clean Water Act. Those provisions included developing and implementing the following plans: Operations Plan, Flow Release Monitoring Plan, Dissolved Oxygen and Temperature Monitoring Plan, Erosion Monitoring Plan, and Debris Removal Plan.
	An additional provision of the July 28, 2006 license amendment required the Licensee to implement the "Memorandum of Agreement Regarding the Proposed Amendment to the License of the Vernon Hydroelectric Project Vernon, Vermont and Hinsdale, New Hampshire" (MOA). The MOA included filing of the Historic Properties Management Plan (HPMP) for the project and the following provisions: (1) conduct photographic documentation of the powerhouse; (2) conduct digital video documentation at key stages of the project to record the removal of the original equipment and installation of the new equipment; (3) conduct archaeological investigations to identify known archaeological sites and areas within project boundaries that have a likelihood of containing archaeological deposits; (4) prepare a Historic Properties Management Plan for the project;

License Article	Summary of Requirement
	and (5) offer, and if accepted, donate generating and electrical equipment removed from the powerhouse to museums and educational organizations.

2.6.4 Compliance History

The Licensee for the Project is aware of only one instance of non-compliance with the conditions of the Project license, which occurred when the Project was owned and operated by a previous Licensee. Specifically, on April 22, 1994, the Commission informed the Licensee that the Project was in violation of its license with regard to submitting annual reports for upstream and downstream passage effectiveness studies. However, prior to the date of that letter the Licensee had requested an extension of time to construct the fish passage facilities (and consequently for conducting the studies). On May 12, 1994, the Licensee submitted a separate request for extension to conduct the required studies, pending actual construction of the facilities. The Commission subsequently approved the construction extension on June 8, 1994, and the study extension on July 5, 1994.

FERC's New York Regional Office conducts regular inspections as required by FERC regulations. In addition, the Licensee's chief dam safety engineer conducts regular inspections. The Licensee completes all necessary corrective actions to address comments and recommendations arising from inspections by the FERC and/or its chief dam safety engineer in a timely manner.

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3.0 EXISTING ENVIRONMENT AND RESOURCE IMPACTS

3.1 INTRODUCTION

This section presents the existing environment and resource impacts (based on existing, relevant, and reasonably available information) required by 18 C.F.R. § 5.6(d)(3), including:

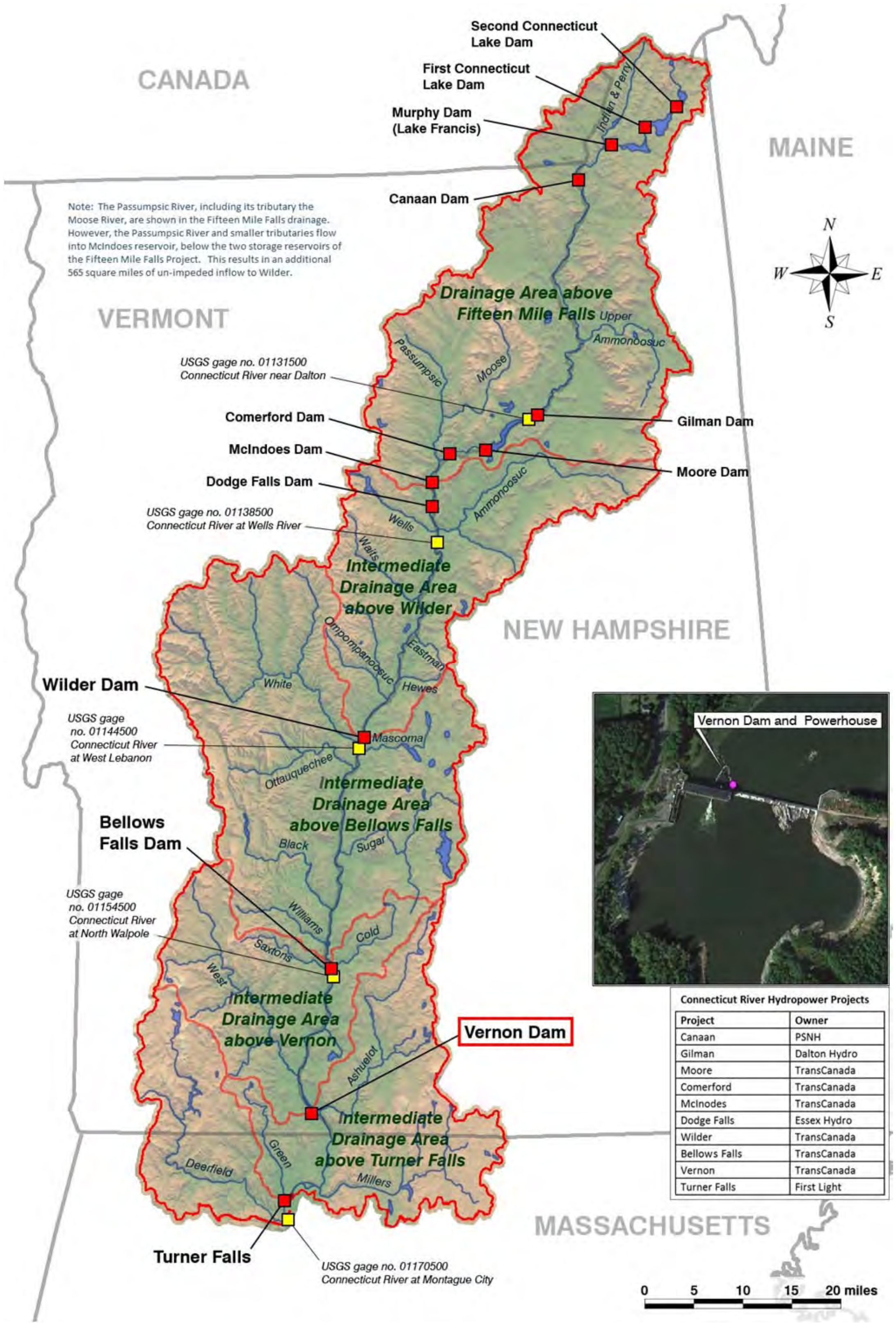
- a description of the existing environment;
- summaries of existing data or studies;
- potential adverse impacts and issues related to project construction, operation, or maintenance; and
- existing or proposed resource protection and mitigation measures (facilities, operations, and management activities).

Throughout this section as we discuss the existing environment and resources, we use the following specific terms:

- Middle Connecticut River Basin – a portion of the entire Connecticut River Basin that lies above the Holyoke dam upstream to and including the entire area impacted by the Wilder dam impoundment.
- Vernon Project affected area – Vernon dam to the upstream extent of the Vernon impoundment.
- Terrestrial project area; wetland-riparian project area – resource specific area delineations for the purpose of the PAD that include lands with flowage easements retained by TransCanada and any land owned in fee by TransCanada, plus a 250-foot buffer around the resulting Project boundary.
- RTE project area – the land within a 1,000-foot buffer to the Project boundary.

3.2 GENERAL DESCRIPTION OF THE LOCALE

The Connecticut River originates in the Fourth Connecticut Lake near the Canadian border and flows in a southerly direction for about 407 miles to the Long Island Sound in southern Connecticut. The upper Connecticut River Basin (figure 3.2-1) has a drainage area of 7,751 square miles and is the northern portion of the entire basin that has a drainage area of 11,250 square miles in Vermont, New Hampshire, Massachusetts, and Connecticut. The upper Connecticut River (to Turners Falls dam in Massachusetts) is about 271 miles long.



Connecticut River Hydropower Projects

Project	Owner
Canaan	PSNH
Gilman	Dalton Hydro
Moore	TransCanada
Comerford	TransCanada
McInodes	TransCanada
Dodge Falls	Essex Hydro
Wilder	TransCanada
Bellows Falls	TransCanada
Vernon	TransCanada
Turner Falls	First Light

Figure 3.2-1. Project and the upper Connecticut River Basin (Source: EPA, 2012, as modified by TransCanada).

There are numerous lakes, ponds, and dams in the Connecticut River Basin. Dams on the main stem of the Connecticut River include First and Second Connecticut Lake dams, Murphy, Canaan, Gilman, Moore, Comerford, McIndoes, Dodge Falls, Wilder, Bellows Falls, Vernon, and Turners Falls. The first dam, 87 miles upstream of the mouth of the Connecticut River at Long Island Sound, is Holyoke dam, in Holyoke, Massachusetts. Major tributaries affecting the Wilder, Bellows Falls, and Vernon projects downstream of the storage reservoirs of Comerford and Moore dams include the Passumpsic, Waits, Ompomanoosuc, White, Ottaquechee, Black, Williams, and West rivers in Vermont, and the Ammonoosuc, Mascoma, Sugar, and Cold rivers in New Hampshire.

3.3 RIVER BASIN DESCRIPTION

The northern and higher elevation areas of the upper Connecticut River Basin are characterized by rugged terrain in the White and Green Mountains with dense northern hardwood and spruce-fir forests. These areas are sparsely populated with only small towns and villages and limited agricultural areas. Most of the larger towns and cities are located at lower elevations and near the Connecticut River Valley. The relatively flat land near the Connecticut River, including the flood plain, has substantial agricultural fields. The reservoir extends northward into the northern portions of Windham County, Vermont, and Cheshire County, New Hampshire.

3.3.1 Major Water Uses

The Connecticut River was used as a means of log conveyance mostly in the spring for the timber industry from the 1800s until about 1921 when the last major log drive was conducted from the upper basin to the saw mills near Bellow Falls (Connecticut River Watershed Council, www.ctriver.org). The large mainstem hydroelectric dams were built on the Connecticut River starting in the early 1900s, and Vernon dam and powerhouse was completed in 1909. The upstream Bellows Falls Project began operating in 1928, and the downstream Turners Falls Project (at RM 122.2, owned by First Light) began operating in 1905. The Northfield Mountain Pumped Storage Project (FERC No. 2485; also owned by First Light), which uses Turners Falls reservoir as its lower reservoir, began operating in 1972. The surface water of the river has long been used for recreational boating, including power boating, canoeing, and rowing, as well as sport fishing.

Water within the Project is used on a limited basis for seasonal irrigation and there are municipal water supply wells in the groundwater aquifer next to the river in Hinsdale, New Hampshire. Vermont Yankee started operating in 1972 and is located on Vernon reservoir about 0.75 mile upstream of Vernon dam. Vermont Yankee's water use is discussed in sections 3.5.3, *Water Use*, and 3.5.6, *Existing Water Quality*. The Connecticut River also receives treated wastewater from private, commercial, municipal, and industrial sources that discharge both to the river and to its tributaries.

Table 3.3-1 identifies the 12 FERC-licensed hydropower and storage projects on the main stem of the Connecticut River. There are also numerous smaller licensed and exempt hydropower projects on the tributaries to the Connecticut River, and

TransCanada owns and operates dams at First and Second Connecticut Lakes as water storage facilities. The U.S. Army Corps of Engineers (USACE) operates numerous flood control dams on tributaries in the upper Connecticut River Basin (table 3.3-2).

Table 3.3-1. Mainstem Connecticut River hydropower projects (Source: FERC, 2012).

Project Name	Owner	FERC No.
Canaan	PSNH	P-7528
Gilman	Dalton Hydro	P-2392
Moore	TransCanada	P-2077
Comerford	TransCanada	P-2077
McIndoes	TransCanada	P-2077
Dodge Falls[a]	Essex Hydro	P-8011
Wilder	TransCanada	P-1892
Bellows Falls	TransCanada	P-1855
Vernon	TransCanada	P-1904
Turners Falls	First Light	P-1899
Northfield (pump storage)	First Light	P-2485
Holyoke	Holyoke Gas and Electric	P-2004

[a] Exempt project.

Table 3.3-2. USACE flood control dams (Source: Brown, 2009).

Project Name	Watershed	State
Union Village	Ompompanoosuc	VT
Deweys Mills	Ottauquechee	VT
North Hartland	Ottauquechee	VT
Stoughton Pond	Black	VT
North Springfield	Black	VT
Ball Mountain	West	VT
Townshend	West	VT
Surry Mountain	Ashuelot	NH
Otter Brook	Ashuelot	NH

3.3.2 Drainage Basin's Tributary Streams

Table 3.3-3 describes the major tributaries flowing into the Connecticut River in the vicinity of the Project.

Table 3.3-3. Project area major tributary information (Source: USGS, 2012; USACE, 1973; CRJC, 2009; FWS, 2010; New Hampshire DES, 2012).

Tributary	Town, State	Drainage Area (square miles)	Enters CT River at River Mile
Upstream of Vernon Dam			
Saxtons River	North Westminster, VT	78	172.5
Cold River	Cold River, NH	102	171.9
West River	Brattleboro, VT	423	149.3
Downstream of Vernon Dam			
Ashuelot River	Hinsdale, NH	421	139.8

Saxtons River

The Saxtons River originates near Grafton, Vermont, in western Windham County and flows through the town of Saxtons River and enters the Connecticut River in Westminster. The river does not have dams on its main stem and is about 20 miles long with a drainage area of about 78 square miles (CRJC, 2009; FWS, 2010).

Cold River

The Cold River originates near the towns of Acworth and Unity in Sullivan County, New Hampshire, and flows south and west to the Connecticut River at the town of Walpole. The first dam is about 7 RM above the confluence with the Connecticut River is Vilas Pool dam in Alstead, New Hampshire. The river is about 24 miles long with a drainage area of about 100 square miles (New Hampshire DES, 2012; FWS, 2010).

West River

The West River originates near the town of Mount Holly in southeastern Rutland County, Vermont, and flows generally southeasterly through the towns of Weston, Londonderry, Jamaica, Townshend, Brookline, Newfane, and Dummerston and joins the Connecticut River in Brattleboro. In the early 1960s, USACE finished two flood control dams along the West River, Ball Mountain Lake, and Townshend Lake, in the upper and middle section of the river. The first dam is about 19 RM above the confluence with the Connecticut River is the Townshed Lake dam operated by the USACE. The river is about 46 miles long and has a drainage area of about 423 square miles (CRJC, 2009; FWS, 2010).

Ashuelot River

The Ashuelot River originates near the town of Washington in Sullivan County, New Hampshire, and flows generally southwesterly through the towns of Keene, Swanzey, and Winchester, and joins the Connecticut River in Hinsdale about 2 miles below Vernon dam. USACE has built two flood control projects in the Ashuelot River watershed, Surry Mountain built in 1941, and Otter Brook in 1958. There are also numerous small hydropower projects on the Ashuelot River and the first dam is about 2 RM above the confluence with the Connecticut River is the Fiske Mill dam (FERC No. 8615) in Hinsdale, New Hampshire. The river is about 64 miles long with a drainage area of 421 square miles (New Hampshire DES, 2012; FWS, 2010).

Table 3.3-4 shows the U.S. Geological Survey (USGS) gages in the Vernon Project vicinity. TransCanada also records reservoir levels, generation, and discharges at 1-hour intervals at the Vernon Project.

Table 3.3-4. Active or recently deactivated USGS gages in the Project vicinity (Source: USGS, 2012).

Site Number	Site Name	Data	Drainage area
Upstream of Vernon Dam			
01154000	Saxtons River at Saxton River, VT	06-20-40 to present	72.2
01154500	Connecticut River and North Walpole, NH	03-06-1942 to 05-28-2012	5,493
01154950	Cold River at High Street, at Alstead, NH	09-16-2009 to present	74.6
01155910	West River Below Townshend Dam near Townshend, VT	04-30-12 to present	282
Downstream of Vernon Dam			
1156500	Connecticut River At Vernon, VT	02-01-36 to 09-30-73	6,266
01161000	Ashuelot River at Hinsdale, NH	03-17-1907 to present	420
01170000	Deerfield River near West Deerfield, MA	03-29-1904 to present	557
01170500	Connecticut River at Montague City, MA	03-31-1904 to present	7,860

3.3.3 Climate

The region near Vernon has mild and humid summers and cold winters. Average July temperatures range from a daily average maximum of 84 degrees Fahrenheit (°F) and a daily average minimum of 59°F. Average January temperatures range from a daily average maximum of 32°F and a daily average minimum of 11°F. The average annual precipitation is 47.0 inches, and this is relatively evenly distributed throughout the year (U.S. Climate Data, 2012). The average annual snowfall is about 55 inches (Vermont State Climate Office, 2012).

3.3.4 References

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3.4 GEOLOGY AND SOILS

3.4.1 Summary of Existing Studies

For descriptions of the geological and soil resources at, or in the vicinity of, the Vernon Project, we reviewed:

- Draft Lower Connecticut River Shoreline Survey Report – 2010. Bellows Falls, Wilder, and Vernon Projects (Kleinschmidt, 2011).
- Technical Report – Phase 1A Archaeological Reconnaissance Survey, Vernon Hydroelectric Project (FERC No. 1904), Windham County, Vermont, and Cheshire County, New Hampshire (PAL, 2008).
- Soil Survey of Cheshire County, New Hampshire (USDA, 1989).
- Soil Survey of Windham County, Vermont (USDA, 1978).
- Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire (Field, 2004).
- Riparian Buffers for the Connecticut Valley (CRJC, 2001b).
- Connecticut River Corridor Management Plan (CRJC, 1997).
- Water Resources – Connecticut River Corridor Management Plan – Wantastiquet Region (CRJC, 2009c).
- USACE Connecticut River Streambank Erosion Study – Massachusetts, New Hampshire and Vermont (Simons et al., 1979).
- Natural Resource Conservation Service – Web Soil Survey (NRCS, 2012).
- *Where the Great River Rises, An Atlas of the Connecticut River Watershed in Vermont and New Hampshire* (Brown, 2009).

3.4.2 Topography

The Vernon Project is located within the New England Uplands section of the New England Physiographic Province (figure 3.4-1). Within the smaller biophysical regions of southeastern Vermont and southwestern New Hampshire, the Vernon Project lies in the southern Vermont Piedmont (PAL, 2008). This is an area to the east of the Green Mountains that runs the entire length of the two states from Canada to Massachusetts, and includes the Connecticut River Valley, and it is the largest physiographic region common to the two states. The floodplains and terraces adjacent to the river generally range from elevation 200 to 300 feet mean sea level (msl). The upland hills adjacent to river terraces generally range from elevation 500 to 800 feet (msl).

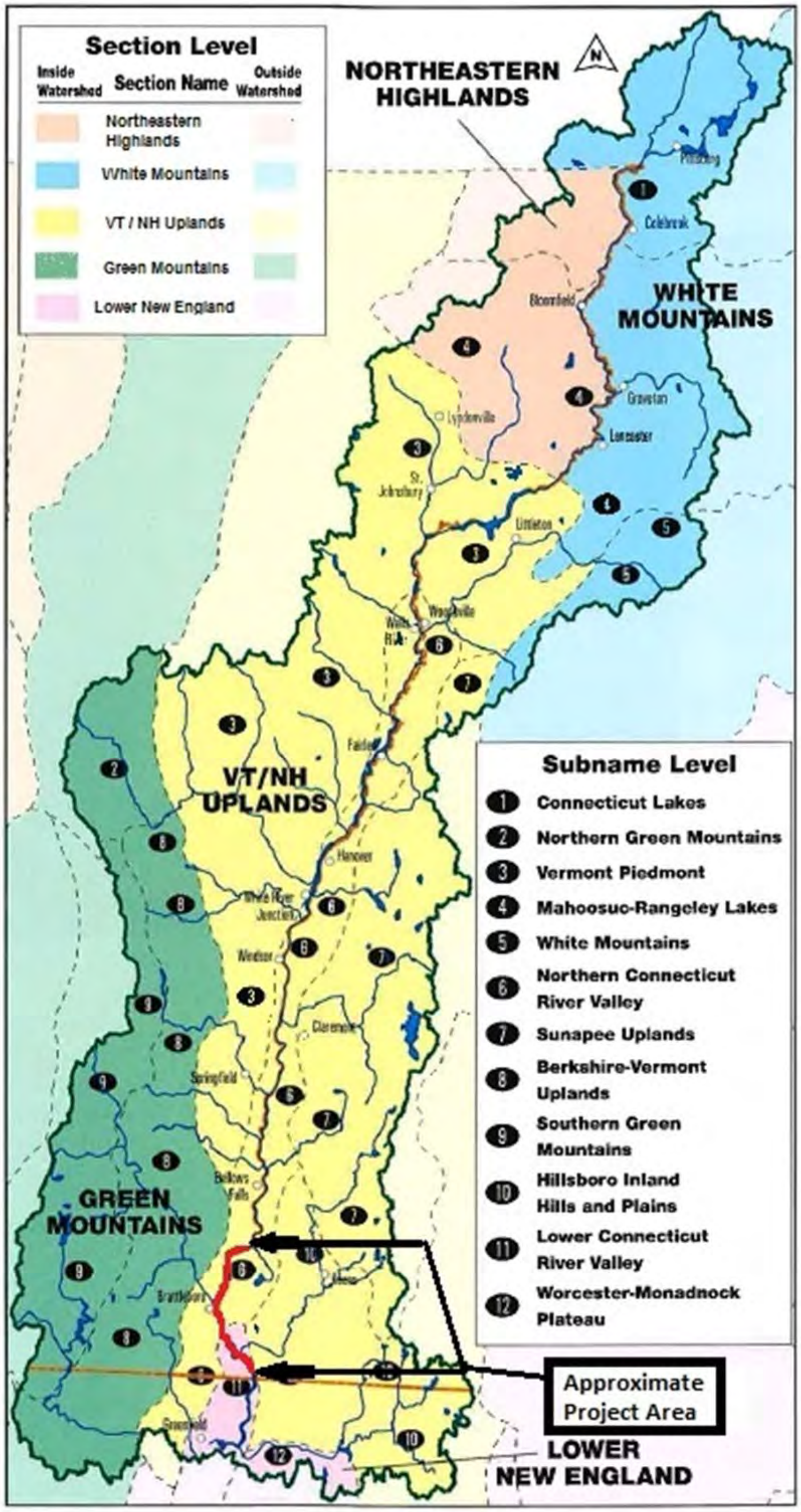

Figure 3.4-1. Physiographic regions of Vermont and New Hampshire showing Project area (Source: Brown, 2009).

The word piedmont, which means “at the foot of the mountains,” is used to describe an area of foothills, and this area is made up of rolling hills and valleys at the foot of the Green Mountains that extend into western New Hampshire. The most notable feature of the piedmont landscape is a number of mountains that rise above the surrounding landscape. These isolated mountains are called monadnocks, a word believed to originate in Abenaki that means “island mountain place,” and consist of resilient granite outcrops. Wantastiqet Mountain in New Hampshire is the most notable monadnock in the Project vicinity; Mount Monadnock is beyond the Project region but it is the largest of these isolated mountains in the southwestern New Hampshire region.

3.4.3 Geological Features

Geologically, the Vernon Project lies within the Connecticut River valley-Gaspé Basin. This geological area takes up the eastern third to half of Vermont and forms the western border of New Hampshire. The area is composed of a sedimentary basin characterized by thick deposits of calcareous sediments including shales and limestones. This layer contains sedimentary, metamorphic, and igneous rock types of Silurian and Devonian age. Igneous bedrock includes felsic intrusions from which the region’s famous granite is quarried.

Surficial geological deposits in the Vernon Project vicinity consist of glaciofluvial, glaciolacustrine, postglacial fluvial sands and gravels, and recent alluvium along the banks of the Connecticut River and glacial till in the adjacent upland areas. The surficial geology of the Project area is in large part attributable to glacial processes. The final Pleistocene advance and retreat of the continental ice mass during the Wisconsin Period eroded and picked up bedrock, realigned drainages, and deposited till, erratics, and glacial moraine along its course. The retreat of the ice from Vermont and New Hampshire about 13,500 years ago left widespread glacial deposits and glacial erosional surfaces. An important part of the deglaciation in this area was the formation of temporary lakes along the margins of the ice fronts. The Connecticut River Valley in the Project vicinity is situated within the boundaries of glacial Lake Hitchcock. Glacial Lake Hitchcock formed as glacial meltwaters released from the ice sheet were dammed behind a natural sand, gravel, and till barrier deposited in the area of Rocky Hill, Connecticut, to the south. Continued ice melt resulted in a massive natural lake impoundment north of Rocky Hill dam, which at its maximum stretched some 200 miles from Rocky Hill to St. Johnsbury, Vermont, and reached a width of some 20 miles. The Connecticut River appears to have essentially continued along the same preglacial course following the drainage of glacial Lake Hitchcock. Glacial Lake Hitchcock persisted in the upper Connecticut Valley until about 12,300 years ago, and its existence likely overlapped with the earliest presence of humans in the area.

3.4.4 Soils

The portion of the Project located in the southeastern part of Windham County, Vermont, is covered by Dummerston-Macomber-Taconic association soils, derived primarily from bedrock-controlled loamy glacial till. These soils are very deep to shallow, gently sloping to very steep, somewhat excessively drained and well-drained soils that formed in loamy glacial till on hills and mountains and have moderate erodibility. The only exception to this soil association is in the vicinity of Vernon dam and the islands just below the dam, which contain Tunbridge-Marlow-Lyman soils. These soils are also very deep to shallow, gently sloping to very steep, somewhat excessively drained to well-drained soils that have formed in loamy glacial till on hills and mountains. Tunbridge soils have low erodibility and Marlow and Lyman soils have moderate erodibility.

The majority of the Project area in Cheshire County, New Hampshire, is made up of Windsor-Agawam-Hoosic soils, which are very deep, on nearly level to very steep land that is excessively drained, well-drained, and somewhat excessively drained. Windsor and Hoosic soils have low erodibility and Agawam soils have moderate erodibility. The soils are loamy and formed in glacial outwash deposits. The only exception to this is in the vicinity of Wantastiquet Mountain State Park in Hinsdale and Chesterfield, which contains Bernardston-Cardigan-Kearsarge-Dutchess Dutchess soils. These soils are also very deep, moderately deep, and shallow on gently sloping to very steep land that is well drained to excessively drained, and consists of loamy soils that formed in glacial till and have moderate erodibility. Soil maps for the Project area can be generated at websoilsurvey.nrcs.usda.gov.

3.4.5 Reservoir Shoreline and Streambanks

Vernon reservoir was created in 1909 with the completion of the hydroelectric dam between Vernon, New Hampshire, and Hinsdale, New Hampshire. Flooding of the river shorelines upstream to the project terminus south of the Westminster-Walpole Bridge widened the river channel in low-lying areas to about elevation 220 feet, as pre-dam construction, town and USGS maps show.

The Vernon Project is operated in a daily cycle “run-of-river” mode, where daily inflow matches daily outflow. This may result in modest daily pond fluctuations due to upstream project-related generation, The Vernon impoundment level is normally operated between elevations 218.6 feet (msl) and 219.8 feet (msl), although the overall dam operating range is between elevation 212.13 feet (msl) and 220.13 feet (msl) when accounting for high flows and the need to exercise the stanchion and hydraulic flashboards, which have sill elevations of 220.13.

The Connecticut River in Massachusetts, New Hampshire, and Vermont was the subject of a detailed streambank erosion study conducted in 1979 for USACE (Simons et al., 1979). The Vernon impoundment was evaluated in this study. The study discussed the various processes that occur along the Connecticut River. The study emphasized two categories of forces that affect the shoreline: (1) those forces that act on or near the surface of the water associated with pool fluctuations; related piping; groundwater; wind waves; boat waves; ice; lack of, or removal of, vegetation; and (2) those forces acting on the full height of the submerged bank such as what occurs during periodic high flow events.

The forces that act at or near the surface of the water generally cause the bank to gradually adjust by developing a bench or berm area wide enough to dissipate the forces causing erosion, increasing upper bank stability as the adjustment occurs. The report includes an estimate that the extent of erosion landward would in most cases be limited to an average of about 10 to 15 feet in a large river (such as the Connecticut River). After the bench is formed, growth of aquatic vegetation usually takes place, further increasing the stability and curtailing further significant upper bank erosion.

The next phase of the erosion process is the bank erosion caused by high velocity flows, or an exertion of tractive shear stress on the submerged bank by the flowing water. Under these circumstances, the maximum force acting on the bank is submerged a considerable distance below the water surface and erosion of the entire bank occurs, and the major bank line moves landward. As the bank line moves landward, the berm formed by water surface fluctuation and related phenomena is overtaken, and in many instances, the bank line may move so far landward that effects caused by past near-surface erosion phenomena are eroded. After the termination of the flood, the surface forces cause the formation of a new bench or berm, and the cycle continues.

Topographic and hydrographic surveys are conducted every two years below Vernon dam, particularly the eastern riverbank. This was initiated in response to a concern about the active erosion noted during a FERC Environmental and Public Use inspection. These investigations and surveys have occurred since the mid-nineties and together with previous survey information going back to the 1950s, indicate that major changes to the riverbank most likely have occurred from two primary causes.[1] First, naturally occurring high (flood) flows have been directed toward the east bank from coarse gravel and bedrock deposits in the river channel below the dam that existed prior to its construction in 1907-1909. The second major cause appears to be from the higher interface between the bank and river from the mid-1970s increase in reservoir elevation of the Turners Falls Project. That reservoir serves as the lower impoundment for the Northfield Mountain Pumped Storage Project. The increased water level created a new soil and water interface on a previously stable but susceptible slope. It also inundated the sand bar at the base of the slope that protected and contributed to the stabilization of the bank during normal flow conditions. Evidence of seeps have also been noted on the drawings, often associated with clay layers that transfer groundwater laterally to the exposed bank.

Biennial surveys show that at this time, the east bank below Vernon dam remains relatively stable, with only minor and normal settling in the location and configuration of the top of the bank and the toe-of-slope settling over time. River bottom hydrography conducted since 1999 has also not shown significant erosion or bottom scouring, despite periodic flood flow events between surveys. The hydrologic analysis of the tailrace area concluded that (1) effects from the operations of turbines at the Vernon Project are inconsequential to channel-forming processes downstream of the dam; and (2) the dynamic movement of soils and observed erosion along the east bank and at the alluvial island adjacent to the west bank of the river is consistent in both cases with typical geomorphic processes in

[1] These study reports were filed with the Commission on: June 30, 1995; May 31, 1996; December 18, 1997; December 29, 1998; December 5, 2001; February 28, 2005; and June 23, 2007.

the Connecticut River watershed. The monitoring program was continued beyond 2006 to include (1) continued biennial monitoring and evaluation of changes in the east bank, including topographic and hydrographic surveys and visual observations of bank condition; and (2) visual assessment of the alluvial island on the west side of the river on the same frequency as the east bank survey for a period of at least two cycles to determine if any active erosion is occurring as a result of operational flows.[2] Biennial monitoring of the east bank will continue into the future with the next report due before end of year 2012 weather and river conditions permitting.

The primary type of erosion present along shoreline of the Vernon Project impoundment is bank slumping (Kleinschmidt, 2011), which is the result of rapid decline of stream inflow following a prolonged high inflow period where bank-full flows combined with surface runoff flow result in high saturation of low cohesion bank material. This type of erosion is exacerbated by land/vegetation clearing close to the bank, commonly associated with farming practices observed along the Project boundaries. Bank slumping results in bare near-vertical bank walls with large clumps of vegetated bank slumped below the obvious original location of the vegetation. The 2010 survey reported 19 locations of bank erosion in the Vernon Project, with 9 (47 percent) associated with agricultural land use practices. Other causes of erosion can include: rapid recession of high water levels following spring melt and storm events, freeze-thaw and wet-dry cycles, ice and debris, surface run-off of rainwater, the removal or loss of vegetation, obstacles in the river (e.g., docks, marinas, retaining walls, boat launches, bridge abutments), and waves and boat wakes (Kleinschmidt, 2011).

The 2010 shoreline survey and the 1979 streambank erosion study conducted for the USACE concluded that Project operations would not likely be a significant contributor to erosion in the impoundment as compared to naturally occurring high river flows coupled with highly susceptible soils (Kleinschmidt, 2011; Simons et al., 1979). Agricultural use along the shoreline and Project boundary was identified as a contributing factor to erosion coupled with moderate levels of recreational access and use and development, though limited, along much of the Project shoreline (Kleinschmidt, 2011).

Maintaining adequate vegetated riparian buffer zones has proved to be a key factor in reducing the occurrence and severity of bank erosion and the protection of cultural resource sites located along the shoreline of the river. In 2002, the state of New Hampshire enacted the Shoreland Water Quality Protection Act, formerly the Comprehensive Shoreland Protection Act (R.S.A. 483-B). The Act empowers the Commissioner of the New Hampshire Department of Environmental Sciences to enforce the Act. The Act establishes requirements to maintain a minimum vegetated Waterfront Buffer of 50 feet along the Connecticut and other rivers, and a secondary Natural Woodland Buffer zone within 150 feet of the shoreline in which 25 percent of the natural vegetation is to be left unaltered. Where this buffer zone

[2] Reports were filed with the Commission on December 10, 2009, and January 28, 2011.

has been maintained, there has been no significant erosion or exposure of archaeological sites (PAL, 2012). In other places, attempts by private landowners to comply with the provisions of the Shoreland Water Quality Protection Act are evident, but these have not been in place long enough to curtail bank erosion. Vermont does not require a riparian buffer zone, which allows farmers to plant crops right to the top of the bank.

3.4.6 Project Effects

TransCanada knows of no information suggesting that the Project or its operations are solely responsible for any adverse effects on geological or soil resources in the vicinity of the Project. As indicated in section 3.4.5, Project operations associated with impoundment fluctuations play a minor role in shoreline erosion, with flood flows from major storms playing a significant role. Other causes of erosion, including agricultural practices, piping, groundwater, wind waves, boat waves, ice, and lack of or removal of vegetation also play roles in ongoing erosion effects on geological and soil resources.

3.4.7 References

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USDA. 1983. Soil Survey of Sullivan County, New Hampshire. United States Department of Agriculture, Soil Conservation Service, Washington, D.C. (not seen, as cited in Hubbard et al., 2012)

3.5 WATER RESOURCES

3.5.1 Summary of Existing Studies

The following sources of information were used to describe the water resources at, or in the vicinity of, the Project:

- USGS National Water Information System web page, Water Data for the nation. Available at: http://nwis.waterdata.usgs.gov/nwis.
- Hourly flow and reservoir levels for January 1, 2001, to December 31, 2011, for the Vernon Project from TransCanada.

- Operational procedures for the Vernon Project from TransCanada.
- *Where the Great River Rises, An Atlas of the Connecticut River Watershed in Vermont and New Hampshire*, Rebecca A. Brown (Editor.) A project of the Connecticut River Joint Commissions. 2009.
- Connecticut River Corridor Management Plan, Water Resources, Wantastiquet Region. Connecticut River Joint Commissions. 2009.
- U.S. Environmental Protection Agency (EPA) Watershed Basin Information. Available at: http://water.epa.gov/scitech/datait/models/basins/BASINS4_index.cfm.
- Freshwater Mussel Survey in the Connecticut River for Vernon, Bellows Falls, and Wilder Hydroelectric Projects. Prepared for TransCanada Hydro Northeast Inc. by Biodrawversity LLC and the Louis Berger Group. 2012.
- Nuclear Regulatory Commission. General Accounting Office Report -11-563. June 2011.
- Aerial photos, topographic maps, USGS maps, and Google Earth.
- New Hampshire Department of Environmental Services (New Hampshire DES) Surface Water Quality Assessments 305(b)/303(d) Integrated reports 2006, 2008, 2010 and 2012 (draft).
- Vermont Department of Environmental Conservation (Vermont DEC) Surface Water Quality Assessments 305(b) and 303(d) reports 2012.
- New Hampshire DES 2004 Connecticut River Water Quality Assessment Project.
- Connecticut River Joint Commissions (CRJC) River Management Plans and Water Resources Management Plans.
- USGS National Water Quality Assessment Program.
- Connecticut River Water Quality Monitoring Project, conducted by the Pioneer Valley Planning Commission and Connecticut River Watershed Council in partnership with the University of Massachusetts Water Resources Research Center.
- Tri-State Connecticut River Targeted Watershed Initiative.
- TransCanada and Normandeau water quality sampling data and reports.

3.5.2 Hydrology

The Connecticut River Basin covers about 11,250 square miles in Vermont, New Hampshire, Massachusetts, and Connecticut. The upper Connecticut River watershed covers about 7,751 square miles of eastern Vermont, western New Hampshire, and extreme north central Massachusetts (see figure 3.1-1). Generally, the Lake Champlain and Hudson River watersheds are located to the west, and the Androscoggin, Saco, and the Merrimack River watersheds are located to the east. The upper Connecticut River watershed has a length in the north-south direction of about 315 miles and a width that varies between 30 and 50 miles (EPA, 2012).

The main stem of the Connecticut River from its source in northern New Hampshire to Turners Falls dam in northern Massachusetts is about 271 miles long. The Vernon Project is located at RM 141.9, and the reservoir extends about 28 miles upstream to approximately the Westminster-Walpole Bridge. The depth of the reservoir at low flow conditions ranges from several feet at the upper end to about 50 feet near the dam. Water released from the Project flows into Turners Falls reservoir, which is also the lower reservoir for First Light's Northfield Mountain Pumped Storage Project. The upper reaches of the Turners Falls reservoir extend to the base of Vernon dam.

Drainage Area

Vernon reservoir extends northward into the northern parts of Windham and Cheshire counties. The reservoir has a total drainage area of 6,266 square miles with a surface area of about 2,550 acres, and is about 26 miles long with a shoreline of more than 56 miles. See section 3.3, *River Basin Description*, for further information. The West River from Vermont flows into Vernon reservoir about 7 river miles upstream of the dam. The two USACE flood control dams on the West River capture and release flood flows and therefore can affect inflow from the drainage area above them in to the Vernon project temporally.

Vernon reservoir has a total water storage volume of 40,000 acre-feet. The licensed operating range of the development is from a minimum elevation of 212.1 feet to a maximum of 220.1 feet, but the normal operating range (non-spill, non-emergency operation conditions) is between elevation 218.1 and 220.1 feet. There is about 5,000 acre-feet of usable storage in the upper 2 feet of operating range, representing less than one-tenth of the volume of the average daily inflow during April, the month with the highest average monthly inflow. Vernon reservoir is riverine in character and ranges in depths of several feet to about 50 feet near the dam. Bathymetry within the reservoir changes rapidly as the result of deposition and scour during high flows such as those that occurred with Tropical Storm Irene in late August of 2011. The mean depth of the reservoir is about 16 feet, and it has a flushing rate of slightly less than 2 days based on the average flow of about 12,000 cfs. The substrate of Vernon reservoir ranges from generally sand, silt, and gravel in the lower end of the reservoir to coarser substrate in the upper reaches of the reservoir (Biodrawversity and LBG, draft 2012). The maximum discharge capacity is 127,600 cfs, and the flood of record was 176,000 cfs (March 1936). Since then, numerous USACE flood control structures have been built, as well as Moore dam that has some flood control capability, and these have help to decrease the peak flow during flood events. Since Moore dam started operation in the late 1950s, and USACE dams in the 1960s, the highest flow recorded at Vernon dam has been less than 110,000 cfs. The peak discharge from Vernon dam during tropical storm Irene reached 102,626 cfs.

Reservoir levels are set in relation to anticipated inflows. If anticipated inflows are likely to exceed the station capacity of 17,100 cfs, but not expected to exceed 45,000 cfs, TransCanada normally pre-draws the reservoir by opening one or more tainter gates to limit reservoir levels at the dam at or below elevation 219.6 feet. When flows are expected to exceed 45,000 cfs, TransCanada uses a combination of tainter gates and submerged hydraulic floodgates, and as needed, removes stanchion panels, lowers hydraulic flashboard panels to keep the reservoir at the dam at or below elevation 218.6 feet. Flows above 70,100 may require pulling stanchion beams should the river begin to rise above 218.6. While there is ice in the river, TransCanada uses a different opening sequence of structures to limit ice accumulation at the dam.

Figure 3.5-1 provides a bar and whisker graph showing hourly median, average, minimum, maximum, and the 5, 25, 75, and 95 percent exceedence values for reservoir levels from January 1, 2001, to December 31, 2011, and shows general compliance with the operating range. However, the reservoir reached a peak elevation of 223.04 feet on August 29, 2011, during the flood associated with Tropical Storm Irene. The minimum reservoir level during the time period shown on figure 3.5-1 was elevation 212.0 feet on September 14, 2011 also as a result of Tropical Storm Irene. The river must reach the concrete crest, in order to re-position the stanchion beams and reconstruct the retention structure. To the extent possible, lowering the reservoir level during high flow conditions at the dam helps decrease the backwater effects of the water level in the upper reaches of the reservoir, and in the riverine reach above the reservoir, to levels lower than what would exist otherwise. TransCanada limits the reservoir drawdown rate to no more than 0.3 foot per hour.

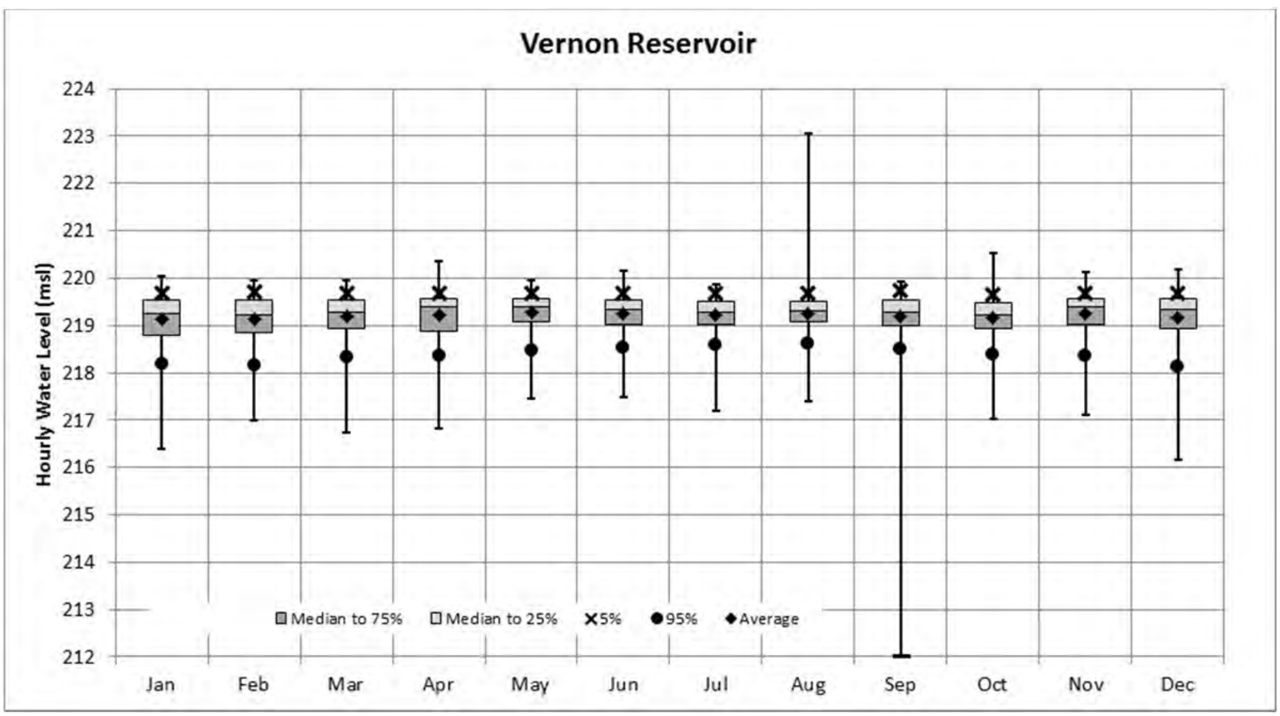


Figure 3.5-1. Project reservoir levels for January 1, 2001, to December 31, 2011 (Source: TransCanada).

Project Inflow and Outflow

Under normal generation conditions, it takes about 4 hours for flows released from the upstream Bellows Falls dam to reach Vernon dam. USGS gage no. 01156500 Connecticut River at Vernon was deactivated in 1973. To provide monthly data representative of releases from the Vernon Project, daily flow data from USGS gage no. 01154500 Connecticut River at North Walpole was prorated by 1.14 to produce monthly exceedence curves (figures 3.5-2 through 3.5-5). This proration was used to account for the normally small amount of inflow from the Cold and West rivers and smaller tributaries that flow into the Connecticut River below the North Walpole gage. Table 3.5-1 summarizes the monthly minimum, average, and maximum monthly values for the same data set as the exceedence curves.

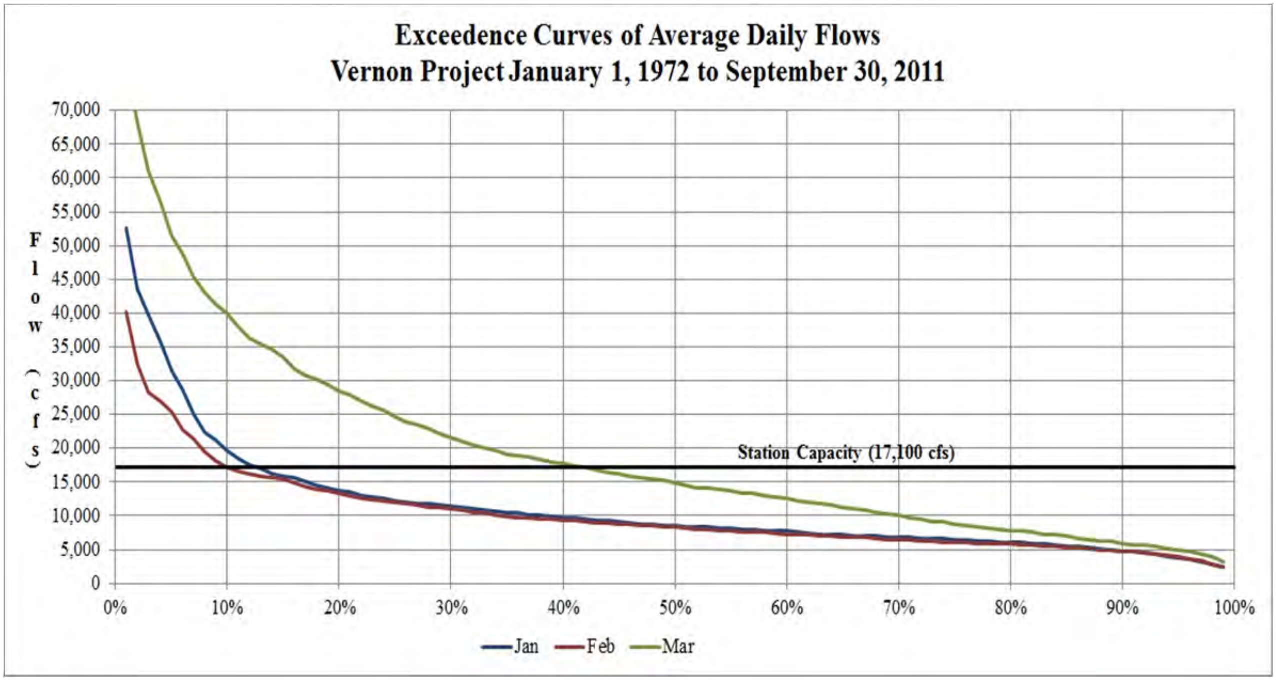


Figure 3.5-2. Exceedence curves for January, February, and March (Source: USGS, 2012, as modified by TransCanada).

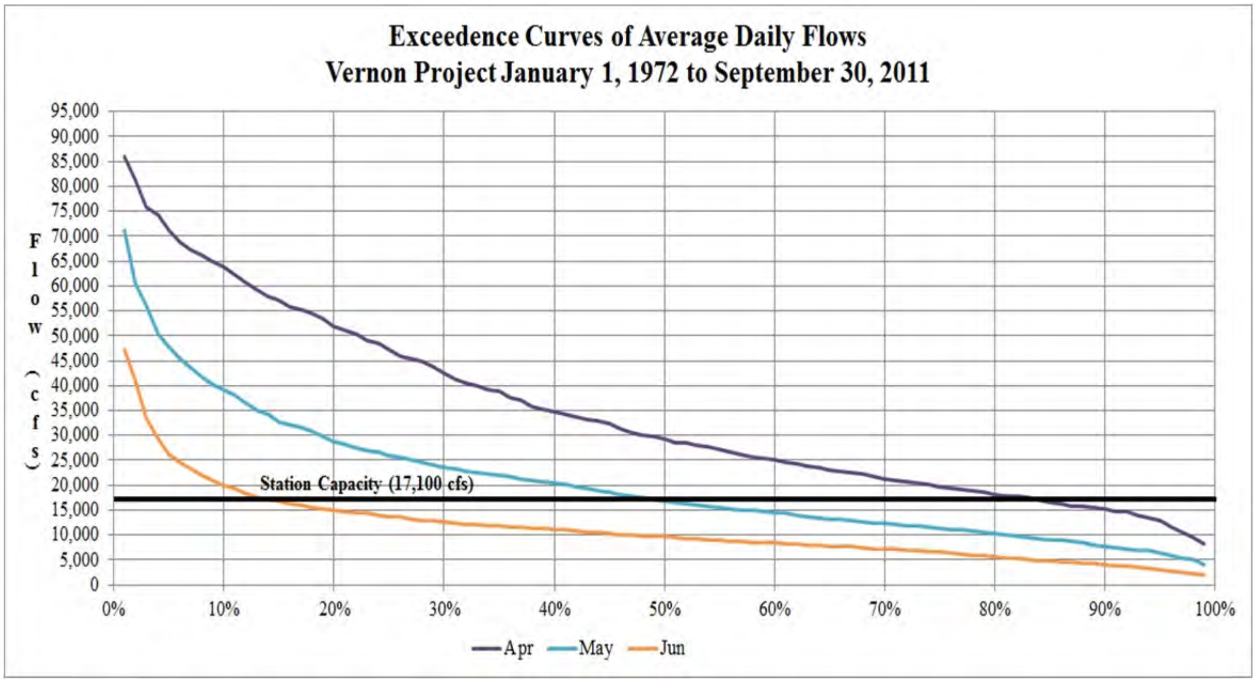


Figure 3.5-3. Exceedence curves for April, May, and June (Source: USGS, 2012, as modified by TransCanada).

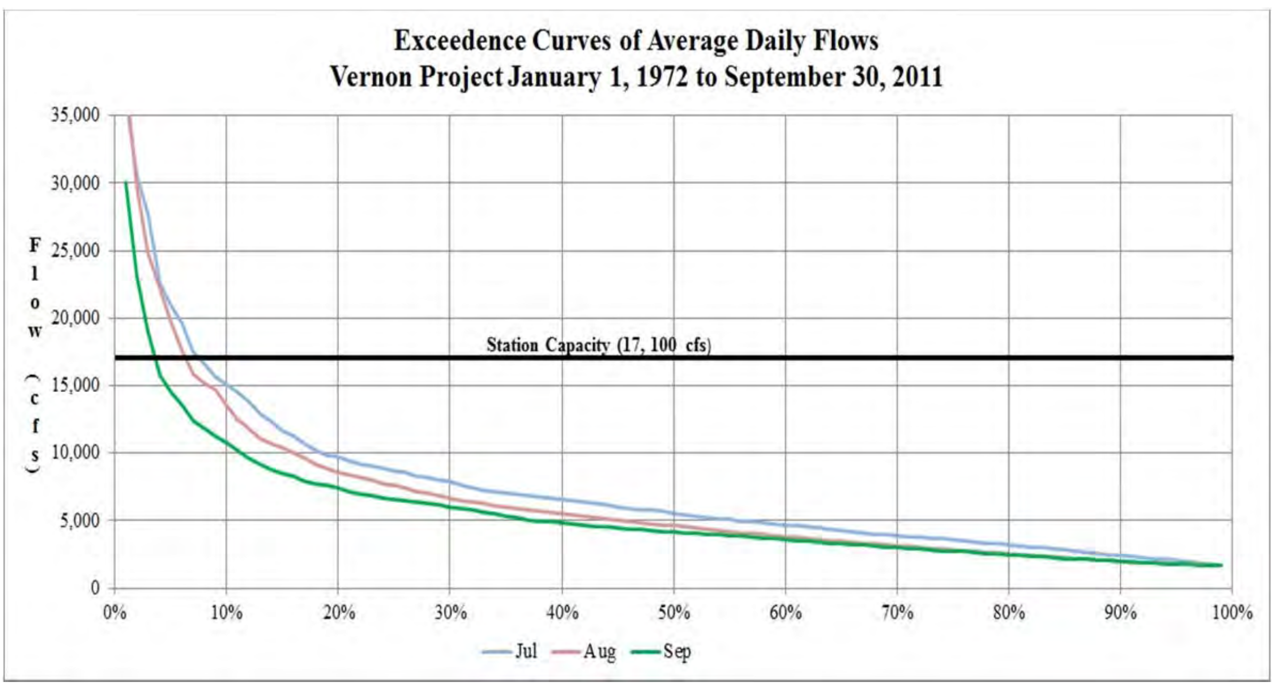


Figure 3.5-4. Exceedence curves for July, August, and September (Source: USGS, 2012, as modified by TransCanada).

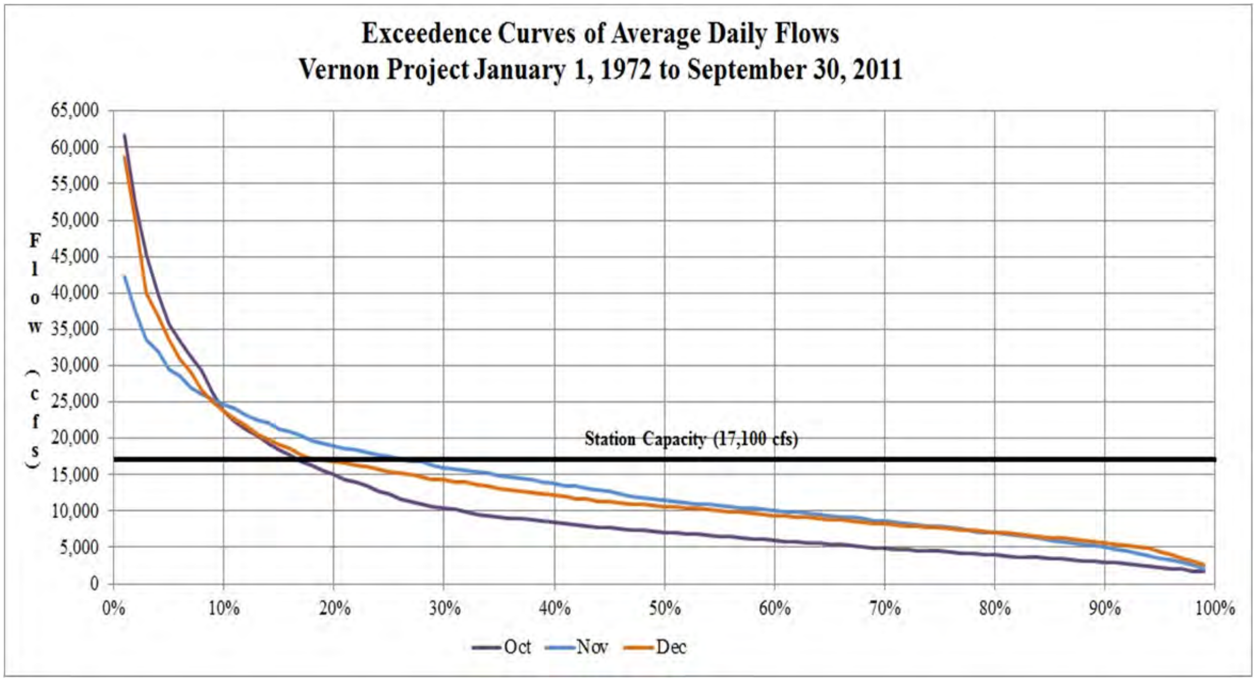
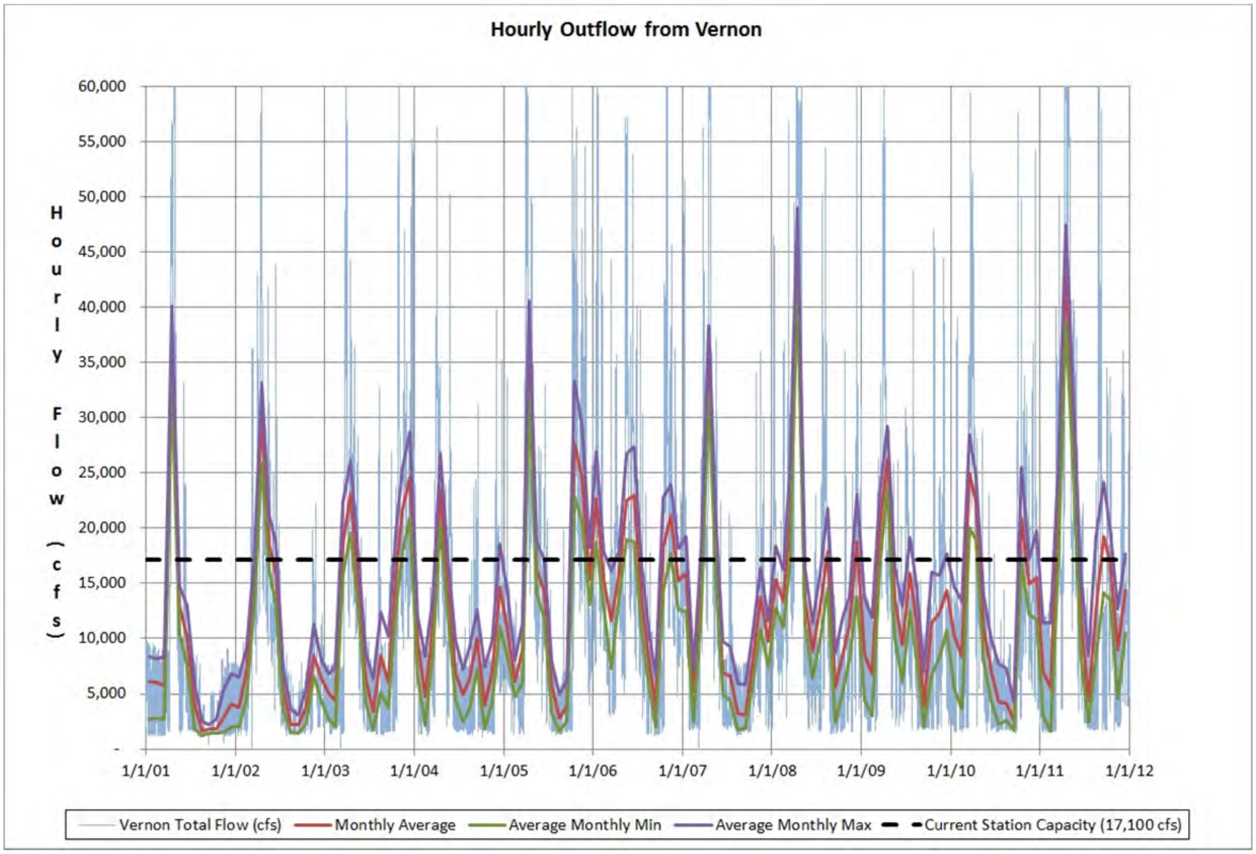


Figure 3.5-5. Exceedence curves for October, November, and December (Source: USGS, 2012, as modified by TransCanada).

Table 3.5-1. Monthly minimum, average, and maximum flow values (cfs) (Source: USGS, 2012, as modified by TransCanada).

Month	Minimum	Year	Average	Maximum	Year
January	2,950	1981	9,823	23,453	2006
February	3,075	1980	8,944	24,509	1981
March	5,760	2001	16,882	38,372	1979
April	8,767	1995	30,079	46,371	2008
May	8,136	1995	18,006	37,505	1972
June	3,463	1999	9,992	23,908	2006
July	2,161	1991	6,708	21,266	1973
August	1,859	2001	5,871	20,295	2008
September	1,748	1995	4,943	14,884	2011
October	2,063	2001	9,585	2,907	2005
November	3,159	2001	11,778	25,985	2005
December	3,031	1978	11,694	25,582	1983

When inflows are less than the station capacity of 17,100 cfs, TransCanada operates the Project as a peaking project to help meet regional electrical demand. During all times, TransCanada's first priority is meeting the minimum flow requirement of 1,250 cfs while maintaining the reservoir within the operational range. Figure 3.5-6 shows hourly outflow as compared to the monthly minimum, average, and maximums. This figure shows that outflows from the Project are normally between the minimum flow and 17,100 cfs, other than during high flow events that are most common in the spring and early fall.



Note: flows above 60,000 cfs are not show in the above figure

Figure 3.5-6 Hourly outflow from the Project (Source: TransCanada, 2012).

3.5.3 Water Use

TransCanada does not propose to change the Project's historical operations and proposes to continue existing operations of the Project for hydropower generation. Based on the existing license issued in 1979, the Vernon Project is required to release a continuous minimum flow of 1,250 cfs or inflow if less.

Other than withdrawals from Vermont Yankee and much smaller withdrawals for the Cheshire County Complex, there is very limited use of surface water from Vernon reservoir for consumption, irrigation, municipal water supply, or industrial uses, and some residential use for seasonal irrigation does occur. New Hampshire requires registration of water withdrawals more than 20,000 gals per day averaged over 7 days or a total of more than 600,000 gallons per day in a 30 day period.

Vermont Yankee withdraws water from Vernon reservoir about 0.75 mile above the dam for condenser and reactor cooling. Cooling water is circulated through the system in one of three modes of operation: open-cycle (also called once-through cooling), closed-cycle, or hybrid cycle. The plant has the highest water withdrawal in the open-cycle mode of operation, withdrawing up to 360,000 gallons per minute (802 cfs) from Vernon reservoir. In the closed-cycle mode, the rate of water pumped is reduced to about 10,000 gallons per minute (22 cfs). The rate of water withdrawn from Vernon reservoir in the hybrid-cycle mode falls between that of the open- and closed-cycle modes (NRC, 2012). This cooling water is returned to the reservoir at a slightly warmer temperature.

The town of Hinsdale, New Hampshire, has groundwater wells that it uses for water supply purposes in the aquifer near the Connecticut River, which may be influenced by infiltration from the Connecticut River (CRJC, 2009). Vermont does not have a system of tracking water withdrawals from the Vermont side of the river, but surface water withdrawals are likely to be very small in volume other than as described above for the Vermont Yankee.

