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September 15, 2014

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

Re: TransCanada Hydro Northeast Inc.'s Initial Study Report
Project Nos. 1892-026, 1855-045, and 1904-073

CLASSIFICATION: PUBLIC; Report contains public material only

Dear Secretary Bose:

TransCanada Hydro Northeast Inc. ("TransCanada") is the owner and licensee of the Wilder Hydroelectric Project (FERC No. 1892), the Bellows Falls Hydroelectric Project (FERC No. 1855), and the Vernon Hydroelectric Project (FERC No. 1904). The current licenses for these projects each expire on April 30, 2018. On October 31, 2012, TransCanada initiated the Integrated Licensing Process by filing with the Federal Energy Regulatory Commission ("FERC" or "Commission") its Notice of Intent to seek new licenses for each project, along with a separate Pre-Application Document for each project.

With this filing, TransCanada submits its Initial Study Report ("ISR") for the three projects, as required by 18 C.F.R. §5.15(c)(1). The ISR is being filed electronically in eight volumes:

Volume I: Status Summary of all Studies
Volume II: Study 7 – Aquatic Habitat Mapping Initial Study Report, September 15, 2014.
Volume III: 2014 Study Site Selection Reports:
A. Study 8 – Channel Morphology and Benthic Habitat Study Site Selection Report, May 9, 2014.

B. Study 9 – Instream Flow Study Revised Site Selection Report, June 20, 2014.
C. Study 13 – Tributary and Backwater Fish Access and Habitats Study Final Site Selection Report, July 21, 2014.
D. Study 13 – Tributary and Backwater Fish Access and Habitats Study Final Site Selection Report - Appendix B – Water Surface Elevation Data (Excel file), July 21, 2014.

Volume IV: Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study - Phase 1 Study Report, May 8, 2014.

Volume V: **Privileged** Data – Study 24 - Dwarf Wedgemussel and Co-occurring Mussel Study Phase 1 Study Report - Appendix B, May 8, 2014.

Volume VI: Study 24 – Dwarf Wedgemussel and Co-Occurring Mussel Study – Phase 2 Revised Study Plan, September 15, 2014.

Volume VII: TransCanada Initial Study Report Supporting Geodatabase – physically filed on DVD, September 15, 2014.

Volume VIII: **Privileged** Data – Study 24 - Dwarf Wedgemussel and Co-occurring Mussel Study – Phase 1 Supporting Geodatabase – physically filed on DVD September 15, 2014.

This filing is made in accordance with the one-year anniversary of the Study Plan Determination ("SPD") for non-aquatics studies.[1] The attached report summarizes study activities through August 2014 for the 18 studies currently being implemented; describes additional work to be completed for each study; summarizes study results that have been finalized to date; and highlights any variances from the Revised Study Plan ("RSP") and/or RSP revisions (as modified in the SPD).

In accordance with 18 C.F.R. § 5.15(c), within 15 days of filing the ISR, TransCanada will hold a meeting to discuss its progress in implementing the study plan and schedule, and the data collected, including any variances from the study plan and schedule if necessary. This meeting will be held on Monday September 29, 2014; if a second day is required to complete the meeting it will be held on Friday October 3, 2014. Both meetings will be held in the conference room at TransCanada's Renewable Operations Center at Wilder Dam in Wilder, Vermont, from 9:00am – 4:30pm. Please park in the area to the right of the access road before you reach the fence and building. Please wait for someone to open the gate as this is a NERC-secure facility.

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[1] On August 27, 2013, Entergy announced plans to decommission its Vermont Yankee Nuclear Power Plant (Vermont Yankee) during the fourth quarter of 2014. Vermont Yankee withdraws its cooling water from and discharges it back to TransCanada's reservoir for the Vernon Project. Operation of Vermont Yankee has influenced Connecticut River water temperatures within the Vernon reservoir and downstream since the plant went into operation in 1972. Because the baseline environmental condition will change after 2014, TransCanada's proposed aquatic studies may have produced data not reflective of baseline conditions if they were conducted while Vermont Yankee was still operating. Because of this unusual circumstance FERC issued two study plan determinations, one on September 13, 2013, for non-aquatic studies not impacted by the closure of Vermont Yankee and a second on February 21, 2014, for aquatic studies.

WebEx sessions have been created for remote audio and video attendees. Please use the information on the WebEx Meeting Information pages attached to this letter.

If there are any questions regarding the information provided in this filing or the process, please contact John Ragonese at 603-498-2851 or by emailing john_ragonese@transcanada.com.

Sincerely,

John L. Ragonese
FERC License Manager

Attachments: Initial Study Report (Volumes I through VI electronically and Volumes VII and VIII via FedEx)

cc: Interested Parties List (distribution through email notification of availability and download from TransCanada's relicensing web site www.transcanada-relicensing.com)

WebEx Meeting Access Information
TC Initial Study Plan Meeting #1

Date: Monday, September 29, 2014
Time: 9:00 am, Eastern Daylight Time (New York, GMT-04:00)
Meeting Number: 920 852 936
Meeting Password: Abcde12345

To join the online meeting:
Link: https://transcanada.webex.com/transcanada/j.php?MTID=m2898c4b556392ee4c45706f17f8d0272
If a password is required, enter the meeting password: Abcde12345
Click "Join".

To join the audio conference only
Call-in toll-free number (US/Canada): 1-866-469-3239
Toll-free dialing restrictions: http://www.webex.com/pdf/tollfree_restrictions.pdf
Access code: 920 852 936

To add this September 29th meeting to your calendar program (for example Microsoft Outlook), click this link: https://transcanada.webex.com/transcanada/j.php?MTID=m1ef93700dc7030e4a83324684deb01c2

TC Initial Study Plan Meeting #2

Date: Friday, October 3, 2014
Time: 9:00 am, Eastern Daylight Time (New York, GMT-04:00)
Meeting Number: 920 135 487
Meeting Password: Abcde12345

To join the online meeting:
Link: https://transcanada.webex.com/transcanada/j.php?MTID=m0b8aa1bf41ae0836c28f0576458e3447
If a password is required, enter the meeting password: Abcde12345
Click "Join".

To join the audio conference only
Call-in toll-free number (US/Canada): 1-866-469-3239
Toll-free dialing restrictions: http://www.webex.com/pdf/tollfree_restrictions.pdf
Access code: 920 135 487

To add this October 3rd meeting to your calendar program (for example Microsoft Outlook), click this link: https://transcanada.webex.com/transcanada/j.php?MTID=m232ebfba178296e4da63cb298dc64030

For assistance go to https://transcanada.webex.com/transcanada/mc
On the left navigation bar, click "Support"

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Initial Study Report

Volume I – Status Summary of all Studies

September 15, 2014

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Additional [or Accompanying] Initial Study Report Volumes:

ACRONYMS AND ABBREVIATIONS

APE	Area of Potential Effects
Bellows Falls Project	Bellows Falls Hydroelectric Project
C.F.R.	Code of Federal Regulations
cfs	Cubic Feet Per Second
Commission	Federal Energy Regulatory Commission
Connecticut River Projects	TransCanada Projects and the Turners Falls Project and the Northfield Mountain Project
DLA	Draft License Application
DO	Dissolved Oxygen
DWM	Dwarf Wedgemussel
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FirstLight	FirstLight Hydro Generating Company
FWS	U. S. Fish and Wildlife Service
GIS	Geographic Information System
HA Study	Hydroacoustic Study
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HSC	Habitat Suitability Curve
ILP	Integrated Licensing Process
ISR	Initial Study Report
LiDAR	Light Detection and Ranging
National Register	National Register of Historic Places
NHDES	New Hampshire Department of Environmental Services

NHFGD	New Hampshire Fish and Game Department
NHNHB	New Hampshire Natural Heritage Bureau
NITHPO	Narragansett Indian Tribal Historic Preservation Officer
NOI	Notice of Intent
Northfield Mountain Project	Northfield Mountain Pumped Storage Project
NRCS	Natural Resources Conservation Service
PAD	Pre-Application Document
PSP	Proposed Study Plan
RSP	Revised Study Plan
SAV	Submerged Aquatic Vegetation
SD1	Scoping Document 1
SD2	Scoping Document 2
SGCN	Species of Greatest Conservation Need
SPD	Study Plan Determination
SSR	Site Selection Report
Stakeholders	State and Federal Agencies, Local Officials, Non-Governmental Organizations, and Other Interested Parties
TCPs	Traditional Cultural Properties
TransCanada	TransCanada Hydro Northeast Inc.
TransCanada Projects	Wilder, Bellows Falls, and Vernon Hydroelectric Projects
Turners Falls Project	Turners Falls Hydroelectric Project
VANR	Vermont Agency of Natural Resources
Vernon Project	Vernon Hydroelectric Project
VTFWD	Vermont Fish and Wildlife Department

VY	Vermont Yankee Nuclear Power Plant
Wilder Project	Wilder Hydroelectric Project

INTRODUCTION

TransCanada Hydro Northeast Inc. (TransCanada) is the owner and licensee of the Wilder Hydroelectric Project (FERC No. 1892) (Wilder Project), the Bellows Falls Hydroelectric Project (FERC No. 1855) (Bellows Falls Project), and the Vernon Hydroelectric Project (FERC No. 1904) (Vernon Project) on the Connecticut River in New Hampshire and Vermont. The Wilder Project, the Bellows Falls Project, and the Vernon Project are collectively referred to herein as the "TransCanada Projects." The current FERC licenses for these projects expire on April 30, 2018.

Background

On October 31, 2012, TransCanada filed with the Federal Energy Regulatory Commission (FERC or Commission) its Notice of Intent (NOI) to seek new licenses for each project, along with a separate Pre-Application Document (PAD) for each project.

FirstLight Hydro Generating Company (FirstLight) is the licensee of the Turners Falls Hydroelectric Project (FERC No. 1889) (the Turners Falls Project) and the Northfield Mountain Pumped Storage Project (FERC No. 2485) (the Northfield Mountain Project).[1] The current licenses for both the Turners Falls Project and the Northfield Mountain Project expire on April 30, 2018. On October 31, 2012, FirstLight filed with the Commission its NOI to seek new licenses for the Turners Fall Project and the Northfield Mountain Project, along with a single PAD for both projects (the FirstLight PAD).

On December 21, 2012, Commission Staff issued its Scoping Document 1 (SD1) for its National Environmental Policy Act analysis of the Connecticut River Projects. Commission Staff indicated in SD1 their intent to prepare a single environmental impact statement for the Connecticut River Projects. In January 2013 in various locations near the projects in New Hampshire, Vermont, and Massachusetts, Commission Staff held six project-specific scoping meetings and one additional scoping meeting to help identify the cumulative effects of licensing the Connecticut River Projects. On April 15, 2013, FERC issued its Scoping Document 2 (SD2), in response to verbal and written comments received at the scoping meetings as well as during the scoping process.

TransCanada received comments on the PADs as well as study requests for the TransCanada Projects from state and federal agencies, local officials, non-governmental organizations, and other interested parties (collectively, stakeholders). On April 16, 2013, TransCanada filed its Proposed Study Plan (PSP) pursuant to 18 Code of Federal Regulations (C.F.R.) § 5.11(a).[2] With its filing of

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[1] The TransCanada Projects, together with the Turners Falls Project and the Northfield Mountain Project, are collectively referred to as the "Connecticut River Projects."

[2] Delays caused by FERC's efiling website prevented a filing on April 15, 2013.

the PSP, TransCanada included a study request responsiveness summary, identifying each study request, the study plan responsive to the request, and the rationale for why any particular study request was not adopted. The April 16, 2013, filing also included TransCanada's schedule for study plan meetings. TransCanada recognized that a single meeting would not be adequate to clarify and discuss its PSP. Therefore, it held a series of study plan meetings and discussions regarding its study plan proposals and received extensive feedback and participation from many interested stakeholders within resource-specific working groups.

Pursuant to 18 C.F.R. § 5.12, comments on the PSP were due on July 15, 2013 (i.e., within 90 days of the filing of the PSP). During the consultation process TransCanada received, discussed, and reviewed comments on its PSP from stakeholders. In addition, in response to comments received and consultation with stakeholders through the study plan meetings, TransCanada filed with FERC an Updated PSP on July 9, 2013.

TransCanada filed its Revised Study Plan (RSP) to address the effects of continued operation of the TransCanada Projects on August 14, 2013. The RSP includes 33 individual studies and data collection efforts. The RSP reflects comments received during the study plan meetings and discussions as well as formal comments filed by stakeholders with FERC. Each of the study plans is described in detail in the RSP.

On August 27, 2013, Entergy announced plans to decommission the Vermont Yankee Nuclear Power Plant (VY) during the fourth quarter of 2014. VY withdraws cooling water from, and discharges it back into, TransCanada's reservoir for the Vernon Project. The effect of decommissioning VY will change the baseline conditions at the Vernon Project.

In a September 13, 2013, Study Plan Determination (SPD), the Director delayed issuing determinations for 20 aquatic resource studies, pending a technical meeting on the issue of VY's decommissioning; however, determinations were issued for the remaining 13 studies unlikely to be affected by VY's continued operation or decommissioning. These studies were approved with or without modifications. In addition, four requested studies were determined to be not required in that SPD (Table 1-2).

On September 24, 2014, TransCanada filed a request for clarification on specific aspects of the determination, and the Director provided clarification on those aspects in a letter dated October 22, 2013.

The VY technical meeting was held on November 26, 2013, to identify aquatic resource studies: (1) not affected by operation of VY that could be implemented in 2014; (2) likely affected by operation of VY; and (3) that may need modification due to the decommissioning of VY. On December 31, 2013, TransCanada submitted revisions to five study plans based on the November 26, 2013, technical meeting and on follow-up discussions with agencies and stakeholders. Minor revisions were made to the following study plans: 6 – *Water Quality*; 13 – *Tributary and Backwater Area Fish Access and Habitats*; 18 – *American Eel*

Upstream Passage Assessment; 21 – *American Shad Telemetry;* and 23 – *Fish Impingement, Entrainment, and Survival*.

On February 21, 2014, the Director issued another SPD for those 20 aquatic resource studies and a "new" Vernon Hydroacoustic Study, that the SPD referred to as a "study requested but not adopted by TransCanada". Fifteen of the 20 proposed studies were deferred until 2015 to allow for the new post-VY baseline condition. Five studies were determined to be not affected by the VY decommissioning and were approved without modification for implementation in 2014.

Summary of Consultation

TransCanada convened and/or participated in several consultation meetings and conference calls and initiated communications with the various resource working groups during the period between filing of the RSP and this filing. Table 1-1 summarizes these consultations.

Table 1-1. Summary of consultation through September 10, 2014.

Date	Studies	Purpose
November 4, 2013	2	Erosion monitoring site selection.
November 26, 2014	6 - 25	FERC initiated discussion of Vermont Yankee Nuclear Power Plant's announced 2014 closure on aquatics-related studies.
March 20, 2014	22	FERC initiated conference call on coordinating juvenile shad needs for TransCanada and FirstLight 2015 studies and 2014 transport and dummy tagging tests.
May 14, 2014	33	TransCanada letters to Tribal representatives requesting a consultation meeting.
May 23, 2014	7, 8, 9, 13, 24	Review of the 2013 Study 7 – Aquatic Habitat Mapping; Site selection for Studies 8, 9, and 13; and review of Study 24 Phase 1 report and Phase 2 Proposed Study Plan.
May 27-28, 2014	31	Meeting and site visits for Study 31 – Whitewater Boating Flow Assessment – for planning purposes.
June 30, 2014	26	Normandeau letter to FWS, VTFWD, and NHFGD requesting minor study adjustments.
July 1, 2014	9, 13, 24	Conference call review of revised Study 9 and 13 site selections and additional discussion and consultation on Study 24 Phase 2 Proposed Study Plan.
July 11, 2014	33	TransCanada re-sending of May 14 letters to Tribal representatives requesting a consultation meeting.
July 21-22, and August 11-12	9	Field review of Study 9 proposed instream flow transects.

Date	Studies	Purpose
August 14, 2014	34	Letter from Commission Staff declining to participate in the scheduled August 26, 2014, study plan consultation meeting.
August 22, 2014	31	Conference call on whitewater boating demonstration at Bellows Falls bypassed reach.
August 25, 2014	9	VTFWD proposed Sumner Falls evaluation.
August 26, 2014	34	Consultation in preparation of filing a study plan for the FERC-requested Vernon Hydroacoustics Study.
September 5, 2014	31	Draft whitewater survey tool provided to boating representatives for comment.

Initial Study Report

This Initial Study Report (ISR) includes Volumes I through VIII. This document, Volume I, summarizes study activities to date for all Integrated Licensing Process (ILP) studies. It briefly describes:

- Study activities to date;
- Additional work to be completed for each study;
- Study results that have been finalized to date; and
- Any variances from the RSP and/or RSP revisions (as modified in the SPDs).

Table 1.2 includes each study's applicable SPD date, implementation year, and current status. It should be noted that final evaluation reporting on project effects for many 2014 resource studies is dependent upon application of the hydraulic and operations models to examine project operations (Studies 4 and 5), which themselves are still in progress.

Table 1-2. Status of all TransCanada Integrated Licensing Process studies.

Study No. and Section No. in ISR Volume I	Study Title	Study Plan Determination	Study Year	Status as of 08/31/2014
1	Historical Riverbank Position and Erosion Study	09/13/2013	2014	In progress
2	Riverbank Transect Study	09/13/2013[1]	2013 - 2015	In progress
3	Riverbank Erosion Study	09/13/2013[1]	2014 - 2015	In progress

Study No. and Section No. in ISR Volume I	Study Title	Study Plan Determination	Study Year	Status as of 08/31/2014
4	Hydraulic Modeling Study	09/13/2013[1]	2014 - 2015	In progress
5	Operations Modeling Study	09/13/2013[1]	2014 - 2015	In progress
6	Water Quality Study	02/21/2014[2]	2015	Not started
7	Aquatic Habitat Mapping Study	02/21/2014	2013 - 2014	Complete
8	Channel Morphology and Benthic Habitat Study	02/21/2014	2014	In progress
9	Instream Flow Study	02/21/2014	2014	In progress
10	Fish Assemblage Study	02/21/2014	2015	Not started
11	American Eel Survey	02/21/2014	2015	Not started
12	Tessellated Darter Survey	02/21/2014	2015	Not started
13	Tributary and Backwater Fish Access and Habitats Study	02/21/2014[2]	2014	In progress
14	Resident Fish Spawning in Impoundments Study	02/21/2014[1]	2015	Not started
15	Resident Fish Spawning in Riverine Sections Study	02/21/2014	2015	Not started
16	Sea Lamprey Spawning Assessment	02/21/2014[1]	2015	Not started
17	Upstream Passage of Riverine Fish Species Assessment	02/21/2014	2015	Not started

Study No. and Section No. in ISR Volume I	Study Title	Study Plan Determination	Study Year	Status as of 08/31/2014
18	American Eel Upstream Passage Assessment	02/21/2014[2]	2015	Not started
19	American Eel Downstream Passage Assessment	02/21/2014	2015	Not started
20	American Eel Downstream Migration Timing Assessment	02/21/2014[1]	2015	Not started
21	American Shad Telemetry Study - Vernon	02/21/2014[2]	2015	Not started
22	Downstream Migration of Juvenile American Shad - Vernon	02/21/2014	2015	Not started
23	Fish Impingement, Entrainment, and Survival Study	02/21/2014[2]	2015	Not started
24	Dwarf Wedgemussel and Co-occurring Mussel Study	02/21/2014	2013 - 2014	In progress
25	Dragonfly and Damselfly Inventory and Assessment	02/21/2014[1]	2015	Not started
26	Cobblestone and Puritan Tiger Beetle Survey	09/13/2013	2014	In progress
27	Floodplain, Wetland, Riparian, and Littoral Vegetation Habitats Study	09/13/2013	2014	In progress
28	Fowler's Toad Survey	09/13/2013	2014	In progress
29	Northeastern Bulrush Survey	09/13/2013	2014	In progress

Study No. and Section No. in ISR Volume I	Study Title	Study Plan Determination	Study Year	Status as of 08/31/2014
30	Recreation Facility Inventory and Use & Needs Assessment	09/13/2013[1]	2014 - 2015	In progress
31	Whitewater Boating Flow Assessment - Bellows Falls and Sumner Falls	09/13/2013[1]	2014	In progress
32	Bellows Falls Aesthetic Flow Study	09/13/2013	2014	Not started
33	Cultural and Historic Resources Study	09/13/2013	2014 - 2015	In progress
34	New Hydroacoustics Study–Vernon	02/21/2014[3]	2015	Not started
n/a	Project Economic Impact Study	09/13/2013	Not required	n/a
n/a	Whitewater Park Feasibility Study	09/13/2013	Not required	n/a
n/a	Contingent Valuation Study	09/13/2013	Not required	n/a
n/a	Climate Change and Continued Project Operations	09/13/2013	Not required	n/a

1. RSP modified by FERC in the SPD issued on this date.
2. TransCanada filed minor study plan modifications on December 31, 2013.
3. FERC requests study in its SPD. TransCanada filed a Request for Rehearing of this study request on March 24, 2014. Proposed Study Plan filed September 15, 2014.

Volumes II through VIII of this ISR contain the following additional documents and data files:

Volume II: Study 7 – Aquatic Habitat Mapping Initial Study Report, September 15, 2014.

Volume III: 2014 Study Site Selection Reports:

A. Study 8 – Channel Morphology and Benthic Habitat Study Site Selection Report, May 9, 2014.

B. Study 9 – Instream Flow Study Revised Site Selection Report, June 20, 2014.

C. Study 13 – Tributary and Backwater Fish Access and Habitats Study Final Site Selection Report, July 21, 2014.

D. Study 13 - Tributary and Backwater Fish Access and Habitats Study Final Site Selection Report - Appendix B – Water Surface Elevation Data (Excel file), July 21, 2014.

Volume IV: Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study - Phase 1 Study Report, May 8, 2014.

Volume V: Privileged Data –Study 24 – Dwarf Wedgemussl and Co-occurring Mussel Study Phase 1 Study Report - Appendix B, May 8, 2014.

Volume VI: Study 24 – Dwarf Wedgemussel and Co-Occurring Mussel Study – Phase 2 Revised Study Plan, September 15, 2014.

Volume VII: TransCanada Initial Study Report Supporting Geodatabase – physically filed on DVD, September 15, 2014.

Volume VIII: Privileged Data – Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study Phase 1 Study Report – Appendix B Supporting Geodatabase – physically filed on DVD, September 15, 2014.

Initial Study Results Meeting

In accordance with 18 C.F.R. § 5.15(c)(2), TransCanada has scheduled the following meeting to discuss the study results and TransCanada or stakeholder proposals, if any, to modify the study plan in light of the progress of the study plan and data collected.

September 29, 2014, 9:00 a.m. – 4:00 p.m. at TransCanada's conference room in TransCanada's River Control Center, 255 Wilder Dam Road, Wilder, VT.

Call in information:

Call in Number: 1-866-469-3239

Meeting Number: 920 852 936

Meeting Password: Abcde12345

To join the online meeting:

1. Go to https://transcanada.webex.com/transcanada/j.php?MTID=m8cb74460af07b9f99532aa1097326490

2. If requested, enter your name and email address.

3. If a password is required, enter the meeting password: Abcde12345

4. Click "Join".

To join the audio conference

1. To receive a call back, provide your phone number when you join the meeting, or call the number below and enter the access code.

2. Call-in toll-free number (US/Canada): 1-866-469-3239

3. Call-in toll number (US/Canada): 1-650-429-3300

4. Toll-free dialing restrictions: http://www.webex.com/pdf/tollfree_restrictions.pdf

5. Access code:920 852 936

If a second meeting day is required, it will be **October 3, 2014, 9:00 a.m. – 4:00 p.m.** at the at TransCanada's conference room in TransCanada's River Control Center, 255 Wilder Dam Road, Wilder, VT.

Call in Number: 1-866-469-3239

Meeting Number: 920 135 487

Meeting Password: Abcde12345

To join the online meeting:

1. Go to https://transcanada.webex.com/transcanada/j.php?MTID=m34d72345ff9ce6c598784a83a164aeb7

2. If requested, enter your name and email address.

3. If a password is required, enter the meeting password: Abcde12345

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3. Call-in toll number (US/Canada): 1-650-429-3300

4. Toll-free dialing restrictions:
   http://www.webex.com/pdf/tollfree_restrictions.pdf

5. Access code:920 135 487

1. Study 1 - Historical Riverbank Position and Erosion Study

1.1 Introduction

TransCanada is conducting this Historical Riverbank Position and Erosion Study (ILP Study 1) to assess the historical erosion and river bank movement within the Wilder, Bellows Falls, and Vernon Project-affected areas to consider the effect and contribution of project operations on erosion in a reasoned way. The RSP for this study was approved without modification in FERC's September 13, 2013, SPD.

Documentation of historical riverbank information, surveys, and photographs will provide an opportunity to quantify or compare changes over an extended period and provide a relative scale and potential quantification of erosion at various locations over time within each project along the Connecticut River. Archival mapping and information will be used to identify where erosion occurred and characterize the degree of erosion that has occurred over time. The study includes the following tasks.

- Conduct a document search within TransCanada's own records to identify historical information on project maps locating the edge of river and erosion monitoring.
- Research available Federal Emergency Management Agency (FEMA) flood insurance studies where field surveys may have been conducted at key locations along the impoundments.
- Research available aerial photographic records, such as those available from the National Agriculture Imagery Program and Natural Resources Conservation Service (NRCS).
- Digitize the river's edge, islands, and bars from various historical references and attempt to overlay them for comparison.
- Within reason, additional sources of valid (i.e., licensed survey) information on river bank changes are being sought by:
    - contacting riverfront landowners and municipalities to request maps and other relevant information;
    - speaking with NRCS personnel who have received requests for assistance from riverfront landowners;
    - conducting archival searches at state and local historical societies in instances where other data are not available; and
    - consulting with the erosion working group to explore further potential resources.

1.2 Study Progress

The study was initiated in the fall of 2013 with progress made on several study tasks, described below.

- TransCanada's own documents were reviewed and numerous previous erosion maps and photographs were identified. Several map years covering a range of time through operation of the projects were selected and the location of erosion shown on the maps is being hand-digitized into a Geographic Information System (GIS) database. Where the location of previous erosion photographs can be confidently established, recent comparative photos are being taken to provide visual comparisons of how the amount and severity of erosion has changed through time.
- Several NRCS offices within the study area were contacted and historical aerial photographs from 1953/1955 and 1970/1975 were acquired for the entire study area. Photographs from the 1990s, and later are available for the entire study area on Granit – New Hampshire's GIS data repository. The acquired historical aerials are being geo-rectified to overlay with recent aerial photographs to determine changes through time in the location of riverbanks, islands, and bars.
- The acquired historical aerial photographs from 1953/1955 and 1970/1975 have been geo-rectified and overlaid on recent aerial photographs in order to determine changes, through time, in the location of riverbanks, islands, and bars.
- Additional sources of valid information on riverbank changes have also been sought. Archival information and old maps were collected from December 2013 to August 2014 at 24 town historical societies, Vermont and New Hampshire state museums, Vermont and New Hampshire state archives, and the Dartmouth College Special Collections. Numerous ground photographs that pre-date project operations were located and could allow for comparisons of bank conditions before and after project operations if the position of the photographs can be positively relocated. A letter was sent in early July to all river abutters seeking additional old surveys, photographs, and other information providing evidence of riverbank changes through time. Of the approximate 1,200 letters sent, 12 responses were received by email and 9 responses through telephone calls. Considerable useful information and resources have been gathered through follow-ups with the responders including:
    - completion of the 1970/1975 aerial photograph set;
    - a partial set of detailed 1:200 scale 1930/31 topographic maps of the Wilder impoundment completed for the New England Power Construction Co.;
    - professional surveys of the same areas completed decades apart; and

  - numerous details on the fate of past bank stabilization efforts and river bank changes over several decades.

1.3 Remaining Activities

Most of the data collection for the study has been completed (95 percent complete), but some additional data collection and the data analysis remain to be conducted and are scheduled for completion by the end of 2014 with the study report to follow.

Remaining activities include the following tasks.

- A selection of erosion maps located in TransCanada's files are being hand-digitized to compare with erosion mapping being completed as part of the Riverbank Erosion Study (Study 3).

- Previous FEMA flood studies will be investigated to identify if any previous surveyed cross sections occur at key locations in the study area and to determine if such cross sections can be resurveyed to document channel changes through time. Such resurveys will occur with additional surveying to be completed as a follow-up to erosion mapping as part of the Riverbank Erosion Study (Study 3).

- The National Agriculture Imagery Program, National Archives, and other sources of aerial photographs are in the process of being contacted to locate aerial photographs from the 1940s or 1930s in the limited number of areas where comparisons of the already geo-referenced aerial photographs show extensive bank erosion and channel migration.

- Eight of the historical societies in the study area remain to be visited, but many of these may no longer be in operation and the town offices in each town are helping to make contacts or determine if a historical society still exists. A selection of old ground photographs taken from known locations will be re-photographed and written documentation of past channel alterations can be investigated more closely as part of the Riverbank Erosion Study (Study 3).

- While most follow-ups with river abutters that responded to the letter have been completed, four landowners remain to be visited and an effort is underway by TransCanada to locate the remaining 1:200 scale 1930/31 topographic maps of the Wilder impoundment completed for the New England Power Construction Co.

1.4 Study Results to Date

Although a detailed analysis of river bank changes observed by comparing the overlaid historical aerial photographs will be conducted as part of Study 3, a visual inspection of the digitized bank lines reveal areas of significant erosion within a relatively stable river planform (i.e., meander growth has occurred with minor changes in shape and very little oxbow – meander cutoff – formation). The individual areas of significant erosion are limited in area (i.e., a single meander bend) but are not limited to a single scope (e.g., geomorphic surface/soil type) and are found throughout the study area.

Information collected from historical societies will be analyzed in detail as part of Study 3 to better understand the processes of erosion, but initial findings appear useful for identifying the locations of islands submerged with raising of impoundment levels and timing of bank stabilization projects.

Information gathered from river abutters will be very useful in the analysis of location, types, severity, and causes of erosion. Many landowners have provided information on past bank stabilization projects in the Wilder impoundment, including both rock and tree revetments that have been completely washed away and providing documentation of more than 50 feet of recent erosion in the past 12 years such as across from Reed Marsh in Wilder impoundment. Bank erosion documented in this way can be corroborated through the aerial photo comparisons and ongoing erosion monitoring (Study 2).

1.5 Variance from Study Plan and Schedule

There have been no significant deviations from the study plan or schedule to this point. All research related to this study is expected to be completed during 2014. Since most of the historical data analysis is associated with Study 3 – Riverbank Erosion Study, the report for this study is expected to consist of a presentation of the historical data rather than an analysis of it which will be incorporated into the Study 3 study report.

2. Study 2 – Riverbank Transect Study

2.1 Introduction

TransCanada is conducting this Riverbank Transect Study (ILP Study 2) to monitor riverbank erosion at selected sites in the Wilder, Bellows Falls, and Vernon impoundments and in the project-affected riverine sections below the dams. Relationships observed between changing water levels and the timing of bank erosion will help establish whether water-level fluctuations, described in terms of magnitude, periodicity, and duration, and increased shear stresses resulting from project operations are correlated with erosion in project-affected areas. Observed water-level fluctuations and shear stresses from non- project-related factors are also being investigated.

The RSP for this 2-year study was modified by FERC in its September 13, 2013, SPD with the following specific changes.

- Flow values that would trigger additional non-spring runoff high-flow event surveys are flows greater than 35,000 cubic feet per second (cfs) at Wilder, 44,000 cfs at Bellows Falls, and 49,000 cfs at Vernon.
- The study area includes an additional erosion monitoring site (for a total of 21 sites) at the Vernon dam east bank (Study 2 site # EMVR1). This site is currently the subject of ongoing biennial monitoring being conducted separately from relicensing studies. The 21 sites include 10 associated with Wilder, 6 with Bellows Falls, and 5 with Vernon.

The study tasks include:

- Selection of survey sites in consultation with the erosion working group;
- Establishment of full river cross sections at the sites using standard topographic and bathymetric survey methods; and
- Conducting repeated surveys, taking ground photographs, and collecting water-level monitoring data at the study sites at least four times per year for 2 years (plus any high-water event monitoring).

2.2 Study Progress

The study was started in the fall of 2013 with progress made on several study tasks.

- A catalogue of nearly 50 possible erosion monitoring sites was developed based on initial analysis of aerial photographs, topographic maps, previous erosion studies, and field reconnaissance. For each site, information was tabulated on an Excel spreadsheet regarding location, land owners, bank stability, bank composition, position along the river channel (i.e., inside or outside of meander bends), proximity to tributaries, and other information relevant to the bank stability at the site.

- An initial selection of 21 sites was made to ensure that the sites were spread throughout the study area (10 associated with Wilder, 6 with Bellows Falls, and 5 with Vernon) and provided a characteristic representation of various soil types, bank heights, bank stability, and channel positions. Pivot tables were created to ensure a range of conditions were represented by the selected sites for later statistical analysis. In consultation with the working group in November 2013 (Appendix A), the list of erosion monitoring sites was finalized (Figures 2-1 thorough 2-6) with only minor changes made to the initially selected sites. This information is included as a GIS layer identified as "TransCanadaStudy_2_Selected Transects_2014" in the geodatabase filed separately on DVD as Volume VII of this ISR, TransCanada Initial Study Report Supporting Geodatabase.

- Erosion monitoring was initiated at the 21 sites in fall 2013 after securing landowner permission at each site and discussing the best location to place rebar stakes to monument survey and photograph locations. Topographic cross sections of the banks were then conducted and ground photographs taken at monumented locations. A second round of monitoring was initiated after spring high flows in May 2014 and was completed in early June 2014. A third round of monitoring was initiated in mid-July 2014 and was completed by the end of July 2014.

- Comparisons were made between cross sections and ground photographs from the first two rounds of monitoring.

- While the erosion monitoring is completed on only one bank, a full river cross section is in progress at each site to document bathymetric conditions that may reveal potential causes of erosion. Ten of the 21 full river cross sections have been completed and the remainder will be completed during September 2014.

- Stratigraphic descriptions of bank sediments have been completed at all 21 monitoring sites and will be used to determine heterogeneities in the banks that might lead to preferential zones at which groundwater seeps out of the bank and to identify highly erosive layers (e.g., sand) on each bank.

- Water-level monitors were deployed at or near each monitoring cross section in July 2014. The monitors are recording water levels at 15-minute intervals and are downloaded during each round of periodic monitoring.

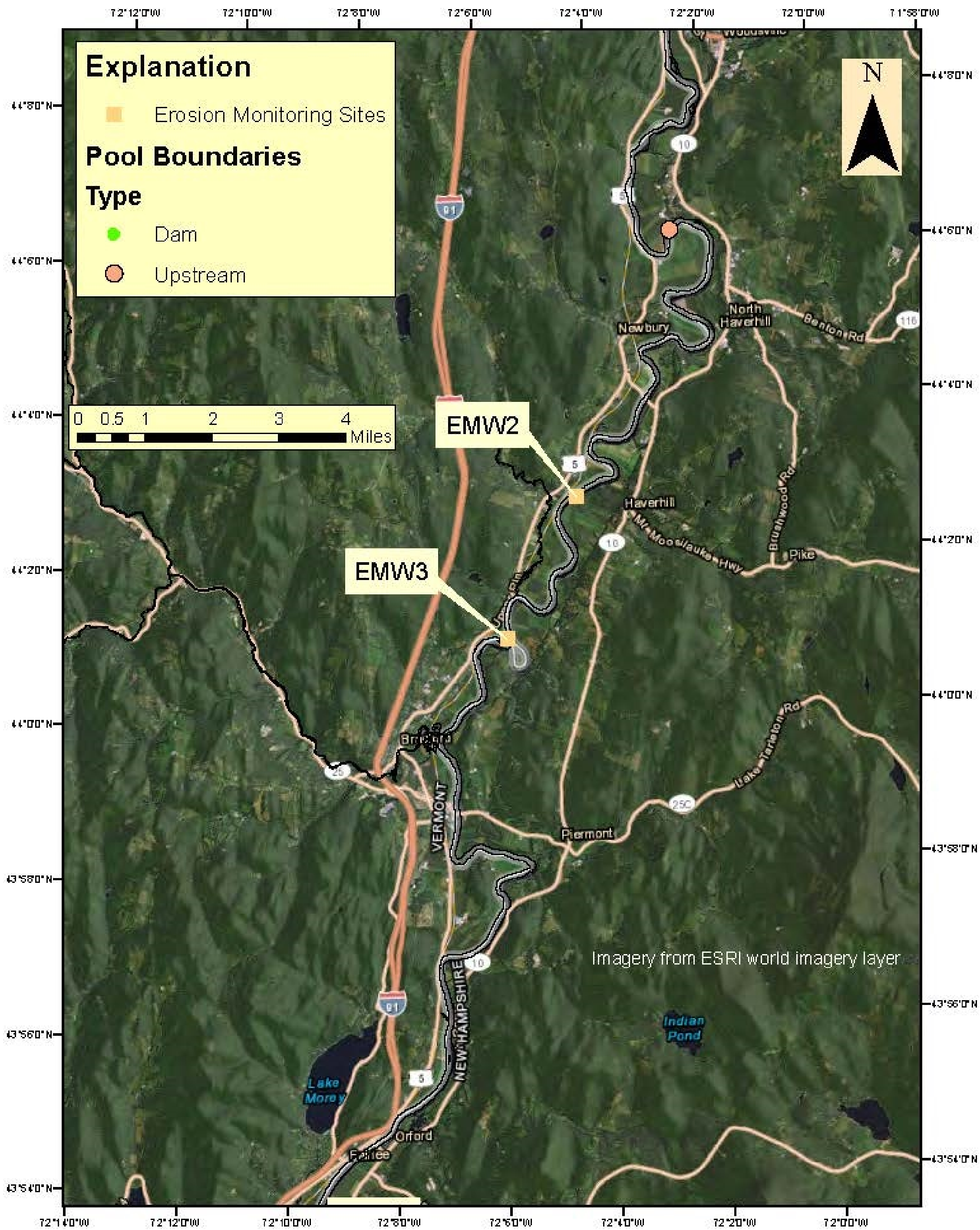

Figure 2-1. Erosion monitoring sites in the upper Wilder impoundment.

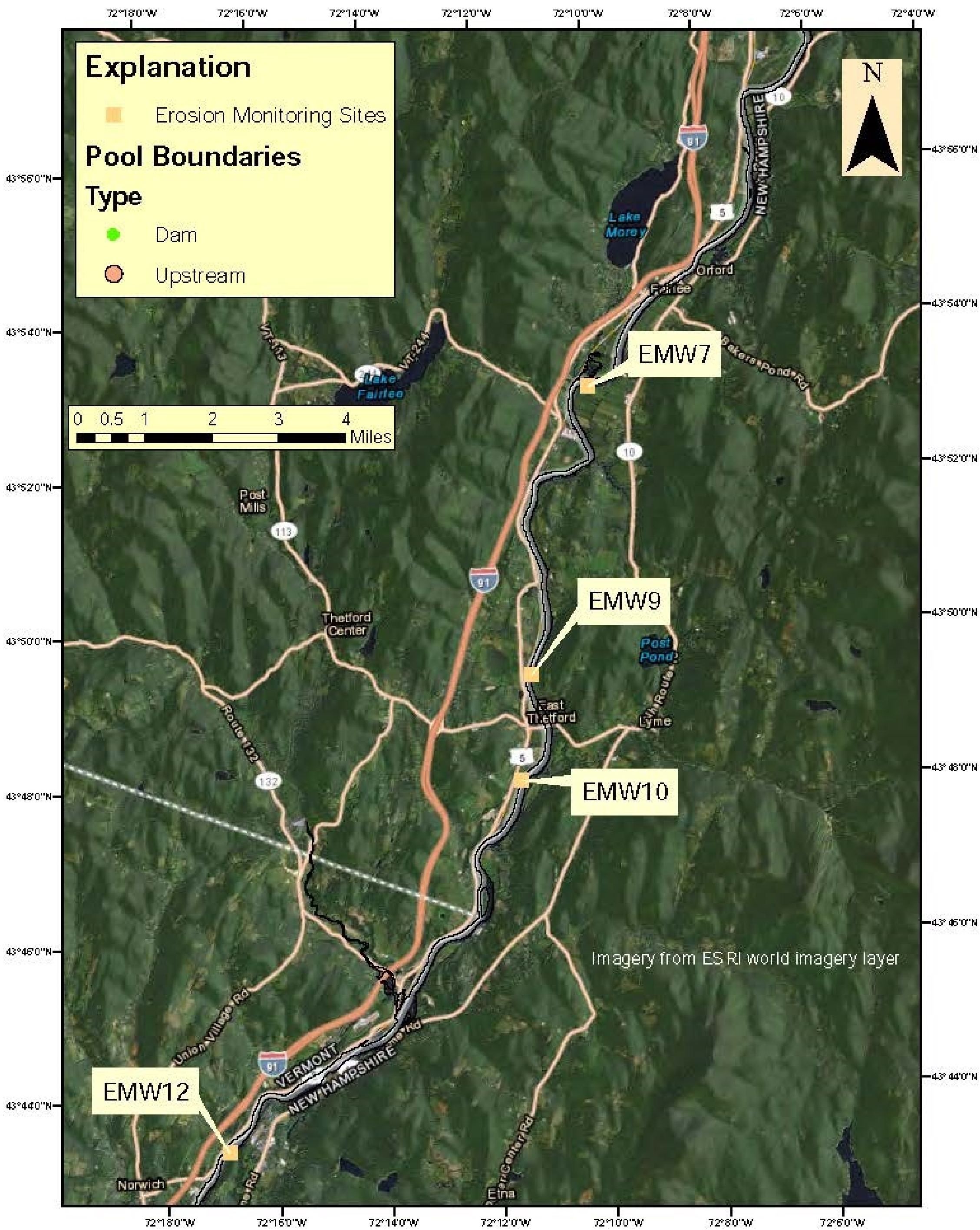

Figure 2-2. Erosion monitoring sites in the lower Wilder impoundment.