3.5.4 Water Rights

Currently the only major water withdrawal from the Connecticut River in the Project area is associated with Vermont Yankee as noted in section 3.5.3, and depending on the mode of operation, most of that withdrawn water is then returned to the Connecticut River. TransCanada is not aware of any other water rights within the Project area.

3.5.5 Water Quality Standards

The state boundary between New Hampshire and Vermont is the low-water mark on the western side of the Connecticut River as it existed before the creation of reservoirs on the river. Because discharges from Project facilities occur in both states, the Project is subject to the water quality standards of both states.

Federal Clean Water Act

In 1972, the Federal Water Pollution Control Act Amendments established the Clean Water Act as the foundation of modern surface water quality protection in the United States. Sections 303 and 305 of the Act guide the national program on water quality. Four subparts of Section 303 are relevant to this water quality discussion – Sections 303(a-c), which discuss the process by which all states are to adopt and periodically review water quality standards and Section 303(d) which directs the states to identify waters of the state that do not meet water quality standards and to develop plans (Total Maximum Daily Loads or TMDLs) to bring those waters into compliance. Section 305(b) directs the states to periodically prepare a report that assesses the quality of surface and ground waters in the state.

State Standards

Vermont

Vermont water quality standards serve as the foundation for protecting Vermont's surface waters. The current standards became effective December 30, 2011 (Vermont DEC, 2011a). Surface waters in Vermont are presently classified as Class A(1), Class A(2), or Class B based on numerical or narrative criteria intended to protect the designated uses for each class. Waters designated as Class A(1) are designated as Ecological Waters that are managed to maintain an essentially natural condition. Class A(2) waters are designated as Public Water Supply waters that are managed for the natural condition with the exceptions of withdrawals for public water supplies. Class B waters are managed to achieve and maintain a level of quality that fully supports multiple designated uses. Currently the Connecticut River is designated as Class B water in Vermont and as a coldwater fish habitat. Applicable water quality standards and the associated designated uses for Class B waters in Vermont are shown in table 3.5-2. Vermont's water quality monitoring program emphasizes biomonitoring (an ambient monitoring program started in 1982) and also measures physical and chemical aspects of water bodies (Vermont DEC, 2010; CRJC, 2009).

Table 3.5-2. Vermont water quality standards applicable to Project waters (Source: Vermont Water Quality Standards, 2011).

Class	Designated Uses	Dissolved Oxygen (DO)	pH	Bacteria (E. coli)	Nutrients
B	Aquatic biota, wildlife and aquatic habitat, aesthetics, public water supply with filtration and disinfection, irrigation of crops, primary contact recreation, boating, fishing, other recreation.	For cold water fish habitat waters, not less than 6 mg/l and 70% saturation	Between 6.5 and 8.5	Not to exceed 77 per 100 ml in one sample; may be waived by permit condition between October 31 and April 1.	Total phosphorus loadings limited so as to not accelerate eutrophication or the stimulation of the growth of aquatic biota in a manner that prevents full support of uses; nitrates not to exceed 5.0 mg/l as NO_3-N at flows exceeding low median monthly flows.

Vermont water quality standards also include qualitative or semi-quantitative criteria for turbidity, alkalinity, taste and odor, toxics and temperature (based in part on whether the waters are designated for cold or warmwater fish habitat), and for aquatic biota, wildlife, and aquatic habitat. These standards are generally not applicable to, nor influenced by, Project generation-related operations. Some of these standards are included in the Project's Nation Pollutant Discharge Elimination System (NPDES) permit (see section 3.5.6.5) and others like turbidity and suspended solids are subject to NPDES construction stormwater permit requirements and are monitored and controlled as applicable to construction related work.

New Hampshire

NH-Env-Wq 1700 Surface Water Quality Regulations, readopted with amendments in 2008, fulfill the section 303 requirements of the federal Clean Water Act. New Hampshire DES routinely samples surface waters to assess compliance with the standards as part of New Hampshire's Surface Water Quality Assessment Program. Standards consist of three parts: designated uses, such as fishing or swimming; numerical or narrative criteria to protect the designated uses; and an antidegradation policy, which maintains existing high quality water that exceeds the criteria. Criteria are established by statute and by administrative rules (Env-Wq 1700).

Surface waters in New Hampshire are classified as Class A or Class B. Class A waters are of the highest quality and are managed to be potentially acceptable for water supply uses after adequate treatment. Class B waters are of the second highest quality and are managed to achieve and maintain certain designated uses. The Connecticut River has been designated a Class B water by the New Hampshire General Court. Applicable water quality standards and the designated uses for Class B waters in New Hampshire are listed in table 3.5-3.

New Hampshire Water Quality Standards also include qualitative or semi-quantitative criteria for turbidity, alkalinity, taste and odor, toxics, and temperature (based in part on whether the waters are designated for cold or warmwater fish habitat), and for aquatic biota, wildlife, and aquatic habitat. These standards are generally not applicable to, nor influenced by, Project generation-related operations. Some of these standards are included in the Project's NPDES permit (see section 3.5.6.5) and others like turbidity and suspended solids are subject to NPDES construction stormwater permit requirements and are monitored and controlled as applicable to construction related work.

Table 3.5-3. New Hampshire water quality classification standards applicable to Project waters (Source: Chapter 485:A, Water Pollution and Waste Disposal, Classification of Waters and Env-Wq 1700 Surface Water Quality Regulations).

Class	Designated Uses	Dissolved Oxygen (DO)	pH	Bacteria (E. coli)	Nutrients	Other
B	Acceptable for fishing, swimming, other recreation, and water supply use after adequate treatment.	At least 75% saturation, based on a daily average; instantaneous minimum of 5.0 mg/l	6.5 to 8 unless due to natural causes	Geometric mean of 3 samples over 60-day period, not to exceed 126 per 100 ml, or no greater than 406 per 100 ml in one sample [a]	No phosphorus or nitrogen in such concentrations that would impair any existing or designated uses, unless naturally occurring.	No discharge of sewage or wastes into waters unless treated to prevent the lowering water quality to below these standards and such disposal may not be inimical to or maintenance of aquatic life.

[a] For designated beach areas, geometric mean not to exceed 47 per 100 ml or 88 per 100 ml in a single sample, unless naturally occurring.

3.5.6 Existing Water Quality

The Connecticut River within the Project area displays water quality characteristics typical to a large New England River. The sources of information used to describe the water quality at, or in the vicinity of, the Project are listed in section 3.5.1.

Relevant Water Quality Data

In 2004, at CRJC's request, New Hampshire DES, assisted by EPA, conducted a water quality study on the 275 miles of the river between the Canadian and Massachusetts borders in anticipation of the 2005 update of the Connecticut River Corridor Management Plan (CRJC, 2009). This data set remains the most comprehensive and definitive dataset available for the Connecticut River. Samples were taken during the months of June through August, and in some cases, September. Data relevant to the Project area are summarized in table 3.5-4; included is data from the Bellows Falls dam bypass, although this sampling site lies just upriver and outside of the Project area. All sites sampled within the Project area were found to be fully supporting the designated uses of aquatic life, primary and secondary contact recreation as defined by the New Hampshire surface water quality regulations (Env-Wq 1700).

Table 3.5-4. Water quality data collected in support of the New Hampshire DES Connecticut River Water Quality Assessment Project (Source: CRJC, 2009).

Location (Collection Site Designation)	DO (mg/L) low/high	DO (%Sat.) low/high	pH low/high	Temp (°C) low/high	Bacteria GeoMean (#/100ml)
Bellows Falls Dam Bypass Reach NHRIV801070501-10-01	7.89 / 9.79	89.5 / 105.5	7.09 / 8.01	15.2 / 24	40.3
Route 123/Walpole Bridge NHRIV801070501-10-02	7.9 / 9.73	91.1 / 101.1	6.62 / 7.71	15.4 / 24	18.3
Immediately upstream of confluence with Partridge Brook NHRIV801070502-06	6.83 / 9.13	78.6 / 93.3	7.01 / 7.62	14.9 / 24	18.5
Route 9 Bridge, Chesterfield NHRIV801070505-10	7.5 / 9.74	88.3 / 96.4	6.49 / 7.63	15.5 / 23	14.7
Route 119 Bridge Hinsdale NHIMP801070507-01	7.78 / 10.27	91.8 / 106.3	6.49 / 7.64	15.2 / 23	33.6

In another study, the University of Massachusetts Water Resources Research Center working with the Targeted Watershed Initiative (TWI) sampled a 14-mile stretch of the Connecticut River for bacteria twice a week during high-use recreation summer months of 2008 and 2009 (TWI, 2010). Ten sampling stations were located between the Wilder Picnic Area in Hartford, Vermont (approximately 40 miles upstream of Bellows Falls dam), and the Wilgus State Park in Weathersfield, Vermont (approximately 20 miles upstream of Bellows Falls dam). Although the sampling sites were substantially upriver of the Project area, the resulting data are discussed here to provide an indication of the bacterial quality of water that might at times be entering Project waters.

The sites were designated to document the effectiveness of combined sewer overflows reduction as well as to more closely examine a stretch of the river listed in 2004 as impaired because of bacteria. Results of the testing found that annual geometric means for the 14 mile stretch of water were below the bacterial water quality standard for primary contact recreation of 126 per 100 ml, although the water quality standard was exceeded for a single sample at two locations in 2008 and at two locations in 2009 under wet conditions. For all sampling sites except one, wet weather bacterial counts were higher than dry weather counts. At three locations, a single sample (out of 27 samples) exceeded the New Hampshire water quality standards single sample maximum of 400 per 100 ml.

The USGS National Water Information System has made available real-time, current, and historic surface water quality records from its streamflow gage located immediately upstream of the Project area at North Walpole, New Hampshire. These data are shown in table 3.5-5.

Table 3.5-5. Water quality data in the vicinity of the Project, provided by the USGS National Water Information Data for USGS gage no. 01154500 Connecticut River at North Walpole (Source: USGS, 2012).

Date	Temp ^{o}C	Sp Cond uS/cm	DO mg/L	pH	Total N (unfiltered) mg/L	Phosphorus (unfiltered) mg/L
4-18-05	7.2	108	11.9	7.2	0.41	0.009
8-11-05	26.7	141	6.9	7.4	0.36	0.006
10-25-06	9.5	87	9.8	7.0	0.44	0.018
12-14-06	2.6	116	13.1	6.9	0.47	0.010
2-07-07				7.0	0.57	0.012
3-28-07		86		7.0	0.84	0.152
4-19-07		81		6.6	0.64	0.194
5-16-07		96	9.5	6.9	0.44	0.011
6-27-07	23.5	142		7.4	0.42	0.011
8-01-07	25.9	125	8.0	7.2	0.38	
9-05-07	22.3	136		7.7	0.42	0.009

The data display the typical seasonal and annual fluctuations in water quality conditions expected for surface waters in this area, although nitrogen levels, as measured by total N, reflect somewhat enriched conditions, most likely as a result of upriver wastewater discharges. Relatively high concentrations of both nitrogen and phosphorus measured in March and April 2007 likely reflect elevated levels of suspended materials in the water associated with spring runoff conditions and therefore may not represent typical water quality.

TransCanada Water Quality Studies

In 2008, TransCanada replaced four 2.0 MW generating units with four 4.0 MW units. New Hampshire DES issued a 401 Water Quality Certificate (No. 2006-008) in July 2006 that required a minimum of two years of dissolved oxygen (DO) and temperature sampling to ensure the new units comply with the New Hampshire and Vermont Class B water quality standards detailed above. The sampling was suspended in the years following completion of the re-powering project until 2011 due to flows being higher than what would have represented a low flow condition in an attempt to evaluate conditions under such circumstances. Sampling also occurred in 2012, although the study plan was modified with input and concurrence from New Hampshire DES and Vermont DEC. Data for both years represents efforts and results summarized in advance of final reports. In 2011, temperature and DO measurements were collected four times a day at each of three stations, on three days (July 20, August 24, and September 28). Station A was located in the forebay 165 feet upstream of the dam, Station B was located 330 feet downstream of the dam, and Station C was located 1,050 feet downstream of the dam. One-meter profile measurements were taken at Station A, and single mid-depth measurements were taken at Stations B and C (Normandeau, 2012a). Temperature ranged from 19.8 to 28.4 ° C, and DO ranged from 7.1 to 9.1 mg/L. None of the measured values fell below New Hampshire or Vermont standards. In 2012, temperature and DO measurements were collected at Station A only. This change to the study plan was made to eliminate redundancy with a comprehensive water quality study TransCanada conducted in 2012, as described below. At Station A, one-meter profile measurements were collected four times a day, on three days (July 26, August 16, and September 13). Temperature ranged from 22.3 to 29.2 ° C, and DO ranged from 6.39 to 7.97 mg/L. None of the measured values fell below New Hampshire or Vermont standards.

In recognition of the fact that there was little current, comprehensive, Project-specific water quality data available, TransCanada undertook a comprehensive water quality study during the summer of 2012. Both New Hampshire DES and Vermont DEC reviewed and contributed to the study plan.

Water quality data were collected for the Vernon Project from June 20, 2012, through September 11, 2012. Monitoring stations were located in New Hampshire waters as shown on figure 3.5-7. Temperature, specific conductivity, pH, and DO were continuously monitored with a YSI model 6920 multiparameter sonde below Vernon dam in the tailrace area for the entire study period at Station V-TR. From week 4 through the end of the study, an additional continuous monitor was installed above the dam at Station V-01 at a depth within the upper 25 percent of the impoundment that also recorded temperature, specific conductivity, pH, and DO data.

Beginning at week 4 and continuing through the end of the study, weekly water samples were collected from Station V-01 and analyzed for nitrate/nitrite; total nitrogen; total phosphorus; total Kjeldahl nitrogen; and Chlorophyll-a. The water samples were extracted as a core and represent a composite of the entire water column.

Weekly water column profiles of temperature, specific conductivity, pH, and DO were recorded with a YSI model 6920 or 600 XLM multiparameter sonde in the Vernon impoundment at Stations V-01, V-02, and V-03 for the entire study period.

Tables 3.5-6 through 3.5-10 show statistical summaries of the field measurements taken at the Project, including maximum, minimum, median, and mean values for the datasets. The 24-hour rolling average for oxygen saturation was determined to compare with New Hampshire state standards for DO as presented in table 3.5-10. Table 3.5-11 presents a summary of all laboratory analyses.

Figure 3.5-7. Map of study area showing monitoring stations. Inset map shows vicinity of Vernon dam.

Table 3.5-6. Summary of temperature data.

Temperature (°C)	V-03 (Weekly Profiles)	V-02 (Weekly Profiles	V-01 (Weekly Profiles)	V-01 (Continuous Monitoring)	V-TR (Continuous Monitoring)
Max	25.13	27.43	28.28	29.33	28.64
Min	20.16	21.42	21.67	22.88	22.83
Median	23.81	24.49	25.11	26.73	26.35
Mean	23.51	24.16	24.87	26.55	26.05

Table 3.5-7. Summary of specific conductivity data.

Specific Conductivity (S/cm)	V-03 (Weekly Profiles)	V-02 (Weekly Profiles	V-01 (Weekly Profiles)	V-01 (Continuous Monitoring)	V-TR (Continuous Monitoring)
Max	161	164	158	162	163
Min	122	113	123	115	116
Median	146	138	141	143	142
Mean	142	139	141	142	141

Table 3.5-8. Summary of pH data.

pH	V-03 (Weekly Profiles)	V-02 (Weekly Profiles	V-01 (Weekly Profiles)	V-01 (Continuous Monitoring)	V-TR (Continuous Monitoring)
Max	7.64	7.56	7.91	7.77	8.04
Min	6.62	7.11	6.66	7.14	7.19
Median	7.23	7.38	7.35	7.37	7.55
Mean	7.21	7.36	7.35	7.38	7.55

Table 3.5-9. Summary of dissolved oxygen data.

Dissolved Oxygen (mg/L)	V-03 (Weekly Profiles)	V-02 (Weekly Profiles	V-01 (Weekly Profiles)	V-01 (Continuous Monitoring)	V-TR (Continuous Monitoring)
Max	10.19	9.80	9.58	9.05	9.77
Min	7.22	7.04	6.42	6.33	7.41
Median	8.60	8.14	7.76	7.87	8.66
Mean	8.52	8.10	7.88	7.84	8.65

Table 3.5-10. Summary of oxygen saturation data.

Oxygen Saturation (% Saturation)	V-03 (Weekly Profiles)	V-02 (Weekly Profiles	V-01 (Weekly Profiles)	V-01 (Continuous Monitoring)	V-TR (Continuous Monitoring)
Max	119.6	114.6	115.2	114.8	117.5
Min	87.3	85.7	78.5	80.7	93.6
Median	99.0	95.1	94.2	98.3	107.4
Mean	100.3	96.4	95.1	98.3	107.5
Minimum 24 hour average	NA	NA	NA	86.6	99.5

Table 3.5-11. Summary of laboratory analyses of weekly water samples from V-01.

Date	NO3/NO2 (mg/L)	TN (mg/L)	TP (mg/L)	Chlorophyll-a (mg/m^3)	TKN (mg/L)
7/12/2012	0.16	0.55	0.013	5.9	0.39
7/19/2012	0.20	0.75	0.058	4.2	0.55
7/26/2012	0.21	0.62	0.013	2.7	0.41
8/2/2012	0.23	0.63	0.010	2.2	0.4
8/9/2012	0.24	0.66	0.009	4.4	0.42
8/16/2012	0.18	0.69	0.038	3.8	0.51
8/24/2012	0.20	0.67	0.014	3.5	0.47
8/30/2012	0.20	0.58	0.013	3.6	0.38
9/6/2012	0.20	0.72	0.019	2.0	0.52
9/13/2012	0.21	0.68	0.013	3.1	0.47
Mean	0.20	0.66	0.020	3.5	0.45

Impoundment Data

DO/oxygen saturation generally decreased from upstream to downstream at the three stations in the impoundment, while temperature and pH increased from upstream to downstream. Specific conductivity values were comparable between the three stations. Generally minor changes in upstream to downstream values of study parameters may reflect the impacts of impoundment of riverine waters, thereby increasing time-of-travel and water column algal activity. The greatest variability in DO/oxygen saturation levels was observed at V-01 which appears to reflect the effects of minor stratification in the deeper water at that station.

Continuous Monitoring Data

DO/oxygen saturation levels were consistently higher at the below-dam station versus the above-dam station, with a difference of approximately 0.8 milligrams per liter (mg/L) between the two stations on average. Temperatures were likewise consistently lower at V-TR than V-01 and likely were influenced by the measurement depth (approximately 3.5 m) at V-01 in the forebay of the dam and the influence of the thermal plume from Vermont Yankee, immediately upstream. pH was on average slightly higher at V-TR, below the dam, than V-01. Conductivity values were comparable between the two stations. Generally minor changes in above-dam to below dam values of study parameters may reflect the differences between a whole-water column value, as would be found in the completely mixed environmental in the tailwater area versus a single point of measurement (approximately 10 feet) in the impoundment.

Applicable State Standards

The 2012 water quality data were within a range that is typical of large, good quality riverine systems in northern New England. All DO/oxygen saturation and pH levels meet state standards for Vermont and New Hampshire.

There are no specified state standards for temperature and specific conductivity, but both parameters reflect natural variations and seasonality as expected. Composite water sample data does not exceed nutrient criteria for either state, although at this time Vermont is the only state with numeric criteria, while New Hampshire only notes phosphorus or nitrogen levels should not impair any existing or designated uses, unless naturally occurring. The values depicted in table 3.5-11 do not suggest impairment would occur.

Section 303(d) Listing, Non-compliant Waters and TMDLs

Under section 303(d) of the federal Clean Water Act, and in adherence with federal water quality planning and management regulations (40 C.F.R. Part 130), all states are required to develop lists of impaired or “Category 5” waters; commonly referred to as the “303(d) list.” The list includes lakes, ponds, rivers, and streams whose water quality does not meet state-defined water quality standards. Each state’s list must be updated every two years and submitted to EPA for approval. The Clean Water Act requires TMDLs to be developed for waters on the list and to provide a schedule indicative of TMDL completion priority.

In recent history, all surface waters in Vermont and New Hampshire have been listed as non-compliant for mercury due to higher than desired mercury levels in fish. The primary source of mercury contamination is atmospheric deposition. In 2007, EPA approved the Northeast Regional Mercury TMDL (NEIWPCC, 2007). This TMDL addressed all fresh surface waters in Vermont and New Hampshire that were impaired for fish consumption use because of atmospheric deposition of mercury. Consequently all surface waters on the 2006 303(d) lists from both states that were listed as impaired for fish consumption due to mercury where atmospheric deposition is the primary source of mercury, were delisted and moved from Category 5 to Category 4A in 2008. Category 4A includes waters impaired or threatened by a pollutant(s), but for which a TMDL study has been completed and approved by EPA. Progress has been made toward reduced atmospheric mercury loading, but the approved management strategy for mercury is adaptive and iterative and may take many years before waters in both states meet water quality standards for mercury.

In New Hampshire, certain changes were made between 2010 and 2012 in the development of the 303(d) list (New Hampshire DES, 2012). Those changes affecting the Project area include both the changes in reporting of mercury impaired waters (noted above) and bacterial impairments. In 2010, EPA approved the *New Hampshire Statewide TMDL for Bacteria-impaired Waters* (New Hampshire DES, 2010). Since the TMDL has been approved by EPA, New Hampshire DES has placed all fresh water assessment units included in the TMDL in impairment Category 4A instead of on the 303(d) list (or Category 5) for primary contact recreation (i.e. swimming) due to *E. coli.* In 2011, EPA approved the *Vermont Statewide TMDL for Bacteria-impaired waters* (Vermont DEC, 2011), which establishes allowable bacterial loadings for Vermont's surface waters, provides documentation of impairments, and outlines the reductions needed to meet water quality standards.

New Hampshire DES previously considered the entire Connecticut River in New Hampshire contaminated by PCBs (CRJC, 2009). Prior to 2008, New Hampshire DES listed the river as impaired for PCBs on its 303(d) list There are no known current sources of PCBs to the Connecticut River, so contaminants found in fish result from either past pollution in the watershed or from atmospheric deposition (CRJC, 2009). In 2008, New Hampshire DES, in conjunction with staff from the New Hampshire Environmental Health Program, determined that the Connecticut River should be delisted for PCBs because listing should only have occurred if a fish consumption advisory had been issued for the river, and no advisory was ever issued for PCBs. The river was listed in prior years because PCBs were detected in fish tissue from the Connecticut River. But further review of that data found that the levels detected fall below human health screening levels (New Hampshire DES, 2008). Consequently, New Hampshire DES no longer lists the Connecticut River as impaired for PCBs.

Table 3.5-12 shows the New Hampshire DES and Vermont DEC listing of impaired or threatened waters within the vicinity of the Project from 2010 and 2012. Tributaries to the Connecticut River are shown only if they are impaired at the mouth, adjacent to Project waters. Also shown is the length of river (where available) and designated use that is impaired, the type of impairment, the TMDL status and the source of impairment.

Table 3.5-12. New Hampshire DES and Vermont DEC 303(d) listing of impaired or threatened waters within the vicinity of the Project.

Unit ID/Location	Size (mi)	Des. Use	Impairment	TMDL Priority	TMDL Schedule	Source Name
2012						
Cold River from mouth to 1.15 miles upstream NHRIV 801070203-12	1.15	AL	pH	Low	2017	Unknown
Bellows Falls Dam Bypass Reach NHRIV801070501-10-01	0.91	AL[a]	pH	Low	2019	Unknown
From confluence with Partridge Brook, NH to the confluence with West River, VT NHRIV801070505-10	13.11	AL	pH	Low	2019	Unknown
West River/Ash Swamp Brook mouth to upstream NHRIV 801070507-01	14.69	AL	Benthic Macroinvertebrate Bioassessment	Low	2017	Unknown
From Vernon Dam south NHRIV802010501-05	7.55	AL	Aluminum, Copper, pH	Low	2017, 2016, 2019	Unknown
Crosby Brook from mouth upstream VT13-13	0.7	AL	Sediment	Medium	NA	Multiple Sources
2010						
Cold River from mouth to 1.15 miles upstream	1.15	AL	pH	Low	2017	Unknown

Unit ID/Location	Size (mi)	Des. Use	Impairment	TMDL Priority	TMDL Schedule	Source Name
From confluence with Partridge Brook, NH to the confluence with West River, VT NHRIV 801070203-12	13.11	AL	pH	Low	2019	Unknown
West River/Ash Swamp Brook NHRIV 801070507-01	14.69	AL	Benthic Macroinvertebrate Bioassessment	Low	2017	Unknown
From Vernon Dam south NHRIV802010501-05	7.55	AL	Aluminum, Copper, pH	Low	2017, 2016, 2019	Unknown
Crosby Brook from mouth upstream VT13-13	0.7	AL	Sediment	Medium	NA	Multiple Sources
Whetstone Brook, Brattleboro VT13-14	NA	CR[b]	E. coli	High	NA	Unknown

[a] Aquatic Life; [b] Contact Recreation

For most of the waters listed above, the source of impairments is unknown. The impairments due to low pH may be due, in part, to the naturally or atmospherically influenced acidic inputs from the Cold River (CRJC, 2009). Crosby Brook is highly urbanized and channelized due to its location near U.S. Interstate 91, and does not meet Vermont Aquatic Life support standards due to sedimentation and elevated temperature. A detailed assessment of sediment sources conducted by New England Interstate Water Pollution Control Commission in 2011 determined multiple sources of sediment, including sediment wash-off from stormwater, channel erosion due to stormwater, gully erosion, and mass slope failure. Multiple restoration efforts are ongoing, including stabilization of eroding slopes and retrofitting of state-owned drainages (NEIWPCC, 2011).

Fish Tissue Contamination and Consumption Advisories

As noted above, the Connecticut River has been listed as impaired for certain toxics. At present, only mercury is considered to be a fish tissue contaminant that is found at high enough levels to present potential human health risks, and therefore warrants a fish consumption advisory. In New Hampshire, the following mercury advisory applies statewide, including Project waters, for all freshwater fish, except stocked trout:

- pregnant and nursing women and women who may get pregnant should consume no more than one 8-ounce meal per month of freshwater fish;
- children under age 7 should consume no more than one 4-ounce meal per month of freshwater fish;
- all other adults and children age 7 and older should consume no more than four 8-ounce meals per month of freshwater fish; and
- when eating bass, pickerel, white perch or yellow perch, limit consumption to fish 12 inches or less in length while following the above guidelines.

Vermont has a similar, albeit species-specific, statewide advisory that would apply to those Project waters that are under Vermont jurisdiction. Table 3.5-13 presents Vermont's fish consumption advisory.

Table 3.5-13. Vermont statewide fish consumption advisory.

General Advisory	Children and Women of Childbearing Age	Everyone Else
Brown Bullhead Pumpkinseed	No more than 5 meals/month	No Restrictions
Walleye	0 meals	No more than 1 meal/month
Lake Trout Smallmouth Bass Chain Pickerel American Eel	No more than 1 meal/month	No more than 3 meals/month

General Advisory	Children and Women of Childbearing Age	Everyone Else
Largemouth Bass Northern Pike Yellow Perch (larger than 10 inches)	No more than 2 meals/month	No more than 6 meals/month
Brook Trout Brown Trout Rainbow Trout Yellow Perch (smaller than 10 inches)	No more than 3-4 meals/month	No Restrictions
All Other Fish	No more than 2-3 meals/month	No more than 9 meals/month

Other Water Quality Considerations – National Pollutant Discharge Elimination System Permits

Vernon Project

The Project was issued an NPDES permit in the mid-1990s and has held a valid discharge permit ever since. This permit allows the Project to discharge minor, non-generation related wastewaters, including non-contact cooling water from turbine bearings and air compressors and internal leakage in wheelpits and sumps. The Project is required to sample its wastewaters quarterly and report the results of the sampling to Vermont DEC. Permit parameters and limits for temperature, pH, and oil/grease are the same for all discharge outfalls as listed below:

- temperature (<90° F);
- pH (6.5-8.5);
- oil/grease (<20 mg/l, not required for non-contact cooling water); and
- daily max limits vary per discharge outfall as noted below:
- 0.03168 million gallons/day (mgd) for S/N 001: Bearing cooling water, sump waters, and other internal drainage water;
- “as necessary” for S/N 002: Uncontaminated water during draft tube dewatering of Units 5 through 8; and
- 0.3356 mgd for S/N 003: Non-contact bearing cooling water and auto-strainer backwash from Units 5 through 10.

TransCanada has never measured a permit exceedence at the Project.

Vermont Yankee

Vermont Yankee discharges cooling water into the Vernon impoundment. Vermont DEC issued a NPDES permit renewal No. VT000264 on July 11, 2001, for the facility, and this was renewed and amended on March 30, 2006.

Other Wastewater Treatment Facilities

There are 33 wastewater treatment facilities within the Connecticut River watershed above the Project that discharge into the Connecticut River main stem or its tributaries. Table 3.5-14 lists these facilities.

Table 3.5-14. Towns within the Connecticut River watershed, above the Project, with wastewater treatment facilities.

Canaan VT	Bradford VT
Colebrook NH	Hanover NH
Stratford Village NH	Lebanon NH
Stratford Mill House NH	Hartford/White River Junction VT
Groveton NH	Quechee VT
Northumberland NH	Meriden Village, Plainfield NH
Lancaster NH	Windsor Weston Heights VT
Lancaster Grange NH	Windsor Main VT
Whitefield NH	Claremont NH
Bethlehem NH	Springfield VT
Littleton NH	Charlestown NH
Lisbon NH	Bellows Falls VT
Woodsville NH	Saxtons River VT
Lunenburg VT	Cheshire County Home NH
Lyndon VT	Putney VT
Ryegate VT	Brattleboro VT
St. Johnsbury VT	

3.5.7 Project Effects on Seasonal Variation of Water Quality

Vernon dam modifies the physical environment of this section of the Connecticut River by increasing depth, time-of-travel (flushing rate), and in the lower portion of the impoundment, width. However, existing and newly collected water quality data indicate that the Project has, and will continue to have, no significant impact on the primary water quality of concern, DO, or on other physical or chemical parameters.

3.5.8 References

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3.6 FISH AND AQUATIC RESOURCES

This section reviews existing information for the fish and aquatic resources occurring within the vicinity of the Vernon Project affected area, extending from Vernon dam 26 miles to the upstream extent of the Vernon impoundment. While the Project boundary is the downstream side of the Vernon dam, a considerable amount of fisheries data has been collected up to 5 miles downstream. Those are included in this review because they are informative regarding fisheries resources and information collected in the immediate Vernon dam tailwater were pooled with data from stations extending further downstream. Downstream of Vernon dam, river flow varies due to Vernon, Northfield Mountain Pumped Storage Project, and Turners Falls Project operations and the Turners Falls project affected area extends to Vernon dam. Vernon dam is located on the Connecticut River at RM 141.9 in the counties of Cheshire, New Hampshire and Windham, Vermont.

3.6.1 Summary of Existing Resources

The Connecticut River is home to a diverse assemblage of fishes ranging from coldwater to warm-water species (Deen, 2009). The creation of reservoirs, such as Vernon reservoir, and land use changes have created substantial warm-water habitat, supporting an outstanding warm water fishery (Vermont Campground Association: http://www.campvermont.com/html/more_info/mi_fishing.htm). New Hampshire Fish and Game biologists compiled lists of suggested fishing locations, though not site specific, that identified the Connecticut River in southwest New Hampshire as fishing locations for American shad (*Alosa sapidissima*, below Vernon dam), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ameirus nebulosus*), common carp (*Cyprinus carpio*), chain pickerel (*Esox niger*), fallfish (*Semotilus corporalis*), largemouth bass (*Micropterus salmoides*), northern pike (*E. lucius*), rock bass (*Ambloplites rupestris*), smallmouth bass (*M. dolomieui*), walleye (*Sander vitreus*), white perch (*Morone americana*), and yellow perch (*Perca flavascens*) (New Hampshire Fish & Game, Suggested Fishing Locations: http://www.wildlife.state.nh.us/Fishing/fishing.htm).

The fishery below Vernon dam is notable for walleye (Carrier and Gries, 2010; New Hampshire Fish & Game). Brook trout (*Salvelinus fontinalis*), smallmouth bass, and carp were also reported in the spring fishery: http://www.wildlife.state.nh.us/Fishing/fisheries_management/walleye_survey.html

The Brattleboro Retreat Meadows, a shallow backwater off of the mouth of the West River, is known for bass, bluegill, pike, pickerel and perch fishing: http://www.brattleboroareaguide.com/fish.html, and the Hinsdale setbacks, shallow backwaters in the Vernon reservoir near Hinsdale, New Hampshire, are known for excellent panfish, northern pike, largemouth bass and black crappie fishing: http://www.wildlife.state.nh.us/Fishing.

In recent years channel catfish (*Ictalurus* punctatus) have become established in the New Hampshire portion of the Connecticut River both above and below the dam: http://www.wildlife.state.nh.us/Fishing/fishing_forecast/Locations_Southwest.htm.

Fish Stocking

The Vermont Department of Fish & Wildlife (Vermont Fish & Wildlife) annually stocks brook trout and rainbow trout (*Oncorhynchus mykiss*) into waters of the state including the primary Project tributaries: Saxtons River and West River (Vermont Fish & Wildlife, 2009, 2010). New Hampshire Fish & Game stocks brook trout, rainbow trout, and brown trout (*Salmo trutta*) in major tributaries to the Connecticut River in the Project affected area including the Cold River (as well as the mainstem Connecticut River in Walpole, New Hampshire, in the vicinity of the Cold River) and to the Ashuelot River (confluence is just downstream of the Project area; New Hampshire Fish & Game, 2009, 2010a, 2011b). Trout stocked in the tributaries may move to the main stem of the river seeking suitable habitat and enhance the fisheries there as well.

FWS has coordinated Atlantic salmon (*Salmo salar*) fry and smolt stocking since 1968. The annual stocking goal was 10 million fry/per year, and since 2002 fry stocking has ranged from 6.0 – 7.8 million stocked annually to tributaries throughout the Connecticut River Basin (USASAC, 2011), including the major tributaries to the river in the Project affected area. However, in July 2012, FWS announced that it would no longer produce hatchery-reared salmon for the Connecticut River restoration effort based on low return rates.

Fish Passage

Diadromous fish species occurring in the Connecticut River include anadromous alosines, Atlantic salmon, and sea lamprey (*Petromyzon marinums*) and the catadromous American eel (*Anguilla rostrata*). Several of these species may occur in the Project affected area.

Upstream fish passage of anadromous species at Vernon dam depends on fish first ascending the Connecticut River and successfully passing the two downstream dams, Holyoke and Turners Falls. Passage via the Vernon fish ladder has been monitored by Vermont Fish & Wildlife since 1981 (table 3.6-1). Additionally, adult American shad have been collected from Holyoke dam and released in Vernon reservoir with unimpeded access to augment volitional upstream passage, bypassing the Turners Falls and Vernon Projects (see table 3.6-7).

Annual passage numbers at the Project have varied over time (table 3.6-1) depending on a number of factors including annual adult population (run) size in the river, numbers passing Holyoke and Turners Falls dams, the timing of passage at Holyoke and Turners Falls dams relative to spawning state, condition of fish that have passed Turners Falls, river flow conditions, and fish ladder effectiveness.

Table 3.6-1. Annual fish passage counts for the Vernon fish ladder, 1981 -- 2012 (Source: Vermont Fish & Wildlife, 2010; Normandeau, 2011b; CRASC, http://www.fws.gov/r5crc/Fish/hist.html).

Year	American Shad	Shad Passage Ratio[a]	Atlantic Salmon[b]	Sea Lamprey	Blueback Herring
1981	97	49%	8	306	20
1982	9	90%	0	5	56
1983	2,597	.	0	379	53
1984	335	.	0	195	7
1985	833	22%	4	1,257	21
1986	982	5%	4	573	94
1987	3,459	18%	10	667	0
1988	1,370	9%	5	281	0
1989	2,953	31%	0	205	49
1990	10,894	39%	9	387	54
1991	37,197	.	6	750	383
1992	31,155	.	13	749	27
1993	3,652	38%	7	627	28
1994	2,681	81%	8	767	10
1995	15,771	86%	5	509	115
1996	18,844	116%	9	853	11
1997	7,384	80%	4	1,506	6
1998	7,289	69%	12	16,438	0
1999	5,097	75%	8	836	0
2000	1,548	60%	5	855	2
2001	1,744	113%	1	3,212	0
2002	356	12%	3	2,210	0

Year	American Shad	Shad Passage Ratio[a]	Atlantic Salmon[b]	Sea Lamprey	Blueback Herring
2003	268	.	0	8,119	0
2004	653	31%	1	3,668	0
2005	167	11%	4	3,669	0
2006	133	9%	4	2,895	0
2007	65	3%	5	17,049	0
2008	271	7%	8	22,434	0
2009	16	0%	7	1,532	0
2010	290	2%	8	3,179	0
2011	46	0%	9	329	0
2012	10,715	40%	4	696	0

a Ratio of reported American shad passage at Vernon dam to Turners Falls gatehouse.

b Atlantic salmon passage numbers modified per Normandeau (2011b).

The ratio of American shad passage at Vernon dam to the number that passed upstream of Turners Falls was highly variable but often high, with a mean of 41 percent over all years (when counts were available) and ranging to about 100 percent in some years (reported counts indicate ratios > 100 percent as a result of counting error). A notable decline in that ratio occurred during 2005 – 2011 but was somewhat masked by overall low returns and passage numbers at downstream facilities. As improvements were made and passage effectiveness improved downstream a corresponding improvement was not apparent at Vernon. In 2011 TransCanada cooperatively supported a basinwide shad study conducted by USGS. As a result of the study, it appeared that an unanticipated bottleneck existed at Vernon dam for some reason, where it had not been before.

In 2012, FWS conducted an inspection of the Vernon fish ladder and identified several items of concern that were address by TransCanada. TransCanada also went through a comprehensive and detailed review of its fish ladder including its pre-season inspection and preparation protocol, operating procedures, and automated functions to identify problems that would likely impact effectiveness. Silt accumulation that resulted from the effects of Tropical Storm Irene was removed, and baffles and stoplogs that were damaged or missing due to high water were repaired. Additionally, the fish ladder entrance weir was designed to adjust automatically with tailwater elevation changes. It was examined during 2011 and was thought to be operating correctly, and a more thorough investigation in 2012, showed the weir was responding correctly to the tailwater monitor reading. Further examination, however, indicated a difference, primarily a delay, in the fish ladder tailwater reading and the official station tailwater reading. Further investigation identified corrosion or blockage in the connectivity piping between the tailrace and the stilling well. That resulted in delayed or inaccurate elevation changes in the stilling well relative to the tailwater, and subsequently caused delayed or inaccurate adjustment to the entrance weir relative to tailwater elevation changes. This was a critical issue because the entrance weir was designed to maintain a difference of approximately 12 inches between the tailwater and the entrance pool within the ladder structure. TransCanada relocated the fish ladder tailwater control instrumentation to another tailwater stilling well and corrected the problem.

Similar to 2011, in 2012 FWS and USGS with support from TransCanada and others assessed American shad passage river-wide (from tidal river to Vernon dam). Results of that study have not been published. However, in 2012, the proportional American shad passage through Vernon fish ladder was 40 percent (table 3.6-1). As of 2012, FWS re-instituted pre-season inspections of fishways on the Connecticut River. Similarly, TransCanada has instituted a more rigorous inspection, testing, and pre-season preparation program for all its fish passage structures.

Several resident species also use the Vernon fish ladder. In 2012 bluegill (N = 555), common carp (N = 209), channel catfish (N = 37), trout sp. (N = 2), walleye (N = 54), white sucker (N = 102), and American eel (N =262) were recorded passing upstream (Lael Will, Vermont Fish & Wildlife, personal communication).

3.6.2 Summary of Existing Studies

Vermont Yankee has conducted targeted studies both in the impoundment and tailwater of Vernon dam. Several other studies of greater scope also include important information pertinent to the Project affected area. Overall, 40 fish species were recorded occurring in the Project affected area, 37 species upstream and 35 species downstream of Vernon dam (table 3.6-2).

Key sources used to characterize the fisheries resources in the Project affected area included:

- Vermont Yankee environmental studies (Normandeau, 2004, 2005b, 2006b, 2007b, 2008b, 2009d, 2010b, 2011b, c, 2012a, b).
- Fish Assemblage and Habitat Assessment of the Upper Connecticut River (Yoder et al., 2009).
- New Hampshire Fish and Game Walleye Creel Survey (Sprankle, 1997, Carrier and Gries, 2010).
- Connecticut River Fish Tissue Contaminant Study (Hellyer, 2006).
- Adult Atlantic Salmon Migration and Behavior Studies (Normandeau 2011b).
- Project specific Atlantic salmon and American shad studies (Normandeau 1995, 1996a, b, c, d, e, 2009b, c; RMC 1990, 1992, 1993a, b; RMC and Sonalysts, 1993).

Table 3.6-2. Fish species occurrence in the Project affected area observed in primary resources reviewed.[a]

Species	Upstream	Downstream
American eel (*Anguilla rostrata*)	1, 3	3
American shad (*Alosa sapidissima*)	1, 3	3
Atlantic salmon (*Salmo salar*)	3	3
Banded killifish (*Fundulus diaphanus*)	3	3
Black crappie (*Pomoxis nigromaculatus*)	1, 2, 3	3
Blueback herring (*Alosa aestivalis*)	3	3
Bluegill (*Lepomis macrochirus*)	1, 2, 3	1, 3
Brook trout (*Salvelinus fontanalis*)	3	
Brown bullhead (*Ameirus nebulosus*)	2, 3	3
Brown trout (*Salmo trutta*)	3	3
Chain pickerel (*Esox niger*)	1, 3	1, 3
Channel catfish (*Ictalurus punctatus*)	3	3
Common carp (*Cyprinus carpio*)	1, 2, 3	3
Common shiner (*Luxilis cornutus*)	1, 3	3
Eastern silvery minnow (*Hybognathus regius*)	3	3
Fallfish (*Semotilus corporalis*)	1, 2, 3	1, 3
Gizzard shad (*Dorosoma cepedianum*)	3	3
Golden shiner (*Notemigonus crysoleucas*)	1, 2, 3	3
Goldfish (*Carassius auratus auratus*)		3
Largemouth bass (*Micropterus salmoides*)	1, 2, 3	1, 3
Longnose dace (*Rhinichthys cataractae*)	3	
Longnose sucker (*Catostomus catostomus*)		1
Mimic shiner (*Notropis volucellus)*	3	3

Species	Upstream	Downstream
Northern pike (Esox *lucius*)	2, 3	3
Pumpkinseed (*Lepomis gibbosus*)	1, 2, 3	3
Rainbow smelt (*Osmerus mordax*)	3	
Rainbow trout (*Oncorhynchus mykiss*)	1, 3	
Redbreast sunfish (*Lepomis auritus*)	3	3
Rock bass (*Ambloplites rupestris*)	1, 2, 3	1, 3
Sea lamprey (*Petromyzon marinus*)	1, 3	1, 3
Smallmouth bass (*Micropterus dolomieui*)	1, 2, 3	1, 3
Spotfin shiner (*Cyprinella spiloptera*)		3
Spottail shiner (*Notropis hudsonius*)	1, 2, 3	3
Tessellated darter (*Etheostoma olmstedi*)	1, 2, 3	3
Walleye (*Sander vitreus*)	3	1, 3
White catfish (*Ameirus catus*)	1, 3	
White perch (*Morone americana*)	3	3
White sucker (*Catostomus commersonii*)	1, 2, 3	1, 3
Yellow bullhead (*Ameirus natalis*)	1, 2, 3	3
Yellow perch (*Perca flavescens*)	1, 2, 3	1, 3

[a] Project affected area defined here as extending about 26 miles upstream and approximately 6 miles downstream of the dam. Documented occurrence is indicated by a numeric reference in the species cell; numeric reference corresponds to data source: 1: Yoder et al. (2009); 2: New Hampshire Fish & Game (unpublished data); 3: Normandeau (2012a).

Vermont Yankee Ecological Studies

In support of an NPDES permit, ecological data have been collected annually for Vermont Yankee since 1967, before the plant began producing power in November 1972. Fisheries data were collected in the lower Vernon reservoir from just above the dam to about 7 miles upstream, and in the Vernon tailrace to about 5 miles downstream. The fisheries sampling programs included:

- targeted electrofishing for American shad in the months of July through October;
- general electrofishing for all species in the months of May, June, September, and October;
- beach seining from mid-summer to mid-fall;
- ichthyoplankton trawls in front of the Vermont Yankee intake structure from May through July; and
- collection of fish impinged on the intake structure circulating water traveling screens when at least one of the three circulating water pumps at Vermont Yankee is operating. A 6-day and subsequent 24-hour impingement sample is collected weekly from April through mid-June and August through October.

Electrofishing Sampling

Eight electrofishing stations with a total of 11 sub-stations (six located upstream and five downstream of Vernon dam) were sampled from 1991-1996. Eight electrofishing stations with a total of 10 sub-stations (six located upstream and four downstream of Vernon dam) were sampled from 1997 to 2011 (Normandeau 2012a). Observations of increased catch per unit effort (CPUE) during recent (since 2006) electrofishing associated with a change in sampling equipment were discussed in the report (Normandeau, 2012a).

Vermont Agency of Natural Resources (Vermont ANR) selected nine Representative Important Species (RIS) of fish to be reviewed by Vermont Yankee for long-term trends: largemouth bass, yellow perch, smallmouth bass, fallfish, walleye, white sucker, spottail shiner, American shad and Atlantic salmon (Normandeau, 2004). A Mann-Kendall non-parametric statistical analysis was used to assess trends in RIS abundance over the 21-year period, however it was stated that the analysis was provided to satisfy permitting requirements that specified that methodology. It was noted that test was not an appropriate analysis because adding additional years of data may result in determination of significant trends where they were not previously determined to be significant, due to increased statistical power rather than a change in the populations, and therefore the results should be carefully considered (Normandeau, 2012a).

Upstream (lower Vernon reservoir). A total of 23,980 fish representing 30 species were collected in the general electrofishing surveys at sampling stations in lower Vernon reservoir during 1991 to 2011 (table 3.6-3). Only the trends for yellow perch (positive, i.e., increasing population trend) and American shad (negative, i.e., decreasing population trend) were significant (see fish passage section).

Downstream. A total of 8,076 fish representing 35 species were collected in the general electrofishing surveys at sampling stations downstream of Vernon dam during 1991 to 2011 (table 3.6-4). Only an increasing trend for smallmouth bass was significant.

Table 3.6-3. Annual number and percent of fish species collected by electrofishing upstream of Vernon dam, 1991-2011 (Source: Normandeau, 2012a).

Species	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000		2001	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
American eel	7	0.5	2	0.2	8	0.8	4	0.4	2	0.2	0	0	0	0	2	0.2	1	0.1	0	0	0	0
American shad	19	1.3	29	3.3	5	0.5	2	0.2	24	2.4	3	0.3	0	0	0	0	0	0	1	0.1	0	0
Atlantic salmon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Banded killifish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	4	0.3
Black crappie	0	0	0	0	0	0	0	0	0	0	5	0.4	3	0.5	7	0.8	10	1.2	12	1.5	9	0.7
Blueback herring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bluegill	128	9	56	6.4	99	10.5	118	11.5	135	13.7	222	19.8	46	7.2	234	25.8	296	35.2	221	28.4	360	27.8
Brook trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown bullhead	19	1.3	19	2.2	29	3.1	8	0.8	20	2	1	0.1	2	0.3	2	0.2	0	0	3	0.4	2	0.2
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centrarchidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chain pickerel	17	1.2	29	3.3	5	0.5	4	0.4	5	0.5	12	1.1	14	2.2	20	2.2	9	1.1	12	1.5	11	0.8
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common carp	11	0.8	6	0.7	8	0.8	7	0.7	11	1.1	2	0.2	1	0.2	2	0.2	3	0.4	2	0.3	0	0
Common shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	0	0	0	0
Eastern silvery minnow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1.1	5	0.6	0	0
Fallfish	1	0.1	0	0	0	0	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Gizzard shad	0	0	0	0	0	0	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Golden shiner	74	5.2	70	8	16	1.7	41	4	46	4.7	39	3.5	15	2.4	74	8.1	66	7.8	24	3.1	55	4.2
Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(continued)

Table 3-6.3. (Continued)

Species	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000		2001	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Largemouth bass	151	10.6	83	9.5	99	10.5	58	5.7	69	7	44	3.9	30	4.7	31	3.4	43	5.1	47	6	91	7
Lepomis sp.	0	0	1	0.1	1	0.1	12	1.2	49	5	0	0	0	0	0	0	0	0	0	0	0	0
Mimic shiner	6	0.4	0	0	0	0	17	1.7	5	0.5	0	0	0	0	0	0	0	0	0	0	0	0
Northern pike	7	0.5	11	1.3	6	0.6	2	0.2	6	0.6	4	0.4	0	0	0	0	0	0	4	0.5	1	0.1
Notropis sp.	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	157	11	94	10.8	144	15.2	97	9.5	68	6.9	109	9.7	11	1.7	71	7.8	23	2.7	70	9	104	8
Redbreast sunfish	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2	0	0	0	0	0	0	0	0
Rock bass	37	2.6	26	3	10	1.1	5	0.5	18	1.8	41	3.7	9	1.4	17	1.9	18	2.1	24	3.1	21	1.6
Sea lamprey	2	0.1	0	0	1	0.1	0	0	0	0	1	0.1	9	1.4	5	0.6	4	0.5	1	0.1	4	0.3
Smallmouth bass	15	1.1	10	1.1	18	1.9	11	1.1	22	2.2	12	1.1	7	1.1	26	2.9	21	2.5	10	1.3	2	0.2
Spotfin shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spottail shiner	104	7.3	73	8.4	46	4.9	85	8.3	23	2.3	249	22.2	146	22.9	39	4.3	76	9	50	6.4	141	10.9
Tessellated darter	2	0.1	0	0	0	0	0	0	0	0	0	0	0	0	2	0.2	0	0	0	0	4	0.3
Unidentifiable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Walleye	15	1.1	1	0.1	12	1.3	12	1.2	13	1.3	6	0.5	7	1.1	6	0.7	3	0.4	2	0.3	7	0.5
White perch	19	1.3	11	1.3	7	0.7	34	3.3	18	1.8	0	0	1	0.2	0	0	1	0.1	0	0	0	0
White sucker	121	8.5	86	9.9	75	7.9	108	10.6	73	7.4	22	2	11	1.7	8	0.9	13	1.5	11	1.4	21	1.6
Yellow bullhead	5	0.4	4	0.5	5	0.5	4	0.4	7	0.7	2	0.2	0	0	2	0.2	4	0.5	7	0.9	5	0.4
Yellow perch	507	35.6	260	29.8	352	37.2	394	38.5	373	37.7	346	30.9	324	50.9	360	39.6	240	28.5	272	34.9	454	35
No. Collections	24		24		24		24		24		20		24		24		24		24		24	
Effort (Hrs)	7.8		8.1		7.9		6.5		8.2		3.5		4		4.3		4		3.9		4	

(continued)

Table 3-6.3. (Continued)

Species	2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
American eel	0	0	0	0	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
American shad	0	0	0	0	0	0	0	0	0	0	1	0.1	6	0.3	0	0	2	0.1	0	0
Atlantic salmon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	0	0
Banded killifish	0	0	0	0	0	0	1	0.3	1	0.1	0	0	0	0	1	0.1	0	0	1	0
Black crappie	4	0.7	13	2	9	1.9	1	0.3	30	2.1	26	1.5	37	2	22	1.2	46	2.3	30	1.3
Blueback herring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bluegill	197	34.1	202	31.8	123	26.6	73	21.8	195	13.5	201	11.6	122	6.6	115	6.4	171	8.7	186	8
Brook trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown bullhead	0	0	3	0.5	1	0.2	0	0	5	0.3	7	0.4	1	0.1	4	0.2	0	0	1	0
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centrarchidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chain pickerel	5	0.9	8	1.3	2	0.4	2	0.6	19	1.3	46	2.7	27	1.5	39	2.2	45	2.3	18	0.8
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Common carp	1	0.2	0	0	4	0.9	1	0.3	8	0.6	2	0.1	0	0	1	0.1	10	0.5	2	0.1
Common shiner	0	0	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern silvery minnow	2	0.3	0	0	0	0	0	0	24	1.7	3	0.2	2	0.1	0	0	0	0	0	0
Fallfish	0	0	0	0	0	0	0	0	0	0	0	0	6	0.3	0	0	2	0.1	0	0
Gizzard shad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Golden shiner	29	5	19	3	27	5.8	21	6.3	41	2.8	81	4.7	105	5.6	31	1.7	80	4.1	48	2.1
Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	31	5.4	27	4.2	33	7.1	20	6	54	3.7	118	6.8	49	2.6	62	3.5	108	5.5	50	2.1

(continued)

Table 3-6.3. (Continued)

Species	2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Lepomis sp.	0	0	11	1.7	0	0	0	0	0	0	0	0	3	0.2	0	0	15	0.8	17	0.7
Mimic shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern pike	1	0.2	0	0	0	0	0	0	3	0.2	1	0.1	4	0.2	2	0.1	3	0.2	5	0.2
Notropis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	81	14	75	11.8	48	10.4	39	11.6	141	9.7	149	8.6	132	7.1	139	7.8	109	5.5	269	11.5
Redbreast sunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock bass	5	0.9	9	1.4	3	0.6	1	0.3	20	1.4	15	0.9	17	0.9	37	2.1	47	2.4	58	2.5
Sea lamprey	0	0	4	0.6	0	0	0	0	0	0	4	0.2	9	0.5	1	0.1	3	0.2	3	0.1
Smallmouth bass	6	1	5	0.8	0	0	2	0.6	24	1.7	2	0.1	20	1.1	11	0.6	16	0.8	44	1.9
Spotfin shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spottail shiner	17	2.9	18	2.8	6	1.3	10	3	89	6.1	85	4.9	282	15.1	240	13.4	392	19.9	435	18.7
Tessellated darter	1	0.2	0	0	2	0.4	0	0	7	0.5	0	0	1	0.1	10	0.6	0	0	4	0.2
Unidentifiable	0	0	0	0	2	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Walleye	2	0.3	0	0	0	0	1	0.3	1	0.1	2	0.1	3	0.2	2	0.1	1	0.1	17	0.7
White perch	3	0.5	2	0.3	0	0	0	0	1	0.1	3	0.2	0	0	0	0	30	1.5	2	0.1
White sucker	18	3.1	8	1.3	4	0.9	4	1.2	12	0.8	15	0.9	46	2.5	18	1	23	1.2	25	1.1
Yellow bullhead	0	0	3	0.5	4	0.9	0	0	1	0.1	3	0.2	1	0.1	1	0.1	2	0.1	1	0
Yellow perch	175	30.3	228	35.8	194	41.9	159	47.5	772	53.3	970	55.9	989	53.1	1050	58.8	867	43.9	1113	47.8
No. Collections	**24**		**24**		**24**		**24**		**24**		**24**		**24**		**24**		**24**		**24**	
Effort (Hrs)	**4**		**4**		**4**		**4**		**4**		**4**		**4**		**4**		**4**		**4**	

Table 3.6-4. Summary of the number and percent of fish species collected by general electrofishing downstream of Vernon dam, 1991-2011 (Source: Normandeau, 2012a).

	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000		2001	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
American eel	13	2	1	0.2	10	2.4	7	1.6	1	0.3	1	0.2	1	0.4	3	0.8	0	0	2	1	0	0
American shad	166	25.6	37	9.2	82	19.9	43	9.6	59	15.6	10	2.4	39	16.2	12	3.3	1	0.2	12	6	34	7.3
Atlantic salmon	0	0	0	0	0	0	0	0	1	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Banded killifish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black crappie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.8	0	0	0	0	1	0.2
Blueback herring	0	0	2	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bluegill	8	1.2	12	3	15	3.6	28	6.3	25	6.6	37	8.8	5	2.1	28	7.7	12	2.6	23	11.4	41	8.8
Brook trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown bullhead	1	0.2	1	0.2	2	0.5	0	0	5	1.3	0	0	0	0	0	0	2	0.4	0	0	0	0
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centrarchidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chain pickerel	3	0.5	6	1.5	4	1	2	0.4	0	0	3	0.7	3	1.2	0	0	0	0	1	0.5	1	0.2
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common carp	3	0.5	1	0.2	3	0.7	4	0.9	7	1.8	4	1	0	0	0	0	0	0	0	0	0	0
Common shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	4.6	1	0.5	1	0.2
Eastern silvery minnow	0	0	0	0	0	0	0	0	6	1.6	0	0	0	0	5	1.4	0	0	0	0	0	0
Fallfish	49	7.6	22	5.5	11	2.7	27	6.1	9	2.4	6	1.4	0	0	25	6.8	86	19	26	12.9	24	5.2
Gizzard shad	0	0	0	0	0	0	0	0	1	0.3	2	0.5	0	0	0	0	1	0.2	1	0.5	0	0
Golden shiner	5	0.8	2	0.5	4	1	4	0.9	0	0	14	3.3	4	1.7	4	1.1	10	2.2	3	1.5	1	0.2
Goldfish	0	0	0	0	0	0	0	0	0	0	1	0.2	0	0	0	0	0	0	0	0	0	0
Largemouth bass	8	1.2	5	1.2	15	3.6	3	0.7	8	2.1	3	0.7	5	2.1	3	0.8	5	1.1	0	0	8	1.7

(continued)

Table 3.6-4 (Continued)

	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000		2001	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Lepomis sp.	6	0.9	0	0	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mimic shiner	15	2.3	0	0	4	1	6	1.3	1	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Northern pike	2	0.3	7	1.7	0	0	6	1.3	10	2.6	3	0.7	1	0.4	0	0	0	0	0	0	1	0.2
Notropis sp.	0	0	0	0	0	0	8	1.8	2	0.5	0	0	0	0	0	0	0	0	2	1	9	1.9
Pumpkinseed	11	1.7	3	0.7	3	0.7	4	0.9	4	1.1	5	1.2	3	1.2	10	2.7	5	1.1	10	5	5	1.1
Redbreast sunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3	0	0	0	0	0	0
Rock bass	30	4.6	25	6.2	22	5.3	37	8.3	47	12.4	37	8.8	6	2.5	43	11.8	38	8.4	13	6.5	60	12.9
Sea lamprey	0	0	1	0.2	3	0.7	0	0	0	0	7	1.7	0	0	6	1.6	3	0.7	0	0	3	0.6
Smallmouth bass	101	15.6	85	21.2	99	24	109	24.4	118	31.1	73	17.3	72	29.9	141	38.6	127	28	42	20.9	197	42.5
Spotfin shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3	0	0	0	0	0	0
Spottail shiner	107	16.5	104	25.9	49	11.9	60	13.5	27	7.1	171	40.6	64	26.6	37	10.1	65	14.3	51	25.4	48	10.3
Tessellated darter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3	0	0	0	0	0	0
Unidentifiable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Walleye	18	2.8	13	3.2	16	3.9	9	2	9	2.4	5	1.2	2	0.8	5	1.4	12	2.6	6	3	3	0.6
White perch	1	0.2	1	0.2	8	1.9	0	0	2	0.5	0	0	1	0.4	0	0	0	0	0	0	1	0.2
White sucker	73	11.3	62	15.5	40	9.7	71	15.9	30	7.9	18	4.3	7	2.9	17	4.7	20	4.4	6	3	11	2.4
Yellow bullhead	0	0	0	0	0	0	0	0	1	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	28	4.3	11	2.7	21	5.1	18	4	6	1.6	21	5	28	11.6	20	5.5	45	9.9	2	1	15	3.2
Total	**648**	**100**	**401**	**100**	**412**	**100**	**446**	**100**	**379**	**100**	**421**	**100**	**241**	**100**	**365**	**100**	**453**	**100**	**201**	**100**	**464**	**100**

(continued)

Table 3.6-4 (Continued)

	2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		All	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
American eel	2	0.9	0	0	0	0	0	0	3	0.9	1	0.2	0	0	0	0	0	0	0	0	45	0.6
American shad	21	9.8	15	6.8	19	11.6	1	2.4	39	11.4	141	24.2	48	9.7	115	21.9	32	4.8	4	1	930	11.5
Atlantic salmon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Banded killifish	2	0.9	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2	0	0	0	0	3	0
Black crappie	3	1.4	1	0.5	1	0.6	0	0	1	0.3	3	0.5	2	0.4	1	0.2	1	0.2	2	0.5	19	0.2
Blueback herring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Bluegill	22	10.2	42	18.9	12	7.3	4	9.8	34	10	29	5	45	9.1	19	3.6	4	0.6	60	15	505	6.3
Brook Trout	1	0.5	0	0	0	0	1	2.4	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0	0	0	3	0.6	0	0	0	0	1	0.3	15	0.2
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2	0	0	1	0
Centrarchidae	0	0	0	0	0	0	0	0	1	0.3	0	0	0	0	0	0	0	0	0	0	1	0
Chain pickerel	0	0	2	0.9	0	0	0	0	0	0	1	0.2	1	0.2	1	0.2	5	0.8	2	0.5	35	0.4
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2	0	0	1	0.3	2	0
Common carp	0	0	2	0.9	0	0	0	0	0	0	2	0.3	3	0.6	0	0	0	0	1	0.3	30	0.4
Common shiner	0	0	1	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0.3
Eastern silvery minnow	2	0.9	0	0	0	0	0	0	4	1.2	0	0	0	0	0	0	0	0	0	0	17	0.2
Fallfish	13	6	6	2.7	8	4.9	3	7.3	14	4.1	60	10.3	21	4.2	99	18.9	172	26.1	17	4.3	698	8.6
Gizzard shad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.1
Golden shiner	1	0.5	0	0	0	0	0	0	0	0	2	0.3	12	2.4	3	0.6	0	0	16	4	85	1.1
Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Largemouth bass	1	0.5	2	0.9	7	4.3	0	0	5	1.5	2	0.3	0	0	3	0.6	2	0.3	5	1.3	90	1.1

(continued)

Table 3.6-4 (Continued).