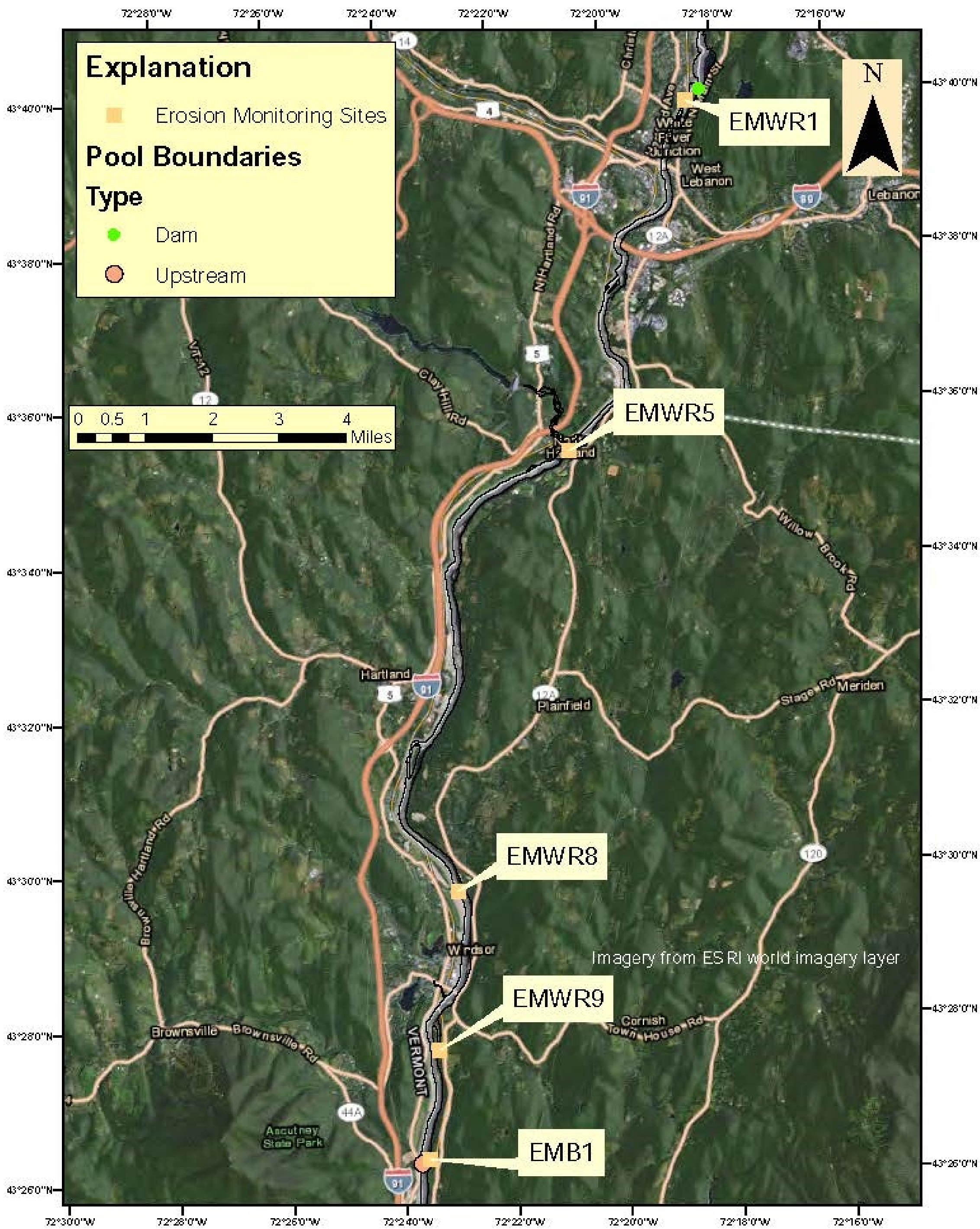

Figure 2-3. Erosion monitoring sites in the Wilder riverine section and upper Bellows Falls impoundment.

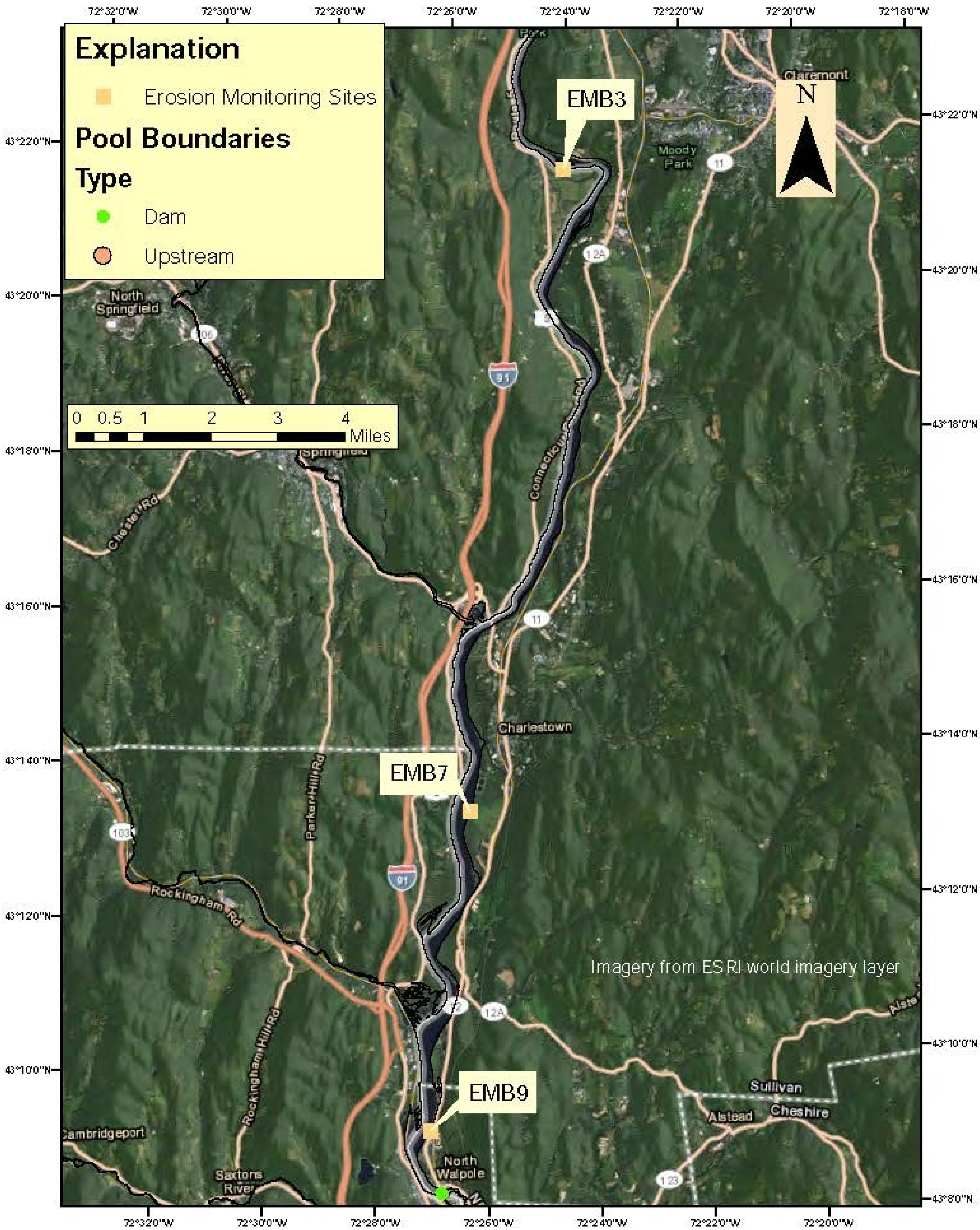

Figure 2-4. Erosion monitoring sites in the lower Bellows Falls impoundment.

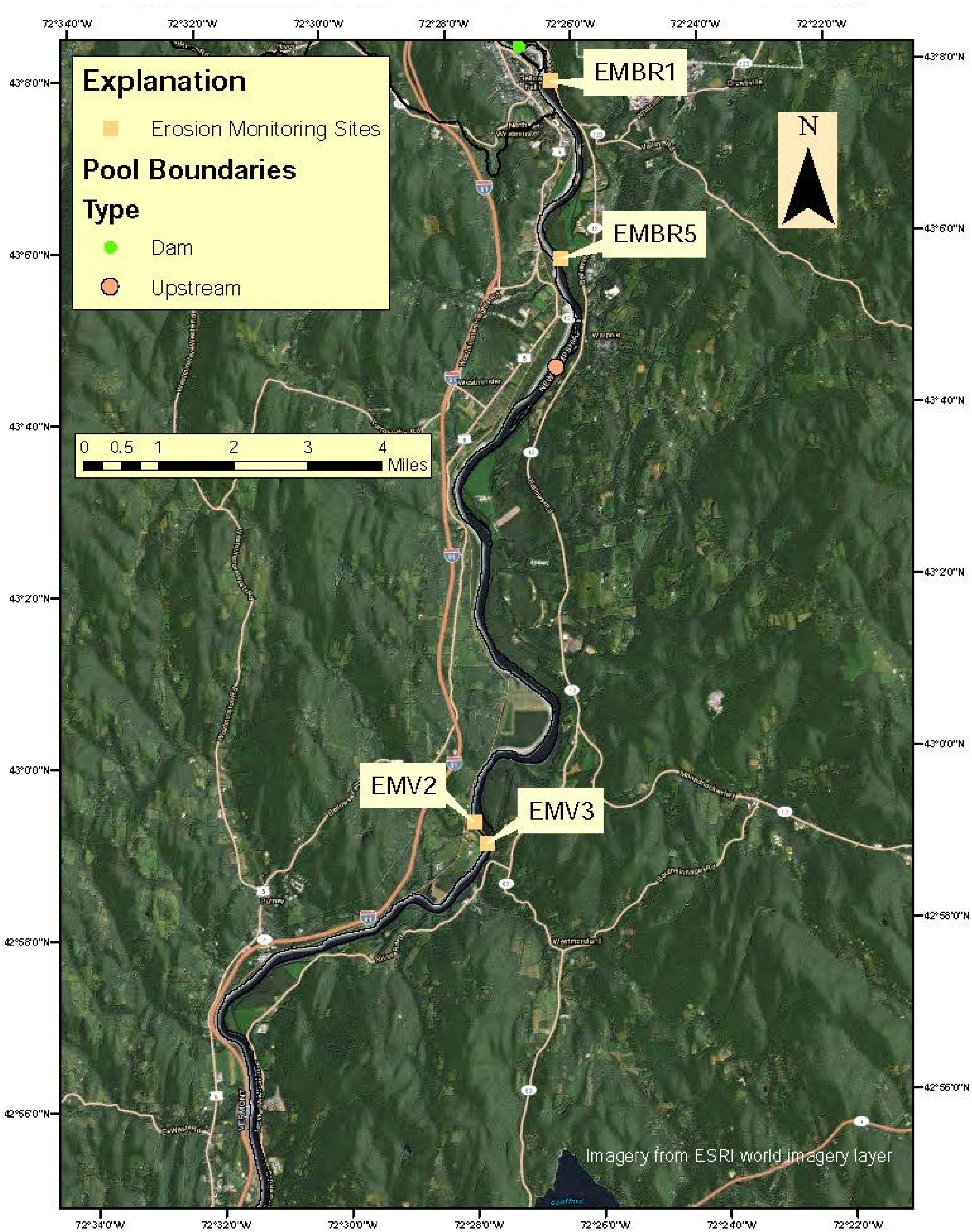

Figure 2-5. Erosion monitoring sites in the Bellows Falls riverine section and upper Vernon impoundment.

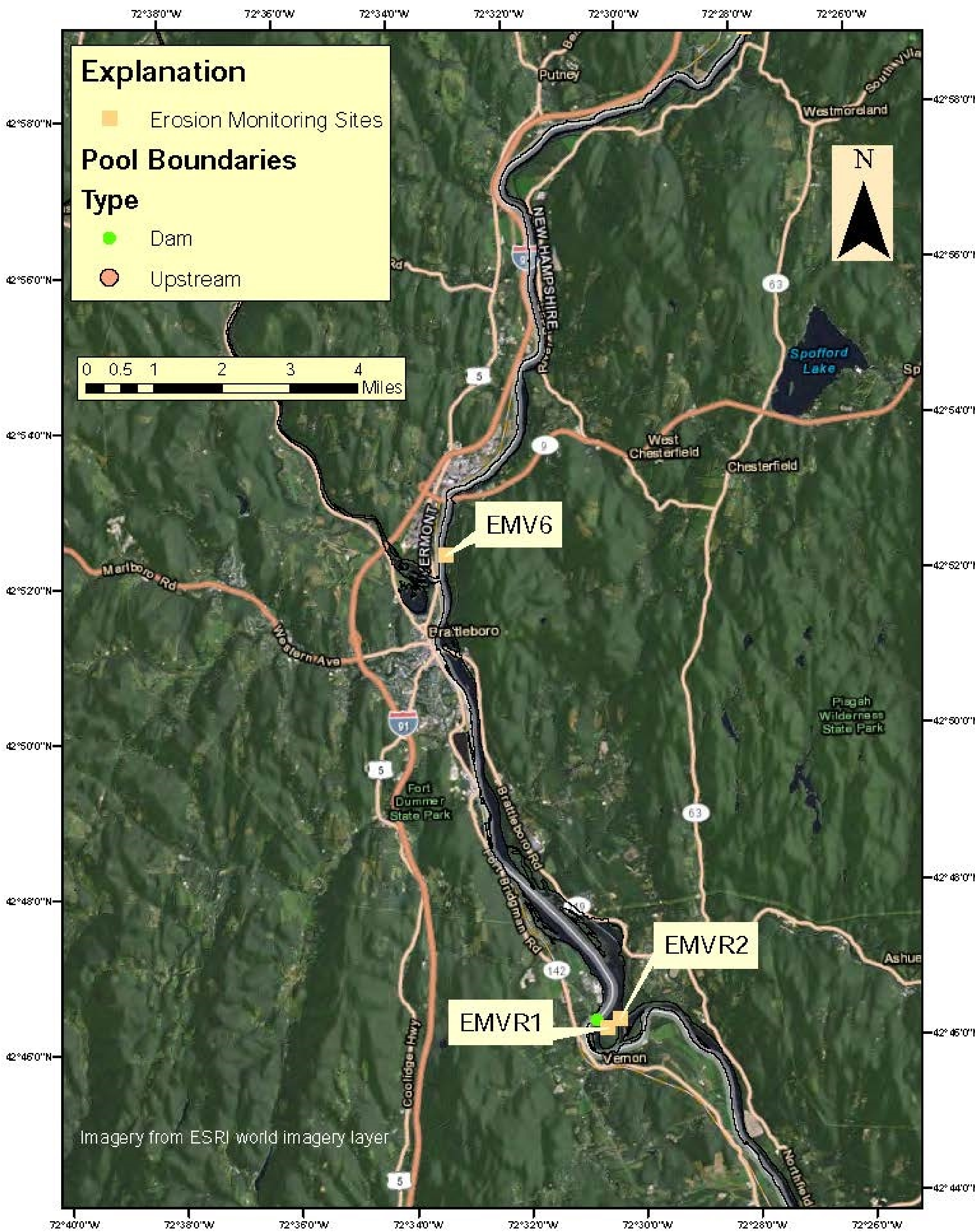

Figure 2-6. Erosion monitoring sites in the lower Vernon impoundment and Vernon riverine section.

2.3 Remaining Activities

Several activities will be undertaken for this study in 2014, including the following tasks.

- At least two more rounds of monitoring will be completed before the end of 2014. Additional rounds may also be necessary if there are high water events during the field season. To date, there have been no high flows that would trigger additional non-spring runoff high-flow event surveys.
- The remaining full river cross sections to complete will be surveyed during the next round of monitoring in September 2014.
- All monitoring sites have local benchmarks established to ensure cross sections are resurveyed in the same position each monitoring period. However, to link all 21 monitoring sites to the same datum, the sites will need to be linked to known nearby benchmarks. This linking survey will be completed in the fall of 2014.
- Data for the completed third round of monitoring will be analyzed and compared with earlier monitoring rounds. The working group will be consulted on the interim results and the need, if any, for additional monitoring at one or more sites.
- Data from water-level monitoring will continue to be downloaded during each monitoring round.
- The stratigraphic descriptions for the monitoring sites are being drafted.

This study will continue in 2015 with additional monitoring, data reduction and analysis, and preparation of draft and final study reports.

2.4 Study Results to Date

A comparison of the November 2013 and May/June 2014 monitoring showed significant bank erosion at only 2 of the 21 monitoring sites. The 2 sites showing erosion are EMW3 (Bellevance site) and EMB7 (Great Meadow site). EMW3 had 4 feet of recession at the top of the bank; while the lower bank accumulated up to 3 feet as material toppling from the top of the bank came to rest. EMB7 had 7 feet of recession at the top of the bank and accumulated 4 feet of bank material at one focused location at the base of the top vertical portion of the bank, suggesting the bank may have failed as a single intact planar slip block.

Minor changes of up to 1 foot or less may have occurred at some of the other sites, but distinguishing these changes from artifacts of the surveying process is difficult. However, point-by-point analyses of the survey data are underway in an attempt to remove these artifacts and more tightly determine how much, if any, change has occurred at the few sites where minor changes may have occurred. Banks with uniform slopes have fewer artifacts and the lack of change can be more clearly documented. Artifacts are more likely to occur where the bank slope changes frequently, undercutting is present, and/or thick vegetation is present because slight variations in the location of a survey point can result in apparent changes on the drafted cross sections even though the ground photographs and observer reports clearly document no change has occurred. In future monitoring rounds, pin flags will be placed at each survey point, so the same points can be reoccupied, thus preventing most artifacts in the surveying process from appearing in the drafted data at sites where no changes are actually occurring.

The stratigraphic columns at each monitoring site show a wide variety of bank sediments with some sites showing heterogeneity in bank sediments while most show a fairly uniform bank stratigraphy.

2.5 Variance from Study Plan and Schedule

There have been only minor variations from the study plan. Full river cross sections were scheduled to be completed during the first round of monitoring in November 2013 but were delayed to ensure that monitoring was completed before snow accumulated. The full river cross sections were further delayed in May 2014 due to high water. To ensure that bank monitoring was completed within a tighter timeframe, a decision was made to complete half of the full river cross sections in July 2014 and the other half in the September 2014 round of monitoring.

Water-level loggers ideally would have been deployed during the first monitoring round in November 2013, but the effort was not undertaken as the loggers would have been deployed for only a week or two before they would have been pulled for the winter. As a result, water-level loggers were installed at or near the 21 monitoring sites during June 2014, slightly later than initially intended due to high water in the earlier spring months. Two of the 21 deployed water-level loggers (the first monitoring sites downstream of Wilder dam and Vernon dam) were not found during the July 2014 monitoring round and were likely removed. Given the likelihood that replaced loggers would also be removed, the monitors were not replaced, but water-level monitoring continues at the other 19 sites. However, water-level loggers installed for Study 13 – Tributary and Backwater Fish Access and Habitats Study may potentially provide additional data to supplement this study's loggers. The overwintered loggers from the 2013 Study 7 – Aquatic Habitat Mapping that are still in place are not located in the vicinity of the two removed loggers and would not provide additional data for this study.

3. Study 3 – Riverbank Erosion Study

3.1 Introduction

TransCanada is conducting this Riverbank Erosion Study (ILP Study 3) to provide baseline data relative to erosion in the Wilder, Bellows Falls, and Vernon Project-affected areas. The objectives of this study are to:

- Determine the location of erosion in project-affected areas and compare these locations with previously compiled erosion maps (e.g., Kleinschmidt, 2011; Simons et al., 1979);
- Characterize the processes of erosion (e.g., piping, slumping, and slips);
- Ascertain the likely causes of erosion (e.g., high flows, groundwater seeps, eddies, and water-level fluctuations related to project operations); and
- Identify the effects of shoreline erosion on other resources (e.g., riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat).

The RSP for this 2-year study was modified by FERC in its September 13, 2013, SPD with the following specific change.

- The study's analysis will include a correlation of visible indicators of erosion with project-caused water-level fluctuations at the 21 transect locations established in the Riverbank Transect Study (Study 2).

3.2 Study Progress

The study was started in early 2014 with progress made on the following study tasks.

- Light Detection and Ranging (LiDAR) information was used along with previously completed surficial geology maps in the study area to create a draft surficial geology map of those portions of the Connecticut River Valley closest to the river channel. The map highlights different geomorphic surfaces with implications regarding the age, soil type, and stratigraphy of the surfaces and underlying materials. Minor surfaces near the bank of the river are also being identified with the LiDAR data, including hummocky terrain that might be an indicator of past/ancient slumping along the river and shallow gentle swales that might represent former channel positions.
- Field checking of the draft surficial geology map was completed for the entire study area to confirm that remotely sensed surfaces viewed with LiDAR, aerial photographs, and topographic maps are discreet features in the field that can be readily discriminated from adjacent surfaces.
- The literature review has been focused on styles of erosion in reservoirs and large rivers and on determining the methods used in past erosion mapping efforts in the study area. This information will be used to create written and

visual descriptions of bank erosion stages that will be used in erosion mapping to be conducted in 2014/2015.

- A GIS bank line shapefile was created by modifying the line used by Kleinschmidt in its 2010 erosion mapping. The LiDAR data did not prove useful for this purpose because the extracted line was based on the water's edge and not the top of the bank, resulting in wide discrepancies with the Kleinschmidt and earlier mapping efforts. Modifications to the Kleinschmidt line included eliminating embayment areas behind the railroad and instead using the railroad line as the bank line where directly impinging on the river as the armor along the railroad may exert an influence on erosion in adjacent areas and, thus, should be reflected in the erosion/bank stability maps.
- The location of erosion mapped by the U.S. Army Corps of Engineers in 1979 has been digitized/clipped to the bank line created for this study, so comparisons of location and total length can later be made with the 2014 mapping and other earlier mapping efforts.
- The features to be mapped during the erosion/bank stability mapping have been defined with bank height, bank composition, and other features to be extracted from the LiDAR data and geomorphic maps, so the field effort can be focused on bank stability and processes of erosion. Maps of bank stability will be subdivided into 5 categories: Erosion – active, Erosion – vegetated, Erosion – healed, Stable, Armored – eroding, and Armored – stable. Initial observations indicate that considerable erosion is occurring in areas not recognized during the Kleinschmidt (and earlier) mapping efforts because less obvious erosion features are often obscured by vegetation. The "Erosion – vegetated" category was created to account for this erosion, but to still enable for more accurate comparisons with earlier maps. The "Erosion – active" category represents conditions that were likely mapped as eroding in earlier efforts even though the amount of erosion occurring in the "Erosion – vegetated" category may be as severe as in the "Erosion – active" category.
- Field mapping of bank stability and erosion processes was initiated in August 2014 after field testing the variously defined bank stability categories earlier in the month. To date, 59 miles of approximately 255 miles (approximately 23 percent) of the banks and islands had been mapped, including portions of the Wilder and Bellows Falls impoundments.
- An initial review of the bathymetric data was completed and will prove useful in understanding the distribution of erosion and other bank features.

3.3 Remaining Activities

Remaining work activities to be completed in 2014 and 2015 for this study include the following tasks.

- Hand-digitizing the geomorphic surfaces that intersect the riverbanks, so the composition, height, stratigraphy and other important features of the riverbank will be known along the river's length.

- Extracting bank heights and composition from the LiDAR data and surficial geology maps.
- While the bank stability and erosion process categories have been defined for internal use for the mapping effort, detailed written descriptions of these categories must still be developed.
- Approximately 77 percent of the mapping is still to be completed, and is scheduled for completion in October 2014.
- Consultation with those involved in preparation of the Kleinschmidt (2011) report on information on how erosion was defined – what features were used to decide if a river bank was mapped as eroding – will be critical for making accurate comparisons with the 2014 mapping.
- The 2014 erosion mapping, once completed, will be compared with previous erosion mapping efforts and links sought between the erosion and possible causal factors such as water-level fluctuations, changes in bank composition and stratigraphy, bathymetric variations along the river, and other factors. The location and severity of erosion will be used to identify potential resources impacted by the erosion.

3.4 Study Results to Date

None at this time.

3.5 Variance from Study Plan and Schedule

There have been no deviations from the study plan or schedule to this point.

3.6 Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report—2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Prepared for TransCanada Hydro Northeast Inc., Westborough, MA. March 2011.

Simons, D.B., Andrews, J.W., Li, R.M., and M.A. Alawady. 1979. Connecticut River Streambank Erosion Study—Massachusetts, New Hampshire, and Vermont. Prepared for the U.S. Army Corps of Engineers, New England Division.

4. Study 4 – Hydraulic Modeling Study

4.1 Introduction

TransCanada is conducting this Hydraulic Modeling Study (ILP Study 4) to develop a hydraulic model to derive hydraulic indices and parameters such as water surface elevations, velocities, and flows across the study area and at locations of interest identified in other resource studies ("econodes"). The results of the hydraulic model will on its own, or in conjunction with the Operations Modeling Study (Study 5), inform the other studies, thereby permitting evaluation of the effects of project operations on aquatic, terrestrial, and geologic resources. The objectives of this study are to:

- Develop relationships between water levels and flows throughout the project impoundments and affected downstream reaches; and
- Provide information regarding specific relationships at econodes of interest to the Operations Modeling Study (Study 5).

The RSP for this study was modified by FERC in its September 13, 2013, SPD with the following specific changes:

- Consult with the New Hampshire Department of Environmental Services (NHDES) and the U.S. Fish and Wildlife Service (FWS), (and presumably, with the Vermont Agency of Natural Resources [VANR]) to establish a process and schedule for selecting the appropriate number and locations of velocity transects, and the appropriate range of calibration flows, and file that information with FERC by December 12, 2013. TransCanada requested, and FERC subsequently approved, an extension of time for that filing.
- File a modified study plan that details the process for selection of velocity transects and calibration flows in consultation with the agencies.

TransCanada filed the modified study plan on March 28, 2014, and on April 9, 2014, FERC issued a letter approving the modified study plan.

4.2 Study Progress

As of August 31, 2014, the following tasks have been completed.

- The preliminary Hydrologic Engineering Centers River Analysis System (HEC-RAS) model was refined to include new and revised cross-section that correspond with key resource locations of interest associated with Studies 7, 8, 9, 13, and 24.
- Operations Model (Study 5) hydrology data, hourly headpond, and hourly project flows were provided for Study 4.
- Modifications were made to the RSP for this study to include velocity comparison and detailing selection of velocity transects. FERC approved the

study plan modification and indicated that the number and location of velocity transects must be established based on consultation with the resource agencies.

- LiDAR data was reviewed for model setup and bathymetry and water-level logger data sets from Aquatic Habitat Mapping (Study 7) were received and reviewed for inclusion in this study. The preliminary HEC-RAS model was set up and discussions with other study leads were held on incorporating the Operations Model (Study 5) hydrology data set.

4.3 Remaining Activities

Consultation with FWS, VANR, and NHDES on velocity calibration and comparison (as detailed in the modified study plan) has not yet occurred. Consultation is dependent upon final transect data to be incorporated from Study 9 – Instream Flow Study. This is necessary since depth data from the riverine sections collected in 2013 from Study 7 – Aquatic Habitat Mapping was not sufficiently detailed to allow its incorporation into the model. As such, consultation is likely to be scheduled during late 2014 or early 2015 once all Study 9 data are available.

The HEC-RAS model cross section locations will also be refined for Study 9 upon completion of the field data collection and data compilation for that study. The HEC-RAS model will then be set up, calibrated, and verified to develop relationships between water levels and flows in the project-affected areas for use in assessing project effects on various resource areas included in other studies.

4.4 Study Results to Date

None at this time.

4.5 Variance from Study Plan and Schedule

- The model's preliminary set up was delayed until May 2014 from January 2014, awaiting final availability of the digital elevation model data (LiDAR and bathymetry), and availability of the baseline operations model hydrology data set. However, this delay does not materially affect the overall study schedule. Results from the aquatic resource studies that were delayed until 2015 as a result of the announced closure of VY will also delay identification of some econodes and modeling of water surface elevations, velocities, and flows.
- LiDAR data were provided to First Light for the purpose of developing its hydraulic model for the Turners Falls Project (up and downstream). In return, First Light will provide TransCanada with its revised and enhanced bathymetry data for the Turners Falls impoundment. This will allow for an expansion of TransCanada's hydraulic model (although separate) to include the reach below Vernon to Turners Falls dam also.

5. Study 5 – Operations Modeling Study

5.1 Introduction

TransCanada is conducting this Operations Modeling Study (ILP Study 5) to develop an operations model for the Wilder, Bellows Falls, and Vernon Projects that will provide information on the effect of flows and water levels resulting from hydrology and operational scenarios, on environmental resources. The objective of this study is to develop a time-series database of hourly water levels and flows for various selected operational scenarios, to enable other studies to assess the effects of project operations on aquatic, terrestrial, and geologic resources at locations of interest. The values will be available at many locations on the river system, including the three projects and identified areas of interest (econodes).

The RSP for this study was modified by FERC in its September 13, 2013, SPD with the following specific change (as clarified in FERC's October 22, 2013, letter in response to TransCanada's September 24, 2013, request for clarification on the determinations for several studies).

- The study plan report (rather than the study plan) must demonstrate the appropriateness of TransCanada's 5-year representative hydrologic subset, show how the selected years are representative of the longer hydrologic record, and document why carry-over storage does not need to be considered in the model.

5.2 Study Progress

The Vista DSS™ operations model has been set up for TransCanada's base case operating conditions.

5.3 Remaining Activities

The next step to implement this study will be to provide the base case operational data to the Hydraulic Modeling Study (Study 4). The rest of this study will be implemented in accordance with the RSP in 2015 in the following order of activities.

- Integration of hydraulic parameters from Study 4 by updating the operations model with econode locations and associated rating curves and routing parameters;
- Re-run the base case operations with the updated model; and
- Refinement to the model, including:
    - Definition of econode indices, which is a relationship between a parameter of interest at the econode (such as a fishery habitat index) and the state of the water resource at that time (river flow and/or water level); and

- Analyses of new scenarios once related studies and the numerous resource studies are more fully implemented (including those delayed until 2015).

5.4 Study Results to Date

None at this time.

5.5 Variance from Study Plan and Schedule

The only deviation from the RSP and schedule to this point is related to delays of numerous aquatics studies as a result of the announced closure of VY. Those study delays will delay development of many econode indices (from Study 4) upon which this study relies for evaluation of various alternative operational scenarios.

6. Study 6 – Water Quality Study

6.1 Introduction

TransCanada will conduct this Water Quality Study (ILP Study 6) in 2015 to determine potential project effects on water quality parameters of dissolved oxygen(DO), water temperature, pH, turbidity, conductivity, nutrients, and chlorophyll-*a*. Documentation of these parameters will provide information on the effects of project operations on water quality over an extended period and during low-flow summer conditions. The water quality data collected will be compared to Vermont and New Hampshire water quality standards to help determine whether the projects are meeting state water quality standards.

The RSP for this study was modified by TransCanada in its December 31, 2013, filing, based on stakeholder agreement from the VY technical meeting, with the following specific change.

- Elimination of the continuous temperature monitoring transect in the Vernon forebay (due to VY's announced closure in 2014).

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

6.2 Study Progress

Preliminary work on the study is scheduled to be completed in the fall and winter of 2014/2015, including the following non-field tasks scheduled to be completed by January 2015.

- Site review and selection of monitoring locations for tributary and upstream-of-impoundment sampling locations; and
- Development of a Sampling & Analysis Plan for review and approval by NHDES and Vermont Department of Environmental Conservation.

6.3 Study Results to Date

None at this time.

6.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

7. Study 7 – Aquatic Habitat Mapping Study

7.1 Introduction

TransCanada conducted this Aquatic Habitat Mapping Study (ILP Study 7) to survey, identify, and map aquatic habitat at the Wilder, Bellows Falls, and Vernon Project-affected areas to provide baseline data to be used to assess potential aquatic effects under current operations (in association with other studies). The objectives of this study were to:

- Survey and map the aquatic habitat types distributed within the project impoundments, tailwaters, and downstream riverine corridors from the upper extent of the Wilder impoundment and downstream to Vernon dam, including the Bellows Falls bypassed reach and the tailwater just below Vernon dam; and
- Use the data collected in conjunction with data from other studies to describe potential influences of project impoundments and project operations on the distribution of aquatic habitat within the project-affected area.

The RSP for this study was approved without modification in FERC's February 21, 2014, SPD; however, the deadline for filing of the final study report was extended to March 1, 2015 in that determination.

7.2 Study Progress

The study was completed in late 2013 with concurrence of the aquatics working group, and data consolidation occurred in early 2014. The ISR was prepared in draft form and provided for working group review on May 8, 2014 (Normandeau 2014). No comments have been received to date on the draft ISR. Results and data from the study were summarized at a May 23, 2014, aquatics working group meeting and impoundment bathymetry and habitat mapping data were provided at the meeting on CDs. A final report based on comments received will be completed by March 1, 2015, in accordance with the SPD final study report deadline.

Data from Study 7 are included as several GIS layers identified as "TransCanadaStudy_7…" in the geodatabase filed separately on DVD as Volume VII of this ISR, TransCanada Initial Study Report Supporting Geodatabase.

7.3 Remaining Activities

None.

7.4 Study Results to Date

See Study 7 – Aquatic Habitat Mapping Initial Study Report in Volume II of this ISR.

7.5 Variance from Study Plan and Schedule

For purposes of providing additional data to 2014 studies, nine water-level loggers were placed in deeper water via SCUBA diving during December 2013 to collect data over the winter months, and this additional data collection effort was not included in the RSP. Data from five of these loggers were retrieved in early June 2014 (when flows were safe for divers). Three loggers were not located and one was not retrieved due to increasing flow levels during the attempted retrieval. It is presumed that that logger continues to collect data. Loggers were re-installed at eight locations for continued data collection in 2014. When logger data are retrieved in late fall 2014, those data will be incorporated into an ILP studies water-level logger database along with water-level logger data from other studies to provide a complete data set.

7.6 Literature Cited

Normandeau (Normandeau Associates, Inc.). 2014. ILP Study 7 Aquatic Habitat Mapping Initial Study Report – Draft for Stakeholder Review. Prepared for TransCanada Hydro Northeast Inc. April 25, 2014.

8. Study 8 – Channel Morphology and Benthic Habitat Study

8.1 Introduction

TransCanada is conducting this Channel Morphology and Benthic Habitat Study (ILP Study 8) to understand how Wilder, Bellows Falls and Vernon Project operations may affect fluvial processes related to the movement of coarse sediment (e.g., gravel, cobble) in the project-affected areas and potential related effects on benthic habitat. The study goal is to understand how project operations affect bedload distribution, particle size, and composition in relationship to habitat availability for different life-history stages of anadromous and riverine fish and for invertebrates. The objectives of this study are to:

- Assess the distribution and extent of the existing substrate types including gravel and cobble bars within the project-affected areas; and
- Identify the current conditions of the channel and determine the stability of the present substrate/benthic habitat and potential project-related effects on these habitats.

The RSP for this study was approved without modification in FERC's February 21, 2014, SPD; however, the deadline for filing of the final study report was extended to March 1, 2015, in that determination.

8.2 Study Progress

A Site Selection Report (SSR) (Stantec and Normandeau, 2014) was developed and provided to the aquatics working group in May 2014. In a consultation meeting on May 23, 2014, the findings of the SSR were presented to the working group. During this presentation, the site selection process and results were summarized and both recommended and contingency study sites were shown using Google Earth. Following the presentation, a member of the working group suggested that, as a contingency, a site farther up the West River may be more suitable than a selected site at the mouth of that tributary.

The working group made no requests for changes to the SSR and the recommended sites were approved, with the allowance for using contingency sites as needed if variables including site access, safety considerations, site characteristics, and/or changing site conditions preclude the use of any recommended sites. The Study 8 SSR is included in Volume III of this ISR.

Field verification of study sites was conducted in July, 2014, and the first round of field data collection was conducted in mid-July and at one site downstream of Vernon on August 11, 2014. During the first round of data collection, a contingency tributary study site (study site "T4") was selected to replace a recommended tributary study site (study site "T3"). Study sites T3 and T4 are both located in the vicinity of the confluence of the Mascoma River with the Connecticut River. Field observations and comparison of study sites T3 and T4 during the first round of field data collection indicated that the depositional feature at study site T4 consisted of more coarse-grained sediments (i.e., gravel and cobble) than study site T3 (which was composed primarily of sand). Based on these observations, study site T4 was determined to be better suited for this study. In addition, at certain study sites, the specific depicted location of the points in the SSR was shifted as necessary to represent the actual, approximate center of each study site. These study locations were fine-tuned in the field based on observed field conditions during the first round of data collection. The study sites are included as a GIS layer identified as "TransCanadaStudy_8_StudySites_2014" in the geodatabase filed separately on DVD as Volume VII of this ISR, TransCanada Initial Study Report Supporting Geodatabase.

8.3 Remaining Activities

Remaining study activities include implementation of the second round of field data collection in late October 2014, data analysis, and preparation of a draft study report for stakeholder review, expected to be completed by the end of 2014. A final report based on comments received will be completed by March 1, 2015, in accordance with the SPD final study report deadline.

An assessment of the potential effects of project operations will be included in the Draft License Applications (DLAs) since results from other studies will be needed to complete that assessment. Relevant studies include the erosion studies (Studies 1, 2, and 3), Hydraulic Modeling Study (Study 4), and Operations Modeling Study (Study 5). None of these studies are complete at this time.

8.4 Study Results to Date

None at this time.

8.5 Variance from Study Plan and Schedule

<u>Variance from Study Plan:</u>

As described in the SSR, the upstream and downstream extents of the study area have been modified from those inaccurately described in the RSP. The original and revised study area extents are summarized below.

The RSP described three types of study sites located in three general areas:

- Upstream (US)-type, mainstem study sites are located on riverine reaches of the Connecticut River upstream of the project impoundments;
- Downstream (DS)-type, mainstem study sites are located on riverine reaches of the Connecticut River downstream of the Wilder and Bellows Falls dams; and
- Tributary study sites are located on selected tributaries to the Connecticut River in the riverine reaches downstream of the Wilder and Bellows Fall dams and in tributaries to the project impoundments.

The following modifications to the RSP's study areas are described in the SSR:

- Mainstem study site selection now excludes the riverine reach upstream of the Wilder Project impoundment and unaffected by project operations; and
- Mainstem study site selection includes the approximately 1.5-mile reach downstream of Vernon dam.

These modifications to study area extents are consistent with the geographic scope of other studies and are appropriate for this study. These modifications were presented during the May 23, 2014, meeting and the working group accepted the modified study area extents (Appendix A). During the consultation meeting, the working group also confirmed that field verification of study sites with the working group (as described in the RSP) would not be necessary.

Variance from Study Schedule:

Work on the study was not initiated in 2013 (as described in the RSP schedule) due to the delay in FERC's SPD until February 21, 2014. Further modifications to the study schedule are not currently anticipated. There have been no other deviations from the study plan or schedule to this point.