	2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		All	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Lepomis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.8	10	0.1
Mimic shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0.3
Northern pike	0	0	0	0	0	0	0	0	0	0	0	0	2	0.4	0	0	1	0.2	1	0.3	34	0.4
Notropis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0.3
Pumpkinseed	10	4.7	5	2.3	2	1.2	0	0	4	1.2	3	0.5	6	1.2	3	0.6	1	0.2	4	1	101	1.3
Redbreast sunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Rock bass	13	6	18	8.1	30	18.3	1	2.4	30	8.8	26	4.5	57	11.5	35	6.7	42	6.4	34	8.5	644	8
Sea lamprey	2	0.9	1	0.5	1	0.6	0	0	5	1.5	5	0.9	5	1	0	0	6	0.9	13	3.3	61	0.8
Smallmouth bass	71	33	84	37.8	48	29.3	13	31.7	116	34	197	33.8	179	36.1	126	24	254	38.5	124	31	2376	29.4
Spotfin shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Spottail shiner	40	18.6	31	14	26	15.9	8	19.5	67	19.6	47	8.1	53	10.7	64	12.2	20	3	28	7	1167	14.5
Tessellated darter	0	0	1	0.5	0	0	0	0	0	0	0	0	0	0	2	0.4	1	0.2	2	0.5	7	0.1
Unidentifiable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Walleye	4	1.9	1	0.5	0	0	0	0	2	0.6	3	0.5	3	0.6	5	1	6	0.9	29	7.3	151	1.9
White perch	0	0	1	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3	16	0.2
White sucker	6	2.8	7	3.2	5	3	2	4.9	8	2.3	32	5.5	19	3.8	29	5.5	26	3.9	14	3.5	503	6.2
Yellow bullhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2	1	0.2	0	0	3	0
Yellow perch	1	0.5	2	0.9	5	3	8	19.5	8	2.3	28	4.8	37	7.5	16	3.1	85	12.9	38	9.5	443	5.5
Total	**215**	**100**	**222**	**100**	**164**	**100**	**41**	**100**	**341**	**100**	**582**	**100**	**496**	**100**	**524**	**100**	**660**	**100**	**400**	**100**	**8076**	**100**

Beach Seining

A sampling program was initiated in 2000 to provide an annual estimate of abundance for juvenile American shad found in Vernon reservoir (Normandeau, 2012b). With the exception of modifications to sampling gear types to begin the 2004 sample year (discontinued use of mid-water trawl and focused solely on beach seine) and number of weekly surveys to begin the 2007 year (increased from an eight-week period to a nine-week period), sampling and analytical methodology has remained consistent throughout the duration of the program. The abundance index (standing crop) for juvenile shad in Vernon reservoir was based on juvenile shad collected in bimonthly samples from a set of randomly selected sampling stations during a consistent time period (July through October) and region (Vernon dam upstream to the confluence with the West River, approximately 7.2 miles). Annual survey locations are based on random selection of available beaches using a proportional allocation scheme (in direct proportion to the amount of habitat in each of four regions defined by shoreline habitat and bathymetry conducted during 2000 (Vernon, Cersosimo, Brattleboro, and Cersosimo Lake).

During 2011, a total of 82 juvenile American shad were collected by beach seine with the majority (98 percent) collected during the mid-September to early-October survey efforts. More than half (54 percent) of the juvenile American shad collected in 2011 were from the Vernon region. All four regions of lower Vernon reservoir contributed to the annual standing crop index for juvenile American shad in 2011. The average of the first eight surveys in 2011 of the standing crop index for Vernon reservoir was 1,821 (SE = 1,038) juvenile American shad. The 2011 abundance index was highly variable among weeks and regions. The peak occurred for the sampling period September 6-12 with an estimated standing crop of 8,063 (SE = 2398). The juvenile American shad standing crop index for Vernon reservoir in 2011 was the third lowest among the 12-year time series of annual index values (table 3.6-5, Normandeau, 2012b). Peak seasonal occurrence of juvenile shad in Vernon reservoir (based on calculated weekly standing crop estimates), has varied among the months of August, September, and October over the years examined.

Ichthyoplankton Sampling

Vermont Yankee's 2011 annual report includes a summary of ichthyoplankton collected by trawl in the vicinity of the plant's cooling water intake structure (CWIS) (Normandeau, 2012a). Collections were made using a 50-cm diameter, 1.5-m long, 363-µm Nitex nylon ichthyoplankton net towed behind a boat in a semi-circular path at surface (approximately 0.3 meters), mid-depth (approximately 1.8 meters), and near bottom (approximately 3.7 meters) depths. From 1991 to 2011, 14,818 larval fish of 23 species, genera, or families were collected, identified, and enumerated (table 3.6-6). The most commonly collected larval fish identified to species was spottail shiner. Carps and minnows (including 'Cyprinidae' and 'Common Carp'), shiners (*Notropis* sp.), white perch, and white sucker were also commonly collected. Yellow perch and white perch were the only species collected during each year of sampling.

Table 3.6-5. Annual juvenile American shad standing crop index and the estimated number of adult American shad in lower Vernon reservoir of the Connecticut River, 2000- 2011 (Source: Normandeau, 2012b).

Year	June Daily Average River Flow at Vernon Dam (cfs)	Juvenile Shad Index in Vernon reservoir	Adult Shad Passed Upstream at Vernon Dam	Total Adult Shad Trucked from Holyoke Lift and Stocked in Vernon reservoir	Combined Number of Adult Shad in Vernon reservoir
2000	8,892	31,244	800	1007	1,807
2001	10,124	2,433	1,666	71	1,737
2002	16,075	10,528	356	600	956
2003[d]	6,681	779	268	869	1,137
2004	6,852	2,066	653	352	1,005
2005	14,781	2,729	167	596	763
2006	22,607	2,601	133	695	828
2007	7,020	1,049	65	495	550
2008	8,910	14,676	271	1,112	1,383
2009	9,500	8,153	16	2,128	2,144
2010	7,150	3,275	290	1,545	1,835
2011	11,885	1,821	46	675	721

Table 3.6-6. Earliest and latest collection dates, and total number by taxon of ichthyoplankton collected in lower Vernon reservoir near the Vermont Yankee cooling water intake structure during 1991 through 2011 (Source: Normandeau, 2012a).

Year	Species	Earliest Capture	Latest Capture	Number
1999	American shad	11-Jun-99	11-Jun-99	1
	American shad Total			**1**
2009	Black crappie	16-Jun-09	16-Jun-09	1
	Black crappie Total			**1**
1994	Bluegill	6-Jul-94	6-Jul-94	1
	Bluegill Total			**1**
2005	Carps and minnows	13-Jun-05	11-Jul-05	364
2006	Carps and minnows	6-Jun-06	11-Jul-06	299
2007	Carps and minnows	7-Jun-07	12-Jul-07	507
2008	Carps and minnows	9-Jun-08	14-Jul-08	65
2009	Carps and minnows	10-Jun-09	15-Jul-09	94
2010	Carps and minnows	3-Jun-10	12-Jul-10	726
2011	Carps and minnows	7-Jun-11	11-Jul-11	64
	Carps and minnows Total			**2119**
2001	Centrarchidae	22-Jun-01	18-Jul-01	31
2002	Centrarchidae	2-Jul-02	17-Jul-02	27
2003	Centrarchidae	25-Jun-03	16-Jul-03	100
2005	Centrarchidae	23-May-05	11-Jul-05	68
2006	Centrarchidae	30-May-06	11-Jul-06	15
2007	Centrarchidae	11-Jun-07	12-Jul-07	195
2008	Centrarchidae	15-May-08	25-Jun-08	31
2009	Centrarchidae	18-May-09	23-Jun-09	7
	Centrarchidae Total			**474**
1999	Clupeidae	21-Jun-99	21-Jun-99	1
2000	Clupeidae	6-Jun-00	6-Jun-00	1
	Clupeidae Total			**2**
1991	Common carp	3-Jun-91	3-Jun-91	1
1992	Common carp	16-Jun-92	23-Jun-92	3
1993	Common carp	16-Jun-93	7-Jul-93	6
1994	Common carp	27-Jun-94	27-Jun-94	1

Year	Species	Earliest Capture	Latest Capture	Number
1996	Common carp	21-Jun-96	3-Jul-96	3
1997	Common carp	18-Jun-97	18-Jun-97	1
1998[a]	*Common carp*	*2-Jun-98*	*8-Jun-98*	*8.8*
1999	Common carp	4-Jun-99	7-Jul-99	43
2000	Common carp	28-Jun-00	28-Jun-00	2
2001	Common carp	22-Jun-01	26-Jun-01	3
2002	Common carp	2-Jul-02	10-Jul-02	2
2003	Common carp	18-Jun-03	16-Jul-03	27
2004	Common carp	17-Jun-04	24-Jun-04	5
2005	Common carp	13-Jun-05	20-Jun-05	3
2007	Common carp	26-Jun-07	12-Jul-07	8
2008	Common carp	25-Jun-08	25-Jun-08	1
2009	Common carp	16-Jun-09	16-Jun-09	12
2010	Common carp	3-Jun-10	23-Jun-10	12
	Common carp Total			**133**
1991	Cyprinidae	30-May-91	15-Jul-91	516
1995	Cyprinidae	8-Jun-95	12-Jul-95	272
	Cyprinidae Total			**788**
1996	Fallfish	11-Jul-96	18-Jul-96	2
1998 [a]	*Fallfish*	*2-Jul-98*	*2-Jul-98*	*1.9*
2002	Fallfish	10-Jul-02	10-Jul-02	3
2010	Fallfish	3-Jun-10	29-Jun-10	17
2011	Fallfish	2-Jun-11	2-Jun-11	1
	Fallfish Total			**23**
1999	Golden shiner	4-Jun-99	4-Jun-99	1
2001	Golden shiner	31-May-01	31-May-01	1
2006	Golden shiner	13-Jun-06	13-Jun-06	1
	Golden shiner Total			**3**
1997	Largemouth bass	2-Jul-97	2-Jul-97	1
1998 [a]	*Largemouth bass*	*2-Jun-98*	*2-Jun-98*	*1.1*
2011	Largemouth bass	14-Jun-11	14-Jun-11	1
	Largemouth bass Total			**2**
1991	Lepomis sp.	30-May-91	10-Jul-91	219

Year	Species	Earliest Capture	Latest Capture	Number
1992	Lepomis sp.	23-Jun-92	14-Jul-92	121
1993	Lepomis sp.	25-May-93	12-Jul-93	56
1994	Lepomis sp.	21-Jun-94	13-Jul-94	28
1995	Lepomis sp.	25-May-95	12-Jul-95	52
1996	Lepomis sp.	21-Jun-96	27-Jun-96	7
1997	Lepomis sp.	8-Jul-97	8-Jul-97	3
2004	Lepomis sp.	17-May-04	15-Jul-04	726
2007	Lepomis sp.	7-Jun-07	2-Jul-07	6
2008	Lepomis sp.	2-Jul-08	14-Jul-08	23
2009	Lepomis sp.	16-Jun-09	15-Jul-09	12
2010	Lepomis sp.	3-Jun-10	12-Jul-10	214
2011	Lepomis sp.	2-Jun-11	11-Jul-11	83
	Lepomis sp. Total			**1550**
1992	Notropis sp.	11-Jun-92	14-Jul-92	515
1993	Notropis sp.	8-Jun-93	12-Jul-93	174
1994	Notropis sp.	14-Jun-94	13-Jul-94	1658
1996	Notropis sp.	8-May-96	18-Jul-96	129
1997	Notropis sp.	12-Jun-97	18-Jul-97	163
	Notropis sp. Total			**2639**
1995	Percidae	25-May-95	25-May-95	1
	Percidae Total			**1**
1998 [a]	Pumpkinseed	2-Jun-98	13-Jul-98	29.4
1999	Pumpkinseed	4-Jun-99	12-Jul-99	201
2000	Pumpkinseed	22-May-00	11-Jul-00	6
	Pumpkinseed Total			**207**
2006	Rainbow smelt	16-May-06	16-May-06	1
	Rainbow smelt Total			**1**
1998 [a]	Rock bass	15-Jun-98	15-Jun-98	3.4
	Rock bass Total			**3.4**
1993	Spottail shiner	12-Jul-93	12-Jul-93	1
1998 [a]	*Spottail shiner*	*2-Jun-98*	*13-Jul-98*	*183.4*
1999	Spottail shiner	4-Jun-99	2-Jul-99	113
2000	Spottail shiner	29-May-00	11-Jul-00	195

Year	Species	Earliest Capture	Latest Capture	Number
2001	Spottail shiner	4-Jun-01	18-Jul-01	978
2002	Spottail shiner	4-Jun-02	17-Jul-02	1236
2003	Spottail shiner	18-Jun-03	16-Jul-03	875
2004	Spottail shiner	17-Jun-04	15-Jul-04	269
	Spottail shiner Total			**3667**
1998 [a]	*Tessellated darter*	*15-Jun-98*	*15-Jun-98*	*4.5*
2001	Tessellated darter	4-Jun-01	4-Jun-01	2
2002	Tessellated darter	13-Jun-02	13-Jun-02	4
2004	Tessellated darter	26-May-04	26-May-04	3
2009	Tessellated darter	23-Jun-09	23-Jun-09	1
2011	Tessellated darter	11-May-11	2-Jun-11	6
	Tessellated darter Total			**16**
1992	Unidentifiable	27-May-92	23-Jun-92	3
1993	Unidentifiable	21-Jun-93	12-Jul-93	2
1994	Unidentifiable	25-May-94	6-Jul-94	6
1995	Unidentifiable	8-Jun-95	8-Jun-95	1
2006	Unidentifiable	16-May-06	11-Jul-06	46
2008	Unidentifiable	9-Jun-08	9-Jun-08	1
2011	Unidentifiable	7-Jul-11	7-Jul-11	1
	Unidentifiable Total			**60**
1991	Walleye	14-May-91	14-May-91	4
1992	Walleye	20-May-92	20-May-92	1
1994	Walleye	25-May-94	1-Jun-94	2
1995	Walleye	12-May-95	12-May-95	1
1998 [a]	*Walleye*	*15-May-98*	*21-May-98*	*13.6*
1999	Walleye	10-May-99	10-May-99	5
2000	Walleye	15-May-00	22-May-00	2
2001	Walleye	21-May-01	21-May-01	2
2003	Walleye	28-May-03	28-May-03	1
2004	Walleye	17-May-04	26-May-04	2
2005	Walleye	16-May-05	20-Jun-05	3
2006	Walleye	9-May-06	23-May-06	11
2008	Walleye	15-May-08	19-May-08	2

Year	Species	Earliest Capture	Latest Capture	Number
2009	Walleye	11-May-09	26-May-09	23
2011	Walleye	17-May-11	26-May-11	5
	Walleye Total			**64**
1991	White perch	21-May-91	25-Jun-91	174
1992	White perch	20-May-92	23-Jun-92	212
1993	White perch	19-May-93	28-Jun-93	248
1994	White perch	25-May-94	6-Jul-94	109
1995	White perch	12-May-95	27-Jun-95	90
1996	White perch	8-May-96	3-Jul-96	149
1997	White perch	5-Jun-97	18-Jun-97	15
1998 [a]	White perch	21-May-98	8-Jun-98	31
1999	White perch	16-Jun-99	16-Jun-99	7
2000	White perch	22-May-00	6-Jul-00	141
2001	White perch	21-May-01	3-Jul-01	31
2002	White perch	28-May-02	2-Jul-02	75
2003	White perch	14-May-03	2-Jul-03	178
2004	White perch	11-May-04	24-Jun-04	36
2005	White perch	16-May-05	27-Jun-05	75
2006	White perch	9-May-06	11-Jul-06	9
2007	White perch	11-Jun-07	26-Jun-07	2
2008	White perch	15-May-08	16-Jun-08	25
2009	White perch	18-May-09	30-Jun-09	17
2010	White perch	25-May-10	15-Jun-10	4
2011	White perch	14-Jun-11	11-Jul-11	3
	White perch Total			**1600**
1996	White sucker	11-Jun-96	11-Jun-96	1
1998 [a]	*White sucker*	*27-May-98*	*2-Jul-98*	*90.2*
1999	White sucker	21-May-99	27-May-99	55
2000	White sucker	29-May-00	13-Jun-00	71
2001	White sucker	31-May-01	22-Jun-01	640
2002	White sucker	28-May-02	19-Jun-02	2
2003	White sucker	28-May-03	4-Jun-03	2
2004	White sucker	26-May-04	26-May-04	11

Year	Species	Earliest Capture	Latest Capture	Number
2007	White sucker	7-Jun-07	7-Jun-07	1
2010	White sucker	25-May-10	15-Jun-10	282
2011	White sucker	2-Jun-11	7-Jun-11	9
	White sucker Total			**1074**
1991	Yellow perch	2-May-91	14-May-91	10
1992	Yellow perch	5-May-92	20-May-92	11
1993	Yellow perch	10-May-93	19-May-93	4
1994	Yellow perch	11-May-94	25-May-94	27
1995	Yellow perch	12-May-95	25-May-95	25
1996	Yellow perch	8-May-96	20-May-96	8
1997	Yellow perch	10-May-97	18-Jun-97	12
1998 [a]	*Yellow perch*	*7-May-98*	*15-Jun-98*	*84*
1999	Yellow perch	5-May-99	11-Jun-99	20
2000	Yellow perch	2-May-00	29-May-00	72
2001	Yellow perch	21-May-01	4-Jun-01	2
2002	Yellow perch	8-May-02	8-May-02	29
2003	Yellow perch	7-May-03	28-May-03	39
2004	Yellow perch	6-May-04	26-May-04	5
2005	Yellow perch	2-May-05	23-May-05	23
2006	Yellow perch	2-May-06	6-Jun-06	59
2007	Yellow perch	8-May-07	8-May-07	3
2008	Yellow perch	1-May-08	9-Jun-08	13
2009	Yellow perch	5-May-09	18-May-09	15
2010	Yellow perch	25-May-10	15-Jun-10	2
2011	Yellow perch	11-May-11	26-May-11	13
	Yellow perch Total			**392**
	Grand Total			**14818**

[a] Ichthyolankton counts from 1998 were calculated and reported as a density (fish per 100 m^3) as opposed to a total count of specimens. They are included here for completeness but are not added into the by Taxon total or the Grand Total values.

Impingement

Vermont Yankee's 2011 annual report includes a summary of collections of fish drawn into the plant's CWIS and caught (impinged) on the intake traveling water screens when at least one of the three circulating water pumps was operating (1991-2011; Normandeau, 2012a). A six-day impingement sample and a subsequent 24-hour impingement sample were collected weekly during the period April 1 through June 15 and August 1 through October 31 of each year. The 24-hour samples identified all fish to species whereas the six-day samples were examined for the presence of two anadromous fish species, Atlantic salmon and American shad.

From 1991 through 2011, 25,893 fish of 35 identified species, four genera and two major taxonomic groups were collected from the traveling screens at the Vermont Yankee CWIS (table 3.6-7). The most frequently collected species from 1991 through 2011 were bluegill, yellow perch, rock bass, American shad, pumpkinseed (L. gibbosus), spottail shiner, and sea lamprey.

Table 3.6-7. Number and species of fish collected from impingement on Vermont Yankee's cooling water intake traveling screens from 1991 through 2011 (Source: Normandeau, 2112c).

Species	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Ameiurus sp.										1
American eel	6	1			2					
American shad	94	26	1	6	210	10	31	1	278	7
Atlantic salmon	2	14	13	21	108	13	2		3	9
Black crappie						1			50	71
Blueback herring	7				26					
Bluegill	197	167	125	186	1347	837	64	53	428	269
Brook trout	1	2								
Brown bullhead	9	52	2	58	54	103	2	1	5	13
Brown trout	2			1		4				
Carps and minnows										
Chain pickerel	1		10	13	2	4	1	1	1	2
Common carp	3		1	1	3				1	
Common shiner					1				1	
Eastern silvery minnow									2	6
Etheostoma sp.						1				
Fallfish										
Gizzard shad	1				7		1	1		1
Golden shiner	17	11	48	44	4	16	7		8	12
Lampreys						3				
Largemouth bass	16	2	2	5	75	3	1	1	4	20
Lepomis sp.	1844	17	54	203	72	1				

Species	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Longnose dace						1				
Mimic shiner	16			4	3					
Northern pike			1	4						
Notropis sp.	1	2	1	111		3				10
Pumpkinseed	55	57	21	79	518	75	2		18	25
Rainbow smelt			1	1			1			
Rainbow trout					1					
Redbreast sunfish									1	
Rock bass	120	131	185	364	146	438	39	20	49	134
Sea lamprey	2	2	26	80	4	5		11	3	12
Smallmouth bass	35	14	9	106	68	10	11	3	11	10
Spottail shiner	33	49	247	588	30	65	22	1	8	
Tessellated darter	2	6	3		2	8	2	3		2
Walleye	55	1	4	9	19	1	10	1	5	3
White catfish										
White perch	138	16	1	3	140	4			3	28
White sucker	11	6	5	6	1	8				1
Yellow bullhead	33	10	7	48	55	73			42	
Yellow perch	137	96	340	563	154	628	26	9	62	322
Total	**2,838**	**682**	**1,107**	**2504**	**3,052**	**2315**	**222**	**106**	**983**	**958**

(continued)

Table 3.6-7. (Continued)

Species	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Ameiurus sp.												1
American eel					12							21
American shad	25	1	13	73	577	3	51	30	23	390	60	1910
Atlantic salmon	9	13	28		17	12	5	6	9	1	19	304
Black crappie	12	7	126	10	127	76	15	21	16	40	14	586
Blueback herring												33
Bluegill	201	254	372	67	352	122	231	83	70	87	255	5767
Brook trout					2	1						6
Brown bullhead	2	22		3	93	4	1	2	4	4	33	467
Brown trout					2							9
Carps and minnows		1										1
Chain pickerel	3	0	11	2	1	2			1		5	60
Common carp			1		1							11
Common shiner	1											3
Eastern silvery minnow	1	2				3						14
Etheostoma sp.												1
Fallfish					1							1
Gizzard shad												11
Golden shiner	15	2	7	1	17	5	1	11	7	1	11	245
Lampreys												3
Largemouth bass	4	2	58	3	17	1	7	7	1	3	3	235
Lepomis sp.								1	4		11	2207
Longnose dace												1
Mimic shiner												23
Northern pike		0	1			1					1	8
Notropis sp.												128
Pumpkinseed	12	27	162	6	118	60	33	29	10	62	228	1597
Rainbow smelt		1			3		13	1	4			25
Rainbow trout												1
Redbreast sunfish												1

Species	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Rock bass	33	74	108	23	175	48	53	43	71	120	471	2845
Sea lamprey	241	69	2	9	24	8	15	207	5	2	319	1046
Smallmouth bass	7	9	27	9	19	3	6	17	3	3	56	436
Spottail shiner	2	59	9	5	14	10	8	22	10	4	40	1226
Tessellated darter	2	8	2	1	4	7	4	8	4	2	13	83
Walleye		4	1	1	5	2	9	4	2		3	139
White catfish				1							1	2
White perch		1	1		3	1	1	1				341
White sucker	2	10	3	1	9	1		2	1	1	4	72
Yellow bullhead			39	1		1	3	4	3	5	12	336
Yellow perch	128	203	171	20	483	505	154	263	166	236	1021	5687
Total	**700**	**769**	**1142**	**236**	**2076**	**876**	**610**	**762**	**414**	**961**	**2580**	**25893**

Fish Assemblage and Habitat Assessment of the Upper Connecticut River

In 2008, an electrofishing survey of the upper Connecticut River was conducted as part of an EPA-funded project with the objective of assessing the relative abundance, composition, distribution, and general health of the fish assemblages as related to both historical and contemporary biological, chemical, and physical characteristics and stressors (Yoder et al., 2009). The 2008 sampling included standardized boat electrofishing at 46 discrete, approximately 1.0 km sampling locations for a cumulative effort of 44.74 km. Seven sampling locations occurred in the Vernon impoundment (from 26.2 to 0.5 miles upstream of the Project) and two stations occurred below the dam (from 0.1 to 5.2 miles downstream). Twenty-one species were recorded occurring upstream of Vernon dam, and 12 species were recorded occurring downstream of Vernon dam (see table 3.6-2).

An initial assessment of the upper Connecticut River mainstem fish assemblages was done using three techniques: an Index of Biotic Integrity (IBI) developed for larger freshwater rivers of Maine, an IBI developed for the Atlantic slope (Daniels et al., 2005, as cited in Yoder et al., 2009), and a Modified Index of Well-Being (MIwb). The MIwb is a diversity index that incorporates two abundance and two diversity measures derived by the amount of fish and biomass. Highly tolerant species, hybrids, and exotic species were eliminated from the abundance (i.e., number and biomass) components of the formula. Both IBIs and the MIwb showed a general decline from the upstream most sites downstream to just above Wilder dam, and then a relative stabilization to the Turners Falls impoundment (figure 3.6-1 below, consisting of three panels identified as A [figure 6], B [figure 7], and C [figure 8]).

A.

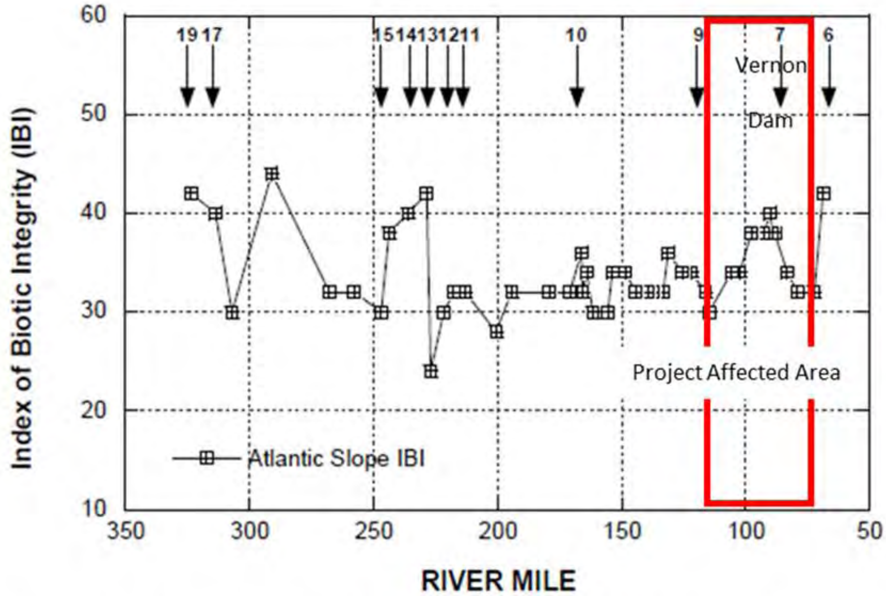

Figure 6. Atlantic slope Index of Biotic Integrity (IBI; Daniels et al. 2005) results in the upper Connecticut R. between Lake Francis and Turners Falls, 2008.

B.

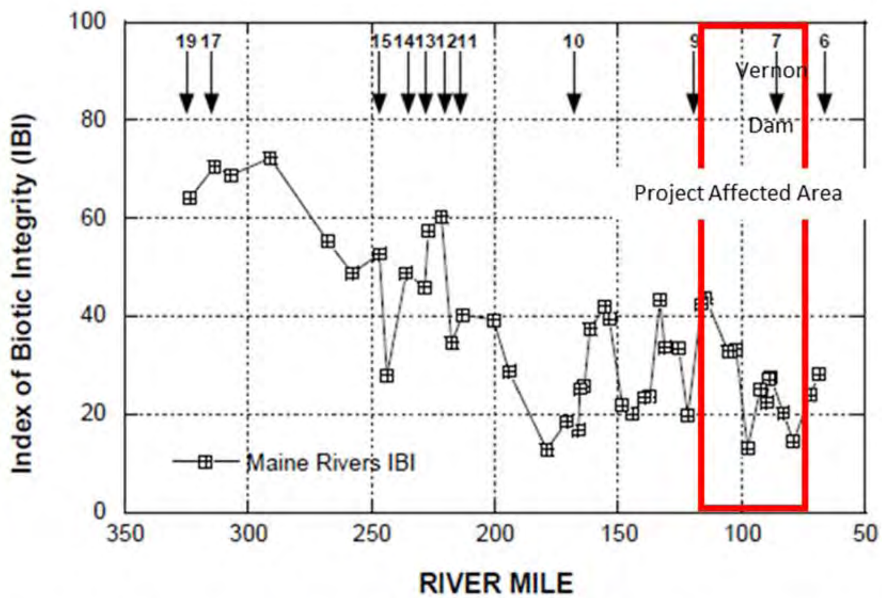

Figure 7. Interim Maine Rivers Index of Biotic Integrity (IBI; Yoder et al. 2008) results in the upper Connecticut R. between Lake Francis and Turners Falls, 2008.

C.

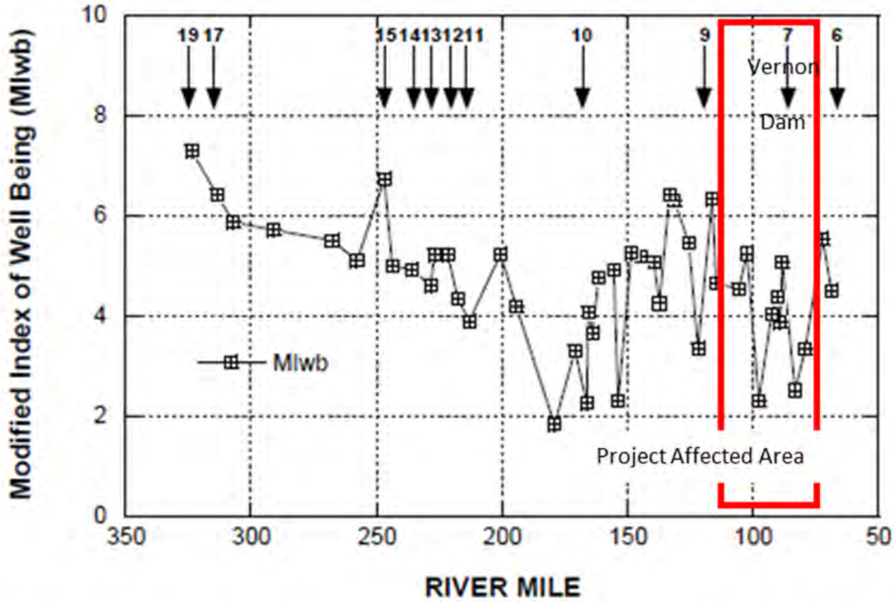

Figure 8. Modified Index of Well-Being (MIwb) results in the upper Connecticut R. between Lake Francis and Turners Falls, 2008.

Source (Yoder et al. 2009)

Figure 3.6-1. Results of Yoder et al. (2009) for the Connecticut River from Lake Francis to Turners Falls.[3] A. Atlantic slope Index of Biotic Integrity; B. Interim Maine Rivers Index of Biotic Integrity; C. Modified Index of Well-Being. Arrows labeled '7' indicate location of Vernon dam. Red box indicates stations within the Project affected area.

New Hampshire Fish and Game Electrofishing Survey

From 1983 to 2011, New Hampshire Fish & Game conducted general electrofishing sampling using standard boat electrofishing techniques in the mainstem Connecticut River. All surveys occurred during July through October. Pertinent surveys were conducted in the Project area upstream of Vernon dam on July 5 and 8, 2002, in the Hinsdale, New Hampshire, area, and September 4, 2007, in the Chesterfield, New Hampshire, area. Species assemblage observed (table 3.6-8) complemented data collected in the Vermont Yankee program (Normandeau, 2012a) and by Yoder et al. (2009, see table 3.6-2).

[3] River miles were measured from the head-of-tide not from the river mouth.

Table 3.6-8. Species presence absence list for New Hampshire Fish & Game boat electrofishing surveys in the Vernon Project area. 'X' indicates species that were collected (Source: New Hampshire Fish & Game, unpublished data).

Date	7/5/2002	7/8/2002	9/4/2007
Location	Hinsdale	Hinsdale	Chesterfield
Program	General Survey	General Survey	General Survey
American Eel			
Black Crappie	X		X
Blacknose Dace			
Bluegill	X		X
Brown Bullhead	X		
Carp	X		X
Common Sunfish	X		X
Common White Sucker			X
Creek Chub			
Eastern Chain Pickerel			
Fallfish			X
Golden Shiner	X		
Largemouth Bass	X	X	X
Northern Pike	X		
Redbreasted Sunfish			
Rock Bass	X		X
Sea Lamprey			
Smallmouth Bass			X
Spottail Shiner			X
Tessellated Darter			X
Unknown			
Walleye			
Yellow Bullhead	X		
Yellow Perch	X		X

New Hampshire Fish & Game Walleye Creel Survey

Walleye are not native to New Hampshire, but with initial stocking in the late 1800s quickly became established and common (New Hampshire Fish & Game, 1939, as cited in Carrier and Gries, 2010). The Connecticut River currently supports a naturally reproducing population of walleye from Monroe, New Hampshire (Comerford dam) south into the state of Connecticut (Carrier and Gries, 2010).

Carrier and Gries (2010) conducted a roving angler survey during spring (March - May) 2008 and 2009 in the southern New Hampshire portion of the Connecticut River including the Vernon dam tail water below the Project. Their objectives included comparison of their angler survey results to a survey conducted in 1996, prior to current walleye regulations (Sprankle, 1997). They also compared walleye total length (TL) data collected in their surveys among years and fisheries (Wilder, Bellows Falls, and Vernon). No significant differences were detected among years (one-way ANOVA, P = 0.41). However, additional data were submitted by cooperating anglers. The combined data (cooperating angler information and creel survey information) were from a combination of the Bellows Falls, Vernon, and Wilder fisheries, with the majority of data from Wilder in 1995-1996, and Bellows Falls and Vernon in 2008 and 2009 (Carrier and Gries, 2010). The combined TL differed significantly among survey years (P = 0.006). Multiple comparisons (Dunn's Method) suggested that mMean TL for both 2008 and 2009 were greater than for 1995/1996 data (Sprankle, 1997), but did not differ from each other (P > 0.05; figure 3.6-2).

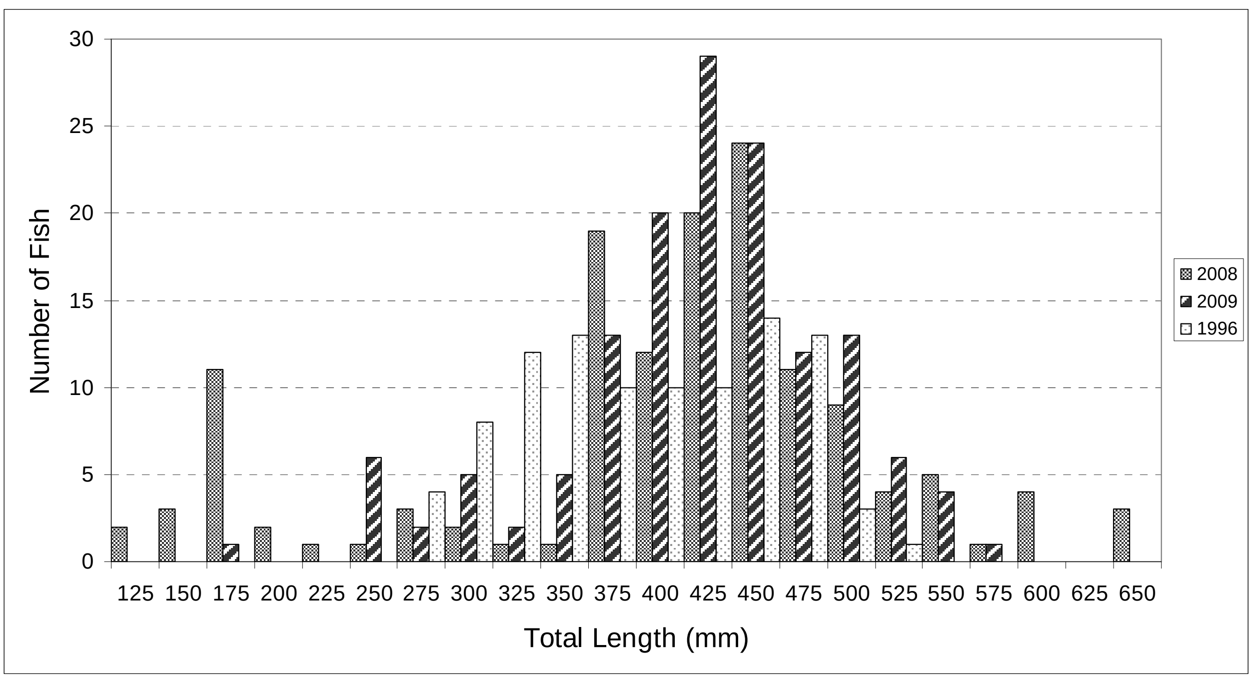

Figure 3.6-2. Length frequency distribution of walleye collected via creel surveys and cooperating anglers. The 1996 data includes data from cooperating anglers in 1995, from Carrier and Gries (2010).

The purpose of Carrier and Gries' (2010) study was to determine if fishery management objectives intended by 1998 regulations (a daily limit of 4 fish; no fish between 406 mm TL and 457 mm TL and only 1 fish larger than 457 mm TL can be harvested) were being met. They concluded that all measurable objectives (at the time of reporting) were met and that the majority (93 percent) of anglers interviewed were supportive of the current walleye regulations on the Connecticut River.

Connecticut River Fish Tissue Contaminant Study

The Connecticut River Fish Tissue Contaminant Study (Hellyer, 2006) was designed to provide a baseline of tissue contaminant data from several fish species. The study objectives were to better understand the risk to human health from eating Connecticut River fish, and to learn what threat eating these fish poses to other mammals, birds, and fish. Study Reach 5 extended from above Vernon dam to Wilder dam and Reach 4 extended from above Turners Falls dam to Vernon dam.

Three species of fish, smallmouth bass, white sucker, and yellow perch were evaluated. Hellyer (2006) found that mercury contamination was concluded to pose a risk to recreational and subsistence fishers and to fish-eating wildlife. Total mercury concentrations in all three species were significantly higher in upstream reaches associated with higher elevation drainage basins that experience greater air deposition than in downstream reaches. Specifically, total mercury was higher in all three species in reach 7 (upstream of Moore dam) samples than all other reaches. Total mercury in samples from reach 6 (upstream of Wilder Dam to Moore dam) were significantly lower than reach 7 in smallmouth bass samples and similar to all reaches downstream of it, but mercury concentrations in white suckers remained relatively high in reach 6 and was significantly higher than all reaches downstream of it. Total mercury concentrations in yellow perch from reach 6 were higher than all reaches downstream of it except for reach 4, which was similar. Mercury concentrations of samples from reach 5, upstream of Vernon dam, and reach 4, downstream of Vernon dam were generally lower than the upstream reaches 6 and 7 and generally similar to reaches downstream of the Project affected area.

Besides evaluating contaminants, the study included examination of condition factor (a measure of the relative condition of a fish incorporating a weight to length ratio) with higher values indicative of more robust fish in better condition, of smallmouth bass, white sucker, and yellow perch among the seven reaches of the Connecticut River. The results included significantly higher condition factor for smallmouth bass in Reach 5 as compared to all other reaches (figure 3.6-3); significantly higher yellow perch condition in Reaches 5 and 6 compared to all other reaches (figure 3.6-4); and no significant differences in white sucker condition factor among reaches (figure 3.6-5, Hellyer, 2006).

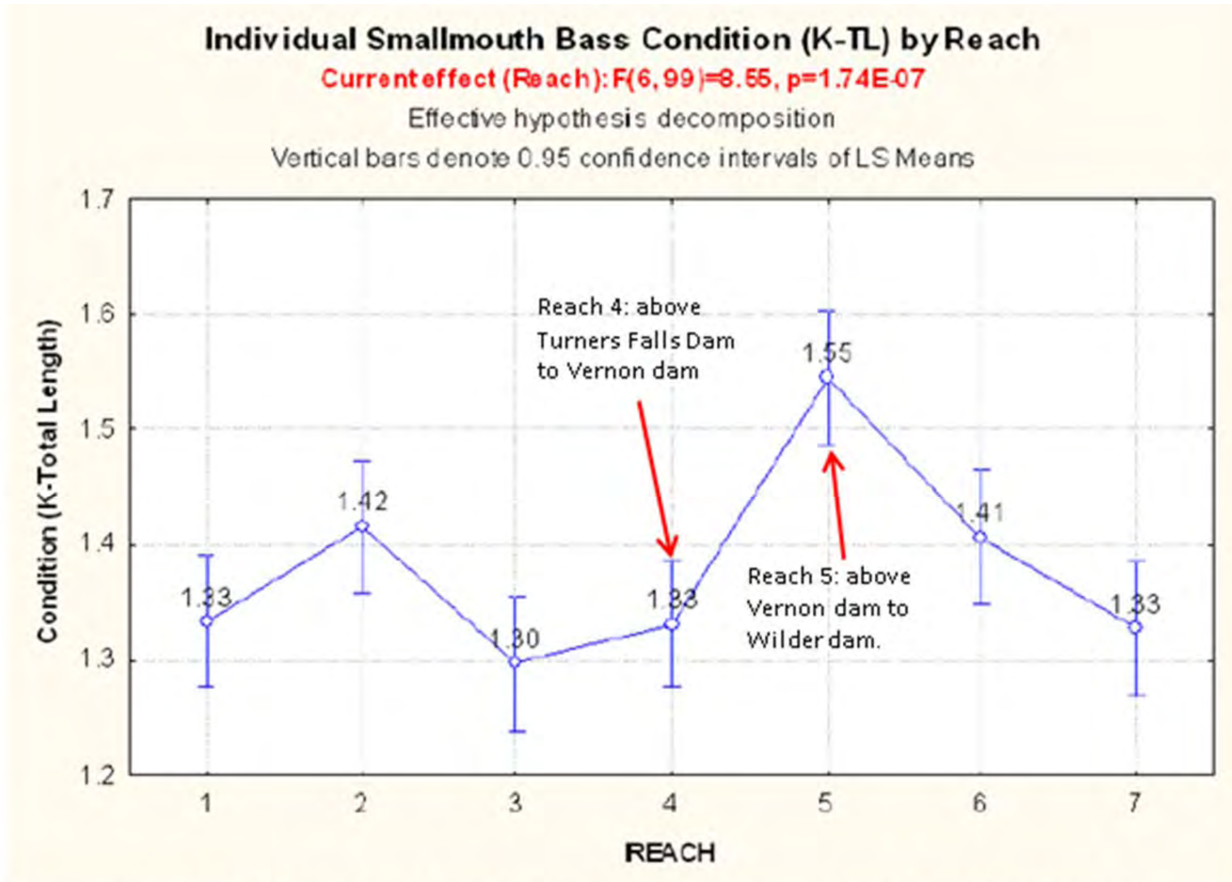

Figure 143. ANOVA of Individual Smallmouth Bass Condition (K-TL) by Reach

Source (Hellyer, 2006)

Figure 3.6-3. Results of Analysis of Variance of individual smallmouth bass condition by Connecticut River reach. Reach 4 = upstream of Turners Falls dam to Vernon dam. Reach 5 = above Vernon dam to Wilder dam.

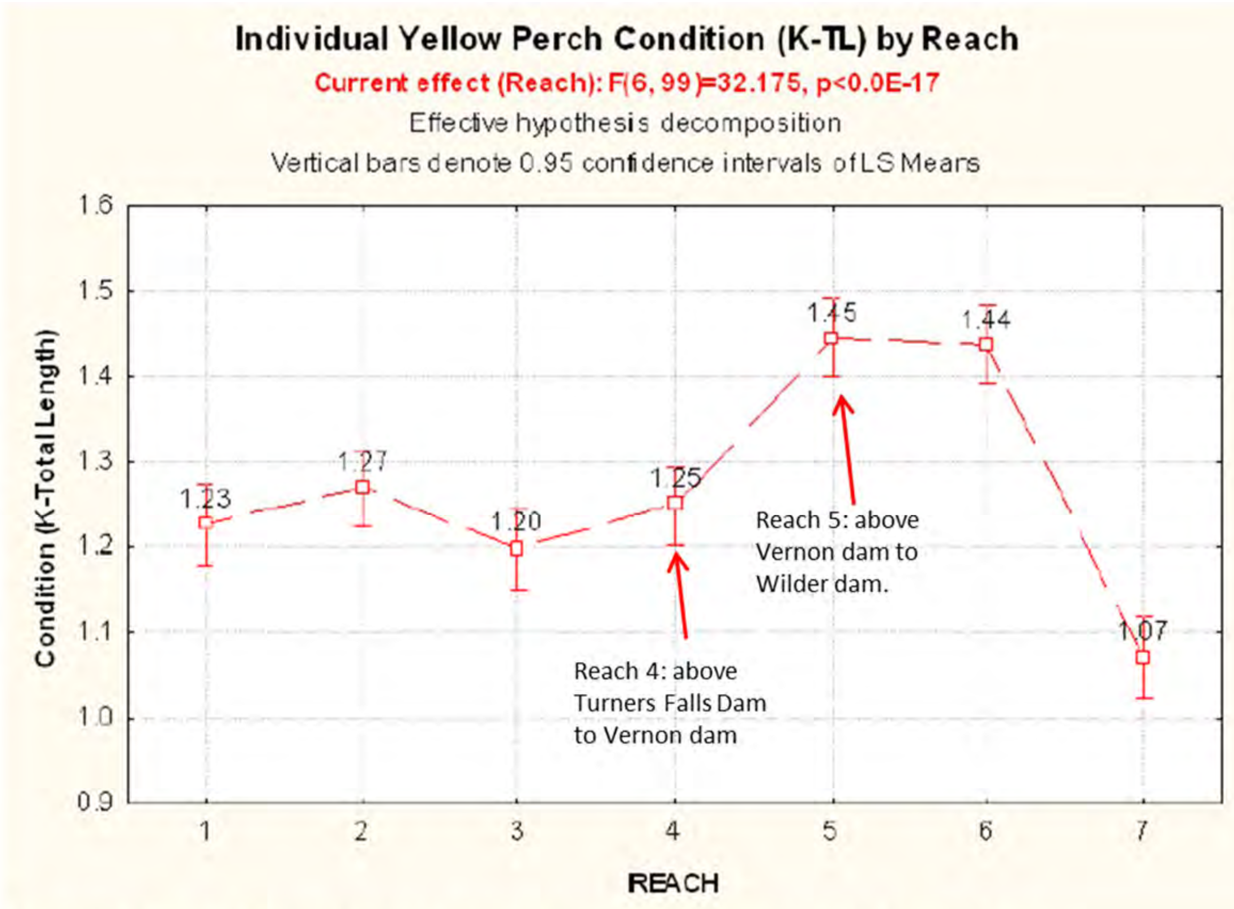

Figure 150. ANOVA of Individual Yellow Perch Condition (K-TL) by Reach

Source (Hellyer, 2006)

Figure 3.6-4. Results of Analysis of Variance of individual yellow perch condition by Connecticut River reach. Reach 4 = upstream of Turners Falls dam to Vernon dam. Reach 5 = above Vernon dam to Wilder dam.

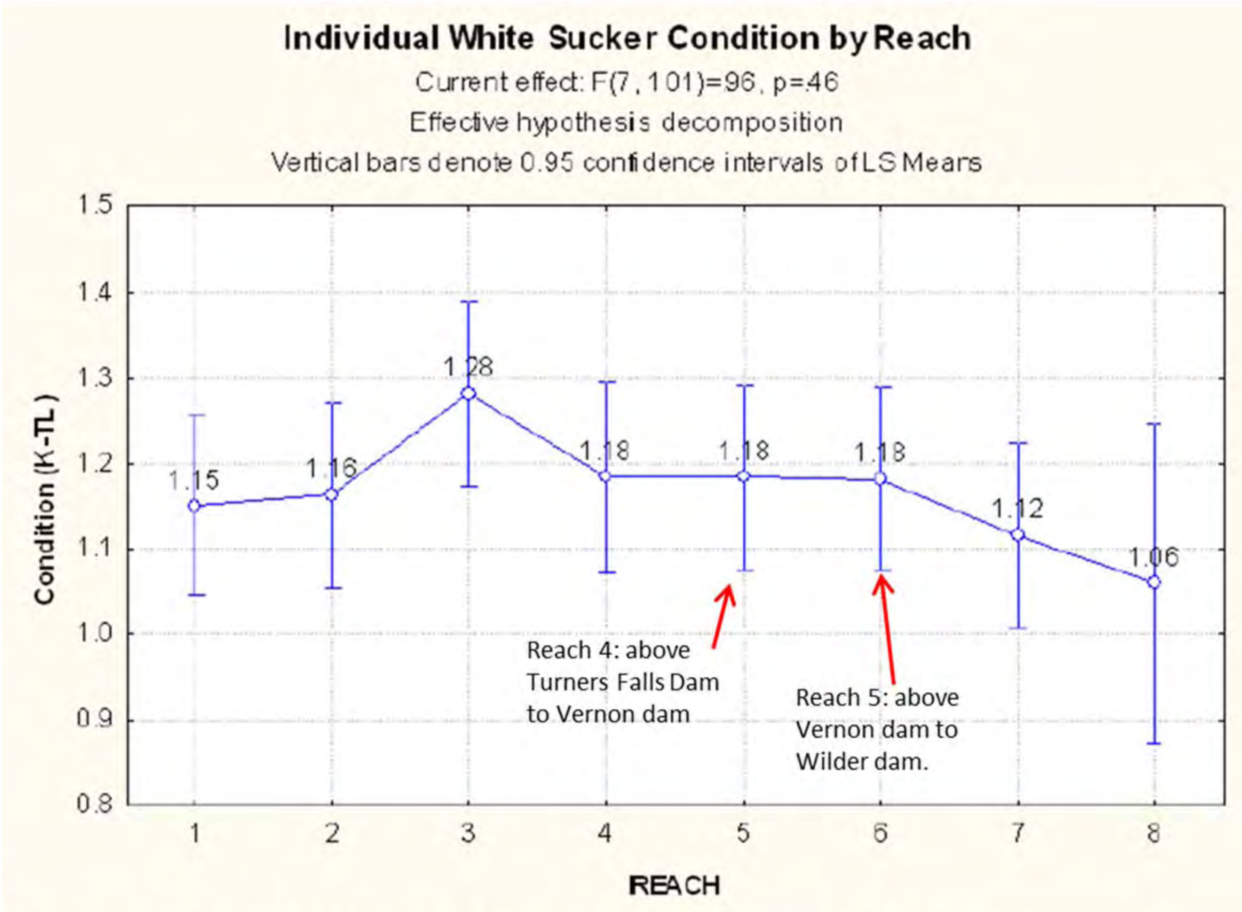

Figure 155. ANOVA of Individual White Sucker Condition by Reach

Source (Hellyer, 2006)

Figure 3.6-5. Results of Analysis of Variance of individual white sucker condition by Connecticut River reach. Reach 4 = upstream of Turners Falls dam to Vernon dam. Reach 5 = above Vernon dam to Wilder dam.

Anadromous Fish Studies

Comprehensive studies of behavior and movement of Atlantic salmon smolts at the Vernon Project were initiated in 1988 to determine the efficiency of existing downstream passage routes, and to assess behavior, such as approach route to the dam, and residency time in the forebay, in relation to Project operations. Studies continued through 1996 as new downstream passage routes were designed and installed and existing routes re-designed. In 1991, use of the existing sluice as the primary fish passage route (RMC, 1990) was superseded by a specially constructed fish pipe that extended from the forebay to the tailrace passing through the powerhouse (RMC, 1992). Subsequent studies showed that emigrating salmon smolts and juvenile and adult American shad did not find the fish pipe as effectively as anticipated. An acoustic deterrent system was tested to divert fish away from the turbine intake structure and towards the fish pipe entrance (RMC and Sonalysts, 1993; RMC, 1993a, b). The results of testing this system were encouraging for juvenile American shad but less so for adult American shad and Atlantic salmon smolts. Consequently, a physical guidance louver array was installed in 1994, and a second, smaller fish bypass was installed in the inner forebay to pass fish not diverted by the louver. The effectiveness of the passage routes was assessed for Atlantic salmon smolts in the spring of 1995 and 1996 and for juvenile American shad in the fall of 1995. Radio telemetry studies conducted with hatchery-reared Atlantic salmon smolts showed a passage efficiency of 74 percent, more than two times greater than the sluice gate passage assessed in 1990 (Normandeau, 1996a, b).

For assessing juvenile American shad passage, non-intrusive methods that included side scan sonar and underwater video recording were used because of the high mortality rates associated with collecting, handling, and marking the fish (Normandeau, 1996e). Although many shad were observed passing the Project, those methods were ineffective at quantifying passage efficiency.

In addition to passage route studies, bypass and turbine survival studies were conducted in 1995 and 1996 for both salmon smolts and juvenile American shad (Normandeau, 1995, 1996c, d). Survival of salmon smolts passing the fish tube was 94 percent and survival of both salmon smolts and juvenile American shad passing the Francis turbines was 95 percent. Survival studies were not conducted for the fish pipe because it was generally assumed to be safer than both the smaller fish bypass and the turbines.

Additional studies were conducted to assess route of passage and turbine passage survival after the 2MW turbine units numbered 5-8 were replaced with 4MW units. A turbine survival study was conducted in 2008. Immediate survival (within 1 hour of passage) of salmon smolts passing one of the new turbines was 97 percent and delayed survival (within 48 hours of passage) was 91 percent (Normandeau, 2009c). In 2009, a radio telemetry study to observe behavior and passage of emigrating Atlantic salmon smolts at the Project was conducted. Results indicated that bypass efficiency was 58.3 percent and that combined with survival estimates yielded greater than 92 percent safe passage by the Project (Normandeau, 2009a).

A federal and multi-state cooperative program to restore American shad and Atlantic salmon to the Connecticut River Basin was begun in 1967 and has evolved to include many other species (Public Law 98-138). Restoration emphasis has been placed on fish passage at barrier dams. Early fishways were justified on the basis of existing American shad runs, and later upriver fishways were built to support future salmon runs (Gephard and McMenemy, 2004). Vermont Fish & Wildlife and Normandeau have monitored adult Atlantic salmon utilization of the Vernon fish ladder since 1998. A small number (most recently about 10 fish / year) of the adult Atlantic salmon collected in the Holyoke dam fish lift are radio tagged and released into the Holyoke reservoir. The first radio tagged adult salmon to pass the Vernon Project was in 1998 (Normandeau, 2011b). Overall, 42 percent of all salmon tagged passed upstream of the Vernon Project, and 87 percent of all tagged salmon that passed Turners Falls also passed the Vernon Project (table 3.6-9).

Table 3.6-9. Summary of radio-tagged adult Atlantic salmon migration in the Connecticut and Deerfield Rivers, 1998 – 2011 (Source: Normandeau, 2011b).

	No.	Percentage of	No. Passed				Entered		Considered
Year	Tagged	Holyoke Run	Cabot	Vernon	Bellows Falls	Wilder	Deerfield River	At DRP No. 2	Deerfield Origin
1998	22	11.2	14	12	1	-	4	3	3
1999	20	22.0	8	5	1	1	11	9	7
2000	10	19.2	3	3	1	-	4	0	0
2001	4	16.7	1	1	1	-	3	2	1
2002	4	11.8	1	-	-	-	1	1	0
2003	4	14.3	-	-	-	-	2	1	0
2004	6	13.3	1	1	1	1	3	3	2
2005	12	9.1	3	3	3	2	8	5	2
2006	14	12.2	4	4	-	-	7	7	5
2007	10	9.6	5	5	3	-	5	4	3
2008	10	12.3	9	7	7	3	1	0	0
2009	10	16.7	7	6	3	-	1	1	1
2010	10	24.4	8	8	4	1	2	1	2
2011	10	13.9	7	7	6	3	2	1	1
Totals	146	13.6	71	62	31	11	54	38	27
Percentage			48.6%	42.5%	21.2%	7.5%	37.0%	26.0%	18.5%
Percentage*				87.3%	50.0%	35.5%		70.4%	50.0%

* - percentages of passers at Vernon are based on total which passed Cabot, at Bellows Falls from Vernon passers, etc.
percentages at DRP No.2 and of Deerfield origin are based on number that entered the Deerfield River.

The Nature Conservancy Northeast Aquatic Connectivity Project

Fragmentation by dams can result in loss of access to quality habitat for one or more life stages of a species (Martin and Apse, 2011). The Northeastern United States (the New England and Mid-Atlantic states) has the highest density of dams and road crossings in the country, with an average of seven dams per 100 miles of river (Anderson and Olivero Sheldon, 2011). The Nature Conservancy conducted the Northeast Aquatic Connectivity (NAC) project with the primary ecological goal of mitigating fish passage barriers to enhance populations of fish including anadromous fish, coldwater species, and other species of greatest conservation need. The project was initiated to support resource agencies in their efforts to strategically reconnect fragmented river, stream, coastal, reservoir, lake and estuarine habitat by removing or bypassing key barriers to fish passage (Martin and Apse, 2011).

The NAC used five metric categories: Connectivity Status, Connectivity Improvement, Watershed and Local Condition, Ecological, and Size/System Type. The metrics were calculated in Geographical Information System (GIS) to assess dams for their potential benefit to anadromous and resident fish if dams were removed or bypassed. The project resulted in the development of two software tools. The Northeast Aquatic Connectivity Tool was developed to execute the weighted ranking process that allows users to re-rank dams at multiple spatial scales (e.g., region, state, watershed), exclude dams that don't meet specific criteria, and modify the metric weights to develop new scenarios. The Barrier Analysis Tool is an ArcGIS 9.3 plugin that facilitates several of the network calculations that were performed for the NAC project (Martin and Apse, 2011). The authors noted that their analysis only examines ecological criteria and does not incorporate social, political, economic, and feasibility factors critical to the evaluation of any dam mitigation project. They explicitly stated that "...these results should be used with caution and examined in the context of other relevant information. They are a screening-level tool and are not a replacement for site-specific knowledge".

In the Connecticut River Basin, a total of 1,422 dams were evaluated in the analysis. Thirty-four percent of dams in the basin were in Vermont and New Hampshire, with a density of one dam per 19 km over 9,140 km of river. One observation of the project was that there were longer functional river networks in the Vermont and New Hampshire portions of the Connecticut River Basin than in the Massachusetts and Connecticut portions.

3.6.3 Conservation Plans

Vermont Wildlife Action Plan

Fish species of greatest conservation need were identified in Vermont's Wildlife Action Plan (WAP) (Kart et al., 2005). Criteria for selection included the degree of species rarity, species designated as at-risk, population trends, species whose habitat are vulnerable to loss, habitat fragmentation, habitat conversion or succession changes and species threatened by exotic plants or animals.

Several species listed in the WAP were either documented, known to use, expected to use, or have potential to be restored to use of habitats within the Vernon Project area. Diadromous species listed as species of greatest conservation need included sea lamprey, American eel (Vermont Species of Concern), blueback herring, American shad, and Atlantic salmon. Resident species included bridle shiner (Vermont Species of Concern), brook trout, and redbreast sunfish (table 3.6-10).

Table 3.6-10. Fish species listed in state conservation plans as species of greatest conservation need that occur in the Project area.

	State Conservation Plan - Species of Greatest Conservation Need, State Rank	
Species	**New Hampshire**	**Vermont**
American eel (*Anguilla rostrata*)	S5	S2, SC
American shad (*Alosa sapidissima*)	S3	S4
Atlantic salmon (*Salmo salar*)	S4	S4
Blueback herring (*Alosa aestivalis*)	S4	SU
Bridle shiner (*Notropis bifrenatus*)	S3, T	S1?, SC
Brook trout (*Salvelinus fontinalis*)	S5	S5
Rainbow Smelt (*Osmerus mordax*)	S5	
Redbreast sunfish (*Lepomis auritus*)		S4
Sea lamprey (*Petromyzon marinus*)	S4	S4/S5
Slimy Sculpin (Cottus cognatuson)	S4/S5	
Tesselated darter (*Etheostoma olmstedi*)	S4	

Notes: Key to state rank: S1 = very rare (critically imperiled); S2 = rare (imperiled) ; S3 = uncommon (vulnerable); S4 = common (apparently secure); S5 = common (secure); SU = unrankable (lack of information)

Key to state status: SC = state species of special concern; T = threatened; E = endangered area.

New Hampshire Wildlife Action Plan

New Hampshire also identified species selected as those in greatest need of conservation in its WAP (New Hampshire Fish & Game, 2007). The species listed are similar to those of the Vermont plan but with some differences (see table 3.6-4). Notably, slimy sculpin and tessellated darter are included because they, along with Atlantic salmon are the only three New Hampshire fish species identified to serve as hosts to the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*) (Nedeau et al., 2000). Healthy populations of slimy sculpin in the Connecticut and Ashuelot rivers likely contribute to the persistence of dwarf wedgemussel populations in New Hampshire (New Hampshire Fish & Game, 2007). Additionally, bridle shiner are listed as threatened by the state of New Hampshire. The state of New Hampshire also considers rainbow smelt to be a species of concern. The anadromous population of rainbow smelt ranging from Labrador to

New Jersey was originally classified as a federal species of special concern by NMFS during 2004 (69 FR 19975) and remain on that list to date.

New Hampshire Inland Fisheries 2011 Master Operational Plan

The New Hampshire Fish & Game Inland Fisheries Division's 2011 Master Operational Plan (New Hampshire Fish & Game, 2011a) is intended to convert goals into management actions. Goals included, among others:

- sustain or improve warmwater fish populations, as well as provide recreational opportunities to fish for these species;
- conduct walleye spawning population stock assessment in the Connecticut River;
- provide anglers with desired trout fishing experiences;
- protect, conserve, enhance, or restore anadromous and freshwater fish species of greatest conservation need;
- restoration of Atlantic salmon to the Connecticut River; and
- provide technical expertise on instream flow policies for the State of New Hampshire and to assist in developing policies for instream flow.