8.6 Literature Cited

Stantec and Normandeau (Stantec Consulting Services Inc. and Normandeau Associates, Inc.). 2014. ILP Study 8 Channel Morphology and Benthic Habitat Site Selection Report. Prepared for TransCanada Hydro Northeast Inc. May 2014.

9. Study 9 – Instream Flow Study

9.1 Introduction

TransCanada is conducting this Instream Flow Study (ILP Study 9) to assess aquatic resources and habitat in the Wilder, Bellows Falls, and Vernon Project-affected riverine areas and in the Bellows Falls bypassed reach under flow conditions affected by project operations. The overall objective of this study is to assess the relationship between stream flow and resultant habitat of key aquatic species as listed in the RSP in riverine reaches downstream of project dams. Specific objectives of this study are to:

- Compute a habitat index versus flow relationship for key aquatic species in each project reach; and
- Use the habitat index versus flow relationship to develop a habitat duration time-series analysis over the range of current operational flows.

The RSP for this study was approved without modification in FERC's February 21, 2014, SPD; however, the deadline for filing of the final study report was extended to December 31, 2015, in that determination.

9.2 Study Progress

An SSR containing a preliminary set of proposed study sites transects, and 2-dimensional modeling locations was developed and presented to the aquatics working group on May 23, 2014. Meeting attendees requested re-evaluation of the selection criteria to focus more on habitats where a response might be expected (e.g., a reduction in the number of pool habitats in favor of shallower habitats) and to differentiate between substrate types within the same habitat type. Attendees also recommended reevaluating the Sumner Falls reach and requested participation in field site visits to Sumner Falls and the Bellows Falls bypassed reach to identify appropriate study approaches at those sites (Appendix A). The SSR was revised (Normandeau 2014) and presented to the working group in a July 1, 2014, conference call (Appendix A) wherein participants concurred with the revised SSR. The Study 9 Revised SSR is included in Volume III of this ISR.

Working group representatives participated in site and transect selection field visits in the Wilder reaches (including Sumner Falls) on July 21 – 22; in the Bellows Falls riverine reach and the Bellows Falls bypassed reach on August 11; and at the Vernon reach on August 12, 2014. Seventy-nine transects were selected in the field with 8 of the originally selected sites being relocated or replaced based on site conditions. These sites have not been fully geo-referenced, so they are not included in in the Study 9 Revised SSR or in the supporting geodatabase in Volume VII of this ISR, TransCanada Initial Study Report Supporting Geodatabase.

During the site visits, participants agreed to add some transects (number as yet undetermined) in the riffle and run section of the upper portion of the Bellows Falls bypassed reach. It was also agreed that a 1-dimensional transect would not be feasible at Sumner Falls, but working group participants recommended that a demonstration flow analysis be conducted there over the range of low to middle flows. TransCanada agreed to consider this alternative pending additional discussion of this option. Vermont Fish and Wildlife Department (VTFWD) representatives prepared a draft Demonstration Flow Analysis Plan on August 25, 2014 (Appendix A), which is currently under review, with the intent of conducting both Sumner Falls and Bellow Falls bypass assessment field work in October.

During study planning, it was agreed that TransCanada could use Habitat Suitability Curves (HSCs) developed as part of FirstLight's Turners Falls Project relicensing for target species and life stages that are the same. TransCanada will submit the FirstLight HSCs along with a proposed HSC for smallmouth bass (the only species not on the FirstLight target species list) as soon as agreement between stakeholders and FirstLight is reached. TransCanada proposes to develop suitability criteria for some mussel species found within the projects through the Dwarf Wedgemussel and Co-occurring Mussel Study (Study 24) Phase 2 sampling planned for 2014.

Field data collection commenced following the working group field visits, and remains ongoing at this time.

9.3 Remaining Activities

Once all transect locations are finalized at the Bellows Falls bypassed reach (expected to be completed with the working group in October 2014), the SSR will be updated to reflect the locations of all final transects.

Field data collection will continue through September and October 2014. Data compilation and analysis will begin upon completion of field data collection. A draft study report will be prepared for stakeholder review in 2015. A final report based on comments received will be completed by December 31, 2015, in accordance with the SPD final study report deadline.

An assessment of the potential effects of project operations will be included in the DLAs since results from the Operations Modeling Study (Study 5) will be needed to complete that assessment.

9.4 Study Results to Date

None at this time.

9.5 Variance from Study Plan and Schedule

The schedule for study implementation is at variance with the RSP schedule due to FERC's February 21, 2014, issuance of the SPD. However, overall study implementation is not expected to be adversely affected by these schedule changes because field work is still planned for summer 2014, but is being extended into fall 2014 due to sustained high flows which delayed the working group field visits and some data collection.

The development of HSCs has also been delayed from the RSP schedule, in part due to the SPD delay as well as delays in stakeholder concurrence on FirstLight's HSCs for target species that are the same for the TransCanada Projects.

9.6 Literature Cited

Normandeau (Normandeau Associates, Inc.). 2014. Revised ILP Study 9 Instream Flow Study – Site and Transect Selection Report. Prepared for TransCanada Hydro Northeast Inc. June 2014.

10. Study 10 – Fish Assemblage Study

10.1 Introduction

TransCanada will conduct this Fish Assemblage Study (ILP Study 10) in 2015 to characterize the occurrence, distribution, and relative abundance of fish species present in the project-affected areas. The specific objectives of this study are to:

- Document fish species occurrence, distribution, and relative abundance within the project impoundments, tailwaters, and downstream riverine sections;
- Compare historical records of fish species occurrence in the project-affected areas to the results of this study; and
- Describe the distribution of resident/riverine and diadromous fish species within the reaches of the river and in relationship to data gathered by related studies, state agencies' surveys, and other information as available (e.g., surveys conducted at Vermont Yankee in the Vernon impoundment).

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

10.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by January 2015.

- Review aquatic habitat mapping and select proposed study locations using stratified random sampling; and
- Present proposed sampling locations to the working group and consult on those locations.

10.3 Study Results to Date

None at this time.

10.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

11. Study 11 – American Eel Survey

11.1 Introduction

TransCanada will conduct this American Eel Survey (ILP Study 11) in 2015 to provide baseline data relative to the presence of American eel upstream in the project-affected areas. The specific objectives of this study are to:

- Characterize the distribution of American eel in the project impoundments, riverine sections, and the project-influenced portions of tributaries upstream of Wilder, Bellows Falls, and Vernon dams; and
- Characterize the relative abundance of American eel in the project impoundments, riverine sections, and the project-influenced portions of tributaries upstream of the dams.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

11.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by January 2015.

- Review aquatic habitat mapping and select proposed study locations using stratified random sampling.
- Present proposed sampling locations to the working group and consult on those locations.

11.3 Study Results to Date

None at this time.

11.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

12. Study 12 – Tessellated Darter Survey

12.1 Introduction

TransCanada will conduct this Tessellated Darter Survey (ILP Study 12) in 2015 to assess the effects of project operations on populations of tessellated darter (*Etheostoma oldstedi*), a New Hampshire Species of Greatest Conservation Need (SGCN) and known host species for the federally listed as endangered dwarf wedgemussel (*Alasmidonta heterodon*). The specific objective of this study is to characterize the distribution and relative abundance of tessellated darter within the project-affected areas. This information will help to determine whether the dwarf wedgemussel population may be constrained due to the distribution and abundance of tessellated darters.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

12.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by January 2015.

- Review aquatic habitat mapping and select proposed study locations using stratified random sampling; and
- Present proposed sampling locations to the working group and consult on those locations.

12.3 Study Results to Date

None at this time.

12.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

13. Study 13 – Tributary and Backwater Fish Access and Habitats Study

13.1 Introduction

TransCanada is conducting this Tributary and Backwater Fish Access and Habitats Study (ILP Study 13) to assess whether water-level fluctuations from Wilder, Bellows Falls, and Vernon Project operations impede fish movement into and out of tributaries and backwater areas within the project-affected areas and whether project operations affect available fish habitat and water quality in those areas. The objectives for this study are to conduct a field study of a subset of tributaries and backwaters in the project-affected areas to:

- Assess potential effects of water-level fluctuations on fish access to these areas; and
- Assess potential effects of water-level fluctuations on available habitat and water quality.

The RSP for this study was modified by TransCanada in its December 31, 2013, filing, based on stakeholder agreement from the VY technical meeting, with the following specific change.

- Monitor water quality parameters in 2015 at any selected sites within areas previously affected by the VY thermal discharge. [Note: The sites randomly selected within the Vernon impoundment are all upstream of the VY outfall. The closest (site CT-V- 5.50) is located just upstream. There are two sites in the riverine section downstream of Vernon dam (CT-VR 6.01 and CT-VR-6.05) that will no longer be affected by VY once it is closed, and these sites will be monitored for water quality in 2015].

The RSP was approved without material modification in FERC's February 21, 2014, SPD; however, the deadline for filing of the final study report was extended to March 1, 2015.

13.2 Study Progress

A preliminary set of randomly selected proposed study sites was developed in an SSR and presented to the aquatics working group on May 23, 2014. Meeting attendees requested that tributaries be re-evaluated more closely with the originally requested 1-foot or less water depth during low impoundment water-level criteria; and that the water-level data for all tributaries and backwaters be provided to the working group (Appendix A). To accomplish this task, depth sounding data collected in the tributary/backwater-impoundment confluence areas during Study 7 sampling conducted in 2013 were assembled and provided to the working group as part of the Revised SSR.

This depth data were used to classify each tributary or backwater confluence as greater or less than 1 foot of depth at low water elevation, and a new subset of locations was selected for detailed sampling. This subset was presented in a Revised SSR provided to the working group in June 2014. During a July 1, 2014, conference call (Appendix A) and in subsequent email communications, the working group approved the proposed 36 randomly selected sites along with the requested addition of a 37th requested site at the Cold River confluence. Following final working group approval, the SSR was revised again and finalized. The Final Study 13 SSR is included in Volume III of this ISR.

Initial site visits at the selected sites began in late July and continued into August 2014. Final study sites are included as a GIS layer identified as "TransCanadaStudy_13_PrimaryStudySites_2014" and a reference layer identified as "TransCanadaStudy_13_RiverMileMarkers_2014" in the geodatabase filed separately on DVD as Volume VII of this ISR, TransCanada Initial Study Report Supporting Geodatabase.

To date, all of the 37 study locations have been visited at least once and most have been visited twice with additional visits scheduled for late September and late October 2014.

During the initial visit, two HOBO-level loggers were installed at each site and were programmed to collect temperature and pressure information at 15-minute intervals. One level logger was installed within the project-affected portion of the confluence area and the second was installed in the mainstem Connecticut River, adjacent to the study site. Using a Real Time Kinematic unit, precise bed elevation information was recorded at each confluence area in the form of one or more channel cross sections, as well as a longitudinal profile following the channel thalweg from the tributary mouth upstream to the end of the project-affected area. Water quality information was recorded at each site and included temperature, DO (percent saturation and mg/L), conductivity, pH, and turbidity. A series of time-stamped photographs was taken to document site conditions at the time of the initial visit.

Sample locations in the Wilder and Bellows Falls impoundments, Wilder riverine section, and the Cold River (located in the Bellows Falls riverine section) that had received an initial visit in July were revisited during late August 2014 (Bellows Falls riverine, Vernon impoundment, and Vernon riverine sites had initial site visits in August). During the follow-up visit, level loggers were checked and downloaded, water quality measurements were repeated, water depths along a channel cross section at the immediate confluence area were measured and site photographs were taken.

13.3 Remaining Activities

All study locations will be visited during late September 2014, and level loggers will be checked and downloaded, water quality measurements will be recorded, water depths along a channel cross section at the immediate confluence area will be measured and recorded, and time-stamped site photographs will be taken. A final visit to all study sites will occur during late October 2014. Sampling procedures during that visit will be the same as those during the September site visits. Level loggers will be removed at that time. In accordance with the RSP, and to the extent possible, September and/or October visits will be coordinated to take place during low flow measurements for the Channel Morphology and Benthic Habitat Study (ILP Study 8) and/or Instream Flow Study (ILP Study 9) to document conditions found during low flows.

An assessment of the potential effects of project operations will be included in the Draft License Applications (DLAs) since results from other studies will be needed to complete that assessment. Relevant studies include the Hydraulic Modeling Study (Study 4), Operations Modeling Study (Study 5), and Instream Flow Study (Study 9). None of these studies are complete at this time.

13.4 Study Results to Date

None at this time.

13.5 Variance from Study Plan and Schedule

The methods and schedule for field work are at variance with the RSP, which assumed that some related studies (Study 10 – Fish Assemblage, Study 14 – Resident Fish Spawning in Impoundments, and Study 15 – Resident Fish Spawning in Riverine Sections) would be conducted concurrently with this study. Those studies were delayed until 2015 in FERC's February 21, 2014, SPD. Delays due to persistent high water, and longer than expected time needed at each site for the initial site visits, delayed the initial field work for the study; however, these delays have not materially affected the study's data collection efforts.

14. Study 14 – Resident Fish Spawning in Impoundments Study

14.1 Introduction

TransCanada will conduct this Resident Fish Spawning in Impoundments Study (ILP Study 14) in 2015 to assess whether project-related, water-level fluctuations in the impoundments affect resident fish spawning. The target species of interest for this study are smallmouth bass, largemouth bass, yellow perch, black crappie, pumpkinseed, bluegill, chain pickerel, northern pike, golden shiner, white sucker, spottail shiner, walleye, and fallfish. The objectives of this study are to:

- Delineate, quantitatively describe (e.g., substrate composition, vegetation type and abundance), and map shallow-water aquatic habitat types subject to inundation and exposure due to normal project operations, noting and describing additional areas where water depths at the lowest operational range are wetted to a depth less than 1 foot, such as flats, near shoal areas, and gravel bars with very slight bathymetric change;
- Conduct analysis of the effects of the normal operation and the maximum licensed impoundment fluctuation range on the suitability of littoral zone habitats for all life stages of target species likely to inhabit these areas;
- Conduct field studies to assess timing and location of fish spawning under existing conditions; and
- Conduct field studies to assess potential effects of impoundment fluctuation on nest abandonment, spawning fish displacement, and egg dewatering.

The RSP was approved in FERC's February 21, 2014, SPD with the following specific change.

- Record species data (e.g., spawning habitat presence and depth of spawning habitat) of eastern silvery minnow (*Hybognathus regius*) if the species is found during other target species surveys, and evaluate project effects on eastern silvery minnow.

The determination also delayed the study until 2015 and the final report to March 1, 2016.

14.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by January 2015.

- Conduct literature reviews;
- Review aquatic habitat mapping and select proposed study locations using stratified random sampling; and

- Present proposed sampling locations to the working group and consult on those locations.

14.3 Study Results to Date

None at this time.

14.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

15. Study 15 – Resident Fish Spawning in Riverine Sections Study

15.1 Introduction

TransCanada will conduct this Resident Fish Spawning in Riverine Sections Study (ILP Study 15) in 2015 to assess whether project-related, water-level fluctuations in the affected areas downstream of Wilder, Bellows Falls, and Vernon dams negatively affect resident fish spawning. The target species included in this study are smallmouth bass, white sucker, walleye, and fallfish. Objectives for this study are to:

- Conduct field studies in the project-affected areas downstream of the Wilder, Bellows Falls, and Vernon dams to locate and map nesting locations and spawning sites; and
- Conduct field studies in the project-affected areas below Wilder, Bellows Falls, and Vernon dams to assess potential effects of operational flows and water-level fluctuations on nest abandonment, spawning fish displacement, and egg dewatering.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

15.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by January 2015.

- Conduct literature reviews;
- Review aquatic habitat mapping and select proposed study locations using stratified random sampling; and
- Present proposed sampling locations to the working group and consult on those locations.

15.3 Study Results to Date

None at this time.

15.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

16. Study 16 – Sea Lamprey Spawning Study

16.1 Introduction

TransCanada will conduct this Sea Lamprey Spawning Study (ILP Study 16) in 2015 to assess the level of spawning activity by sea lamprey (*Petromyzon marinus*) in the project-affected areas and to determine whether project operations are affecting the success (i.e., survival to emergence) of lamprey spawning. New Hampshire and Vermont have classified sea lamprey as an SGCN. New Hampshire has listed the conservation status of sea lamprey as "vulnerable." The objectives of this study are to:

- Identify areas within the Wilder, Bellows Falls, and Vernon Project-affected areas and riverine reaches where suitable spawning habitat exists for sea lamprey;
- Conduct a telemetry study of sea lamprey during their upstream migration period in the spring, focusing on areas of suitable spawning habitat and areas of known spawning;
- Conduct spawning ground surveys to observe the use of this habitat for spawning purposes and, hence, confirm suitability;
- Obtain data on redd characteristics, including location, size, substrate, depth and velocity; and
- Assess whether operations at the Wilder, Bellows Falls, or Vernon Projects adversely affect these spawning areas, specifically if flow alterations cause dewatering and/or scouring of sea lamprey redds.

The RSP was approved in FERC's February 21, 2014, SPD with the following specific change.

- Conduct habitat-based surveys to identify suitable spawning habitat and redds, using data from Study 7 – Aquatic Habitat Mapping to focus survey efforts on potential spawning habitat including shallow, fast-moving water with gravel/cobble substrate.

The determination also delayed the study until 2015 and the final report to March 1, 2016.

16.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by January 2015.

- Conduct literature reviews;
- Review aquatic habitat mapping and select proposed study locations using stratified random sampling; and

- Present proposed sampling locations to the working group and consult on those locations.

16.3 Study Results to Date

None at this time.

16.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

17. Study 17 – Upstream Passage of Riverine Fish Species Assessment

17.1 Introduction

TransCanada will conduct this Upstream Passage of Riverine Fish Species Assessment (ILP Study 17) in 2015 to determine the use and temporal distribution of riverine fish passing upstream in the existing Wilder, Bellows Falls, and Vernon fish ladders during the open-water period and to determine the appropriate operation period for these fishways to pass riverine and diadromous fish. The objectives of this study are to:

- Identify the use and temporal distribution of upstream passage through the Wilder, Bellows Falls, and Vernon fishways by riverine and diadromous fish species;
- Operate and monitor the fishways during the open-water period (ice-out until freezing temperatures make it infeasible) to assess fishway use over a longer period than the existing May–July period;
- Identify potential appropriate operating windows during the open-water period for the fishways for riverine species; and
- Identify potential appropriate operating windows during the open-water period for diadromous species, such as American eel and sea lamprey.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

17.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by January 2015.

- Conduct literature reviews;
- Review aquatic habitat mapping and select proposed study locations using stratified random sampling; and
- Present proposed sampling locations to the working group and consult on those locations.

17.3 Study Results to Date

None at this time.

17.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

18. Study 18 – American Eel Upstream Passage Assessment

18.1 Introduction

TransCanada will conduct this American Eel Upstream Passage Assessment (ILP Study 18) in 2015 to provide baseline data on the presence of American eels attempting to move upstream of the projects and the locations where they congregate while attempting upstream passage. The objectives of this study are to:

- Conduct systematic surveys of eel presence/abundance at tailrace and spillway locations at the Wilder, Bellows Falls, and Vernon Projects to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures; and
- Collect eels with temporary trap/pass devices from areas identified from the surveys at locations of eel concentrations to assess whether eels can be collected and passed in substantial numbers.

The RSP for this study was modified by TransCanada in its December 31, 2013, filing, based on stakeholder agreement from the VY technical meeting, with the following specific changes.

- Consolidate the systematic surveys and temporary eel trap passes into a single study year;
- Install temporary eel trap passes within 24 hours to the extent possible if adequate concentrations of eels are identified in the systematic surveys; and
- Develop a communication and consultation protocol with agencies and the aquatics working group that enables periodic, updated information on the surveys, observations, and data from eel trap passes to be shared.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

18.2 Study Progress

Preliminary work on the study is scheduled to be conducted in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by March 2015.

- Design and construct 8 eel trap passes; and
- Develop communications and consultation protocol and share it with agencies and the working group.

18.3 Study Results to Date

None at this time.

18.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

19. Study 19 – American Eel Downstream Passage Assessment

19.1 Introduction

TransCanada will conduct this American Eel Downstream Passage Assessment (ILP Study 19) in 2015 to identify project-related effects on downstream passage timing, injury, stress, and survival in order to maximize the number of American eels migrating to their spawning grounds. The objectives of this study are to:

- Quantify the movement rates, timing, and relative proportion of silver eels passing via various routes at the projects including through the turbines, the Bellows Falls bypassed reach, downstream passage facilities, and spillways; and
- Assess instantaneous and latent mortality and injury of silver eels passed through each turbine type.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

19.2 Study Progress

No preliminary study work has been conducted or is planned for 2014.

19.3 Study Results to Date

None at this time.

19.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

20. Study 20 – American Eel Downstream Migration Timing Assessment

20.1 Introduction

TransCanada will conduct this American Eel Downstream Migration Timing Assessment (ILP Study 20) in 2015 to assess the timing of American eels migrating from the Connecticut River to their spawning grounds. The objective of this desktop study is to characterize the general migratory timing and presence of silver phase American eels in the Connecticut River relative to environmental factors, including air and water temperature, turbidity, rainfall, river flow, lunar phase, and flow-related operations of mainstem river hydroelectric projects. A thorough desktop review of existing eel downstream migration literature will be conducted and is intended to augment any field data collected at Cabot Station by FirstLight in its ILP Study 3.3.5 (Evaluate Downstream Passage of American Eel).

The RSP was approved in FERC's February 21, 2014, SPD with the following specific change.

- Study analysis should incorporate results from the "Vernon Hydroacoustic Study" to help quantify and characterize silver phase eel outmigration within the Connecticut River basin upstream of Vernon dam to provide information on the timing and magnitude of downstream eel migration.

The determination also delayed the study until 2015 and the final report to March 1, 2016.

20.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including conducting literature reviews.

20.3 Study Results to Date

None at this time.

20.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

21. Study 21 – American Shad Telemetry Study

21.1 Introduction

TransCanada will conduct this American Shad Telemetry Study (ILP Study 21) in 2015 to characterize effects, if any, of project operations on behavior, approach routes, passage success, survival, and residency time by adult American shad (as they move through the Vernon Project during both upstream and downstream migrations; and to characterize whether project operations affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches from downstream of Vernon dam to the Bellows Falls Project. The objectives of the study are to:

- Assess near-field attraction to, and entrance efficiency of, the Vernon fish ladder;
- Assess internal efficiency of the Vernon fish ladder;
- Assess upstream passage past VY's discharge located on the west bank of the river 0.45 mile upstream of the Vernon fish ladder exit;
- Assess upstream migration beyond Vernon dam up to the Bellows Falls Project;
- Characterize project operational effects on post-spawn downstream migration route selection, passage efficiency, downstream passage timing/residence, and survival related to the Vernon Project;
- Identify areas that American shad use for spawning;
- Assess effects (e.g., water velocity, depths, inundation, and exposure of habitats) of project operations on identified spawning areas; and
- Quantify spawning activity.

The RSP for this study was modified by TransCanada in its December 31, 2013, filing, based on stakeholder agreement from the VY technical meeting, with the following specific changes.

- Conduct a limited review of the 2012 shad data from a study conducted by USGS (rather than a full analysis of that data) to see whether those data may contribute to existing information on optimal placement of receivers and/or selection of radio frequencies for this study; and
- Eliminate temperature tags from the fish tagging protocol.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

21.2 Study Progress

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following non-field tasks expected to be completed by February 2015.

- Review the USGS 2012 data; and
- Consult with the aquatics working group on any critical study modifications that may be warranted as a result of the 2012 data review.

21.3 Study Results to Date

None at this time.

21.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

22. Study 22 – Downstream Migration of Juvenile American Shad - Vernon

22.1 Introduction

TransCanada will conduct this Downstream Migration of Juvenile American Shad Study - Vernon (ILP Study 22) in 2015 to assess whether project operations affect the safe and timely passage of emigrating juvenile American shad. The objectives of this study are to:

- Assess project operation effects on the timing, route selection, migration rates, and survival of juvenile shad migrating past the project;
- Characterize the proportion of juvenile shad using all possible passage routes at the Vernon Project over the period of downstream migration under normal operational conditions; and
- Conduct controlled turbine passage survival tests for juvenile shad passed through one of the older Francis units (Unit Nos. 1 to 4) and one of the new Kaplan units (Unit Nos. 5 to 8) to estimate the relative survival specific to those unit types.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

22.2 Study Progress

TransCanada representatives participated in a March 20, 2014 teleconference with FWS, state and federal agency representatives FirstLight representatives, and FERC Staff to discuss options for obtaining juvenile shad for tagging for the 2015 studies (Appendix A).

Preliminary work on the study is scheduled to begin in the fall and winter of 2014/2015, including the following tasks expected to be completed by January 2015.

- Coordinate with the FWS and the national fish hatchery that is raising juvenile shad in 2014 to conduct a transport survival evaluation and tagging experiment in October 2014.
- Evaluate the Vernon Project's turbine specifications, priority of operations, unit-loading conditions, and historical operations (from Study 5), and share with the working group to select the test turbines to be included in the study.

22.3 Study Results to Date

None at this time.

22.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

23. Study 23 – Fish Impingement, Entrainment, and Survival Study

23.1 Introduction

TransCanada will conduct this Fish Impingement, Entrainment, and Survival Study (ILP Study 22) in 2015 to assess the adequacy of the intakes at the projects to minimize fish mortality resulting from impingement and entrainment of fishes residing in the Connecticut River. The objectives of this desktop study are to:

- Provide a description of physical characteristics of the Wilder, Bellows Falls, and Vernon Projects (including forebay characteristics, intake location and dimensions, approach velocities, and rack spacing);
- Identify current routes of fish movement past each project and the risk of injury/mortality associated with each route (considering seasonality, flow direction and velocity, existing management regimes);
- Analyze target species for factors that may influence vulnerability to entrainment and mortality;
- Assess the potential for impingement and estimate survival rates for target species;
- Assess the potential for entrainment and estimate survival rates for target species;
- Estimate turbine passage survival rates;
- Estimate total project survival considering all passage routes for American shad and river herring at the Vernon Project; and
- Estimate total project survival considering all passage routes for American eel, Atlantic salmon, and sea lamprey at the Wilder, Bellows Falls, and Vernon Projects.

The RSP for this study was modified by TransCanada in its December 31, 2013, filing, based on stakeholder agreement from the VY technical meeting, with the following specific changes.

- Reschedule the study for late summer and fall 2015 in accordance with delayed associated studies' schedules.

The RSP was approved without modification (except to delay the study until 2015, and the final report to March 1, 2016) in FERC's February 21, 2014, SPD.

23.2 Study Progress

No preliminary study work has been conducted or is planned for 2014.

23.3 Study Results to Date

None at this time.

23.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

24. Study 24 - Dwarf Wedgemussel and Co-occurring Mussel Study

24.1 Introduction

TransCanada is conducting this Dwarf Wedgemussel and Co-occurring Mussel Study (ILP Study 24) to study of the effects of Wilder and Bellows Falls Project operations on the federally endangered dwarf wedgemussel (DWM) (*Alasmidonta heterodon*). This study includes an adaptive, two-phase plan developed in collaboration with the aquatics working group throughout the design and implementation of the study. The study goals and objectives are as follows.

Goal 1: Assess the distribution, population demographics, and habitat use of DWM in the Wilder and Bellows Falls Project areas. This goal has three specific objectives:

- <u>Objective 1 (Phase 1):</u> Conduct an initial survey of the 17-mile-long reach of the Connecticut River from Wilder dam to the upstream end of the Bellows Falls impoundment to determine the distribution, relative abundance, and habitat of the DWM;
- <u>Objective 2 (Phase 1):</u> Determine the best sites for quantitative mussel sampling in areas where DWMs are known to occur in the Wilder and Bellows Falls Project areas and the reach surveyed for Objective 1; and
- <u>Objective 3 (Phase 2):</u> At sites identified in Objective 2, collect statistically sound and repeatable data, using quantitative methods, to determine density, age-class structure, and habitat for the DWM and co-occurring mussel species.

Goal 2: Assess the influence of flow regime (which includes water-level fluctuations) on the DWM, co-occurring mussel species, and mussel habitat. This goal has two specific objectives:

- <u>Objective 4 (Phase 2):</u> Observe and record behavior of the DWM and co-occurring mussel species *in situ* during varying flow conditions; and
- <u>Objective 5 (Phase 2):</u> Assess the potential effects of project operations on DWMs and their habitat.

The RSP for this study was approved without modification in FERC's February 21, 2014, SPD; however, the deadline for filing of the final study report was extended to March 1, 2015, in that determination.

24.2 Study Progress

Phase 1 fieldwork was completed in September 2013 and the Phase 1 Study Report was prepared (Biodrawversity et al., 2014a). The public version of the report was shared with the working group (included as Volume IV of this ISR). The privileged version of the report containing specific DWM locations was provided to specific agency staff in August, as requested. The privileged data from Appendix B of the report are also being filed separately in Volume V of this ISR.

A Proposed Phase 2 Study Plan was developed, distributed, and discussed with the working group at the May 23, 2014, consultation meeting (Biodrawversity et al., 2014b) (Appendix A) and following comments received via email from The Nature Conservancy in June, a working group conference call was held on July 1, 2014 (Appendix A). The Proposed Phase 2 Study Plan was subsequently revised in response to those comments (included in Volume VI of this ISR); however, it was not distributed because there was an indication that further comments were being prepared by FWS.

FWS provided comments in the form of a "counter proposal" on September 4, 2014, (Appendix B). Based upon all the initial comments received previously, it was anticipated that further comments would be slight modifications on the previous discussions and draft study plan. Because the study field work time table was at risk, TransCanada initiated field work based upon its revised but yet undistributed Phase 2 Study Plan (filed as Volume VI of this ISR), presuming that any issues remaining could be addressed rather easily and while field work was in progress. That is not the case, however.

FWS comments dated September 4, recommend a wholly different direction than the RSP and the SPD specified, representing a significant departure from the study's goals and objectives. FWS proposes to extend the geographic scope of the study into the Connecticut River watershed well outside of areas influenced by project operations (e.g., Farmington River, Johns River, Ashuelot River, Connecticut River upstream from the Moore reservoir) without indicating any nexus to the projects. FWS also believes that to achieve the goal of determining DWM distribution (a goal of the study as designed), the study should re-survey historical sites both within and outside of the project-affected area for valid comparison over time. This recommendation seems to conflate *distribution* with *trends*, which is not a goal of the study. This shift of focus toward trends falls largely within the realm of long-term monitoring, which is not appropriate for a relicensing study. TransCanada believes a fundamental flaw with the FWS approach is the inadequate population baseline from historical surveys. Earlier surveys varied widely in approach and methods that will not allow for rigorous or scientifically defensible trend or effects analyses.

However, there are elements TransCanada sees in the FWS counter proposal that it believes it can reasonably accommodate, such as bank-to-bank transects. A more formal response to this seemingly new study request is pending. Copies of any further consultation, and/or a Final Phase 2 Study Plan will be filed independently of this ISR.

24.3 Remaining Activities

TransCanada initiated fieldwork during August based upon its revised Phase 2 Study Plan which consisted of establishing 20 monitoring transects and conducting transect surveys at the 6 selected sites. Data from this effort are being processed and analyzed at this time. Quadrat surveys are scheduled to be conducted in September 2014.

An assessment of the potential effects of project operations will be included in the DLAs since results from other studies will be needed to complete that assessment. Relevant studies include the Hydraulic Modeling Study (Study 4), and Operations Modeling Study (Study 5). These studies are not complete at this time.

24.4 Study Results to Date

Phase 1 of the study is complete (Biodrawversity et al., 2014a), and that report is included as Volume IV of this ISR, with privileged data included separately in Volume V. The study sites are included as GIS layers in the privileged Study 24 geodatabase filed separately on DVD as Volume VIII of this ISR.

The Study 24 Revised Phase 2 Study Plan is included in Volume VI of this ISR.

24.5 Variance from Study Plan and Schedule

The RSP was adaptive, and though objectives and proposed methods were modified based on Phase 1 results and the subsequent re-evaluation of tasks needed to accomplish the Phase 2 objectives, there were no deviations from the main objectives of the study plan or the schedule to this point.

24.6 Literature Cited

Biodrawversity, LBG, and Normandeau (Biodrawversity, LLC, The Louis Berger Group, and Normandeau Associates, Inc). 2014a. ILP Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study, Phase 1 Report (Public Version). Draft for Stakeholder Review. Prepared for TransCanada Hydro Northeast Inc. May, 2014.

Biodrawversity, LBG, and Normandeau. 2014b. ILP Study 24 - Dwarf Wedgemussel and Co-occurring Mussel Study, Proposed Phase 2 Study Plan. Prepared for TransCanada Hydro Northeast Inc. May, 2014.

25. Study 25 – Dragonfly and Damselfly Inventory and Assessment

25.1 Introduction

TransCanada will conduct this Dragonfly and Damselfly (odonates) Inventory and Assessment (ILP Study 25) in 2015 to inventory the river-dependent odonate assemblages in the project-affected areas, including life history, ecology, and behavior information for each species and to assess the potential influence of project operations on river-dependent odonate larval emergence/eclosion and habitat. The four study objectives are to:

- Conduct a baseline inventory and habitat assessment that builds on prior surveys in the project areas;
- Collect field data on the emergence and eclosion behavior of river-dependent odonates in the project areas;
- Review and synthesize available information on the life history, ecology, and behavior of river-dependent odonates that occur in the project areas; and
- Use information gathered in objectives 1–3, combined with data and analyses from other studies, to develop an overall assessment of the potential effects of project operations on odonate emergence/eclosion and habitat.

The RSP was approved in FERC's February 21, 2014, SPD with the following specific change.

- Increase the survey frequency from once per month to twice per month from June through August.

The determination also delayed the study until 2015 and the final report to March 1, 2016.

25.2 Study Progress

No preliminary study work has been conducted or is planned for 2014.

25.3 Study Results to Date

None at this time.

25.4 Variance from Study Plan and Schedule

The study is scheduled for 2015 in order to evaluate post-VY closure baseline river conditions per the February 21, 2014, SPD.

26. Study 26 – Cobblestone and Puritan Tiger Beetle Survey

26.1 Introduction

TransCanada is conducting this Cobblestone and Puritan Tiger Beetle Survey (ILP Study 26) to detect and gather information on known and new cobblestone tiger beetle and Puritan tiger beetle populations along the Connecticut River throughout the Wilder, Bellows Falls, and Vernon Project-affected areas. One of these species, the Puritan tiger beetle (*Cicindela puritana*) is listed as threatened federally and in Vermont. It is also listed as endangered in New Hampshire. The cobblestone tiger beetle (*Cicindela marginipennis*) is listed as threatened in both New Hampshire and Vermont. The objectives of this study are to:

- Obtain baseline distributional and abundance data and map occurrences of cobblestone and Puritan tiger beetle populations along the Connecticut River throughout the project-affected areas;
- Define the particular habitat requirements of each species;
- Assess the vulnerability of each species to disturbances such as siltation, flow fluctuations, and changes in shoreline composition and vegetation;
- Identify areas where suitable habitat may exist for these tiger beetle species and the portions of those habitats affected by project operations; and
- Assess whether project operations are adversely affecting the survival success of adult and larval cobblestone and Puritan tiger beetles.

The RSP for this study was approved without modification in FERC’s September 13, 2013, SPD.

26.2 Study Progress

A description of likely habitats to begin screening the study area for potential sampling sites was developed, and field reconnaissance for study site selection was performed in late June 2014. Thirteen sites were selected based on the existence of previous or historical records and confirmation of suitable habitat during field reconnaissance (Figures 26-1 and 26-2). These sites are included as a GIS layer identified as “TransCanadaStudy_26_StudySites_2014” in the geodatabase filed separately on DVD as Volume VII of this ISR, TransCanada Initial Study Report Supporting Geodatabase.

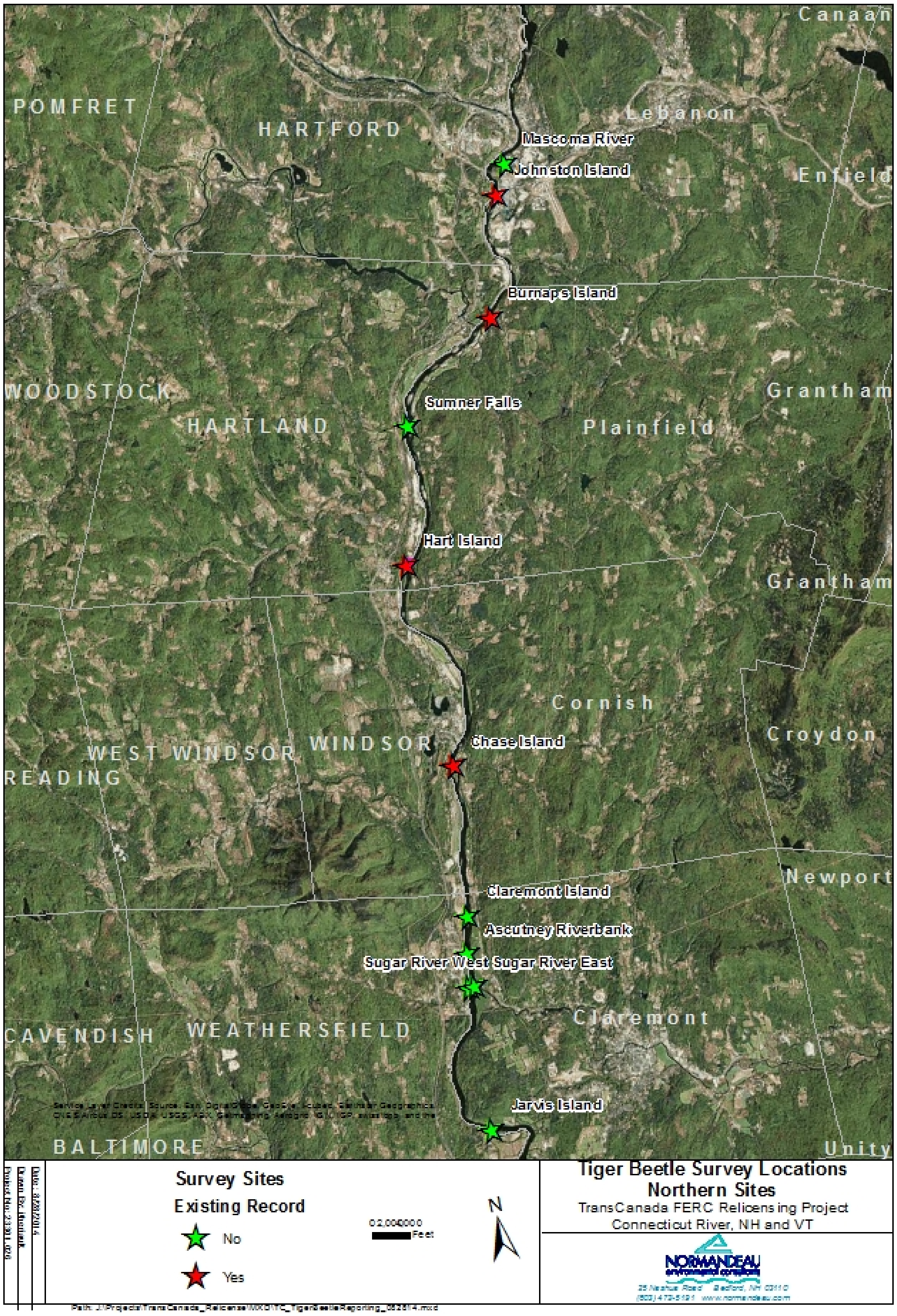

Figure 26-1. Map of beetle survey site locations – northern study area.