Fishery Management Plans

Atlantic salmon management in the Connecticut River Basin is supported by state and federal legislation which created the Connecticut River Atlantic Salmon Commission (CRASC). The Connecticut River distinct population segment of Atlantic salmon was extirpated by the early 1800s with the loss of stocks indigenous to the Connecticut River (NMFS, 1999, Fay et al., 2006). Connecticut River restoration efforts have been conducted following the 1998 Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River (CRASC, 1998). The Commission developed a cooperative effort which includes habitat protection, fisheries management, research, regulation, hatchery production and stocking. The strategic plan seeks to accomplish the program mission to: "protect, conserve, restore and enhance the Atlantic salmon population in the Connecticut River Basin for the public benefit, including recreational fishing." However, during July 2012, FWS announced that it would no longer produce hatchery-reared stock for the effort to restore Atlantic salmon to the Connecticut River Basin due to the continued costs for low numbers of returns.

CRASC (1992) produced a management plan for American shad in the Connecticut River Basin with the overarching goal "to restore and maintain a spawning shad population to its historic range in the Connecticut River Basin and to provide and maintain sport and the traditional in-river commercial fisheries for the species." The primary management objectives pertinent to the Vernon Project included achieving and sustaining an adult population of 1.5 – 2 million entering the mouth of the Connecticut River annually, and achieving 40 to 60 percent passage at Holyoke dam, Massachusetts, and each successive upstream dam (Turners Falls, Vernon). In combination with a management objective of a maximum exploitation (fishing) rate of 40 percent, those objectives equate to an annual upstream passage objective of 144,000 to 432,000 American shad at Vernon dam. Other pertinent management objectives included:

- enhance and promote the recreational opportunities throughout the species' historical range;
- establish and maintain a permanent population monitoring program on the Connecticut River; and
- establish an annual research program to address management programs associated with shad restoration goals and objectives.

CRASC (2004) produced an amended management plan for river herring (blueback herring and alewife), in the Connecticut River Basin with the goal to "restore and maintain a spawning river herring population within its historic range in the Connecticut River Basin." The primary management objective pertinent to the Vernon Project included achieving and sustaining annual passage of 300,000 – 500,000 adults at Holyoke, Massachusetts (the first barrier to upstream migration on the mainstem Connecticut River), and passage of 40-60 percent of the spawning run at each successive dam (through Vernon). Those objectives equate to an annual passage of blueback herring at Vernon dam of 48,000 – 180,000. Other objectives pertinent to Vernon included to: "enhance, restore and maintain river herring habitat in the Connecticut River Basin."

The Atlantic States Marine Fisheries Commission (ASMFC) published its fishery management plans for American eel (ASMFC, 2000, 2008). The initial management plan presented primary objectives pertaining to an increased understanding of eel life history and population dynamics and sources of mortality through fishery dependent data collection, research and monitoring; protection and enhancement of eels in currently used habitats; and restoration to historically used habitats where practical. The 2008 addendum was published, in part, due to evidence that the American eels stock had declined and is at or near low levels. In it, ASMFC strongly recommended that member states and FWS request special consideration for American eel in the FERC relicensing process, including improving upstream and downstream passage, and collecting data on both (ASMFC, 2008).

ASMFC published its fishery management plan for American shad and river herring (blueback herring and alewife) in 1985 (ASMFC, 1985) in response to low commercial landings. Objectives of the plan included regulation of fishing mortality to ensure survival and enhancement of depressed stocks; improving habitat accessibility through improved or new fish passage facilities; improving water quality; ensuring that river flow allocation decisions consider flow needs of alosine fishes; ensuring that water withdrawal effects, including turbine mortalities, do not result in stock declines; initiate and expand stock restoration programs (laval and adult stocking); and support research programs relevant to development of management recommendations.

Amendment 2 to the plan (ASMFC, 2009), specific to river herring was published because stock assessments determined that many populations of river herring were in decline or depressed. The objectives of the amendment included preventing further declines in river herring abundance; improving the understanding of commercial fishery bycatch mortality; increasing understanding of fisheries, stock dynamics, and population health in order to evaluate management performance; retain existing or make more conservative regulations; and promote improvements in degraded critical habitat. Recommendations pursuant to habitat access that may be pertinent to the Vernon Project, assuming restoration of the migratory river herring population to the Connecticut River above Turners Falls Dam included (paraphrased):

- Evaluate effectiveness of existing fish passage facilities and where inadequate improve them.
- Evaluate passage survival of post-spawn and juvenile fish passing by available routes (e.g., turbines, spillage, bypass) and optimize passage for the route with the best survival rate.
- Prevent entrainment in hydropower intakes with behavioral barrier devices.
- Ensure that decisions on river flow allocation consider the flow needs of alosine fishes and minimize deviation from natural flow regimes.
- Ensure that water withdrawal effects do not impact alosine stocks by impingement/entrainment; employ intake screens or deterrent devices as needed to prevent egg and larval mortality, and alter water intake velocities, if necessary, to reduce mortality.
- To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream and adjusting in-stream flows.
- When considering options for restoring alosine habitat, include study of, and possible adjustment to, dam-related altered river flows.
- Document the impact of power plants and other water intakes on larval, postlarval, and juvenile mortality in spawning areas, and calculate the resultant impact to adult population size.

Amendment 3 to the ASMFC fishery management plan (ASMFC, 2010), specific to American shad, was published because a 2007 American shad stock assessment found that stocks were at all-time lows and did not appear to be recovering to acceptable levels. It identified the primary causes for continued declines as excessive total mortality, habitat loss and degradation, and migration and habitat access impediments. The objectives of amendment 3 included maximizing juvenile emigration from freshwater complexes; restoring and maintaining spawning stock biomass and age structure to achieve maximum juvenile recruitment; and manage harvest so that objectives 1 and 2 will not be compromised. A strategy to achieve those objectives included ensuring that adequate monitoring techniques are implemented to measure migratory success (i.e., upstream and downstream fish passage at barriers). The plan identified a number of issues specific to dams, some of which may be pertinent to the Vernon Project, including:

- State and federal agencies should work to identify hydropower dams that pose significant impediment to diadromous fish migration, and target them for appropriate recommendations FERC relicensing.
- Evaluate the effectiveness of upstream and downstream passage; when passage is inadequate, facilities should be improved.
- Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
- Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.
- Evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities and implement measures to pass fish via the route with the best survival rate.
- To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
- Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation).
- Ensure that decisions on river flow allocation take into account American shad instream flow needs and minimize deviation from natural flow regimes.
- Study the impacts and possible alteration of dam-related operations to enhance river habitat.

3.6.4 Diadromous Species Descriptions

This section provides a summary of the life history and distribution of diadromous fish species that are known or suspected to inhabit Project waters.

American Eel

The American eel is a catadromous fish species, spending the majority of its life cycle in freshwater and returning to the sea for the purposes of spawning. Various developmental stages of the species occur in freshwater, coastal waters and the open ocean as far north as Labrador and Greenland along the North American east coast to as far south as the Gulf of Mexico and northern South America (Facey and Van Den Avyle, 1987).

Following spawning in the Sargasso Sea (south of Bermuda, east of the Bahamas), the American eel larvae (leptocephali) are transported from spawning areas to the eastern seaboard by ocean currents (Facey and Van Den Avyle, 1987). While drifting, leptocephali undergo a metamorphosis during which changes to the depth and width of the body occur. During this period, the body thickness increases to a cylindrical form, larval teeth disappear, the aspect of the head and jaws changes and the digestive tract becomes functional (Smith and Tighe, 2002). American eels migrate towards freshwater from the ocean in the form of glass eels, the un-pigmented post-larval form of the species. As they enter coastal areas, the body begins to pigment and the eels are then known as elvers (Facey and Van Den Avyle, 1987). The majority of glass eels and elvers reach the coastal rivers of New England during the spring (March-June). As elvers enter the growth phase they become known as yellow eels and will remain in that phase until they prepare to depart for spawning. When in freshwater, American eels tend to be bottom dwellers, increasing their activity levels at night (Scott and Crossman, 1973). They prefer to hide in burrows, plant masses or other natural substrate shelters (Facey and Van Den Avyle, 1987).

Sexual differentiation does not occur until eels are about 8 to 10 inches (20 to 25 cm) long. American eels may spend between 5 and 20 years in freshwater and sexual maturing takes place in the later summer or fall (Smith and Tighe, 2002). Upon initiation of maturity, eels stop feeding, develop a sharply bicolored body pattern (gray to black dorsal side and white ventral side), eyes and pectoral fins enlarge and the individual begins to move downstream. As yellow eels begin to sexually mature, they are known as silver eels. Outmigrating silver eels primarily move at night and are also stimulated by pulses in flow associated with rain events. The minimum size of silver eels is approximately 11.5 inches (29 cm) for males and 18 inches (45 cm) for females. Female American eels grow much larger than males and average 24-39 inches (60-100 cm). American eels are among the most fecund fish species with egg production estimates reported to reach up to 10 million eggs.

American eel have been documented within the Project area both upstream (Yoder et al., 2009; Normandeau, 2012a) and downstream of the dam (Normandeau, 2012a). Yoder et al. (2009) collected one American eel at one (of seven total) station sampled in the Vernon area. The single American eel was collected in a 0.66 km electrofishing sample at a station upstream of the dam. Relative abundance was 1.5 fish/km and the numeric proportion of the catch was 0.5 percent. Normandeau (2012a) documented American eel within the Project area both upstream and downstream of the dam. Standardized electrofishing sampling within the Project area and over the 21-year period 1991 – 2011 produced a total of only 27 American eels upstream of the dam and 45 downstream of the dam. Upstream of the dam, American eel were collected during 8 of the 21 sampling years and represented 0.1 percent of the total fish catch during that period. Downstream of the dam, American eel were collected during 12 of the 21 sampling years and represented 0.6 percent of the total fish catch during that period. In 2012, Vernon fish laddder counts included 262 American eels (Lael Will, Vermont Fish & Wildlife, personal communication).

American Shad

American shad are an anadromous, highly migratory, coastal pelagic, schooling species that spend the majority of their life at sea (Stier and Crance, 1985, Munroe, 2002). American shad are found along the Atlantic coast from northern Labrador down to the St. John's River, Florida. They are the largest member of the herring family (Clupeidae) and females are larger than males at all ages. Mature male shad range from 12 to 17.5 inches (30.5 - 44.7 cm) and mature females range from 15 to 19 inches (38.3 – 48.5 cm) (Stier and Crance, 1985).

American shad form large schools during their time at sea, ranging vertically from surface waters to a depth of 220 meters (722 feet, Munroe, 2002). Adult shad return to coastal rivers to spawn during the spring when water temperatures are 16.5 – 19.0° C (61.7 - 66.2° F). In New England waters, males reach sexual maturity between ages 3 and 5 and females between ages 4 and 6. American shad are prolific spawners and large females can produce up to 600,000 eggs. Fecundity is highest in the southern portion of the species range and in older and larger females. Male American shad arrive at spawning areas ahead of females. Although shad spawn only in freshwater, there does not appear to be any required distance upstream of brackish water (Stier and Crance, 1985). Shad runs typically reach far upriver and often to the headwaters. Spawning occurs in river areas characterized by broad flats with relatively shallow water (1-6 m, 3.3 – 19.7 feet) and moderate current (0.3-1.0 m/s, 0.98 – 3.3 feet/s). Viable eggs have been recorded over bottom types ranging from fine sand to course rock and ledge but never over silt or mud bottom (Munroe, 2002). Northern populations of American shad exhibit high post-spawning survival and are considered iteroparous (repeat spawners). Fertilized shad eggs slowly sink to the bottom where they water-harden. Hatching takes place over a 6 to 15 day period (depending on water temperature) and the majority of larvae emerge during June. Larvae may remain in fresh water or drift into brackish water and grow rapidly; transforming into juveniles approximately 4 to 5 weeks after hatching (Stier and Crance, 1985). Juvenile shad form schools and gradually move downriver prior to departing for the ocean during late fall of the same year that they were hatched.

Extensive information regarding the annual abundance of young-of-year American shad in the Vernon Project area have been collected for Vermont Yankee (Normandeau, 2012b, c; see section 3.6.2), and the abundance of adult American shad spawners passed or transported to Vernon reservoir is enumerated annually (see section 3.6.1). The annual abundance of spawners in the Vernon Project area is directly related to numbers that pass the Turners Falls Project downstream; however, the proportion of those that ascend the river to the Project area was not thoroughly studied until very recently. Results of a FWS/USGS radiotelemetry study of shad migration throughout the Connecticut River conducted in 2011 and 2012 have not been finalized, but are expected to provide information regarding the relative proportion of spawners reaching the Project area.

A seasonal average annual index (average of biweekly standing crop index estimates July - October) of juvenile American shad standing crop in Vernon reservoir is presented in table 3.6-5 for the years 2000 – 2011, ranging from a low of 779 in 2003 to a high of 31,244 in 2000. This value has not yet been calculated for 2012 but is expected to be high due to the highest spawner upstream passage since 1996 (see table 3.6-1).

Young-of-year American shad age and size distributions and migration timing has been documented for pre-migrant juveniles collected from the Connecticut River near Northfield, Massachusetts, and two sites in Holyoke reservoir (O'Donnell and Letcher, 2008). In Vernon reservoir, juvenile American shad growth rates were estimated for fish collected in beach seining samples conducted from July through October for 2004 – 2011 (Normandeau, 2005b, 2006b, 2007b, 2008b, 2009d, 2010b, 2011c, 2012b). Overall estimates of growth rate for the period that juveniles were observed each year ranged from 0.13 mm/d in 2005 to 1.0 mm/d in 2008. In 2011, the estimated growth rate was 0.22 mm/d. In 1995, Smith and Downey (1995c) calculated the juvenile American shad growth rate in the Vernon reservoir to be 0.75 mm/day. In 1995, adult male American shad collected from the Vernon fish ladder were predominantly age classes 3 and 4 while females were predominantly age 4 and 5 (Smith and Downey, 1995a). Also in that year, when Vernon fish ladder passage was 86 percent of the passage count for Turners Falls, Smith and Downey (1995b) determined that the peak of sexual maturity was in the first half of June in the Vernon reservoir.

Atlantic Salmon

Atlantic salmon is a highly migratory, anadromous fish species that was indigenous to suitable riverine habitat from northeastern Labrador south to the Housatonic River located in Long Island Sound (Kocik and Friedland, 2002). Numerous reviews detailing the life history of Atlantic salmon exist (Kocik and Friedland, 2002; Fay et al., 2006; NMFS, 2009). Adult Atlantic salmon begin to return to natal freshwater rivers during the spring and continue into October, often producing a spring and a fall run. The majority of fish returning to rivers in New England have been at sea for two years. A lesser component of the run is consists of one or three sea-winter fish and repeat spawners. Fecundity increases with age with a one sea-winter fish producing an average of 3,040 eggs, a two sea-winter fish producing an average of 7,560 eggs, a three sea-winter fish producing an average of 10,200 eggs and a repeat spawner producing an average of 11,350 eggs (Baum, 1997). Nests, or redds, are constructed by female salmon and eggs are deposited and immediately fertilized by male salmon during the late fall, generally in riffle habitat with coarse gravel substrate. Following the fall spawn, approximately 20 percent of spent adult salmon (called kelts) move downstream to the ocean but the majority return to the ocean the following spring (Baum, 1997).

Eggs remain in the gravel until hatching during the early spring. Following a three to six week period, the young salmon emerge as fry and begin to actively seek food. As fry begin to feed, they develop cryptic vertical stripes and are then known as parr. Atlantic salmon in the Gulf of Maine typically remain in the parr stage for one to four years and remain resident to the freshwater river. Following that period, parr undergo a series of physiological and morphological changes known as smoltification:they lose their parr markings and develop a streamlined, silvery body and a pronounced forked tail. In this smolt stage salmon migrate downstream to the ocean. This downstream migration takes place during spring (April-June). Outmigrating smolts must adapt to changes in water temperature, pH, dissolved oxygen, salinity, pollution levels, predation and other factors as they move downstream.

Atlantic salmon fry and smolts have been stocked in tributaries throughout the Connecticut River Basin since 1968, with an annual stocking goal of 10 million fry per year, Since 2002, fry stocking has ranged from 6.0 – 7.8 million stocked annually to tributaries throughout the Basin (USASAC, 2011). Atlantic salmon smolts migrating downstream from tributaries upstream of the Project must pass downstream of the Project. For example, between 2004 and 2011, 13,351 stream-reared smolts collected at Moore dam have been released below McIndoes Falls dam (Normandeau 2005a, 2006a, 2007a, 2008a, 2009a, 2010a, 2011a). Hatchery reared smolts (n=1,921), utilized for radio telemetry, acoustic and PIT tag studies at Moore dam also were transported to and released below McIndoes dam. Early telemetry studies at Moore dam (1998 and 2000) yielded only ten passages during a spill event. Of those, three passed all the dams between Moore and Turners Falls (Comerford, McIndoes, Dodge Falls, Wilder, Bellows Falls, and Vernon). Those three fish arrived at Turners Falls between six and eight days after passing Comerford dam.

During July 2012, FWS announced that it would no longer produce hatchery-reared stock for the effort to restore Atlantic salmon to the Connecticut River Basin due to the continued costs for low numbers of returns. No further status of the program or state management changes is available at this time.

Overall, 42 percent of all adult Atlantic salmon tagged with radio transmitters at Holyoke dam since 1998 passed upstream of the Vernon Project, and 87 percent of all tagged salmon that passed the Turners Falls Project also passed the Vernon Project (see table 3.6-9). See section 3.6.2 for summaries of Atlantic salmon smolt emigration studies conducted at Vernon dam.

Blueback Herring

Blueback herring are a schooling, anadromous clupeid species found along the Atlantic coast from Nova Scotia down to the St. John’s River, Florida (Pardue, 1983, Munroe, 2002). Although adult blueback herring have been reported up to 15 inches (38 cm) in length, few individuals attain a length greater than 12 inches (30 cm; Munroe, 2002). Females are longer than males (Munroe, 2002).

Blueback herring return to coastal rivers to spawn from March through July, with individuals in the northern part of the range spawning later in the year (Pardue, 1983). The majority of blueback herring are fully recruited to the spawning population by age 5 with most first time spawners being age 4 (Munroe, 2002). Fecundity among individuals varies (30,000 – 400,000 eggs) with highest levels observed in older and larger females. Male blueback herring arrive at spawning streams earlier than females and spawning generally begins at water temperatures of 10-15°C. Spawning occurs in fresh or brackish water above the head of tide and typically takes place over areas of hard substrate where flow is rather swift. Spent adult fish return to the ocean shortly after spawning. Spawned eggs are pelagic or semidemersal, becoming less adhesive as they progress through the water-hardening stage (Pardue, 1983, Munroe, 2002). Following hatching (3-4 days at 20-21°C) the yolk-sac larvae have limited swimming ability and are carried by river flows downstream to slower moving water where they grow and develop into juveniles (Munroe 2002). Juvenile blueback herring typically emigrate from nursery areas between June and November (Pardue, 1983).

The Connecticut River blueback herring population has declined to the point where none have been recorded passing Vernon dam since 2000, so there are presently no blueback herring using habitats in the Project area. However, access to those habitats is provided by fish passage at all mainstem dams so future population restoration would presumably result in the reintroduction of the species to the Project area.

Sea Lamprey

Sea lamprey are an elongate, eel-like anadromous species found along the Atlantic coast from Labrador to Florida (Smith, 1985; Flescher and Martini, 2002). Adult sea lamprey reach an average length of 28 inches (72 cm) at the start of spawning with a maximum recorded length of 35 inches (90 cm; Flescher and Martini, 2002). Sexually mature adults can be characterized by strong sexual dimorphism with male lamprey developing a pronounced ventral ridge and female lamprey developing a prominent ventral ridge.

While at sea, adult sea lamprey parasitize a range of fish species by attaching to them with 11-12 rows of horny, hooked teeth located in an oral hood. Sea lampreys typically attach to the side of their prey and rasp at the flesh until they can feed on blood. Adult sea lampreys return to coastal streams during the spring, peaking during May and June in Gulf of Maine rivers. Sea lampreys seek out river or stream reaches that contain gravel substrate and swift current velocities, and eggs are deposited in a shallow nest depression constructed on the bottom. The majority of spawning adults are eight years of age (Beamish and Medland, 1988) and an average female contains 200,000 eggs. Deposited eggs develop over a 10-13 day period after which the larvae (called an ammocoete) develops gill clefts, an oral hood and body pigmentation (Flescher and Martini, 2002). Ammocoetes travel downstream to low velocity areas with muddy or sand bottom where they construct a shallow burrow. Ammocoetes are filter feeders and diatoms comprise the majority of their diet. The larval period generally lasts for 5 years (Beamish and Medland, 1988) after which the ammocoetes transform into juveniles over a 4 to 6 month period. During the transformation, eyes and related musculature, oral hood and teeth, salivary glands, new kidneys and pigmentation develop (Flescher and Martini, 2002). Juvenile lamprey move away from the river bottom and downstream where they are capable of entering seawater and adopting a parasitic life style.

Sea lamprey were documented in the Project area both upstream and downstream of Vernon dam (Yoder et al., 2009; Normandeau, 2012a). The 2008 electrofishing survey sampled seven river km of habitat in the Project area upstream of the dam and 2 river km downstream of the dam. Abundance relative to total catch at the three sites where sea lamprey were present upstream ranged from 1 to 5 fish / km, contributing 0.58 -5.95 percent of the numeric total of all fishes collected. Sea lamprey at the two stations downstream of the dam was 2 and 23 fish / km, contributing 22 and 32 percent of the numeric total collections (Yoder et al., 2009). Annual upstream passage counts for adult sea lamprey through Vernon fish ladder ranged from 104 in 1993 to 22,434 in 2008 (table 3.6-1). In Vermont Yankee electrofishing surveys from 1991 – 2011, a total of 51 sea lamprey were collected upstream of Vernon dam, contributing 0.2 percent of the total catch, and 61 were collected downstream, contributing 0.8 percent of the total catch (Normandeau, 2012a).

3.6.5 Resident Species Descriptions

A summary of the life history and distribution of selected resident game species as well as species of greatest conservation need (Kart et al., 2005, New Hampshire

Fish & Game, 2007) either documented in the Project area or that may reside in the Project area are described below.

Bridle Shiner

Bridle shiner is a small freshwater minnow species occurring in the Atlantic drainage of the eastern United States from southern Maine to Virginia and west to New York (Scott and Crossman, 1979). Bridle shiner prefer clear water in the low current sections of streams and rivers. They often associate with moderate levels of submerged aquatic vegetation and bottom substrates of silt and/or sand. Spawning takes place from late-May through July in water depths of 2-3 feet and areas surrounded by dense vegetation. Bridle shiner was listed as threatened by the state of New Hampshire in 2008.

New Hampshire Fish & Game has not described the Connecticut River as bridle shiner habitat; however, four individuals were identified from a single collection in the Wilder Project area upstream. Bridle shiner have not been observed in impingement, ichthyoplankton or electrofishing samples collected (1991-2011) in the area of Vermont Yankee and the Vernon Project (Normandeau, 2012a). Similarly, Yoder et al. (2009) did not collect bridle shiner in the Vernon Project area.

Brook Trout

Brook trout is native to the Atlantic seaboard south to Cape Cod, in the Appalachian Mountains southward to Georgia, west in the upper Mississippi and Great Lakes drainages to Minnesota, north to Hudson Bay (Scott and Crossman, 1979). Since the late nineteenth century, brook trout have been introduced into 20 additional states (Raleigh, 1982). Brook trout prefer clear, cool, well oxygenated water in streams and lakes. They tend to seek water temperatures below 68° F.

Brook trout spawn during the fall (September – November) in gravel beds located in the shallows of stream headwaters (Scott and Crossman, 1979). Mature fish (generally age 3) may migrate significant distances to reach appropriate spawning habitat with males arriving on site prior to females. Spawning takes place over a nesting area which is excavated by the female. The eggs are relatively large and fecundity estimates vary by body size with a reported range of 100 to 5,000 eggs. Eggs overwinter in the gravel substrate and hatching times range from 50 to 100 days, depending on water temperatures. Upon hatching, brook trout larvae remain in the gravel. They become free swimming at a body length of approximately 1.5 inches.

Brook trout have been documented within the Vernon Project area both upstream and downstream of the dam (Normandeau, 2012a). New Hampshire and Vermont both stock brook trout into tributaries that enter the Project area, and brook trout have been reported from the fishery below Vernon dam. Standardized electrofishing sampling within the Project area and over the 21-year period 1991 – 2011 produced a total of 2 brook trout collected downstream of the dam. Brook trout were collected during two of the 21 sampling years and represented less than 0.1 percent of the total fish catch during that period. A total of six brook trout were collected during impingement sampling conducted at Vermont Yankee during 4 of the 21 sampling years, and represented less than 0.1 percent of the total number impinged during that period

Rainbow Trout

The original range of rainbow trout included freshwater habitats and coastal areas of the eastern Pacific Ocean extending from northwestern Mexico up to the southwestern coast of Alaska. Their popularity as a sport and food fish, as well as the variety of strains available resulted in human introductions that have greatly expanded their distribution. Rainbow trout, first introduced into New England waters during the late 1800's (New Hampshire in 1878 and Vermont in 1886) are now found in cold water streams and lakes across both states, including the Connecticut River and its tributaries (Scarola, 1987, Langdon et al., 2006).

Rainbow trout are spring spawners with most strains spawning from mid-April to the later part of June. Rainbow trout spawn almost exclusively in streams, and successful reproduction has been documented within intermittent tributaries and lake outlets. River-resident rainbow trout generally spawn in headwater areas of the main stem or smaller tributaries. Mature rainbow trout (2-3 years of age or older) may start to ascend spawning tributaries as early as late fall in search of suitable spawning habitat, and spawning behavior generally occurs at water temperatures between 50-60° F. Females locate areas for redd excavation, which typically consist of riffles located above larger sized holding pools or tail-outs below pools where water depth, flows, and gravel sizes are appropriate. Females often spawn in several different redds with one or more males. After spawning the female moves upstream of the redd and covers it with gravel. Like most fish species, water temperatures heavily influence the incubation period, but eggs generally hatch in 4-7 weeks. Sac-fry remain in the gravel for up to a week while they absorb their egg sacs, and free-swimming fry begin to feed within two weeks of hatching. Fry of river resident rainbow trout remain in the stream system.

Juvenile and adult rainbow trout are opportunistic feeders that consume a wide variety of food. Aquatic insects are the most common item consumed, but zooplankton, terrestrial insects, crustaceans, mollusks, amphibians, leeches, and fish can be seasonally or locally important. Rainbow trout, like other salmonids, generally shift their diet from smaller sized food items (i.e. plankton) to larger items as they grow in size. Fish generally do not become an important part of the diet until adult rainbow trout reach approximately 12 inches in length.

The states of New Hampshire and Vermont both stock rainbow trout into tributaries that enter the Project area. Rainbow trout have not been observed in ichthyoplankton or electrofishing samples collected (1991-2011) in the area of Vermont Yankee (Normandeau, 2012b). A single rainbow trout was collected during one of the 21 years of impingement sampling at Vermont Yankee and represented less than 0.1 percent of the total number impinged during that period. Yoder et al. (2009) collected a single rainbow trout at one (of nine) stations sampled in the Vernon Project area. The fish was collected at an upstream station with a relative abundance of 1 fish / km and the numeric proportion of the catch was 0.6 percent.

Redbreast Sunfish

Redbreast sunfish inhabit the shores of lakes and ponds, and pools of clear streams with little current, but are more stream adapted than other sunfishes found in the Connecticut River Basin. Redbreast sunfish can be found over gravelly bottoms with or without vegetation (Scarola, 1987). Suitable water temperatures for growth and survival of adult and juvenile fish are assumed to be 15 - 35° C, and for spawning and incubation the optimal range is assumed to be 21 - 27° C. Spawning nests are generally constructed at depths less than 1.5 m, and a mixture of coarse sand and gravel appears to be required for successful spawning. Water velocities at nest sites are less than 0.06 m/s with an average of 0.02 m/s.

The redbreast sunfish occurs along the Atlantic Slope from New Brunswick to Florida, as well as Gulf Coast drainages. In Vermont, redbreast sunfish are found in the Connecticut River and lakes Morey and Fairlee (Orange County) and the Black River (Windsor County). However, its spotty distribution and relatively infrequent observation, even within the waters where it is known to occur, led to the species listing by Vermont as a species of greatest conservation need. The species is known to occur in the Connecticut River from the White River to Vernon dam (Kart et al., 2005).

Normandeau (2012a) collected two redbreast sunfish in electrofishing samples collected upstream and downstream of the dam and within the Vernon Project area during the 21-year period 1991-2011. A single redbreast sunfish was collected during the 21 years of electrofishing downstream of the dam and represented 0.3 percent of the total catch during that year (1998). Similarly, a single redbreast sunfish was collected during the 21 years of electrofishing upstream of the dam and represented 0.2 percent of the total catch during that year (1997).

Slimy Sculpin

Slimy sculpin is found in all major watersheds, except coastal watersheds in New Hampshire in cool streams and cold deep lakes with rock and gravel substrates. The species is commonly found under rocks in both rivers and lakes. Populations are more common in central and northern New Hampshire, often sharing stream habitat with eastern brook trout (Scarola, 1987). Slimy sculpin spawn in spring in water temperatures from 40 to 50° F (Scott and Crossman, 1973).

Slimy sculpin was listed as a species of greatest conservation need in New Hampshire because it is one of three New Hampshire fish species, along with tessellated darter and Atlantic salmon, that serve as hosts to the federally and state endangered dwarf wedgemussel (*Alasmidonta heterodon*) (Nedeau et al., 2000). Healthy populations of slimy sculpin in the Connecticut River likely contribute to the persistence of dwarf wedgemussel populations in New Hampshire (New Hampshire Fish & Game, 2007), however neither Normandeau (2012a) nor Yoder et al. (2009) collected slimy sculpin in the Vernon Project area.

Smallmouth Bass

Smallmouth bass are not native to the Connecticut River, and were introduced into New Hampshire waters some time during the 1860s (Scarola, 1987). The native range for this species was limited to the Great Lakes-St. Lawrence system and the Ohio, Tennessee, and upper Mississippi river systems. This species now occurs almost everywhere in the United States (Scott and Crossman, 1979). Smallmouth bass inhabit cool and warm, generally clear, large creeks, streams, and rivers with gravelly and rocky substrates. Often they become a dominant species in reservoirs that impound streams with the above attributes (Jenkins and Burkhead, 1993). Usually they are found around the protection afforded by the rocks of shoals and talus slopes, or submerged vegetation in moderately shallow water (Scott and Crossman, 1979).

Smallmouth bass were common both upstream and downstream of Vernon dam (Yoder et al., 2009, Normandeau, 2012b, 2012a). In sampling conducted by Yoder et al. (2009) abundance ranged from 3 to 32 fish / km sampled for stations in the Project area upstream of the dam with the lowest abundance in the Vernon impoundment. In the two stations sampled downstream of Vernon dam, smallmouth bass abundance was 4-28 fish / km. The smallmouth bass proportion of catch ranged from 1.0 – 44.4 percent over all stations in the Project area. A total of 224 smallmouth bass were documented in the Vernon Project area during 2011 electrofishing and impingement sampling conducted for Vermont Yankee (Normandeau, 2012a). Smallmouth bass represented 4.2 percent by count and 15.7 percent by weight of 2011 catch (electrofishing and impingement combined) over all sampling in the Project area. Catch-per-unit-effort (CPUE (number/hour) for smallmouth bass captured by electrofishing conducted during 2011 upstream of the dam was 11.0 and downstream was 46.5. CPUE (number/haul) for juvenile smallmouth bass by beach seine within the Project area (July-November 2011) ranged from 0 to 0.9 individuals (Normandeau, 2012a). New Hampshire Fish & Game compiles length-weight data for smallmouth bass collected from general electrofishing samples in the Vernon reservoir as well (New Hampshire Fish & Game, unpublished data). Earlier, Downey (1990) analyzed age and growth of smallmouth bass collected from 1968 – 1989, and Downey (1985) compared age and growth for 2,416 smallmouth bass samples collected from 1969 – 1983 both in lower Vernon reservoir and downstream of Vernon dam. Binkerd et al. (1990) evaluated the movement and growth of smallmouth bass in relation to Vermont Yankee using mark-recapture techniques. They tagged 1,865 fish over 9 years, and recaptured 11 percent. They found that movement was limited and 80 percent were captured at the station where they were tagged. The study was repeated 1990 – 1994 with similar results (Smith et al., 1995).

In Vermont Yankee sampling during the 21-year period 1991 – 2011, standardized electrofishing sampling within the Project area produced a total of 284 smallmouth bass upstream of the dam and 2,376 downstream of the dam. Upstream of the dam, smallmouth bass were collected during 20 of the 21 sampling years and represented 1.2 percent of the total fish catch during that period. Downstream of the dam, smallmouth bass were collected during each of the 21 sampling years and represented 29.4 percent of the total fish catch during that period. Smallmouth bass were collected during each of the 21 years during which impingement sampling was conducted at Vermont Yankee, totaling 436 fish and representing 1.7 percent of the total fish impinged during the 1991-2011 time- period.

Tessellated Darter

Tessellated darter resides year round in freshwater and is one of over 100 species of darter in the genus Etheostoma (Smith, 1985). Tessellated darters range from the St. Lawrence drainage in southern Quebec, the southern tributaries of Lake Ontario, the Connecticut River and coastal Massachusetts to the Altamaha River in Georgia. Tessellated darters have a slender, elongate body and an average total length of 2.3 inches (5.8 cm; Scott and Crossman, 1979). Although male tessellated darters grow to a larger size then females, female of the species live longer. Female tessellated darters have been aged as old as four years whereas male individuals have not been aged older than three years. This species is characterized by a distinctive series of dark X- or W-shaped marks along the midline of the body.

Although tessellated darters prefer areas with moderate to no current, they can be found in areas with swifter current (Scott and Crossman, 1979). Outside of the breeding season, tessellated darters show a preference for sandy or mud bottoms. Spawning occurs during the spring and exact timing likely varies with latitude. Male tessellated darters move into rocky spawning habitat in advance of females. They establish and defend a territory and clear off the underside of a rock for use as a spawning site. Upon arrival of a female, spawning takes place and five or six clutches of 30-200 eggs are deposited and fertilized. Following spawning, females depart the area and the male darter remains to guard the eggs. Eggs hatch over a period of five to eight days (depending on water temperatures).

Tessellated darter play an important role in the life cycle of the dwarf wedgemussel, a federally endangered freshwater mussel species inhabiting small streams to large rivers with moderate flow within the Atlantic drainage (Wicklow, 2005). The species is generally found in hydrologically stable areas and preferred habitat is comprised of gravel, coarse sand, find sand and clay. Similar to other freshwater mussel species, the reproductive cycle for the dwarf wedgemussel requires a host fish onto which the glochidia (larvae) can parasitize and metamorphose into juveniles. Dwarf wedgemussel glochidia have hooked valves which they use to attach to fins, lips and other soft, scaleless tissue of their host (Michaelson and Neves, 1995), typically during April to mid-June (Wicklow, 2005). Tessellated darter is one of three New Hampshire fish species, along with slimy sculpin and Atlantic salmon, that have been identified as host species (Nedeau et al., 2000).

Tessellated darter have been documented within the Vernon Project area both upstream and downstream of the dam (Yoder et al., 2009, Normandeau, 2012a, 2012b). In sampling conducted by Yoder et al. (2009) abundance was 1-2 fish / km sampled for stations in the Project area upstream of the dam, contributing 1.3 to 1.8 percent of the numeric catch, but none were collected in the two stations downstream of the dam.

In Vermont Yankee sampling, 19 tessellated darters were documented in the Vernon Project area during 2011 electrofish and impingement sampling (Normandeau, 2012a). Tessellated darter represented 0.4 percent by count and 0.1 percent by weight of 2011 catch (electrofish and impingement combined) over all sampling in the Project area. CPUE (number/hour) for tessellated darter captured by electrofishing conducted during 2011 upstream of the dam was 1.0 and downstream was 0.9.

Standardized electrofishing from1991 – 2011 produced a total of 33 tessellated darters upstream of the dam and 7 downstream of the dam. Upstream of the dam, tessellated darter were collected during 9 of the 21 sampling years and represented 0.1 percent of the total fish catch during that period. Downstream of the dam, tessellated darter were collected during 5 of the 21 sampling years and represented 0.1 percent of the total fish catch during that period. Additionally, tessellated darters were collected during 19 of the 21 years during which impingement sampling was conducted at Vermont Yankee, totaling 83 fish and representing 0.3 percent of the total impinged during the 1991-2011 time period. A total of 16 larval tessellated darter were collected upstream of the Vernon dam during 6 of the 21 years sampled 1991-2011. The majority of individuals were collected during June.

Walleye

Walleye are native to freshwater rivers and lakes of Canada and the United States, primarily east of the Rocky Mountains and west of the Appalachians. As a highly prized sport fish, walleye have been widely introduced into rivers and reservoirs, including the Connecticut River. Walleye tolerate a wide range of environmental conditions, necessary for widespread introductions, but are reported to be most abundant in medium to large (greater than 247 acres) lentic and lotic systems with generally mesotrophic conditions. Such systems also share cool temperatures (or at least provide access to them, e.g., cool tributaries, deeper portions of reservoirs), shallow to moderate depths, extensive littoral areas, moderate turbidities, and access to areas of clean, rocky substrate (McMahon et al., 1984).

Walleye have been documented within the Vernon Project area both upstream and downstream of the dam (Yoder et al., 2009, Normandeau, 2012b, Normandeau, 2012a). In sampling conducted by Yoder et al. (2009) abundance was 1 fish / km sampled for stations in the Project area upstream of the dam. The walleye proportion of catch ranged was 1.4 percent over all stations in the Project area upstream of the dam. A total of 49 walleye were documented in the Vernon Project area during 2011 electrofishing and impingement sampling conducted for Vermont Yankee (Normandeau, 2012a). Walleye represented 0.9 percent by count and 3.1 percent by weight of 2011 catch (electrofish and impingement combined) over all sampling in the Project area. CPUE (number/hour) for walleye captured by electrofishing conducted during 2011 upstream of the dam was 4.3 and downstream was 10.9.

Standardized electrofishing sampling within the Project area and over the 21-year period 1991 – 2011 produced a total of 113 walleye upstream of the dam and 151 downstream of the dam. Upstream of the dam, walleye were collected during 19 of the 21 sampling years and represented 0.5 percent of the total fish catch during that period. Downstream of the dam, walleye were collected during 19 of the 21 sampling years and represented 1.9 percent of the total fish catch during that period. Additionally, walleye were collected during 19 of the 21 years during which impingement sampling was conducted at Vermont Yankee, totaling 139 fish and representing 0.5 percent of the total impinged during the 1991-2011 time period. A total of 64 larval walleye were collected upstream of the Vernon dam during 15 of the 21 years sampled 1991-2011. The majority of individuals were collected during mid to late-May.

New Hampshire Fish & Game collects length and weight data for walleye collected in general electrofishing samples in Vernon reservoir (New Hampshire Fish & Game, unpublished data), and compiled length frequency distributions of walleye collected in the Vernon dam fishery during 2008 and 2009 (figure 3.6-2, Carrier and Gries, 2010). In earlier sampling, Downey (1990) analyzed age and growth of walleye, collected from 1968 – 1989, and Smith (1995) assessed age and growth of 842 walleye captured from 1968 to 1994.

3.6.6 Aquatic Habitat

In conjunction with the assessment of the fish assemblage of the mainstem Connecticut River (Yoder et al., 2009), a qualitative evaluation of macrohabitat was made for each location sampled. The Qualitative Habitat Evaluation Index (QHEI; Rankin, 1989, 1995; Ohio EPA, 2006), a physical habitat index designed to provide an empirical, qualitative evaluation of the lotic macrohabitat characteristics that are important to fish assemblages, was used. The QHEI consists of a visual estimate of the quality, composition, amount, and extent of substrate, cover, channel, riparian, flow, pool/run/riffle, and gradient variables, and has been shown to correspond predictably with key attributes of fish assemblage quality (Rankin, 1989, 1995).

Stations within the Vernon Project area (to 5.2 miles downstream) showed similar quality attributes in the Project area upstream of the dam as compared to habitats further upstream of the Project area. Modified attributes increased with proximity to the dam and consequently a decrease of 'good' attributes was observed. Modified attributes were typical of impoundments including silt, substrate embeddedness, slow flow, and lack of riffle-run habitat. Downstream of the Project, high quality habitat was observed with diverse substrate, good cover, and low-normal substrate and riffle-run embeddedness. In their sampling immediately below Vernon dam, Yoder et al. (2009) observed an exceptionally high QHEI (95.5) with no modified attributes (figure 3.6-6).

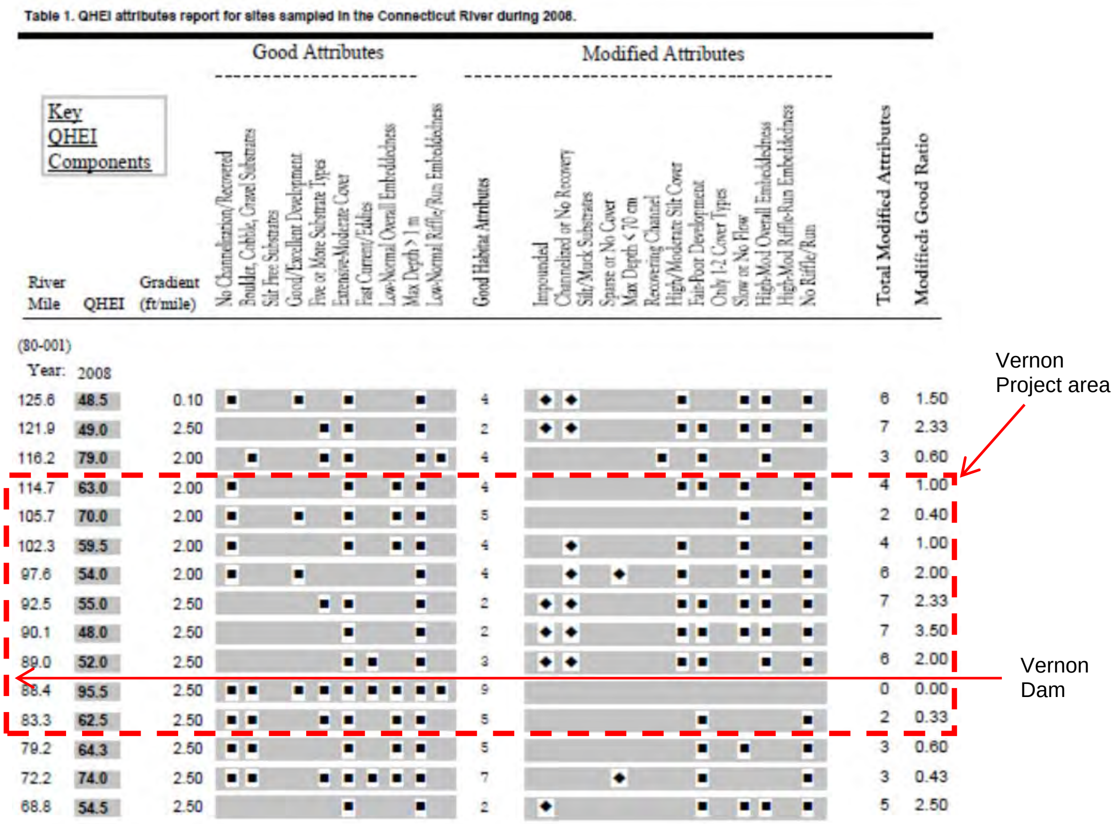

Table 1. QHEI attributes report for sites sampled in the Connecticut River during 2008.

Key QHEI Components

Good Attributes: No Channelization/Recovered; Boulder, Cobble, Gravel Substrates; Silt Free Substrates; Good/Excellent Development; Five or More Substrate Types; Extensive-Moderate Cover; Fast Current/Eddies; Low-Normal Overall Embeddedness; Max Depth > 1 m; Low-Normal Riffle/Run Embeddedness

Modified Attributes: Impounded; Channelized or No Recovery; Silt/Muck Substrates; Sparse or No Cover; Max Depth < 70 cm; Recovering Channel; High/Moderate Silt Cover; Fair-Poor Development; Only 1-2 Cover Types; Slow or No Flow; High-Mod Overall Embeddedness; High-Mod Riffle-Run Embeddedness; No Riffle/Run

(80-001) Year: 2008

River Mile	QHEI	Gradient (ft/mile)	No Channelization/Recovered	Boulder, Cobble, Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Five or More Substrate Types	Extensive-Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 1 m	Low-Normal Riffle/Run Embeddedness	Good Habitat Attributes	Impounded	Channelized or No Recovery	Silt/Muck Substrates	Sparse or No Cover	Max Depth < 70 cm	Recovering Channel	High/Moderate Silt Cover	Fair-Poor Development	Only 1-2 Cover Types	Slow or No Flow	High-Mod Overall Embeddedness	High-Mod Riffle-Run Embeddedness	No Riffle/Run	Total Modified Attributes	Modified: Good Ratio
125.6	48.5	0.10	■			■		■			■		4	◆	◆					■			■	■		■	6	1.50
121.9	49.0	2.50					■	■			■		2	◆	◆					■	■		■	■		■	7	2.33
116.2	79.0	2.00		■			■	■			■	■	4						■		■			■			3	0.60
114.7	63.0	2.00	■					■		■	■		4							■	■		■			■	4	1.00
105.7	70.0	2.00	■			■		■		■	■		5										■			■	2	0.40
102.3	59.5	2.00	■					■		■	■		4		◆					■			■			■	4	1.00
97.6	54.0	2.00	■			■					■		4		◆		◆			■			■	■		■	6	2.00
92.5	55.0	2.50					■	■			■		2	◆	◆					■	■		■	■		■	7	2.33
90.1	48.0	2.50						■			■		2	◆	◆					■	■		■	■		■	7	3.50
89.0	52.0	2.50						■	■		■		3	◆	◆					■	■			■		■	6	2.00
88.4	95.5	2.50	■	■		■	■	■	■	■	■	■	9														0	0.00
83.3	62.5	2.50	■	■			■	■		■	■		5								■					■	2	0.33
79.2	64.3	2.50	■	■				■		■	■		5								■		■			■	3	0.60
72.2	74.0	2.50	■	■			■	■	■	■	■		7				◆				■					■	3	0.43
68.8	54.5	2.50						■			■		2	◆							■		■	■		■	5	2.50

Figure 3.6-6. Qualitative Habitat Evaluation Index report for sites sampled in the Connecticut River during 2008 (Source: Yoder et al., 2009).

Essential Fish Habitat

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act, amended in 1996 (Public Law 94-265), habitats essential to federally managed commercial fish species are to be identified, and measures taken to conserve and enhance that habitat. Essential Fish Habitat was defined 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).

3.6.7 Mussels and Macroinvertebrates

The following resources and studies were reviewed to describe freshwater mussel and macroinvertebrate resources in the Vernon Project affected area:

- New Hampshire and Vermont Wildlife Action Plans, 2005
- FWS Northeast Region
- Ecological studies of the Connecticut River conducted for Vermont Yankee
- A freshwater mussel survey in the Connecticut River for the Vernon, Bellows Falls, and Wilder Hydroelectric Projects contracted by TransCanada
- Surveys and reports sponsored by Vermont Fish & Wildlife
- Surveys and reports sponsored by the New Hampshire Fish & Game
- EPA National Rivers and Streams Assessment http://water.epa.gov/type/rsl/monitoring/riverssurvey/index.cfm
- New Hampshire DES Biological Monitoring Program

Mussels

The Connecticut River watershed in New Hampshire and Vermont supports nine species of freshwater mussels, seven are found within the mainstem of the Connecticut River and near the mouth of mainstem tributaries, including the federally endangered dwarf wedgemussel. Six species of freshwater mussel have been identified in the Vernon Project affected area. A mussel survey of the Project affected area, with emphasis on dwarf wedgemussel, was commissioned by TransCanada and carried out in 2011 by Biodrawversity and LBG (draft 2012). The survey was developed in response to state and Federal wildlife agency staff's identification of this resource data gap during a pre-relicensing meeting.

Biodrawversity and LBG surveyed the tail water below the Vernon dam (less than 1 mile below the dam) and 22 sites in the Vernon impoundment for freshwater mussels, with a focus on dwarf wedgemussel. Mussels were found at every surveyed site. Four species were found in the tail water, they were: eastern elliptio (*Elliptio complanata*), eastern lampmussel (*Lampsilis radiata*), alewife floater (*Anodonta implicata*), and eastern floater (*Pyganodon cataracta*). Six species were found in the impoundment, they included the four species found in the tail water plus triangle floater (*Alasmidonta undulata*) and creeper (*Strophitus undulatus*). Eastern elliptio was the dominant species upstream (average abundance per site was between 101 and 200 mussels) and downstream of the Vernon dam (average abundance per site of about 150 mussels; Biodrawversity and LBG, draft 2012; figure 3.6-7). This species was found at every survey location and far outnumbered other species at all locations except near the dam where eastern lampmussel was nearly as abundant. Very few triangle floater and creeper were found in the Vernon impoundment though suitable habitat was present (Biodrawversity and LBG, draft 2012). No dwarf wedgemussels were found in the Vernon impoundment or tailwater (Nedeau, 2005; Biodrawversity and LBG, draft 2012).

These results were supported by previous studies; Nedeau (2005) reported finding eastern elliptio, eastern lampmussel, and alewife floater in Vernon impoundment and Ferguson (1999), who assessed dwarf wedgemussel distribution and habitat in large tributaries of the Connecticut River, found eastern floater near the mouth of the West River in an area called Retreat Meadows; he did not find dwarf wedgemussel. Numerous surveys targeted dwarf wedgemussel but did not find the species in the Project affected area (e.g., Ferguson, 1999; Nedeau, 2005)

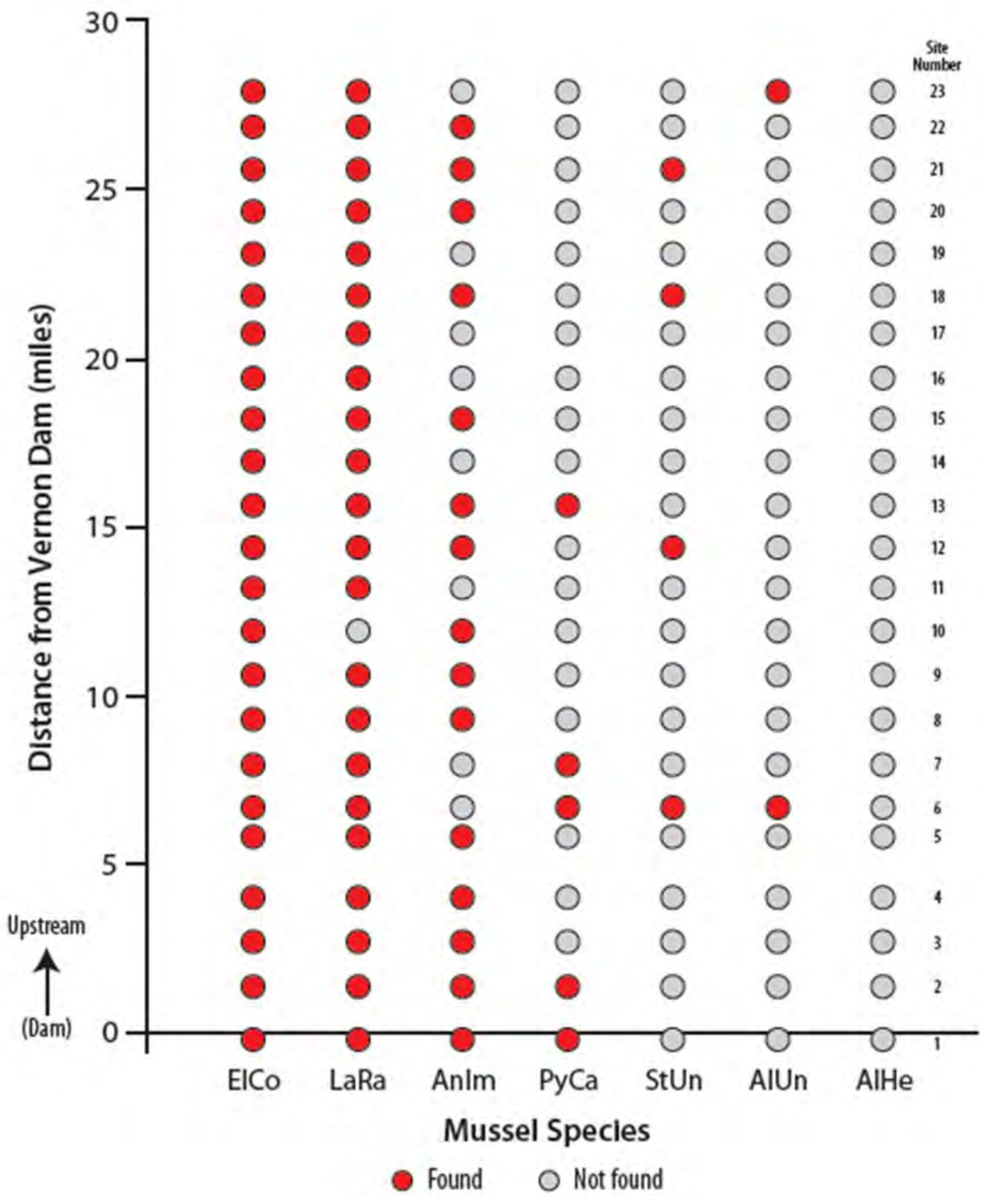

Figure 3.6-7. Survey sites where mussel species were found in the Project affected area. Abbreviations are: ElCo = eastern elliptio, LaRa = eastern lampmussel, AnIm = alewife floater, PyCa = eastern floater, StUn = creeper (Source: Biodrawversity and LBG, draft 2012).

In their WAP, Vermont Fish & Wildlife classify alewife floater as a species of greatest conservation need, with a rating of rare (S2). This species inhabits streams, rivers, and lakes; however, highest densities are found in coastal ponds with a direct unimpeded connection to rivers that support yearly runs of alewife. Its habitat use and population density seems to be more strongly tied to where its host fish are likely to spawn or congregate (Nedeau, 2008). Biodrawversity and LBG (draft 2012) found relatively small numbers of alewife floater in the impoundment (n=166, CPUE =8.44 mussels/hour) and tail water (n=75, CPUE = 18.75 mussels/hour).

Brook floater, an endangered species in New Hampshire and threatened in Vermont was reported in the West River (Fichtel and Smith, 1995) from the town of Dummerston upstream to Jamaica, Vermont. However, the West River in Dummerston is more than three miles from its confluence with the Connecticut River and outside of the Project affected area. The brook floater rarely occurs in lakes or reservoirs but may inhabit the upstream end of small impoundments created by run-of-river dams. Five of the six populations in the Connecticut River watershed are restricted to relatively undisturbed stream reaches in upper portions of large watersheds with relatively intact upland forests (Nedeau, 2008).

In support of an NPDES permit, ecological data have been collected in the Vernon impoundment near Vermont Yankee for 40 years. Beginning with a baseline study in 1994 and continuing annually from 1998 to present, collections were made to determine the presence or absence of the invasive zebra mussel (*Dreissena polymorpha*) and Asiatic clam (*Corbicula fluminea*). To date neither species has been collected.

Macroinvertebrates

In support of an NPDES permit, macroinvertebrate data have been collected for Vermont Yankee in the Project affected area. Data include a one year of study in the Vernon impoundment from near the dam to about 1.5 miles upstream, and a summary of over 21 years of study in the tailwater. Collections in the impoundment were made in 2002 using Hester-Dendy type multiplate artificial substrate samplers deployed in three transects crossing the river (3 stations) in the vicinity of Vermont Yankee, and one transect crossing the river (2 station) upstream of Vermont Yankee. Pairs of multiplate samplers were used at each station and deployed for a four- or five-week incubation period during each of three separate sampling events to represent the months of July, August, and October 2002. Multiplate samplers were deployed in redundant pairs to reduce the chances of data loss, a total of 22 samplers were used. The resident community of macroinvertebrates that settled onto the plates in each month is summarized in table 3.6-11.

Two stations were sampled downstream of Vernon dam for benthic macroinvertebrates, one station was located less than one mile below the dam and the other was about five miles below the dam. Because the downstream stations are outside the Project affected area, they are not included in this review. Over the 21 years of sampling, several changes were made to the monitoring program due to equipment loss, gear changes, sample processing changes, and Vermont Yankee's NPDES permit modifications. From 1991 through 2001, samples were collected by grab sampling (Ekman grab prior to 1996; Ponar grab 1996 to 2001) and “rock basket” colonization sampling. Beginning in 1991 and continuing until 2001, rock baskets were submerged for two exposure periods between June and October that ranged from 30 to 60 days. Beginning in 2002, rock basket samplers were deployed for 30 days (±7 days) during June, August, and October. Table 3.6-12 shows the composition of macroinvertebrates collected in the Vernon tail water from 1991 through 2011.

Table 3.6-11. Abundance of macroinvertebrates found on Hester-Dendy Multiplate samplers in the lower section of the Vernon impoundment in 2002. A "P" designation means the organism was found in the sample but not enumerated (Source: Normandeau, 2003).

Taxa		July	August	October
Platyhelminthes				
Turbellaria	Dugesia tigrina	26	0	2
Nematoda				
Nematoda	Nematoda	5		
Annelida				
Oligochaeta	Limnodrilus sp.	1		1
	Enchytraeidae			1
	Nais behningi	2		
	Nais communis	491	316	175
	Nais sp.	1		
	Pristinella sp.	5	5	
	Prostoma graescense	1	2	1
	Ripistes parasita	198	37	1
	Slavina appendiculata	3		1
	Stylaria lacustris	9	16	2
	Stylaria fossularis		1	18
	Stylaria sp.		2	
	Tubificidae w/capilliform chaetae		2	1
Mollusca				
Gastropoda	Amnicola limosa	8		
	Amnicola sp.	3	1	
	Physa sp.	12	14	1
	Planorbidae	5		
	Menetus dilatatus		5	1
Arachnida				
Acarina				
Hydrachnida	Hydrachnida	2		2
Crustacea				
Brachiopoda	Cladocera	0	P	P
Amphipoda	Hyalella azteca		2	5
Insecta				

Taxa		July	August	October
Ephemeroptera	Baetidae	5		2
	Baetis sp.	6	4	2
	Caenis sp.	4	22	1
	Heptageniidae	1	5	
	Heptagenia sp.		1	
	Isonychia sp.	5		
	Stenacron sp.	38	2	
	Stenonema sp.	762	246	2
	Tricorythodes sp.	3	12	
Odonata	Enallagma sp.	2	1	
	Neurocordulia sp.	2		
Plecoptera	Acroneuria sp.	1		62
	Paraleuctra sp.			4
	Taeniopteryx sp.			12
Coleoptera	Dineutus sp.	7	1	
	Stenelmis sp.	2	1	
	Ancyronyx sp.		1	
Trichoptera	Agraylea sp.			4
	Ceraclea sp.	3		
	Cheumatopsyche sp.	118	24	5
	Hydropsyche sp.	4	1	
	Hydroptila sp.			3
	Macrostemum carolina	3	1	
	Nectopsyche sp.		2	
	Neureclipsis sp.	47	11	1
	Oecetis sp.	9	28	
	Orthotrichia sp.	32	8	
	Oxyethira sp.	1	1	1
	Polycentropus sp.			1
Diptera	Ablabesmyia sp.	42	57	17
	Bezzia sp.			2
	Brillia sp.	1		1
	Cardiocladius sp.		14	
	Chironomus sp.		5	
	Clinocera	1	1	
	Corynoneura sp.	4	15	332
	Cricotopus sp.	21	6	
	Cryptochironomus sp.	12	1	
	Dicrotendipes sp.	548	626	
	Endochironomus sp.		3	
	Eukiefferiella sp.	23	450	
	Glyptotendipes sp.	5	27	
	Microspectra sp.		1	
	Microtendipes sp.	2		
	Nanocladius sp.	2		

Taxa		July	August	October
	Orthocladiinae		4	
	Orthocladius sp.	24	8	
	Polypedilum sp.	27	93	
	Parachironomus sp.		1	
	Pseudochironomus sp.	1		
	Rheotanytarsus sp.	697	107	
	Stictochironomus sp.	6		
	Tanytarsini	5	1	
	Tanytarsus sp.	24	100	
	Tanytarsini		1	
	Tvetenia sp.	1	1	
	Xenochironomus sp.	2		
Porifera	Porifera	0		
Rotifera	Rotifera	0		
Hydroidea	Hydra sp.	6		
Bryozoa	Bryozoa		P	
Total		3281	2297	664

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Table 3.6-12. Composition of macroinvertebrates collected in the Connecticut River less than one mile downstream of Vernon dam (Source: Normandeau, 2011a)

Taxon	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Turbellaria	36	37.1	96	11.1	0	0	8	1.2	2	0.5	0	0	0	0	0	0	0	0	0	0
Oligochaeta	0	0	16	1.9	0	0	0	0	3	0.7	356	35.5	2	0.9	4	1.7	0	0	0	0
Gastropoda	7	7.2	18	2.1	45	12.1	74	10.9	3	0.7	6	0.6	10	4.5	4	1.7	4	4.5	6	5.8
Pelecypoda	0	0	0	0	0	0	4	0.6	0	0	0	0	0	0	2	0.8	0	0	0	0
Crustacea	1	1	94	10.9	41	11	30	4.4	19	4.4	136	13.6	0	0	6	2.5	24	27.3	84	80.8
Ephemeroptera	9	9.3	59	6.8	69	18.5	25	3.7	59	13.6	18	1.8	0	0	20	8.5	24	27.3	10	9.6
Trichoptera	8	8.2	76	8.8	63	16.9	98	14.4	39	9	272	27.1	4	1.8	118	50	2	2.3	0	0
Diptera	25	25.8	91	10.6	65	17.4	271	39.9	161	37.2	160	16	10	4.5	68	28.8	16	18.2	4	3.8
Other	11	11.3	412	47.8	90	24.1	170	25	147	33.9	54	5.4	194	88.2	14	5.9	18	20.5	0	0
Total	**97**	**100**	**862**	**100**	**373**	**100**	**680**	**100**	**433**	**100**	**1002**	**100**	**220**	**100**	**236**	**100**	**88**	**100**	**104**	**100**

	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Turbellaria	984	10.7	86	2.5	4	1.1	41	3.9	9	2.7	0	0	3	0.3	10	5.8	5	0.8	21	3.5	0	0
Oligochaeta	19	0.2	2	0.1	8	2.3	43	4.1	2	0.6	30	11.1	27	2.5	1	0.6	3	0.5	2	0.3	0	0
Gastropoda	72	0.8	13	0.4	2	0.6	18	1.7	12	3.7	25	9.3	38	3.5	4	2.3	16	2.4	8	1.3	1	0.6
Pelecypoda	6	0.1	0	0	3	0.9	1	0.1	1	0.3	1	0.4	3	0.3	0	0	3	0.5	4	0.7	2	1.3
Crustacea	47	0.5	11	0.3	61	17.5	11	1.1	7	2.1	12	4.4	20	1.8	21	12.3	25	3.8	17	2.8	11	7
Ephemeroptera	401	4.4	452	13.2	40	11.5	187	18	148	45.1	102	37.8	418	38.6	57	33.3	271	41.4	276	45.5	98	62
Trichoptera	7114	77.5	1722	50.4	155	44.5	232	22.3	10	3	65	24.1	67	6.2	42	24.6	200	30.5	197	32.5	28	17.7
Diptera	484	5.3	1050	30.7	72	20.7	473	45.5	117	35.7	19	7	468	43.2	23	13.5	72	11	45	7.4	9	5.7
Other	54	0.6	81	2.4	3	0.9	34	3.3	22	6.7	16	5.9	39	3.6	13	7.6	60	9.2	36	5.9	9	5.7
Total	**9181**	**100**	**3417**	**100**	**348**	**100**	**1040**	**100**	**328**	**100**	**270**	**100**	**1083**	**100**	**171**	**100**	**655**	**100**	**606**	**100**	**158**	**100**

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Data collected for the National Rivers and Streams Assessment (NRSA), conducted by EPA, included sampling stations in the Project vicinity. The NRSA is a study of the conditions of the Nation's flowing waters and will combine a first-ever assessment of the nation's rivers with the second national survey of small wadeable streams (EPA 2012). Field sampling to collect baseline data was conducted in 2008 and 2009 and a final report is scheduled to be released by EPA at the end of 2012. Benthic macroinvertebrate data and analytical metric results are unavailable at this time; however a summary of overall abundance data is provided in table 3.6-13. NRSA sampling was conducted at two stations within the Vernon Project, one station 6 miles upstream of the dam, and on two separate occasions at one station 23 miles upstream of the dam (D. Neils, New Hampshire DES Biological Monitoring Program Manager, personal communication).