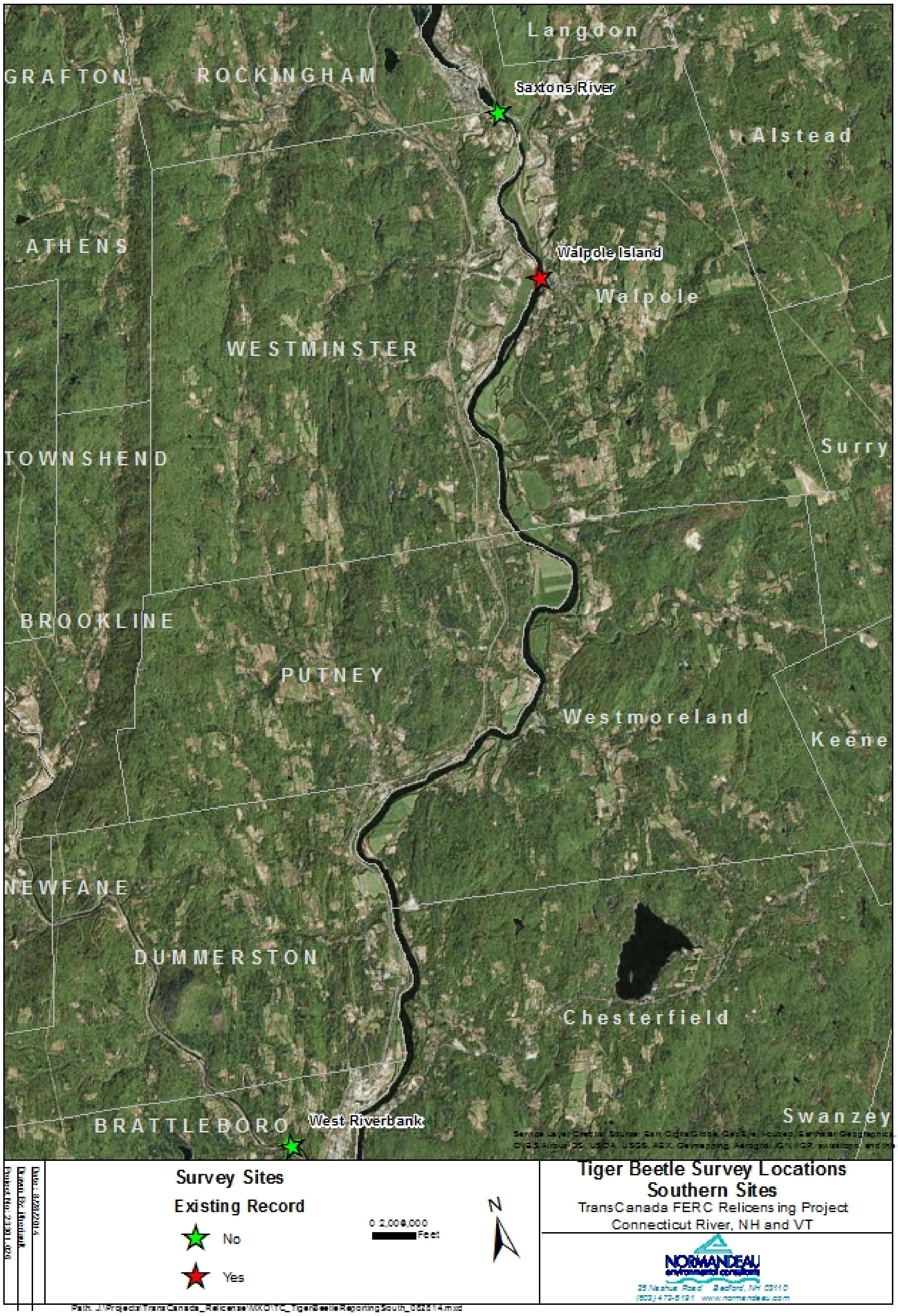

Figure 26-2. Map of beetle survey site locations – southern study area.

A Scientific Collection Permit from VTFWD and a Scientific License from New Hampshire Fish and Game Department (NHFGD) were issued in late June 2014.[3]

During July and August 2014, three visits were conducted, where 12 sites were surveyed at each visit. Two sites (Burnap Island and Chase Island) were only visited twice due to limited access during some visits. A final visit was conducted the first week of September to conclude the study fieldwork at those two survey locations.

During each visit, scientists searched the available habitat for one person-hour and noted the presence and abundance of cobblestone tiger beetles, Puritan tiger beetles, and the common shore tiger beetle (*Cicindela repanda*) and noted any active or inactive burrows observed at the site. The common shore tiger beetle was used as a marker for general beetle activity because it is a common species and a reasonable indicator for suitable weather conditions.

When target species were observed, scientists noted habitat type, behavior and photographed the individual when possible. A detailed assessment of cobblestone tiger beetle habitat availability was performed at each site during one of the three visits.

26.3 Remaining Activities

Following the conclusion of sampling events, data from the study will be analyzed and a draft study report will be prepared in late 2014 for working group review. A final report based on comments received is expected to be completed by February 2015.

An assessment of the potential effects of project operations will be included in the DLAs since results from other studies will be needed to complete that assessment. Relevant studies include the Riverbank Erosion Study (Study 3), Hydraulic Modeling Study (Study 4), Operations Modeling Study (Study 5), Channel Morphology and Benthic Habitat Study (Study 8), and Instream Flow Study (Study 9). None of these studies are complete at this time.

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[3] The New Hampshire license only allowed the capture and release of cobblestone tiger beetles with an aerial net. Cobblestone tiger beetles and Puritan tiger beetles could be photographed. Larval borrows could be gently probed with a grass blade to determine the angle and depth of burrows, no larvae of either species could be harmed, excavated, or collected.

The Vermont permit allowed using aerial nets, binoculars, and cameras to survey for both cobblestone and Puritan tiger beetles. It also allowed using the "fishing" technique (Brust et al., 2010) to probe one burrow to verify the presence of cobblestone tiger beetle, but larvae could not be removed.

Live specimens of both species had to be released unharmed.

26.4 Study Results to Date

Preliminary results indicate that cobblestone tiger beetles were present at greater than half of study sites including several new state records (Table 26-1). No Puritan tiger beetles were observed. Common shore tiger beetles were present at all but one study site (Saxtons River), occasionally in great numbers. Detailed accounts of study observations will be available in the final report once study data has been compiled and checked for quality control.

Table 26-1: Cobblestone tiger beetle preliminary survey results.

Survey Site	Cobblestone Tiger Beetle Present?	River Section	Previous State Record?
Mascoma River	No	Wilder Riverine	No
Johnston Island	Yes	Wilder Riverine	Yes
Burnap's Island	Yes	Wilder Riverine	Yes
Sumner Falls	Yes1	Wilder Riverine	No
Hart Island	Yes	Wilder Riverine	Yes
Chase Island	Yes	Bellows Falls Impoundment	Yes
Claremont Island	No	Bellows Falls Impoundment	No
Ascutney Riverbank	Yes	Bellows Falls Impoundment	No
Sugar River	Yes[2]	Bellows Falls Impoundment	No
Jarvis Island	Yes[2]	Bellows Falls Impoundment	No
Saxtons River	No	Bellows Falls Riverine	No
Walpole Island	Yes	Bellows Falls Riverine	Yes
West River	Yes	Vernon Impoundment	No[3]

1 Observed outside survey period
2 Observed with low certainty
3 Previous record just upstream, outside influence of the Vernon Project

26.5 Variance from Study Plan and Schedule

On June 30, 2014, FWS, NHFGD, and VTFWD were notified by email of minor adjustments to the study field schedule and scope, as described below (Appendix A).

- The RSP described sampling one time per month in mid-June, mid-July, and early August. The adjustment involved retaining three sampling events but condensing them into the period from early July into mid-August. The New Hampshire and Vermont records for cobblestone tiger beetles all indicated observations between July 7 and August 28. Kristian Omland, who is a recognized expert in tiger beetles, including cobblestone tiger beetles, and involved with the study, concurred with delaying the start of the survey period until the second week in July. Mr. Omland has no record of cobblestone tiger beetles in Vermont prior to July 8. The study adjustment proposed beginning the field surveys after that date and subsequently sampling every two weeks until mid-August.

- The RSP described sampling 30 minutes for adults and 30 minutes for larval burrows. The sample approach adjustment focused on adults because the cobblestone tiger beetle larvae and their burrows have not been scientifically described and cannot be distinguished from other tiger beetles, including the common shore tiger beetle, which appears ubiquitous on the Connecticut River. The adjusted study plan included a 30-minute survey at each site for adults and a qualitative estimate of the number of burrows.
- The RSP described collecting cobblestone tiger beetle larvae if more than 10 burrows are identified. Per requests from VTFWD and NHFGD, the study was adjusted to exclude collection of larvae. Because they have not been scientifically described, larval collection would not aid positive identification of cobblestone tiger beetles and would unnecessarily deplete the population.
- The RSP described sampling for federally threatened Puritan tiger beetles. The known historical sites were flooded with the construction of the Bellows Falls impoundment and no Puritan tiger beetles have been observed since 1932, despite multiple surveys since that date. FWS did not issue a collection permit for Puritan tiger beetles for this study because of the low likelihood of finding this species, although the state collection permits did allow some types of collection. The study adjustment concentrated the sampling effort more on cobblestone tiger beetle because of the higher probability of locating this species; although all species observed were noted.

26.6 Literature Cited

Brust, M.L., W.W. Hoback, and J.J. Johnson. 2010. Fishing for Tigers: A Method for Collecting Tiger Beetle Larvae Holds Useful Applications for Biology and Conservation. The Coleopterists Bulletin 64(4):313–138.

27. Study 27 – Floodplain, Wetland, Riparian, and Littoral Habitats Study

27.1 Introduction

TransCanada is conducting this Floodplain, Wetland, Riparian, and Littoral Habitats Study (ILP Study 27) to provide baseline mapping and characterization of riparian, floodplain, wetland, and littoral vegetation and habitats within the Wilder, Bellows Falls, and Vernon Project-affected areas and to assess the potential effects of project-caused water-level fluctuations on those habitats. The objectives of this study are to:

- Quantitatively describe (e.g., substrate composition, vegetation type, and abundance with a focus on invasive species) and map riparian, floodplain, and wetland habitats within 200 feet of the river's edge and the extent of this habitat if it extends beyond 200 feet;
- Quantitatively describe (e.g., substrate composition, vegetation type, and abundance) and map shallow-water aquatic habitat types within the zone of daily water-level fluctuations and where water depths at the lowest operational range are wetted to a depth of less than 1 foot (flats, nearshore area, gravel bars, with very slight bathymetric change);
- Qualitatively describe associated wildlife (e.g., bald eagle nesting, waterfowl nesting); and
- Assess potential effects of project operations on riparian, floodplain, wetland, and littoral vegetation habitats, and associated wildlife.

The RSP for this study was approved without modification in FERC's September 13, 2013, SPD.

27.2 Study Progress

Desktop terrestrial habitat mapping was completed, showing cover types within the 200-foot buffer zone and the floodplains within the three project areas and in the riverine habitats connecting the projects. Terrestrial cover types and 1-foot contours were merged with the aquatic habitat mapping data from Study 7 (Aquatic Habitat Mapping) to provide seamless maps of the study area. Preliminary ground-truthing was conducted, as well as data quality control check of approximately 50 percent of the terrestrial buffer mapping. New Hampshire Natural Heritage Bureau (NHNHB) and VTFWD were contacted to request updated rare species lists. Both states responded that no new data beyond the 2012 survey (Normandeau, 2013) were added, so no update was necessary.

Winter bald eagle roosting habitat mapping criteria were refined based on in-house experience and discussions with Chris Martin (New Hampshire Audubon), and areas meeting those criteria were mapped in the study area.

Submerged aquatic vegetation (SAV) beds were mapped from a 2012 August orthophoto in which all floating-leaved, and many submerged aquatic beds were visible.

Field verification of the terrestrial habitat mapping occurred in July and August 2014. These surveys were conducted by a combination of work from boats and on foot for locations with road access. A team of biologists visited most cover types in each impoundment to verify the mapping and to characterize the vegetation, structure, primary hydrologic inputs, and evidence of disturbance at multiple representative sites. For wetland cover types, the primary functions and values were assessed. Mapped floodplain cover types were visited and ground-verified based on evidence of duration and frequency of flooding.

Observations on invasive species included delineating stands formed by clumping species, primarily Phragmites (*Phragmites australis*) and Japanese knotweed (*Polygonum cuspidatum*). Most other species did not occur in well-defined beds, therefore, could not be mapped as easily. In those cases, their presence and relative dominance were noted in all representative cover types, and whenever encountered during the site reviews. SAV bed boundaries were reviewed in the field and modified as needed. The dominant SAV plant species, substrates, and structure of the aquatic beds were recorded.

The mapped bald eagle habitats were assessed for appropriate structure and their potential to serve as night roosts for wintering bald eagles. Other wildlife species and sign were recorded as encountered, with a focus on water-dependent species. Areas of active erosion were recorded as encountered.

27.3 Remaining Activities

The terrestrial habitat maps are currently being revised to reflect the changes and observations resulting from the field verification effort. After the revisions and QC are complete, the maps will be finalized and the results will be summarized. A draft study report will be prepared in late 2014 for working group review. A final report based on comments received is expected to be completed by February 2015.

An assessment of the potential effects of project operations will be included in the DLAs since results from other studies will be needed to complete that assessment. Relevant studies include the Riverbank Erosion Study (Study 3), Hydraulic Modeling Study (Study 4), Operations Modeling Study (Study 5), Channel Morphology and Benthic Habitat Study (Study 8), and Instream Flow Study (Study 9), and none of these studies are complete at this time.

27.4 Study Results to Date

Draft maps have been completed of all terrestrial cover types, floodplains, aquatic vegetation beds, invasives, and bald eagle winter roosts in the study area. The maps are currently being revised to incorporate field verification findings. The associated data from the field portion of this study are being tabulated and compiled in a database for future analysis.

27.5 Variance from Study Plan and Schedule

There have been no deviations from the study plan or schedule to this point.

27.6 Literature Cited

Normandeau. 2013. Rare, Threatened, and Endangered Plant and Exemplary Natural Community Assessment. Final Report. Prepared for TransCanada Hydro Northeast Inc. April 2013.

28. Study 28 – Fowler's Toad Survey

28.1 Introduction

TransCanada is conducting this Fowler's Toad Survey (ILP Study 28) to obtain baseline distributional and abundance data on Fowler's toad (*Anaxyrus fowleri*) along the Connecticut River in the Bellows Falls and Vernon Project-affected areas. This species is under consideration to be listed as endangered by the State of Vermont in 2014 and is also a Vermont-listed rare species. The Wilder impoundment and Wilder riverine project-affected area are not included in this study because they are unlikely to support this species because these areas lie north of the northernmost Vermont record for Fowler's toad. The objectives of this study are to:

- Develop additional information regarding the distribution and relative abundance of Fowler's toad;
- Develop additional information regarding the distribution and condition of suitable Fowler's toad habitat within the study area; and
- Assess whether project operations are likely to have an effect on suitable Fowler's toad habitat, and if those effects are likely to be positive or negative.

The RSP for this study was approved without modification in FERC's September 13, 2013, SPD.

28.2 Study Progress

Locations for field sampling were identified via the vegetation and substrate cover type maps developed as part of terrestrial habitat mapping (for Study 27). Local experts, including Jim Andrews, expert herpetologist and curator of the Vermont Reptile and Amphibian Atlas, were contacted for input on potential sampling locations.

Sixteen sites were selected as having the highest potential to support Fowler's toad. Thirteen of those sites were accessible for study and 2 additional sites were identified during field checks, a total of 15 survey sites. The locations included 11 sites associated with the Bellow Falls Project and 4 sites associated with the Vernon Project. Field work for this study (call surveys and acoustic monitoring) was completed during June and July 2014. Figure 28-1 illustrates the locations of the survey sites.

These sites are included as a GIS layer identified as "TransCanadaStudy_28_StudySites_2014" in the geodatabase filed separately on DVD as Volume VII of this ISR, TransCanada Initial Study Report Supporting Geodatabase.

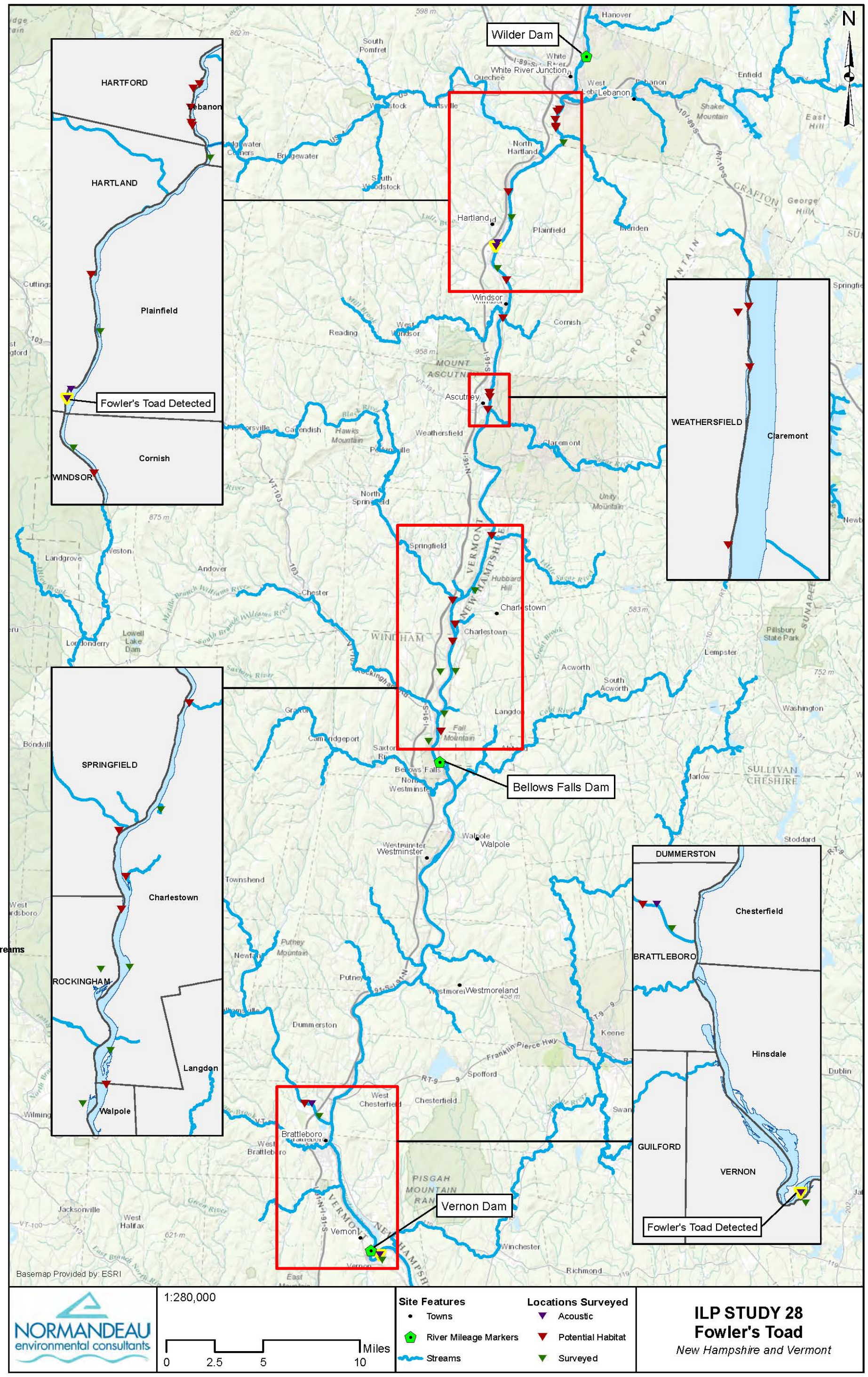

Figure 28-1: Fowler's toad study sites with preliminary detections shown.

28.3 Remaining Activities

Analysis of data from the thousands of acoustic monitoring records is in progress and will be completed in the fall of 2014. A draft study report will be prepared in late 2014 for working group review. A final report based on comments received is expected to be completed by February 2015.

An assessment of the potential effects of project operations will be included in the DLAs since results from other studies will be needed to complete that assessment. Relevant studies include the erosion studies (Studies 1, 2, and 3), Hydraulic Modeling Study (Study 4), Operations Modeling Study (Study 5), and the terrestrial habitat mapping analysis (from Study 27). None of these studies are complete at this time.

28.4 Study Results to Date

Preliminary call survey data suggests that Fowler's toad was detected at two sites, one on Hart Island in the Wilder riverine section, and one on Stebbins Island in the riverine reach downstream of Vernon. The Hart Island site is located approximately eight miles (straight line distance) downstream from well documented sightings of Fowler's toads in Hartford, Vermont. Fowler's toads were also present at Stebbins Island and the Stebbins Road area in Vernon, Vermont, just downstream of Vernon dam. These sites are illustrated in Figure 28-1 and in"TransCanadaStudy_28_FowlersToadDetected_2014 in the geodatabase filed separately on DVD as Volume VII of this ISR, TransCanada Initial Study Report Supporting Geodatabase.

28.5 Variance from Study Plan and Schedule

There have been no deviations from the study plan or schedule to this point.

29. Study 29 – Northeastern Bulrush Survey

29.1 Introduction

TransCanada is conducting this Northeastern Bulrush Survey (ILP Study 29) to assess the potential effects of Wilder, Bellows Falls, and Vernon Project operations on northeastern bulrush (*Scirpus ancistrochaetus*), a federally listed endangered species known to occur in one location within the Bellows Falls Project on a beaver flowage in Rockingham, Vermont. The objectives of this study are to:

- Document the presence or absence and status of previously documented populations of northeastern bulrush in the study area;
- Survey for additional locations of populations of northeastern bulrush in likely habitats;
- Estimate the elevation of identified populations of northeastern bulrush to daily project operational flows and impoundment levels to assess the potential influence of project operations on those populations; and
- Assess effects on populations from non-flow-related project operations within the project boundaries (e.g., recreation, agricultural leases).

The RSP for this study was approved without modification in FERC’s September 13, 2013, SPD.

29.2 Study Progress

Preliminary habitat analysis and cover type review to identify suitable survey locations for northeastern bulrush have been completed, and nine sites within the project boundaries were identified as worthy of field visits: one at the Wilder Project, four at Bellows Falls Project, and four at the Vernon Project. NHNHB and VTFWD were contacted for their existing records for this species near the Connecticut River. NHNHB did not provide any additional data. VTFWD provided confirmation of the known record in the Bellows Falls Project area.

Field visits to 8 of the 9 sites were conducted in late August 2014. The remaining previously known site was visited in early September.

29.3 Remaining Activities

Maps of the potential habitats will be prepared along with summaries of the existing habitat conditions at each site in the fall of 2014. A draft study report will be prepared in late 2014 for working group review. A final report based on comments received is expected to be completed by February 2015.

An assessment of the potential effects of project operations will be included in the DLAs since results from other studies will be needed to complete that assessment. Relevant studies include the terrestrial habitat mapping analysis (Study 27), Hydraulic Modeling (Study 4), Operations Modeling (Study 5), Riverbank Erosion (Study 3), and Recreational Facility Inventory and Use & Needs Assessment (Study 30), none of which are complete at this time.

29.4 Study Results to Date

No northeastern bulrush were identified during the surveys. Four of the nine sites supported habitats that could be suitable for this species, based on field observations of hydrology and plant communities and in comparison to the known site. Four other sites were deemed unlikely to support northeastern bulrush based on the presence of a direct connection to the river and local habitat conditions. No northeastern bulrush were identified at the known site.

29.5 Variance from Study Plan and Schedule

There have been no deviations from the study plan or schedule to this point.

30. Study 30 – Recreation Facility Inventory and Use & Needs Assessment

30.1 Introduction

TransCanada is conducting this Recreation Facility Inventory and Use & Needs Assessment (ILP Study 30) to assess recreation resource opportunities, uses, and needs within the Wilder, Bellows Falls, and Vernon Project-affected areas. In addition, the study will assess public recreation access opportunities at the Connecticut River from the upstream end of the Wilder impoundment to the downstream limit of the Vernon Project. The goals of this study are to:

- Obtain information about the condition of existing recreation facilities and access sites at the projects and along project-affected reaches of the Connecticut River;
- Obtain information about existing recreation use and opportunities, access, and present and future use estimates for sites within and in riverine sections between the projects;
- Conduct an assessment of the need to enhance recreation opportunities and access at the projects;
- Present the recreation use and opportunities at the projects within the larger context of regional opportunities;
- Photograph views from public recreation facilities to document existing aesthetic conditions; and
- Lay the foundation for preparation of a Recreation Management Plan for the projects that will be included in the DLAs.

The RSP for this study was modified by FERC in its September 13, 2013, SPD with the following specific changes.

- Onsite survey sampling events are extended to one-half hour after sunset.
- Question 36 of the Onsite Intercept Survey Form is revised to include individuals 16-17 years of age.
- Survey questions on the mailed and onsite questionnaires are revised to be consistent in use of the scales for all Likert-type questions with higher ratings corresponding to higher levels of satisfaction.
- Facility inventory forms are revised to include the number and type of formal and informal campsites.
- Spot count forms are revised to document the number of cars double-parked and/or not parked in designated spots due to parking overflows.

- The site condition evaluation form is revised to include a not applicable column and scoring scales for the facility sites and visitor use impact monitoring are modified so that higher scores reflect better conditions.

30.2 Study Progress

Traffic counters were installed at 18 recreation sites. Traffic counters were calibrated and are recording data properly and were successfully downloaded after the first month of data collection. Winter sampling during two weekends in March and April resulted in the return of about six mailed-in survey forms, while peak season sampling has resulted in hundreds of collected interviews through August 2014. Two of the three scheduled visits to boat-in campsites were completed with the final visit scheduled over Labor Day weekend. Site inventory work has been ongoing concurrent with the spot count and interview visits. Mailing lists and supplies for the mailed survey are being finalized and scheduled for mailing out in early September 2014.

30.3 Remaining Activities

Recreation monitoring (spot counts, interviews, traffic counts) will continue under the remaining fall shoulder season monitoring schedule provided in the RSP and limited monitoring will occur in the early winter of 2014/2015. Condition inventories will be reviewed and finalized throughout the fall following the rubrics developed for this task. Mailed surveys will be distributed in September 2014 to capture resident's most recent recreation season perceptions. Data entry is an ongoing activity.

Once compiled, data will be analyzed, and a draft study report will be prepared in the spring of 2015 for working group review. A final report based on comments received will be completed by the summer of 2015.

30.4 Study Results to Date

A total of 47 recreation sites were visited over a time frame of 16 weeks between April and August 2014. Through the end of August, staff collected approximately 350 in-person surveys and performed more than 1,500 spot counts at those recreation sites. Two of the three required visits to the canoe-in campsites were completed, and each campsite was inventoried and photo-documented. Data from interviews and spot counts continue to be entered into a database, which will be used for analysis once the field season is complete.

30.5 Variance from Study Plan and Schedule

Only minor deviations from the study schedule have occurred, but they do not materially affect the study. Site inventories and initial monitoring were delayed until late March 2014 because investigators preferred to initiate monitoring during the snow-free period to be able to capture all the sites; some of which could have been overlooked during winter conditions. Thus, the limited monitoring in the months of January and February specified in the RSP was not conducted in 2014. This monitoring will be completed in January and February of 2015.

31. Study 31 – Whitewater Boating Flow Assessment – Bellows Falls and Sumner Falls

31.1 Introduction

TransCanada is conducting this Whitewater Boating Flow Assessment at Bellows Falls and Sumner Falls (ILP Study 31) to evaluate the suitability of whitewater boating opportunities in the bypassed reach below the Bellows Falls dam and to study the effects of Wilder Project operations on paddling opportunities at Sumner Falls. The goal of this study is to assess the presence, quality, access, flow information, and flow ratings for paddling opportunities in a stepwise manner. The objectives of the study are to:

- Identify recreational paddling opportunities at Sumner Falls and determine the suitability of the Bellows Falls bypassed reach for whitewater boating;
- Describe flow-quality relationships at each location and identify acceptable and optimal ranges for each study site;
- Describe potential effects of project operations on paddling at each location and identify boaters' sensitivity to current operations regimes (e.g., project discharges ranging from minimum flow to full generation);
- Broadly characterize recreational paddling-relevant hydrology of the existing operating regime and qualitatively describe the relationship between paddling opportunities and project operations;
- Characterize the potential for whitewater boating in the Bellows Falls bypassed reach within the context of regional opportunities and those provided through current project operations;
- Determine the potential number of days flows for whitewater boating are available under the projects' current operations at each study site;
- Identify resource needs (e.g., aquatic habitat) and competing recreational uses (e.g., canoeing or fishing) that are or will be affected by flows suitable for whitewater boating;
- Identify all safety issues associated with whitewater boating and further development of opportunities for such at both locations;
- Identify public access obstacles at Sumner Falls and Bellows Falls bypassed reach; and
- Characterize effects on current project operations associated with providing various flows for recreational paddling.

The RSP for this study was modified by FERC in its September 13, 2013, SPD with the following specific changes

- The study will assess at least three controlled releases from Wilder for the Sumner Falls evaluation and at least four controlled releases from the Bellows Falls dam with provisions for additional releases based on interviews with paddlers and study participants.
- The study includes at least 12 boater participants.

31.2 Study Progress

During late winter and early spring 2014, photographs and videography clips were taken at various natural flow levels at both study sites. A boater consultation meeting and field visits were conducted on May 27 and 28, 2014, to discuss the details and logistics of the flow evaluation studies for Sumner Falls and the Bellows Falls bypassed reach (Appendix A). The Sumner Falls evaluation occurred on June 28 and 29, 2014.

Stakeholders participated in a teleconference on August 22, 2014 to discuss the schedule, flow levels, duration, boaters and other logistics associated with conducting the Bellows Falls bypassed reach boating work. The Bellows Falls bypassed reach boating evaluation is currently planned for October 18-19, 2014.

31.3 Remaining Activities

TransCanada consulted with interested parties during an August 22 teleconference to refine the survey tool for the Bellows Falls portion of the study. A final survey tool for that evaluation was developed and provided to the participating boating representatives for final comments on September 5, 2014 (Appendix C). Stakeholder comments are expected by mid-September and the survey tool will be finalized prior to the field evaluation. The remaining field-orientated activities in the Bellows Falls bypassed reach will be completed in October 2014.

Once compiled, data will be analyzed and a draft study report will be prepared in the winter of 2014/2015 for working group review. A final report based on comments received is expected to be completed by spring of 2015.

31.4 Study Results to Date

Sixteen boaters participated in the Sumner Falls flow evaluation on June 28 and 29, 2014. Boat types included play boats, kayaks, canoes, and stand-up paddle boards. Many of the boaters had never been to Sumner Falls. Five flow levels (4,000 cfs; 4,800 cfs; 6,750 cfs; 7,400-8,100 cfs; and 13,000 cfs) were boated with post-run surveys collected after each run followed by the close-out survey. Study results are preliminary at this time; however, boaters indicated multiple 'play' areas throughout the falls complex across a range of flows. There are no final study results to present at this time.

31.5 Variance from Study Plan and Schedule

There have been no deviations from the study plan or schedule to this point.

32. Study 32 – Bellows Falls Aesthetic Flow Study

32.1 Introduction

TransCanada is conducting this Bellows Falls Aesthetic Flow Study (ILP Study 32) to characterize the aesthetic conditions in the Bellows Falls bypassed reach at various levels of flow and to provide a range of aesthetic ratings that can be used to assess conditions relative to Vermont's water quality standards. The study objectives are to:

- Collect videography and still photography to document the appearance of the bypassed reach under various existing and controlled flows conditions;
- Identify populations potentially affected by the aesthetic conditions in the bypassed reach and determine how the interests of these populations relate to the aesthetic conditions;
- Identify flow ratings and timing preferences across the full range of potential user groups; and
- Estimate the costs to provide different levels of flow and assess the trade-offs of the various flows among different populations.

The RSP for this study was approved without modification in FERC's September 13, 2013, SPD.

32.2 Study Progress

Photograph and video footage captured as part of the flow demonstration conducted during the whitewater boater consultation meeting/site visit on May 27-28, 2014, will be used to support this study. Photographs and video footage taken of the flows during the whitewater flow study (Study 31) and the instream flow study (Study 9) to be conducted in October 2014 will also be used for this study.

32.3 Remaining Activities

TransCanada will continue to collect photos and videos in October 2014 in conjunction with spill events in the bypassed reach for Study 9 and Study 31. Focus group participant lists will be developed and individuals will be invited to participate in the study in late fall of 2014 after the photos and video are compiled.

Once compiled, data will be analyzed and a draft study report will be prepared in the winter of 2014/2015 for working group review. A final report based on comments received is expected to be completed by spring of 2015.

32.4 Study Results to Date

None at this time.

32.5 Variance from Study Plan and Schedule

There have been no deviations from the study plan or schedule to this point.

33. Study 33 – Cultural and Historic Resources Study

33.1 Introduction

TransCanada is conducting this Cultural and Historic Resources Study (ILP Study 33) of the Wilder, Bellows Falls and Vernon Projects to assist FERC in complying with Section 106 of the National Historic Preservation Act, as amended and its implementing regulations (36 C.F.R. § 800). The study includes the following tasks:

- Complete consultation with affected Native American Tribes and other interested parties to determine the Area of Potential Effects (APE) for each of the projects;
- Gather information about cultural resources investigations that have been carried out to date, including Phase 1A archaeological surveys and historic architectural resource determinations of National Register of Historic Places (National Register) eligibility; and
- Identify the methodology and a schedule for carrying out investigations to complete the identification and evaluation of archaeological sites, historic architectural resources, and traditional cultural properties (TCPs) within the APEs. The study objectives are to:
  - Define the APE for the projects;
  - Identify and evaluate historic properties (buildings, sites, structures, objects, and TCPs) that are listed or eligible for listing in the National Register within the APE; and
  - Assess the potential effects of the projects on historic properties and resolve any potential adverse effects through the development of Programmatic Agreements.

The work is being conducted within the framework of the Section 106 process and in close coordination with the consulting parties. The RSP for this study was approved without modification in FERC's September 13, 2013, SPD.

33.2 Study Progress

Recommended APEs for each of the projects were developed through consultation among FERC and the Vermont and New Hampshire State Historic Preservation Offices during meetings conducted in the summer of 2013. The RSP for this study defines the recommended APEs as all land within the FERC project boundaries owned in fee simple by TransCanada and 10 meters (33 feet) of land inland from the top of bank in areas along the Connecticut River and affected portions of tributaries where TransCanada holds flowage rights.

On May 14, 2014, TransCanada sent letters to the Narragansett Indian Tribal Historic Preservation Officer (NITHPO) and The Nolumbeka Project, Inc., to request a meeting to discuss their participation in the TCP Study and archaeological investigations. After no response was received, TransCanada sent a follow-up communication on July 11, 2014, reiterating its request to meet with the NITHPO and The Nolumbeka Project, Inc., and informing them that the archaeological investigations would commence. Copies of correspondence are included in Appendix A. To date, there has been no response from the NITHPO or The Nolumbeka Project, Inc.

The following is an update on the status of the investigations.

- Vernon Project 2013 Monitoring Program/Update of Phase 1A Archaeological Reconnaissance Survey Report:
    - Fieldwork was completed in August 2014 and a draft report is being prepared.
- Phase IB Archaeological Identification Surveys – Wilder, Bellows Falls, and Vernon Projects:
    - Fieldwork on TransCanada fee-owned land is approximately 60 percent completed. Coordination is ongoing with private landowners to allow crews to cross their properties in order to access remaining TransCanada fee-owned property.
    - Coordination is ongoing with private landowners to grant permission to conduct Phase 1B archaeological testing on their properties.
- Historic Architectural Resources National Register Evaluation:
    - Fieldwork was completed in August 2014.
    - Research is ongoing.
    - A draft report will be prepared in the fall of 2014.
- Traditional Cultural Properties Identification Survey:
    - Background archival ethnographic material is being gathered.
    - No meeting with NITHPO and The Nolumbeka Project, Inc., has been accomplished due to a lack of response to TransCanada's invitation and solicitations to participate in this study. As a result, Tribal consultation and interviews have not been conducted at this time.

33.3 Remaining Activities

The Phase II Archaeological Site Evaluations for the Vernon, Bellows Falls, and Wilder Projects are scheduled to be conducted during the spring/summer of 2015.

33.4 Study Results to Date

None at this time.

33.5 Variance from Study Plan and Schedule

The schedule for completion of the cultural resource investigations is at variance with the RSP schedule due to prolonged Tribal consultation efforts, and ongoing negotiations with private landowners to access their lands in order to conduct Phase 1B archaeological investigations.

34. Study 34 - Requested Vernon Hydroacoustic Study

34.1 Introduction

In its February 21, 2014, SPD, FERC requested that TransCanada conduct a two-year hydroacoustic study (HA Study) through consultation with FWS, VANR, NHFGD, and Commission Staff to determine the timing, duration, and magnitude of the downstream migration of juvenile American shad and adult silver American eels at the Vernon Project. TransCanada was required to consult with stakeholders and to develop a proposed study plan for implementation during the 2015 and 2016 field seasons. FERC's stated study goals and objectives for the HA Study in the SPD are to:

- Determine the timing, duration, and magnitude of the downstream migration of juvenile American shad and adult silver American eels at the Vernon Project; and
- Assess the project's effect on downstream migratory delay of juvenile shad.

34.2 Study Progress

A Request for Rehearing on this study was filed by TransCanada on March 24, 2014. FERC issued an Order Granting Rehearing for Further Consideration on April 23, 2014. Additional information was provided by TransCanada in its June 27, 2014, Response to Supplemental Information. TransCanada twice requested (on June 19 and July 25, 2014) that FERC expedite action on the Request for Rehearing, but FERC has to date, not acted on the Request for Rehearing.

TransCanada held a consultation meeting with the aquatics working group on August 26, 2014 (Appendix A). An email received from FERC staff declining to participate in the consultation meeting is included in Appendix A. Written comments were received via email from FWS on September 9, 2014 and a Proposed Study Plan (PSP) including a responsiveness summary was prepared. The HA Study PSP, consultation record, and supplemental information is being filed simultaneously to, but separately from this ISR.

34.3 Remaining Activities

None at this time.

34.4 Study Results to Date

None at this time.

34.5 Variance from Study Plan and Schedule

Not applicable at this time.

Appendix A
Consultation Record

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APPENDIX A

Consultation Record

Meeting notes and copies of consultation communications for the studies below are included in the following pages, except where noted.

Date	Studies	Consultation
November 4, 2013	2	Erosion monitoring site selection consultation.
November 26, 2014	6 - 25	FERC initiated discussion of Vermont Yankee Nuclear Power Plant's announced 2014 closure on aquatics-related studies. NOT INCLUDED: Transcripts are available on the FERC elibrary.
March 20, 2014	22	FERC initiated conference call on coordinating juvenile shad needs for TransCanada and FirstLight 2015 studies; and 2014 transport and dummy tagging tests.
May 14, 2014	33	TransCanada letter to Tribal representatives requesting a consultation meeting.
May 23, 2014	7, 8, 9, 13, 24	Review of the 2013 Study 7 – Aquatic Habitat Mapping; Site selection for Studies 8, 9, and 13 and review of Study 24 Phase 1 report and Phase 2 Proposed Study Plan.
May 27-28, 2014	31	Meeting and site visits for Study 31 – Whitewater Boating Flow Assessment, for planning purposes.
June 30, 2014	26	Normandeau letter to FWS, VTFWD, and NHFGD requesting minor study adjustments.
July 1, 2014	9, 13, 24	Conference call review of revised Study 9 and Study 13 site selections and additional discussion and consultation on Study 24 Phase 2 Proposed Study Plan.
July 11, 2014	33	TransCanada re-sending of May 14 letters to Tribal representatives requesting a consultation meeting.
July 21-22, and August 11-12	9	Field reviews of Study 9 proposed instream flow transects. NOT INCLUDED: Results of those field reviews will be included in the study report.
August 14, 2014	34	Letter from Commission Staff declining to participate in the scheduled August 26, 2014, study plan consultation meeting.
August 22, 2014	31	Conference call on whitewater boating demonstration at Bellows Falls bypassed reach.
August 25, 2014	9	VTFWD proposed Sumner Falls evaluation.
August 26, 2014	34	Consultation in preparation of filing a study plan for the FERC-requested Vernon Hydroacoustics Study.