Data summarized for these collections includes taxa richness (number of taxa), total abundance of macroinvertebrates, EPT richness (total number of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) orders in the sample), and the percent of the sample composed of the most abundant taxon. In their final report EPA will use these metrics and a host of other biological data to develop an index to rate the condition of sampled rivers and streams as good, fair, or poor for key indicators of ecological and human health. While the data in table 3.6-13 alone cannot be used to rate the condition of the sampled sites, a general description can be formulated.

The Vernon benthic data are representative of benthic communities found in large rivers. The low numbers, and in some samples, lack, of EPT taxa at the two sample sites is not unexpected. EPT taxa prefer riffle habitat with moderate flow and cobble and gravel substrate, a habitat type not typically found in the Vernon impoundment. At the Walpole site, metric values were more optimal later in the collection season. It is unlikely that the earlier lower metric values were the result of suboptimal habitat conditions considering the subsequent collection values indicated good conditions.

Table 3.6-13. Summary metrics from benthic samples in the Project affected area collected by EPA for the National Rivers and Streams Assessment.

Station ID	Town	Sample Date	Sample Type	Metric	Value
FW08NH016	Hinsdale	9/3/2008	PRIMARY	taxa richness	45
				total abundance	580
				EPT richness	0
				% dominant taxon	26
FW08NH007	Walpole	9/4/2008	PRIMARY	taxa richness	17
				total abundance	74
				EPT richness	0

Station ID	Town	Sample Date	Sample Type	Metric	Value
				% dominant taxon	45
FW08NH007	Walpole	9/24/2008	PRIMARY	taxa richness	83
				total abundance	522
				EPT richness	24
				% dominant taxon	15
FW08NH007	Walpole	9/24/2008	DUPLICATE	taxa richness	70
				total abundance	551
				EPT richness	16
				% dominant taxon	14

In 1992 Vermont DEC collected macroinvertebrate data along the west back of the Connecticut River using kick nets. One station was located 0.2 miles downstream of the Vernon dam (Steve Fiske, Aquatic Biologist Vermont DEC Biomonitoring Section, personal communication). Data calculated from the sample collection included density or abundance of macroinvertebrates, taxa richness, EPT richness, PMA-O and EPT/EPT + Chironomidae abundance (table 3.6-14). PMA-O is a measure of order-level similarity to a model based on reference stream conditions; values of 35 to 49 percent indicate moderately impaired conditions and values greater than or equal to 65 percent indicate non-impaired conditions (Novak and Bode, 1992). The EPT/EPT + Chironomidae Abundance metric is the ratio of the abundance of pollution intolerant EPT orders to the pollution tolerant Diptera family Chironomidae; higher values indicate less impaired conditions. These data indicate that in 1992 the tail water of the Vernon project was considered moderately impaired by the PMA-O metric and non-impaired by the EPT/EPT + Chironomidae Abundance metric.

Table 3.6-14. Data calculated from benthic samples collected in the Project affected area in 1992 by Vermont DEC (Source: Steve Fiske, Aquatic Biologist Vermont DEC Biomonitoring Section, personal communication).

VTDEC Site ID	Location	Density	Taxa Richness	EPT Richness	PMA-O	EPT / EPT + Chironomidae Abundance
CT-1300001412	0.2 mi below Vernon Dam	980.0	17.0	9.0	40.6	0.96

New Hampshire DES provided macroinvertebrate data collected in wadeable tributaries of the Connecticut River from 1997 to 2010 (D. Neils, New Hampshire DES Biological Monitoring Program Manager, personal communication). Samples were collected using artificial substrate (AS) such as rock baskets, and kick nets. Three kick net sample techniques were used: a kick net (K) was three to five 1-minute kicks in riffles only, composited into a single sample; multi-habitat (MH) was a 30 second kick in each habitat type proportional to the amount of each respective habitat type available; Environmental Monitoring and Assessment Program (EMAP)[4] kick nets were collected from 11 equidistant transects within a study reach 40 times the channel width. For the EMAP, the placement of the kicks moved in a standardized fashion from river left to river center to river right, then back to river center to river left, etc., until each of the transects had been sampled. Effort/kick was about 1 minute or enough time to adequately sample a square with sides equal to the net's opening width.

The data set provided by New Hampshire DES was culled to include data that were collected: (1) after 2001 (i.e., data less than 10 years old) because benthic macroinvertebrate communities can be affected by changes in habitat and water quality, even over a short time; and (2) within one river-mile of the tributaries confluence with the Connecticut River, representing an upstream extent of the area potentially affected by the Vernon project.

Using baseline data from over 150 sample locations throughout the state, New Hampshire DES developed a multimetric Benthic Index of Biological Integrity (B-IBI) to rate the overall ecological integrity of the biological community. Two samples were collected at the Ash Swamp Brook station during summer 2002, using two sampling techniques (table 3.6-15). The B-IBI values indicated an impaired aquatic community condition (D. Neils, New Hampshire DES Biological Monitoring Program Manager, personal communication).

Table 3.6-15. New Hampshire DES collection data for benthic samples collected in a tributary of the Project affected area (Source: D. Neils, New Hampshire DES Biological Monitoring Program Manager, personal communication).

Station ID	Waterbody	Approximate RM From CT River	Collection Date	Sample Type[a]	B-IBI	Condition
NH HEX 57.03	Ash Swamp Brook	0.5 mi	18-Jul-02	MH	43.04	Impaired
NH HEX 57.03	Ash Swamp Brook	0.5	19-Sep-02	AS	41.18	Impaired

[a] Sample Type: MH= multi-habitat kick net, AS= artificial substrate.

[4] EMAP is a research program run by EPA’s Office of Research and Development to develop the tools necessary to monitor and assess the status and trends of national ecological resources.

3.6.8 Project Effects

Project effects can occur as a result of river fragmentation, impoundment, and hydroelectric operations. River fragmentation can reduce or obstruct fish and aquatic community connectivity and therefore genetic diversity and stock structure. However, those impacts are reduced by the provision of fish passage and the length of the impoundment. Upstream and downstream fish passages are used by both migratory and resident species, providing connectivity. Iterative development of downstream fish passage facilities have resulted in relatively high guidance effectiveness for Atlantic salmon smolts, and high survival rates have been determined for smolts passed downstream through the Project's turbines. Additionally, the length of the impoundment provides diverse habitats reducing the fragmentation effect, and in general, the Project area is characterized by a rich and diverse fish community both upstream and downstream of the dam.

The Project impoundment results in a more lentic environment characterized by reduced current speed and complexity, and increased sedimentation and therefore reduced substrate complexity/increased substrate embeddedness. The modest increase in water surface area associated with tributary confluences and setbacks created by railroads and culverts can result in warmer water temperatures and consequently lower DO concentrations in those areas. In addition to the broad range of fish species present in main channel habitat, fish and aquatic species communities or life stages that favor more lentic conditions are also likely to reside in these setback areas. Those areas yield healthy fisheries for a variety of species including panfish, largemouth bass, northern pike, pickerel, perch, and black crappie.

Daily Project operations and high water events could alter downstream habitat and impact species assemblages, feeding, spawning and recruitment, and migration patterns of fish. A diverse fish community exists downstream of the Project and a notable walleye and smallmouth bass fishery exists there, suggesting that the effects are limited. Upstream fish passage effectiveness (relative to numbers passed upstream at Turners Falls) has generally been high for both American shad and Atlantic salmon.

Seven species of freshwater mussel are found within the mainstem of the Connecticut River and near the mouth of mainstem tributaries. Six of those have been identified in the Project affected area, and only the endangered dwarf wedgemussel was not present. Threats to mussel species and macroinvertebrates include stranding from water level fluctuations, sedimentation and erosion.

Because no changes are proposed to Project operations, no new effects on aquatic resources are anticipated.

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3.7 WILDLIFE AND BOTANICAL RESOURCES

This section reviews existing information for the wildlife and botanical resources occurring within the vicinity of the Vernon Project. For these resources, the subject area is referred to as the terrestrial project area and is defined as including lands with flowage easements retained by TransCanada and any land owned in fee by TransCanada, plus a 250-foot buffer around the resulting Project boundary (figure 3.7-1). This terrestrial project area extends from the top of the impoundment to approximately 0.5 mile below the dam.

3.7.1 Summary of Existing Studies

The primary literature sources used to complete the Wildlife and Botanical Resources section include:

- USGS land cover maps (Homer et al., 2007);
- the Wildlife Action Plans (WAPs) for New Hampshire and Vermont (New Hampshire Fish & Game, 2005 and Kart et al., 2005);
- Vermont Ecological Hotspots layer (Vermont Biologic Diversity Project, 1999);
- New HampshireWAP Tier Rankings (New Hampshire Fish & Game, 2008);
- Conservation Land maps from state-sponsored GIS data bases for both New Hampshire (UNH-CSRC, 2012) and Vermont (UNH-CSRC, 2012; UVM-SAL, 2009);
- Sperduto and Kimball's *The Nature of New Hampshire* (2011); and.
- Thompson and Sorenson's *Wetland, woodland, wildland: A guide to natural communities of Vermont* (2000).

The USGS land cover layers have the benefit of using the same cover typing system in both states. This land use mapping system appears more focused on distinguishing agricultural and developed cover types. Therefore it combines all forested habitat into a single cover type, but identifies grassland and agricultural uses (pasture land and cropland), and several categories of urban/developed areas (figure 3.7-2). The New Hampshire WAP includes a map component, which allowed habitat types along the Connecticut River on the New Hampshire side to be evaluated. The Vermont WAP provides habitat descriptions but does not provide mapping, therefore cover types could only be inferred from the USGS maps. Because USGS provides only a single cover type for Forest, the Vermont WAP forested habitats could not be distinguished.

The total acreage of the Vernon terrestrial project area (Project boundary plus 250-foot buffer) is approximately 1,718 acres, excluding the open water of the river. The acreages of the various cover types within the terrestrial project area using USGS maps, and their relationship to the New Hampshire and Vermont WAPs is provided in table 3.7-1. The general agreement was quite reasonable among the cover type boundaries within the three land use systems, although some discrepancies were observed. One that is significant to this Project are the railroad beds (several of which travel long stretches within the Project), utility rights of way and major roads, many of which are classified by USGS as “developed open space” with an approximately 200-foot wide buffer on either side. Many of these areas include lands that are mapped as various forest or grassland cover types in the New Hampshire and Vermont WAPs.

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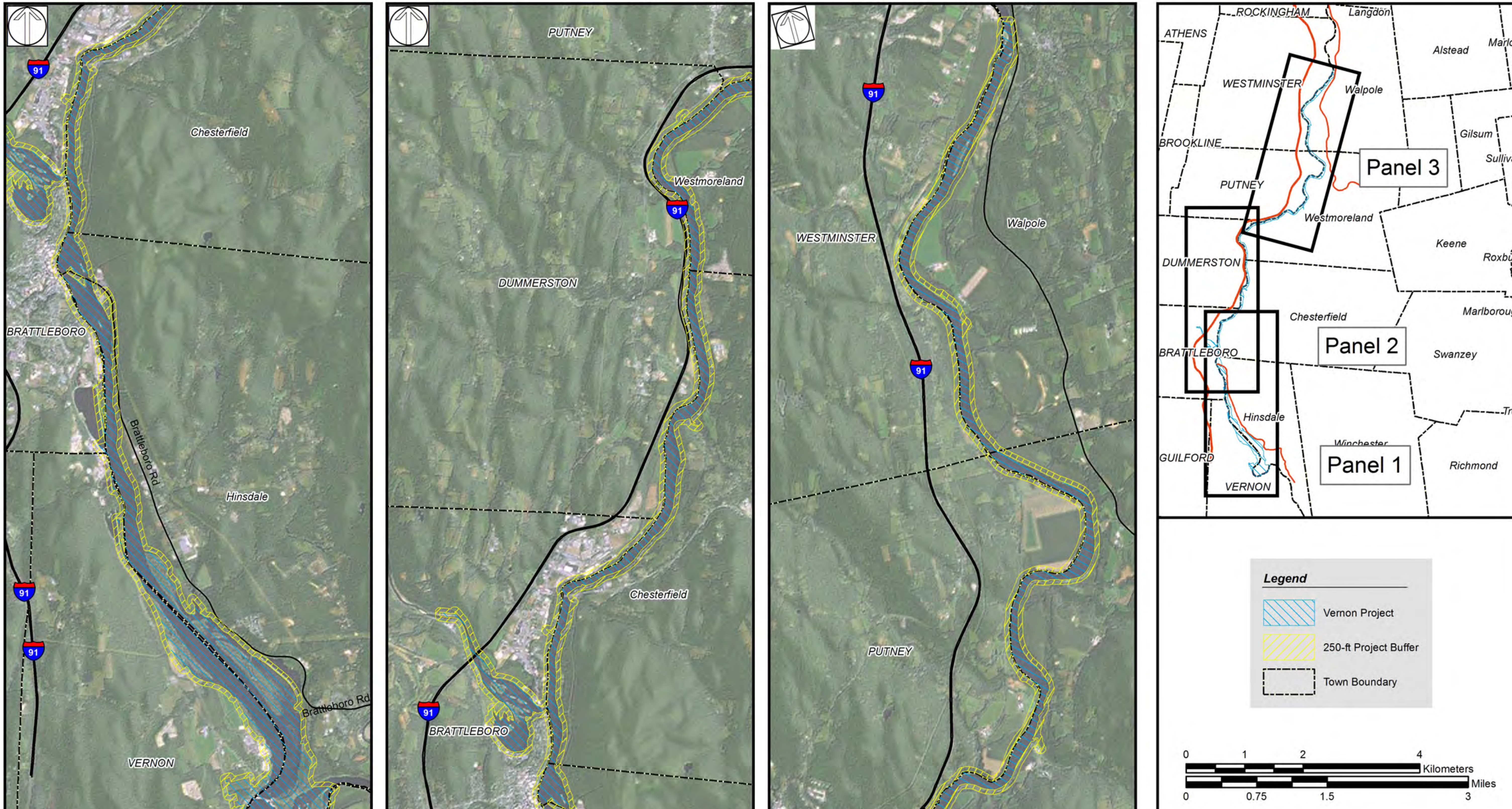

Figure 3.7-1. Terrestrial project area.

TransCanada Hydro Northeast Inc.
Boundaries
Vernon Project (NO.1904)

Prepared by Normandeau Team (09-10-12)

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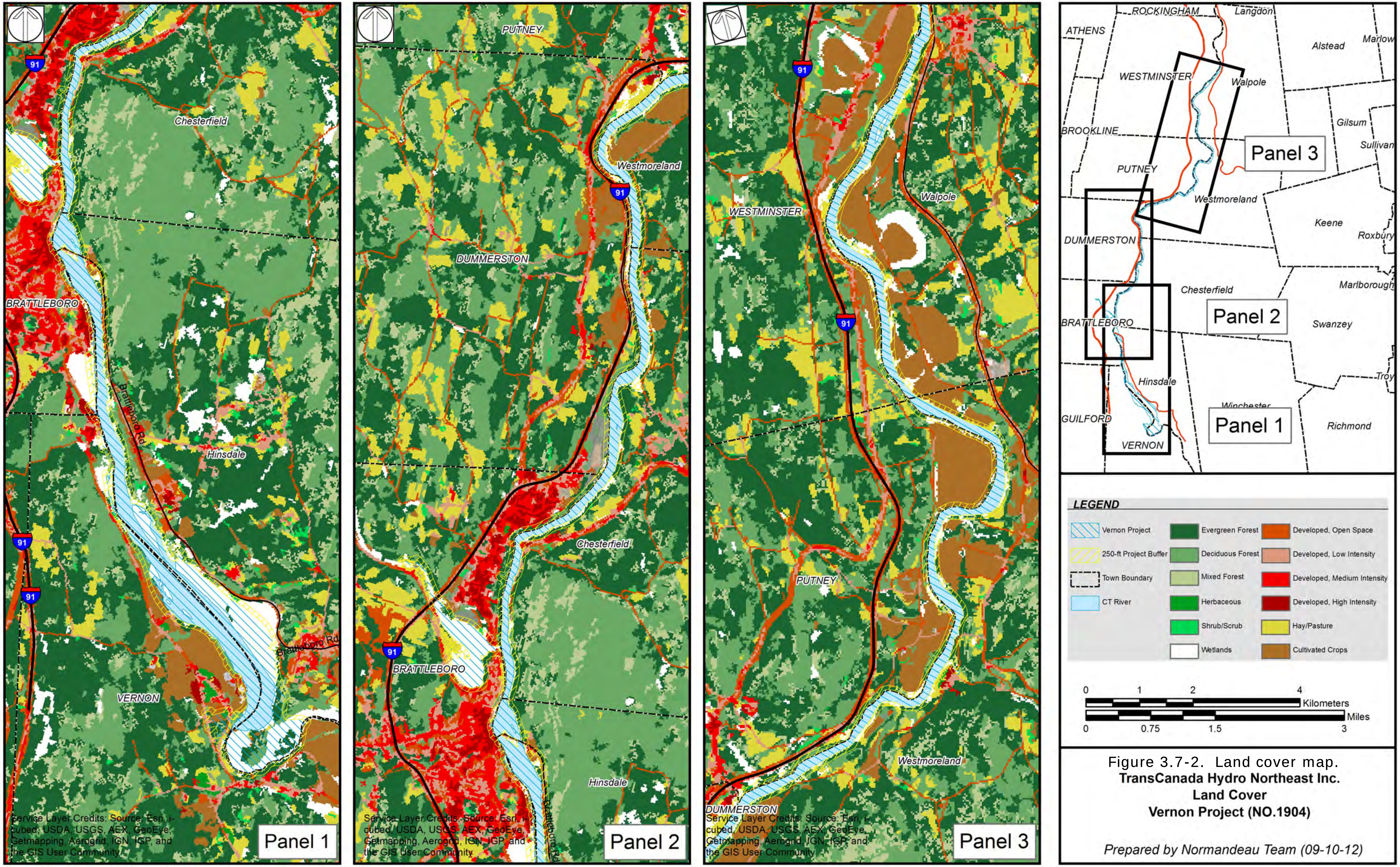

Figure 3.7-2. Land cover map.
TransCanada Hydro Northeast Inc.
Land Cover
Vernon Project (NO.1904)

Prepared by Normandeau Team (09-10-12)

Document Path: J:\Projects\TransCanada_PAD\MXD\Final\9-6-12\TC_PAD_VernonDam_LandCover_AWT_090612_Final.mxd

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The land area associated with the various cover types using USGS maps, and their relationship to the New Hampshire and Vermont WAPs is provided in table 3.7-1. The general agreement was quite reasonable among the cover type boundaries within the three land use systems, although some discrepancies were observed. One that is significant to this Project are the railroad beds (several of which travel long stretches within the Project boundary), utility rights of way and major roads, many of which are classified by USGS as "developed open space" with an approximately 200-foot wide buffer on either side. Many of these areas include lands that are mapped as various forest or grassland cover types in the New Hampshire and Vermont WAPs.

For information about habitat quality, we consulted the Vermont Ecological Hotspots layer (Vermont Biologic Diversity Project, 1999), the New Hampshire WAP Tier Rankings (New Hampshire Fish & Game, 2008), and the Conservation Land maps for both New Hampshire (UNH-CSRC, 2012) and Vermont (UNH-CSRC, 2012; UVM-SAL, 2009).

Table 3.7-1. Comparison of habitat and land cover layers among the USGS, New Hampshire, and Vermont land cover maps for the Vernon terrestrial project area.

<table>
<tr><th>USGS Land Cover</th><th>NH WAP</th><th>VT WAP</th><th>Acres</th></tr>
<tr><td rowspan="3">Forest (Mixed, Coniferous or Deciduous)</td><td>Appalachian Oak Pine Forest</td><td>Oak-Pine-Northern Hardwood Forest</td><td rowspan="3">956</td></tr>
<tr><td>Hemlock Hardwood Pine Forest[a]</td><td>Hemlock-Northern Hardwood Forest</td></tr>
<tr><td>Floodplain Forest</td><td>Floodplain Forest</td></tr>
<tr><td>Hay/Pasture</td><td rowspan="3">Grassland[a]</td><td rowspan="3">Grassland and Hedgerow</td><td>138</td></tr>
<tr><td>Cultivated Crops</td><td>294</td></tr>
<tr><td>Grassland/Herbaceous</td><td>4</td></tr>
<tr><td>Developed, High Intensity</td><td rowspan="3">not mapped</td><td rowspan="3">not mapped</td><td>99</td></tr>
<tr><td>Developed, Medium Intensity</td><td>112</td></tr>
<tr><td>Developed, Low Intensity</td><td>53</td></tr>
<tr><td>Developed, Open Space</td><td></td><td></td><td>23</td></tr>
<tr><td>Other</td><td></td><td></td><td>39</td></tr>
<tr><td></td><td colspan="2">Total Terrestrial Project Area</td><td>1,718</td></tr>
</table>

[a] New Hampshire WAP layers extending into Vermont

3.7.2 Wildlife Habitats

Existing Upland Community Types

The terrestrial project area for the Project plus a 250-foot buffer is approximately 1,718 acres. The terrestrial project area supports a variety of habitat types and a diversity of land uses (figure 3.7-2). Forested upland areas surrounding the Connecticut River at the Vernon Project are generally a mix of Hemlock Hardwood Pine and Appalachian Oak Pine (New Hampshire Fish & Game, 2005) and support numerous plant and wildlife species. In addition, hay and pasture lands create grassland habitats, particularly toward the northern end of the project area. Adjacent to and sometimes within the project area, several floodplain forests border the Connecticut River. Urban/suburban development, including roads and railroads, form a significant component of the landscape and affect wildlife utilization of the project area. Throughout the project area, various types of disturbance and habitat edges create early successional habitats.

Forest. In the USGS land cover maps, the forest cover type includes all forested habitats on both the New Hampshire and Vermont sides of the Connecticut River. Forest covers 956 acres or 56% of the terrestrial project area. The following sections describe the dominant cover types identified in the New Hampshire and Vermont WAPs.

*Hemlock Hardwood Pine***.** Hemlock Hardwood Pine communities are transitional forests found at elevations less than 1,500 feet (New Hampshire Fish & Game, 2005). They lack many boreal species and central hardwood species but are dominated by hemlock (*Tsuga canadensis)* and white pine (*Pinus strobus*) along with American beech (*Fagus grandifolia*) and oak (*Quercus*) species. Common shrub species include low and highbush blueberries (*Vaccinium* species), witch hazel (*Hammamelis virginiana*) and beaked hazelnut (*Corylus cornuta*). Typical herbs of this community include starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), and Canada mayflower (*Maianthemum canadense*) (New Hampshire Fish & Game, 2005; Sperduto and Kimball, 2011).

The wildlife of a Hemlock Hardwood Pine forest uses the abundant botanical resources for food and cover (table 3.7-2). Moose (*Alces alces*) and white-tailed deer (*Odocoileus virginianus*) use understory trees for browse (Sperduto and Kimball, 2011; Thompson and Sorenson, 2000). Black bear (*Ursus americanus*) feed on beech nuts, acorns, blueberries, and dogwood (*Cornus spp*.) fruit. Vernal pools created in forested depressions provide breeding habitat for wood frogs (*Lithobates sylvatica*), spotted salamanders (*Ambystoma maculatum*), and a host of invertebrate species. Songbirds such as vireo (*Vireo spp*), ovenbird (*Seiurus aurocapillus*), and downy woodpecker (*Picoides pubescens*) breed in Hemlock Hardwood Pine forests (Sperduto and Kimball, 2011).

Appalachian Oak Pine. Appalachian Oak Pine forests are associated with low elevations (<900 feet) and are most common in southern New Hampshire and southern Vermont in comparatively warmer, drier habitats (New Hampshire Fish & Game, 2005; Kart et al., 2005). Distinguishing tree species typically include black oak (*Quercus velutina),* white oak (*Quercus alba),* hickories *(Carya spp),* and pitch pine (*Pinus rigida*). Common shrub species are mountain laurel (*Kalmia latifolia)*, and dogwood. Typical herbaceous species are tick-trefoils (*Desmodium spp.)*, sweet goldenrod (*Solidago spp.)*, false foxgloves (*Agalinis spp.)* and wild indigo (*Baptisia australis*; Sperduto and Kimball, 2011).

Appalachian Oak-Pine forests host a wide array of plant species, which in turn supports a diversity of wildlife. Mast consists primarily of crops of acorns and pine cones, creating an abundance of food. The leftover seeds germinate into young trees for browsers such as white-tailed deer and moose. When early successional breeding habitat is associated with Appalachian Oak-Pine forests, American woodcock (*Scolopax minor*) roost in trees on the forest edge (Sperduto and Kimball, 2011; Thompson and Sorenson, 2000; DeGraaf and Yamasaki, 2001). Common birds in this forest type include tufted titmouse (*Baeolophus bicolor*), white-breasted nuthatch (*Sitta carolinensis*), hermit thrush (*Catharus guttatus*), and dark-eyed junco (*Junco hyemalis*; DeGraaf and Yamasaki, 2001). The sandy, well-drained soils provide nesting habitat for Eastern painted turtles (*Chrysemys picta*) and snapping turtles (*Chelydra serpentina*) when appropriate wetland habitat is nearby.

*Floodplain Forest**.*** This community type is included in the Forest cover type under the USGS system, but is a separate cover type in both the New Hampshire WAP and the Vermont WAP. Floodplain forests occur in the lowlands bordering the Connecticut River with a primary canopy cover of silver maple, green ash or red maple. The estimated extent of this important riparian community type on the New Hampshire side of the terrestrial project area is 109 acres, based on mapped NH WAP data. Comparable data for Vermont is not available. A detailed account of this habitat type can be found in section 3.8.2, *Wetlands, Riparian, Littoral, and Floodplain Habitat*.

Grassland and Agricultural Lands. The USGS land cover map layers show 294 acres of cultivated crops, 138 acres of hay/pastureland, and four acres of grassland/herbaceous comprising 25% of the terrestrial project area (figure 3.7-2). These categories are all combined as Grassland in the New Hampshire WAP, and a single cover type of Grassland and Hedgerow in the Vermont WAP. Grasslands under the state definitions are areas consisting primarily of grasses, sedges and other herbaceous plants with little tree or shrub cover (New Hampshire Fish & Game, 2005; Kart et al., 2005).

Grassland/herbaceous and pasture/hay provide valuable early successional habitat for wildlife. Wildlife commonly found in grassland/herbaceous and pasture/hay habitats include eastern cottontail (*Sylvilagus floridanus)*, common garter snake (*Thamnophis sirtalis)*, meadow vole (*Microtus pennsylvanicus)*, pickerel frog (*Rana palustris*), bobolink (*Dolichonyx oryzivorus)*, killdeer (*Charadrius vociferous)*, and American goldfinch (*Carduelis tristis)*. When grassland is adjacent to wetland, it can provide nesting habitat for common snapping turtles (*Chelydra serpentine)* and painted turtles (*Chrysemys picta)*. Grassland is declining in the northeast as previously farmed lands succeed to forest habitat and fire is suppressed (Kart et al., 2005).

Existing Upland Significant Habitats

Bald Eagle Breeding / Wintering. Bald eagles breed and overwinter in the vicinity of the Vernon Project. They are federally protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c) and are state-listed as Threatened in New Hampshire and Endangered in Vermont. For a full species account, see section 3.9.4.

Migratory Songbird Stopovers. The Connecticut River serves as a migratory pathway for birds. As a north-south running feature, it serves as an important orientation tool for bird species during migration. Between 1996-1998, during six days of surveying, an average of 3,782 migratory birds were observed annually near the White River confluence with the Connecticut River just below Wilder dam (Litwin and Lloyd-Evans, 2006). The number of birds observed per survey was strongly correlated with proximity to the river, and even stronger at lower Connecticut River survey sites in Massachusetts (Litwin and Lloyd-Evans, 2006).

Locations within the terrestrial project area providing stopover habitat should be considered ecologically important habitat. One example is the Wantastiquet Mountain Natural Area in Chesterfield, New Hampshire, which has diverse acidic talus/rocky summit forests and provides stopover habitat for warblers during spring migration (Visit New Hampshire, 2012).

Unique Botanical Resources. The Connecticut River and its floodplains support a number of unique botanical habitats and resources. The banks of the river make fertile agricultural land and grassland habitat (Kart et al., 2005), but the conversion to agriculture comes at the cost of floodplain forest habitat. Although no ecologically significant floodplain forests have been identified in the Vernon terrestrial project area (Marks et al., 2011), the New Hampshire WAP shows many small floodplain forest habitats within the terrestrial project area, particularly in the towns of Westmoreland, Walpole, and the southern part of Hinsdale. Floodplain forests are discussed in more detail in Section 3.8.2 - Wetlands, Riparian, Littoral and Floodplain Habitat.

Large numbers of rare plant species are concentrated along the Connecticut River banks and floodplains. Consultation with the Natural Heritage Bureaus of New Hampshire and VT has resulted in the identification of 39 species within the north-south Project boundaries within 1,000 feet of the river edge (Section 3.9 - Rare, Threatened and Endangered Plants and Animals).No federally listed terrestrial plant or animal species occur in the Vernon terrestrial project area.

3.7.3 Plant and Animal Species

Animal Species. Table 3.7-2 lists examples of wildlife species that are likely to utilize habitats in the Vernon terrestrial project area.

Table 3.7-2. Representative wildlife species likely to occur in the Project vicinity (Source: DeGraaf and Yamasaki, 2001).

Common Name	*Basic Habitat Type*
Birds	
Alder Flycatcher	Wetland
American Crow	Generalist
American Goldfinch	Grassland
American Robin	Generalist
American Woodcock	Grassland/Shrubland/Wetland
Baltimore Oriole	Grassland/Forest Edge
Bank Swallow	Riparian/Grassland
Barn Swallow	Grassland
Barred Owl	Forested
Belted Kingfisher	Riparian
Black-Capped Chickadee	Forested/Developed
Black-Throated Green Warbler	Forested
American Black Duck	Riparian/Open Water
Blue Jay	Generalist
Bobolink	Grassland
Broad-Winged Hawk	Forested
Brown-Headed Cowbird	Grassland/Forest Edge
Cedar Waxwing	Generalist
Common Yellowthroat	Shrubland/Wetland
Dark-Eyed Junco	Forested
Downy Woodpecker	Forested
Eastern Phoebe	Forested/Developed
Golden-Crowned Kinglet	Forested
Gray Catbird	Shrubland/Forest Edge
Great Blue Heron	Wetland/Riparian
Great-Crested Flycatcher	Forested/Forest Edge
Green Heron	Wetland
Hermit Thrush	Forested
Killdeer	Grassland
Mourning Dove	Generalist
Northern Cardinal	Generalist
Ovenbird	Forested
White-Breasted Nuthatch	Forested
Red-Eyed Vireo	Forested
Red-Tailed Hawk	Forested/Grassland
Red-Winged Blackbird	Wetland/Riparian
Rock Dove (Pigeon)	Developed
Rose-Breasted Grosbeak	Forested
Ruffed Grouse	Forested
Star-Nosed Mole	Forested/Wetland
Song Sparrow	Shrubland/Wetland
Swamp Sparrow	Wetland
Tufted Titmouse	Forested/Developed
White-Throated Sparrow	Forested

Common Name	*Basic Habitat Type*
Wild Turkey	Forested/Grassland
Wood Duck	Forested/Wetland
Yellow-Rumped Warbler	Forested
Reptiles / Amphibians	
American Toad	Generalist
Bullfrog	Wetland
Common Snapping Turtle	Wetland/Open Water
Common Garter Snake	Grassland
Gray Tree Frog	Wetland/Forested
Green Frog	Wetland
Northern Red-Backed Salamander	Forested
Painted Turtle	Wetland/Open Water
Pickerel Frog	Wetland/Open Water
Red-Spotted Newt	Wetland/Forested
Ribbon Snake	Wetland
Spotted Salamander	Wetland/Forested
Spring Peeper	Wetland/Forested
Wood Frog	Wetland/Forested
Mammals	
Beaver	Forested/Wetland
Black Bear	Forested
Coyote	Generalist
Deer Mouse	Forested/Forest Edge
Eastern Chipmunk	Generalist
Eastern Cottontail	Grassland
Gray Squirrel	Generalist
Meadow Vole	Grassland
Mink	Riparian
Moose	Forested
Muskrat	Wetland
Northern Short-Tailed Shrew	Generalist
Raccoon	Generalist
Red Fox	Generalist
River Otter	Riparian
Snowshoe Hare	Forested
Star-Nosed Mole	Wetland
Striped Skunk	Forested/Developed
Virginia Opossum	Developed/Generalist
Water Shrew	Wetland/Stream
White-Tailed Deer	Forested
Woodchuck	Grassland/Forest Edge

Plant Species. Table 3.7-3 lists examples of native plant species that are likely to occur in the terrestrial project area of Vernon. While this list is not comprehensive, it is representative of the high diversity of plant species and their habitats found within the Vernon Project.

Table 3.7-3. Representative native plant species likely to occur in the Project vicinity (Source: New Hampshire Fish & Game, 2005; Sperduto and Kimball, 2011; Kart et al., 2005).

Common Name	*Scientific Name*	*Basic Habitat Type*
American Beech	*Fagus grandifolia*	Hemlock Hardwood Pine
Aster	*Aster spp.*	Grassland
Big Bluestem	*Andropogon gerardii*	Grassland
Black Birch	*Betula lenta*	Appalachian Oak and Pine Forest/Hemlock Hardwood Pine
Black Cherry	*Prunus serotina*	Hemlock Hardwood Pine
Black Huckleberry	*Gaylussacia baccata*	Appalachian Oak and Pine Forest
Black Oak	*Quercus velutina*	Appalachian Oak and Pine Forest
Bracken	*Pteridium aquilinum*	Appalachian Oak and Pine Forest
Dangleberry	*Gaylussacia frondosa*	Appalachian Oak and Pine Forest
False Foxgloves	*Agalinis spp.*	Appalachian Oak and Pine Forest
Flowering Dogwood	*Cornus florida*	Appalachian Oak and Pine Forest
Round-Leaved Dogwood	*Cornus rugosa*	Appalachian Oak and Pine Forest
Goldenrod	*Solidago spp.*	Grassland
Gray Birch	*Betula populifolia*	Appalachian Oak and Pine Forest
Hemlock	*Tsuga canadensis*	Hemlock Hardwood Pine
Shagbark Hickory	*Carya ovata*	Appalachian Oak and Pine Forest
Hillside Blueberry	*Vaccinium pallidum*	Appalachian Oak and Pine Forest
Ironwood	*Ostrya virgininana*	Appalachian Oak and Pine Forest
Little Bluestem	*Schizachyrium scoparium*	Grassland
Lowbush Blueberry	*Vaccinium angustifolium*	Appalachian Oak and Pine Forest
Maple-Leaved Viburnum	*Viburnum acerifolium*	Appalachian Oak and Pine Forest
Meadowsweet	*Filipendula ulmaria*	Grassland
Mountain Laurel	*Kalmia latifolia*	Appalachian Oak and Pine Forest
Paper Birch	*Betula papyrifera*	Appalachian Oak and Pine Forest/Hemlock Hardwood Pine
Pennsylvania Sedge	*Carex pensylvanica*	Appalachian Oak and Pine Forest

Common Name	*Scientific Name*	*Basic Habitat Type*
Pin Cherry	*Prunus pensylvanica*	Hemlock Hardwood Pine
Pinweed	*Lechea spp.*	Appalachian Oak and Pine Forest
Pitch Pine	*Pinus rigida*	Appalachian Oak and Pine Forest
Poverty Oat-Grass	*Danthonia spicata*	Appalachian Oak and Pine Forest
Red Maple	*Acer rubrum*	Appalachian Oak and Pine Forest/Hemlock Hardwood Pine
Red Oak	*Quercus rubra*	Appalachian Oak and Pine Forest/Hemlock Hardwood Pine
Rough-Leaved Rice Grass	*Oryzopsis asperifolia*	Appalachian Oak and Pine Forest
Sassafras	*Sassafras albidum*	Appalachian Oak and Pine Forest
Scarlet Oak	*Quercus coccinea*	Appalachian Oak and Pine Forest
Scrub Oak	*Quercus ilicifolia*	Appalachian Oak and Pine Forest
Sessile-Leaved Bellwort	*Uvularia sessilifolia*	Hemlock Hardwood Pine
Sugar Maple	*Acer saccharum*	Hemlock Hardwood Pine
Sweet Fern	*Comptonia peregrina*	Appalachian Oak and Pine Forest
Tick-Trefoil	*Desmodium spp.*	Appalachian Oak and Pine Forest
White Ash	*Fraxinus americana*	Hemlock Hardwood Pine
White Oak	*Quercus alba*	Appalachian Oak and Pine Forest
White Pine	*Pinus strobus*	Appalachian Oak and Pine Forest/Hemlock Hardwood Pine
Whorled Loosestrife	*Lysimachia quadrifolia*	Appalachian Oak and Pine Forest
Wild Indigo	*Baptisia australis*	Appalachian Oak and Pine Forest
Wild Sarsaparilla	*Aralia nudicaulis*	Hemlock Hardwood Pine
Wintergreen	*Gaultheria procumbens*	Appalachian Oak and Pine Forest/Hemlock Hardwood Pine
Witch Hazel	*Hamamelis virginiana*	Appalachian Oak and Pine Forest/Hemlock Hardwood Pine
Woodland Sedge	*Carex blanda*	Appalachian Oak and Pine Forest
Yellow Birch	*Betula alleghaniensis*	Hemlock Hardwood Pine
Canada Mayflower	*Maianthemum canadense*	Appalachian Oak and Pine Forest

Birds of Conservation Concern

Table 3.7-4 lists the FWS-designated Birds of Conservation Concern (BCC) for Region 14 (Atlantic Northern Forests U.S. portion only), which includes the Vernon terrestrial project area (FWS, 2008). The BCC list identifies "species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973." The conservation concerns of these species may be the result of population declines, naturally or human-caused small ranges or population sizes, threats to habitat, or other factors (FWS, 2008).

Based on their ranges and habitat preferences, eight species from the list have the potential to occur in the terrestrial project area during their breeding season. Several other species, including the bay-breasted warbler, the Bicknell's thrush, and the olive-sided flycatcher, likely use the Connecticut River as a migratory pathway, taking advantage of stopover habitat available within the Vernon terrestrial project area.

Table 3.7-4. Birds of Conservation Concern for Region 14 and their potential to occur in the Project vicinity (Source: FWS 2008; Sibley2000).

Common Name	Scientific Name	Potential of Occurrence During Breeding Season
Red-Throated Loon	*Gavia stellata*	Unlikely
Pied-Billed Grebe	*Podilymbus podiceps*	Potential
Horned Grebe	*Podiceps auritus*	Unlikely
Greater Shearwater	*Puffinus gravis*	Unlikely
Great Cormorant	*Phalacrocorax carbo*	Unlikely
American Bittern	*Botaurus lentiginosus*	Potential
Least Bittern	*Ixobrychus exilis*	Potential
Snowy Egret	*Egretta thula*	Unlikely
Bald Eagle	*Haliaeetus leucocephalis*	Known
Peregrine Falcon	*Falco peregrinus*	Known
Yellow Rail	*Coturnicops noveboracensis*	Unlikely
Solitary Sandpiper	*Tringa solitaria*	Unlikely
Lesser Yellowlegs	*Tringa flavipes*	Unlikely
Upland Sandpiper	*Bartramia longicauda*	Unlikely
Whimbrel	*Numenius phaeopus*	Unlikely
Hudsonian Godwit	*Limosa haemastica*	Unlikely
Red Knot	*Calidris canutus*	Unlikely
Semipalmated Sandpiper (Eastern)	*Calidris pusilla*	Unlikely
Purple Sandpiper	*Calidris maritima*	Unlikely
Arctic Tern	*Sterna paradisaea*	Unlikely
Olive-Sided Flycatcher	*Contopus cooperi*	Unlikely
Bicknell's Thrush	*Catharus bicknelli*	Unlikely
Wood Thrush	*Hylocichla mustelina*	Potential
Blue-Winged Warbler	*Vermivora pinus*	Potential
Bay-Breasted Warbler	*Dendroica castanea*	Unlikely
Canada Warbler	*Wilsonia canadensis*	Potential
Nelson's Sharp-Tailed Sparrow	*Ammodramus nelsoni*	Unlikely

Common Name	Scientific Name	Potential of Occurrence During Breeding Season
Saltmarsh Sharp-Tailed Sparrow	*Ammodramus caudacutus*	Unlikely
Rusty Blackbird	*Euphagus carolinus*	Unlikely

Invasive Species

The Connecticut River supports a relatively large number of invasive species. The Invasive Plant Atlas of New England (IPANE) identifies the species listed in table 3.7-5 as occurring in the general vicinity of the Project. Active management efforts to date by IPANE and the Silvio O. Conte National Federal Wildlife Refuge (SOCNFWR) have largely focused on the lower Connecticut River Valley in the states of Connecticut and Massachusetts. However, Ibáñez et al. (2009) has constructed predictive modeling for southern New Hampshire and Vermont for three common invasive plants and IPANE continuously monitors and accepts reports of invasive populations.

Table 3.7-5. Invasive plant species likely to occur in the Project vicinity (Source: IPANE, 2012).

Common Name	Scientific Name	Habitat
Autumn-Olive	*Elaeagnus umbellata*	Field/Pasture, Gravel Pit, Early Successional Forest, Edge, Yard or Garden
Bell's Honeysuckle	*Lonicera x bella*	Field/Pasture, Early Successional Forest, Edge, Floodplain Forest,Open Disturbed Area,Yard or Garden
Black Swallowtail	*Cyanchum louiscae*	Riparian
Black Swallowwort	*Vincetoxicum nigrum (syn: Cynanchum louiseae)*	Field/Pasture, Forest, Edge, Floodplain Forest, Wetland
Common Reed	*Phragmites australis ssp. australis*	Emergent wetland
Curly Pondweed	*Potamogeton crispus*	Aquatic
Eurasian watermilfoil	*Myriophyllum spicatum*	Aquatic
European Barberry	*Berberis vulgaris*	Field/Pasture, Early Successional Forest, Edge, Floodplain Forest

Common Name	Scientific Name	Habitat
European Buckthorn	*Rhamnus cathartica*	Field/Pasture, Early Successional Forest, Edge, Floodplain Forest,Open Disturbed Area,Yard or Garden
Garlic Mustard	*Alliaria petiolata*	Forest, Edge, Floodplain Forest, Roadside,Wet Meadow,Yard
Glossy Buckthorn	*Rhamnus frangula (syn: Frangula alnus)*	Field/Pasture, Early Successional Forest, Edge, Floodplain Forest, Wetland, Open Disturbed Area,Yard or Garden
Japanese Barberry	*Berberis thunbergii*	Field/Pasture, Early Successional Forest, Edge, Floodplain Forest, Wet Meadow
Japanese honeysuckle	*Lonicera japonica*	Upland forest
Japanese Knotweed	*Fallopia japonica (syn: Polygonum cuspidatum)*	Field, Early Successional Forest, Edge, Floodplain Forest, Wetland, Wet Meadow, Yard or Garden
Morrow's Honeysuckle	*Lonicera morrowii*	Field/Pasture, Early Successional Forest, Edge, Floodplain Forest,Open Disturbed Area,Yard or Garden
Multiflora Rose	*Rosa multiflora*	Early Successional Forest, Edge, Open Disturbed Area, Pasture, Yard or Garden
Oriental Bittersweet	*Celastrus orbiculatus*	Field/Pasture, Early Successional Forest, Edge, Yard or Garden
Purple Loosestrife	*Lythrum salicaria*	Emergent wetlands
Tatarian Honeysuckle	*Lonicera tatarica*	Field/Pasture, Early Successional Forest, Edge, Floodplain Forest,Open Disturbed Area,Yard or Garden
Winged Burning Bush	*Euonymous alatus*	Field/Pasture, Early Successional Forest, Edge, Yard or Garden
Yellowflag Iris	*Iris pseudacorus*	Floodplain, Wetland

3.7.4 Project Effects

Potential effects of the Vernon Project on wildlife and botanical resources can occur as a result of hydroelectric operations. The normal operating range of the reservoir is approximately 2 feet. Wetland or water-dependent wildlife and plant species will likely be adversely affected by the daily wetting and drying cycles along the river's edge. Most terrestrial wildlife and plant species utilize habitats at higher elevations and thus are generally above the influence of daily water level fluctuations. While the disturbance resulting from both daily project operations and high water events sustains the unique habitats that support RTE species, it also creates increased opportunities for invasive plant species to colonize and dominate the shorelines of the Project. Because no changes are proposed to project operations, no new effects to wildlife and botanical resources are anticipated.

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3.8 WETLANDS, RIPARIAN, LITTORAL, AND FLOODPLAIN HABITAT

3.8.1 Summary of Existing Studies

Mapping by the National Wetland Inventory (NWI) was the primary source for describing the wetland and littoral vegetated habitats for the Project. Additional information was obtained from the USGS Land Cover Maps (Homer et al., 2007), and a TransCanada shoreland study (Kleinschmidt, 2011), although that data set was limited to point locations and general cover type. Riparian and floodplain habitat descriptions were obtained from the New Hampshire WAP and Vermont WAP, with additional descriptions supplemented by Sperduto and Kimball (2011) and Thompson and Sorenson (2000). For these resources, the area referred to in this section of the PAD is termed the terrestrial project area, defined the same as that for section 3.7, including lands with flowage easements retained by TransCanada and any land owned in fee by TransCanada, plus a 250-foot buffer around the resulting Project boundary (see figure 3.8-1).

3.8.2 Habitats

Wetlands

Palustrine wetlands include all non-tidal freshwater wetlands dominated by trees, shrubs, persistent emergent vegetation, emergent mosses or lichens (Cowardin et al., 1979). They offer a variety of habitat types for wildlife from vegetated beaver ponds to open marshes to vernal pools. According to NWI maps, wetland habitats cover 123 acres in the vicinity of the Project (figure 3.8-1). Palustrine cover types occurring in this Project area are divided into three sub-categories: emergent (66 acres), scrub-shrub (7 acres), and forested (50 acres).

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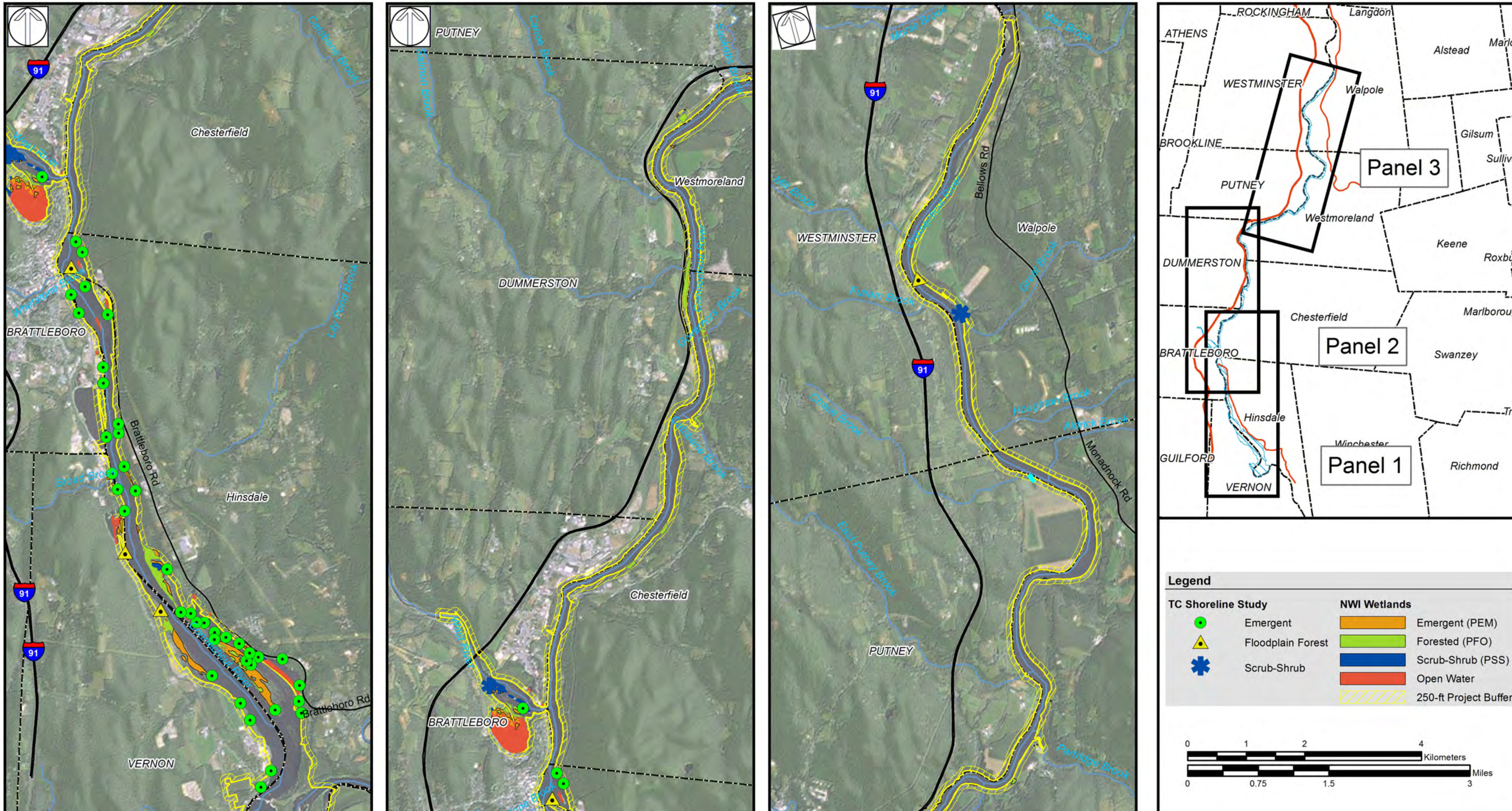

TransCanada Hydro Northeast Inc.
Wetlands
Vernon Project (NO.1904)

Prepared by Normandeau Team (09-10-12)

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Emergent. Emergent wetlands are characterized by the presence of herbaceous hydrophytes for most of the growing season. These wetlands, often referred to as marshes, meadows, or fens, provide unique habitat features for many species. Some aquatic wildlife species, such as the spotted turtle (*Clemmys guttata*), prefer habitats with abundant emergent vegetation, because it provides them with good cover for foraging. Marshes adjacent to the river will support muskrat, American black duck (*Anas rubripes)*, wood duck (*Aix sponsa)*, painted turtle and bullfrog (*Rana catesbeiana)*. In semi-permanent emergent wetlands, bullfrog, pickerel frog, ribbon snake (*Thamnophis sauritus)*, and green heron (*Butorides virescens)* are common (DeGraaf and Yamasaki, 2001). Other wetland-dependent wildlife species commonly observed in emergent wetlands include green frog (*Rana clemitans*), beaver (*Castor canadensis*), red-spotted newt (*Notopthalmus viridescens*), and great blue heron (*Ardea herodias)*.

Scrub-Shrub. Scrub-shrub wetlands are dominated by woody vegetation less than 6 meters tall. Typical wildlife found in this wetland type includes grey tree frogs (*Hyla versicolor*) and spring peepers (*Pseudacris crucifer*) which will use scrub-shrub wetlands for breeding habitat. Some birds prefer to nest and feed in scrub-shrub wetlands, including the swamp sparrow (*Melospiza georgiana)*, alder flycatcher (*Empidonax alnorum)* and American woodcock. Many mammals utilize scrub-shrub wetlands during certain portions of the year, including black bear, moose, white-tail deer, raccoon (*Procyon lotor)* and mink (*Mustela vison)*. Smaller species such as water shrew (*Sorex palustris)* may live there for most of the growing season.

Scrub-shrub habitat often occurs in patches within another wetland type, so many generalist wetland species are also supported. Some other common species found in scrub-shrub habitat include red-spotted newt, wood frog, and green frog.

Forested. Forested wetlands are dominated by woody vegetation greater than 6 meters tall. Species that rely on upland forested habitat as part of their home range, such as deer, moose, and many songbirds, also inhabit forested wetlands. Some, though not all, forested wetlands function as vernal pools. These fishless temporary to semi-permanent aquatic basins serve as breeding grounds for a specific set of obligate species. When vernal pools become inundated with water in the spring, wood frogs and spotted salamanders lay eggs in the pools (Colburn, 2001). In addition to vernal pool obligate breeders, many of these other species can be found in forested wetlands: spotted turtle, red-spotted newt, moose, green frog, spring peeper, gray tree frog, star-nosed mole (*Condylura cristata)*, and shorebirds.

Riparian. For the purposes of this section, the term “riparian” shall be used to refer to anything connected or immediately adjacent to the shoreline or bank of the Connecticut River. Although the term “riparian buffer” generally refers to the naturally vegetated shoreline, floodplain or upland forest adjacent to a surface water body, the quantification of riparian habitat requires the calculation of a buffer size from which to base the numbers. The New Hampshire Innovative Land Use Planning Handbook suggests a minimum 50-foot buffer in order to cover the “middle core” natural riparian buffer for a greater than first order stream (Williams, 2008). Vermont ANR suggests a riparian buffer of 100 feet for streams with high potential vertical channel adjustment, riparian dependent species, significant riparian natural communities and increased risk of erosion (Vermont ANR, 2005). Lee et al. (2004) reviewed state and provincial riparian buffer requirements for the United States and Canada and found that buffer requirements ranged from 15.1 meters (49.5 feet) to 29 meters (95.1 feet). For acreage calculations in this document, we assumed a 100-foot buffer from the edge of the river.

The riparian zone can include floodplain, wetland (forested, scrub-shrub, or emergent), upland forest or grassland (for detailed accounts of upland habitats, see section 3.72). The riparian zone serves as the primary interface between riverine and upland habitats, influencing both the primary productivity and food resources within the river. Primary wildlife resources associated with riparian habitats include early spring plant growth in lowland riparian habitats, which provide food sources for migrating birds, black bear, white-tailed deer, and otter (*Lutra canadensis)*. In addition, bank swallows (*Riparia riparia)* and belted kingfishers (*Ceryle alcyon)* dig nesting sites in sandy riparian areas adjacent to rivers (Sperduto and Kimball, 2011).

Table 3.8-1 shows the acreages associated with each riparian habitat type according to the USGS Land Cover maps (Homer et al., 2007). Approximately 58 acres (approximately 20 percent) of the riparian zone comprise the Developed category, but most of that cover type is Open Space, which includes some rail corridors and roads running along portions of the river corridor. The Open Space cover type includes an approximately 200-foot wide buffer off the right-of-way, much of which is in natural or semi-natural habitat and will be used extensively by wildlife in the area. Development which extends to the river's edge can form a barrier to wildlife movement along the riparian corridor.

Table 3.8-1. Riparian habitat types and their associated acreages within 100 feet of river's edge within the Project's terrestrial project area.

Habitat Type		Acres
Upland Forest (Deciduous, Evergreen, or Mixed)		298
Total Wetland		163[a]
	Woody	97
	Emergent/ Herbaceous	66
Grassland/Herbaceous		0
Pasture/Hay		28
Cropland		62
Developed (Open Space, Low, Medium, or High Intensity)		58
TOTAL		609

[a] NWI estimate uses a 100-foot riparian zone, smaller than the 250-foot terrestrial project buffer used in this section

Floodplain

Floodplain forests occur in the regularly flooded valleys of major rivers or the floodplains of lakes. The soils in floodplain habitats are variable based on the exact location, but they tend to be exposed mineral soils, mineotrophic, and of alluvial origin (New Hampshire Fish & Game, 2005; Sperduto, 2011; Vermont FWD, 2005). A unique suite of flood-tolerant plant species characterizes this habitat type. When associated with large, high-gradient rivers like the Connecticut, the most common canopy cover is silver maple or sugar maple with a sparse shrub layer and a lush herbaceous layer dominated by either ostrich fern (*Matteuccia struthiopteris*) or sensitive fern (*Onoclea sensibilis*) depending on the gradient of the river (New Hampshire Fish & Game, 2005; Vermont Fish and Wildlife, 2005).

On the Connecticut River, the most common floodplain forest community is dominated by silver maple, wood nettle (*Laportea canadensis*), and ostrich fern (Sperduto and Kimball, 2011). In New Hampshire and Vermont, floodplain forests support many species at the northern edge of their range. This, in combination with the conversion of significant portions of floodplain habitat to agriculture, contributes to the rarity of many state-listed floodplain forest species (e.g., Green Dragon (*Arisaema dracontium*)) in New Hampshire and Vermont. In addition, the fragmented and sometimes disturbed nature of floodplain forests leaves them vulnerable to invasive exotic plant species (Vermont Fish & Wildlife, 2005).

Floodplain forests provide important nesting and migratory stopover habitats for birds. Bald eagles nest in large, tall floodplain trees, and silver maple floodplains attract nesting gray catbirds (*Dumetella carolinensis)*, song sparrow (*Melospiza melodia)*, and Baltimore orioles (*Icterus galbula*; Sperduto and Kimball, 2011). Warblers migrating northward feed on insects among the emerging maple leaves and flowers (Sperduto and Kimball, 2011). In addition, fish can become trapped in pools when floodwaters recede from floodplains, providing food for raccoons and other predators. These pools can provide breeding and foraging locations for a number of amphibians, reptiles and invertebrates, including wood turtle, wood frog, spotted salamander, ribbon snakes and a variety of insects.

Littoral

The littoral zone, in the context of a large river system, is the habitat between about a half-meter of depth and the depth of light penetration (Wetzel, 1975). The littoral width varies based on the geomorphology and rate of sedimentation of the stretch of river (Wetzel, 1983). Based on the NWI maps and the TransCanada Lower Connecticut River Shoreline study (Kleinschmidt, 2011), a notable littoral habitat for wildlife was identified starting at the confluence of the Sprague Brook in Hinsdale, New Hampshire, extending northward past the Liscomb Brook confluence, and ending near the Chesterfield, NH town line. In addition, Nedeau (2006) reported extensive beds of *Vallisneria spp*. near the boat launch at the end of Ferry Road in Brattleboro, Vermont, indicating a locally wide littoral zone.

3.8.3 Project Effects

Potential effects of the Project on wetland, floodplain, riparian, and littoral resources can occur as a result of hydroelectric operations. The daily water level fluctuation of approximately 2 vertical feet has resulted in a zone of sparse vegetation along the most shorelines of the impoundment. Wetland and littoral resources in this zone are limited by the frequent wetting and drying. Floodplain and riparian habitats are generally situated at higher elevations and thus are above the influence of daily water level fluctuations. Because no changes are proposed under the new project operation, no new effects on wetland, floodplain, riparian, and littoral resources are anticipated.

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3.9 RARE, THREATENED, AND ENDANGERED SPECIES

3.9.1 Summary of Existing Studies

Listings of all rare, threatened, and endangered species (RTE) and communities were obtained from map and database information provided by FWS, the New Hampshire Natural Heritage Bureau (New Hampshire NHB), and the Vermont Natural Heritage Information Project (Vermont NHIP). The request included lands within 1,000 feet of the river's edge, which for the purposes of this PAD will be referred to as the RTE project area. Habitat information was derived from the Heritage Bureau's fact sheets and several flora manuals (Magee and Ahles, 2007; Seymour, 1969).

3.9.2 RTE Species in the RTE Project Area

The presence of RTE species in the RTE project area was determined by consulting the map layers provided by New Hampshire NHB and Vermont NHIP. Table 3.9-1 shows the 35 species that are listed by FWS and states as occurring in the Project RTE project area.

Table 3.9-1. Rare, threatened, and endangered species found within the RTE project area.

Scientific Name	Common Name	VT Status[a]	NH Status[a]	Fed Status[a]	Habitat
Invertebrate Animals					
Alasmidonta heterodon	Dwarf wedge mussel[5]	E	E	E	Variable-sized rivers with stable flow and substrate (MANHESP)
Alasmidonta varicosa	Brook floater	T	E	-	Sections of stream with low to moderate flow and stable substrates (MANHESP)
Cicindela marginipennis	Cobblestone tiger beetle	T	E	-	Sandy beaches on river's edge
Gomphus ventricosus	Skillet clubtail	-	SC	-	Medium to large rivers with mud bottom (Nikula et al)
Stylurus amnicola	Riverine clubtail	-	SC	-	Medium to large rivers with sand, gravel or mud bottom (Nikula et al)
Vertebrate Animals					
Dendroica cerulea	Cerulean warbler	-	SC	-	Mature, deciduous, floodplain forests (DeGraaf and Yamasaki)
Haliaeetus leucocephalus	Bald eagle	E	T	P[b]	Large lakes, rivers; large, riparian trees for nesting, roosting (DeGraaf and Yamasaki)
Plants					
Asclepias tuberosa	Butterfly milkweed	T	E		Dry fields and roadsides (Magee and Ahles)
Cardamine concatenata	Cut-leaved toothwort	-	E	-	Rich woods and talus (NHB) rich, moist woods (Magee and Ahles)

[5] As described in section 3.6.7, *Mussels and Macroinvertebrates*, numerous surveys were targeted for dwarf wedgemussel but did not encounter the species in the Project affected area (e.g., Ferguson, 1999; Nedeau, 2005).

Scientific Name	Common Name	VT Status[a]	NH Status[a]	Fed Status[a]	Habitat
Carex foenea	Bronze sedge	E	-	-	Dry fields, banks (Seymour); Open woods and slopes in dry sandy or gravelly soil (Magee and Ahles)
Carex retroflexa	Reflexed sedge	-	E	-	Rich, deciduous woods (Magee and Ahles)
Crassula aquatica	Pygmy-weed	-	E	-	Aquatic bed; Brackish marshes, mudflats, and borders (NHB); Tidal mud flats usually within the limits of the tide, and margins of freshwater pools and rivers (Magee and Ahles)
Crocanthemum bicknellii	Plains frostweed	T	-	-	Dry sandy soils in the open (Seymour)
Crotalaria sagittalis	Rattlebox	T	E	-	Dry sandy soils in the open (Seymour)
Cyperus diandrus	Low cyperus	E	-	-	Shores of ponds and rivers (Seymour); Wet soil, especially of pond and stream margins (Magee and Ahles)
Cyperus houghtonii	Houghton's umbrella sedge	T	E	-	Dry sandplain openings (NHB); sandy soil of barrens, fields, lake shores and waste places (Magee and Ahles)
Cyperus squarrosus	Incurved umbrella sedge	-	E	-	Sandy pondshores / Sand plain basin marshes; Poor wet meadows; Southern riverbanks
Equisetum palustre	Marsh horsetail	T	E		Shallow water, marshes, meadows, moist woodlands, streambanks and shores (Magee and Ahles)
Galearis	Showy orchid	-	T	-	Rich, deciduous

Scientific Name	Common Name	VT Status[a]	NH Status[a]	Fed Status[a]	Habitat
spectabilis					woods (Magee and Ahles)
Hackelia virginiana	Virginia stickseed		E		Rich woods and thickets (Magee and Ahles)
Helianthus strumosus	Harsh sunflower	T	-	-	Open woods and thickets (Magee and Ahles)
Heteranthera dubia	Grass-leaved mud-plantain	-	T	-	Aquatic bed, southern riverbanks (NHB); Quiet water (Magee and Ahles)
Hydrophyllum virginianum	Eastern waterleaf	-	T	-	Rich, deciduous, often wet woods (Magee and Ahles)
Hypericum ascyron	Great St. John's-wort	T	E	-	Calcareous riverside seeps (NHB); pond and river thickets (Magee and Ahles)
Isoetes engelmannii	Engelmann's quillwort	T	E	-	On shores, usually muddy, of ponds and rivers, in shallow water (Seymour)
Isoetes riparia var. canadensis	Canada shore quillwort	-	E	-	Aquatic bed; Sandy pondshores / Sand plain basin marshes; Brackish marshes, mudflats, and borders
Lechea mucronata	Hairy pinweed	E			Dry fields, clearings, roadsides (Magee and Ahles)
Lespedeza hirta	Hairy bush-clover	T	-	-	Dry open woods (Seymour); woodland borders, fields, roadsides
Lobelia kalmii	Brook lobelia	-	T	-	Calcareous riverside seeps; rich wet meadows (NHB); Calcareous pond and stream margins, bogs, wooded swamps and wet ledges (Magee and Ahles)
Packera paupercula	Balsam groundsel	-	T	-	Rich fens and seeps; calcareous riverside seeps (NHB); cliffs, rocks, fields (Magee and Ahles)

Scientific Name	Common Name	VT Status[a]	NH Status[a]	Fed Status[a]	Habitat
Panax quinquefolius	American ginseng	-	T	-	Rich woods (Magee and Ahles)
Physostegia virginiana	Obedient plant	T	-	-	Roadsides, fields, moist soil (Seymour), river edges, woodlands (Magee and Ahles)
Potamogeton nodosus	Long-leaved pondweed	-	T	-	Aquatic bed (NHB); shallow or deep ponds and streams (Magee and Ahles)
Potamogeton zosteriformis	Flat-stem pondweed	-	E	-	Aquatic bed (NHB); Ponds and sluggish streams (Magee and Ahles)
Sanicula odorata	Clustered sanicle		E		Rich woods (Magee and Ahles)
Senna hebecarpa	Northern wild senna	T	E		Fields, open woods, roadsides (Magee and Ahles)
Solidago speciosa	Showy goldenrod	-	E	-	Fields, roadsides (Magee and Ahles)
Spiranthes lucida	Shining ladies'-tresses	-	E	-	Rich fens and seeps; rich wet meadows; calcareous riverside seeps
Staphylea trifolia	American bladdernut	-	T	-	Rich woods and talus, floodplain forest; southern riverbanks

[a] SC=Special Concern; T=Threatened; E=Endangered.

[b] Bald eagle is federally protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c).

3.9.3 Habitat Requirements and Critical Habitat Designations

No federally listed species or Critical Habitats have been designated in the RTE project area. However, several habitat types within the RTE project area support populations of state-listed species. Calcareous seeps bordering the river support a number of state-listed species, including shining ladies tresses, elk sedge and brook lobelia. Many floodplain forest species including American bladdernut, and American ginseng have been observed in the Project vicinity, taking advantage of the rich, mesic forested habitat. Marshy, littoral river margins provide habitat for listed pondweeds (*Potamogeton spp.*) and pygmyweed.

3.9.4 Biological Opinions, Status Reports, and Recovery Plans

The following sections address the status and management efforts for federally listed species that occur within the Project vicinity. The State of Vermont has developed recovery plans for several bird species known to use the Project area: the bald eagle, state-listed as endangered (Vermont Fish & Wildlife, 2010), the peregrine falcon, no longer listed (Fowle, 2000), and the osprey, no longer listed (Parren, 1997). The State of New Hampshire does not have recovery plans for listed species, but does address their management in the New Hampshire WAP.

Bald Eagle. Several sections of the Project area provide both breeding and winter roosting habitat for bald eagles. Bald eagles are federally protected under the Bald and Golden Eagle Protection Act (16 U.S.C. § 668-668c) and the Migratory Bird Treaty Act, and state-listed as threatened in New Hampshire and endangered in Vermont. Vermont's 2010 Bald Eagle Recovery Plan emphasizes monitoring, management, and education to reach that state's goal of ultimately delisting the species.

During the winter, bald eagles move from nesting sites to coastal sites and inland locations with sufficient open water (DeGraaf and Yamasaki, 2001). Roosting sites generally consist of dense stands of east-facing softwood trees for optimal cover and morning sun exposure. According to the Vermont NHIP and the New Hampshire NHB, bald eagles roost in two locations within the RTE project area: Vernon Dam in Vernon, Vermont, and Hinsdale, New Hampshire, and in the north end of Putney, Vermont, and Westmoreland, New Hampshire. In 2012 during a two-week long mid-winter eagle survey, a total of 15 eagles (12 adults, 3 immatures) were observed on the Connecticut River south of the Wilder Dam and north of the Massachusetts border (C. Martin, personal communication, 12 January 2012).

Bald eagles choose their nesting sites based on the proximity of large bodies of water with abundant fish resources, large trees for nest building, and they prefer minimal human disturbance (DeGraaf and Yamasaki, 2001). Two known bald eagle nesting territories exist within the Project area. In Hinsdale, New Hampshire/Vernon, Vermont, nesting has occurred since 1999 with seven successful years and a total of nine fledged young. There was no evidence of hatching in this nest in 2010 (Martin, 2010). A territory in Walpole, New Hampshire/Westminster, Vermont, was discovered in 2010, and two successful young have fledged in the last two years (C. Martin, personal communication, 14 August 2012).

Dwarf Wedgemussel. A recovery plan has been written by FWS for this federally endangered species (Moser, 1993). The main goals of the plan are to protect and enhance habitat of current dwarf wedgemussel populations and establish or expand populations within rivers or river corridors historically containing the species (Moser, 1993). The most recent 5-year review was published in 2007, retaining the species' status as federally endangered (FWS, 2007). For more detail, see section 3.6.7, *Mussels and Macroinvertebrates*.

Biodrawversity LLC conducted a freshwater mussel survey from the upper limit of the Wilder Project to the lower limit of the Vernon Project in 2011 (Biodrawversity LLC and LBG, 2012). The primary objectives were to assess the distribution, abundance, demographics, and habitat of dwarf wedgemussel in this reach of the Connecticut River, as well as to gather information on co-occurring mussel species. A total of 23 transects were surveyed within the Vernon RTE project area. Dwarf wedgemussels were not found within any of the transects (Biodrawversity LLC and LBG, 2012).

Rare Plant and Community Field Survey. In the 2012 growing season, Normandeau, at the request of TransCanada, conducted a field survey for listed threatened or endangered plants and communities within the immediate environs of the Connecticut River. The survey area covered all three TransCanada projects (Wilder, Bellows Falls, and Vernon) and extended from the upper end of the Wilder impoundment to Vernon dam. The survey assessed the current status of individual populations of all plant species listed by New Hampshire and Vermont that are potentially influenced by Project operations. TransCanada consulted with FWS, the New Hampshire NHB, and the Vermont NHIP to define the appropriate level of effort and list of species to be included in this study. The purposes of the study are to: (1) document the presence or absence and status of these rare species; (2) identify additional locations of rare species in priority target habitats; and (3) to estimate their elevation relative to daily Project operations to evaluate the potential influence of Project operations on rare species and communities (Normandeau 2012b, in progress). The detailed results of this survey will be available in late 2012.

Individual occurrences of rare species and exemplary natural communities proximal to normal operational flows of the Wilder, Bellows Falls, and Vernon projects that were documented in this study correspond to one of three broad groups: (1) aquatic floating leaved and submerged species that remain inundated during daily operational flows; (2) aquatic to emergent species that are partially or entirely within the range of daily operational flows; and (3) species that are restricted wholly or in large part to areas on the riverbank above daily operational flows (inundated by flows exceeding normal operational maximum flows). Examples of each of these species were documented during the study.

Many rare plant species populations have apparently adapted to, tolerate, or rely on the existing flow regime associated with the particular zone they occur in. Given the length of time normal operational flows have been in place, it is likely that rare species intolerant of daily inundation either did not occur in this lower riverbank zone historically (i.e., prior to dam construction) or have since been relegated to areas either above or below the normal operational range, where habitat conditions remain suitable for the particular individual species. Some species (or individual populations) apparently tolerate or benefit from the daily inundation associated with normal operational flows.

3.9.5 Project Effects

Potential effects of the Project on RTE species or communities can occur as a result of hydroelectric operations. The normal daily water level fluctuation of approximately 2 vertical feet has resulted in a zone of sparse vegetation along the most shorelines of the impoundment. Rare species that use habitats along the impoundment edge may be adversely affected by the daily wetting and drying cycles while others rely on the continual or seasonal flooding and scouring to maintain suitable habitat and suspend succession.

An ongoing TransCanada field study of rare plants and communities is determining the distribution of plants and communities bordering the river within the Project area. Many rare plant species populations have apparently adapted to, tolerate, or rely on the existing flow regime associated with the particular zone they occur in. Given the length of time normal operational flows have been in place, it is likely that rare species intolerant of daily inundation either did not occur in this lower riverbank zone historically (i.e., prior to dam construction) or have since been relegated to areas either above or below the normal operational range, where habitat conditions remain suitable for the particular individual species. Some species (or individual populations) tolerate or benefit from the daily inundation associated with normal operational flows.

Project impacts on dwarf wedgemussel can occur as a result of river fragmentation, impoundment, and hydroelectric operations. The Project impoundment results in a more lentic environment characterized by reduced current speed and complexity and increased sedimentation, and therefore reduced substrate complexity/increased substrate embeddedness.

Because no changes are proposed to Project operations, no new effects on rare state-listed or federally listed terrestrial plant species or communities resources are anticipated.

3.9.6 References

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3.10 RECREATION AND LAND USE

3.10.1 Summary of Existing Studies

This section reviews the numerous existing recreation facilities and opportunities adjacent to the Project boundary as well as within a regional context (defined as 60 miles from the Project, discussed in more detail below) and places them within the context of existing recreation use data, buffer zones, and identified recreation needs. This section also examines non-recreation land use and management on Project lands, as well as adjacent to the Project boundary. TransCanada defined the Project's affected area for recreation and land use as Vernon reservoir within the Project boundary, and lands owned by TransCanada, immediately downstream of Vernon dam that support Vernon Project recreational opportunities and facilities.

The following sources of information were used to describe the recreation resources of the Project area:

- Vernon Project Exhibit R Maps;
- CRJC Connecticut River Corridor Management Plan; Recreation Plan; Water Resources Plan, and Boating on the Connecticut River Maps;
- New Hampshire and Vermont Statewide Comprehensive Outdoor Recreation Plans (SCORPs);

- Regional planning documents, including management plans from: Windham Regional Commission and the Southwest Region Planning Commission;
- Brattleboro and Walpole Town Plans;
- FERC Licensed Hydropower Development Recreation Report – Form 80s;
- New Hampshire Walleye Creel Survey Data; and
- Aerial photos, topographic maps, USGS maps, Connecticut River Paddler Trail map info, and Google Earth.

3.10.2 Existing Recreational Facilities and Opportunities

Recreation facilities and opportunities in the Project area are discussed below. These facilities and opportunities are largely enjoyed by visitors originating from the towns and communities throughout the Connecticut River Valley including Vermont, New Hampshire, and Massachusetts. Interstate Route 91, US Route 5, and Vermont Route 142 run in a north-south direction along the Vermont side of the valley, and New Hampshire Routes 119 and 63 run along the New Hampshire side. The Boston and Maine Railroad runs along the New Hampshire side crossing into Vermont at Brattleboro. The Central Vermont Railroad runs along the Vermont side. These railroad tracks, along with significant amounts of private residential property and large industrial type complexes along the river, make recreation access difficult to many areas along the reservoir. Recreation facilities and opportunities within the Project boundary are shown on figure 3.10-1. Recreation access to Project lands and waters is provided by a variety of managing entities including state, municipal, non-governmental agencies, and private landowners.

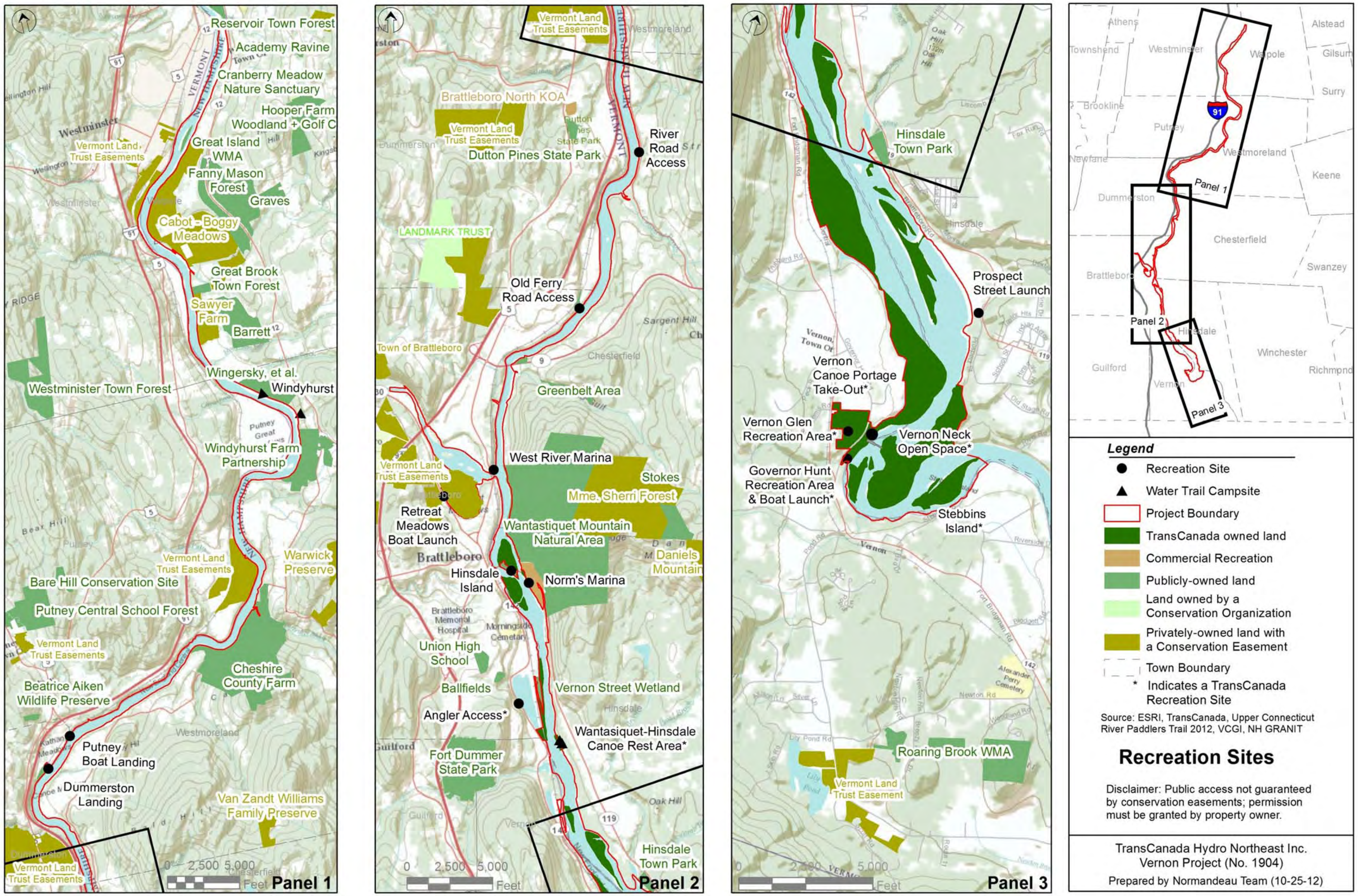

Figure 3.10-1. Recreation sites and lands within the Project vicinity.

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Project Facilities and Opportunities in the Project Area

Popular recreation activities in the Connecticut River Valley include camping, fishing, boating/floating, swimming, hiking, bicycling, picnicking, sightseeing, wildlife viewing, canoe/kayaking, snowmobiling, cross-country skiing, and hunting. The Project's primary recreation facilities and use are focused around the Connecticut and West rivers including Vernon reservoir. The Connecticut River Water Trail travels along the full length of the Connecticut River in Vermont and New Hampshire. CRJC publishes boating maps and information on-line while the Connecticut River Watershed Council has published *The Connecticut River Boating Guide: Source to Sea* (third edition 2007) a map and guidebook of this entire trail for boating enthusiasts (http://www.ctriver.org/publication/boating%20guide/index.html).

Vernon reservoir extends north from Vernon dam in Vernon, Vermont, and Hinsdale, New Hampshire, about 26 miles to Westminster, Vermont, and Walpole, New Hampshire. The reservoir has approximately 69 miles of shoreline with a surface area of 2,550 acres at normal pond elevation of 220.13 feet and is largely surrounded by private lands. Recreation access to the reservoir is provided in seven of the ten communities in the Project. Boat ramps with access to Vernon reservoir are not provided in Westminster, Vermont, or Westmoreland, New Hampshire but a boat launch in Walpole provides access to small boats below Bellows Falls Station and can reach the Vernon project downstream.

The primary activities that occur at Vernon reservoir include camping, fishing, hiking, boating (motorized and canoe/kayaking), swimming, hunting, and winter sports such as ice fishing, snowmobiling, and cross-country (Nordic) skiing and ice skating. Boating on the reservoir is very popular with numerous access points for both trailered motor boats and cartop/hand launch canoe/kayak trips. Table 3.10-1 summarizes the Project and Project-related public recreation facilities that provide access to Vernon Project. Project recreation sites are those owned and managed by TransCanada and contained within the existing FERC approved Exhibit R recreation maps while Project-related are those that are adjacent to or provide access to Wilder reservoir or other Project lands. The majority of the recreation sites are modest with few amenities other than access to the river to fish or launch a boat. There are two marinas: West Marina at the mouth of the West River in Brattleboro, Vermont, and Norms Marina in Hinsdale, New Hampshire.

According to CRJC (2008), the river reach between the Bellows Falls and Vernon dams offers something for nearly every kind of boater. Moving water below Bellows Falls provides fine small boating, canoeing and kayaking, while Vernon reservoir provides ample deep water for power boating and flat water for rowing and sculling. Powerboating is usually limited to the section from Windyhurst Farm in Westmoreland, New Hampshire, down to the dam. Jet skis are perhaps more common here than in any other part of the river (CRJC, 2008). The only section that is wide enough for legal use of jet skis and water skiing over headway speed (no wake/6 mph) is from Vernon dam to the Fort Hill bridge in Brattleboro, Vermont, around the Route 119 Bridge, and near the two marinas.

Table 3.10-1. Recreation access within the Project boundary (Source: CRJC, 2008).

Site Name	Site Type	RM	Town	Manager
Putney Boat Landing	Boat ramp	157	Putney, VT	State of VT
Dummerston Landing	Boat ramp (cartop)	152	Dummerstown, VT	State of VT
River Road Access	Boat ramp	149	Chesterfield, NH	Town of Chesterfield, NH
Old Ferry Road Access	Boat ramp	147	Brattleboro, VT	State of VT
Retreat Meadows Boat Launch	Boat ramp (cartop)	145	Brattleboro, VT	Brattleboro Retreat
West River Marina	Commercial marina	145	Brattleboro, VT	Private (open to public)
Norm's Marina	Boat ramp	144	Hinsdale, NH	Private (open to public, fee)
Hinsdale Island	Boat ramp (cartop)	144	Hinsdale, NH	State of NH
Fisherman Access Area*	Angler Access	142	Vernon, VT	TransCanada
Prospect Street Launch	Boat ramp	139	Hinsdale, NH	Town of Hinsdale, NH

Site Name	Site Type	RM	Town	Manager
Vernon Canoe Portage*	Canoe Portage Take-out	138	Vernon, VT	TransCanada
Vernon Glen*	Picnic Area	138	Vernon, VT	TransCanada
Vernon (Governor Hunt) Recreation Area & Boat Launch* (below Vernon dam)	Boat ramp (cartop only above the dam) and fish ladder display area	137	Vernon, VT	TransCanada
Vernon Neck Open Space*	Open Space	136	Hinsdale, NH	TransCanada

Notes: * indicates TransCanada recreation site as noted on the current FERC approved Exhibit R – Recreation.

New Hampshire boating law is enforced on the Connecticut River. Boats may not exceed headway speed within 150 feet (300 feet for ski craft) from shore, islands, bridges, other boats, swimmers, or floats. The legal speed of travel on the river therefore depends upon the river's width.

Power boat wakes are one of the key causes of bank erosion on the main stem of the river above Wilder dam (CRJC, 2008). CRJC (2008) notes that, with the increase in the types of boating traffic and the potential for shoreline erosion resulting from boat wakes, more enforcement of boating laws is needed.

Fishing is a year-round activity on the main stem of the Connecticut River. The tributaries offer coldwater species such as rainbow, brown, and the native brook trout, and the reservoir provides habitat for warmwater species such as perch, pickerel, bass, bullheads, northern pike, and walleye. Fish passage facilities now provide for passage of anadromous fish and resident species. Section 3.6; *Fish and Aquatic Resources*; provides a detailed discussion of fish in the Connecticut River. New Hampshire fishing licenses or Vermont resident licenses are required for the Connecticut River, and licenses are good for fishing on all the river's tributaries up to the first bridge.

Ice fishing is a popular activity in Vernon reservoir and within the setbacks; however, the area near Vermont Yankee no longer freezes because the plant discharges water warmer than ambient from its cooling operations. Although this is not a Vernon Project effect, it occurs within the Vernon Project boundary because of the shared resource between the two electric generating plants.

Swimming is popular along natural beaches within the reservoir and downstream from the dam at Governor Hunt Recreation Area and Stebbins Island. New Hampshire DES, assisted by EPA, assessed water quality in the entire river in New Hampshire in 2004. New Hampshire considers the entire reach of the river between Bellows Falls and Vernon dams to be safe for swimming, although the state of Vermont cautions that nonpoint sources of pollution threaten swimming here. Threats include sediment and turbidity; nutrients; pathogens; metals; organics from combined sewer overflows; and runoff from urban areas, industrial and municipal sources, and agricultural lands (CRJC, 2008). Section 3.5 includes information on water quality in the Project area.

Land-Based Recreation in the Vicinity of the Project

TransCanada holds fee ownership of 287 acres of land in the Vernon Project. Of this, 16 acres are used for plant and related facilities, 34 acres are developed for public outdoor recreational use as part of TransCanada's recreation program, 14 acres have been used for agricultural and other uses, 98 acres have been set aside as natural lands, and the remaining 125 acres are undeveloped open space available for daytime visitation by the public. The Vernon Neck, opposite the Vernon station in Hinsdale, New Hampshire area comprises the bulk of the undeveloped open space. The Project exhibit R recreation map is included in Attachment 2 to this PAD.

During the warmer summer months, through-project canoeing is common and canoe only river camping is popular along the Connecticut River Water Trail.

Several primitive canoe campsites were developed along the Connecticut River including within the Vernon Project. Table 3.10-2 shows primitive canoe campsites open to the public. There is no charge for use of the campsites, which are available on a first-come, first-served basis. They typically include tent platforms, fire ring and privy or composting toilet. There are two commercial campsites just off Route 5 (CRJC, 2008); Brattleboro North KOA and Hidden Acres Camping Resort (adjacent to Dutton Pines State Park). Fort Dummer State Park also provides camping. TransCanada maintains a canoe portage trail around the west side of the dam.

The Connecticut River's role as a migratory flyway brings an abundance of waterfowl to the river each spring and fall, especially to the shallow waters of "setbacks" at the mouths of tributaries, such as Retreat Meadows at the confluence of the West River (CRJC, 2008). The riverfront and floodplains from the Massachusetts border to Weathersfield Bow (including all of the Vernon Project) are recognized as the Middle Connecticut River Important Bird Area (see section 3.7, *Wildlife and Botanical Resources*). Wildlife viewing, especially in these areas, is a popular recreational activity.

New Hampshire and Vermont have enacted reciprocal migratory waterfowl hunting rights for licensed waterfowl hunters in the Connecticut River Zone; a designated area essentially between Interstate 91 in Vermont and Route 12 and 63 in New Hampshire. A person holding either a Vermont or a New Hampshire resident hunting license for migratory waterfowl and coots may hunt them in this area subject to the Connecticut River Reciprocal Agreement. It is illegal to use lead shot while hunting migratory waterfowl.

During the winter months, recreation continues throughout the Connecticut River Valley, and cross-country skiing, snowmobiling, ice skating, and ice fishing are all very popular on the Connecticut River and nearby shorelands. Snowmobiling and cross-country ski trails crisscross the region connecting towns and businesses, and distance skaters are known to use the river (CRJC, 2008). Ice fishing is popular and, seasonally, ice fishing shanties are placed on the ice up and down the river.

Trails in the Connecticut River Valley are enjoyed by hikers, walkers, joggers, mountain bikers, snowshoers, Nordic skiers and snowmobilers (CRJC, 2008). Every town in the region offers trails enriched by views of the river (CRJC, 2008). Hiking opportunities exist on a number of trails that run near the river and adjacent to the project boundary. Many towns and communities have published maps showing hiking trails along the Connecticut River. Some of the hiking opportunities adjacent to the Vernon Project include:

- The Wantastiquet Trail in Chesterfield and Hinsdale, which parallels the river and ascends Wantastiquet Mountain, is a popular hiking route.
- The Wantastiquet-Monadnock Greenway Trail has been extended to Chesterfield. Interpretive trails at the Cheshire County Farm feature remnants of floodplain forest and lead visitors to benches at the water's edge.
- A trail now connects Windmill Hill and Pinnacle Ridge from Rockingham to the Putney-Dummerston Line.

Table 3.10-2. Connecticut River water trail campsites (Source: CRJC, 2008).

Campsite Name	Town	Manager	RM	Capacity	Amenities
Windyhurst	Westmoreland, NH	Private landowner	159	8	Located downstream of Windyhurst Farm
Wantastiquet - Hinsdale Canoe Rest Area	Hinsdale, NH	TransCanada	142	8	No sanitary facilities; no fires at request of local fire department - use cookstoves
Stebbins Island Canoe Rest Area*	Hinsdale, NH	TransCanada	137	10+	limited to small groups to minimize disturbance to nearby nesting bald eagles; recycling toilet; no fires at request of local fire department - use cookstoves

Notes: * indicates TransCanada recreation site as noted on the current FERC approved Exhibit R – Recreation

- Another riverfront trail connects Route 119 in Hinsdale with the Route 9 bridge in Chesterfield.
- Three former railroad beds on the New Hampshire side have been converted to recreational trails: 42- mile Cheshire Recreational Trail, which links North Walpole with Fitzwilliam provides views of the Connecticut River; The Ashuelot Recreational Trail runs 21 miles between Keene and Winchester and the For Hill Recreational Trail runs 8.9 miles in Hinsdale along the Connecticut River.
- A snowmobile trail system links most towns in the area. Agreements with private landowners allow passage during the winter but not generally for summer use by the public. Cross country skiers also use these trails. CRJC (2008) recognizes that snowmobiling on the river is not safe and recommends snowmobile clubs discourage their members from riding on the river.

Aside from formal trails, New Hampshire's Current Use law (R.S.A. 79-A), a tax incentive to qualifying landowners that agree to maintain their land in an undeveloped condition, contributes to the aesthetic and recreational values throughout the state as over half the land in New Hampshire is enrolled in the program. Property owners in the Current Use program receive additional tax savings under the recreational discount if they keep their land open for public recreation uses and without fee all year for hunting, fishing, snowshoeing, hiking, skiing and nature observation. Although lands in the Current Use program can be posted against trespassing, very little actually is (SPACE, 2007).

3.10.3 Recreational Use

New Hampshire residents reported that the Connecticut River is the fourth most visited waterbody in the state behind Lake Winnipesaukee, Lake Sunapee, and the Merrimack River (New Hampshire OEP, 2007). TransCanada (2009) estimated the Project received 84,000 recreation days with a peak weekend average of 1,600 recreation days.

3.10.4 Shoreline Buffer Zones

The Connecticut River is a designated river under the New Hampshire Rivers Management and Protection Program which has supported the development of Local Advisory committees representing many of the communities along the New Hampshire shoreline along with encouraging local shoreline zoning and development restrictions to protect the river. The New Hampshire Shoreland Water Quality Protection Act also regulated development within 250 feet of the river. State law requires a 50-foot building setback and a 150-foot natural shoreland buffer, and in many towns the local zoning is often more protective. Within the protected shoreland, certain activities are restricted or prohibited, and others require a permit from the New Hampshire DES. The Shoreland Water Quality Protection Act addresses all construction and building within this buffer including residences, docks, building setbacks, impermeable surfaces, erosion control during construction projects, and vegetation maintenance. All activities that are regulated by the New Hampshire DES must also comply with applicable local, state, and federal regulations.

While some Vermont towns have local zoning that protects their Connecticut River shoreland, there is no state protection of shorelands in Vermont (CRJC, 1997a). Vermont ANR has issued riparian buffer guidance for Act 250[6]-regulated projects, which recommends 100 feet from lakes and ponds and either 50 or 100 feet from rivers and streams. New Hampshire jurisdiction extends to the low water mark on the Vermont side, and in some places the state line has been inundated by the construction of dams.

TransCanada-owned lands within the Project area are managed in accordance with the recreation, cultural, visual, and aesthetic conditions of the current FERC license.

3.10.5 Current and Future Recreation Needs Identified in Management Plans

Management plans that cover recreation resources within the Project vicinity include the New Hampshire and Vermont Statewide Comprehensive Outdoor Recreation Plan's (SCORP), Connecticut River Corridor Management Plan (prepared by CRJC), and regional plans developed by the Upper Valley Lake Sunapee Regional Planning Commission, Southwest Regional Planning Commission, and Windham Regional Commission. The towns of Walpole, New Hampshire, and Brattleboro, Vermont, master plans also were reviewed.

New Hampshire SCORP

The 2007 New Hampshire SCORP, among other things, identifies and prioritizes outdoor recreation opportunities and constraints most critical in New Hampshire. The plan lists the following as current recreation-related issues of statewide importance:

- Stewardship of natural resource base for outdoor recreation;
- Providing different, sometimes competing, recreational opportunities;
- Limited financial and human resources to address a range of recreation needs;

[6] The Vermont legislature passed Act 250 known as the Land Use and Development Act in 1970. The law created nine District Environmental Commissions to review large-scale development projects using 10 criteria designed to safeguard the environment, community life, and aesthetic character of the state. The Commission has the authority to issue or deny permits for any project that encompasses more than 10 acres or more than 1 acre for towns that do not have permanent zoning and subdivision bylaws. The law also applies to any development project with more than 10 housing units or housing lots and may also apply for construction proposed above 2,500 feet of elevation.

- Education of recreational users, municipalities, and landowners about responsible behavior, laws, and liability;
- Impacts of existing land use patterns on recreational opportunities; and
- Importance of local outdoor recreation opportunities and open space protection in promoting increased health and wellness.

Vermont SCORP

The 2005 Vermont SCORP, among other things, assesses Vermont's outdoor recreation resources, issues, and directions for the next 5 years. The plan lists the following as current recreation-related issues of statewide importance relevant within the context of the Connecticut River:

- Vermont's natural resource base, which provides the foundation for outdoor recreational pursuits, is conserved and enhanced;
- The majority of private landowners in Vermont continue to allow access to their land for public recreation; and
- Outdoor recreationists in Vermont appreciate nature and the natural resource base and treat private and public resources and other users with respect.

In addition to these general priorities, the Vermont SCORP identifies seven issues directly applicable to water-based recreation throughout the state and not just the Connecticut River, including:

1. Access areas of the Vermont Fish & Wildlife are being used for a variety of activities other than the intended fishing and wildlife-based recreation pursuits;
2. Conflicts among anglers, floaters, landowners, and swimmers, especially during high use periods (hot summer weekends), exist in many areas. These include littering, trash dumping, and inconsiderate behavior;
3. Public access is a top concern for water-based recreational issues;
4. Some existing and improvised access sites have erosion problems;
5. There is a need for legal portage sites where there are obstacles to floaters who have no legal way to portage past them;
6. In some places and instances, water-based recreationists access waters from private property without permission; and
7. Adequate boat speed enforcement is needed.

Windham Regional Commission

Within the Vernon Project, Westminster, Putney, Dummerston, and Brattleboro, Vermont, are the towns served by the Windham Regional Commission. The Windham Regional Plan identifies a single regional recreational goal:

- To maintain and enhance recreational opportunities for both residents and visitors in keeping with the carrying capacity of natural resources and public facilities.

The plan recognizes that the Windham region is rich in water resources; however, it notes there is a shortage of access to lakes and ponds in the region. The plan notes that 28 lakes and ponds in the region are more than 20 acres; however, only 9 miles of shorelines of these major lakes and ponds are on public or conserved lands. The plan also states the following policies related to water-based recreation in the region:

- Recognize the recreational potential of watercourses and shorelines and provide facilities for water-oriented day use.
- Provide separate areas or facilities for conflicting uses of recreational resources. For example, swimmers and motorboats should not compete for the use of the same resource when such conflicts create safety hazards or significantly impair the use or enjoyment of the resource.

Southwest Regional Planning Commission

Within the Vernon Project, Walpole, Westmoreland, Chesterfield, and Hinsdale, New Hampshire, are served by the Southwest Regional Planning Commission (SWRPC). The SWRPC Regional Plan (2002) addresses 11 topics as warranting attention in community planning and municipal governance including recreation. Specific areas of concern related to recreation resources within the SWRPC area include:

- displacement of wild places that have traditionally been available to public use (for trails, hunting and fishing, swimming, or nature appreciation) by new housing and roads;
- an aging population that will need different sorts of recreation and transportation to reach it; and
- management of recreational facilities under increased use, which will require an increase in volunteer and fiscal resources.

Connecticut River Corridor Management Plan

According to CRJC (2008), adequate public access to the Connecticut River within the Project area for motor boats already exists. There are major public boat ramps located in nearly every town (other than Westmoreland, New Hampshire, and Westminster, Vermont) where the river is wide enough to accommodate power boat traffic (Putney, Dummerston, Hinsdale, Brattleboro, and Vernon). The boat ramp in Walpole provides small boat and canoe access to the reach below the Bellows Falls Project as well as the Vernon Project impoundment. These access points are spaced no more than 5 miles apart. Furthermore, the river's depth, width, flow, and fluctuating level in this segment make it difficult for development of marinas with conventional docks and gas service on the water.

The CRJC recreation subcommittee believes that adding further access for trailered boats will create additional boating conflicts, contribute to water quality problems, and strain the already limited enforcement ability of the New Hampshire Marine Patrol. CRJC (2008) identified a need for more access for canoes and kayaks, because these craft cannot travel as far and as fast as power craft. There is currently no public boat access in Westminster, where the river is suitable only for very shallow draft boats, or in Westmoreland, where the river is too shallow for large power boats, and the valuable farmland that is vulnerable to erosion from boat wakes is located on both sides of the river. The subcommittee recommends that Westminster seek assistance to acquire riverfront property for providing a public cartop boat access. The subcommittee is reluctant to recommend a ramp for large trailered boats in Westmoreland but suggests that the question of need and location deserves ample public discussion.

Upper Connecticut River Water Trail Strategic Assessment

The Upper Connecticut River Water Trail Strategic Assessment was funded by the Vermont River Conservancy (Pollack, 2009) to build upon previous planning processes that established the Connecticut River Trail. The goals of the study included identifying potential organizations that could develop the Connecticut River Paddlers Trail; better understand the location of existing access and campsites; assess gaps in camping and access sites; and develop guidelines for the establishment of new sites. The assessment characterized paddling resources (access and camping opportunities and needs) within the Vernon Project area. The report noted that the reach from Walpole, New Hampshire, to Brattleboro, Vermont (17 miles), was one of the longest stretches without officially designated campsites.

3.10.6 Specially Designated Lands

Silvio O. Conte National Fish and Wildlife Refuge

Silvio O. Conte National Fish and Wildlife Refuge was established in 1997 to conserve, protect, and enhance the abundance and diversity of native plant, fish, and wildlife species and the ecosystems on which they depend throughout the 7.2 million acre Connecticut River watershed. Legislators made the charge so comprehensive because they realized that, in order to protect migratory fish and other aquatic species, there was a need to protect the whole river system and its watershed; the health of any aquatic ecosystem is linked to the health of the whole watershed upstream. It is one of only three refuges in the National Wildlife Refuge System that has “Fish” in its title (FWS, 2012).

In order to accomplish the purposes of the Conte Act, areas which contribute substantially or in unique ways to protecting the fish, birds, federally listed species, wetlands, and overall biodiversity within the watershed were identified. Land acquisition, a traditional conservation tool, is limited to a few high priority sites or “Special Focus Areas.” As of June 2012, the refuge comprises 35,371 acres extending from northern Vermont and New Hampshire to southern Connecticut (FWS, 2012). The Nulhegan Basin Division in Vermont's Northeast Kingdom accounts for 26,738 acres. There are two divisions in northern New Hampshire (Pondicherry and Blueberry Swamp), three in Massachusetts (Fort River, Mill River, and Westfield River), and one in Connecticut (Salmon River).

These divisions account for 34,783 acres or 98 percent of the refuge acreage. All of these areas are outside and considerable distance from the Project. For more discussion on designated special focus areas along the Connecticut River within the Vernon Project area see section 3.7, *Wildlife and Botanical Resources.*

National Blueways System

In May 2012, the U.S. Department of the Interior designated the 410-mile long Connecticut River as America's first National Blueway (Interior, 2012). Within the Interior Department, the Connecticut River (and other to-be designated rivers) will be given priority for conservation and restoration programs the agency administers, such as funding for fisheries restoration, water conservation, and recreation.

National Heritage River Designation

The Connecticut River was locally nominated, and is designated as an American Heritage River under Presidential Executive Order 13061- Federal Support of Community Efforts along American Heritage Rivers (September 11, 1997). This designation encourages natural resource and environmental protection, economic revitalization, and historic and cultural preservation through federal agency support of community-based efforts to preserve, protect, and restore these rivers and their communities.

National Wild and Scenic River System Designation

Under the National Wild and Scenic Rivers System, in January 1980, the Connecticut River from Newbury, Vermont, to Vernon, Vermont, was identified in the recreation rivers study under a preliminary list of rivers under evaluation. However, this reach of the Connecticut River is not free-flowing because of the three hydroelectric projects in this region (Wilder, Bellows Falls, and Vernon)) and to date no segments of the river within the Project area have been designated under this program.

Connecticut River Byway

Designated a national scenic byway in 2005, the Connecticut River Byway follows the river on both sides throughout New Hampshire and Vermont. More than 500 miles of roads on both sides of the river are included, and encompass the major state roads that border the river as well as several spur routes to scenic areas or special attractions. In the Project area, it follows U.S. Route 5 and New Hampshire routes 63, 12, and 123, passing through historic villages, scenic river overlooks, and river crossings.

Project Lands under Study for Inclusion in National Trails System or Wilderness Area

There are no areas within or in the vicinity of the Project boundary that are included in or have been designated as wilderness areas, recommended for such designation, or designated as a wilderness study area under the Wilderness Act.

State Protected River Segments

The Connecticut River from Fourth Connecticut Lake to the Massachusetts state line has been incorporated into the New Hampshire Rivers Management and Protection Program (RMPP) (New Hampshire RSA 483). The RMPP provides certain instream flow protection measures for designated rivers and a river classification system to match general river characteristics with the specific protection measures. According to New Hampshire RSA 483:7-a, rivers can be classified as natural, rural, rural-community, or community. For each river classification, state law establishes specific protection measures that pertain to structures and activities within the river; these include allowances for dams, hydroelectric energy facilities, channel alterations, maintenance of water quality, protected instream flows, inter-basin water transfers, and recreational uses of those river segments classified as “natural.” The non-overlapping segments within the Vernon Project are classified as rural, rural-community, and community. By law, the only land use protection measures that are included with a river designation are those for solid and hazardous waste facilities. Community segments are designated as such in part to recognize and support associated uses including hydropower.

3.10.7 Regionally or Nationally Important Recreation Areas

Both land and water based recreation opportunities abound throughout New England. Within a 60 mile radius, about an hour’s drive of the Vernon Project, there are over 1,200 ponds, lakes or reservoirs (surface water) that have the potential to provide a water based recreation experience. It’s important to note however that the overwhelming majority of these lakes or ponds are smaller than 100 acres, may not be open to the public and may not offer identical recreation opportunities or experiences as those available within the Vernon Project. There are about 80 lakes, ponds, or reservoirs larger than 250 acres within the 60-mile radius. Figure 3.10-2 shows the relative location of the Vernon Project in the region and potential land- and water-based recreation lands within a 60 mile distance. Table 3.10-3 summarizes the larger bodies of water (greater than 250 acres of open water) within this area that likely provide similar water based recreation opportunities.

In addition to water-based recreation opportunities there are numerous local, state and national forests or parks within the same 60 mile study area. There are thousands of conservation tracts within 60 miles of the Vernon Project in New Hampshire, Vermont and Massachusetts which are shown in figure 3.10-2.[7] There are 128 state or national parks or forests with some portion of their land area within 60 miles of the Project.

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[7] Although conservation easements are known to exist in all three states, only Vermont withholds data pertaining to those easements on private lands from non-research based organizations and thus unavailable to publish in this document at the time of printing. Conservation easements are shown in relation to recreation sites in figure 3.10-1).

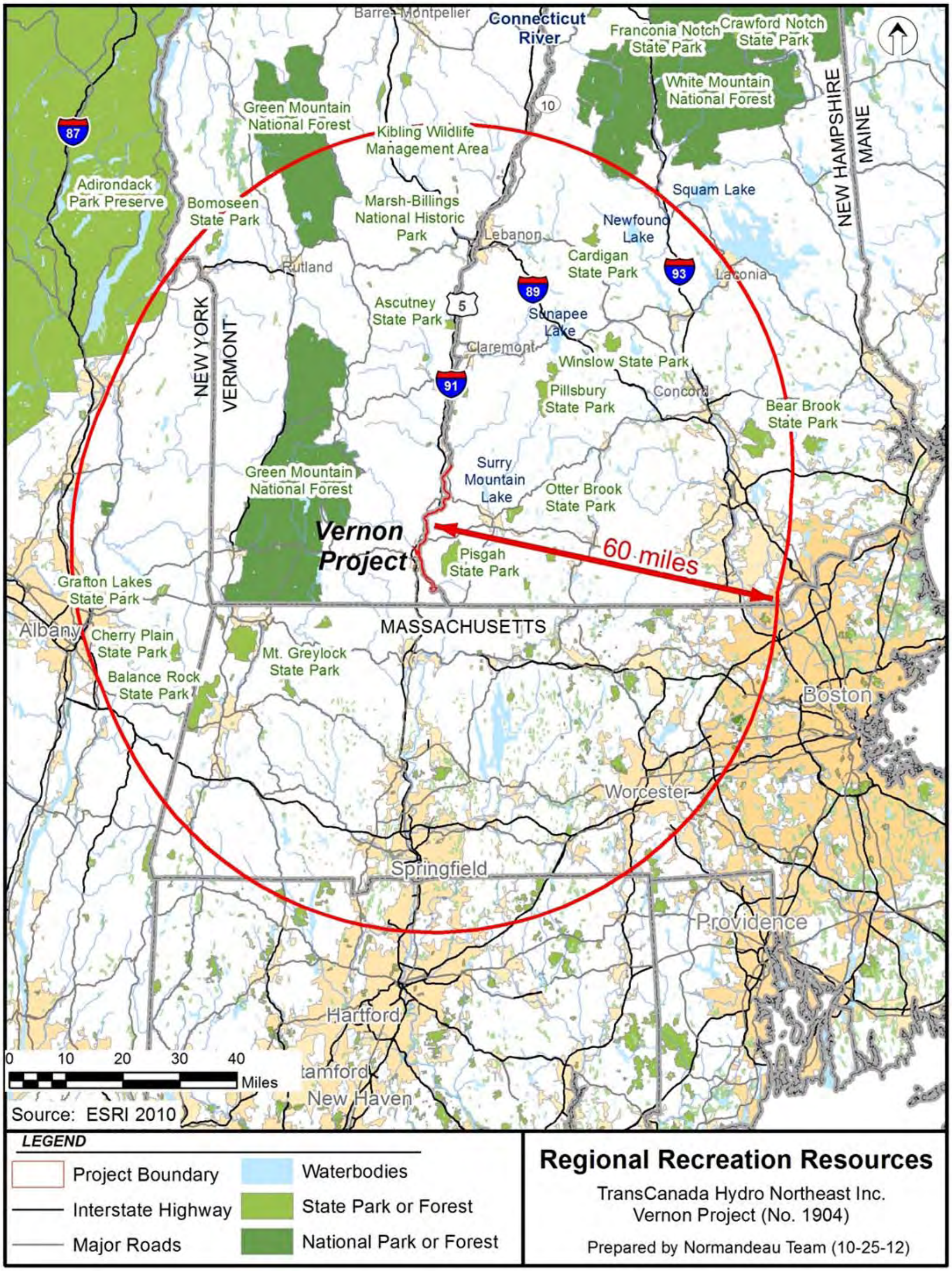

Figure 3.10-2. Land and water based recreation opportunities within 60 miles of the Project.

Table 3.10-3. Reservoirs, lakes, and ponds larger than 250 acres and within 60 miles of the Project.

Lake	Acres
Lake Winnipesaukee*	45,850
Newfound Lake	4,250
Swamp Pond	4,128
Lake Sunapee	4,064
Saratoga Lake	3,718
Bomoseen, Lake	2,330
Barkhamsted Reservoir	2,202
Harriman Reservoir	2,010
Somerset Reservoir	1,498
Massabesic Lake	1,363
Lily Pond	1,338
Long Pond	1,222
Waukewan, Lake	1,101
Pleasant Lake	1,056
Cobble Mountain Reservoir	1,037
Otis Reservoir	992
Goose Pond	960
Highland Lake	954
Sudbury Reservoir	934
Colebrook River Lake	934
Mascoma Lake	864
Saint Catherine, Lake	826
Spofford Lake	736
Nubanusit Lake	736
Flint Pond	704
Chittenden Reservoir	698
Cossayuna Lake	634
Crystal Lake	614
Northwood Lake	595
Webster Lake	589
Lake Monomonac	570
Mud Pond	563
Quaboag Pond	538
Morey, Lake	531
Silver Lake	518
Dobsonville Pond	512
Powder Mill Pond	486
Franklin Pierce Lake	486
Little Sunapee Lake	467
Fairlee, Lake	448
Stockbridge Bowl	390
Springfield Reservoir	390
Massasecum, Lake	390
Sunset Lake	378
Spectacle Pond	371
Big Pond	365
Penacook Lake	365
Tighe Carmody Reservoir	358
Manchaug Pond	346
Little Turkey Pond	339
Grafton Pond	339
Contoocook Lake	333
Glen Lake	326
Weare Reservoir	326
Singletary Pond	320
Eastman Pond	320
Whitin Reservoir	314
Wickaboag Pond	314
Mashapaug Pond	314
Deering Reservoir	314
Bare Hill Pond	314
Stiles Reservoir	307
Walker Pond	301
Upper Naukeag Lake	301
Cobbetts Pond	301
Loon Pond	294
Hickory Hills Lake	294
Mare Meadow Reservoir	288
Canaan Street Lake	288
Pleasant Pond	282
Forge Pond	275
Beaver Lake	275
Nagog Pond	269
Lower Naukeag Lake	269
Lake Lashaway	269
Quinapoxet Reservoir	262
Middle Pond	262
Pemingewasset Lake	256
Littleville Lake	256
Thorndike Pond	250

[a] Limited portion within 60 mile radius of Project.

Table 3.10-4 summarizes the national, state and local parks and forests that provide outdoor recreation opportunities within 60 miles of the Project that are greater than two square miles in size (those thought to provide the most important amounts of land in the region). In addition to the lands shown in table 3.10.7-2, the towns and counties within this area provides an additional 36.2 square miles of lands for recreation purposes.

Table 3.10-4. National, state, county, or municipal parks or forests larger than 2 square miles and within 60 miles of the Project.

Name	Square Miles
National Park or Forest	
Assabet River National Wildlife Refuge	3.4
Green Mountain National Forest	974.4
Saratoga National Historic Park	4.3
White Mountain National Forest[a]	1,260.3
State Park or Forest	
Adirondack Park Preserve[a]	8,845.9
Algonquin State Forest	3.8
Ascutney State Park	2.5
Ashburnham State Forest	22.7
Bates Memorial State Park	20.6
Bigelow Hollow State Park	5.6
Callahan State Park	5.0
Charles Downer State Forest	6.1
Deer Hill State Reservation	7.1
Gifford Woods State Park	3.7
Greenfield State Park	5.2
J Harry Rich State Forest	6.4
Molly Stark State Park	2.7
Moore State Park	24.0
Mount Greylock State Reservation	3.7
Mount Sunapee State Park	9.0
Orange State Forest	4.5
Peebles Island State Park	4.8
Peoples State Forest	8.3
Pillsbury Conserv State Park	8.2
Pillsbury State Forest	19.8
Royalston State Forest	2.2
Thetford Hill State Forest	5.3
Townsend State Forest	4.4
Upton State Forest	3.0
Wadleigh State Park	2.0

Name	Square Miles
Whitehall State Park	3.2
Winchendon State Forest	3.4
Windsor James State Park	6.7
County Park or Forest	
Kibling Wildlife Management Area	2.6

[a] Limited portion within the 60-mile radius of the Project.

3.10.8 Non-recreational Land Use and Management within the Project Boundary

Project operations and maintenance are the primary non-recreational activities that occur within Project lands. Maintenance activities include road maintenance, vegetation/debris clearing, and snow removal. In compliance with the existing Project license, TransCanada has also granted permission to others for the use of Project lands. These permitted uses include agricultural leases, roads, bridges, telephone, and electrical transmission lines. All docks are associated with the private lands that abut the Project but are not on Project land. They are relatively few and have not required a formal permitting process or management.

TransCanada's Wildlife Plan for the Vernon Project lists TransCanada lands that provide wildlife values. In addition to providing wildlife habitat, a dominant land use within the Project boundary is managed through agricultural leases with local farmers. Overall, these lands include:

- Vernon Neck undeveloped open space 125 acres
- Stebbins Island Picnic Area 32 acres
- Hinsdale Natural Area 23.1 acres
- Vernon Agricultural Land 14 acres
- Vernon Natural Area 36.5 acres
- Natural Areas 6.8 acres

3.10.9 Recreational and Non-recreational Land Use and Management Adjacent to the Project Boundary

Land based recreation not associated or dependent on the river is provided by the US Government (e.g., National Forests, USACE recreation at flood control dams), States of Vermont and New Hampshire (e.g., state parks, wildlife management areas, visitor centers), municipal water resource reservations (Quabbin Reservoir, municipal fire districts), neighboring towns (park facilities in Brattleboro, Vermont, and Hinsdale, New Hampshire) public schools, and private businesses (including two private campgrounds in Brattleboro). Property owners throughout the Connecticut River Valley have placed their lands into various conservation easements (e.g., agricultural, open space, habitat protection) which may or may not allow public recreational use of the property depending on the type of easement and any restrictions associated with the deed.

Large enterprises such as Vermont Yankee, a lumber mill, concrete plant, and gravel mining and wastewater treatment operations occupy the shoreline in Vermont south of Brattleboro center. The Wantastiquet Mountain Natural Area is a large, steep, forested tract of land in Hinsdale across the river from Brattleboro. Aside from town centers where commercial and residential land uses dominate, the primary land use around most of the Project is bottom land agriculture. Prime agricultural soils in the corridor are believed by some to be the best agricultural soils located in either state (CRJC, 1997b). The agriculture is a mix of dairy, vegetable, and hay farming operations.

3.10.10 Project Effects

The Project provides multiple water orientated recreation resources to the towns and communities along its shoreline. In addition to the public access points, local businesses dedicated to supplying additional recreation related services and goods (e.g., marinas, overnight lodging and camping, outfitters, downriver float trips, tackle shops) are established in the area providing additional value to the recreation resources. The project is a year round recreation destination for camping, boating, hiking, bird watching, fishing, and snow and ice sports. TransCanada's current exhibit R: Recreation Maps identifies public access areas and open space within Vernon reservoir and immediately downstream of Vernon dam in the project boundary.

Flows in this section depend upon tributary inflow contribution and operations at the upstream dams at Wilder and Bellows Falls, and the river may be shallow in some places in times of low flow. Instream anglers and boaters must be aware of the potential for water releases from the dams because they may result in either gradual or sudden changes in water level and current depending on reach. TransCanada's current Public Safety Plan identifies signs, lights and sirens used to warn the public before changes in operations at the Project. Inherently, due to upstream seasonal storage, flows through the project during typical low flow periods are higher than what they would be in a natural system and as a result there are numerous recreational benefits that result.

During weekends and on holidays from Memorial Day through the beginning of October the water level in the reservoir is kept at 218.6 feet from 4 pm Friday to midnight Sunday. TransCanada may, on rare occasions during these periods, draw down water levels during this period to accommodate dam-related construction projects, or upon request of the states, towns, or railroads for such projects as bridge abutment or rail line infrastructure construction, or maintenance.

Water level fluctuations and lack of freezing of the reservoir in front of and downstream of Vernon dam make it unsafe and impractical for consistent use of these areas for winter ice based recreation activities like ice skating, ice fishing, snowmobiling and cross country skiing.

Both Project and non-project public and private recreational development appear to satisfy present demand. The Project supports long-distance, scenic river corridor experiences in part due to the private and Project rural and agricultural land use that abuts the impoundment. In addition, railroad tracks that parallel the river also limit shoreline encroachment and development. Collectively, these factors have resulted in long impoundment reaches that support high-value, in-stream opportunities that are unique. This aligns closely with recreational goals outlined in the various regional and statewide plans. Due to the largely undeveloped nature of the lands within and adjacent to the Project boundary, which are largely private land with flowage easement retained; shoreline protection laws; local zoning and the lack of over-demand or use conflicts, there does not appear to be sufficient need for a shoreline management plan for this Project.

TransCanada does not propose any changes to the existing Project. Therefore there would be no incremental effects on recreation resources associated with the Project as proposed.

3.10.11 References

CRJC. 2008. Connecticut River Corridor Management Plan, Wantastiquet Region. Charlestown, NH. Available online at: http://www.crjc.org/new%20WR5%20chapter/WATER.LRS5.final.pdf.

CRJC. 1997b. Connecticut River Corridor Management Plan. Summary of the Wantastiquet Region Subcommittee Plan. Charlestown, NH.

FWS (U.S. Fish and Wildlife Service). 2012. Silvio O. Conte National Fish and Wildlife Refuge, Northeast Region Web Site. Accessed at: http://www.fws.gov/r5soc/. (Accessed August 28, 2012).

New Hampshire DES. 2012. Watershed Management Bureau, Designated Rivers Map. March 2012. Available on the web at: http://des.nh.gov/organization/divisions/water/wmb/rivers/documents/designated_rivers.pdf. (Accessed August 28, 2012).

New Hampshire OEP (Office of Energy and Planning). 2007. New Hampshire Statewide Comprehensive Outdoor Recreation Plan (SCORP): 2008-2013. Concord, New Hampshire. December 2007.

SPACE (Statewide Program of Action to Conserve Our Environment). 2007. A Layperson's Guide to New Hampshire Current Use. Available at: http://www.nhspace.org/downloads/SPACE_Laypersons_Guide_07.pdf. (Accessed October 10, 2012).

3.11 AESTHETIC RESOURCES

3.11.1 Summary of Existing Studies

There are numerous existing management plans and policy documents that address the Connecticut River Valley, including the Project vicinity. This section reviews those resources, and places them within the context of existing aesthetic resources. TransCanada has defined the Project effect area for aesthetics as Vernon dam and reservoir within the Project boundary.

The following sources of information were used to describe the aesthetics resources of the Project area:

- Vernon Project exhibit R maps;
- 1970 FERC License application for the Vernon Project;
- 2006 FERC License amendment application for the Vernon Project;
- CRJC Connecticut River Corridor Management Plan; Recreation Plan, Water Resources Plan, and Boating on the Connecticut River maps;
- Regional planning documents, including management plans from Windham Regional Commission and the Southwest Region Planning Commission;
- Brattleboro, Vermont, and Walpole, New Hampshire, town plans; and
- Aerial photos, topographic maps, USGS maps, Connecticut River Paddler Trail map info, and Google Earth.

3.11.2 Visual Characteristics

The Connecticut River Valley is bounded by the Green Mountains in Vermont and the White Mountains in New Hampshire. The U.S. Department of Transportation, Federal Highway Administration, recognizes the valley for its scenery, and designated a distinct collection of roads and waypoint communities as a national scenic byway. The mix of open space, villages, farms, country roads, mountainous terrain, historic architecture, and surface waters in the area provides for scenic vistas and an attractive landscape.

Land use along the corridor of the Connecticut River is primarily rural and agricultural, with considerable land forested and undeveloped. A majority of the land along the New Hampshire side of the river is zoned for limited residential use (New Hampshire DES, 2008). Land cover maps (see figure 3.7-2) show a similar development pattern along the Vermont side of the river. There are infrequent commercial and industrial sites existing developments are well-screened from the river (New Hampshire DES, 2008). Figures 3.11-1 and 3.11-2 show examples of the visual character within the Project.

Figure 3.11-1. Photo of Connecticut River and Vernon reservoir near Dummerston Landing.

Figure 3.11-2. Photo of Vernon reservoir looking north near Putney Boat Landing.

The settlement patterns of Europeans in the Connecticut Valley developed a mosaic of villages and small cities surrounded by rural areas. This pattern persists in many areas today. This pattern of development is characteristic of the valley and lends to its appeal for both visitors and residents (New Hampshire DES, 1997). Town squares with white houses and churches, stately brick homes, and rows of brick mill buildings provide a historic architectural heritage of outstanding quality (New Hampshire DES, 1997).

The Connecticut River and its valley provide some of the most valuable scenic views within Vermont and New Hampshire. The river provides views of long stretches of flat water, surrounding wetlands full of wildlife, views from the river of distant peaks, town hall steeples, vast agricultural fields and farmlands, and traditional New England homes such as those in Brattleboro. U.S. Route 5 from Brattleboro to Bellows Falls parallels the river and is part of the Scenic Byway.

Agricultural fields and working forestlands juxtaposed to dense villages combine to create the traditional New England landscape that residents and tourists cherish. The Vernon Project is located in the fertile soils of the Connecticut River Valley; as such much of the surrounding land use is agricultural and forested areas. Other land use types include: rural residential areas; commercial, industrial, and transportation developments; and wetlands. Railroad tracks are commonly found along the banks on both sides of the river and in proximity to the Project along the shoreline.