2013

November 4, ~~2014~~ Study 3 Erosion Monitoring Site Selection – Erosion Working Group Consultation

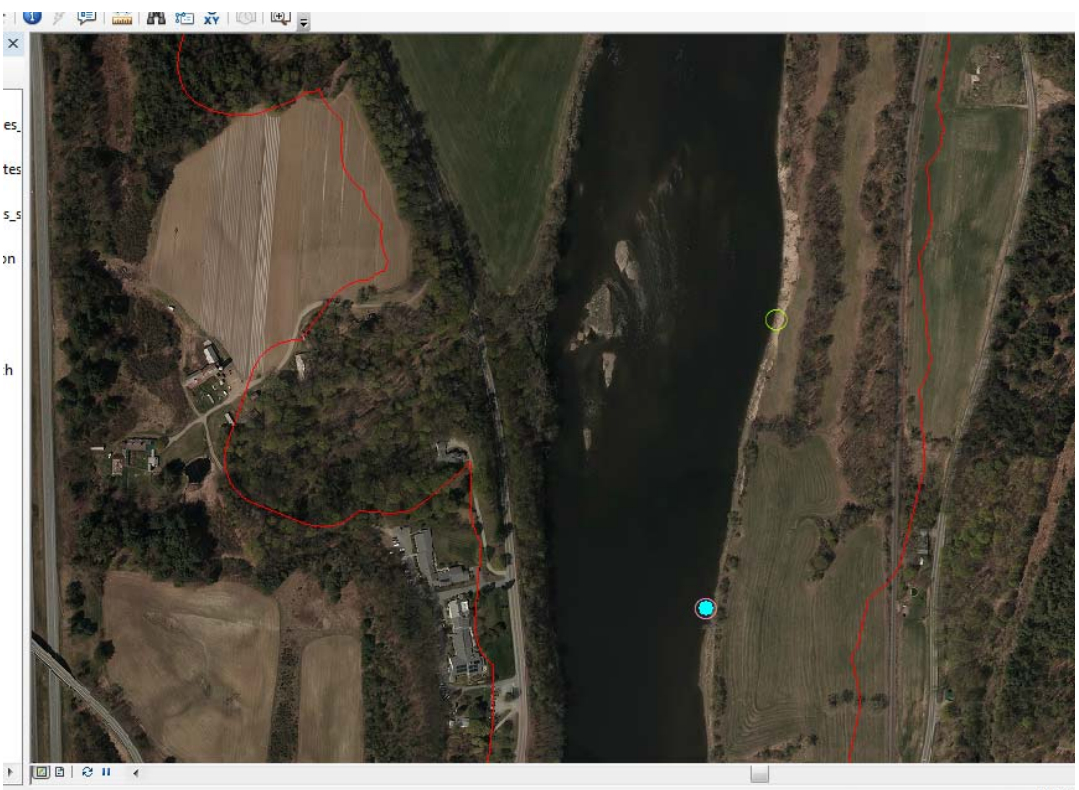
Participants:

- John Ragonese, TransCanada
- Jennifer Griffin, TransCanada
- John Field, Field Geology
- Jonathan Garber, Field Geology
- Owen David NHDES
- Jeff Crocker VT DEC
- Rod Wentworth VT DFW
- Mark Goodwin, City of Lebanon
- Joe Hassell , FERC
- Landowners:
  - John Mudge
  - John Bruno
  - Bill Lipfert

Using Webex, sites were shown on GIS aerial layer.

Adjusted location of one site at head of BF pond/bottom of Wilder riverine section north of Claremont Ascutney bridge (Lipfert property) See below. From blue dot to Green circle.

Other than that not a lot of issues or questions.



John Ragonese

From: William Lipfert <wlipfert@yahoo.com>
Sent: Monday, November 04, 2013 10:07 AM
To: andrew.gast-bray@lebcity.com; angie.scangas@hdrinc.com; ddeen@ctriver.org; dhjorth@louisberger.com; gregg.comstock@des.nh.gov; jeff.crocker@state.vt.us; McClammer@aol.com; joseph.hassell@ferc.gov; jfield@field-geology.com; JMudgeNH@aol.com; John Ragonese; khodge@louisberger.com; kenneth.hogan@ferc.gov; lael.will@state.vt.us; mfischer@normandeau.com; owen.david@des.com; rruppel@uvlsrpc.org; ralph.nelson@hdrinc.com; Robert.Mitchell@hdrinc.com; sara.cavin@uvlt.org; sharonfrancis17@gmail.com
Subject: Re: Materials for Nov. 4 Conf Call re: Study 2-Riverbank Transect Monitoring Site Selection - Location Still Bad
Attachments: Lipfert Erosion.jpg

Hello John,

Thank you for arranging today's call. While you have changed the lat/long of the location on the Lipfert Property, the location is still not correct. As discussed, the location now appears to be about 1/4 mile south of our property. As I noted below, the correct location is 43.438/-72.3931. The attached photo also shows the location.

The undercut bank at this location is at least 60 feet high (those sumacs shown at the top of the bank are about 12 feet high for reference), rather than the 17 feet height referenced in the spreadsheet. Thank you for agreeing to move the monitoring location to my property.

Bill Lipfert
603-448-8738

From: William Lipfert <wlipfert@yahoo.com>
To: "andrew.gast-bray@lebcity.com" <andrew.gast-bray@lebcity.com>; "angie.scangas@hdrinc.com" <angie.scangas@hdrinc.com>; "ddeen@ctriver.org" <ddeen@ctriver.org>; "dhjorth@louisberger.com" <dhjorth@louisberger.com>; "gregg.comstock@des.nh.gov" <gregg.comstock@des.nh.gov>; "jeff.crocker@state.vt.us" <jeff.crocker@state.vt.us>; "McClammer@aol.com" <McClammer@aol.com>; "joseph.hassell@ferc.gov" <joseph.hassell@ferc.gov>; "jfield@field-geology.com" <jfield@field-geology.com>; "JMudgeNH@aol.com" <JMudgeNH@aol.com>; "john_ragonese@transcanada.com" <john_ragonese@transcanada.com>; "khodge@louisberger.com" <khodge@louisberger.com>; "kenneth.hogan@ferc.gov" <kenneth.hogan@ferc.gov>; "lael.will@state.vt.us" <lael.will@state.vt.us>; "mfischer@normandeau.com" <mfischer@normandeau.com>; "owen.david@des.com" <owen.david@des.com>; "rruppel@uvlsrpc.org" <rruppel@uvlsrpc.org>; "ralph.nelson@hdrinc.com" <ralph.nelson@hdrinc.com>; "Robert.Mitchell@hdrinc.com" <Robert.Mitchell@hdrinc.com>; "sara.cavin@uvlt.org" <sara.cavin@uvlt.org>; "sharonfrancis17@gmail.com" <sharonfrancis17@gmail.com>
Sent: Wednesday, October 30, 2013 1:28 PM
Subject: Re: Materials for Nov. 4 Conf Call re: Study 2-Riverbank Transect Monitoring Site Selection - Bad Lat/Long?

Hello John,

Thank you for sending the list of proposed erosion monitoring sites. The location of the site we are interested in (EMB-1) shows up accurately in the PDF files. However, the lat/long data in the spreadsheet appears incorrect. EMB-1 is listed as being at 43.45393/-72.3906. This is at least a mile in error, it would appear. The correct location would be closer to 43.438/-72.3931.

If your consultant team concurs the spreadsheet contains erroneous data, it would be helpful to receive a corrected copy prior to our call on November 4th.

Thank you.

Bill Lipfert

Cornish NH

From: John Ragonese <john_ragonese@transcanada.com>
To: mimi.emerson@gmail.com; andrew.gast-bray@lebcity.com; angie.scangas@hdrinc.com; wlipfert@yahoo.com; cleve_kapala@transcanada.com; ddeen@ctriver.org; dhjorth@louisberger.com; gregg.comstock@des.nh.gov; jeff.crocker@state.vt.us; jennifer_griffin@transcanada.com; McClammer@aol.com; oldgraywolf@verizon.net; joseph.hassell@ferc.gov; jmbruno70@gmail.com; john.devine@devinetarbell.com; jfield@field-geology.com; john.howard@gdfsuezna.com; JMudgeNH@aol.com; john_ragonese@transcanada.com; blackrivercleanup@yahoo.com; khodge@louisberger.com; kenneth.hogan@ferc.gov; lael.will@state.vt.us; li@eurekasw.com; ldewald@entergy.com; mwamser@gomezandsullivan.com; Marselis@comcast.net; mfischer@normandeau.com; nscormen@gmail.com; owen.david@des.com; rruppel@uvlsrpc.org; ralph.nelson@hdrinc.com; Robert.Mitchell@hdrinc.com; sara.cavin@uvlt.org; sharonfrancis17@gmail.com; suemackenzie@earthlink.net; wendy@vermontjewel.com; tom.christopher@comcast.net
Sent: Wednesday, October 30, 2013 10:57 AM
Subject: Materials for Nov. 4 Conf Call re: Study 2-Riverbank Transect Monitoring Site Selection

To the Erosion Work Group:

As mentioned in my email last Thursday, we have scheduled a conference call on November 4th, at 9:30am to discuss our recommended erosion monitoring sites associated with Study 2 – Riverbank Transect Study. Material for that meeting is attached and has been posted on the Erosion, Geology and Soils, Fluvial Analyses Workgroup Page of TransCanada's private relicensing web site (http://www.transcanada-relicensing-team.com/default.aspx). Your username and password to access the site was sent to you via an email from Tina Ochs on July 3, 2013.

The material attached includes a Word document describing the procedures used to select monitoring sites, an Excel list of all sites visited with the selected sites highlighted in yellow, and PDF's of maps showing the location of each site. In the Excel list of sites, the comment in each cell of column A shows a photo of the site.

After arriving at a suitable final list on Monday, we will access the sites over the following two weeks to conduct the first round of monitoring prior to the onset of winter. As a reminder, we have included the conferencing Webex call-in information below . Thank you in advance for your cooperation and participation.

John

John L. Ragonese, FERC License Manager
TransCanada
4 Park Street; Concord NH 03301
CELL: 603.498.2851 (best option); 603.225.5528; FAX 603.225.3260
Email: john_ragonese@transcanada.com

Webex information:

Topic: CT River Erosion Working Group - Monitoring Site Selection
Date: Monday, November 4, 2013
Time: 9:30 am, Eastern Standard Time (New York, GMT-05:00)
Meeting Number: 926 223 602
Meeting Password: Abcd1234

To join the audio conference only

To receive a call back, provide your phone number when you join the meeting, or call the number below and enter the access code.
Call-in toll-free number (US/Canada): 1-866-469-3239
Call-in toll number (US/Canada): 1-650-429-3300
Toll-free dialing restrictions: http://www.webex.com/pdf/tollfree_restrictions.pdf

Access code:926 223 602

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3. If a password is required, enter the meeting password: Abcd1234
4. Click "Join".

To view in other time zones or languages, please click the link:
https://transcanada.webex.com/transcanada/j.php?ED=245543942&UID=0&PW=NMjUxOGFlMGEz&ORT=MiMxMQ%3D%3D

For assistance
----
1. Go to https://transcanada.webex.com/transcanada/mc
2. On the left navigation bar, click "Support".

You can contact me at:
john_ragonese@transcanada.com

To add this meeting to your calendar program (for example Microsoft Outlook), click this link:
https://transcanada.webex.com/transcanada/j.php?ED=245543942&UID=0&ICS=MI&LD=1&RD=2&ST=1&SHA2=AAAAAtmJ-PZnkeqTtkUUdVst6ruZgLavFUeS306EYCQYnci7&RT=MiMxMQ%3D%3D

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John Ragonese

From: John Ragonese
Sent: Sunday, November 03, 2013 8:47 PM
To: mimi.emerson@gmail.com; andrew.gast-bray@lebcity.com; angie.scangas@hdrinc.com; wlipfert@yahoo.com; Cleveland Kapala *; ddeen@ctriver.org; dhjorth@louisberger.com; gregg.comstock@des.nh.gov; jeff.crocker@state.vt.us; Jennifer Griffin; McClammer@aol.com; oldgraywolf@verizon.net; joseph.hassell@ferc.gov; jmbruno70@gmail.com; john.devine@devinetarbell.com; jfield@field-geology.com; john.howard@gdfsuezna.com; JMudgeNH@aol.com; John Ragonese; blackrivercleanup@yahoo.com; khodge@louisberger.com; kenneth.hogan@ferc.gov; lael.will@state.vt.us; li@eurekasw.com; ldewald@entergy.com; mwamser@gomezandsullivan.com; Marselis@comcast.net; mfischer@normandeau.com; nscormen@gmail.com; David, Owen (NHDES); rruppel@uvlsrpc.org; ralph.nelson@hdrinc.com; Robert.Mitchell@hdrinc.com; sara.cavin@uvlt.org; sharonfrancis17@gmail.com; suemackenzie@earthlink.net; wendy@vermontjewel.com; tom.christopher@comcast.net
Subject: Final pre-call Erosion Site selection spreadsheet
Attachments: Copy of Transcanada_EM site list 11_3_withpcharts.xlsx; TC_EMsites_10_29 reduced.pdf

A couple modifications have been made to the spreadsheet for the 9:30 Call on Monday November 4th. Make sure you are viewing the 11_3 with charts version for the call or view using WebEx desktop sharing. Also attached are the pdf site location maps previously sent.

For the upcoming November 4th Erosion Monitoring Site conference call is at 9:30, please refer to this UPDATED Excel spreadsheet. The sites identified as "yes" in column B on the Master Sheet (tab) are the recommended sites.

Meeting information

Topic: CT River Erosion Working Group - Monitoring Site Selection
Date: Monday, November 4, 2013
Time: 9:30 am, Eastern Standard Time (New York, GMT-05:00)
Meeting Number: 926 223 602
Meeting Password: Abcd1234

To start or join the online meeting

Go to
https://transcanada.webex.com/transcanada/j.php?ED=245543942&UID=504728117&PW=NMjUxOGFlMGEz&RT=MiMxMQ%3D%3D

Audio conference information

To receive a call back, provide your phone number when you join the meeting, or call the number below and enter the access code.
Call-in toll-free number (US/Canada): 1-866-469-3239
Call-in toll number (US/Canada): 1-650-429-3300
Toll-free dialing restrictions: http://www.webex.com/pdf/tollfree_restrictions.pdf

Access code:926 223 602

John L. Ragonese, FERC License Manager
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4 Park Street; Concord NH 03301
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Teleconference Memo

To: Public Files
From: Kenneth Hogan
Date: June 24, 2014
Dockets: P-1892-026, P-1855-045, P-1904-073, P-1889-081, P-2485-063
Projects: Wilder, Bellows Falls, Vernon, Turners Falls, and Northfield Mountain projects

Subject: Teleconference the management options for obtaining juvenile American shad for 2015 FERC Connecticut River Projects studies requiring tagging March 20, 2014 Conference Call - Notes

On March 20, 2014, Commission staff participated in a conference call hosted by the U.S. Fish and Wildlife Service regarding the need for, and logistics associated with obtaining juvenile shad to support the required radio telemetry studies at the projects. The Meeting Minutes are attached to this memo.

Management options for obtaining juvenile American shad for 2015 FERC Ct River Projects studies requiring tagging

March 20, 2014

Conference Call - Notes

Participants: *John Ragonese, Jen Griffen, Rick Simmons, Doug R., Matt Carpenter, Chris Thomichek, Joe McKeon, Mike Bailey, Larry Lofton, Dan Wong, Kevin Cheung, Gabe Gries, Caleb Slater, Ken Hogan, Melissa Grader, John Warner, Ken Sprankle*

Group discussed Study # 22 for TransCanada, which will require radio tagging of 100 juveniles, which should be > 110 mm (TL). Rick Simmons noted desire and benefit of releasing these tagged fish in much larger groups of wild fish (better survival, movement behavior). The untagged escort fish could be obtained from the wild. In addition, they plan to examine tag retention using dummy tagged fish and a control group which will require 100 fish, at >110mm. The Hi-Z tagged fish for turbine studies also should be >110mm, and the total needed for that part of study was noted as 450 fish. The grand total needed, with no margin for any issues/losses is 650 for fish >110 mm. Given expected losses/issues with these hatchery fish, it was agreed that 2,000 fish should be the target number for shipment from North Attleboro National Fish Hatchery for the TC study fish needs, in 2015. It was agreed that shipment from the hatchery should occur in two batches, as a tentative plan for fall of 2015.

The group discussed Study 3.3.3 for FirstLight Power, which will require 224 juveniles, which should be >110mm for radio tagging. In addition, studies that will use the Hi-Z tag (NAI doing this study for both owners), will require – at this time – an additional 875 juveniles >110mm. It was noted on the call by FERC that FLP must show what standard operational condition(s) are for turbines – which may increase study fish needs. Bob Stira was working on this item. The grand total needed, with no margin for losses/issues is 1099. Given expected losses/issues with these fish, and using similar multiplier as with TransCanada, a total of approximately 3,000 fish should be the target number for shipment from NANFH, in 2015. It was agreed that shipment from the hatchery should occur in two batches, as a tentative plan for fall of 2015.

Larry Lofton (NANFH), described how they had done some trial rearing in 2013, and believed that starting earlier (getting fish on station ASAP), using some new diets, and trying some different approaches (use ponds in addition to tanks), was possible this year.

Ken Sprankle discussed plan to obtain shad for fish health testing in early April – 2014, from commercial netters, Bob Stira was willing to cover purchase costs. Ken would process fish ASAP, send out samples to USFWS lab, with the goal of having clearance to move shad from Holyoke Fish Lift, up to one month earlier than in past year. This would advance rearing time and thus growth potential for trials in 2014.

Larry asked about timing, and it was noted by Ken S. that we should target a first batch “delivery” for mid-September and a second (final) batch perhaps for Oct 1 – in 2015, when studies would be occurring.

This would need to be based on fish size which may require some delay for more growth, unknown, and also the 2015 planned Turners Canal outage period consideration, maybe high flow events, etc. John Warner noted we would need to flexible.

Larry asked about the use of the 2014 trial year fish in the fall, could they be of any use? Rick Simmons stated they could use juvenile fish in the fall of 2014. It was agreed there would be great value in doing a loading and transport from NANFH to Vernon. Fish could be held at Vernon in cages and Rick could possible conduct the tag retention studies noted in the Plan in fall of 2014.

Joe McKeon stated that for 2014 there is no interest by USFWS to seek any reimbursement for this work, aside from FLP covering commercial netter fish sample cost (60 adults). If USFWS is successful in producing and delivering juveniles in 2014, the USFWS will be able to provide some figure for an agreement in 2015 based on 2014 information. John Rangonese and Bob Stira agreed with this plan.

Ken Sprankle noted he would provide information on incremental progress for this effort (e.g., fish being taken to NANFH, egg take time, hatch/rearing, growth..), with emails to this group in spring and summer of 2014. This will keep Normandeau updated and allow their planning for cages at Vernon in the fall and other arrangements that may be required for this trial year efforts.

Few additional items on Plans -

- Normandeau described experience with holding cages for receiving hatchery fish and have used them at Vernon. Kleinschmidt did not provide details on this component of their study, at this time. Kleinschmidt should provide some additional details on this given concerns with handling and holding of these juvenile fish.
- Kleinschmidt did not note the plan to release any "untagged" juveniles to enhance survival of radio tagged individuals which may aid in movement/motivation. The FLP study would be expected to benefit from paired releases of wild fish with radio tagged juveniles and as more study details are developed this component can hopefully be more fully developed.
- The agencies and FERC are awaiting turbine operational setting data to determine whether additional juvenile study shad will be necessary for survival studies. Bob Stira will be providing that information.

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May 14, 2014

Mr. John Brown, Tribal Historic Preservation
Officer
Narragansett Indian Tribe
4425-A South County Trail
Charlestown, RI 02813

**Re: TransCanada Hydro Northeast Inc. Relicensing Wilder, Bellows Falls and Vernon Projects;
Further consultation/discussion regarding Tribal participation in required Cultural Resource Studies;**

Dear Mr. Brown:

In following up with FERC's direction to TransCanada with respect to preparing a Traditional Cultural Property (TCP) study related to the Connecticut River, we have engaged Willamette Cultural Resources Associates (Willamette CRA) as a consultant for this project.

Willamette CRA brings extensive expertise in conducting TCP studies associated with hydropower projects and FERC relicensing in particular. Principal David Ellis and cultural anthropologist Donald Shannon have produced nearly a dozen reports on the Columbia River and its tributaries throughout Oregon and Washington. Mr. Shannon has the added benefit of having worked for and with several Tribes as an ethnographer documenting Tribal use and ties to areas affected by hydropower projects. They will assist us in guiding background research and generating a report focusing on TCPs in the Areas of Potential Effect (APE) for the projects as defined in the FERC-approved study plan. We feel their experience in the Northwest will be a good fit for the Northeast, where these kinds of studies are uncommon.

TransCanada's selection of a consultant well versed in the preparation and delivery of TCP assessments and reports will assure that the required elements specified in the FERC Study Determination dated September 13, 2013 are completed. The Narragansett Indian Tribe and other representatives such as the Nolumbeka Project have tribal history and knowledge that would contribute to the collection of Traditional Ecological Knowledge. Our ethnographer would like the opportunity to coordinate interviews with tribal representatives with the intent to obtain such information. Upon completion of the research and interviews, the ethnographer, tribal representatives, and potentially the interviewees, may determine it necessary to visit areas within the APEs. The purpose of the visits would be to 1) allow tribal representatives to show locations identified during the interviews, 2) document and map locations, 3) verify potential correlations with known archaeological resources, 4) identify any potential project-related effects, (5) determine potential correlations with known archaeological resources, and 6) enable the ethnographer to obtain any additional information on the potential TCPs. The specific methodology will be based upon discussions with the Narragansett Tribe and the Nolumbeka Project.

In addition to the TCP evaluation and documentation, TransCanada will be conducting archaeological investigations. We would like to discuss whether there is interest and how Narragansett Tribe and the Nolumbeka Project might wish to participate in those investigations.

It is our desire to begin these evaluations and investigations with meetings to discuss to what extent and how the Narragansett Tribe and others such as the Nolumbeka Project can and wish to contribute to this effort.

We look forward to arranging a meeting with your office at your earliest convenience. At this meeting, we can introduce our consultants and address any questions or concerns you may have as we move forward with this project. We are looking for specific dates when you or Doug Harris would be available to meet during the last week of May or first week of June.

If there are further questions regarding this matter, please contact me at 603-498-2851 to discuss things further. I look forward to you providing us with dates and times we can make this happen. Thank you for your consideration.

Sincerely,

John L. Ragonese
FERC License Manager

Cc: Kimberly D. Bose, Secretary, FERC (filed electronically)
Ken Hogan, FERC (via email)
John Howard, FL (via email)
Joe Graveline, Nolumbeka Project (via email)

Attachment: Donald Shannon Curriculum Vitae

WILLAMETTE CULTURAL RESOURCES ASSOCIATES, LTD.

Donald Shannon
Cultural Anthropologist

Curriculum Vitae

Contact Information

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Portland, Oregon 97214
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Education

1993	B.A., Anthropology, Washington State University
1996	M.A., Anthropology, Washington State University
1999-2000	Graduate Research Assistant, Department of Anthropology, University of Oklahoma

Professional Affiliations

The Society for Applied Anthropology

Employment History

1993-1995	Ethnographer. Washington State University/National Institutes of Child Health and Human Development.
1995	Archaeological Laboratory Technician. Center for Northwest Anthropology, Washington State University.
1996	Research Assistant. Department of Anthropology, Washington State University.
1996-97	Field Archaeologist. Center for Northwest Anthropology, Washington State University.
1998	Field Archaeologist. Rainshadow Research, Pullman WA.
1999-2000	Chickasaw Nation Ethnographer. Health Promotion Programs. University of Oklahoma, Norman.
2000	Ethnographer. Chickasaw Nation of Oklahoma. Ada, Oklahoma.
2000	Ethnographer. University of Oklahoma Health Science Center.
2000	Field Director, Central African Republic. National Institutes of Child Health and Human Development/Washington State University.
2001	Adjunct Faculty, Department of Sociology and Anthropology. Linfield College Division of Continuing Education. McMinville, Oregon.
2001-2002	Ethnographer. SWCA Environmental Consultants, Inc., Salt Lake City, UT 84101
2002-2003	Ethnographer. Historical Research Associates, Seattle, WA.
2003-2011	Traditional Cultural Property Coordinator. History/Archeology Program, Confederated Tribes of the Colville Reservation.

2011-Present Cultural Anthropologist, Willamette Cultural Resources Associates, Ltd., Portland Oregon.

Specialized Training

2002 "Hazardous Waste Operations and Emergency Response". 40 hour training administered and certified by Argus Pacific Industrial Hygiene. July 8-12, Seattle, WA.

2003 "Introduction to Section 106". Presenter, Dr. Thomas F. King, National Preservation Institute. September 9-12, Seattle, WA.

2006 "Introduction to ArcGIS 1". September 18th and 19th, class evaluation #24045401.

2011 "Consultation and Protection of Native American Sacred Lands". Instructor, Claudia Nissley. National Preservation Institute. October 27-28, Vancouver, WA.

Professional/Technical Reports

Reports produced for SWCA Environmental Consultants, Inc.

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the I-15 North, 31st Street to 2700 North, Ogden Reconstruction Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA).

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the 700 East, 12300 South to 9400 South Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA).

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the Layton City I-15 Interchange Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA).

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the I-215 North, 300 East to the I-80 Interchange (West Side) Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA).

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the State Route 191 Blanding to Moab Passing Lanes Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA). Shannon, Donald

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the C-Bar Company's Proposed White Lakes Water Line, Box Elder County, Utah"*. Shannon, Donald

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the South Central Communications Antimony to Koosharem Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA) and South Central Communications. Shannon, Donald

2001 *The 2003 Kern River Expansion Project: Previous Ethnographic Investigations Report*. Cultural Resources Report No. 01-147. SWCA, Inc. Environmental Consultants, Salt Lake City, Utah. Shannon, Donald and Molly Rhodenbaugh.

2001 *History and Prehistory Along the San Pedro, Los Angeles, and Salt Lake Railroad: Results of Archeological Investigations for the Level (3) Communications Fiber Optic Line from Salt Lake City to the Utah/Nevada Border. Volume III: Discoveries and Test Excavations*. Prepared for Utah Bureau of Land Management. Report on file at State Historic Preservation

Office, Salt Lake City. (Junior author with; Seddon, Matthew T., Sonia Hutmacher, Ken Lawrence, Rachel Gruis, Kryslin Taite, Scott B. Edmisten).

2001 *History and Prehistory Along the San Pedro, Los Angeles, and Salt Lake Railroad: Results of Archeological Investigations for the Level (3) Communications Fiber Optic Line from Salt Lake City to the Utah/Nevada Border. Volume IV: Excavations at Tintic Junction and Jericho Section Station*. Prepared for Utah Bureau of Land Management. Report on file at State Historic Preservation Office, Salt Lake City (Junior author with; Seddon, Matthew T., Sonia Hutmacher, Ken Lawrence, Rachel Gruis, Kryslin Taite, Scott B. Edmisten).

Reports Produced for Historical Research Associates, Inc.

2002 *Native American Ethnographic and archeological overviews for 14 Western States; BLM Noxious Vegetation Treatment Management Plan Draft Environmental Impact Statement*. Prepared for ENSR Consulting and Engineering. Shannon, Donald and Gail S. Thompson.

2002 *Wanapum Ethnography and Ethnohistory*. Prepared for Yakima Test Center, Department of Defense. Shannon, Donald, with James A. Carter, Trent K. DeBoer, Meredith Wilson.

2002 *Cultural Resources and Native American Traditional Cultural Properties impacted by the BPA Kangley-Echo Lake Power Line Transmission Project*. Submitted to the Bonneville Power Administration. Shannon, Donald, and Gail S. Thompson

2002 *Lake Sammamish River Pedestrian Bridge Cultural Resource Assessment*. Submitted to HNTB Engineering Services, Redmond WA. Shannon, Donald.

Reports Produced for the Confederated Tribes of the Colville Reservation

2003 *Identification of Traditional Cultural Properties for Bonneville Power Administration Schultz-Hanford Transmission Line Project*. Document prepared for the Bonneville Power Administration.

2003 (George, Tillie, with Guy Moura and Donald Shannon) *Grand Coulee Dam to the International Boundary; Identification of Place Names in the Franklin D. Roosevelt Lake Area*. Document prepared for the Bonneville Power Administration.

2003 *Chief Joseph Dam and Rufus Woods Lake Cultural Resources Project: Identification of Traditional Cultural Properties from Grand Coulee Dam to Chief Joseph Dam*. Document submitted to the Bonneville Power Administration.

2003 (Morgan, Vera E and Guy F. Moura, with contribution by Donald Shannon) *"Banks Lake and Coulee Ponds Drawdown, Identification of Traditional Cultural Properties"* in *A Class III Historic Resources Inventory of Pond A (Coulee City Ponds) of the Dry Falls Dam-Banks Lake Project, Grant County, Washington*. Prepared for the Bureau of Reclamation.

2003 *Identification of Traditional Cultural Properties for Paschal Sherman Indian School Construction*. Prepared for Colville Confederated Tribes, Draft Environmental Impact Statement.

2003 *Annual Report on the Chief Joseph Dam and Rufus Woods Reservoir contract DACW 67-00 D-1002 and 2003 update*. Document prepared for the United States Army Corps of Engineers, Seattle District.

2004 (With Consuelo Johnston) *Palus Lineal Descent and Cultural Affiliation Study Associated with Palus Cemetery*. Document submitted to the United States Army Corps of Engineers, Walla Walla District.

2004 *Grand Coulee Dam Project: Access database of 408 place names in original Indian language, English translation, and place name information*. Document prepared for the Bonneville Power Administration.

2004 *Grand Coulee Dam to the International Boundary; Identification of Place Names in the Franklin D. Roosevelt Lake Area*. Document prepared for the Bonneville Power Administration.

2005 *Draft 2005 Annual Report Chief Joseph Dam and Rufus Woods Lake Traditional Cultural Property Research*. Document prepared for the United States Army Corps of Engineers, Seattle District.

2005 *Traditional Cultural Property (TCP) Component of the Chief Joseph Dam Hatchery Project*. Document prepared for the Bonneville Power Administration.

2005 *Four Bears Project Traditional Cultural Property Component*. Document prepared for Colville Confederated Tribes Forestry Program.

2005 *North Omak Lake Road Project TCP Research*. Document prepared for Colville Confederated Tribes.

2005 (With Michael Finley and Amelia Marchand) *Poker among the Colville Confederated Tribes: results of History/Archaeology Program Preliminary Research*. Document prepared for Colville Business Council.

2005 *Newly identified Traditional Cultural Places for the Grand Coulee Dam Project, FY'05*. Document submitted to the Bonneville Power Administration.

2005 (With Guy F. Moura and contributions by Adam Fish) *Traditional Cultural Property Themes and Subtype Based on Palus Territory (Hart 2003)*. Document prepared for the United States Army Corps of Engineers, Walla Walla District.

2005 (With Guy F. Moura) *Wild Horse Wind Power Traditional Cultural Property Study: Inventory Technical Report Presenting Summary of Overview Data and Documentation*. Document submitted to Zilkha Renewable Energy, in support of application to the State of Washington Energy Facility Site Evaluation Council.

2006 *Chief Joseph Dam as a Fishery: Traditional Cultural Property Scoping*. Document prepared for the United States Army Corps of Engineers, Seattle District.

2006 (With Guy Moura) *Fiscal Year 2006 Grand Coulee Dam Project Annual Letter Report for Contract # 00024429*. Document prepared for the Bonneville Power Administration.

2007 *Letter of preliminary results, High Level Class I Traditional Cultural Property Inventory for Potholes Supplemental Feed Route and Odessa Subarea Special Study, Columbia Basin Project, Washington*. Document prepared for United States Bureau of Reclamation, Yakima.

2007 (With Guy F. Moura) *Chief Joseph Dam/Rufus Woods Lake Traditional Cultural Property Final Technical Report*. Document prepared for the United States Army Corps of Engineers, Seattle District.

2007 *Salish place names and traditional use areas and CCT Fish and Wildlife Mitigation lands*. Document prepared for Fish and Wildlife Program, Colville Confederated Tribes.

2008 *Final Traditional Cultural Property Study of the Bridgeport Unit Portion of the Sagebrush Flats Wildlife Area*. Document prepared for the Bonneville Power Administration.

2009 (With Guy F. Moura and Lawrence Harry Kulpschinikin) *Draft Chief Joseph Dam Tribal Fishery Site: Traditional Cultural Property Investigations. Okanogan County, State of Washington*. the United States Army Corps of Engineers, Seattle District.

2009 *Final Traditional Cultural Property Study of 45GR664*. Intergovernmental Contract No. 38664. Produced for the Bonneville Power Administration.

2010 Mid Columbia River Coho Reintroduction Project. Intergovernmental Contract No. 38664. Produced for the Bonneville Power Administration. (With Guy F. Moura, and contributions from Lawrence Harry Kulpschinikin)

2010 (With Guy F. Moura) *Palus Village Traditional Significance Statement in Support of Determination of Eligibility*. Document prepared for United States Army Corps of Engineers, Walla Walla District.

2010 (With Guy F. Moura and Lawrence Harry Kulpschinikin) *Waste Management of Washington East Wenatchee Traditional Cultural Property Study*. Document prepared for Waste Management of Washington.

2011 (With Guy F. Moura) *The Salmon Fishery at the Chief Joseph Dam as a Traditional Cultural Property*. National Register of Historic Places Registration Determination of Eligibility Form 10-900. Submitted to the United States Army Corps, Seattle District.

2011 (With Matilda George and Guy F. Moura) *Native American Place Names in the Traditional Homelands of the Nespelem, Sanpoil, Colville, and Lakes, North-central Washington*. Document for public release, produced for the Colville Confederated Tribes.

2011 *Traditional Cultural Properties in the Saddle Mountains Bureau of Land Management Holdings*. Produced for the Bureau of Land Management, Spokane Office.

2011 (With Crystal Harris-Smith) *Traditional Cultural Properties in the Okanogan Highlands Bureau of Land Management Holdings*. Produced for the Bureau of Land Management, Spokane Office.

2011 (with contributions by Lawrence Harry Kulpschinikin). *Douglas Rapids Transmission Line Traditional Cultural Property Study*. Prepared for Douglas County Public Utility District. Prepared by Confederated Tribes of the Colville Reservation, History/Archaeology Program.

Reports Produced for Willamette Cultural Resources Associates, Ltd.

2011 (With Paul S. Solimano, Matt Goodwin, and Kanani Paraso). *Cultural Resources Survey for the Proposed Alder Creek Restoration Project, Multnomah County, Oregon*. Prepared for Wildlands, Portland, Oregon.

2012 (With Paul S. Solimano, Andrew Pflandler, B.A., and David V. Ellis, M.P.A.) *Archaeological Survey of the Swauk Wind Project Kittitas County, Washington*. Prepared for Swauk Wind, LLC. Seattle, Washington.

2012 (With Matt Goodwin, B.S., Kanani Paraso M.A., R.P.A, and David V. Ellis, M.P.A.) Archaeological Survey and Above Ground Resources Assessment for the Proposed City of Dundee Fire Station Yamhill County, Oregon.

2012 (With Todd Ogle) Cultural Resources Survey of the North Creek In-Stream and Riparian Enhancement Project. Clackamas County, Oregon. Prepared for the Clackamas County Soil and Water Conservation District, Oregon City, Oregon.

2012 (With Paul S. Solimano, Daniel Gilmour, and David Ellis) *Approach and Methods for Updating the Lower Snake River, Tri-Cities and Palouse Canyon Archaeological Districts* (Draft Report). Prepared for the United States Army Corps of Engineers, Walla Walla District, Washington.

2012 (With Paul S. Solimano, Kenneth M. Ames, and Charles M. Hodges) *Historic Context for Precontact Cultural Resources in Parts of Klickitat County, Washington*. Prepared for Washington Department of Archaeology and Historic Preservation.

2013 *List of Culturally Sensitive Sites in Cascade Crossing Project Corridor*. Prepared for URS Corporation, for Portland General Electric.

2013 (With Matt Goodwin and Todd Ogle) *Cultural Resources Survey of the Corral Creek Obstruction Removal Project*. Submitted to Clackamas County Soil and Water Conservation District.

2013 (With David V. Ellis, M.P.A.) *Cultural Resources Survey for the Proposed Nichols Landing, Hood River, Oregon*. Final Report Prepared for Naito Development, Portland, Oregon.

2013 (With Todd Ogle, Paul Solimano, and Danny Gilmour) *Archaeological Inventory Survey for NWW Project Lands, Dworshak Reservoir, Idaho*. Document prepared for the Walla Walla Army Corps of Engineers.

2013 (With Paul Solimano and Danny Gilmour) *Rock Image Cultural Context*. Document prepared for the Walla Walla Army Corps of Engineers.

2013 (With David V. Ellis, M.P.A.) *Columbia River Treaty*. Provided technical assistance to the Bonneville Power Administration and assisted in Tribal coordination. STT Working Group, Draft Work Plan Framework.

2013 (With Paul Solimano and Danny Gilmour) *John Day Historic Properties Management Plan*. Document prepared for the Walla Walla Army Corps of Engineers.

2013 *Cascade Crossing Final Ethnographic Report, Including Summarized Tribal Oral History Reports*. Prepared for URS Corporation, for Portland General Electric.

2013 (With Dave V. Ellis, M.P.A., and Matt Goodwin, B.S.) *Cultural Resources Survey of the Newport Airport Runway Rehabilitation Project and Apron Expansion Area, Lincoln County, Oregon*. Prepared for Precision Approach Engineering, Inc. and the City of Newport, Oregon.

2013 (With Todd Ogle, M.A., R.P.A. and Renae Campbell B.A.) *Cultural Resources Survey of the Willamette Narrows State Wildlife Grant Restoration Project, Clackamas County, Oregon*. Prepared for Metro Portland, Oregon.

2013 (With Paul Solimano) National Register of Historic Places Registration Form of Four Sites Near Memaloose Island (Lyle Site/45-KL-110).

2014 (With Daniel M. Gilmour, M.A., R.P.A., Todd B. Ogle, M.A., R.P.A., Andy Pfandler, B.A., Michael A. Daniels, B.S., and David V. Ellis, M.P.A.) *Cultural Resources Survey Report and Evaluative Site Testing Report for Precontact Site 35-LIN-791 for Metropolitan Land Group's Columbus Development Project, City of Albany, Linn County, Oregon*. Prepared for Metropolitan Land Group LLC.

Peer Reviewed Publications

1998 Hewlett, Barry S., Michael Lamb, Donald Shannon, Birgit Leyendecker and Axel Scholmerich. *Culture and Early Infancy Among Central African Foragers and Farmers.* Developmental Psychology; 1998, Vol. 34, No.4, 653-661.

2002 *The Impact of Incarceration on Chickasaw Fathers.* In Southern Indians and Anthropologists: Culture, Politics, and Identity. Lisa J. Lefler and Frederic W. Gleach, eds. Athens: University of Georgia Press. Proceedings of the Southern Anthropological Society Meetings, University of Georgia Press.

Conference Presentations

1996 *The impact of logging on indigenous groups in northern Congo.* Paper presented at the Northwest Anthropological Meetings, Moscow, Idaho.

1996 *Parental investment among Aka foragers and Ngandu farmers.* With Barry Hewlett, Axel Scholmerich, and Michael Lamb. Paper presented at the annual meetings of the American Anthropological Association, San Francisco, California

1997 *Breastfeeding and inter-birth interval among the Aka: An evolutionary perspective.* Paper presented at the Northwest Anthropological Meetings. Ellensburg, Washington.

2000 *The impact of incarceration on father-child relations among the Chickasaw*. Paper presented at the Southern Anthropological Society Meetings, Mobile, Alabama.

2001 *Father-Child Relations among the Chickasaw, a cross-cultural perspective*. Presented at 1st Annual Masculinity Conference, Portland Community College, Sylvania campus, Portland Oregon.

2001 *Building the Aka School, a community driven development project*. Presented to the Three Rivers Anthropological Society and the W.S.U.-Vancouver Anthropology Club, Washington State University, Vancouver Washington.

2004 *Traditional Cultural Property Compliance in the Confederated Tribes of the Colville Reservation History/Archaeology Program as Applied Anthropology*. Presented at Honoring the Heritage of the Plateau Peoples: Past, Present and Future. Conference held at Washington State University, Pullman.

2004 *Traditional Cultural Properties: How Come?* Workshop for Tribal Historic Preservation Officers and Washington State Department of Transportation staff on Traditional Cultural Property compliance. Doubletree Hotel, Spokane, Washington.

2005 *Traditional Cultural Property Compliance as Applied Anthropology: Two Case Studies from the Kittitas Valley*. Paper presented at the Northwest Anthropological Meetings, Spokane, Washington.

2007 *Traditional Cultural Properties in Section 106 compliance*. Presentation to Colville Tribal staff, city of Oroville, Okanogan County Public Utility District (PUD). Nespelem, WA.

2007 *The Chief Joseph Dam as a Fishery; Traditional Cultural Property Research*. Paper presented at the Northwest Anthropological Meetings, Pullman, Washington.

2007 *Traditional Cultural Properties research at the Colville Confederated Tribes*. Paper presented at the Northwest Anthropological Meetings, Pullman, Washington.

2007 *Introduction to identification of culturally modified lithic materials*. Presentation given to field staff of the Washington State Department of Natural Resources, Republic, Washington.

2009 *Traditional Cultural Property Research at the Colville Confederated Tribes*. Given to Wanapum Heritage Days. Wanapum Village, Washington.

2009 *Traditional Cultural Property Research at the Colville Confederated Tribes*. Washington State Department of Transportation Cultural Resources Conference. Red Lion Inn, Wenatchee WA.

2010 *Documenting cultural continuity of the Colville Confederated Tribes through compliance based research*. Northwest Anthropological Conference, Ellensburg, Washington.

2011 *Salish place names and cultural use areas on the eastern slopes of the Cascades compiled through compliance research*. Northwest Anthropological Conference, Moscow, Idaho.

2012 *Mining archival texts for ethnographic data relevant to a Section 106 undertaking: a primer on ethnographic work while doing background research*. Northwest Anthropological Conference, Wild Horse Casino, Umatilla Indian Reservation.

2013 *Don't Believe Everything you read about Northwest Tribes: The need for ethnographic research in the northwest*. Northwest Anthropological Conference, Portland, Oregon.

2013 *Dealing with Traditional Cultural Properties and Historic Properties of Cultural and Religious Significance to Indian Tribes: How to conduct ethnographic research in a compliance context*. Cultural Resource Protection Summit. Squaxin Island, Washington.

US Northeast Hydro Region
Concord Hydro Office
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May 14, 2014

Joseph Graveline, President
The Nolumbeka Project, Inc.
88 Columbus Avenue
Greenfield, MA 01301

Re: TransCanada Hydro Northeast Inc. Relicensing Wilder, Bellows Falls and Vernon Projects;
Further consultation/discussion regarding interest participation in required Cultural Resource Studies;

Dear Mr. Graveline:

In following up with FERC's direction to TransCanada with respect to preparing a Traditional Cultural Property (TCP) study related to the Connecticut River, we have engaged Willamette Cultural Resources Associates (Willamette CRA) as a consultant for this project.

Willamette CRA brings extensive expertise in conducting TCP studies associated with hydropower projects and FERC relicensing in particular. Principal David Ellis and cultural anthropologist Donald Shannon have produced nearly a dozen reports on the Columbia River and its tributaries throughout Oregon and Washington. Mr. Shannon has the added benefit of having worked for and with several Tribes as an ethnographer documenting Tribal use and ties to areas affected by hydropower projects. They will assist us in guiding background research and generating a report focusing on TCPs in the Areas of Potential Effect (APE) for the projects as defined in the FERC-approved study plan. We feel their experience in the Northwest will be a good fit for the Northeast, where these kinds of studies are uncommon.

TransCanada's selection of a consultant well versed in the preparation and delivery of TCP assessments and reports will assure that the required elements specified in the FERC Study Determination dated September 13, 2013 are completed. The Narragansett Indian Tribe and other representatives such as the Nolumbeka Project have tribal history and knowledge that would contribute to the collection of Traditional Ecological Knowledge. Our ethnographer would like the opportunity to coordinate interviews with tribal representatives with the intent to obtain such information. Upon completion of the research and interviews, the ethnographer, tribal representatives, and potentially the interviewees, may determine it necessary to visit areas within the APEs. The purpose of the visits would be to 1) allow tribal representatives to show locations identified during the interviews, 2) document and map locations, 3) verify potential correlations with known archaeological resources, 4) identify any potential project-related effects, (5) determine potential correlations with known archaeological resources, and 6) enable the ethnographer to obtain any additional information on the potential TCPs. The specific methodology will be based upon discussions with the Narragansett Tribe and the Nolumbeka Project.

In addition to the TCP evaluation and documentation, TransCanada will be conducting archaeological investigations. We would like to discuss whether there is interest and how Narragansett Tribe and the Nolumbeka Project might wish to participate in those investigations.

It is our desire to begin these evaluations and investigations with meetings to discuss to what extent and how the Narragansett Tribe and others such as the Nolumbeka Project can and wish to contribute to this effort.

We look forward to arranging a meeting with your office at your earliest convenience. At this meeting, we can introduce our consultants and address any questions or concerns you may have as we move forward with this project. We are looking for specific dates when you or Howard Clark would be available to meet during the last week of May or first week of June.

If there are further questions regarding this matter, please contact me at 603-498-2851 to discuss things further. I look forward to you providing us with dates and times we can make this happen. Thank you for your consideration.

Sincerely,

John L. Ragonese
FERC License Manager

Cc: Kimberly D. Bose, Secretary, FERC (filed electronically)
Ken Hogan, FERC (via email)
John Howard, FL (via email)
John Brown, NITHPO (via email)
Doug Harris, Deputy THPO (via email)

Attachment: Donald Shannon Curriculum Vitae

WILLAMETTE CULTURAL RESOURCES ASSOCIATES, LTD.

Donald Shannon
Cultural Anthropologist

Curriculum Vitae

Contact Information

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Education

1993	B.A., Anthropology, Washington State University
1996	M.A., Anthropology, Washington State University
1999-2000	Graduate Research Assistant, Department of Anthropology, University of Oklahoma

Professional Affiliations

The Society for Applied Anthropology

Employment History

1993-1995	Ethnographer. Washington State University/National Institutes of Child Health and Human Development.
1995	Archaeological Laboratory Technician. Center for Northwest Anthropology, Washington State University.
1996	Research Assistant. Department of Anthropology, Washington State University.
1996-97	Field Archaeologist. Center for Northwest Anthropology, Washington State University.
1998	Field Archaeologist. Rainshadow Research, Pullman WA.
1999-2000	Chickasaw Nation Ethnographer. Health Promotion Programs. University of Oklahoma, Norman.
2000	Ethnographer. Chickasaw Nation of Oklahoma. Ada, Oklahoma.
2000	Ethnographer. University of Oklahoma Health Science Center.
2000	Field Director, Central African Republic. National Institutes of Child Health and Human Development/Washington State University.
2001	Adjunct Faculty, Department of Sociology and Anthropology. Linfield College Division of Continuing Education. McMinville, Oregon.
2001-2002	Ethnographer. SWCA Environmental Consultants, Inc., Salt Lake City, UT 84101
2002-2003	Ethnographer. Historical Research Associates, Seattle, WA.
2003-2011	Traditional Cultural Property Coordinator. History/Archeology Program, Confederated Tribes of the Colville Reservation.

2011-Present Cultural Anthropologist, Willamette Cultural Resources Associates, Ltd., Portland Oregon.

Specialized Training

2002 "Hazardous Waste Operations and Emergency Response". 40 hour training administered and certified by Argus Pacific Industrial Hygiene. July 8-12, Seattle, WA.

2003 "Introduction to Section 106". Presenter, Dr. Thomas F. King, National Preservation Institute. September 9-12, Seattle, WA.

2006 "Introduction to ArcGIS 1". September 18th and 19th, class evaluation #24045401.

2011 "Consultation and Protection of Native American Sacred Lands". Instructor, Claudia Nissley. National Preservation Institute. October 27-28, Vancouver, WA.

Professional/Technical Reports

Reports produced for SWCA Environmental Consultants, Inc.

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the I-15 North, 31st Street to 2700 North, Ogden Reconstruction Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA).

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the 700 East, 12300 South to 9400 South Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA).

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the Layton City I-15 Interchange Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA).

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the I-215 North, 300 East to the I-80 Interchange (West Side) Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA).

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the State Route 191 Blanding to Moab Passing Lanes Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA). Shannon, Donald

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the C-Bar Company's Proposed White Lakes Water Line, Box Elder County, Utah"*. Shannon, Donald

2001 *Native American Contacts and Identification of Traditional Cultural Properties for the South Central Communications Antimony to Koosharem Project*. Submitted to the Utah Department of Transportation (UDOT) on behalf of the Federal Highway Administration (FHWA) and South Central Communications. Shannon, Donald

2001 *The 2003 Kern River Expansion Project: Previous Ethnographic Investigations Report*. Cultural Resources Report No. 01-147. SWCA, Inc. Environmental Consultants, Salt Lake City, Utah. Shannon, Donald and Molly Rhodenbaugh.

2001 *History and Prehistory Along the San Pedro, Los Angeles, and Salt Lake Railroad: Results of Archeological Investigations for the Level (3) Communications Fiber Optic Line from Salt Lake City to the Utah/Nevada Border. Volume III: Discoveries and Test Excavations*. Prepared for Utah Bureau of Land Management. Report on file at State Historic Preservation

Office, Salt Lake City. (Junior author with; Seddon, Matthew T., Sonia Hutmacher, Ken Lawrence, Rachel Gruis, Kryslin Taite, Scott B. Edmisten).

2001 *History and Prehistory Along the San Pedro, Los Angeles, and Salt Lake Railroad: Results of Archeological Investigations for the Level (3) Communications Fiber Optic Line from Salt Lake City to the Utah/Nevada Border. Volume IV: Excavations at Tintic Junction and Jericho Section Station*. Prepared for Utah Bureau of Land Management. Report on file at State Historic Preservation Office, Salt Lake City (Junior author with; Seddon, Matthew T., Sonia Hutmacher, Ken Lawrence, Rachel Gruis, Kryslin Taite, Scott B. Edmisten).

Reports Produced for Historical Research Associates, Inc.

2002 *Native American Ethnographic and archeological overviews for 14 Western States; BLM Noxious Vegetation Treatment Management Plan Draft Environmental Impact Statement*. Prepared for ENSR Consulting and Engineering. Shannon, Donald and Gail S. Thompson.

2002 *Wanapum Ethnography and Ethnohistory*. Prepared for Yakima Test Center, Department of Defense. Shannon, Donald, with James A. Carter, Trent K. DeBoer, Meredith Wilson.

2002 *Cultural Resources and Native American Traditional Cultural Properties impacted by the BPA Kangley-Echo Lake Power Line Transmission Project*. Submitted to the Bonneville Power Administration. Shannon, Donald, and Gail S. Thompson

2002 *Lake Sammamish River Pedestrian Bridge Cultural Resource Assessment*. Submitted to HNTB Engineering Services, Redmond WA. Shannon, Donald.

Reports Produced for the Confederated Tribes of the Colville Reservation

2003 *Identification of Traditional Cultural Properties for Bonneville Power Administration Schultz-Hanford Transmission Line Project*. Document prepared for the Bonneville Power Administration.

2003 (George, Tillie, with Guy Moura and Donald Shannon) *Grand Coulee Dam to the International Boundary; Identification of Place Names in the Franklin D. Roosevelt Lake Area*. Document prepared for the Bonneville Power Administration.

2003 *Chief Joseph Dam and Rufus Woods Lake Cultural Resources Project: Identification of Traditional Cultural Properties from Grand Coulee Dam to Chief Joseph Dam*. Document submitted to the Bonneville Power Administration.

2003 (Morgan, Vera E and Guy F. Moura, with contribution by Donald Shannon) *"Banks Lake and Coulee Ponds Drawdown, Identification of Traditional Cultural Properties"* in *A Class III Historic Resources Inventory of Pond A (Coulee City Ponds) of the Dry Falls Dam-Banks Lake Project, Grant County, Washington*. Prepared for the Bureau of Reclamation.

2003 *Identification of Traditional Cultural Properties for Paschal Sherman Indian School Construction*. Prepared for Colville Confederated Tribes, Draft Environmental Impact Statement.

2003 *Annual Report on the Chief Joseph Dam and Rufus Woods Reservoir contract DACW 67-00 D-1002 and 2003 update*. Document prepared for the United States Army Corps of Engineers, Seattle District.

2004 (With Consuelo Johnston) *Palus Lineal Descent and Cultural Affiliation Study Associated with Palus Cemetery*. Document submitted to the United States Army Corps of Engineers, Walla Walla District.

2004 *Grand Coulee Dam Project: Access database of 408 place names in original Indian language, English translation, and place name information*. Document prepared for the Bonneville Power Administration.

2004 *Grand Coulee Dam to the International Boundary; Identification of Place Names in the Franklin D. Roosevelt Lake Area*. Document prepared for the Bonneville Power Administration.

2005 *Draft 2005 Annual Report Chief Joseph Dam and Rufus Woods Lake Traditional Cultural Property Research*. Document prepared for the United States Army Corps of Engineers, Seattle District.

2005 *Traditional Cultural Property (TCP) Component of the Chief Joseph Dam Hatchery Project.* Document prepared for the Bonneville Power Administration.

2005 *Four Bears Project Traditional Cultural Property Component*. Document prepared for Colville Confederated Tribes Forestry Program.

2005 *North Omak Lake Road Project TCP Research*. Document prepared for Colville Confederated Tribes.

2005 (With Michael Finley and Amelia Marchand) *Poker among the Colville Confederated Tribes: results of History/Archaeology Program Preliminary Research*. Document prepared for Colville Business Council.

2005 *Newly identified Traditional Cultural Places for the Grand Coulee Dam Project, FY'05*. Document submitted to the Bonneville Power Administration.

2005 (With Guy F. Moura and contributions by Adam Fish) *Traditional Cultural Property Themes and Subtype Based on Palus Territory (Hart 2003)*. Document prepared for the United States Army Corps of Engineers, Walla Walla District.

2005 (With Guy F. Moura) *Wild Horse Wind Power Traditional Cultural Property Study: Inventory Technical Report Presenting Summary of Overview Data and Documentation*. Document submitted to Zilkha Renewable Energy, in support of application to the State of Washington Energy Facility Site Evaluation Council.

2006 *Chief Joseph Dam as a Fishery: Traditional Cultural Property Scoping*. Document prepared for the United States Army Corps of Engineers, Seattle District.

2006 (With Guy Moura) *Fiscal Year 2006 Grand Coulee Dam Project Annual Letter Report for Contract # 00024429*. Document prepared for the Bonneville Power Administration.

2007 *Letter of preliminary results, High Level Class I Traditional Cultural Property Inventory for Potholes Supplemental Feed Route and Odessa Subarea Special Study, Columbia Basin Project, Washington*. Document prepared for United States Bureau of Reclamation, Yakima.

2007 (With Guy F. Moura) *Chief Joseph Dam/Rufus Woods Lake Traditional Cultural Property Final Technical Report*. Document prepared for the United States Army Corps of Engineers, Seattle District.

2007 *Salish place names and traditional use areas and CCT Fish and Wildlife Mitigation lands*. Document prepared for Fish and Wildlife Program, Colville Confederated Tribes.

2008 *Final Traditional Cultural Property Study of the Bridgeport Unit Portion of the Sagebrush Flats Wildlife Area*. Document prepared for the Bonneville Power Administration.

2009 (With Guy F. Moura and Lawrence Harry Kulpschinikin) *Draft Chief Joseph Dam Tribal Fishery Site: Traditional Cultural Property Investigations. Okanogan County, State of Washington.* the United States Army Corps of Engineers, Seattle District.

2009 *Final Traditional Cultural Property Study of 45GR664*. Intergovernmental Contract No. 38664. Produced for the Bonneville Power Administration.

2010 Mid Columbia River Coho Reintroduction Project. Intergovernmental Contract No. 38664. Produced for the Bonneville Power Administration. (With Guy F. Moura, and contributions from Lawrence Harry Kulpschinikin)

2010 (With Guy F. Moura) *Palus Village Traditional Significance Statement in Support of Determination of Eligibility*. Document prepared for United States Army Corps of Engineers, Walla Walla District.

2010 (With Guy F. Moura and Lawrence Harry Kulpschinikin) *Waste Management of Washington East Wenatchee Traditional Cultural Property Study*. Document prepared for Waste Management of Washington.

2011 (With Guy F. Moura) *The Salmon Fishery at the Chief Joseph Dam as a Traditional Cultural Property*. National Register of Historic Places Registration Determination of Eligibility Form 10-900. Submitted to the United States Army Corps, Seattle District.

2011 (With Matilda George and Guy F. Moura) *Native American Place Names in the Traditional Homelands of the Nespelem, Sanpoil, Colville, and Lakes, North-central Washington*. Document for public release, produced for the Colville Confederated Tribes.

2011 *Traditional Cultural Properties in the Saddle Mountains Bureau of Land Management Holdings*. Produced for the Bureau of Land Management, Spokane Office.

2011 (With Crystal Harris-Smith) *Traditional Cultural Properties in the Okanogan Highlands Bureau of Land Management Holdings*. Produced for the Bureau of Land Management, Spokane Office.

2011 (with contributions by Lawrence Harry Kulpschinikin). *Douglas Rapids Transmission Line Traditional Cultural Property Study*. Prepared for Douglas County Public Utility District. Prepared by Confederated Tribes of the Colville Reservation, History/Archaeology Program.

Reports Produced for Willamette Cultural Resources Associates, Ltd.

2011 (With Paul S. Solimano, Matt Goodwin, and Kanani Paraso). *Cultural Resources Survey for the Proposed Alder Creek Restoration Project, Multnomah County, Oregon*. Prepared for Wildlands, Portland, Oregon.

2012 (With Paul S. Solimano, Andrew Pflandler, B.A., and David V. Ellis, M.P.A.) *Archaeological Survey of the Swauk Wind Project Kittitas County, Washington*. Prepared for Swauk Wind, LLC. Seattle, Washington.

2012 (With Matt Goodwin, B.S., Kanani Paraso M.A., R.P.A, and David V. Ellis, M.P.A.) Archaeological Survey and Above Ground Resources Assessment for the Proposed City of Dundee Fire Station Yamhill County, Oregon.

2012 (With Todd Ogle) Cultural Resources Survey of the North Creek In-Stream and Riparian Enhancement Project. Clackamas County, Oregon. Prepared for the Clackamas County Soil and Water Conservation District, Oregon City, Oregon.

2012 (With Paul S. Solimano, Daniel Gilmour, and David Ellis) *Approach and Methods for Updating the Lower Snake River, Tri-Cities and Palouse Canyon Archaeological Districts* (Draft Report). Prepared for the United States Army Corps of Engineers, Walla Walla District, Washington.

2012 (With Paul S. Solimano, Kenneth M. Ames, and Charles M. Hodges) *Historic Context for Precontact Cultural Resources in Parts of Klickitat County, Washington*. Prepared for Washington Department of Archaeology and Historic Preservation.

2013 *List of Culturally Sensitive Sites in Cascade Crossing Project Corridor*. Prepared for URS Corporation, for Portland General Electric.

2013 (With Matt Goodwin and Todd Ogle) *Cultural Resources Survey of the Corral Creek Obstruction Removal Project.* Submitted to Clackamas County Soil and Water Conservation District.

2013	(With David V. Ellis, M.P.A.) *Cultural Resources Survey for the Proposed Nichols Landing, Hood River, Oregon*. Final Report Prepared for Naito Development, Portland, Oregon.
2013	(With Todd Ogle, Paul Solimano, and Danny Gilmour) *Archaeological Inventory Survey for NWW Project Lands, Dworshak Reservoir, Idaho*. Document prepared for the Walla Walla Army Corps of Engineers.
2013	(With Paul Solimano and Danny Gilmour) *Rock Image Cultural Context*. Document prepared for the Walla Walla Army Corps of Engineers.
2013	(With David V. Ellis, M.P.A.) *Columbia River Treaty*. Provided technical assistance to the Bonneville Power Administration and assisted in Tribal coordination. STT Working Group, Draft Work Plan Framework.
2013	(With Paul Solimano and Danny Gilmour) *John Day Historic Properties Management Plan*. Document prepared for the Walla Walla Army Corps of Engineers.
2013	*Cascade Crossing Final Ethnographic Report, Including Summarized Tribal Oral History Reports*. Prepared for URS Corporation, for Portland General Electric.
2013	(With Dave V. Ellis, M.P.A., and Matt Goodwin, B.S.) *Cultural Resources Survey of the Newport Airport Runway Rehabilitation Project and Apron Expansion Area, Lincoln County, Oregon*. Prepared for Precision Approach Engineering, Inc. and the City of Newport, Oregon.
2013	(With Todd Ogle, M.A., R.P.A. and Renae Campbell B.A.) *Cultural Resources Survey of the Willamette Narrows State Wildlife Grant Restoration Project, Clackamas County, Oregon*. Prepared for Metro Portland, Oregon.
2013	(With Paul Solimano) National Register of Historic Places Registration Form of Four Sites Near Memaloose Island (Lyle Site/45-KL-110).
2014	(With Daniel M. Gilmour, M.A., R.P.A., Todd B. Ogle, M.A., R.P.A., Andy Pfandler, B.A., Michael A. Daniels, B.S., and David V. Ellis, M.P.A.) *Cultural Resources Survey Report and Evaluative Site Testing Report for Precontact Site 35-LIN-791 for Metropolitan Land Group's Columbus Development Project, City of Albany, Linn County, Oregon*. Prepared for Metropolitan Land Group LLC.

Peer Reviewed Publications

1998	Hewlett, Barry S., Michael Lamb, Donald Shannon, Birgit Leyendecker and Axel Scholmerich. *Culture and Early Infancy Among Central African Foragers and Farmers.* Developmental Psychology; 1998, Vol. 34, No.4, 653-661.
2002	*The Impact of Incarceration on Chickasaw Fathers.* In Southern Indians and Anthropologists: Culture, Politics, and Identity. Lisa J. Lefler and Frederic W. Gleach, eds. Athens: University of Georgia Press. Proceedings of the Southern Anthropological Society Meetings, University of Georgia Press.

Conference Presentations

1996	*The impact of logging on indigenous groups in northern Congo.* Paper presented at the Northwest Anthropological Meetings, Moscow, Idaho.
1996	*Parental investment among Aka foragers and Ngandu farmers*. With Barry Hewlett, Axel Scholmerich, and Michael Lamb. Paper presented at the annual meetings of the American Anthropological Association, San Francisco, California
1997	*Breastfeeding and inter-birth interval among the Aka: An evolutionary perspective*. Paper presented at the Northwest Anthropological Meetings. Ellensburg, Washington.

2000 *The impact of incarceration on father-child relations among the Chickasaw*. Paper presented at the Southern Anthropological Society Meetings, Mobile, Alabama.

2001 *Father-Child Relations among the Chickasaw, a cross-cultural perspective*. Presented at 1st Annual Masculinity Conference, Portland Community College, Sylvania campus, Portland Oregon.

2001 *Building the Aka School, a community driven development project*. Presented to the Three Rivers Anthropological Society and the W.S.U.-Vancouver Anthropology Club, Washington State University, Vancouver Washington.

2004 *Traditional Cultural Property Compliance in the Confederated Tribes of the Colville Reservation History/Archaeology Program as Applied Anthropology*. Presented at Honoring the Heritage of the Plateau Peoples: Past, Present and Future. Conference held at Washington State University, Pullman.

2004 *Traditional Cultural Properties: How Come?* Workshop for Tribal Historic Preservation Officers and Washington State Department of Transportation staff on Traditional Cultural Property compliance. Doubletree Hotel, Spokane, Washington.

2005 *Traditional Cultural Property Compliance as Applied Anthropology: Two Case Studies from the Kittitas Valley*. Paper presented at the Northwest Anthropological Meetings, Spokane, Washington.

2007 *Traditional Cultural Properties in Section 106 compliance*. Presentation to Colville Tribal staff, city of Oroville, Okanogan County Public Utility District (PUD). Nespelem, WA.

2007 *The Chief Joseph Dam as a Fishery; Traditional Cultural Property Research*. Paper presented at the Northwest Anthropological Meetings, Pullman, Washington.

2007 *Traditional Cultural Properties research at the Colville Confederated Tribes*. Paper presented at the Northwest Anthropological Meetings, Pullman, Washington.

2007 *Introduction to identification of culturally modified lithic materials*. Presentation given to field staff of the Washington State Department of Natural Resources, Republic, Washington.

2009 *Traditional Cultural Property Research at the Colville Confederated Tribes*. Given to Wanapum Heritage Days. Wanapum Village, Washington.

2009 *Traditional Cultural Property Research at the Colville Confederated Tribes*. Washington State Department of Transportation Cultural Resources Conference. Red Lion Inn, Wenatchee WA.

2010 *Documenting cultural continuity of the Colville Confederated Tribes through compliance based research*. Northwest Anthropological Conference, Ellensburg, Washington.

2011 *Salish place names and cultural use areas on the eastern slopes of the Cascades compiled through compliance research*. Northwest Anthropological Conference, Moscow, Idaho.

2012 *Mining archival texts for ethnographic data relevant to a Section 106 undertaking: a primer on ethnographic work while doing background research*. Northwest Anthropological Conference, Wild Horse Casino, Umatilla Indian Reservation.

2013 *Don't Believe Everything you read about Northwest Tribes: The need for ethnographic research in the northwest*. Northwest Anthropological Conference, Portland, Oregon.

2013 *Dealing with Traditional Cultural Properties and Historic Properties of Cultural and Religious Significance to Indian Tribes: How to conduct ethnographic research in a compliance context*. Cultural Resource Protection Summit. Squaxin Island, Washington.

TransCanada Hydro Northeast Inc.
Aquatics Working Group Consultation Meeting

May 23, 2014
White River Junction, VT

Attendees – see table attached. Presentations are posted to TransCanada's (TC) secure website for viewing by the working group (ILP Step I – Initial Study Reports, General category).

Study 7 – Aquatic Habitat Mapping: Study results/data were discussed and CDs of bathymetry and habitat data were provided to meeting attendees.

Study 9 – Instream Flow Study site and transect selection:
The site/transect selection process and proposed transects were summarized. It was noted that the Site Selection Report did not have the mesohabitat maps with transects overlaid as shown in the presentation (the presentation maps are available on the secure website). These maps will be included in the revised report. By design, 1-D transects can be calibrated separately or may be tied to a standard benchmark for application of a step-backwater model (WSP). There was general consensus on, and requests for TC to revisit the selection criteria, where the sampling effort would focus on –habitat types where a species response is expected, rather than based on relative proportions of all available habitat types. For example, deep pools may have less of a species response than other habitat types and less sampling is needed in those locations even though pools make up a large percent of the overall study area habitat. It was suggested that the number of pool transects be reduced. There was agreement on re-allocation of transects rather than adding numerous additional transects.

- Task 1 - TC will re-visit transect selection and re-allocate sampling effort by habitat type, where applicable.
- Task 2 - TC will re-visit transect selection in places where habitat type is the same but substrate is different and seek to include that diversity in transect selection. It was noted that the phase 1 study results from Study 24 – Dwarf Wedgemussel - can also contribute mesohabitat and substrate data from scuba diving that was conducted and will be looked at as well.

VDFWD would like to see the Bellows Falls bypassed reach in relatively dry conditions and at higher flows to see what habitat and substrate look like and determine what type of study should be done there (TC was not proposing to study the bypassed reach given the lack of habitat for target species). TC will provide an opportunity to view photos and video of the bypassed reach taken in support of the whitewater boating study. VDFWD said that this may be sufficient for their purposes without the need to schedule a site visit for that purpose. Alternatively, demonstration flows may be able to be released and stakeholders could weigh in regarding the habitat suitability of the different flows. TC noted that none of the target species need the type of habitat found at Sumner Falls (bedrock cascades), and there is nothing really to model there. However, several stakeholders felt that a transect was very worthwhile there due to its unique features and characteristics. A stakeholder noted that for the FirstLight instream flow studies at the Turner's Falls bypassed reach, consideration was being given to different types of bedrock (some types offered more cover than others) and a similar approach could be taken at Sumner Falls and perhaps the Bellows Falls bypassed reach. A stakeholder raised the question - what is the definition of "bedrock" particularly as applied to the Bellows Falls bypassed reach.

- Task 3 – TC will provide an opportunity to view photos and video of the bypassed reach taken in support of the whitewater boating study.
- Task 4 – TC will provide potential dates for a site visit to the Sumner and Bellows Falls (dates will be after July 4th). The site visits may not be necessary after photos and video are reviewed.
- Task 5 – TC will re-evaluate adding a transect to the Sumner Falls reach.

- Attendees suggested that consultation on species is still needed (however, the target species list was uncontested during Study Plan consultation meetings and no Revised Study Plan comments were filed relative to the list. Most HSC curves will be the same as FirstLight's curves (pending final agreement between FirstLight and their stakeholders). Only a few target species, smallmouth bass and some mussels are unique to the TC projects. Proposed suitability curves for smallmouth bass will be sent out to the working group for comment. Pending an agreement on the Study 24, Phase 2 Study Plan, the intent is to develop HSC for mussel species in the study area. In the event site-specific HSC cannot be developed, TC will use curves developed for the FirstLight study (if available) and/or explore alternative HSC.

- Task 6 – Stakeholders to provide TC with a list of requested additional species for consideration and further consultation.
- Task 7 – TC obtain HSCs from FirstLight when finalized.

It was noted that Vernon had been mapped at higher flows and higher elevation conditions relative to the Turners Falls impoundment than optimal, and TC needs to look more closely under lower flow and elevation conditions. FirstLight's bathymetry data below Vernon could be used and HEC-RAS transect and water level data will be shared by them.

- Task 7 - TC will re-map the reach below Vernon during low flow and low elevation conditions and may redistribute transects based on revised mapping.

Study 13 – Tributary and Backwater Fish Access and Habitats Study site selection:
The site selection process and proposed study locations were summarized. The selection process was randomized since there are so many tributaries and backwaters (139 total), and that water level fluctuation in those areas relative to the mainstem water level fluctuations was

the main criterion used. This approach differed from the study plan and the working group questioned the site selection methodology that did not use the study plan's 1-foot or less criterion. TC indicated that based on data from Study 7, the relative water level fluctuation could serve as an appropriate selection criterion, but the group felt that the 1-foot criterion should still be used.

It was agreed that the data from Study 7 will be re-evaluated using tributary bed profiles (bed elevation and width from bank to bank) and 1-foot contour data in impoundment tributaries. The 10 small tributaries in riverine sections that were not evaluated in Study 7 will be evaluated in the field. Data tables from Study 7 will be compiled and sites will be re-selected based on their depth at low stage and on level of water fluctuation. The results will be shared with the working group and a conference call will be scheduled within the next few weeks.

- Task 8 – TC will collect tributary bed profiles (bed elevation and width from bank to bank) on the remaining 10 tributaries in riverine sections, and re-select sampling sites based on tributary bed profiles in riverine reaches and 1-foot contour data in impoundment tributaries.

Stakeholders noted that the study plan included planned field work from early spring 2014 through early spring 2015. TC mentioned that was based on the timing of other spawning studies originally planned for 2014, but now delayed until 2015. The study plan stated that water level recorders would be installed to capture early spring flows; however, some water level recorders were over-wintered so that data is already available. TC also noted that early spring runoff conditions and high flows are not project-based operations, so it should not be a problem to exclude the spring field effort. This stakeholder concern was related to spring spawners, specifically white sucker. TC indicated that this Study 13 is not related to spawning, but rather to physical access only. Several other studies in 2015 will be focused on spawning and additional water level recorders will be installed for those studies, as well as some loggers in 2014 for erosion sites, HEC-RAS modeling and the like.

Study 8 – Channel Morphology and Benthic Habitats Study:
The site selection process and results were summarized and both recommended and contingency sites were shown on Google Earth. The study expects two field visits under low flow conditions. It was suggested that, as a contingency, a site further up the West River may be more suitable than at the mouth. Otherwise, there were no comments and the recommended sites were approved, with the allowance for using contingency sites as needed if variables including site access, safety considerations, site characteristics and/or changing site conditions, are determined to preclude use of any of the recommended sites.

Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study:
The proposed Phase 2 study plan was summarized and discussed. Due to the lack or low density of Dwarf Wedgemussel (DWM) found, TC proposed including co-occurring species in Phase 2 mussel sampling (along with DWM) since all of the mussel species generally utilize the same types of habitats in the Connecticut River. The phase 2 plan further proposed:

- Combined quantitative and qualitative sampling at 20 transects at 6 locations where DWM had been found before.
- Quantitative sampling (systematic study design with quadrats and double sampling) in one reach (Cornish Bridge to Chase Island) to provide a quantitative dataset that will help in the development of habitat suitability criteria (HSC) for mussels. The site is also a planned 2D modeling site for Study 9.
- HSC will be developed for dwarf wedgemussels and co-occurring species using field data (2011 to 2014), other published information and case studies, and expert review. These HSC will be used in concert with TransCanada's other studies (especially Study 4 - Hydraulic Modeling, Study 5 - Operations Modeling, Study 7 - Aquatic Habitat Mapping, and Study 9 - Instream Flow Study) to assess the potential effects of flow regime/water level fluctuations on mussels and mussel habitat.
- In situ video monitoring of dwarf wedgemussels (Objective 4 of the original plan) is not now proposed because of the absence (or extremely low density) of DWM in some areas such as the free-flowing reach below Wilder, and the fact that mussels occur in 6-25 foot water depths in impoundments where they experience little or no change in habitat parameters during daily flow fluctuations.

A stakeholder suggested that we need to try to understand why mussels were found in certain locations and not in others. Stakeholders also reported that they didn't have much time to review the Phase 1 report and the Phase 2 Study Plan, and that other colleagues will need to review both. It was agreed that there would be a conference call in 2-3 weeks once the plan has been reviewed more closely.

- Task 9 – Stakeholders provide comments on proposed Phase 2 Study Plan.
- Task 10 – TC set up working group conference call for week of June 9 or 16.

Meeting Attendees:

Name	**Affiliation**
Owen David	NHDES
Jim McClammer	CRJC
Katie Kennedy	TNC
Eric Davis	VTDEC
Bob Nasdor	American Whitewater
Tom Christopher	NE FLOW
Rod Wentworth	VTFWD
Lael Will	VTFWD
Gabe Gries	NHFGD
David Deen	CRWC
John Warner	USFWS
Melissa Grader (by phone)	USFWS
John Howard	FirstLight
Mark Wamser	Gomez & Sullivan

Name	Affiliation
John Ragonese	TC
Jen Griffin	TC
Ethan Nedeau	Biodrawversity
Doug Hjorth	Louis Berger Group
Robin MacEwan	Stantec
Maryalice Fischer	Normandeau
Drew Trested	Normandeau
Rick Simmons	Normandeau
Steve Eggers (by phone)	Normandeau

TransCanada Hydro Northeast Inc.
Whitewater Boating Working Group Consultation Meeting
May 27, 2014 – N. Walpole, NH
and May 28, 2014 – Sumner Falls and Bellows Falls

May 27th meeting (attendees – see list below)
The purpose of the meeting was to discuss ILP Study 31 – Whitewater Boating Flow Assessment – Bellows Falls and Sumner Falls and logistics related to implementing the study with participation by the boating community (referred to collectively as the boaters).

The revised study plan (as modified and approved by FERC in the September 13, 2013 study plan determination) was discussed, specifically, the boater survey which had been completed for Sumner Falls and included in the plan, but not yet customized for Bellows Falls. Norm Sims requested time to review the questionnaire for Sumner Falls and agreed to provide input on that within 2 weeks. A survey form for Bellows Falls was not included with Study Plan 31, largely because many unanswered questions related to boating the bypassed reach, , but it did include a commitment to develop one in consultation with the boating community. The boaters recommended reviewing the FirstLight questionnaire for the Turners Falls bypassed reach boating study and combine elements from both that survey and the Sumner Falls survey into a draft Bellows Falls survey.

Photos and short videos taken at different flow levels at both Sumner Falls and Bellows Falls were reviewed, as were the different skill levels, boat types and boating community representatives needed for study participation. It was noted that Sumner Falls would be more attractive to "park and play" boaters since the area has limited boating features, while Bellows Falls appeared to be more attractive to "river runners" with a higher skill level, although the relatively short length of the bypassed reach was noted. Optimal conditions at Sumner Falls could vary due to the different waves that are generated within the rapids at certain flows that would provide "good" conditions for different skill levels. It was noted that flows at Sumner Falls are reflected by present river conditions including both Wilder operations and inflow from tributaries such as the White River and Ottaquechee rivers which TransCanada (TC) has no control.

Boating community representatives at the meeting agreed to find qualified boaters for participation, based on different skill levels, boat types and interest. For Bellows Falls, it was indicated that class III or better boaters would be needed and someone with boating safety background would be an important participant due to the potential safety concerns there.

Potential flow levels and schedules for flow demonstrations were discussed. TC indicated that it could be very difficult to provide specific flows at specific times, depending both on water availability, the need to maintain impoundment elevations within certain bounds, and on the needs of the regional electricity market and TC's planned generation protocols. John Ragonese will consult with TC Operations and Power Marketing on the ability to schedule specific flows at specific times.

For Sumner Falls a 2 -day event would be needed. Flows would start around 3,500 cfs and increase to 11,000 cfs (station generating capacity) with 2 flows demonstrated each day. It was noted that it takes 2 hours for flows from Wilder to reach Sumner Falls based on the Jesup's Milk Vetch study conducted in 2012.

For Bellows Falls, flow ranges were discussed based on review of the photographs, but boaters wanted to see live flows before committing to specifics. It was suggested that the demonstrations consider starting with the higher flows and decrease. TC noted that flows from Wilder take 8 hours to reach Bellows Falls. The boating representatives at the meeting agreed to provide dates that would not work due to other boating events, FirstLight's scheduled flow demonstrations, and personal commitments of likely participants. It was noted that if Sumner Falls demonstration occurred in the fall, Dartmouth student boaters would be more available than in summer. Boating representatives also requested that TC provide lodging, lunches, and shuttle services to participants during the demonstration flow events.

Adam Beeco from FERC reminded the group that modifications to the boater questionnaire constitute a material modification to the study plan and should be identified as such in the study report, with agreement reached on it by the working group. Adam also mentioned that the study plan included a provision for a reconnaissance run of a small boater group at a single flow at Bellows Falls. If that plan changes, it is also a variance from the study plan to be documented. Any variances should be filed with comments from the study group to address FERC's concerns about reasons and outcomes related to the variance from the study plan.

After the meeting, the group viewed the Bellows Falls bypassed reach from near the dam and from the Vilas Bridge just below the fish barrier dam at flows of about 2,100 cfs. Access locations were briefly scouted and there is no easy route to the river due to steepness of the bank, the lack of TC-owned land, and the presence of the railroad.

May 27, 2014 Meeting Attendees:

Name	Affiliation
Bob Nasdor	American Whitewater
Tom Christopher	NE FLOW
Norman Sims	AMC
Kevin Mendick	NPS
Adam Beeco (by phone)	FERC
Bud Newell	TRC/FirstLight
Sarah Verville (by phone)	TRC/FirstLight
John Ragonese	TC
Jen Griffin	TC
Matthew Cole	TC
Jot Splenda	The Louis Berger Group, Inc.
Maryalice Fischer	Normandeau

May 28th field reconnaissance (attendees – see list below)
Meeting participants met at Sumner Falls at 9 am to view and discuss study mechanics, logistics, specific waves at the falls of potential importance, potential boaters and boat types, potential dates of study, safety concerns, Wilder operations, gage info, TC's flow phone, hydrology travel times, and general uses associated with this popular feature. During the period from 9 am thru 11 am, we observed flows estimated to rise from about 12,150 cfs up to about 14,700 cfs based on the West Lebanon gage, which includes Wilder's discharge as well as about 1,730 cfs from the White River and an additional 900 cfs from the Ottaquechee rivers.. A 2-hour water travel time prior to the study period and between different flow levels needs to be incorporated ensure stable target flows at Sumner Falls throughout the study days. Consensus was reached that Sumner Falls should be a 2-day study with 4 total flows, tentatively scheduled for the weekend of June 28 & 29 (to be confirmed by John Ragonese). The boaters committed to identifying 12 boaters and fulfilling the range of boat types discussed for this location. Jot Splenda would be responsible for identifying thru-boating open canoe type users to understand how they are affected by the falls and offer a select number of individuals an opportunity to participate in the study.

The group moved to discuss Bellows Falls at TC's North Walpole office over lunch while arrangements were made to provide various demonstration flows in the bypassed reach that afternoon. Norman Sims discussed his initial comments on the language in the Sumner Falls questionnaire. He would continue to review the survey and respond with final comments within 2 weeks. Boater interview forms and liability/waiver forms were discussed; John Ragonese committed to following up with these. Bob Nasdor recommended any boaters going over the fish dam should be in creek boats for their own safety but that they run the reach with consideration for a broader sense of boaters and types, not just the type of boat they were in that day.

The group walked to the bypassed reach and observed releases in the following order: 1,100, 4,500, 3,500, 2,500, 7,000 cfs. John R., Jot S., and for the last three flows Bob N. observed the upper bypassed reach taking photo and videos. Matthew C., Tom C., and Norman S. observed flows from the upper railroad bridge at the dam and also from the closed Vilas Bridge, and recorded flows over the fish dam. The group reconvened very briefly at TC's office to share the separate observations and view each other's videos. The boaters were interested in boating over the fish dam at 7,000 cfs although they commented that it was still intimidating, not for every participant. The upper section looked fun with diversity in waves at different flows but was considered class II at the lowest flows and class III or IV at flows above 3,500 cfs. Observing this range of flows was very helpful to everyone. The group realizes the amount of work necessary to boat the bypassed reach (flow levels, safety, expert boaters, logistics, etc.) and is looking at the October time frame to conduct the study. The topic of whether to boat the higher flows first was revisited and it was thought best to start low and work to high flows and just portage the fish dam at the lower flows. The boaters would make recommendation on flow requests.