Vernon dam is adjacent to Vermont Route 142, and an obstructed view through the trees of the Governor Hunt Recreation Area to the dam and Project facilities is available to motorists on this road. The brick construction of the powerhouse is consistent for historic buildings throughout the Connecticut River Valley because brick is a common building material for the area and era of construction. The fish ladder provides a viewing area to people visiting the dam. Views of the river in the Project area are provided at public access points up and down the river as well as at the Walpole-Westminster bridge, Route 9 bridge in Brattleboro, the Route 119 bridge in Brattleboro, and select sections of U.S. Interstate 91, U.S. Route 5, Routes 142 and 119, and local roads paralleling the river. Railroad tracks along the shoreline limit access to the river and corresponding views within the town of Brattleboro, the largest concentration of people along this stretch of the river.

3.11.3 Project Effects

The river is a significant landform and integral part of the history of the towns along the river including the small city of Brattleboro. Operation of the Project is visible from numerous points around it. Undeveloped steep wooded shorelines, railroad corridors and agricultural lands adjacent to the impoundment maintain a serene, intimate corridor, typical of this portion of the Connecticut River Valley. These types of uses and the resulting visual character are marketed throughout the region to stimulate tourism within the valley.

The normal operating range of the Vernon Project is 2 feet or less depending upon inflow as described in section 2.5, *Current Project Operations.* The primary impact of operations is the amount of shoreline that is visible as the Project stores and releases water for generation needs. TransCanada mitigates these impacts by voluntarily holding the reservoir level at a normal pool elevation of 220 feet from Friday at 4 pm through Sunday at midnight during the summer recreation season (May 21 – September 16).

Overall, the reservoir is aesthetically pleasing to view. Aesthetic impacts associated with operations are limited to a narrow band of exposed bank associated with reservoir drawdown. Within the context of the larger exposed banks caused by erosion during high flow events the band is small. Exposed mudflats and shoal areas surrounding tributaries in the more downstream portions of the impoundment are the result of river profile operations necessary to contain high flows within the banks of the river upstream. Changes in the amount of exposed shoreline are most noticeable where the river bank slopes are gentle. This type of shoreline highlights the visual contrasts of changing reservoir elevations as compared to steep or armored shorelines as the changes expose the native soils between the vegetation at the high water mark and a drawn down reservoir. Given the size of the Connecticut River and its prominence within the greater landscape setting, a less than 2-foot change in reservoir elevation is a modest change and likely to be barely perceptible to the majority of observers in the vicinity of the Project.

TransCanada does not propose any changes to the existing Project. Therefore there would be no associated effects on aesthetic resources.

3.11.4 References

New Hampshire DES. 2008. New Hampshire Rivers Management and Protection Program, Connecticut River Report to the General Court.

New Hampshire DES. 1997. New Hampshire Rivers Management and Protection Program, River Nomination Form, Connecticut River. July 15, 1991.

Southern Windsor County RPC (Regional Planning Commission). 2009. 2009 SWCRPC Regional Plan. http://swcrpc.org/wp/wp-content/uploads/2011/08/2009-SWCRPC-Regional-Plan.pdf. (Accessed October 15, 2012).

3.12 CULTURAL RESOURCES

3.12.1 Discovery Measures

Under the National Historic Preservation Act (NHPA) and its implementing regulations found at 36 C.F.R. § 800(m), the term “historic properties” is applied to any prehistoric or historic district, site, building, structure, object, or Traditional Cultural Property (TCP) included in, or eligible for inclusion in, the National Register of Historic Places (National Register; 36 C.F.R. § 800.16[l]). TCPs are defined as those properties that are eligible for inclusion in the National Register because of their “association with cultural practices or beliefs of a living community that are (a) rooted in that community’s history, and (b) are important in maintaining the continuing cultural identity of the community” (Parker and King, 1998). For purposes of this PAD, the term “cultural resources” is applies to any pre-contact or historic district, site, building, structure or TCP regardless of the resource’s individual National Register eligibility.

Archaeological and Historic Studies

Section 106 of the NHPA requires the determination of a Project's area of potential effects (APE) in consultation with the appropriate State Historic Preservation Offices (SHPOs). According to the implementing regulations of the NHPA, the APE is defined as "the geographic area or areas within which an undertaking may direction or indirectly cause changes in the character or use of historic properties if such properties exist" (36 C.F.R. § 800.16[d]). The APE directly relates to the area to be studied for cultural resources. TransCanada established an APE for the Project that conforms to the Project boundaries and encompasses all lands owned in fee simple, the impoundment area, and areas along the banks of Vermont and New Hampshire shoreline from Vernon dam north to Walpole Bridge where flowage rights are maintained (Olausen and Cherau, 2008). The APE includes all known historic properties associated with the Vernon Project, including the buildings and structures associated with historic hydroelectric development and archaeological sites and archaeologically sensitive areas that have been identified. The APE also encompasses all areas where Project operations and other known Project activities are likely to occur and have the potential to affect historic properties.

There has been one archaeological survey undertaken specifically for the Project prior to studies completed for the current licensing effort. This study was completed by PAL in 2007 and consisted of a Phase IA survey of the Project APE (Cherau and O'Donnchadha, 2008, as cited by Olausen and Cherau, 2008). This study resulted in the documentation of archaeological sites within, or in proximity to, the Project boundaries as well as areas of archaeological sensitivity along the Project shorelines in Vermont and New Hampshire.

In 1998-1999, PAL completed a study to identify historic standing structures within the Deerfield and Connecticut River hydroelectric systems (Doherty and Kierstead, 1999, as cited by Olausen and Cherau, 2008). The purpose of this study was to establish a baseline archival record of information for all of the hydroelectric developments along the rivers then owned by TransCanada's predecessor and record baseline conditions. The documentation was completed in accordance with the standards of the National Park Service's Historical American Engineering Record (HAER) program and Vermont, New Hampshire, and Massachusetts documentation standards.

Earlier, in 1990, a Phase I survey for a proposed riverbank erosion control study was completed by the University of Massachusetts Archaeological Service (Holmes et al., 1991, as cited by Olausen and Cherau, 2008). This study included the Vernon dam tailrace area.

2008 Historic Properties Management Plan

In 2008, TransCanada prepared a Historic Properties Management Plan (HPMP; Olausen and Cherau, 2008) for the Vernon Project in accordance with the requirements of a 2006 Memorandum of Agreement (MOA) among the Commission, TransCanada, New Hampshire SHPO, and Vermont SHPO to address adverse effects associated with a license amendment to Units 5-8 repowering project as well as the future operation of the hydro project in general. The HPMP was approved by the Commission in January 2010. The HPMP contains a discussion of previous cultural resources studies undertaken for, or in the vicinity of the Vernon Project, including a large-scale survey undertaken in 1990 by the University of Massachusetts Archaeological Series for the downstream Turners Falls Development (Holmes et al., 1991, as cited by Olausen and Cherau, 2008). This study included the Vernon Dam tailrace shorelines. A more recent Phase IA archaeological survey was conducted specifically for the Vernon Project in 2007 (Cherau and O'Donnchadha, 2008, as cited by Olausen and Cherau, 2008). This survey identified archaeological sites potentially affected by the Project as well as sensitive areas along the Project shorelines in Vermont and New Hampshire. The HPMP describes these resources with details provided in the associated Phase IA report and outlines processes and procedures for addressing potential impacts to historical properties.

3.12.2 Cultural, Historical, and Archaeological Resources

Archaeological and Historic-era Resources

According to the Vernon HPMP, 37 cultural resource sites are located within the Project APE (Olausen and Cherau, 2008) (table 3.12-1). Eleven of the resources are exclusively from the pre-contact period, and 26 sites are exclusively from the historic period. The pre-contact period resources consist of sites that are primarily characterized as lithic scatters (stone tools, and/or tool-making debris), but several contain glass or copper trade beads indicating use during the contact period, and one is a petroglyph site. The historic period resources comprise a mixture of historic structures including historic forts, dwellings, bridge and ferry crossing features, and industrial buildings.

Table 3.12-1. Summary of documented pre-contact and historic resources located within the Project APE.

State Site Number	Project Vicinity	Site Type[a]	Brief Description	Temporal / Cultural Affiliation	Location Relative to the Project[a]	National Register Eligibility
27-CH-85	Hinsdale, NH	P	Features, projectile points, ceramics. glass trade beads, chipping debris (chert, shist)	Late Woodland/contact period village	Fee-owned lands	Eligible; possible National Historic Landmark (not listed)
VT-FS-06 (WD)	Putney, VT	H	Not discovered to date	ca 1755 to ca 1760	Shoreline diversion and flowage rights	Undetermined
VT-FS-15 (WD)	Vernon, VT	P	Reported Native American encampment during King Philip's WarNo finds, local tradition	17th Century King Philips War 1675-1676	Shoreline - diversion and flowage rights	Undetermined
VT-WD-01	Vernon, VT	P	Groundstone pestle, copper beads, poundstone, pottery, burials	Contact/early historic period?	Shoreline - diversion and flowage rights	Undetermined
VT-WD-03	Brattleboro, VT	P	Ground and chipped stone tools, aboriginal	Early Archaic; Late Archaic (Laurentian); Middle Woodland;	Shoreline - diversion and flowage rights	Undetermined

State Site Number	Project Vicinity	Site Type[a]	Brief Description	Temporal/ Cultural Affiliation	Location Relative to the Project[a]	National Register Eligibility
			pottery	Late Woodland		
VT-WD-05	Vernon, VT	P	Groundstone hammer, pestle, mortar, projectile points	Unknown	Shoreline - diversion and flowage rights	Undetermined
VT-WD-07	Brattleboro, VT	P	West River petroglyphs	Unknown	Shoreline - diversion and flowage rights	Undetermined
VT-WD-08 (WD)	Vernon, VT	P	Aboriginal pottery, unknown artifacts in Needham Collection	Unknown	Shoreline - diversion and flowage rights	Undetermined
VT-WD-10	Vernon, VT	P	Projectile points, glass trade bead, copper beads, copper "Thunderbird", gorge, gorget, nutting stones, pestle, pottery	Archaic through Woodland periods; Squakhaeg Village - contact/early historic period	Shoreline - diversion and flowage rights	Eligible

State Site Number	Project Vicinity	Site Type[a]	Brief Description	Temporal/ Cultural Affiliation	Location Relative to the Project[a]	National Register Eligibility
VT-WD-13	Brattleboro, VT	H	Stone foundation remains of fortification and possible 19th Century building; associated artifact assemblage	19th Century	Shoreline diversion and flowage rights	Undetermined
VT-WD-18	Dummerston, VT	P	Unknown. No form on file	No information	Shoreline - diversion and flowage rights	Undetermined
VT-WD-34	Brattleboro, VT	P	Two loci: northern one heavily disturbed, southern one yielded quartz and quartzite flakes, large quartzite scraper and fire-cracked rocks	PaleoIndiand and/or Early Archaic Period (?)	Shoreline - diversion and flowage rights	Potentially Eligible
None yet assigned	Hinsdale, NH	P	"Indian encampment"	Suspected part of King Philip's winter encampment 1676-1676	Fee-owned lands	Undetermined

State Site Number	Project Vicinity	Site Type[a]	Brief Description	Temporal / Cultural Affiliation	Location Relative to the Project[a]	National Register Eligibility
B-2	Brattleboro, VT	H	Mill building	19th Century	Shoreline diversion and flowage rights	Undetermined
B-3	Brattleboro, VT	H	Industrial building	19th Century	Shoreline diversion and flowage rights	Undetermined
B-4	Brattleboro, VT	H	Industrial building	19th Century	Shoreline diversion and flowage rights	Undetermined
B-5	Brattleboro, VT	H	Industrial building	19th Century	Shoreline diversion and flowage rights	Undetermined
B-6	Brattleboro, VT	H	Industrial building	19th Century	Shoreline diversion and flowage rights	Undetermined
B-7	Brattleboro, VT	H	Industrial building	19th Century	Shoreline diversion and flowage rights	Undetermined
B-8	Brattleboro, VT	H	Industrial building	19th Century	Shoreline diversion and flowage rights	Undetermined

State Site Number	Project Vicinity	Site Type[a]	Brief Description	Temporal/ Cultural Affiliation	Location Relative to the Project[a]	National Register Eligibility
B-9	Brattleboro, VT	H	Industrial building	19th Century	Shoreline diversion and flowage rights	Undetermined
B-10	Brattleboro, VT	H	Railroad spur	19th Century	Shoreline diversion and flowage rights	Undetermined
B-11	Brattleboro, VT	H	Dwelling (?)	19th Century	Shoreline diversion and flowage rights	Undetermined
C-1	Chesterfield, NH	H	Ferry landing	19th Century	Shoreline diversion and flowage rights	Undetermined
C-2	Chesterfield, NH	H	Dwelling	19th Century	Shoreline diversion and flowage rights	Undetermined
C-3	Chesterfield, NH	H	Ferry landing	19th Century	Shoreline diversion and flowage rights	Undetermined
C-4	Chesterfield, NH	H	Log cabin	18th Century	Shoreline diversion and flowage rights	Undetermined

State Site Number	Project Vicinity	Site Type[a]	Brief Description	Temporal/ Cultural Affiliation	Location Relative to the Project[a]	National Register Eligibility
D-1	Dummerston, VT	H	Dwelling/ferry landing	19th Century	Shoreline diversion and flowage rights	Undetermined
D-2	Dummerston, VT	H	Dwelling/ferry landing	19th Century	Shoreline diversion and flowage rights	Undetermined
H-1	Hinsdale, NH	H	Shattuck's Fort	18th Century	Shoreline diversion and flowage rights	Undetermined
P-1	Putnam (Putney?), VT	H	Dwelling	19th Century	Shoreline diversion and flowage rights	Undetermined
P-2	Putnam (Putney?), VT	H	Ferry landing	19th Century	Shoreline diversion and flowage rights	Undetermined
V-1	Vernon, BT	H	Vernon Dam worker's camp	Early 20th Century	Fee-owned lands	Undetermined
W-1	Westminster, VT	H	Bridge abutments	19th Century	Shoreline diversion and flowage rights	Undetermined

State Site Number	Project Vicinity	Site Type[a]	Brief Description	Temporal/ Cultural Affiliation	Location Relative to the Project[a]	National Register Eligibility
Wa-1	Walpole, NH	H	Bridge abutments	19th Century	Shoreline diversion and flowage rights	Undetermined
We-1	Westmoreland, NH	H	Ferry landing	19th Century	Shoreline diversion and flowage rights	Undetermined
We-2	Westmoreland, NH	H	Ferry landing	19th Century	Shoreline diversion and flowage rights	Undetermined

[a] P = Strictly pre-contact, H = strictly historic-era.

[b] Flowage rights = rights to flow water but no land access rights.

Historic Hydroelectric System Features

The Project was constructed between 1907 and 1909 and consists of the Vernon powerhouse, which is a Renaissance Revival-style building, and the Vernon dam, a concrete gravity dam that spans the Connecticut River. The Project was the first large-scale hydroelectric development constructed remote from a load center and requiring transmission in New England. It was developed by Chase & Harriman, who later formed the largest power-generating company in the region (Olausen and Cherau, 2008). The Project was also the first plant in the Northeast to deliver electricity through long distance transmission lines. Historic structures associated with the Project include the Crew Shack, Hoister House, Pump House, Superintendent's House, and Superintendent's garage.

In October 2006, TransCanada initiated the Vernon repowering project to replace and upgrade generation within the Vernon powerhouse by removing four of the original 2-MW generating units and replacing them with four new 4-MW units.

3.12.3 Sites of Cultural Significance to Indian Tribes

There are no federally recognized tribes in the states of Vermont and New Hampshire. However, on April 12, 2011, the state of Vermont formally recognized the Elnu Abenaki and Nulhegan Band of Coosuk Abenaki Nation as State-recognized Bands. Non-recognized tribes in the state of Vermont include the Traditional Abenakis of Mazipskwik and the Abenaki Nation of Mississquoi. In the state of New Hampshire, there are two non-recognized tribes: the Abenaki Nation of New Hampshire and the Penacook New Hampshire Tribe. In accordance with the HPMP, any tribal consultation should be in the form of written correspondence describing the nature of any cultural resources investigation (Olausen and Cherau, 2008).

As noted above, TCPs are defined as those cultural resources that are eligible for inclusion in the National Register because of their "association with cultural practices or beliefs of a living community that are (a) rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1998). These resources may include geographic places, natural resource procurement locations, and other features and locations of spiritual or cultural significance to tribes.

To date, no tribes have expressed concern regarding cultural resources, including potential TCPs, within the Project APE.

In addition to TCPs, tribes may also have interests in previously unidentified cultural materials that may be identified within the Vernon APE during Project activities or during routine operation and maintenance. Should such materials be identified, TransCanada would:

1. Halt all work in the immediate vicinity of the discovery;
2. Assume that the find is eligible for listing in the National Register;
3. protect it until a formal determination of eligibility can be made;

4. Consult with the New Hampshire or Vermont SHPO to determine if the find is significant; and
5. If the find is determined to be significant, continue to consult with the New Hampshire or Vermont SHPO to assess the effects of project activities on the property and to determine appropriate mitigation measures.

If human remains are encountered during project operations or other Project activities, they would not be removed, and care will be taken to protect them in place from any activity that might result in vandalism or other damage. The appropriate county medical examiner and law enforcement agencies would be notified in accordance with Vermont Statutes and New Hampshire Statute 227-C. The treatment and disposition of any human remains would take into account each state's SHPO consultation process and the ACHP's *Policy Statement Regarding Treatment of Human Remains and Grave Goods* (ACHP, 1988). TransCanada and the New Hampshire or Vermont SHPO and other parties, as determined by law, would be consulted according to the statutory processes. If protection in place is not possible and the remains must be removed, appropriate special permits would be obtained in consultation with the New Hampshire or Vermont SHPO prior to excavation, collection, or transportation of the remains.

3.12.4 National Register Eligibility and Cultural Values

Individual resource significance can be defined in a number of ways. The legal definition of significance of a site for the National Register is codified at 36 C.F.R. § 60.4:

> *National Register criteria for evaluation.* The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and (a) **that are associated with events** that have made a significant contribution to the broad pattern of our history; or (b) **that are associated with the lives of persons** significant in our past; or (c) **that embody the distinctive characteristics** of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or (d) **that have yielded, or may be likely to yield, information** important in prehistory or history[8].

In addition to the criteria set forth at 36 C.F.R. § 60.4, properties can have other cultural values that should be considered. Amendments to the National Historic Preservation Act in 1992 (§101(d)(6)(A)) specify that TCPs claimed by an Indian

[8] Emphasis added.

tribe may be determined eligible for inclusion in the National Register. No potential TCPs have been identified within the Project APE.

Of the 37 resources in the study area, two are eligible for listing on the National Register (VT-WD-10, 27-CH-85). One of these (27-CH-85) may also be an unlisted National Historic Landmark. One additional resource is potentially eligible for listing (VT-WD-34). The National Register eligibility of the remaining 34 resources within the APE has not been determined.

The structures that comprise the Vernon Project, including the ancillary houses and other buildings, have been determined by the Vermont SHPO and New Hampshire SHPO to be eligible for listing on the National Register as a historic district under criteria A and C at the state level in the areas of Industry, Engineering, and Architecture. The Project is significant as the first large-scale hydroelectric development to be built in New England and as the first plant to transmit energy in the region through long-distance transmission lines (Olausen and Cherau, 2008).

3.12.5 Project Effects

Between 2006 and 2008, the Vernon Repowering Project was initiated and completed. Because the powerhouse is eligible for listing on the National Register, an MOA to resolve adverse effects associated with the modifications was executed between the Commission, Vermont SHPO, New Hampshire SHPO, and TransCanada on April 17, 2007. The MOA called for completion of the following measures:

1. Photo documentation of the powerhouse;
2. Digital video documentation of key stages of the project to record the removal of the original equipment and installation of the new equipment;
3. Archaeological investigations to identify known archaeological sites and areas within the project boundaries that have a likelihood of containing archaeological deposits;
4. Preparation of a HPMP; and
5. An offer, if accepted, to donate the generating and electrical equipment removed from the powerhouse to museums and educational organizations.

All of these mitigation measures were implemented, including development of the HPMP, and on June 19, 2009, the New Hampshire SHPO concurred that all of the requirements of the MOA had been met.

In its HPMP, TransCanada states that there are no ongoing or planned Project-related activities with the potential to impact historic properties. However, the HPMP identifies various Project-related activities that could affect historic properties in the future including:

- Ground disturbance associated with any new construction of new Project buildings or infrastructure;
- Modification of Project shorelines, including those related to the installation of active soil erosion and sediment control measures, and re-vegetation measures;
- Recreational use; and
- Modifications to the character-defining features of contributing components of the Vernon Hydroelectric Project Historic District.

Additionally, the HPMP identifies looting and unauthorized excavation activities as an ongoing problem at archaeological site 26-CH-85. To remedy this problem, the HPMP states that TransCanada would monitor the site and consult with the New Hampshire SHPO to determine and implement protection controls by December 30, 2008. The monitoring effort produced no evidence of further looting or excavations.

The HPMP includes requirements for archaeological monitoring, personnel training, assessment of effects to historic properties (including historic structures), the treatment of human remains and unanticipated discoveries, public interpretation, and consultation with the Vermont and New Hampshire SHPOs, ACHP, Commission, and tribes as appropriate. Further, the HPMP includes a list of activities that are exempt from further review.

3.12.6 References

Cherau, S. and B. O'Donnchadha. 2008. Phase IA archaeological Reconnaissance Survey, Vernon Hydroelectric Project (FERC No. 1904, Windham County, Vermont and Cheshire County, New Hampshire. Public Archaeology Laboratory, Pawtucket, RI. Submitted to TransCanada Northeast Hydro, Concord, NH.

Doherty, J. and M. Kierstead. 1999. Deerfield and Connecticut River Hydroelectric Projects System-wide Historical and Photographic Documentation. Report submitted to USGen, New England, Inc.

Holmes, R.D., M.T. Mulhollard, and C.D. Hertiz. 1991. Archaeological Reconnaissance Survey for the Proposed Riverbank Erosion Control Study, Massachusetts, Vermont, and New Hampshire. University of Massachusetts, Archaeological Services Report. Submitted to Northeast Utilities, Hartford, CT.

Olausen, S.A. and S.G. Cherau. 2008. Historic Properties Management Plan, Vernon Hydroelectric Project, FERC No. 1904. PAL Report No. 2092. Public Archaeology Laboratory, Pawtucket, RI. Submitted to TransCanada Hydro Northeast, Inc., Concord, NH.

Parker, P.L. and T.K. King. 1998. National Register Bulletin 38, Guidelines for Documenting and Evaluating Traditional Cultural Properties. U.S.

Department of the Interior, National Park Service, National Register, History and Education, National Register of Historic Places. Washington, DC.

3.13 SOCIOECONOMIC RESOURCES

3.13.1 Overview

The Project is located in Windham County in Vermont and Cheshire County in New Hampshire. The reservoir extends about 26 miles upstream along about 69 miles of shoreline. The communities of Vernon, Brattleboro, Dummerston, Putney, and Westminster are located in Vermont, from south to north along the river, within or within proximity to the Vernon Project. The New Hampshire communities of Hinsdale, Chesterfield, Westmoreland, and Walpole are located, from south to north along the river, within proximity to the Project. The relatively larger communities of Keene, Swanzey and Winchester lie to the east of the Vernon Project. Greenfield, Massachusetts, lies to the south.

3.13.2 Summary of Existing Studies

The following sources of information were used to describe the socioeconomic resources of the Project vicinity, which includes the counties of Windsor, Windham, and Orange in Vermont, and Grafton, Cheshire, and Sullivan counties in New Hampshire, we consulted records of the U.S. Census Bureau and gathered information from relevant plans by Regional Planning Commissions including the Windham Regional Plan (2009) and the Southwest Region Natural Resources Inventory (2003).

3.13.3 Land Use Patterns

This region is predominantly rural, and the vast majority of the land is undeveloped. Specifically, in the southeast region of Vermont (primarily Windham County), 86 percent of the land is forested and only 6 percent is open space, which includes agriculture. Less than 5 percent of the region falls into urban or developed areas, such as residential, commercial, industrial, and public or semi-public uses. The town of Brattleboro is a socioeconomic center within Windham County, Vermont, with more than 12,000 residents. The remaining 3 percent of the region is covered by water or wetlands (Windham Regional Commission, 2006). Physical limitations have played a dominant role in the region's development patterns, with linear development with the river and stream valleys establishing the road system along those streams, linking village nodes in each major valley (Windham Regional Commission, 2006). The region's open lands include agriculture, and many of those lands are located in the Connecticut River Valley. Agriculture remains an important and defining component of the region's landscape, and the Connecticut River Valley has the largest amount of prime farmland in the region.

The landscape of the southwest region of New Hampshire (primarily Cheshire County) is mostly forested with rural and suburban residential development dispersed between village centers (Southwest Region Planning Commission, 2003). Most of the land area in the region is zoned for low density residential use, with a variety of agricultural and commercial uses interspersed. A relatively small proportion of the land in southwest region towns is zoned for medium- or high-density residential, commercial, or mixed uses, and these areas are usually existing village centers and downtowns, with a few small areas zoned exclusively for commercial or industrial use (Southwest Region Planning Commission, 2003). The western portion of the southwest region is dominated by Keene as a socioeconomic center, with employment, commercial, and population centers at the intersection of a number of New Hampshire roads and highways (Southwest Region Planning Commission, 2003).

3.13.4 Population and Demographic Patterns

Cheshire County, New Hampshire, and Windham County, Vermont, had estimated 2012 populations of 77,117 and 44,513, respectively. Growth in population in these counties has been positive between 1990 and 2010, although both states have grown at a slightly higher rate of growth than the counties. Both counties are relatively less populated than their respective states overall, although Cheshire County is more populated than Windham County. Table 3.13-1 shows regional county and state population trends.

Table 3.13-1. Population trends in the Project vicinity (Source: U.S. Census, 2010a).

State and County	1990	2000	2010	Percent Change 1990-2000	Percent change 2000-2010	Population per Square Mile (2010)
Cheshire County, NH	70,121	73,825	77,117	5%	4%	109
New Hampshire	*1,109,252*	*1,235,786*	*1,316,470*	*11%*	*7%*	*147*
Windham County, VT	41,588	44,216	44,513	6%	1%	57
Vermont	*562,758*	*608,827*	*625,741*	*8%*	*3%*	*67*

Table 3.13-2 displays the demographic information for the counties in the Project region as well as state information for comparison. The population density in the counties is lower than their respective state population densities, reflecting the rural nature of these counties. Additionally, the counties in the Project region have slightly older populations and higher proportions of white residents when compared to their respective state populations.

Table 3.13-2. 2010 Demographic statistics for counties in the Project region (Source: U.S. Census, 2010a, Demographic Summary File).

Demographic Indicator	Windham County	Vermont	Cheshire County	New Hampshire
Geography and Population				
Population	44,513	625,741	77,117	1,316,470
Area (Square Miles)	*785*	*9,217*	*707*	*8,953*
Population Density (persons per square mile)	57	67	109	147
Gender				
Male	*49.1%*	*49.3%*	*48.8%*	*49.3%*
Female	*50.9%*	*50.7%*	*51.2%*	*50.7%*
Age				
Persons under 5 years old	*4.8%*	*5.1%*	*4.8%*	*2.7%*
Persons under 18 years old	*19.9%*	*20.7%*	*19.6%*	*21.8%*
Persons 18 to 64 years old	*64.0%*	*64.7%*	*65.7%*	*64.7%*
Persons 65 years old and over	*16.1%*	*14.6%*	*14.7%*	*13.5%*
Race				
White	*95.3%*	*95.3%*	*96.3%*	*93.9%*
Black	*0.9%*	*1.0%*	*0.5%*	*1.1%*
American Indian and Alaska Native	*0.3%*	*0.4%*	*0.3%*	*0.2%*
Asian	*1.0%*	*1.3%*	*1.2%*	*2.2%*
Hispanic or Latin (for any race)	*1.7%*	*1.5%*	*1.4%*	*2.8%*
Two or More Races	*2.0%*	*1.7%*	*1.4%*	*1.6%*

Demographic Indicator	Windham County	Vermont	Cheshire County	New Hampshire
Households				
Number of Households	*18,290*	*256,442*	*30,204*	*518,973*
Average Size of Households	*2.23*	*2.34*	*2.40*	*2.46*

The largest city in proximity to the Vernon Project is Brattleboro, Vermont, which is located about 6 miles north of the Project. Brattleboro has a population of about 12,000. The city of Keene, New Hampshire, with a population of 23,400, is located about 16 miles from the Project. Vernon, Vermont, and Hinsdale, New Hampshire, are the closest towns to the Vernon Project. Table 3-13-3 identifies the closest communities to the Vernon Project.

Table 3.13-3. Population of cities and towns near the Project (Source: U.S. Census, 2010a).

County	Cities and Towns	2010 Population
Windham County, VT	Brattleboro	12,046
	Putney	2,702
	Westminster	3,178
	Vernon	2,206
	Dummerston	1,864
Cheshire County, NH	Chesterfield	3,604
	Hinsdale	4,046
	Westmoreland	1,874
	Walpole	3,734
	Winchester	4,341
	Swanzey	7,230
	Keene	23,409

3.13.5 Employment and Income

The counties of Cheshire, New Hampshire, and Windham, Vermont, have an employed labor force of about 63,000, which accounts for 6 percent of Vermont and New Hampshire's employed labor force. Unemployment in Cheshire County, New Hampshire, was 10 percent in 2010, higher than the state's unemployment rate of 7 percent. Median household income in the two counties was lower than the respective state income, with Cheshire County considerably lower at $52,644 compared to New Hampshire's median household income of $61,989. Labor force and income figures are summarized in table 3.13-4.

Table 3.13-4. 2010 County and state labor force and income (Source: U.S. Census, 2010b).

Labor Force and Income	Cheshire, NH	New Hampshire	Windham, VT	Vermont
Civilian Labor force	44,472	745,784	24,872	351,795
Employed	40,141	696,250	23,247	328,350
Unemployed	4,331	49,534	1,625	23,445
Percent Unemployed	10%	7%	7%	7%
Median Household Income	$52,644	$61,989	$47,386	$51,605

Table 3.13-5 summarizes employment by industry. Across the two counties and the states, educational services and healthcare and social assistance remains an important sector employing almost 30 percent of the workforce in both counties. Other important employing industries include manufacturing; retail trade; and arts, entertainment, and recreation and accommodations and food services.

Table 3.13-5. 2010 Employment by industry in Project counties (Source: U.S. Census, 2010b).

Industry	Windham, Vermont	Vermont	Cheshire, New Hampshire	New Hampshire
Civilian employed population 16 years and over	23,247	328,350	40,141	696,250
Agriculture, forestry, fishing and hunting, and mining	2.8%	2.7%	0.8%	0.8%
Construction	8.4%	7.5%	6.5%	7.2%
Manufacturing	9.9%	10.4%	14.8%	13.0%
Wholesale trade	4.0%	2.6%	4.3%	3.0%
Retail trade	10.7%	12.0%	12.4%	13.1%

Industry	Windham, Vermont	Vermont	Cheshire, New Hampshire	New Hampshire
Transportation and warehousing, and utilities	3.6%	3.5%	4.3%	3.8%
Information	1.8%	2.0%	1.6%	2.2%
Finance and insurance, and real estate and rental and leasing	4.7%	4.8%	5.3%	6.7%
Professional, scientific, and management, and administrative and waste management services	7.1%	8.9%	6.3%	10.1%
Educational services, and health care and social assistance	29.5%	27.2%	28.9%	23.8%
Arts, entertainment, and recreation, and accommodation and food services	10.0%	9.2%	8.3%	8.1%
Other services, except public administration	4.2%	4.4%	4.3%	4.3%
Public administration	3.3%	4.8%	2.1%	3.8%

3.13.6 Project Effects

Operation of the three Lower Connecticut River Hydroelectric Projects at Wilder, Bellows Falls, and Vernon has a considerable positive impact on the local economies in the region. Although there are employees assigned to each project, the crews rove between locations and address work project needs that arise. For that reason, these effects are summarized for all three Lower Connecticut projects. The total union workforce payroll for the three projects for 2011 was $2.1 million and non-union payroll amounted to $850,000 for a total payroll impact of just under $3 million.

In addition to wages and benefits paid to employees who live locally, TransCanada also purchases many goods and services within the local area, including fuel, vehicle maintenance, plant-related consumables and equipment, construction services and materials, and office supplies, among others. For 2011, materials purchased in the local area amounted to $156,000, and another $144,800 was paid to local vendors for services to the three projects including the Operations Center at Wilder and the engineering and support functions in Lebanon and North Walpole, New Hampshire.

TransCanada, through its Community Investment Program, also contributed approximately $170,000 in charitable donations in 2011 to 28 qualified non-profit grantee organizations serving the region (combined for the Wilder, Bellows Falls, and Vernon projects). The grants were made for a variety of educational, environmental, social service, arts and culture, and health and wellness projects to benefit the region.

Finally, TransCanada is a large property owner, and in 2011, paid over $8 million in local property taxes to New Hampshire and Vermont communities within all three Lower Connecticut project boundaries. In addition, TransCanada pays business taxes to the states of New Hampshire and Vermont as well as utility property tax in New Hampshire.

3.13.7 References

Southern Windsor County Planning Commission. 2009. 2009 SWCRPC Regional Plan. http://swcrpc.org/wp/wp-content/uploads/2011/08/2009-SWCRPC-Regional-Plan.pdf. (Accessed October 15, 2012).

Southwest Region Planning Commission. 2003. Southwest Region Natural Resources Inventory. http://www.swrpc.org/files/data/nat_res/Southwest%20Region%20NRI.pdf. (Accessed October 15, 2012).

U.S. Census. 2010a. 2010 Decennial Census, SF1. Total Population for Counties and County Subdivisions. Available: http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

U.S. Census. 2010b. American Community Survey, 2008-2010 Estimates for Counties, States, and County Subdivisions. Available: http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

3.14 TRIBAL RESOURCES

3.14.1 Summary of Existing Studies

The following sources of information were checked for information about tribes in Vermont and New Hampshire who may have resource interests in the Project area:

- Abenaki Nation of Missisquoi. http://tribal.abenakination.com (accessed August 22, 2012).

- Bureau of Indian Affairs. http://www.bia.gov (accessed August 22, 2012).
- Cowasuck Band–Pennacook/Abenaki people. http://www.cowasuck.org.
- Elnu Abenaki tribe. http://elnuabenakitribe.org (accessed August 21, 2012).
- Koasek Abenaki of the Koas http://www.koasekabenaki.org (accessed August 22, 2012).
- Koasek Traditional Band of the Sovereign Abenaki Nation http://www.cowasuckabenaki.com
- Mashantucket Pequot Museum and Research Center. http://www.pequotmuseum.org (accessed August 22, 2012).
- National Conference of State Legislatures. http://www.ncsl.org/issues-research/tribal/list-of-federal-and-state-recognized-tribes.aspx#State (accessed August 21, 2012).
- Nulhegan Band of Coosuk Abenaki Nation. http://www.abenakitribe.org (accessed on August 22, 2012).
- New Hampshire Division of Historic Resources http://www.nh.gov/nhdhr (accessed August 21, 2012).
- Vermont Commission on Native American Affairs. http://vcnaa.vermont.gov (accessed on August 21, 2012).
- Vermont Division for Historic Preservation. http://accd.vermont.gov/strong_communities/preservation (accessed August 21, 2012).

3.14.2 Indian Tribes

There are no federally recognized tribes in the states of Vermont and New Hampshire.

Vermont law 1 V.S.A §§ 851–853 recognizes Abenakis as Native American Indians. Vermont Governor Peter Shumlin signed legislative bills on April 22, 2011, that recognized the Elnu Abenaki tribe and the Nulhegan Band of Coosuk Abenaki as State-recognized tribes. The Koasek Abenaki of the Koas tribe and the Missisquoi Abenaki tribe were both recognized by the state on May 17, 2012.

According to the New Hampshire Division of Historic Resources (http://www.nh.gov/nhdhr/review/tribal_list.htm) Native American organizations with interests in the state include: the Abenaki Nation of New Hampshire, the Cowasuck Band–Pennacook/Abenaki people, the Koasek Abenaki of the Koas, Koasek Traditional Band of the Sovereign Abenaki Nation, the Nulhegan Band of the Coosuk Abenaki Nation, and the Abenaki Nation of the Missisquoi.

3.14.3 Tribal Lands

There are no tribally owned lands located within the Project area.

3.14.4 Tribal Interests and Project Effects

Indian Trust Assets (ITAs) are legal interests in assets held in trust by the federal government for tribes or tribal individuals. Assets can be real property, physical assets or property rights. Examples of ITAs are lands (including tribal reservations and allotments), mineral rights, water rights, hunting and fishing rights, and rights to other natural resources. ITAs do not include things in which a tribe or individuals have no legal interest.

TransCanada's records do not indicate the presence of any ITA lands or granted rights, easements, or permits to property or resources within the Project boundary or on TransCanada fee-owned lands.

4.0 PRELIMINARY ISSUES AND STUDIES LIST

4.1 RESOURCE ISSUES

This section identifies issues associated with the potential effects of the continued operation of the Vernon Project under a new license; initial study proposals based upon these issues; and current and proposed protection, mitigation, and enhancement (PM&E) measures by TransCanada to address these issues

In section 3, we describe the existing environment based on available information, and identify project effects. Several consultation meetings were held between 2009 and 2012 in an attempt to brief State and Federal agencies on the upcoming relicensing and discussed resource information needs for the PAD development. TransCanada also requested feedback relative to studies it could initiate in advance of the PAD that would, 1) address obvious gaps in pre-PAD information and 2) be studies or initiatives that would be necessary to evaluate resources and project impacts. The following list represents the studies and initiatives undertaken in advance of drafting the PAD and their current status as of this document:

- GIS/Digital project maps – under development at present
- Lower Connecticut River Project Shoreline Survey and Mapping - completed; report or material to be finalized
- Vernon fish ladder shad effectiveness evaluation – study completed by USGS; report pending
- Water Quality monitoring – field work completed; report pending
- Dwarf wedge mussel survey of waters affected by the three projects – field work completed; final report pending TransCanada review
- Rare, threatened and endangered Species survey of the project reservoir edges – field work completed; report for TransCanada is pending
- River operations optimization/simulation model - under development at present
- Phase 1A historic and archaeological reconnaissance surveys of the Bellows Falls and Wilder Projects - field work completed; report pending

Beyond discussion about PAD data and information needs and the specific initiatives indicated, TransCanada has presented facility information and the operations overview to state and federal agencies and interested organizations and stakeholders at various outreach and consultation meetings over the past three years. We solicited comments or concerns at each of those meeting and those expressed are represented in this section.

4.2 GEOLOGY AND SOILS

4.2.1 Preliminary Issues

The Vernon Project shoreline has eroded at some locations as documented by surveys conducted by TransCanada in 2008. Surveys have not been performed following Tropical Storm Irene, which caused floods and water levels above the normal operating ranges of the Vernon Project. A study conducted for USACE of the entire Connecticut River in 1979 concluded that erosion at the Project is typically at elevations higher than the Project's normal operating range and would occur with or without the Project. Project operations are not a significant contributor to erosion in the reservoir compared to naturally occurring high river flows coupled with highly susceptible soils and agricultural uses. During high flow periods, the Vernon Project is operated to minimize the potential for flooding via impoundment drawdown to maintain reservoir elevation to the extent possible.

4.2.2 Proposed Studies

No studies are being proposed specific to geology or soils resources. TransCanada views erosion as a principally natural process that can be observed on all river systems to varying degrees, whether managed or natural and free-flowing. Consideration of the role of the Project within the context of natural flows, susceptible soils, climate change and micro-climate events, long-term fluvial geomorphology processes, riparian land use and vegetation, and a complex of other factors would be essential to isolate the Project and any associated operational impacts.

4.2.3 Continued or Proposed PM&E measures

There are no PM&E measures under the existing license relative to geology and soil resources, and none are proposed. Information from the 2008 survey will be made available to the public for review and comment through the relicensing website: www.transcanada-relicensing.com.

4.3 WATER RESOURCES

4.3.1 Preliminary Issues

Water resources are finite yet highly variable due to annual and seasonal snow pack and storm related precipitation events, both of which affect upstream hydro project storage, flow augmentation and generation as well as inflows from the unregulated portions of the Project's drainage area. In order for the Project to contribute and perform its vital role in the New England energy mix, it must take this water resource and optimize its use and value within the confines of a deregulated energy market geared toward utilizing the most inexpensive energy available for the consumer. There is no current analysis with respect to how these water resource variables affect the operation of the Project within the confines of the regional energy market in terms of both reservoir operation or Project discharge, and electric generation and economics.

Vernon dam modifies the physical environment of this section of the Connecticut River by increasing depth, time-of-travel (flushing rate), and in the lower portion of the impoundment, width. Available historical and current data indicate that water quality conditions upstream, downstream, and within the Project meet state standards. Water quality data suggest that the Project has no significant impact on temperature or DO or other chemical parameter in the river or on other chemical parameters. It is not anticipated that continued operation would adversely affect water quality. However, current comprehensive water quality data specific to the Project could be enhanced.

4.3.2 Proposed Studies

TransCanada proposes to develop a river optimization model that will optimize water resources, generation or value, and provide analytical results and outputs to make determinations or develop alternatives. Operating scenarios will be evaluated against a baseline scenario representing existing operation. Inputs will be naturalized inflow. Constraints will reflect current operating requirements in existing project licenses as well as allow for alternative constraints to be developed within the projects under review for relicensing. Outputs in terms of discharge will be available for use by downstream projects with other models known to be under development. Further discussion of TransCanada's river model will occur within an anticipated river modeling working group composed of stakeholders and downstream hydro operators.

To address the lack of Project-specific water quality data, TransCanada conducted a water quality study at the Project in 2012 based upon pre-PAD agency consultation and study plan review. The summary results are provided in the PAD. The full report is pending and will be available shortly.

4.3.3 Continued or Proposed PM&E Measures

No specific PM&E measures are proposed beyond continuing the appropriate minimum flow releases.

4.4 FISH AND AQUATIC RESOURCES

4.4.1 Preliminary Issues

The Vernon Project affected area provides a diverse warmwater fish assemblage with a high species richness both upstream (37 species) and downstream (35 species) of the dam. A healthy recreational fishery exists in the Project affected area: the tail water below Vernon dam is notable for walleye; and shallow backwaters of the impoundment are popular for panfish, largemouth bass, northern pike, pickerel, perch, and black crappie. Long-term collection data indicate populations for eight of nine index species in the impoundment and below the dam have remained stable through 21 years of monitoring. American shad was the single species with reduced population numbers in the impoundment in recent years. Repairs made to the Project fish ladder in 2012 have already improved passage to the impoundment for those fish that arrive to the Project area.

Vernon dam is one of numerous dams on the Connecticut River that affect diadromous fish and can interrupt habitat connectivity for resident fish. Vermont Fish & Wildlife and New Hampshire Fish & Game annually stock resident fish species in tributaries to the Project. Up until July 2012, FWS coordinated the stocking of Atlantic salmon fry and smolts. Based upon the available information, no immediate resource issues with regard to fish habitat or fish passage are apparent. With regard to American eel, current agency management goals and expectations would suggest continued expansion of eel passage at upstream dams. Vernon presently has no provision for eel passage.

TransCanada conducted mussel surveys at the Vernon Project in 2011 that identified four mussel species in the tailwater of Vernon dam and six species in the reservoir. No federally listed dwarf wedgemussels were found. Threats to mussels include stranding from water level fluctuations, water quality degradation, sedimentation, erosion, and river channel alteration.

4.4.2 Proposed Studies

At this time, absent additional stakeholder comment, issue scoping and consultation and discussion, TransCanada is not proposing studies specific to fish and aquatic resources.

4.4.3 Continued or Proposed PM&E Measures

TransCanada will continue to operation the upstream fish ladder and downstream fish passage, primarily for the successful passage of anadromous fish (shad) pass Vernon dam under any new license.

4.5 WILDLIFE AND BOTANICAL RESOURCES

4.5.1 Preliminary Issues

Terrestrial wildlife and botanical species likely to be impacted by Vernon project operations include those species that utilize the edges of the river. Most wildlife species will not be adversely affected by the approximate 2-foot normal daily water level fluctuation. Species that may experience habitat degradation include those that rely on shallow benthic infauna (migratory shorebirds). Bank erosion may be deleterious to plant species that occupy the riparian zone, but may benefit some wildlife, including bank-nesting species (belted kingfisher and bank swallows), and mink and otter that utilize undercut riverbanks for travel and cover.

Terrestrial wildlife species that utilize Project lands at Vernon include migratory birds, and most local wildlife.

Shoreline botanical resources are impacted within the approximate 2-foot normal water level zone due to the frequent wetting and drying, for which few species are adapted. On the riverbank immediately above that zone, herbaceous plant diversity tends to be high and includes a number of rare species. The habitat for these species is maintained by water and ice during high flow events. This disturbance also creates opportunities for invasive plant species to colonize this zone, as documented by the large number of known invasives on the Connecticut River, many of which occur in the Wilder Project.

4.5.2 Proposed Studies

At this time, absent additional stakeholder comment, issue scoping and consultation and discussion, TransCanada is not proposing studies specific to general wildlife or botanical resources. See section 4.7 for a discussion of rare, threatened and endangered plant species.

4.5.3 Continued or Proposed PM&E Measures

No specific PM&E measures are proposed at this time.

4.6 WETLANDS, RIPARIAN, FLOODPLAIN, AND LITTORAL RESOURCES

4.6.1 Preliminary Issues

Project operations have the potential to impact wetland, floodplain, riparian, and littoral resources similarly to those described for wildlife and botanical resources (section 4.5.1). The shoreline zone affected by the approximate 2-foot normal daily water level fluctuation includes habitats within all of the categories in this section: wetland, floodplain, riparian and littoral. The scour zone in the upper riverbank similarly affects portions of wetland, floodplain and riparian habitats.

4.6.2 Proposed Studies

At this time, absent additional stakeholder comment, issue scoping and consultation and discussion, TransCanada is not proposing studies specific to wetlands, riparian, littoral, and floodplain habitat resources.

4.6.3 Continued or Proposed PM&E Measures

No specific PM&E measures are proposed at this time.

4.7 RARE, THREATENED, AND ENDANGERED SPECIES

4.7.1 Preliminary Issues

The Vernon Project is known to support 39 rare, threatened, and endangered (RTE) species, including the federally listed dwarf wedgemussel. Project operations have the potential to affect RTE species that occur within the influence of the river. Plants, which comprise 32 of the 39 listed species, may be adversely affected by erosion and scour, as well as fluctuating water levels.

4.7.2 Proposed Studies

Based on pre-PAD agency consultation, issue identification, study request and study plan collaboration, in the 2012 growing season, TransCanada conducted a study of listed threatened or endangered plants and communities within the likely influence of Vernon Project impoundment. TransCanada consulted with FWS, the New Hampshire Natural Heritage Bureau and the Vermont Natural Heritage Inventory Program to define the appropriate level of effort and list of species to be included in this study. The purpose of the study is to confirm the records of known occurrences, to survey for new occurrences in likely habitats, and to determine the potential Project impacts on the individual populations and habitats. The field survey documented the current status of individual populations of all plant species listed by New Hampshire and Vermont that are potentially influenced by Project operations. A report on the study is pending and will be available shortly.

This survey may be expanded to include non-project affected project lands owned by TransCanada as well as riparian areas above the limits of the downstream Vernon impoundment.

4.7.3 Continued or Proposed PM&E Measures

Proposed PM&E measures will be based on the results of the rare, threatened and endangered species studies.

4.8 RECREATION AND LAND USE

4.8.1 Preliminary Issues

Continued operation of the Vernon Project could affect adequate access to Project lands and waters for recreational use given the limit acreage within the Project boundary. However, recreational opportunities afforded through permits and leases adequately meet the demand for fishing, boating, camping, swimming, and picnicking at the Project and therefore over-development or increased opportunities of some forms of recreation can create conflicts with and impact values associated with existing recreational activities and uses.

4.8.2 Proposed Studies

At this time, absent additional stakeholder comment, issue scoping and consultation and discussion, TransCanada is not proposing studies specific to recreational resources.

4.8.3 Continued or Proposed PM&E Measures

TransCanada will continue to operate and maintain the seven existing recreation facilities at the Project throughout the term of any new license and will continue to permit state and local governments to operate an additional ten recreational facilities that provide access to Project lands and waters for recreational boating, fishing, picnicking, and environmental education.

4.9 AESTHETIC RESOURCES

4.9.1 Preliminary Issues

Reservoir fluctuations would remain the same under the proposed operations. No additional issues have been identified relative to aesthetic resources

4.9.2 Proposed Studies

No aesthetic studies are proposed.

4.9.3 Continued or Proposed PM&E Measures

No PM&E measures have been identified, and none are proposed.

4.10 CULTURAL RESOURCES

4.10.1 Preliminary Issues

Continued operation of the Project has the potential to affect known or as yet unknown archaeological sites and historic properties. A full assessment of specific Project effects resulting from Project operation, maintenance, and recreation use on cultural resources in the Project APE, including hydroelectric system features, was completed and approved by the SHPO consistent with the provisions of the MOA executed in 2007.

4.10.2 Proposed Studies

TransCanada does not propose any additional cultural surveys at this time.

4.10.3 Continued or Proposed PM&E Measures

TransCanada will continue to implement the procedures in its approved HPMP for the Vernon Project.

4.11 SOCIOECONOMICS

4.11.1 Preliminary Issues

No issues have been identified relative to socioeconomic resources.

4.11.2 Proposed Studies

No studies are proposed.

4.12 RELEVANT QUALIFYING COMPREHENSIVE PLANS

Section 10(a)(2)(A) of the FPA, 16 U.S.C. §803 (a)(2)(A), requires the Commission to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project.

On April 27, 1988, the Commission issued Order No. 481-A, revising Order No. 481, issued October 26, 1987, establishing that the Commission will accord FPA section 10(a)(2)(A) comprehensive plan status to any federal or state plan that: (1) is a comprehensive study of one or more of the beneficial uses of a waterway or waterways; (2) specifies the standards, the data, and the methodology used; and (3) is filed with the Secretary of the Commission.

Under 18 C.F.R. §4.38, each license application must identify relevant comprehensive plans and explain how and why a proposed project would or would not comply with such plans.

The plans listed below are those on the Commission's August 2012 lists of comprehensive plans relevant to projects in New Hampshire and Vermont, excluding those not relevant to the Vernon Project, and those that appear on both the New Hampshire and Vermont lists.

New Hampshire

Atlantic States Marine Fisheries Commission. 1999. Amendment 1 to the Interstate Fishery Management Plan for shad and river herring. (Report No. 35). April 1999.

Atlantic States Marine Fisheries Commission. 2000. Technical Addendum 1 to Amendment 1 of the Interstate Fishery Management Plan for shad and river herring. February 9, 2000.

Atlantic States Marine Fisheries Commission. 2009. Amendment 2 to the Interstate Fishery Management Plan for shad and river herring, Arlington, Virginia. May 2009.

Atlantic States Marine Fisheries Commission. 2010. Amendment 3 to the Interstate Fishery Management Plan for shad and river herring, Arlington, Virginia. February 2010.

Atlantic States Marine Fisheries Commission. 1998. Interstate fishery management plan for Atlantic striped bass. (Report No. 34). January 1998.

Atlantic States Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American eel (Anguilla rostrata). (Report No. 36). April 2000.

Connecticut River Atlantic Salmon Commission. 1992. A management plan for American shad in the Connecticut River Basin. Sunderland, Massachusetts. February 1992.

Connecticut River Joint Commissions. New Hampshire Department of Environmental Services. 1997. Connecticut River corridor management plan. Charlestown, New Hampshire. Concord, New Hampshire. May 1997.

Connecticut River Joint Commissions. New Hampshire Department of Environmental Services. Connecticut River corridor management plan: 2008 Update to the Water Resources Chapter: (a) Headwaters Region; (b) Upper Valley Region; (c) Wantastiquest Region; (d) Riverbend Region; and (e) Mt. Ascutney Region. Charlestown, New Hampshire. Concord, New Hampshire.

Connecticut River Joint Commissions. New Hampshire Department of Environmental Services. Connecticut River corridor management plan: 2009 Update to the Recreation Plan: (a) Headwaters Region; (b) Upper Valley Region; (c) Wantastiquest Region; (d) Riverbend Region; and (e) Mt. Ascutney Region. Concord, New Hampshire.

National Marine Fisheries Service. Amendment #1 to the Atlantic salmon Fishery Management Plan; and Components of the proposed Atlantic herring Fishery Management Plan for Essential Fish Habitat. Volume 1. October 7, 1998.

National Marine Fisheries Service. 1998. Final Recovery Plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. December 1998.

New Hampshire Office of State Planning. 1977. Wild, scenic, & recreational rivers for New Hampshire. Concord, New Hampshire. June 1977. 63 p.

New Hampshire Office of State Planning. 1989. New Hampshire wetlands priority conservation plan. Concord, New Hampshire. 95 pp.

New Hampshire Office of Energy and Planning. New Hampshire Statewide Comprehensive Outdoor Recreation Plan (SCORP): 2008-2013. Concord, New Hampshire. December 2007.

New Hampshire Office of State Planning. 1991. Public access plan for New Hampshire's lakes, ponds, and rivers. Concord, New Hampshire. November 1991. 65 pp.

State of New Hampshire. 1991. New Hampshire rivers management and protection program [as compiled from NH RSA Ch. 483, HB 1432-FN (1990) and HB 674-FN (1991)]. Concord, New Hampshire. 19 pp.

State of New Hampshire. 1992. Act designating segments of the Connecticut River for New Hampshire's rivers management and protection program. Concord, New Hampshire. May 15, 1992. 7 pp.

U.S. Fish and Wildlife Service. 1989. Atlantic salmon restoration in New England: Final environmental impact statement 1989-2021. Department of the Interior, Newton Corner, Massachusetts. May 1989.

Vermont (excluding those plans already listed above for New Hampshire)

Atlantic States Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American eel (Anguilla rostrata). (Report No. 36). April 2000.

Connecticut River Atlantic Salmon Commission. 1992. A management plan for American shad in the Connecticut River Basin. Sunderland, Massachusetts. February 1992.

Connecticut River Atlantic Salmon Commission. 1998. Strategic plan for the restoration of Atlantic salmon to the Connecticut River. Sunderland, Massachusetts. July 1998. 105 pp.

National Marine Fisheries Service. 1998. Amendment #1 to the Atlantic salmon Fishery Management Plan; and Components of the proposed Atlantic herring Fishery Management Plan for Essential Fish Habitat. Volume 1. October 7, 1998.

Vermont Agency of Environmental Conservation. 2002. White River Basin plan. Waterbury, Vermont. November 2002.

Vermont Agency of Environmental Conservation. 1986. Vermont Rivers Study. Waterbury, Vermont. 236 pp.

Vermont Agency of Natural Resources. 1988. Hydropower in Vermont: an assessment of environmental problems and opportunities. Waterbury, Vermont. May 1988.

Vermont Agency of Natural Resources. 1988. Wetlands component of the 1988 Vermont recreation plan. Waterbury, Vermont. July 1988. 43 pp.

Vermont Agency of Natural Resources. 1986. The waterfalls, cascades, and gorges of Vermont. Waterbury, Vermont. May 1986. 320 pp.

Vermont Department of Fish and Wildlife. 1993. The Vermont plan for brook, brown, and rainbow trout. Waterbury, Vermont. September 1993.

Vermont Department of Forests, Parks and Recreation. Vermont State Comprehensive Outdoor Recreation Plan (SCORP): 2005-2009. Waterbury, Vermont. July 2005.

Vermont Natural Heritage Program. New Hampshire Natural Heritage Inventory. 1988. Natural shores of the Connecticut River: Windham County, Vermont, and Cheshire County, New Hampshire. December 1988.

Federal Agency Plans

National Park Service. The Nationwide Rivers Inventory. Department of the Interior, Washington, D.C. 1993.

U.S. Fish and Wildlife Service. Canadian Wildlife Service. 1986. North American waterfowl management plan. Department of the Interior. Environment Canada. May 1986.

U.S. Fish and Wildlife Service. Undated. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.

4.13 RELEVANT RESOURCE MANAGEMENT PLANS

The following list includes additional relevant resource management plans not included in the list of Comprehensive Plans in section 4.3.

New Hampshire

Cold River Watershed Management Plan. Cold River Local Advisory Committee. 2009

Guiding Change: The Southwest Region at the Beginning of the 21st Century. Southwest Regional Planning Commission. 2002.

New Hampshire Fish and Game Department Inland Fisheries Division 2011 Master Operational Plan. 2011.

New Hampshire Wildlife Action Plan. New Hampshire Fish & Game Department. 2007.

Vermont

Basin 11 Management Plan – West River, Williams River, Saxtons River. Vermont Agency of Natural Resources. 2008.

Vermont Bald Eagle Recovery Plan. Vermont Department of Fish and Wildlife. 2010.

Vermont Osprey Recovery Plan. Vermont Department of Fish and Wildlife. 1997.

Vermont Peregrine Falcon Recovery Plan. Vermont Department of Fish and Wildlife. 2000.

Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. 2005.

Windham Regional Plan. Windham Regional Commission. 2006.

Federal Agency Plans

Dwarf Wedgemussel (Alasmidonta heterodon) Recovery Plan. United States Fish and Wildlife Service, Northeast Region. 1993.

Dwarf Wedgemussel (*Alasmidonta heterodon*) 5-Year Review: Summary and Evaluation. United States Fish and Wildlife Service New England Field Office. 2007.

Jesup’s Milk Vetch Recovery Plan, United States Fish and Wildlife Service, Northeast Region. 1989.

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5.0 CONTACTS AND CONSULTATION

5.1 LIST OF CONTACTS USED TO PREPARE THE PAD

In addition to searches and reviews of publicly available data and information, table 5.1-1 includes contacts made by TransCanada and consultants with federal, state, interstate agencies, NGOs or the public for data or information relevant to the content of the PAD.

Table 5.1-1. Contacts used to prepare the PAD.

Resource Area	Nature of Contact	Agency/Organization name	Contact Person
Aquatics	Request for macroinvertebrate data	U.S. Environmental Protection Agency Region 1, Instream Flow Program	Ralph Abele
Aquatics	Request for macroinvertebrate data	New Hampshire DES Biological Monitoring Program	Dave Niels
Aquatics	Request for macroinvertebrate data	Vermont DEC, Biomonitoring Section	Steve Fiske
Fisheries	Request for fisheries data in CT River and tributaries	New Hampshire Fish & Game	Gabe Gries
Fisheries	Request for fisheries data in CT River and tributaries	Vermont Fish &Wildlife	Rod Wentworth, Ken Cox, Rich Kern, Lael Will
Fisheries	Request for fisheries data in CT River and tributaries	FWS	Ken Sprankle
Fisheries	Request to use/reference study reports	Vermont Yankee	Lynn DeWald
General	Inquiry about status of CT River Management Plan and updates	CRJC	Rachel Ruppel
Land Use	Vermont GIS data: lands with conservation easements	Windham Regional Commission	Jeff Nugent, GIS Planner
Land Use	Vermont GIS data: lands with conservation easements	University of Vermont, Spatial Analysis Lab	Sean MacFaden
Rare, Threatened and Endangered Species (RTE)	Request for publications related to natural communities and rare plants, and hydrologic modeling resources.	The Nature Conservancy	Doug Bechtel
Rare, Threatened and Endangered Species (RTE)	Request for information on GIS layers	NH Granit (NH GIS Clearinghouse)	

Resource Area	Nature of Contact	Agency / Organization name	Contact Person
Rare, Threatened and Endangered Species (RTE)	Request for information on bald eagle in the region	Audubon Society of New Hampshire	Chris Martin
Rare, Threatened and Endangered Species (RTE)	Request for information on species and refuge units	Silvo O. Conte National Fish and Wildlife Refuge	Mark Maghini
Water Quality	Inquiry about current VT river basin plans	Vermont DEC, Watershed Management Division	Marie Caduto
Water Quality	Location of mapping of Vermont's 303(d) and 305(b) rivers	Vermont DEC, Conservation Watershed Management Division	Tim Clear

5.2 SUMMARY OF PRE-PAD CONSULTATION

TransCanada has held or participated in several consultation meetings and public forums during the pre-PAD phase for parties interested in the relicensing of the Wilder, Bellows Falls, and Vernon projects. These meetings were held to educate stakeholders on the Projects' facilities and operations, discuss issues, and identify and develop pre-PAD study scopes and relicensing process and timetables. Most of the earlier meetings and consultation were with state and federal resource agencies. More recently, these meetings included FERC relicensing staff, NGOs, and members of the public.

Meeting with State and Federal Resource Agency Staff - September 28, 2009

TransCanada met with staff from New Hampshire, Vermont, and Massachusetts fishery and water quality agencies and staff from FWS to discuss a number of Deerfield River and Connecticut River ongoing studies, mitigation plans, and proposed pre-relicensing activities. Related to relicensing, discussions mainly focused on a preliminary timetable for initiating relicensing and the potential for pre-PAD studies to be performed in 2010.

Meeting with State and Federal Resource Agency Staff – October 6, 2010

TransCanada met with staff from New Hampshire, Vermont, and FWS to discuss the status of water quality and fisheries related studies conducted in 2010 at Deerfield River and Connecticut River projects. The meeting was held at FWS offices in Concord, New Hampshire. Related to relicensing, discussions mainly focused on an overview of two pre-PAD studies that had been identified (dwarf wedgemussel and a shoreline survey) and on planning for a meeting in early 2011 to identify and invite all resource agency staff that would potentially be involved in TransCanada's upcoming relicensing.

Various Consultation Discussions and Correspondence During 2010

Throughout 2010, consultation discussions and correspondence occurred between TransCanada and state and federal resource agency staff. The primary focus of these discussions was on a study related to a dwarf wedgemussel survey in which the identification of a preferred vendor, development of a scope of work, and initiating the study were discussed.