Action items are immediate for Sumner Falls and longer term for Bellows Falls:

1. John Ragonese will:
    a. Confirm late June dates for conducting the Sumner Falls study.
    b. Follow up with legal on waivers for boaters.
    c. Study exceedence curves to figure out how to sustain higher spills at Bellows Falls and provide data to Jot Splenda.
    d. Identify for Jot, TC staff to contact during Sumner Falls runs to get flows.
    e. Consider expense support and boat shuttles during demonstration flows and communicate to Bob Nasdor.
    f. Consult internally about ability to schedule specific flows at Bellows Falls bypassed reach in October.
2. Tom Christopher will email FirstLight's pre-run questionnaire to Jot for use in this study.
3. Bob Nasdor will be in charge of identifying boaters and boater types for Sumner Falls, including open boats and for Bellows Falls.
4. Norman Sims will finish review of Sumner Falls questionnaire by June 6th.
5. All boaters will:
    a. Prepare a Safety Plan that includes measures to assist throughout the study and rescues and provide a copy for review and comment to TC; and will approach Frank Mooney for his safety and river expertise for the Safety Plan.
    b. Identify a safety expert for the pre-run briefing at both studies.
    c. Identify flows to boat in Bellows Falls bypassed reach over a 2-day study.
    d. Provide dates that boaters are not available for the Bellows Falls October flow study.
6. Jot Splenda will:
    a. Follow up with Bob and Tom on boater lists (names, type of water craft) and on pre-run questionnaires.
    b. Interview and invite select thru-boaters to participate at Sumner Falls.
    c. Develop the Bellows Falls questionnaire for stakeholder review.
    d. Organize (with assistance from TC) all logistics related to Sumner Falls (timing, staffing, lunch, etc.).

May 28, 2014 Reconnaissance Attendees:

Name	**Affiliation**
Bob Nasdor	American Whitewater
Tom Christopher	NE FLOW
Norman Sims	AMC
Kevin Mendick	NPS
Bud Newell	TRC/FirstLight
John Ragonese	TC
Matthew Cole	TC
Jot Splenda	The Louis Berger Group, Inc.

June 30, 2014

Mr. Mark Ferguson
Vermont Department of Fish & Wildlife
1 National Life Drive, Davis 2
Montpelier, VT 05620-3702

Ms. Emily Preston
NH Fish & Game Department
11 Hazen Drive
Concord, NH 03302-0095

Ms. Susi von Oettingen
US Fish and Wildlife Service
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301

Re: Proposed Adjustments to TransCanada's Puritan and Cobblestone Tiger Beetle Study Plan #26

Dear Mr. Ferguson, Ms. Preston, and Ms. Von Oettingen:

Normandeau has begun the field work for tiger beetle surveys on Wilder, Bellows Falls and Vernon projects as part of TransCanada's relicensing effort. On June 23 and 24, the survey team visited multiple sites that have either historically supported cobblestone tiger beetles (*Cincindela marginipennis*) (CTB) or appeared to provide potential habitat based on the aquatic and terrestrial habitat mapping conducted under Study Plans #7 and #27. To date, we have identified 12 sites that appear most likely to support the CTB. Based on the field surveys and discussion with you, we are proposing several adjustments to the study plan.

1) The Study Plan describes sampling one time per month in mid-June, mid-July and early August. We propose to continue three sampling events but to condense the survey window to early July into mid-August. The NH and Vermont records for CTB all indicate observations between July 7 and August 28. Kristian Omland, who is a recognized expert in tiger beetles, including CTB, and is working with us on this project, concurs delaying the start of the survey period until the second week in July. We propose beginning the field surveys the week of July 7 and subsequently sampling every two weeks until mid-August.
2) The Study Plan describes sampling 30 minutes for adults and 30 minutes for larval burrows. We propose adjusting the sample approach to focus on adults because the CTB larvae and their burrows have not been scientifically described, and cannot be distinguished from other tiger beetles, including the common shore tiger beetle (*Cicindela repanda*), which appears

ubiquitous on the Connecticut River. The adjusted study plan would include a 30-minute survey at each site for adults and a qualitative estimate of the number of burrows,

3) The Study Plan describes collecting CTB larvae if more than 10 burrows are identified. Per requests from Vermont Department of Fish and Wildlife and New Hampshire Fish and Game Department, we propose to not collect larvae. Because they have not been scientifically described, larval collection would not aid positive identification of CTB and would unnecessarily deplete the population.
4) The Study Plan describes sampling for federally-Threatened Puritan tiger beetles (*Cicindela puritana*). The known historic sites were flooded with the construction of the Bellows Falls impoundment and no Puritans have been observed since 1932 despite multiple surveys since that date. The US Fish and Wildlife Service did not issue a collection permit for Puritans because of the low likelihood of our finding this species. We propose to concentrate our sampling efforts on the CTB because of the higher probability of locating this species.

Please let me know if you have any issues with these proposed adjustments. Thank you for your review and do not hesitate to contact either John Ragonese (TransCanada Relicensing Manager, 603) 225-5528, john_ragonese@transcanada.com) or me (603-637-1158, sallen@normandeau.com) with questions.

Sincerely,

Sarah Allen
Task Manager

cc: John Ragonese (TransCanada)

Jennifer Griffin (TransCanada)

Ken Hogan (FERC)

Maryalice Fisher (Normandeau)

TransCanada Hydro Northeast Inc.
Aquatics Working Group Consultation Conference Call

July 1, 2014

Attendees – see table below. Revised site selection reports are posted to TransCanada's (TC) secure website for viewing by the working group (ILP Step I – Initial Study Reports, Response to Comments).

Study 13 – Tributary and Backwater Fish Access and Habitats Study site selection:

The revised site selection process and report were summarized. There were a total of 192 tributaries and backwaters identified using enhanced National Hydrologic Dataset information. Some locations were split into a tributary and a backwater rather than combined which also increased the number of potential study sites. Sites were randomized and 36 were selected for study (refer to revised site selection report for details).

Normandeau noted that Table 4-2 had not been included and participants requested another table (now Table 4-5) showing stream order. Both tables were provided to participants (attachment 1 to this document) after the call and included in the "Updated Revised Site Selection Report" available on the secure website.

Participants generally agreed that the revised selection process and report were acceptable. Melissa Grader requested a couple more days to comment, and submitted questions via email to TC during that time frame. TC and Normandeau provided responses via email (attachment 2 to this document).

Study 9 – Instream Flow Study site and transect selection:

The revised site/transect selection process and report were summarized. Potential dates for working group field visits were discussed. A Doodle poll was created after the meeting to solicit preferred dates for those visits. Participants agreed that the revised site selection process and report were acceptable.

TC reported that bathymetry below Vernon dam would be obtained from FirstLight (FL), and that TC and FL were trying to coordinate low flows from Vernon with low Turners Falls impoundment levels for FL's whitewater boating demonstration on July 21. This occasion could provide a good opportunity to see the area at low flow/low elevation and allow for Study 9 work in that reach.

Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study:

Katie Kennedy had submitted technical comments and questions on the Phase 2 Study Plan via email which were discussed on the call. Those comments and questions formed the basis of discussion during the call and will be included in a responsiveness summary (attachment 3 to this document) prepared along with the revised study plan. Katie expressed interest in looking at unoccupied habitat, and Ethan Nedeau noted that the 2011 and 2013 studies included that (of 210 sites surveyed, only 31 had dwarf wedgemussel (DWM); thus, the majority of sites constituted unoccupied habitat). Ethan further noted that that there may not be any good way to define habitat suitability accurately since DWM are habitat generalists.

Katie requested and TC agreed that the study plan will be revised to include more detail as suggested in her email, including a description of the habitat variables collected in the prior studies and those to be collected in 2014. The working group also requested the raw habitat data collected.

Meeting Attendees:

Name	**Affiliation**
Owen David	NHDES
Gabe Gries	NHFGD
Eric Davis	VTDEC
Lael Will	VTFWD
Jeff Crocker	VTDEC
John Warner	USFWS
Melissa Grader	USFWS
Katie Kennedy	TNC
David Deen	CRWC
Ken Hogan	FERC
John Ragonese	TC
Jen Griffin	TC
Ethan Nedeau	Biodrawversity
Maryalice Fischer	Normandeau
Drew Trested	Normandeau
Rick Simmons	Normandeau
Steve Eggers	Normandeau
Jen Bryant	Normandeau

From: John Ragonese [mailto:john_ragonese@transcanada.com]
Sent: Friday, July 11, 2014 11:14 AM
To: BrwnJbb123@aol.com; dhnithpo@gmail.com; oldgraywolf@verizon.net; twomoons45@verizon.net
Cc: Frank.winchell@ferc.gov; kenneth.hogan@ferc.gov; Steve A. Olausen (SOlausen@PALINC.COM); don@willamettecra.com
Subject: TransCanada Cultural Resources Study 33: Meeting, Consultation and Participation
Importance: High

Dear Messrs. Brown, Harris, Graveline and Howard:

The Narragansett Indian Tribe and other representatives such as the Nolumbeka Project have tribal history and knowledge that would contribute to the collection of Traditional Ecological Knowledge. TransCanada has previously (see attached May 14 2014 letters delivered and accepted) and by this email re-states its interest in meeting and discussing participation with our hydro relicensing related Cultural Resource Study 33. It has been and is our desire to meet and discuss to what extent and how the Narragansett Tribe and others such as the Nolumbeka Project can and wish to contribute to this effort.

Our ethnographer, Don Shannon of Willamette Cultural Resources Associates, would like the opportunity to coordinate interviews with tribal representatives with the intent to obtain such information. Upon completion of the research and interviews, the ethnographer, tribal representatives, and potentially the interviewees, may determine it necessary to visit areas within the APEs. The purpose of the visits would be to 1) allow tribal representatives to show locations identified during the interviews, 2) document and map locations, 3) verify potential correlations with known archaeological resources, 4) identify any potential project-related effects, (5) determine potential correlations with known archaeological resources, and 6) enable the ethnographer to obtain any additional information on the potential TCPs. The specific methodology will be based upon discussions with the Narragansett Tribe and the Nolumbeka Project.

In addition to the TCP evaluation and documentation, TransCanada is conducting archaeological investigations. In our May 14 2014 letter we inquired whether or not there would be interest and if so, how Narragansett Tribe and the Nolumbeka Project might wish to participate in those investigations. At this time absent any response from you in almost 60 days, we must initiate those field investigations in order to meet our schedule and utilize the remaining available field season. We cannot wait any longer for your response. If you express an interest in accompanying the field crews, let us know immediately and we can provide you with the plan and schedule for their investigations.

We continue to desire and look forward to arranging a meeting with your office at your earliest convenience. At this meeting, we can introduce Mr. Shannon and address any questions or concerns you may have as we move forward with this project. We are looking for specific dates when you would be available to meet.

Sincerely,

John Ragonese
John L. Ragonese, FERC License Manager
TransCanada
4 Park Street; Concord NH 03301 CELL: 603.498.2851 (best option); 603.225.5528; FAX 603.225.3260
Email: john_ragonese@transcanada.com

From: Shana Murray [mailto:Shana.Murray@ferc.gov]
Sent: Thursday, August 14, 2014 4:56 PM
To: Jennifer Griffin; andrew.gast-bray@lebcity.com; bob@americanwhitewater.org; rstira@gdfsuezna.com; brett.battaglia@hdrinc.com; Brian Hanson; cfoss@nhaudubon.org; dclem@lymeproperties.com; ddeen@ctriver.org; Don Mason; dhjorth@louisberger.com; Doug Royer; Drew Trested; eric.davis@state.vt.us; ethan@biodrawversity.com; gabe.gries@wildlife.nh.gov; gregg.comstock@des.nh.gov; jeff.crocker@state.vt.us; McClammer@aol.com; john.howard@gdfsuezna.com; John Ragonese; john_warner@fws.gov; kkennedy@tnc.org; blackrivercleanup@yahoo.com; Kenneth Hogan; ken_sprankle@fws.gov; lael.will@state.vt.us; li@eurekasw.com; LRobinson@GEIConsultants.com; ldewald@entergy.com; mark.goodwin@lebcity.com; mwamser@gomezandsullivan.com; mary.mccann@hdrinc.com; Maryalice Fischer; matthew.carpenter@wildlife.nh.gov; mbutts@uvlsrpc.org; melissa_grader@fws.gov; michael.sears@hdrinc.com; michael.chelminski@stantec.com; Nicholas Ettema; nscormen@gmail.com; normansims1@gmail.com; owen.david@des.nh.gov; Rick Simmons; Robert.Mitchell@hdrinc.com; rod.wentworth@state.vt.us; sara.cavin@uvlt.org; Shawn Keniston; shelley.hadfield@lebcity.com; Stephen.Arnold@hdrinc.com; Steven Eggers; wendy@vermontjewel.com; tom.christopher@comcast.net; Thomas Payne; Chris Gurshin
Cc: Matt Buhyoff
Subject: RE: Scheduling Hydroacoustics Consultation Meeting

Good Afternoon Everyone,

We appreciate the invite to this Hydroacoustics consultation meeting. Unfortunately, because there is a pending rehearing request before us on this very study, we are unable to participate at this time according to the Commission's ex parte rules.

Shana

From: Jennifer Griffin <jennifer_griffin@transcanada.com>
Sent: Thursday, August 14, 2014 3:57 PM
To: andrew.gast-bray@lebcity.com; bob@americanwhitewater.org; rstira@gdfsuezna.com; brett.battaglia@hdrinc.com; bhanson@normandeau.com; cfoss@nhaudubon.org; dclem@lymeproperties.com; ddeen@ctriver.org; dmason@normandeau.com; dhjorth@louisberger.com; droyer@normandeau.com; dtrested@normandeau.com; eric.davis@state.vt.us; ethan@biodrawversity.com; gabe.gries@wildlife.nh.gov; gregg.comstock@des.nh.gov; jeff.crocker@state.vt.us; McClammer@aol.com; john.howard@gdfsuezna.com; John Ragonese; john_warner@fws.gov; kkennedy@tnc.org; blackrivercleanup@yahoo.com; Kenneth Hogan; ken_sprankle@fws.gov; lael.will@state.vt.us; li@eurekasw.com; LRobinson@GEIConsultants.com; ldewald@entergy.com; mark.goodwin@lebcity.com; mwamser@gomezandsullivan.com; mary.mccann@hdrinc.com; mfischer@normandeau.com; matthew.carpenter@wildlife.nh.gov; mbutts@uvlsrpc.org; melissa_grader@fws.gov; michael.sears@hdrinc.com; michael.chelminski@stantec.com; Nicholas Ettema; nscormen@gmail.com; normansims1@gmail.com; owen.david@des.nh.gov; rsimmons@normandeau.com; Robert.Mitchell@hdrinc.com; rod.wentworth@state.vt.us; sara.cavin@uvlt.org; Shawn Keniston; shelley.hadfield@lebcity.com; Stephen.Arnold@hdrinc.com; seggers@normandeau.com; wendy@vermontjewel.com; tom.christopher@comcast.net;

tpayne@normandeau.com; cgurshin@normandeau.com
Cc: Shana Murray; Matt Buhyoff
Subject: RE: Scheduling Hydroacoustics Consultation Meeting

Hi Everyone,

Thanks for hanging in there with us on this one. We've finalized the date for the Hydroacoustics meeting, Tuesday August 26th, 9:30 – 4:00 with a break from about 12:00 – 1:30 (USFWS staff have a conf. call), we'll provide pizza for lunch. The Fairfield Inn conference room is not available, but TransCanada's new office building has an available conference room. The new office (nick-named the ROC) is in Wilder, VT next to the old operations center and the Wilder Station, below is a Google Maps screen shot. The address is 255 Wilder Dam Road.

We have 2 WebEx call-in numbers for the meeting, one for the AM portion and one for the PM portion. The summarized information for calling in is here, the detailed information is below the Google Map.

Topic: Hydroacoustic Study Consultation AM portion
Date: Tuesday, August 26, 2014
Time: 9:30 am, Eastern Daylight Time (New York, GMT-04:00)
Meeting Number: 928 210 885
Meeting Password: Abcde12345

Topic: Hydroacoustic Study Consultation PM portion
Date: Tuesday, August 26, 2014
Time: 1:30 pm, Eastern Daylight Time (New York, GMT-04:00)
Meeting Number: 926 434 873
Meeting Password: Abcde12345

Please let me know if you have any questions.

Jen

TransCanada Relicensing
Recreation-Whitewater Boating Working Group Meeting
August 22, 2014 - Conference Call

Attendees:
Adam Beeco - FERC
Bob Nasdor, Norm Sims, Tom Christopher – Boaters
Jen Griffin, Matthew Cole, John Ragonese - TransCanada
Jot Splenda – Louis Berger Group
Maryalice Fischer - Normandeau

Call Notes:

- Brief summary of Study 31 – Whitewater Boating Flow Assessment – Sumner and Bellows Falls
    - Preliminary walk of the bypassed reach and discussions occurred in late May. The group viewed a series of releases between 2500 and 7500 cfs (not confirmed with data) and agreed at that time to wait on further discussions related to Bellows Falls until after the Sumners Falls portion of the study (completed), which is the purpose of this call.

- Survey tool - What types of issues are important to boaters in this section that would help build the questionnaire.
    - Jot will draft and circulate next week based on today's conversation. Will need responses back b/t Sept 5 – 15th.
    - Will refer to Sumner Falls and/or Turners Falls surveys.

- Discuss and set dates for flow study
    - For boaters - Oct 18-19, or Oct 25-26 would be best. Boaters requested at least 2 of their 3 representatives are available to boat and dates prior to these do not work.
    - For Adam - would like to combine with TC's study report meeting on Oct 3rd.
    - John - want to avoid the Columbus Day weekend. He will also talk to TC Operations and fall plans to pull down FMF reservoirs.

- Discuss flows levels and duration – what TC can do vs. what boaters would like
    - Eliminate single flow, go to multiple flows – okay with Adam
    - Start at lower flows and then increase progressively
    - Boaters have 6 flow suggestions: 2,500; 3,500; 4,500; 5,500; 7,500; 10,000.
    - Jot – concerned about the ability to score the lower flows with precision given how close together the flows are and the lack of precision from the gates.
    - Boaters do get tired with a lot of runs and play/exploration at each flow level. So 2 days might be needed for 5 or 6 flows. Could schedule 3 lower flows the first day, and the other 3 higher flows the second day. It takes about 30 minutes for flow to stabilize. Will need about 1 ½ hours at each flow and time for post run questionnaires.
    - Adam – the output of this study is to identify a minimum, optimum, and maximum.

  - John - 1,000 cfs amounts to a few inches of gate opening for the very large gates so the level of accuracy available may not reflect these exact flows. John R – don't know if TC can give 10,000 cfs since that flow can slightly exceed the rate of drawdown under license requirement if there is no inflow.
  - Studying low flows is of interest to both boaters and TC
  - Discussion around potential bias in boater evaluations if flows incrementally increase.
  - It is a good idea to have a stable, surveyed reference point correlated to a particular flow. It is okay for this study to have some roughness in the flow levels.
  - John – TC will come up with some kind of physical reference point, not sure yet how it will be done. Might be chain links in the gate, physical gage in the channel, etc.

- Who will be boating?
  - 8 – 12 boaters, selected by the boater representatives. Mostly kayaks, perhaps a canoe or two. Rafts aren't necessary for this test.
  - Boating representatives need to be personally familiar with boater abilities in this case due to safety issues, in order to have them included in the study.

- TC liability waiver
  - Yes, boaters will sign it.

- Boaters prepare their own safety plan
  - Boaters – want to have one or more safety boater down toward the bottom of the study reach.
  - Boaters will prepare info to share with study boaters. For Turners Falls, they notified all boaters of gear and equipment they need.
  - Need to figure out how to get an injured boater out of the reach. At Turners Falls, FirstLight alerted the fire/EMT department of the study and to make sure they have someone available. Tom – better to rely on boaters to extract any injured boaters. John – if boaters are going to extract, TC needs a plan for that process.

- Approach to the fish barrier dam
  - TC doesn't want boaters to go over the barrier dam and boaters are okay with stopping before the dam, for purposes of this study.
  - John – Reach above fish dam ~ 1,300 feet long, reach below fish dam includes backwater too, about 3-400 feet long. At 7,000 cfs, the lower section is backed up with water eliminating it as a desirable study section.
  - There are no big features immediately below the barrier dam, it is a big wave train.
  - Bob concerned that this study is not capturing potential boating features that may currently be inundated by the dam.

  - Adam – fish and habitat studies will also look at how the barrier dam is affecting the reach, in addition to the recreation perspective. FERC will look at how beneficial or detrimental it is in a balanced way.

- Access trail to put-in location/and take out at end
  - John – TC is arranging for the put-in location. Boaters will need to carry the boats back up the bypassed reach from above the barrier dam (it is walkable). There may be a place to take out at the rapids above the pool/barrier dam.

- Logistics
  - TC will have food, water available.
  - Lodging –Boaters feel hotel is required; JR committed to a per diem similar to the system used for study participants at Sumner Falls.
  - May need a cover or place to debrief at end, or use TC's office.
  - Sanitary facilities – use TC's office or boaters suggest a port-a-john.

- Wrap up/Follow up
  - Jot will write up notes from call.
  - Jot will revise pre-survey and send around. Boater reps will return it b/t Sept 5 – 15th.
  - Boater reps will prepare and send safety plan.
  - Boaters will recruit expert boaters; some of which boated at Sumner Falls.
  - John will send a couple of photos (can also use Google Earth) to try and locate safety people and potential safety take out (completed during the call).
  - John to check with TC Operations on dates and confirm if Oct 18-19, or Oct 25-26 is doable.

Instream Flow Study at Sumner Falls

Rod Wentworth, Vermont Fish and Wildlife Department

August 25, 2014

Sumner Falls consists of highly irregular ledge formations that cross the Connecticut River. This reach provides valuable fish habitat that is rare in the river. The reach includes steep riffles and rapids, as well as small drops over ledge that create chutes of flow into pools. This represents both a diversity of rare habitat types and a spatial diversity at the microhabitat scale that is attractive to many fishes. In addition, the reach provides reaeration of river water to help address the oxygen demands from upstream wastewater discharges. These habitat types attract fish due to the aeration, cover and habitat diversity. Fish can find feeding lanes (slow water areas next to fast water) and velocity shelters during high flow conditions.

The goal of this study is to determine an appropriate base flow regime that will protect and enhance the aquatic resources of the Sumner Falls reach. Since Sumner Falls is a steeper reach than most others, it may be more sensitive to low flow conditions. The objective of the study is to qualitatively assess the relationship between base flows and aquatic habitat. The effects of hydropeaking will be addressed by drawing inferences from the PHABSIM transect data and modeling from the other reaches.

The ledge formation and resulting hydraulics and complex currents cannot be effectively modeled. In addition, there are safety concerns with trying to take measurements at higher flows. Given the value of the reach for fish habitat, a demonstration flow assessment (DFA) is recommended (described in Annear et al. 2004[1], pages 185-187). This would consist of expert visual assessment of specific areas within the reach, along with some spot measurements of depth and possibly velocity. Observation sites would be accessed from shore or by canoeing across the large pool to mid-channel ledge islands.

The reach will be assessed at various flows for its habitat value to fish that utilize these flowing water environments, according to the following criteria:

- Water depths suitable for most adult fish (greater than 1 foot)
- Water depths suitable for juvenile fish (greater than 0.7 foot)
- Lack of quiescent conditions in areas that are not pools
- Pools areas not stagnant and maintain circulation
- Broken water surface and turbulence that provides cover
- Diversity of water velocities at microhabitat scale (fast water next to eddies, shear zones)
- Stranding potential
- Sufficient flow entering the large pool to provide some water movement
- Overall appearance of habitat conditions

The assessment team will be made up of biologists with expertise in fish and their habitat preferences. Habitat will be assessed by study participants using a habitat evaluation form for the criteria, ratings and notes. Each criterion will be rated on a scale of 1 to 5 for each flow at each observation site. Team members should also make note of other relevant habitat observations.

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[1] Annear, T., I. Chisholm, H. Beecher, A. Locke, and 12 other authors. 2004. Instream Flows for Riverine Resource Stewardship, revised edition. Instream Flow Council, Cheyenne, WY.

Four or more target assessment flows will be identified in advance. Since the time of travel for flow from Wilder dam to Sumner Falls is 2 hours, 2.5 hours is needed between observation flows. Therefore, the study will need to be done over two days. Target flows will be provided by controlled releases from Wilder dam, and the quantity will be measured with ACDP equipment slightly upstream or downstream of Sumner Falls at the time of each assessment flow release.

Observations will start with the lowest flow to enable the best possible observation of the channel structure and then the progression of habitat change as flow is increased. Specific observation locations will be identified in advance and then refined as needed at the time of the study. The recommended viewing locations and areas to be assessed (see also attached map) are

1. From right shore, above falls (where we discussed the study approach on 7/22); conditions in
    a. ledge area nearest the Vermont side,
    b. adjacent low flow channel, and
    c. channel on NH side of central ledge area.
2. From right shore, below falls where water enters the large pool.
3. From ledge island, run above kayak play wave.
4. From ledge island, chute closest to river center.
5. From ledge island, area below ledges, left of and just upstream of kayak play wave.
6. From ledge island, area downstream of kayak play wave, after water spills to the right over a small ledge ridge, including where it joins flow from center chute.

Photos and video of the conditions at each flow and observation location will be obtained.

Target observation flows will be determined from the PHABSIM study results for the reaches between Wilder dam and the upstream end of the Bellows Falls impoundment. Based on a review of those results, the resource agencies will recommend target observation flows.

Sumner Falls DFA Observation Sites

Vermont Agency of Natural Resources

vermont.gov

LEGEND

NOTES

Map created using ANR GIS mapping techology.

1: 2,472

July 24, 2014

126.0 0 63.00 126.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 206 Ft. 1cm = 25 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

TRANSCANADA HYDRO NORTHEAST INC.
HYDROACOUSTICS STUDY CONSULTATION MEETING
AUGUST 26, 2014 – WILDER, VT

Attendees:

USFWS:	John Warner, Ken Sprankle (by phone)
NHFGD:	Gabe Gries (by phone)
VTDEC:	Eric Davis (by phone)
NHDES:	Owen David
CRWC:	David Deen
TC:	John Ragonese
Normandeau:	Dr. Chris Gurshin, Rick Simmons, Maryalice Fischer

FERC staff were invited to participate in the meeting, as required in the FERC Study Plan Determination, but FERC staff declined via email on August 14, 2014, stating "…because there is a pending rehearing request before us on this very study, we are unable to participate at this time according to the Commission's ex parte rules". A copy of that correspondence is included at the end of this Attachment A.

Meeting Purpose:

- FERC Study Plan Determination of February 21, 2014 required consultation with state and federal agencies prior to development of a study plan for a hydroacoustics (HA) study at Vernon.
- Provide the working group a better sense of the costs to implement various HA system layouts/configurations. TC wants to show how costs scale up rapidly for different configurations by showing 11 examples of HA configurations that were intended to various aspects of FERC's study goals and objectives..
- Discuss the similarities and differences between the FirstLight HA study goals, objectives and facility constraints and those at Vernon based upon the FERC study goals and objectives.

Background:

- In the Revised Study Plan, TC's original study plan 22 proposed to use a single beam HA transducer at the fish pipe for 2 months to study juvenile shad. The results of Study 22 would be analyzed in conjunction with other studies that assessed route selection and turbine survival of juvenile shad. FERC ordered TC to develop a 2-year HA study and to assess adult American eel to supplement other eel studies (studies 11, 19, 20). HA would be used in a 2-year study to evaluate magnitude, timing, duration and delay for both juvenile shad and adult eel.
- FERC has not acted on TC's rehearing request of March 24, 2014.
- TC has to comply with the determination order.

Discussion:

TransCanada presented a spreadsheet of 11 various configurations as well as plan view diagrams of how they could be deployed. A copy of these materials follows these meeting notes in this Attachment A.

FWS (Sprankle) wants to know the various routes of potential egress, and understand the trash gate. FWS is most interested in monitoring in front of the turbine trash racks (rather than behind) and the surface sluice gate, assuming it is the primary spill gate likely to be used.

TC (Ragonese) indicated that the trash gate /sluice is only opened to move trash, and not open all the time. The first spill gates to open are tainter gates 1 and 2, then the 8 subgates. Other spill gates are only opened as necessary if flows increase.

FWS (Sprankle) – this array (#2, #3) is too far upstream. FWS is interested in where the fish are closer to the dam, and when they are in front of the trash racks etc. Normandeau (Gurshin) referred to the study requests/comments and FWS's prior request. He noted that shad school tightly during the day, forming a mass so you can't distinguish the number of fish, particularly near intakes.

Gurshin: May see some individual fish movement on the periphery of the school but it is difficult to get a good estimate of abundance. The primary reason for the example configurations (#2, #3) was to get at magnitude. You also cannot see directionality with HA (are they moving up and down in the water column).

FWS (Sprankle) – if there is a mass of fish detected, and then they disappear from the echoes, FWS wants to understand where they went (e.g., through turbines, fish bypass etc.). FWS wants to use HA to put radio tagged fish into context and see if they are behaving in the same manner as wild fish. FWS notes that FirstLight will monitor/tag from 08/15 – end of October rather than TC's 2 or 4 month examples.

Ragonese – notes that upstream array configurations will not capture project delay.

Gurshin – notes that a dam mounted array – also won't answer question of project delay. HA behind trashracks is the same as the 2009 study but with split beam and rotators, different frequency (to cut down on noise, bubbles, etc.), and different beam angle shape (6 x 12^{o} elliptical) to optimize coverage and improve on the 2009 study. Use of DIDSON is so far the best way to distinguish eels from background.

Ragonese – to get at what TC thinks agencies want (timing, duration, delay and magnitude of the run) would require 3 arrays.

Gurshin – delay can be estimated via 3 arrays by tracking signal peaks (since you can't know if they are the same fish or not) and time delays. In telemetry you know when each fish arrives.

FWS (Sprankle). An array in front of the trash rack intakes to characterize when fish show up in forebay area and then directional movement into trashracks (via vertical positioning). FWS would be interested in that proposal. How long those targets remain in that area, where they move up/down etc.

Ragonese – to clarify, FWS is suggesting monitoring in front of racks. Shad and/or eel?

FWS (Sprankle) – FWS is interested in shad; FWS didn't talk about eels in their requests or comments.

NHFGD (Gries) - notes that NH is interested in eels.

FWS (Warner) – FWS wouldn't anticipate asking for a $4 or $8 million study. The question TC seems to be asking is, is configuration 11 (3 arrays plus dam array for shad and eel) what agencies really need.

FWS (Sprankle) – read from FWS rehearing comment letter of April 23, 2014 - FWS stepped back from the notion of 3 arrays in favor of a single array. Would prefer that array in front of the intakes. What can TC control in terms of operations?

Ragonese response – not much.

Ragonese – what exactly are agencies asking us to monitor? All gates/passage routes or just unit intake in forebay? What TC is showing for costs and configurations are examples not proposals or options just illustrations of how systems designed for the goals of the SPD affect cost. TC is looking for more clarity of what agencies want and need by showing different example configurations and their cost implications.

FWS (Warner) – will need some time internally to focus on what pieces FWS needs and get back to TC.

(NHFGD) Gries – agrees with Warner, it is difficult to say today what is needed.

NHDES (David) - question about using HA for eel, notes that FL is using it for that.

Gurshin – describes FWS study references in 04/23/14 letter (via table provided). Only 2 studies even included eels. For eels, HA is still R&D based. Gurshin has not come across peer-reviewed scientific studies that use fixed-location hydroacoustics to study timing, delay, duration, or magnitude of out-migration of juvenile shad at hydroelectric dams or any riverine site. There are a few examples of entrainment studies, and more for other herring species like threadfin shad, alewife, bluebacks.

Ragonese – questioned the agencies if TC is misreading the goals in either the SPD or have agencies changed their view on what is wanted. Is TC misunderstanding terminology or objectives?

Simmons/Gurshin – “magnitude” definition needs clarity. We understand the behavioral aspects as fish approach intakes. There is a big difference b/t relative abundance vs. absolute abundance.

FWS (Sprankle) – FWS wants relative abundance (equals magnitude in his view) over the run, with river/operational conditions, how fish were moving/milling and where (inside/outside of fish boom, etc.).

Ragonese - TC had defined magnitude as the scale/shape (e.g. the curve) of the run over the duration of the run.

FWS (Sprankle) – FWS criticism of study 22 was that HA at the fish pipe only would not be representative over all operations/flows.

Gurshin – Because juvenile shad school, echo counting would not provide a reliable abundance estimate. Instead, volume backscattering strength over time could be one relative measure of abundance. Other relative indices could include categorical data, low-medium-high, or percentages to characterize temporal and spatial distributions.

Ragonese – what about potential delay caused by the project, how to draw that out?

FWS (Sprankle) – from the literature, it seems that delay can be characterized by how targets move (with volume analysis) to get sense of size of school – when are the fish moving, when do they sound, when are they no longer within the zone of monitoring?

Gurshin – delay implies a unit of time (slower or longer than a reference). That is why configuration # 11 for instance would be needed to get an upstream sense prior to influence from the project as well as the downstream.

FWS (Sprankle) – assume tagged fish come down with wild fish, then compare rates of movement b/t tagged vs. wild fish. When does the group of wild fish sound? Why wouldn’t you be able to discern that?

Ragonese – what is the sounding depth you have in mind? Sprankle –20 feet. Shad and the fish passage facilities are surface oriented. Fish height in water column depends on time of day among other things.

Ragonese - none of the forebay is deep except right in front of the intakes.

Gurshin – split beam HA will not be able to track movement of schools of fish between different potential routes/locations horizontally because you cannot track or discern schools from one beam to another. They will be passing through the single beam or not, but you won’t know if it is the same school or not in each beam.

FWS (Warner) – want to identify fish behavior within operations.

Gurshin – putting transducers in front of racks to monitor behavior, there would be a question on relative magnitude data. A school could just stay within the HA beam for several days and look like a large migratory run, vs. a smaller school that keeps milling and passes the beam repeatedly.

FWS (Sprankle) – with horizontal and vertical beams, you can't get any directional information of targets?

Gurshin – Within a single beam, you can get some info on individuals on the periphery, and can get some phase info on a school and you can get some up/downstream and east/west, but only <u>within an individual beam</u>. You cannot piece together data from multiple transducers as that creates too much uncertainty. DIDSON (high frequency multi-beam sonar that produces video image) might get at some of that.

Gurshin – we could give you relative magnitude (high/low/medium).

FWS (Sprankle) – that is okay.

Ragonese – but is it worth the cost?

FWS (Sprankle) – it is definitely worth the cost along with the tagging, HA will help answer the questions of is the fish bypass working, which turbines are they using, etc. relative to wild fish

FWS (Sprankle) – is DIDSON more susceptible to turbidity than split-beam?

Gurshin (in response to questions from Ragonese) – DIDSON uses video rather than signal processing, but if there are high particulates and debris, range and quality of images can be affected. You would need more DIDSON units to provide coverage, and to account for reduced range from turbidity, other environmental conditions (e.g. wind, debris) as DIDSONs have a very narrow beam. Data processing would entail a lot more data than split beam, but you could compress the data, use image recognition software, etc., but at much higher cost.

Simmons – DIDSON could also identify and/or distinguish species in some cases at a certain distance.

<u>Meeting Outcome:</u>

FWS (Warner) – will review with Sprankle, may have some questions on technology, and will get back to TC.

CRWC (Deen) – requests that FWS to share that with others in the working group.