Pre-Licensing Meeting with State and Federal Resource Agency Staff - April 12, 2011

TransCanada met with agency representatives on April 12, 2011, to initiate discussion about the upcoming FERC relicensing of the Wilder, Bellows Falls, and Vernon projects. The purpose of the meeting was to provide agencies with an overview of how the Projects are operated and the primary parameters guiding operation, and to discuss preliminary issues and pre-PAD studies that could be conducted in 2011 and 2012 to support development of the PADs.

Table 5.2-1. Agencies represented at the 2011 pre-licensing meeting.

NH Department of Cultural Resources
NH Department of Environmental Services
NH Fish and Game Department
NH Geological Survey
NH Department of Resources and Economic Development, Natural
VT Department of Environmental Conservation
VT Department of Fish and Wildlife
U.S. Fish and Wildlife Service

Various Consultation Discussions and Correspondence During 2011

Throughout 2011, numerous consultation discussions and correspondence occurred between TransCanada and state and federal resource agency staff. The primary focus of these discussions was on two studies. One related to initiating work on the dwarf wedgemussel survey, and the other related to a basin-wide American shad study to be conducted by USGS staff from the FWS Conte Research Laboratory with support from TransCanada, as the study scope included the Vernon Project. Additional discussions centered on a GIS-based shoreline erosion survey in advance of the relicensing of all three projects.

Vernon Adult Shad Study Consultation Meeting with USGS – February 16, 2012

A meeting on February 16, 2012 was held with USGS staff to discuss their 2012 Connecticut River American shad study scope relative to activities at Vernon dam. Discussion included TransCanada's support of, and involvement in, the study. The study scope was adjusted and finalized over subsequent weeks through email exchange.

Rare, Threatened, and Endangered Species Studies Initial Consultation Meeting - May 24, 2012

TransCanada conducted an agency consultation meeting on May 24, 2012, to discuss pre-PAD studies needed to fill known data gaps related to rare, threatened and endangered species. Data sharing agreements and the proposed scopes of two studies planned for 2012 were discussed. Agency representatives provided input and recommendations on the pre-PAD rare plant/community survey along the river within the Wilder, Bellows Falls and Vernon projects (and the pre-PAD Jesup's milk vetch/Wilder flow study not affecting Vernon). Agencies represented at the meeting included NH Department of Resources and Economic Development, Natural Heritage Bureau, VT Department of Fish and Wildlife, Endangered Species Program and FWS.

Rare, Threatened, and Endangered Species Study Consultation 2012

On behalf of TransCanada, Normandeau staff engaged in ongoing consultation with the state and FWS representatives from the initial consultation meeting on the draft study plan for the pre-PAD RTE study encompassing the Wilder, Bellows Falls and Vernon Project to be conducted in 2012. Normandeau provided a draft study scope and agency staff provided comments on it. The scope was subsequently revised to address those comments and received agency concurrence. The detailed consultation record will be included in the final study report.

Water Quality Study Consultation 2012

On behalf of TransCanada, Normandeau staff engaged in ongoing consultation with New Hampshire and Vermont agency water quality staff on the pre-PAD baseline water quality study to be conducted in 2012, encompassing the Wilder, Bellows Falls and Vernon projects. Normandeau provided a draft study scope and agency staff provided comments on it. The scope was subsequently revised to address those comments and received agency concurrence. The detailed consultation record will be included in the final study report.

Pre-PAD Stakeholder Meeting - September 5, 2012

TransCanada identified more than 50 likely interested parties among state and federal resource agencies and NGOs and invited them to attend an introductory stakeholder meeting held on September 5, 2012, at the West Lebanon, New Hampshire public library. Table 5.2-2 identifies the organizations that were represented at the meeting. The meeting introduced agency staff, NGOs, and the public to the relicensing for the Wilder, Bellows Falls, and Vernon projects. The relicensing process and timetable were discussed by FERC representatives, and TransCanada representatives discussed the projects and their operations. Pre-PAD studies, both those already completed and those still in progress, were also described. Attendees were able to ask questions, identify issues and provide comments on the projects and the relicensing process.

Table 5.2-2. Organizations represented at the pre-PAD stakeholder meeting.

American Rivers
Audubon Society of NH
Connecticut River Joint Commissions
Connecticut River Watershed Council
Federal Energy Regulatory Commission
National Park Service
NH Department of Environmental Services
NH Fish and Game Department
NH Rivers Council
The Nature Conservancy
U.S. Fish and Wildlife Service
Upper Valley Lake Sunapee Regional Planning Commission
VT Department of Environmental Conservation
VT Department of Fish and Wildlife
Windham Regional Commission

FERC Site Visits - October 1 through 3, 2012

FERC conducted its scoping meeting site visits prior to submittal of the PADs, so as to avoid winter weather conditions if the site visits were held after FERC's notice of commencement of relicensing proceedings as would normally happen. A one-day visit was conducted at Wilder, Bellows Falls, and Vernon, on October 1st, 2nd, and 3rd, respectively. FERC representatives introduced the role and authority of FERC, the relicensing process and timetables. TransCanada representatives provided an overview of each project and its operations. Attendees were invited on guided facility tours and on boat tours on each project's reservoir. Attendees were able to interact directly with FERC and TransCanada representatives to ask questions and raise issues.

A total of 42 individuals (excluding TransCanada representatives) attended the Vernon site visit (table 5.2-3). In addition to 11 members of the public, including local residents and representatives of downstream Connecticut River hydroelectric projects, the following organizations were represented at the FERC site visit.

Table 5.2-3. Organizations represented at the FERC site visit.

Audubon Society of New Hampshire
Connecticut River Watershed Council
Federal Energy Regulatory Commission
National Park Service
New England Flow
NH Department of Environmental Services
NH Fish and Game Department
The Green Island Project of the Sustainable Valley Group, Inc.
The Nature Conservancy
Trout Unlimited
U.S. Fish and Wildlife Service
VT Department of Environmental Conservation
VT Department of Fish and Wildlife
VT Division of Historic Preservation
Windham Regional Commission

ATTACHMENT 1

PROJECT BOUNDARY MAPS

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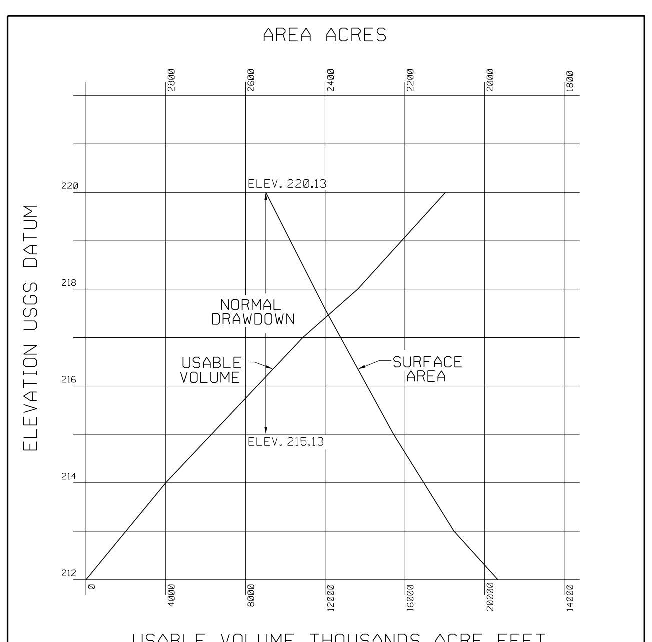
H-36370

I N D E X   O F

P R O J E C T   M A P S



THE PROJECT BOUNDARY, SHOWN BY THE SHADED LINE, IN GENERAL FOLLOWS THE OUTSIDE LINES OF LANDS OWNED IN FEE AND THE ELEVATION 220.13 CONTOUR LINE ON LANDS ON WHICH THE APPLICANT HOLDS FLOWAGE RIGHTS.

HOWEVER, THE EXACT LOCATION OF A LINE DELINEATING THE OUTSIDE LIMITS OF SUCH FLOWAGE RIGHTS CAN NOT BE DETERMINED SINCE IT CHANGES UNDER VARYING STREAM FLOW, FLOOD, ICE AND OTHER CONDITIONS.

VERMONT

TRACED FROM U.S.G. SURVEY
BELLOWS FALLS, KEENE & BRATTLEBORO QUADRANGLES

SCALE = $\frac{1}{62500}$

ELEVATIONS ARE BASED ON MEAN SEA LEVEL AS DETERMINED BY REFERENCE TO A UNITED STATES COAST AND GEODETIC SURVEY BENCH MARK NEAR VERNON, VERMONT, STAMPED 'E4 1927' (ELEVATION 272.293 FEET) AS DESCRIBED ON PAGE 13, UNITED STATES COAST AND GEODETIC SURVEY SPECIAL PUBLICATION No. 182.

SEE EXHIBIT K-1 FOR DESCRIPTION OF PROJECT BOUNDARY

THESE MAPS ARE COMPILED FROM MAPPINGS, AERIAL SURVEYS, AND FIELD SURVEYS MADE AND SUPERVISED, FOR THE MOST PART, IN THE YEARS 1906 TO 1948, BY COMPANY EMPLOYEES NOW RETIRED OR DECEASED. RECOGNIZED STADIA METHODS WERE USED EXCEPT WHERE GREATER ACCURACY WAS REQUIRED.

______________ VICE PRESIDENT

INDEX FOR PLANT AREA SHEET AND DETAIL MAPS DRAWN TO SCALE 1"=400'

EXHIBIT K–2 **INDEX SHEET 1B**

NEW ENGLAND POWER COMPANY

VERNON PROJRCT NO. 1904

PROJECT MAP

MAY 1980

0' 5000' 10000' 20000' 30000'

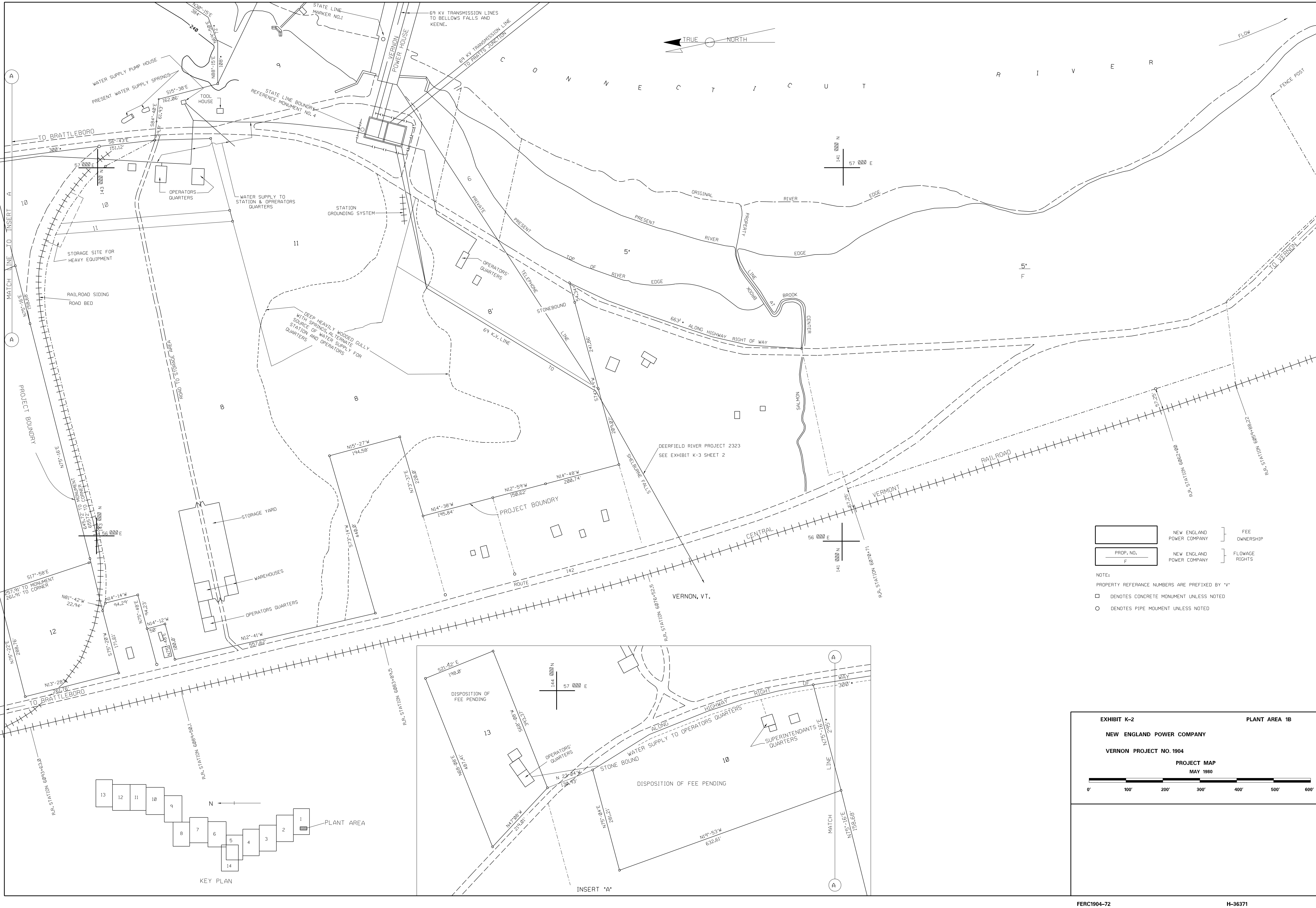


EXHIBIT K-2 **PLANT AREA 1B**

NEW ENGLAND POWER COMPANY

VERNON PROJECT NO. 1904

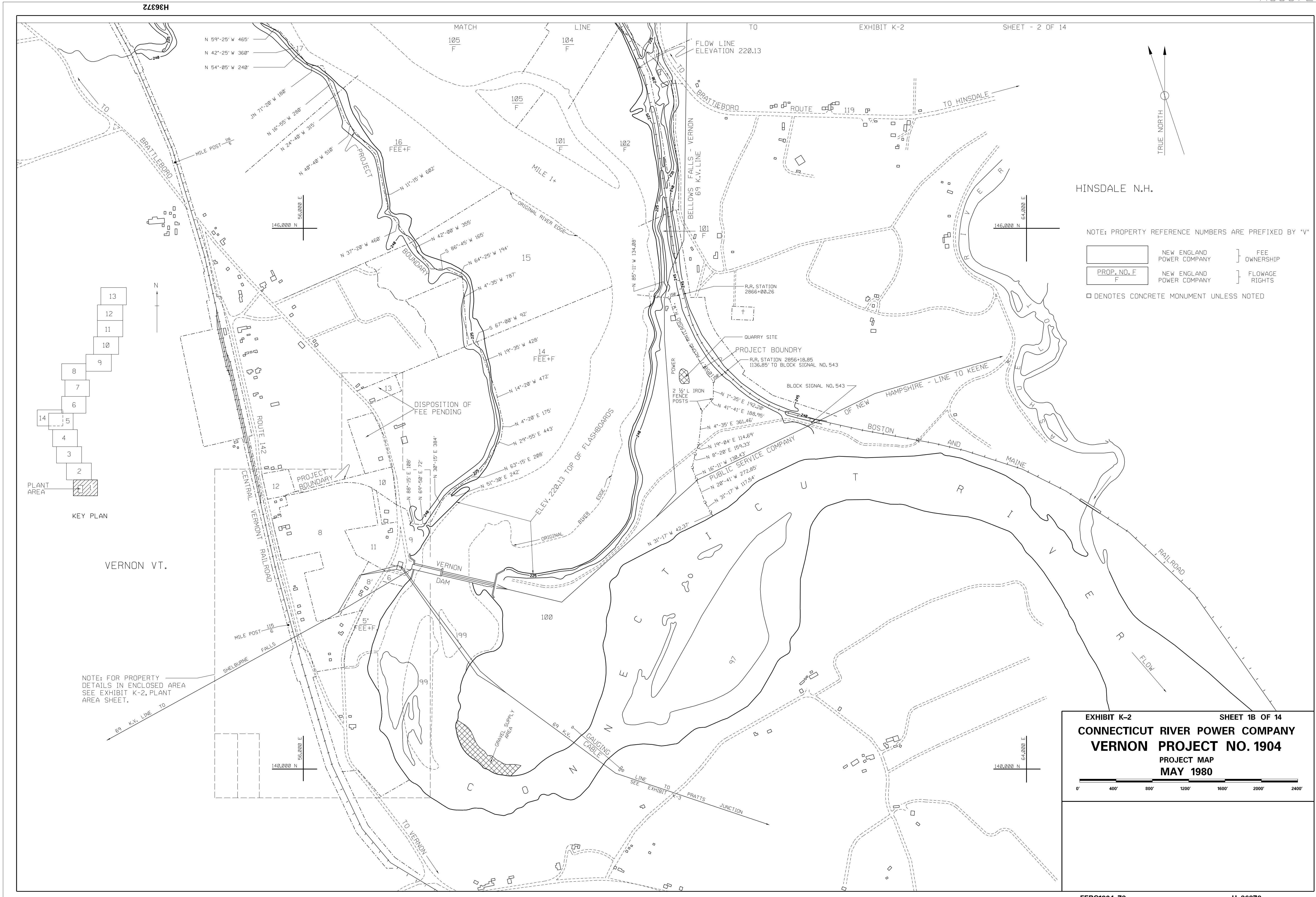
PROJECT MAP

MAY 1980

0' 100' 200' 300' 400' 500' 600'

FERC1904-72 H-36371

H36371



MATCH LINE TO EXHIBIT K-2 SHEET - 2 OF 14
FLOW LINE ELEVATION 220.13
TO BRATTLEBORO ROUTE 119 TO HINSDALE
TRUE NORTH
HINSDALE N.H.
BELLOWS FALLS - VERNON 69 K.V. LINE
R.R. STATION 2866+00.26
QUARRY SITE
PROJECT BOUNDRY
R.R. STATION 2856+18.85 1136.85' TO BLOCK SIGNAL NO. 543
BLOCK SIGNAL NO. 543
POWER
2 ½" L IRON FENCE POSTS
BOSTON AND MAINE RAILROAD
OF NEW HAMPSHIRE - LINE TO KEENE
PUBLIC SERVICE COMPANY
CONNECTICUT RIVER
ASHUELOT RIVER
FLOW
ELEV. 220.13 TOP OF FLASHBOARDS
ORIGINAL RIVER EDGE
MILE 1+
PROJECT BOUNDARY
DISPOSITION OF FEE PENDING
VERNON DAM
GRAVEL SUPPLY AREA
69 K.V. GAUGING CABLE
LINE TO PRATTS JUNCTION SEE EXHIBIT K-3
TO VERNON
ROUTE 142
CENTRAL VERMONT RAILROAD
MILE POST 115/6
MILE POST 116/5
SHELBURNE FALLS
69 K.V. LINE TO
VERNON VT.
KEY PLAN
PLANT AREA
NOTE: FOR PROPERTY DETAILS IN ENCLOSED AREA SEE EXHIBIT K-2, PLANT AREA SHEET.
NOTE: PROPERTY REFERENCE NUMBERS ARE PREFIXED BY 'V'
NEW ENGLAND POWER COMPANY } FEE OWNERSHIP
PROP. NO. F / F NEW ENGLAND POWER COMPANY } FLOWAGE RIGHTS
□ DENOTES CONCRETE MONUMENT UNLESS NOTED
N 59°-25' W 465'
N 42°-25' W 360'
N 54°-05' W 240'
N 71°-20' W 180'
N 16°-55' W 208'
N 24°-40' W 315'
N 40°-40' W 510'
N 11°-15' W 602'
N 37°-20' W 460'
N 42°-00' W 355'
S 86°-45' W 165'
N 64°-25' W 194'
N 4°-35' W 787'
S 67°-00' W 92'
N 19°-35' W 428'
N 14°-20' W 472'
N 4°-20' E 175'
N 29°-55' E 443'
N 63°-15' E 208'
N 51°-30' E 242'
N 30°-15' E 384'
N 69°-50' E 72'
N 88°-15' E 108'
N 85°-11' W 134.08'
N 1°-35' E 192.28'
N 41°-41' E 188.95'
N 4°-35' E 361.46'
N 19°-04' E 114.69'
N 8°-20' E 159.33'
N 16°-11' W 130.43'
N 20°-41' W 272.85'
N 31°-17' W 117.54'
N 31°-17' W 42.37'
105 F
104 F
105 F
101 F
102 F
16 FEE+F
15
14 FEE+F
101 F
13
12
10
11
8
6
8'
5' FEE+F
100
99
99
97
146,000 N
56,000 E
146,000 N
64,000 E
140,000 N
56,000 E
140,000 N
64,000 E
EXHIBIT K-2 SHEET 1B OF 14
CONNECTICUT RIVER POWER COMPANY
VERNON PROJECT NO. 1904
PROJECT MAP
MAY 1980
0' 400' 800' 1200' 1600' 2000' 2400'
FERC1904-73
H-36372
H36372
MICROFILM OF THESE ORIGINAL DRAWINGS FILED WITH FERC 5/30/80

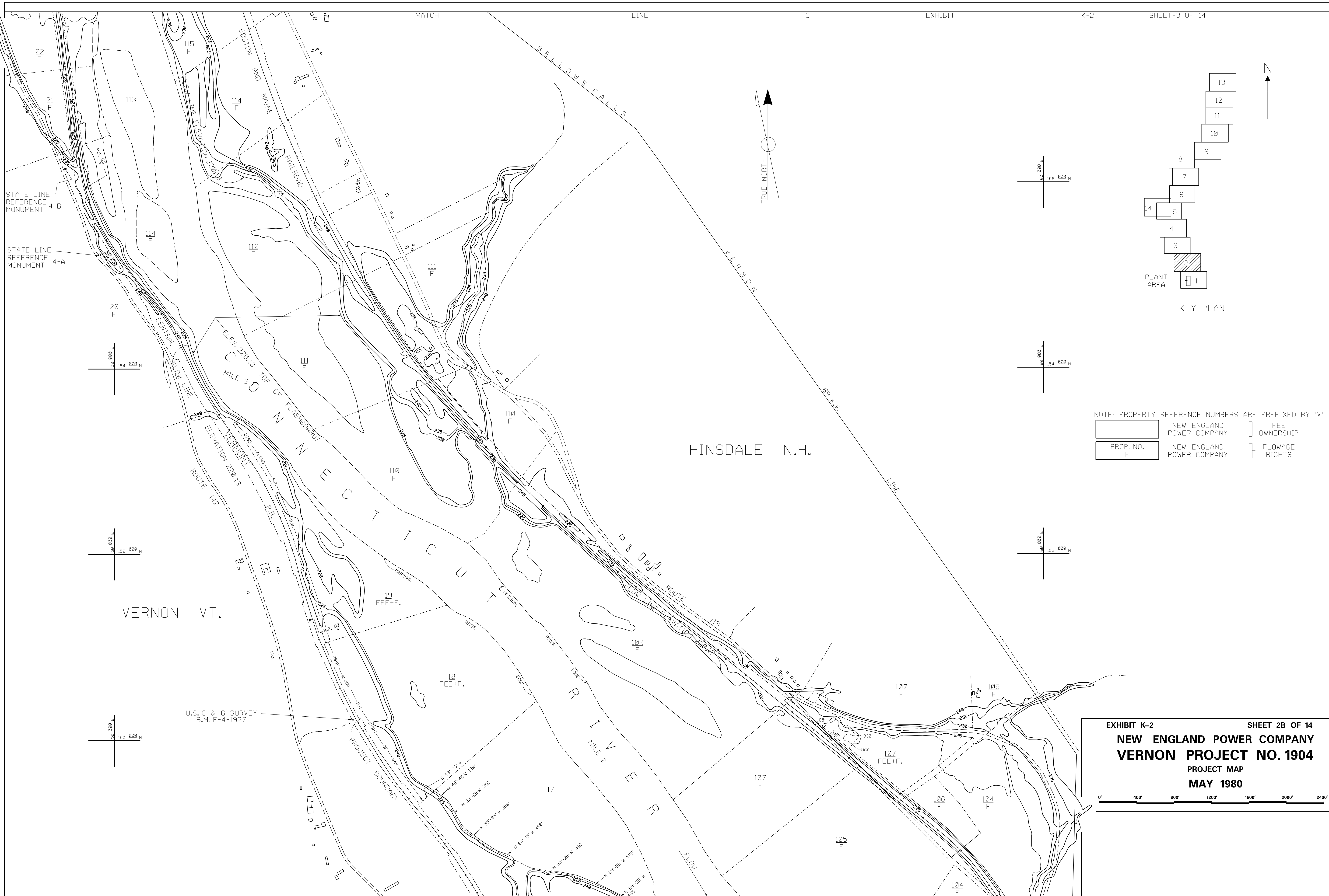


EXHIBIT K-2 SHEET 2B OF 14

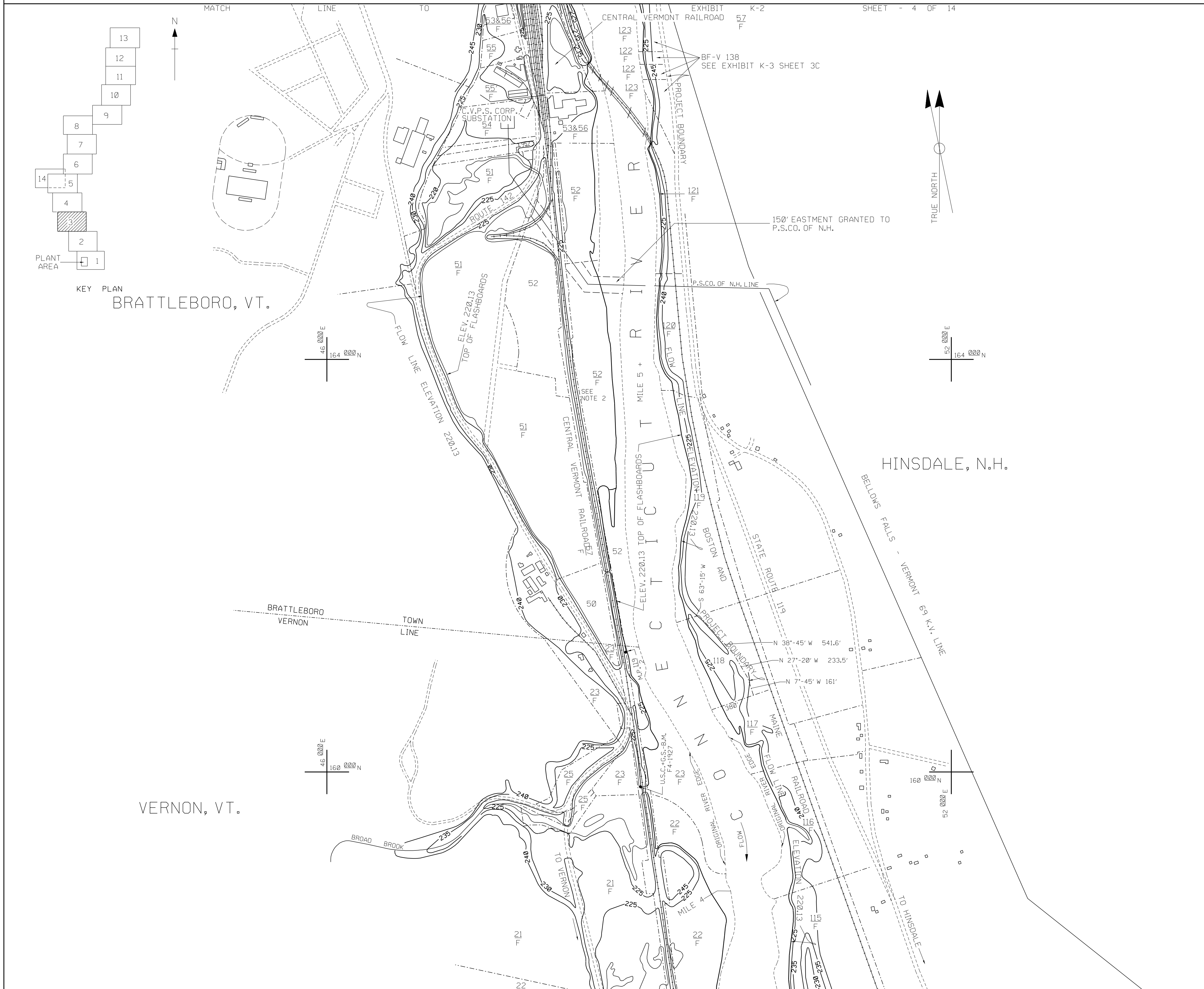
NEW ENGLAND POWER COMPANY

VERNON PROJECT NO. 1904

PROJECT MAP

MAY 1980

FERC 1904-74 H-36373



NOTE:

1. PROPERTY REFERENCE NUMBERS ARE PREFIXED BY "V"
2. DISPOSITION OF FEE PENDING

(blank box)	NEW ENGLAND POWER COMPANY	FEE OWNERSHIP
PROP.NO. F	NEW ENGLAND POWER COMPANY	FLOWAGE RIGHTS

EXHIBIT K-2 SHEET 3C OF 14

NEW ENGLAND POWER COMPANY

VERNON PROJECT NO.1904

PROJECT MAP

MAY 1980

0' 400' 800' 1200' 1600' 2000' 2400'

FERC 1904-75 H-36374

H-36375

EXHIBIT K-2 SHEET-5 OF 14

EXHIBIT K-2 SHEET 4B OF 14

NEW ENGLAND POWER COMPANY

VERNON PROJECT NO. 1904

PROJECT MAP

MAY 1980

0' 400' 800' 1200' 1600' 2000' 2400' FEET

EXHIBIT K-2 SHEET-3 OF 14

FERC 1904-76 H-36375

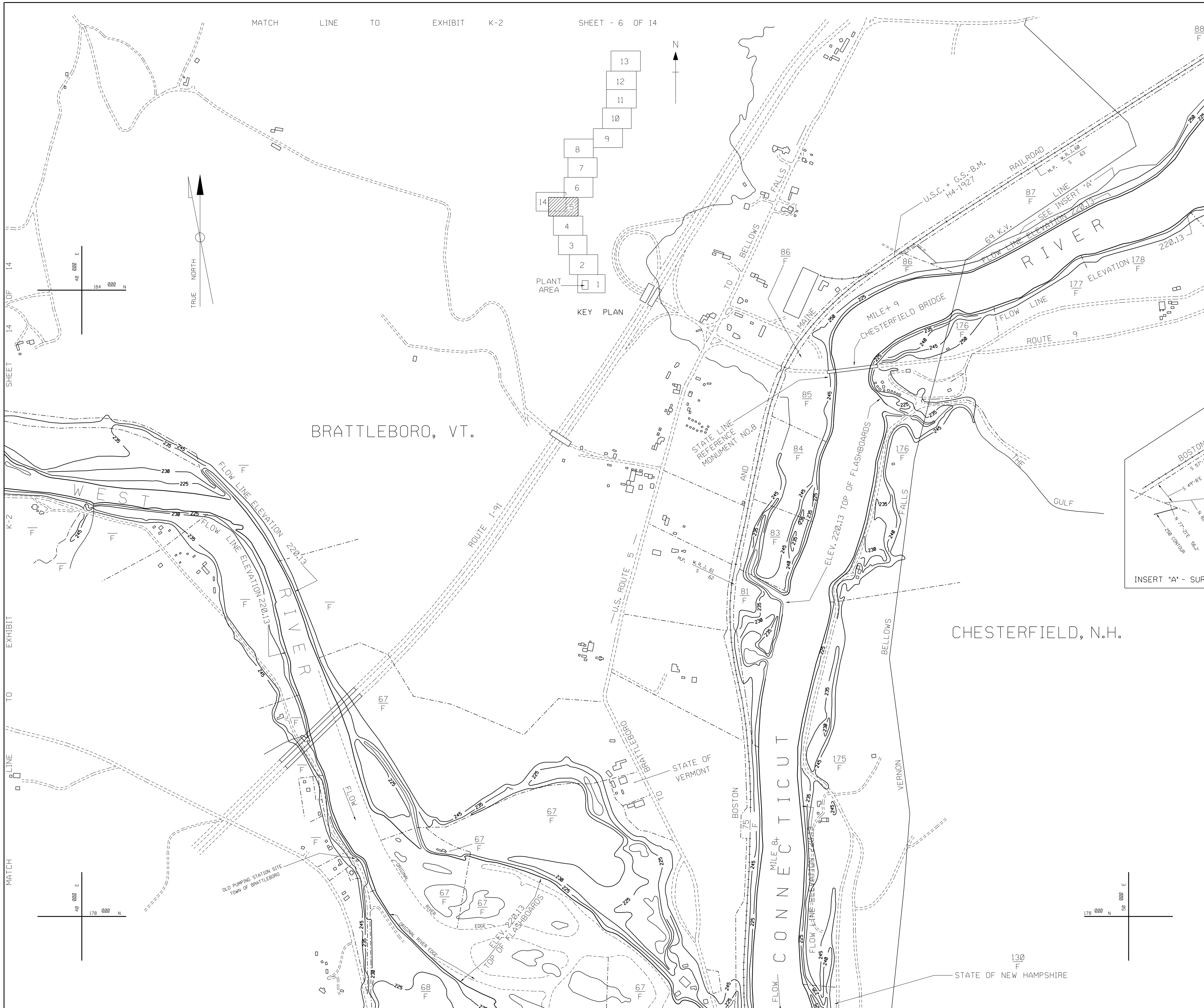
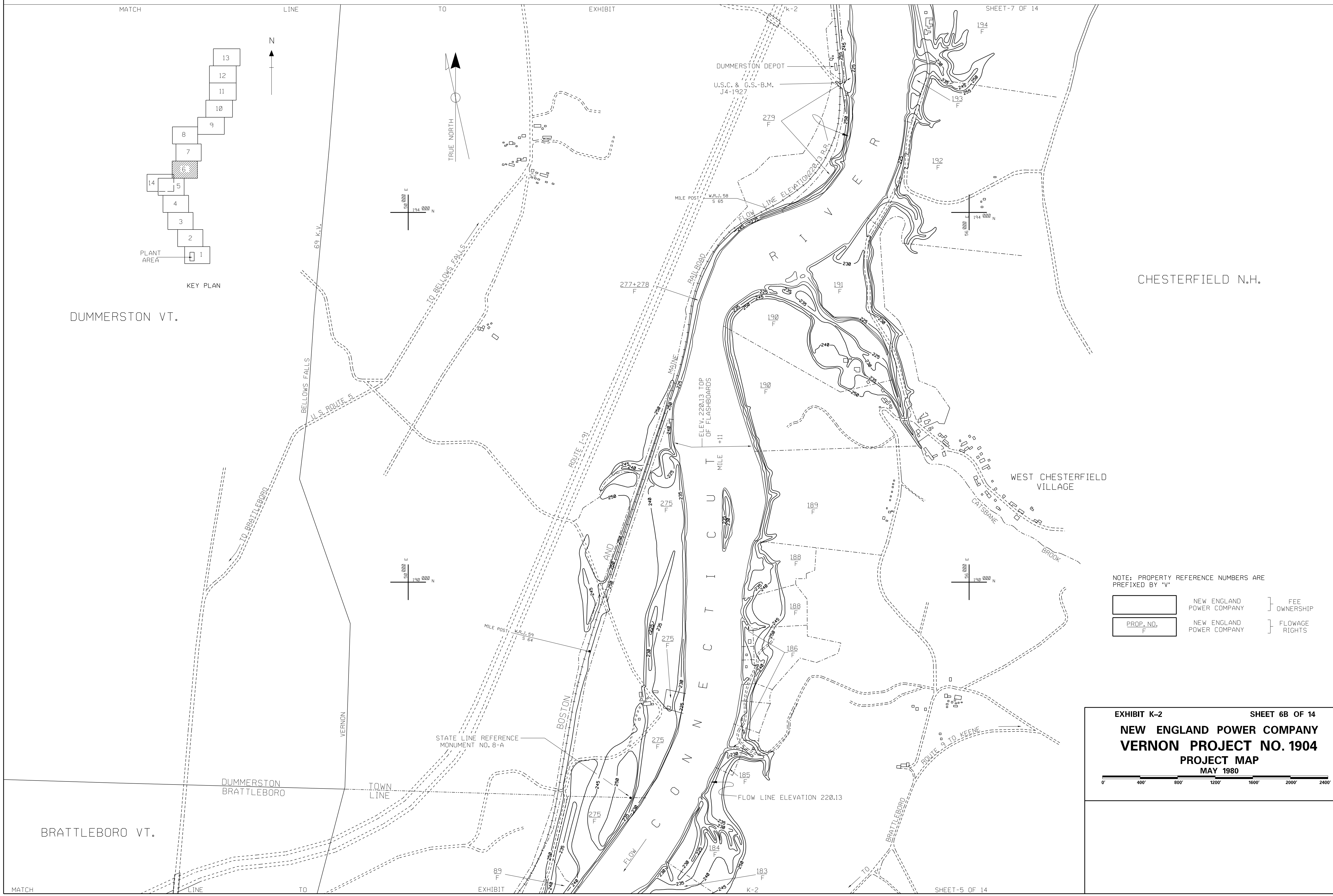


EXHIBIT K-2 **SHEET 5B OF 14**

NEW ENGLAND POWER COMPANY
VERNON PROJECT NO. 1904
PROJECT MAP
MAY 1980



NOTE: PROPERTY REFERENCE NUMBERS ARE PREFIXED BY "V"

(blank box)	NEW ENGLAND POWER COMPANY	FEE OWNERSHIP
PROP. NO. F	NEW ENGLAND POWER COMPANY	FLOWAGE RIGHTS

EXHIBIT K-2 SHEET 6B OF 14

NEW ENGLAND POWER COMPANY
VERNON PROJECT NO. 1904
PROJECT MAP
MAY 1980

0' 400' 800' 1200' 1600' 2000' 2400'

NOTES: PROPERTY REFERENCE NUMBERS ARE PREFIXED BY "V"

(blank box)	NEW ENGLAND POWER COMPANY	FEE OWNERSHIP
PROP. NO. F	NEW ENGLAND POWER COMPANY	FLOWAGE RIGHTS

EXHIBIT K-2 SHEET 7B OF 14

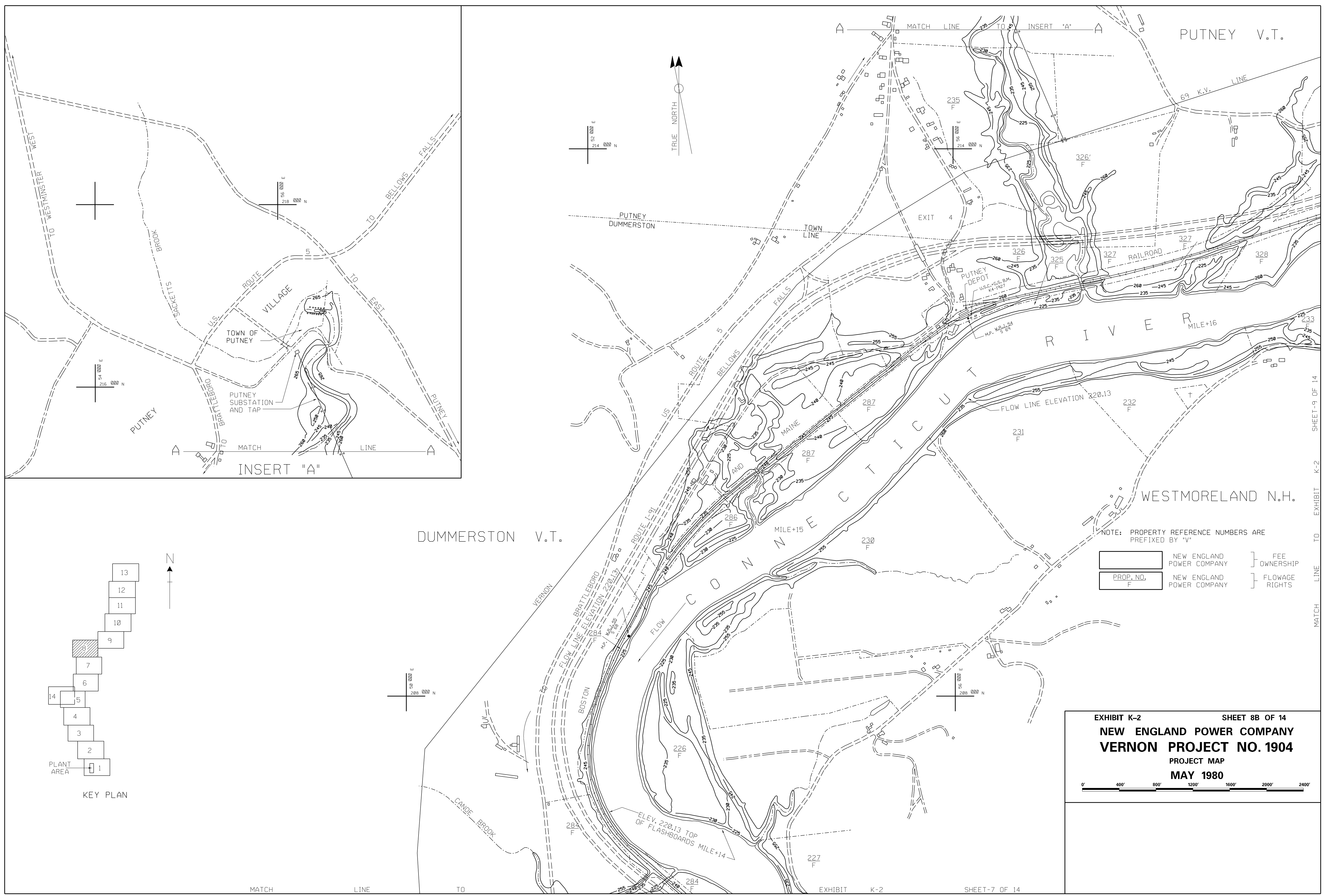
NEW ENGLAND POWER COMPANY

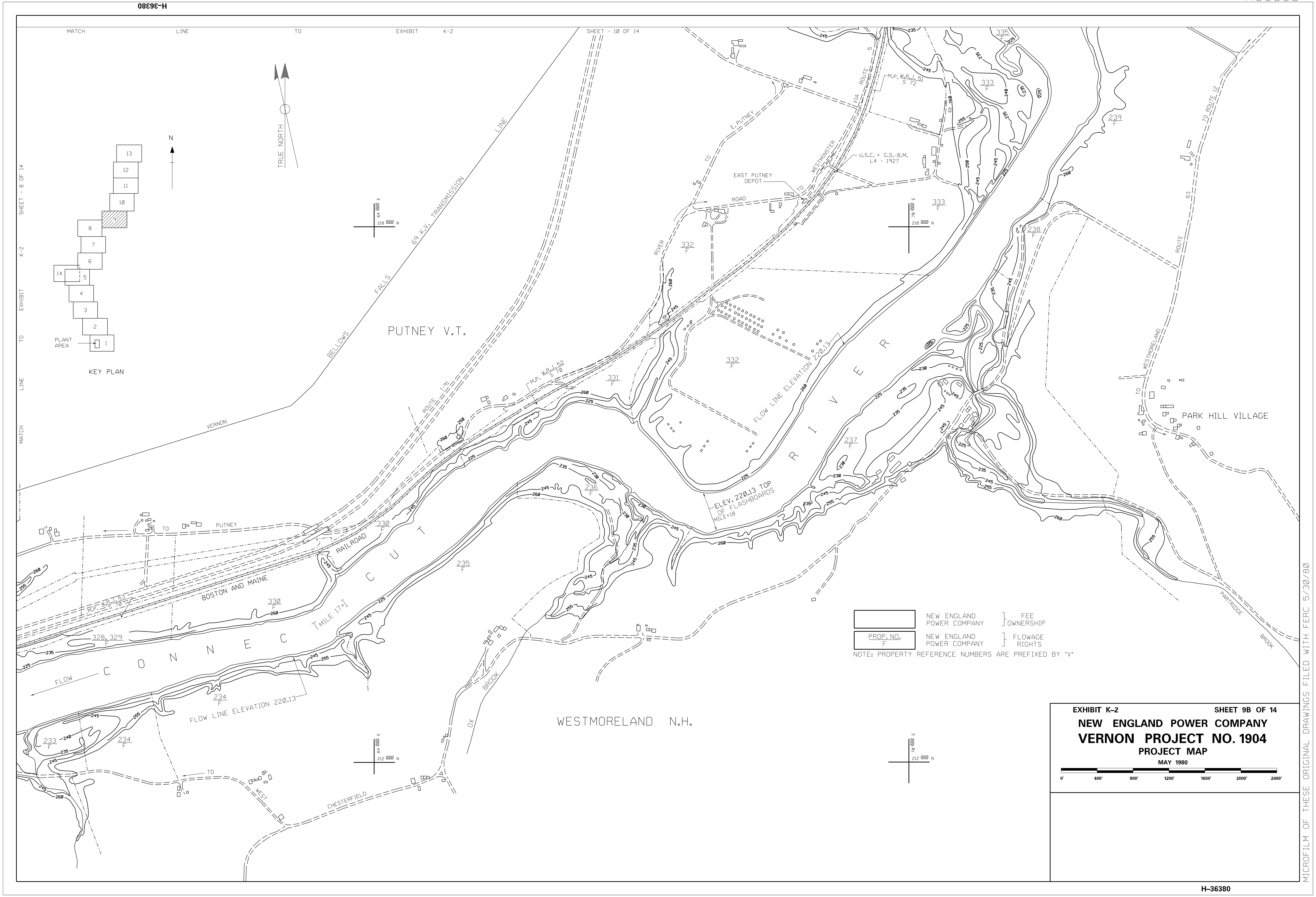
VERNON PROJECT NO. 1904

PROJECT MAP

MAY 1980

0 400' 600' 1200' 1600' 2000' 2400'


PUTNEY V.T.
WESTMORELAND N.H.
DUMMERSTON V.T.
CONNECTICUT RIVER
MATCH LINE TO INSERT 'A'
MATCH LINE TO EXHIBIT K-2 SHEET-9 OF 14
MATCH LINE TO EXHIBIT K-2 SHEET-7 OF 14
FLOW LINE ELEVATION 220.13
ELEV. 220.13 TOP OF FLASHBOARDS MILE+14
MILE+15
MILE+16
PUTNEY DEPOT
RAILROAD
BOSTON AND MAINE
US ROUTE 5
BELLOWS FALLS
ROUTE I-91
BRATTLEBORO
VERNON
EXIT 4
TOWN LINE
PUTNEY DUMMERSTON
69 K.V. LINE
CANOE BROOK
TRUE NORTH
FLOW
NOTE: PROPERTY REFERENCE NUMBERS ARE PREFIXED BY "V"
NEW ENGLAND POWER COMPANY } FEE OWNERSHIP
PROP. NO. F NEW ENGLAND POWER COMPANY } FLOWAGE RIGHTS
INSERT "A"
TOWN OF PUTNEY
VILLAGE
PUTNEY SUBSTATION AND TAP
SACKETTS BROOK
TO WEST WESTMINSTER
TO EAST PUTNEY
KEY PLAN
PLANT AREA
EXHIBIT K-2
SHEET 8B OF 14
NEW ENGLAND POWER COMPANY
VERNON PROJECT NO. 1904
PROJECT MAP
MAY 1980
FERC1904-80
H-36379
MICROFILM OF THESE ORIGINAL DRAWINGS FILED WITH FERC 5/30/80



H36380
H-36380
MATCH LINE TO EXHIBIT K-2 SHEET - 10 OF 14
MATCH LINE TO EXHIBIT K-2 SHEET - 8 OF 14
TRUE NORTH
N
KEY PLAN
PLANT AREA
PUTNEY V.T.
BELLOWS FALLS 69 K.V. TRANSMISSION LINE
VERNON
PARK HILL VILLAGE
WESTMORELAND N.H.
EAST PUTNEY DEPOT
U.S.C. + G.S.-B.M. L4 - 1927
M.P. W.R.J.51 S 72
M.P. W.R.J.52 S 70
M.P. W.R.J.53 S 70
BOSTON AND MAINE RAILROAD
FLOW LINE ELEVATION 220.13
ELEV. 220.13 TOP OF FLASHBOARDS MILE+18
MILE 17+I
FLOW
C O N N E C T I C U T R I V E R
PARTRIDGE BROOK
OX BROOK
TO ROUTE 12
NEW ENGLAND POWER COMPANY — FEE OWNERSHIP
PROP. NO. F — NEW ENGLAND POWER COMPANY — FLOWAGE RIGHTS
NOTE: PROPERTY REFERENCE NUMBERS ARE PREFIXED BY "V"
EXHIBIT K-2
SHEET 9B OF 14
NEW ENGLAND POWER COMPANY
VERNON PROJECT NO. 1904
PROJECT MAP
MAY 1980
0' 400' 800' 1200' 1600' 2000' 2400'
MICROFILM OF THESE ORIGINAL DRAWINGS FILED WITH FERC 5/30/80

EXHIBIT K-2 SHEET 10B OF 14

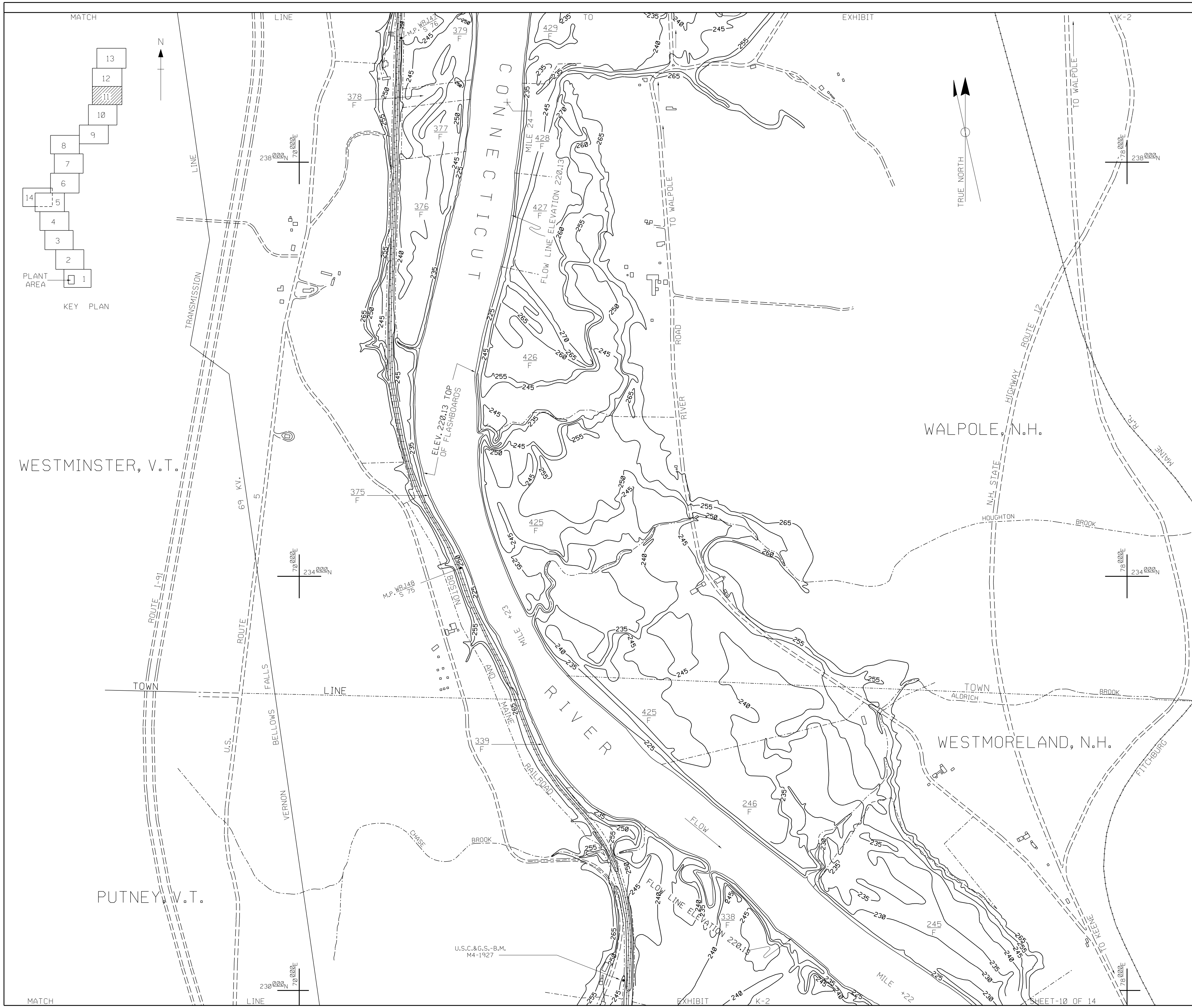
NEW ENGLAND POWER COMPANY

VERNON PROJECT NO. 1904

PROJECT MAP

MAY 1980

H-36381



NOTE:
PROPERTY REFERENCE NUMBERS ARE PREFIXED BY "V"

(box)	NEW ENGLAND POWER COMPANY	FEE OWNERSHIP
PROP.NO. F	NEW ENGLAND POWER COMPANY	FLOWAGE RIGHTS

EXHIBIT K–2 SHEET 11B OF 14

NEW ENGLAND POWER COMPANY

VERNON PROJECT NO.1904

PROJECT MAP

MAY 1980

0' 400' 800' 1200' 1600' 2000' 2400'

FERC1904–83 H–36382

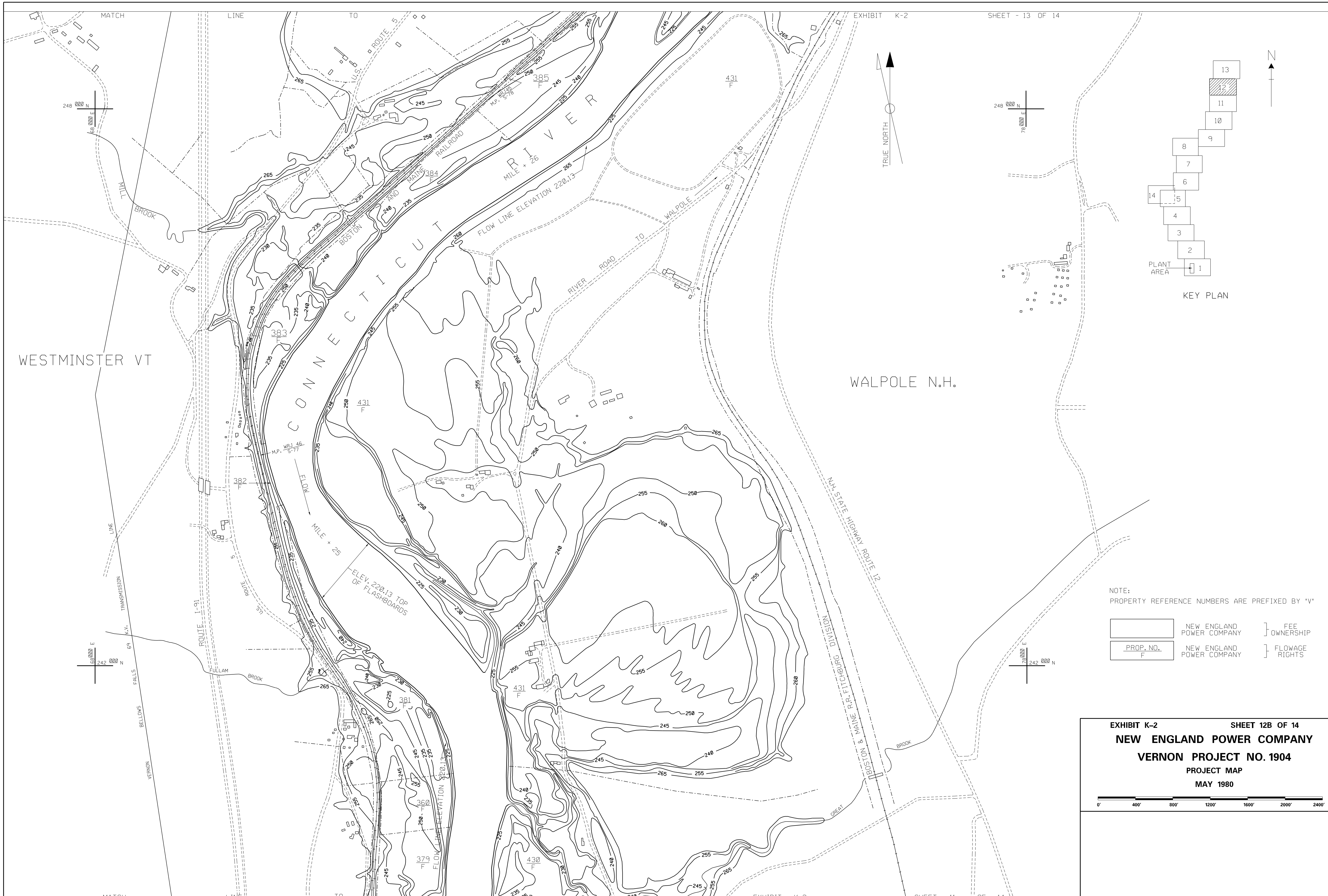


EXHIBIT K-2 SHEET 12B OF 14

NEW ENGLAND POWER COMPANY

VERNON PROJECT NO. 1904

PROJECT MAP

MAY 1980

0' 400' 800' 1200' 1600' 2000' 2400'

FERC1904-84 H-36383

H36384

EXHIBIT K-2 SHEET 13B OF 14

NEW ENGLAND POWER COMPANY

VERNON PROJECT NO.1904

PROJECT MAP

MAY 1980

H-36384

NOTE: PROPERTY REFERENCE NUMBERS ARE PREFIXED BY "V"

[box]	NEW ENGLAND POWER COMPANY	FEE OWNERSHIP
PROP. NO. F	NEW ENGLAND POWER COMPANY	FLOWAGE RIGHTS

EXHIBIT K–2 **SHEET 14B OF 14**

NEW ENGLAND POWER COMPANY

VERNON PROJECT NO. 1904

PROJECT MAP

MAY 1980

0' 400' 800' 1200' 1600' 2000' 2400'

ATTACHMENT 2

PROJECT RECREATION MAPS

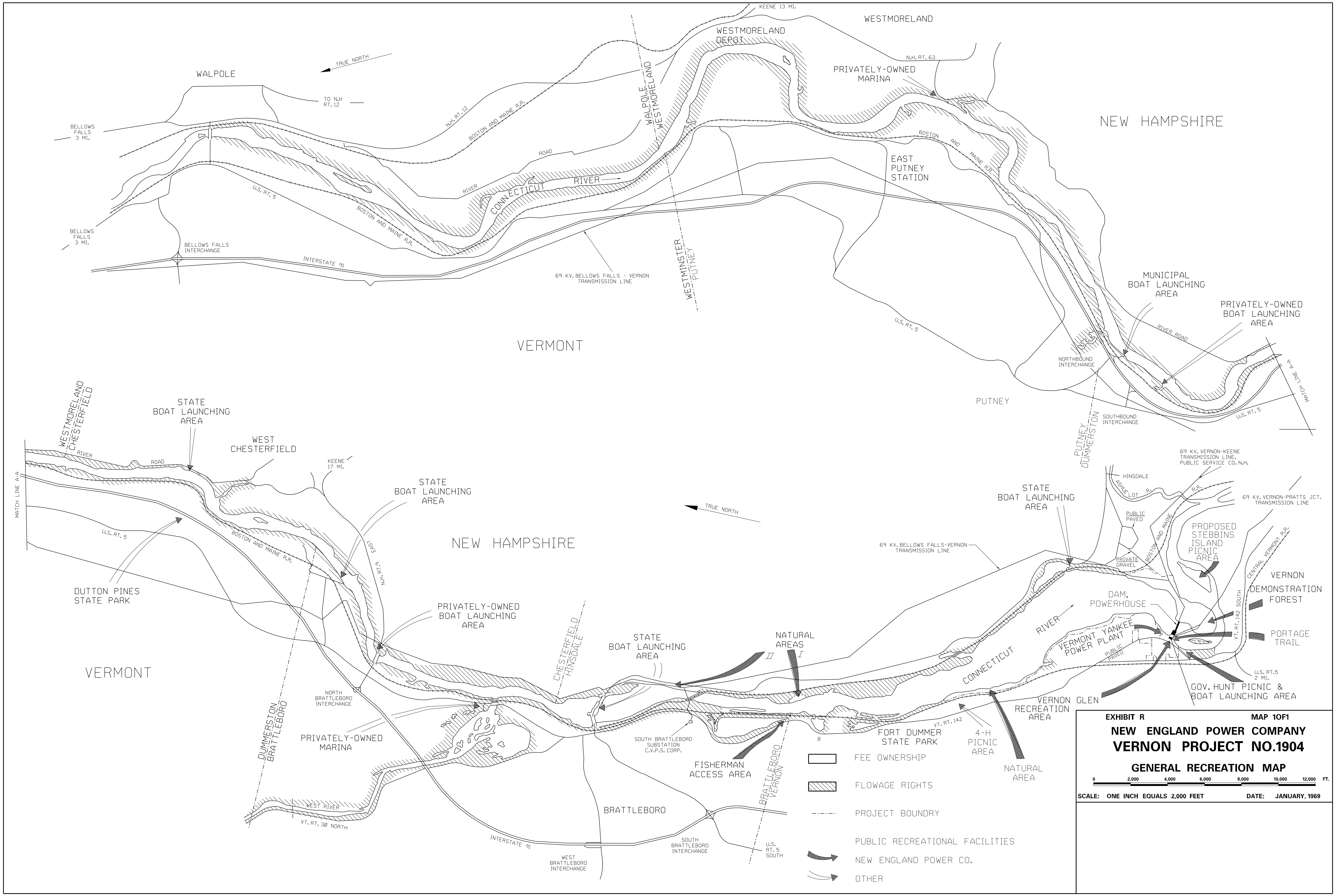


EXHIBIT R — MAP 1OF1

NEW ENGLAND POWER COMPANY

VERNON PROJECT NO.1904

GENERAL RECREATION MAP

0 — 2,000 — 4,000 — 6,000 — 8,000 — 10,000 — 12,000 FT.

SCALE: ONE INCH EQUALS 2,000 FEET — DATE: JANUARY, 1969

H-26399