TransCanada

Hydroacoustics Consultation Meeting
August 26, 2014

Meeting Materials

TransCanada Hydroacoustics Study Systems Cost Estimate
8/25/2014

	TransCanada Hydroacoustics Study Systems designed to meet Agency Stated Goals	# Arrays	Monitoring Duration	Target Fish	Field Labor and Expense (excludes diving costs)	Data processing, analysis, reporting	Hydro-acoustic Equipment and related	Imaging Sonar (DIDSON), Rotator	Ancillary Equipment and Costs	Total +/- 10%
1	**Proposed** - Single split-beam at fish pipe (part of Study 22). Total Study 22 cost = $360,000-$420,000	n/a	2 months	shad	20,000	33,000	60,000		20,000	**133,000**
2	**One single-level upstream array (2 months):** Equipment: # of transducer - 24. Ancillary Equipment includes generator power, fuel, software licenses and data storage, HTI support for installation of HA equipment. Field labor - longer mobilization and set-up, same frequency (weekly), more effort due to # of transducers, more data processing and analysis.	1	2 months	shad	146,000	156,000	196,000		32,000	**530,000**
3	**One single-level upstream array (4 months):** Equipment: # of transducer - 24; Ancillary Equipment includes generator power, fuel, software licenses and data storage, HTI support for installation of HA equipment. Field labor - longer mobilization and set-up, same frequency (weekly) over twice as long monitoring period. Data processing of twice as much data. Equipment rental and related costs for nearly twice as long.	1	4 months	shad	192,000	275,000	310,000		34,000	**811,000**
4	**Dam mounted single-level array w/ DIDSON & rotator:** Equipment: # of Didson/Rotators - 1; # of transducers - 15; Ancillary Equipment includes generator power, fuel, software licenses and data storage, HTI support for installation of HA equipment. Field labor - longer mobilization and set-up, same frequency (weekly) over twice as long monitoring period. Data processing of twice as much data and additional DIDSON processing and analysis. Equipment rental and related costs for nearly twice as long.	1 @ dam	4 months	shad	158,000	300,000	250,000	122,000	33,000	**863,000**

	TransCanada Hydroacoustics Study Systems designed to meet Agency Stated Goals	# Arrays	Monitoring Duration	Target Fish	Field Labor and Expense (excludes diving costs)	Data processing, analysis, reporting	Hydro-acoustic Equipment and related	Imaging Sonar (DIDSON), Rotator	Ancillary Equipment and Costs	Total +/- 10%
5	**Dam mounted bi-level array w/ DIDSON & rotator:** Equipment: # of Didson/Rotators - 1; # of transducers - 30; Ancillary Equipment includes generator power, fuel, software licenses and data storage, HTI support for installation of HA equipment. Field labor - longer mobilization and set-up, same frequency (weekly) over twice as long monitoring period. Data processing of twice as much data plus additional for processing and analysis for eel, and for DIDSON. Equipment rental and related costs for nearly twice as long.	1 @ dam	4 months	shad and eel	205,000	350,000	370,000	122,000	33,000	**1,080,000**
6	**One bi-level upstream array w/2 DIDSONS, no rotators:** Equipment: # of Didson - 2; # of transducers - 24; Ancillary Equipment includes generator power, fuel, software licenses and data storage, HTI support for installation of HA equipment. Field labor - longer mobilization and set-up, same frequency (weekly) over twice as long monitoring period. Data processing of twice as much data plus additional data analysis for eel and for DIDSON. Equipment rental and related costs for nearly twice as long.	1	4 months	shad and eel	192,000	350,000	310,000	118,000	33,000	**1,003,000**
7	**Three single-level arrays (2 months):** Equipment: # of transducer - 72; Ancillary Equipment includes generator power, fuel, software licenses and data storage, HTI support for installation of HA equipment. Field labor - longer mobilization and set-up for 3 arrays, same frequency (weekly) more effort due to more transducers.	3	2 months	shad	438,000	468,000	588,000		96,000	**1,590,000**
8	**Three single-level arrays (4 months):** Equipment: # of transducer - 72; Ancillary Equipment includes generator power, fuel, software licenses and data storage, HTI support for installation of HA equipment. Field labor - longer mobilization and set-up for 3 arrays, same frequency (weekly) more effort due to more transducers over twice as long, more data processing and analysis.	3	4 months	shad	576,000	729,000	930,000		102,000	**2,337,000**

	TransCanada Hydroacoustics Study Systems designed to meet Agency Stated Goals	# Arrays	Monitoring Duration	Target Fish	Field Labor and Expense (excludes diving costs)	Data processing, analysis, reporting	Hydro-acoustic Equipment and related	Imaging Sonar (DIDSON), Rotator	Ancillary Equipment and Costs	Total +/- 10%

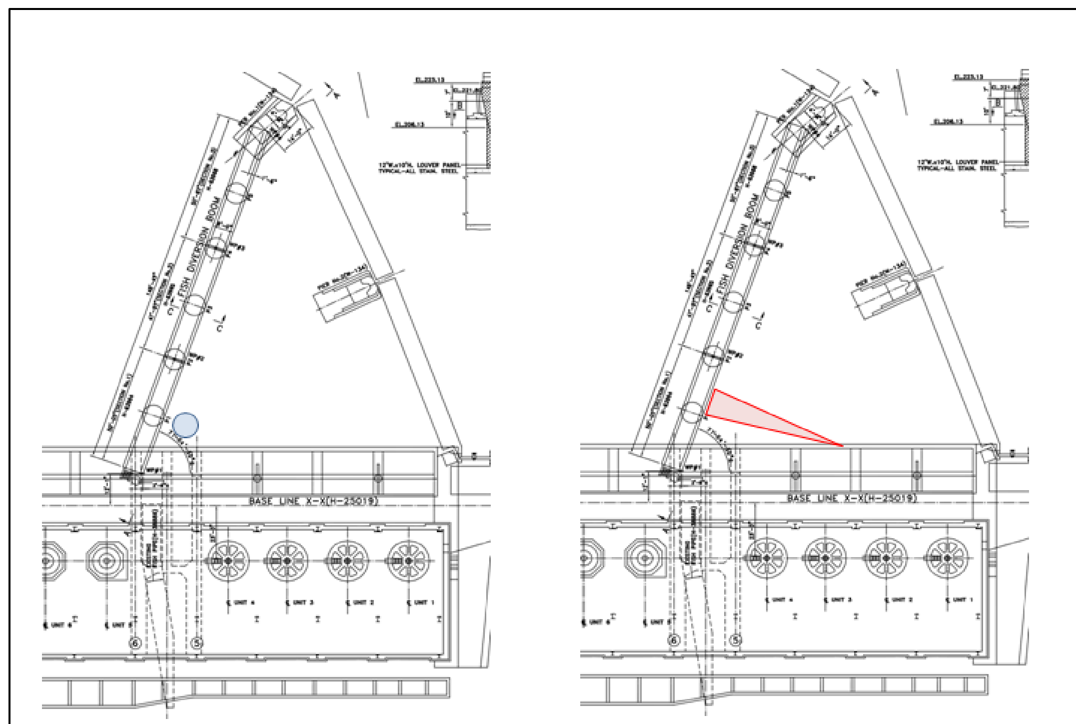
9	**Three bi-level arrays w/2 DIDSONS on each array, no rotators**:
	Equipment:
	  # of Didson - 6
	  # of transducer - 72;
	Ancillary Equipment includes generator power, fuel, software licenses and data storage, HTI support for installation of HA equipment. Field labor - longer mobilization and set-up for 3 arrays, same frequency (weekly) more effort due to more transducers over twice as long, more data processing and analysis.
		3	4 months	shad and eel	588,000	1,050,000	930,000	354,000	102,000	**3,024,000**

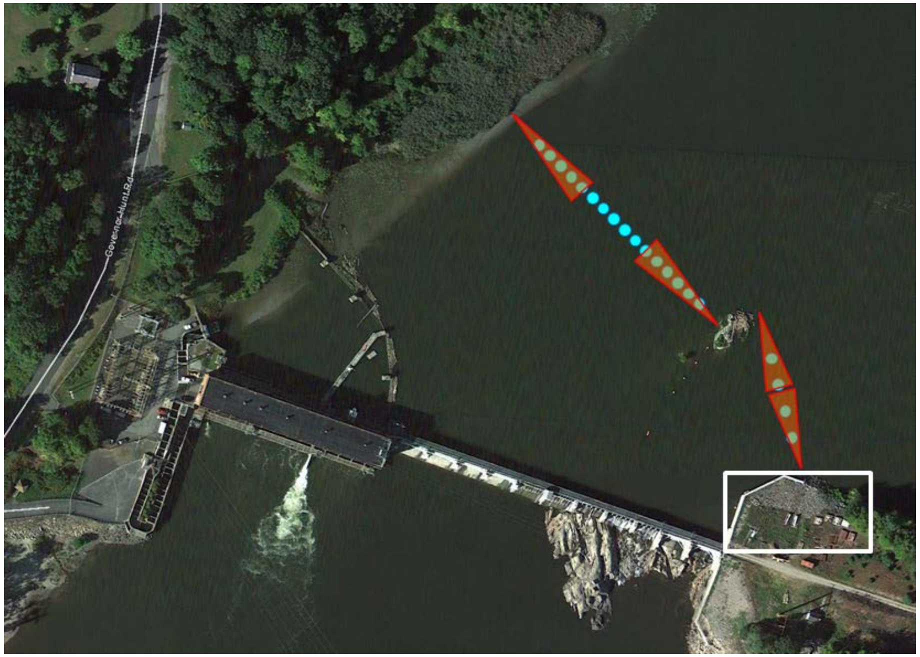
10	**Dam mounted single-level array w/ DIDSON & rotator (4) PLUS Three single-level arrays (8) for 4 months. (Design to meet stated FERC Study requirement goals.)**	4 inc dam	4 months	shad	734,000	1,029,000	1,180,000	122,000	135,000	**3,200,000**
11	**Dam mounted bi-level array w/ DIDSON & rotator (5) PLUS Three bi-level arrays w/2 DIDSONS on each array (9), no rotators. (Design to meet stated FERC Study requirement goals.)**	4 inc dam	4 months	shad and eel	793,000	1,400,000	1,300,000	476,000	135,000	**4,104,000**

For both 10 and 11, there would be some modest savings in field labor/expense and ancillary equipment.

1) shad only:
Conceptual diagram of the location of single split-beam transducer (in white square) mounted to sample about 100% of the fish pipe entrance for monitoring the temporal pattern in relative abundance of out-migrating juvenile American shad at Vernon Dam.

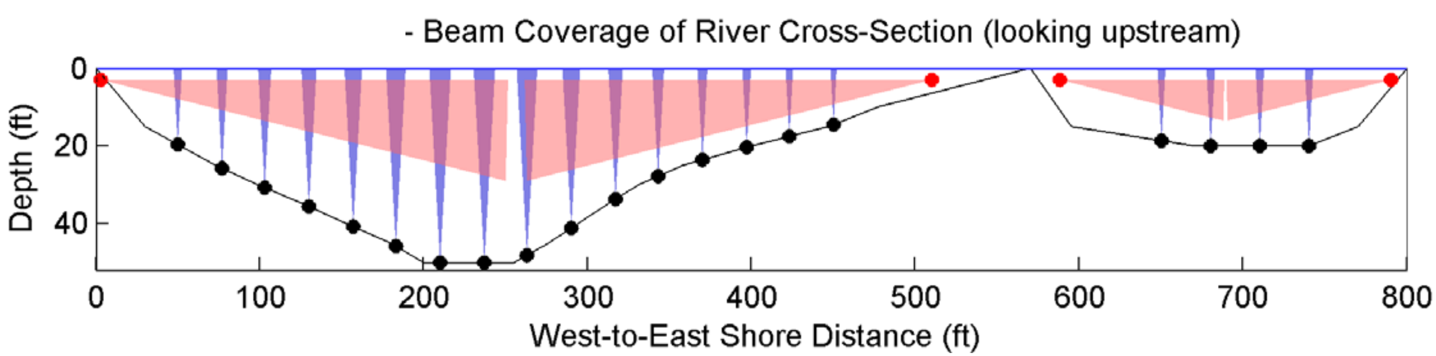
1) Beam geometry of two configurations depending on evaluation of site conditions. Left: blue circle showing a 10-ft wide beam footprint from a 15° split-beam transducer mounted near the bottom and aimed toward the surface. Right: red triangle represents the ideal beam cone shape from a 15° split-beam transducer mounted to the dam face and aimed horizontally near the fish pipe entrance.





2) and 3) shad only: Conceptual diagram. Cyan dots represent the 20 upward-looking split-beam transducers mounted onto the riverbed; Red triangles represent the conical beams of four horizontally aimed transducers pointing away from the shore slopes; the white rectangle delineates proposed area for an instrumentation shed and generator to support the study

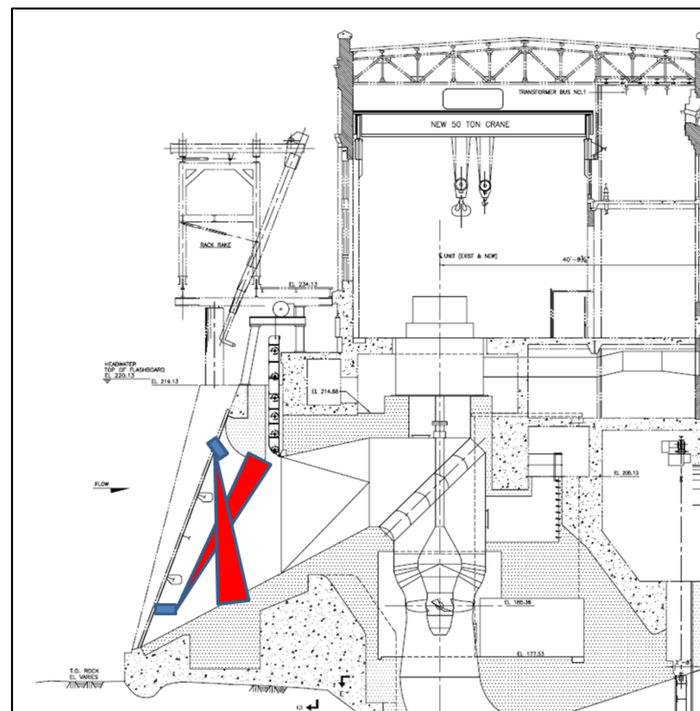
2) and 3): Beam geometry. Beams are mapped to scale but axis units are not to 1:1 scale to improve visualization. Blue cones represent upward-looking 15° split beam transducers and red cones represent side-looking 6° split beam transducers.



5) – shad and eel: Conceptual diagram of sampling configuration for Plan D. Cyan dots represent the upward-looking split-beam transducers at fish bypass, fish pipe, and trash sluice. Red triangle represent the conical beams of four horizontally aimed transducers pointing across opening to the two tainter gates; and blue bar represents the bank of 10 upward-looking and 10 downward-looking elliptical split-beam transducers mounted behind the trash racks.

5): Example of an upward-looking (for shad) and downward-looking (for eel) transducer (200 kHz split-beam) mounted on pan-tilt rotators for adjusting to optimal sampling behind the trash racks

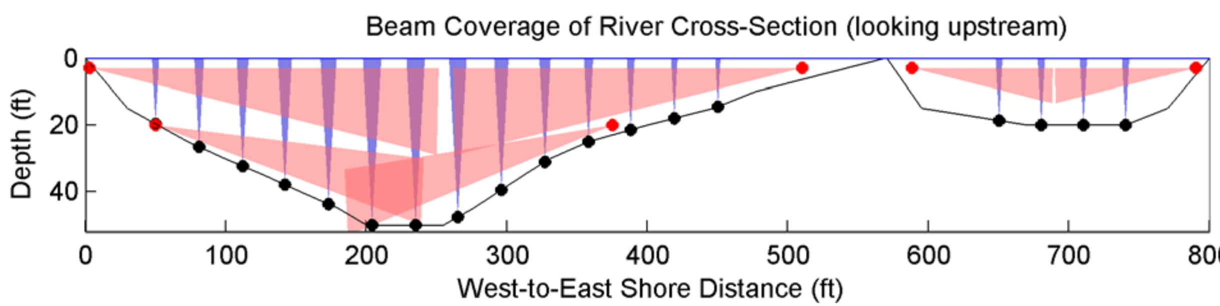
Note: Item 4) would have only upward looking transducers for shad monitoring.



6) –shad and eel: Similar to 2) and 3), but replace two of the upward-looking split-beam transducers with two horizontally aimed transducers to sample near the bottom of the center of the channel where eels are likely to prefer. Two horizontally-aimed imaging sonars would also be used to classify eels.

Cyan dots represent the 18 upward-looking split-beam transducers mounted onto the riverbed; Red triangles represent the conical beams of 6 horizontally aimed transducers pointing away from the shore slopes; green triangle represent imaging sonars; the white rectangle delineates proposed area for an instrumentation shed and generator to support the study

6): Blue cones represent upward-looking 15° split beam transducers and red cones represent side-looking 6° split beam transducers. Note: Imaging sonars would be aimed horizontally and co-located with the bottom centered horizontal transducers.



7) and 8) – shad only; and 9) – shad and eel: Replicates 2) and 3) at three sites – upstream, in the forebay, downstream. Red lines mark the transducer arrays . Exact locations may shift following site evaluations.

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APPENDIX B

Study 24 – Dwarf Wedgemussel Counter Proposal

Received from FWS via email on September 4, 2014

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DWM Counter Proposal from the Fish and Wildlife Service

1. **Background**
    a. TransCanada's final Study Plan 24 lists two goals and five objectives:
        i. Goal 1: Assess the distribution, population demographics, and habitat use of the dwarf wedgemussel (DWM) in the Wilder and Bellows Falls project areas.
            1. Objective 1 (Phase 1): conduct an initial survey of the 17-mile-long reach of the Connecticut River from Wilder dam to the upstream end of the BF impoundment to determine the distribution, relative abundance, and habitat of the DWM.
            2. Objective 2 (Phase 1): Determine the best sites for quantitative mussel sampling in areas where DWM are known to occur in the Wilder and BF project areas and the reach surveyed for Objective 1; and
            3. Objective 3 (Phase 2): At sites identified in Objective 2, collect statistically sound and repeatable data, using quantitative methods, to determine density, age-class structure, and habitat for DWM and co-occurring mussel species.
        ii. Goal 2: Assess the influence of flow regime on DWM, co-occurring mussel species, and mussel habitat.
            1. Objective 4 (Phase 2): Observe and record behavior of DWM and co-occurring mussel species in situ during varying flow conditions; and
            2. Objective 5 (Phase 2): Assess the potential effects of flow regime on DWM and their habitat.
    b. TransCanada undertook Phase 1 activities in 2011 and 2013. The results are reported in ILP Study 24: Dwarf Wedgemussel and Co-Occurring Mussel Study Phase I Report (Nedeau, 2014).
        i. Mr. Nedeau surveyed both impounded and free-flowing stretches of river from the head of Wilder pool downstream to the Vernon tailrace. No DWM were found immediately below the three dams or in the free flowing sections below the dams. DWM were found towards the upper end of the BF and Wilder headponds but at relatively low densities.
        ii. The low densities observed make achieving Objectives 2 through 5 difficult.

2. **Issue**
    a. The Fish and Wildlife Service has had the opportunity to review numerous DWM studies and surveys that have been conducted within the Connecticut River watershed since the 1980s. After having reviewed and synthesized those data (including the two surveys conducted for TransCanada), several concerns have arisen:

- **i.** In addition to no DWM being found at sites that historically supported them (e.g., Sumner Falls and Cornish Covered Bridge), the Catch Per Unit Effort (CPUE e.g. #/observer hour) appears to have fallen dramatically at other historical sites (e.g., Middle Connecticut macrosites 4, 6 and 9 which roughly correspond to 2011 survey sites 45, 43 and 41).
- **ii.** Of the many surveys that have been conducted on Connecticut River DWM, only very few have included quantitative analyses (e.g., at the Lunenburg macrosite, substrate was analyzed and at the Ashuelot River Long Term Monitoring sites depth, velocity and substrate were examined in detail).
- **iii.** From the qualitative and quantitative information provided in previous reports, it appears that when DWM are found in tributaries and mainstem reaches not directly influenced by hydropower operations (e.g., Lunenburg, Northumberland, upstream from Moore Reservoir), they occur in shallow water, whereas in areas directly influenced by hydropower operations, DWM either are absent or occur in deeper water at the far upstream reaches of reservoirs.
- **iv.** Based on existing information, there are only a few "high density" sites within the Connecticut River watershed: the Johns River (northern macrosite), the Ashuelot River, the Farmington River, and several sites within the middle Connecticut macrosite (the upstream end of the Wilder headpond).

3. Conclusion

- **a.** Where sites have been surveyed repeatedly over time, it appears there is a long-term trend of declining CPUE.
- **b.** While many surveys have been conducted within the Connecticut River watershed, nearly all of them only collected qualitative habitat data. In addition, those evaluations focused on metrics such as velocity, substrate and depth. Newer mussel studies are collecting additional data such as temperature, bottom velocity, shear stress, distance to cover, cover type, and sediment compaction. Without gathering detailed data on microhabitat use, we do not know the relative suitability of habitat where DWM occur, we do not know the suitability of habitat where they do not presently occur, and we cannot assess whether potentially suitable habitat and currently occupied habitat are being impacted by current project operations.
  - **i.** Given the low densities of DWM that occur within the project affected area, it likely will be necessary to collect data from sites outside of the affected area in order to look at sites of varying DWM densities that represent differing habitat suitabilities.
  - **ii. [no text provided]**

4. Recommendations on how to proceed with Phase 2

a. How to meet Goal 1 (DWM distribution, population demographics and habitat use in project affected area)

    i. Distribution Info - Already have some via 2011 and 2013 surveys, BUT also need to resurvey explicitly at historical sites both within and outside of project affected area (using historical methodology – to allow for “apples to apples” comparison)

    ii. Population demographic: presence/absence, CPUE, shell length at sites where DWM were found in 2011 and 2013 surveys and from historical sites

    iii. Habitat Use – collect microhabitat and site level data from sites representing range of DWM densities

    iv. Analysis
        1. Use all data (current and historical) to do trend analysis and see if changes in distribution, CPUE and/or size class have occurred temporally or spatially
        2. Analyze pre and post deregulation operations data to see if there is a relationship between operations and distribution, CPUE or size class. (e.g., if CPUE has declined within project affected area but not outside it, and changes to operations such as timing, frequency or duration of peaking have occurred in that time period, suggests relationship exists)
        3. Perform regression analysis and model comparison to determine which habitat metrics are most important (e.g., dependent variables: density class, CPUE, presence/absence, size class; independent variables: habitat components, operational protocols e.g., level of fluctuation, frequency, etc.)

b. How to meet Goal 2 (Project Effects)

    i. Need to develop HSI curves for DWM using Connecticut River empirical data and possibly data from other watersheds
        1. Use habitat data collected from within project affected area (including historical sites) and outside of project area (mainstem and tribs)
    ii. HSI Development & Analysis
        1. Per Pandolfo (2014) protocol (modified)
            a. Habitat suitability = habitat use/habitat availability (by density class and over all densities)
            b. Habitat preference – random v. non-random
    iii. Project operations analysis
        1. Run HSI curves in Flow Study as well as in headpond analysis (using existing data such as bathymetry, impoundment fluctuation, habitat mapping, etc.)

5. Specific Recommendations for Methodology

Phase 2, Task 1 - Resurvey: A given site will be surveyed at the same location, using the same methodology, as was used in the historical surveys. Resurvey the following historical sites: northern macrosite – Lunenburg (Connecticut River), Johns River, Farmington River, and within the project affected reach: Middle Connecticut macrosite sections 4, 6 and 8; Sumner Falls, Cornish Covered Bridge (north and south); Rt. 5 Cemetery, Horseback Ridge, and Charlestown.

Phase 2, Task 2 - Quantitative Habitat Data: Rather than collecting detailed data from the 2D hydraulic modeling site (where densities of DWM are very low and therefore likely does not represent optimal habitat), quantitative habitat metrics should be collected from a number of sites representing low, medium and high CPUE based on current or historical data.

- Determine how many sites will be surveyed - tentatively, all 2011/2013 sites where DWM were found at CPUE of >= 3 (6); subset of sites with CPUE <3 (min. 5); plus Johns R (potentially 1 high, 1 med, 1 low)., Lunenburg site (1 high), Ashuelot R (1 high, 1 med., 1 low), and Farmington R (1 high, 1 med., 1 low) for a total of n=21 sites.
- Data collection will entail sampling 1-meter^2 (m^2) quadrats along transects, similar to what was proposed in Task 3, Part 1 of the Proposed Phase 2 Study Plan. At each site, the total number of quadrats will be equivalent to the average channel width in meters divided by 5, rounded up to the nearest multiple of 9, or N = 27, whichever is greater. There will always be 9 quadrats per transect. The number of transects will be equivalent to the total number of quadrats divided by 9; however, there will be a minimum of 3 transects per site.
- Each transect will be placed *perpendicular* to flow (bank to bank), 10 meters apart. Along each transect, quadrats will be selected in a stratified-random fashion, with 3 random quadrats selected and sampled in each of three lateral channel sections: right bank, mid-channel, and left bank. The division between the sections will be based on depth (e.g., maximum channel depth)/2, or a mutually-agreeable alternative), with a minimum section width of 3 meters. Selection of transects and random selection of quadrats will occur formally and prior to the day of field sampling, using a random number generator or similar technique.
- For each quadrat, a 0.25 m^2 will be excavated to a depth of 10 cm and sieved through a 10-mm sieve to estimate density of sub-surface DWM.
- In addition, observations will be made between quadrats and within 1 m of each side of each transect to survey and collect data for additional DWM.
- For *each site (*n=21), the following data will be collected:
    - stream shading
    - bank angle
    - bankfull width
    - bankfull cross sectional area
    - bankfull mean and maximum depth
    - width to depth ratio
    - bank erosion hazard index

    - median particle size (D50), D16 and D84
    - continuous hourly temperature @ 10 cm above, 5 cm below and 15 cm below interface
    - watershed area
    - land use
    - riparian land use (15 and 30 m buffers)
    - ecoregion
    - geologic rock type
    - stream power
- For *each quadrat* and for *each transect*, the start and end time of sampling (to determine CPUE – #/quadrat and #/observation hours – as well as to correlate to flow and/or WSE) will also be recorded.
- For *each quadrat*, the following additional data will be collected:
    - Number of DWM
    - Presence and number of tessellated darters
    - Co-occurring mussel species
    - Species composition and percent cover of aquatic vegetation
    - Percent cover of woody debris
- For *each quadrat* (with or without DWM) and for each DWM encountered outside of a quadrat[4], the following additional data will be collected:
    - GPS coordinates
    - Distance to shore (specify bank)
    - Presence of groundwater seeps or other groundwater inflow
    - Variables necessary to calculate shear velocity, shear stress, Froude number and Reynolds number
- For *each individual DWM* encountered on the surface (within quadrats, outside of quadrats, or along the sides of each transect), and for *quadrats without DWM* (on the surface or at all), the following additional data will be collected:
    - water depth
    - mean column water velocity (m/s)
    - bottom water velocity (m/s)
    - embeddedness/substrate penetrability
    - substrate roughness
    - bottom temperature
    - dominant and subdominant substrate
    - distance to nearest cover and nearest cover type (per Pandolfo, cover in this context is the nearest material that could slow water velocity or potentially provide shelter or habitat for DWM)

[4] If DWM encountered outside of transects are at densities > 1 m^2, one measurement point may be taken per 1 m^2 (equivalent to the size of a quadrat).

- For *each individual DWM* encountered within each quadrat (surface and subsurface), between quadrats, and along the sides of each transect, the following data will be collected:
  - Shell length
  - Shell condition
  - Location (transect, quadrat or location along transect, surface or subsurface)

*Note: Phase 2 proposal includes surveying 400 2.25-m^2 quadrats in the 2D area plus a 1-m^2 quadrat every 5 m along twenty 50-m long transects at current and historical DWM sites within project affected area, for a total of 600 quadrats. For our proposal, mainstem sites have an average river width of 400 ft. (122 m); one site is 1,000 ft. (305m); tribs ave. 35m. Using these estimates, the total number of quadrats to be surveyed using our protocol would be 567 1-m^2 quadrats.

Water level loggers should be placed at each site prior to initiating field work and should remain in place until the end of the summer. River flow should be measured, estimated or calculated during each sampling event. If bathymetric data do not exist at a given survey site (e.g., those outside of the project affected area or in free-flowing reaches within the project affected area) then it should be collected.

6. Specific Recommendations for Analysis:

Habitat Analysis: Because the quantitative data will no longer be collected from the 2D hydraulic model site (i.e., Chase Island), the methodology used by Maloney et al. (2012) is likely not appropriate to use in the current study. Rather, we recommend a methodology similar to Pandolfo (Chapter 4, 2014[5]) be used. In general, the analysis components include:

- Microhabitat suitability:
  - Suitability calculated by dividing microhabitat use at a site by availability at that site over range of values for each parameter.
  - Bootstrap two-sided Kolmogrorov-Smirnov test to test for significant differences between use and availability distributions for each habitat parameter (i.e., non-random use of habitat by DWM).
- Assessment of relationship between abiotic/biotic factors and DWM density, using correlation and linear regression techniques.

HSC Development: Using the data from the quadrat task as well as other relevant data from DWM studies conducted both within and outside of the Connecticut River basin, a DELPHI panel of DWM experts will develop habitat suitability curves. These curves will then be used in the instream flow study (1-dimensional and 2-dimensional) for the free-flowing reaches within the

[5] Pandolfo, T.J. 2014. Biotic and abiotic influences on common and imperiled freshwater mussels at multiple spatial and temporal scales with inferences to global change. PhD dissertation, North Carolina State University, Raleigh, North Carolina. 179 pp.

project affected area (including steady state analysis, habitat time-series analysis, and habitat persistence analysis). For impounded reaches, the potential for water surface elevation fluctuations to influence relevant habitat metrics, both spatially and temporally, should also be analyzed.

7. **Schedule**

Data collection should take place in early summer, 2015 (June and July). To the extent practicable, surveys should occur during base flow conditions.

APPENDIX C

Study 31 – Whitewater Boating Flow Assessment

Bellows Falls Draft Survey Tool

Provided via email on September 5, 2014

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Bellows Falls Bypassed Reach Boating Study

Section A: Pre-Run Boater Information

1. Date: ___________, 2014
2. Name:____
3. What is your age?
4. Are you…
   - □ Male
   - □ Female
5. How would you describe yourself as a boater (what type of boater are you?):
6. What type of watercraft do you generally use for whitewater paddling? (Circle one)
   - Hard shell kayak
   - Inflatable kayak
   - OC1
   - OC2
   - C1
   - C2
   - Raft
   - Cataraft
   - Other (describe):_______________
7. How many years have you been using this type of watercraft? _________ Years
8. How would you rate your skill level with this type of watercraft? *(Circle one)*
   - □ Novice (comfortable running Class II whitewater)
   - □ Intermediate (comfortable running Class III whitewater)
   - □ Advanced (comfortable running Class IV whitewater)
   - □ Expert (comfortable running Class V whitewater)
9. In general, how many days per year do you spend whitewater boating?_________
10. Have you boated the Bellows Falls Bypassed Reach on the Connecticut River before? Yes_____ No_____

11. Please respond to each of the following statements about your river-running preferences.

	Strongly disagree	Moderately disagree	Slightly disagree	No Opinion	Slightly agree	Moderately agree	Strongly agree
I often run rivers with Class II and III rapids.	1	2	3	4	5	6	7
I often run rivers with difficult rapids (Class IV-V).	1	2	3	4	5	6	7
Running challenging whitewater is the most important part of my boating trips.	1	2	3	4	5	6	7
I often boat short river sections (under 4 miles) to take advantage of whitewater play areas.	1	2	3	4	5	6	7
I often boat river segments to experience a unique and interesting place.	1	2	3	4	5	6	7
I often boat short river segments to run challenging rapids.	1	2	3	4	5	6	7
I select boating opportunities based on length and experience regardless of difficulty.	1	2	3	4	5	6	7
I am willing to tolerate difficult put-ins and portages (boat carries in excess of 1,000 feet over unimproved footpaths) in order to run interesting reaches of whitewater.	1	2	3	4	5	6	7
I often boat rivers that feature large waves and powerful hydraulics.	1	2	3	4	5	6	7
I often boat steep technical rivers.	1	2	3	4	5	6	7
I enjoy boating both difficult and easy rivers.	1	2	3	4	5	6	7

12. Do flow levels influence whether or not you take a trip?

□ Yes

□ No

13. Do flow levels influence ***how*** you take trips (when you go, what craft you use, which rapid you run, how much gear you take, etc.)? If yes, please describe below.

Section B: Post-run Questions

Date: ___/ ___/ 2014 Flow Number: _______ Flow ________ cfs Your name: ____________________________

1. What type of craft did you use for this run? *(Circle one)*
   Kayak: (hybrid · play boat · creek boat · river boat) Canoe (open decked)
   Other: ______________________________

2. Your whitewater skill level for the type of watercraft used?
   - □ Novice (comfortable running Class II whitewater)
   - □ Intermediate (comfortable running Class III whitewater)
   - □ Advanced (comfortable running Class IV whitewater)
   - □ Expert (comfortable running Class V whitewater)

3. In general, what class (example: II–V) was the whitewater difficulty at this flow? _________

4. Did you have any significant problems (e.g., had to swim, pinned, or wrapped a boat) during your run? Please provide a brief description and location of any incident.

5. Please evaluate the flow on this trip for your craft and skill level for each of the following characteristics. *(Circle one number for each item).*

	Totally Unacceptable			Marginal			Totally Acceptable
Navigability	1	2	3	4	5	6	7
Availability of challenging technical rapids	1	2	3	4	5	6	7
Availability of powerful hydraulics	1	2	3	4	5	6	7
Availability of play boating areas	1	2	3	4	5	6	7
Overall whitewater challenge	1	2	3	4	5	6	7
Safety (due to flow levels)	1	2	3	4	5	6	7
Safety (due to debris or other in-channel physical hazards)	1	2	3	4	5	6	7
Number of hazards present in river	1	2	3	4	5	6	7
Aesthetics of river/channel	1	2	3	4	5	6	7
Length of run	1	2	3	4	5	6	7
Boating instruction potential	1	2	3	4	5	6	7
Overall Rating	1	2	3	4	5	6	7

6. In general, would you consider the minimum acceptable flow (enough flow for an enjoyable recreation experience) to be higher, lower, or about the same as this flow for the features you like? *(Circle one).*

□ Much lower flow
□ Slightly lower flow
□ About the same; this was the best flow
□ Slightly higher flow
□ Much higher flow

7. Relative to this flow, would you consider the optimum flow for this type of trip to be higher, lower, or about the same as this flow for the features you like? *(Circle one).*

□ Much lower flow
□ Slightly lower flow
□ About the same; this was the best flow
□ Slightly higher flow
□ Much higher flow

8. What is the minimum skill level necessary to successfully run this segment at this flow level?

□ Novice (no previous boating experience)
□ Beginner (some previous boating experience)
□ Intermediate
□ Advanced
□ Expert

8. Were there a few "critical spots" at this flow level, and if so where?
□ No
□ Yes____

9. List the primary advantages of this flow…..

10. List the primary disadvantages of this flow…

Section C: Close-out Questions

1. Compared to other *river reaches of similar difficulty*, how would you rate the boating opportunity at this location (**assume optimal flows**). *(Circle one number for each; if you are unsure about a comparison, leave that item blank).*

Compared to….	**This reach is………**				
	Worse than average	**Below Average**	**Average**	**Above Average**	**Much better than average**
Other reaches within 2 hour drive, this reach is….	1	2	3	4	5
….other reaches in New England, this reach is….	1	2	3	4	5

2. Please provide overall evaluations for Bellows Falls Bypassed Reach for the following flows for your craft and skill level. Please consider all the flow-dependent characteristics that contribute to high quality trips (e.g., boatability, whitewater challenge, safety, availability of surfing or other play areas, and aesthetics).

Bellows Falls	**Totally Unacceptable**			**Marginal**		**Totally Acceptable**	
	1	2	3	4	5	6	7
2,500	1	2	3	4	5	6	7
	1	2	3	4	5	6	7
3,500	1	2	3	4	5	6	7
	1	2	3	4	5	6	7
4,500	1	2	3	4	5	6	7
	1	2	3	4	5	6	7
5,500	1	2	3	4	5	6	7
	1	2	3	4	5	6	7
7,500	1	2	3	4	5	6	7
	1	2	3	4	5	6	7
10,000	1	2	3	4	5	6	7
	1	2	3	4	5	6	7
	1	2	3	4	5	6	7

3. Please specify the flows that you think would provide the following types of experiences on the bypassed reach.
(Note: It's okay to specify flows you have not observed, but which you think would provide the type of experience specified).

	Flow in cfs
What is the lowest flow that you consider acceptable for a minimum quality whitewater experience?	
What flow provides the highest quality whitewater experience?	
What is the lowest flow level that provides a safe run?	
What is the highest flow level that provides a safe run?	
What is the highest flow level you would consider running?	

4. Please evaluate the boating access for this segment of the bypassed reach (circle one):

	Totally Unacceptable			Marginal			Totally Acceptable
Put-in access	1	2	3	4	5	6	7
Take-out access	1	2	3	4	5	6	7

Section D: End of Study Focus Group Discussion Topics

1. Identify challenging features, play areas, rapids or sections and rate their difficulty (use aerial)
2. Discuss advantages and disadvantages of each flow
3. Preferred flow ranges
4. Interest in variability in flows and its importance
5. Access
6. Who is the potential typical user
7. Highest and lowest flows that provide safe runs
8. Overall evaluation on the range of water flows available

WebEx Meeting Access Information
TC Initial Study Plan Meeting #1

Date: Monday, September 29, 2014
Time: 9:00 am, Eastern Daylight Time (New York, GMT-04:00)
Meeting Number: 920 852 936
Meeting Password: Abcde12345

To join the online meeting:
Link: https://transcanada.webex.com/transcanada/j.php?MTID=m2898c4b556392ee4c45706f17f8d0272
If a password is required, enter the meeting password: Abcde12345
Click "Join".

To join the audio conference only
Call-in toll-free number (US/Canada): 1-866-469-3239
Toll-free dialing restrictions: http://www.webex.com/pdf/tollfree_restrictions.pdf
Access code: 920 852 936

To add this September 29 meeting to your calendar program (for example Microsoft Outlook), click this link: https://transcanada.webex.com/transcanada/j.php?MTID=m1ef93700dc7030e4a83324684deb01c2

TC Initial Study Plan Meeting #2

Date: Friday, October 3, 2014
Time: 9:00 am, Eastern Daylight Time (New York, GMT-04:00)
Meeting Number: 920 135 487
Meeting Password: Abcde12345

To join the online meeting:
Link: https://transcanada.webex.com/transcanada/j.php?MTID=m0b8aa1bf41ae0836c28f0576458e3447
If a password is required, enter the meeting password: Abcde12345
Click "Join".

To join the audio conference only
Call-in toll-free number (US/Canada): 1-866-469-3239
Toll-free dialing restrictions: http://www.webex.com/pdf/tollfree_restrictions.pdf
Access code: 920 135 487

To add this September 29 meeting to your calendar program (for example Microsoft Outlook), click this link: https://transcanada.webex.com/transcanada/j.php?MTID=m232ebfba178296e4da63cb298dc64030

For assistance go to https://transcanada.webex.com/transcanada/mc
On the left navigation bar, click "Support"

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Initial Study Report

Volume II

September 15, 2014

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TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 7
Aquatic Habitat Mapping

Initial Study Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Prepared for
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September 15, 2014

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1. INTRODUCTION

This report presents the results of the 2013 Aquatic Habitat Mapping Study (ILP Study 7) conducted in support of Federal Energy Regulatory Commission (FERC) relicensing efforts by TransCanada Hydro Northeast Inc. (TransCanada) for the Wilder Hydroelectric Project (FERC Project No. 1892), Bellows Falls Hydroelectric Project (FERC No. 1855) and the Vernon Hydroelectric Project (FERC No. 1904). TransCanada has initiated the Integrated Licensing Process (ILP) for these projects in order to extend the term of their operating licenses beyond the current expiration date of April 30, 2018 for each project.

Operation of TransCanada's Wilder, Bellows Falls and Vernon hydroelectric projects may have potential effects on fish and aquatic resources in the associated impoundments, tailwaters and downstream riverine sections of the Connecticut River. Specifically, water level fluctuations and flow conditions at certain times may affect the ability of fish and other aquatic species to use aquatic habitats. Minimal information existed pertaining to characteristics, types, and proportions of aquatic habitat within the project impoundments, tailwaters and riverine reaches. Specific aquatic habitat data within all project reaches was lacking and this study served to fill those data gaps.

2. STUDY OBJECTIVES AND STATUS

2.1 Study Objectives

The goal of this study was to survey, identify and map aquatic habitat in the Wilder, Bellows Falls and Vernon project-affected impoundments, tailwaters, and downstream riverine reaches; and provide baseline information that can contribute to the assessment of potential effects under current licensed operations. The objective was to survey and map the aquatic habitat types distributed within the project impoundments, tailwaters, and downstream riverine reaches from the Wilder dam downstream to the upper extent of the Turners Falls Project impoundment, including the Bellows Falls bypassed reach.

Methodologies and results presented in this report for the identification and mapping of aquatic habitat in the study area is broken down into four categories: 1) Impoundment Bathymetry in Section 5 of this report), 2) Impoundment Aquatic Habitat Mapping in Section 6, 3) Riverine Aquatic Mesohabitat Mapping in Section 7, and 4) Water Surface Elevation Monitoring in Section 8.

2.2 Study Status

The Revised Study Plan for this study was approved without modification in FERC's February 21, 2014 Study Plan Determination; however, the deadline for filing of the Final Study Report was extended to March 1, 2015 in that determination.

The study had been largely completed in late 2013 with concurrence of the aquatics working group, and data consolidation occurred in early 2014. The Initial Study

Report was prepared in draft form and provided for working group review. Results and data from the study were summarized at a May 23, 2014 working group meeting. Impoundment bathymetry and habitat mapping data was provided to meeting attendees in Arc GIS format on CDs.

Nine water level loggers were left in the Connecticut River over the winter of 2013/2014 and were searched for in early June 2014. Three were not found and presumed lost or submerged under bottom sediment or debris. Time constraints due to higher flows from rain events during searches forced the early termination of this effort, but it is presumed that the remaining level logger is still in place and recording data. Five of the loggers were successfully retrieved, downloaded, and reinstalled; and replacement level loggers were installed at the three sites with missing level loggers (see Table 8-4).

Data retrieved in 2014 and 2015 from these level loggers and from level loggers installed for other studies (e.g., Study 2 – Riverbank Transect Study, Study 13 – Tributary and Backwater Fish Access and Habitat Study) will be incorporated into the Final Study Report and level logger database file.

3. PROJECT OVERVIEW

3.1 Wilder Hydroelectric Project

The Wilder Project's dam and powerhouse are located on the Connecticut River at river mile (RM) 217.4. Required minimum flow is 675 cubic feet per second (cfs) or inflow, whichever is less. A generated minimum flow of 700 cfs is supplied by the No. 3 turbine generator. The remaining two turbine units have operating capacities of 6,000 cfs. The riverine segment extends approximately 17 miles downstream to the upper extent of the Bellows Falls impoundment.

3.2 Bellows Falls Hydroelectric Project

The Bellows Falls Project consists of a dam located at RM 173.7 on the Connecticut River and a canal and powerhouse located approximately 1,700 feet downstream of the dam. Minimum flow of 1,083 cfs or inflow, whichever is less is required, with a generated minimum flow of 1,300 cfs. The impoundment extends upstream approximately 26 miles to Chase Island near the town of Windsor, Vermont, approximately 17.7 miles downstream of Wilder dam. The powerhouse consists of three turbines with a generating capacity 3,670 cfs each. The riverine segment extends approximately 6 miles downstream of the tailrace.

The Bellows Falls bypassed reach is approximately 3,500 ft in length and generally flow through the reach is due to dam leakage. Spill occurs into the reach when project capacity is exceeded. A fish barrier was constructed in 1996 in the lower portion of the reach to prevent fish from gaining access to the upper portion of the reach and possibly becoming stranded.

3.3 Vernon Hydroelectric Project

The Vernon dam and powerhouse are located on the Connecticut River at RM 141.9. The impoundment extends upstream about 26 miles to the Walpole Bridge (Route 123) at Westminster Station, Vermont, approximately 6 miles downstream of the Bellows Falls Project. The powerhouse consists of 10 generating units ranging in capacity from 1,465 cfs to 2,035 cfs. The segment from Vernon dam downstream approximately 1.5 miles may at times exhibit riverine characteristics, depending on operational scenarios at the Vernon project relative to those at the downstream Turners Falls Project (FERC No. 1889) and Northfield Mountain Pumped Storage Project (FERC No. 2485).

4. STUDY AREA

The study area includes all impounded and riverine segments of the Connecticut River from Wilder dam to just downstream of Vernon dam (Figure 4-1). There is a 45-mile impoundment associated with Wilder dam and 26-mile impoundments associated with each of the Bellows Falls and Vernon dams. Riverine segments consist of an approximate 17-mile segment downstream of Wilder dam, a 6-mile segment downstream of Bellows Falls dam, the approximately 3,500-foot long Bellows Falls bypassed reach, and an approximate 1.5-mile segment downstream of Vernon dam.

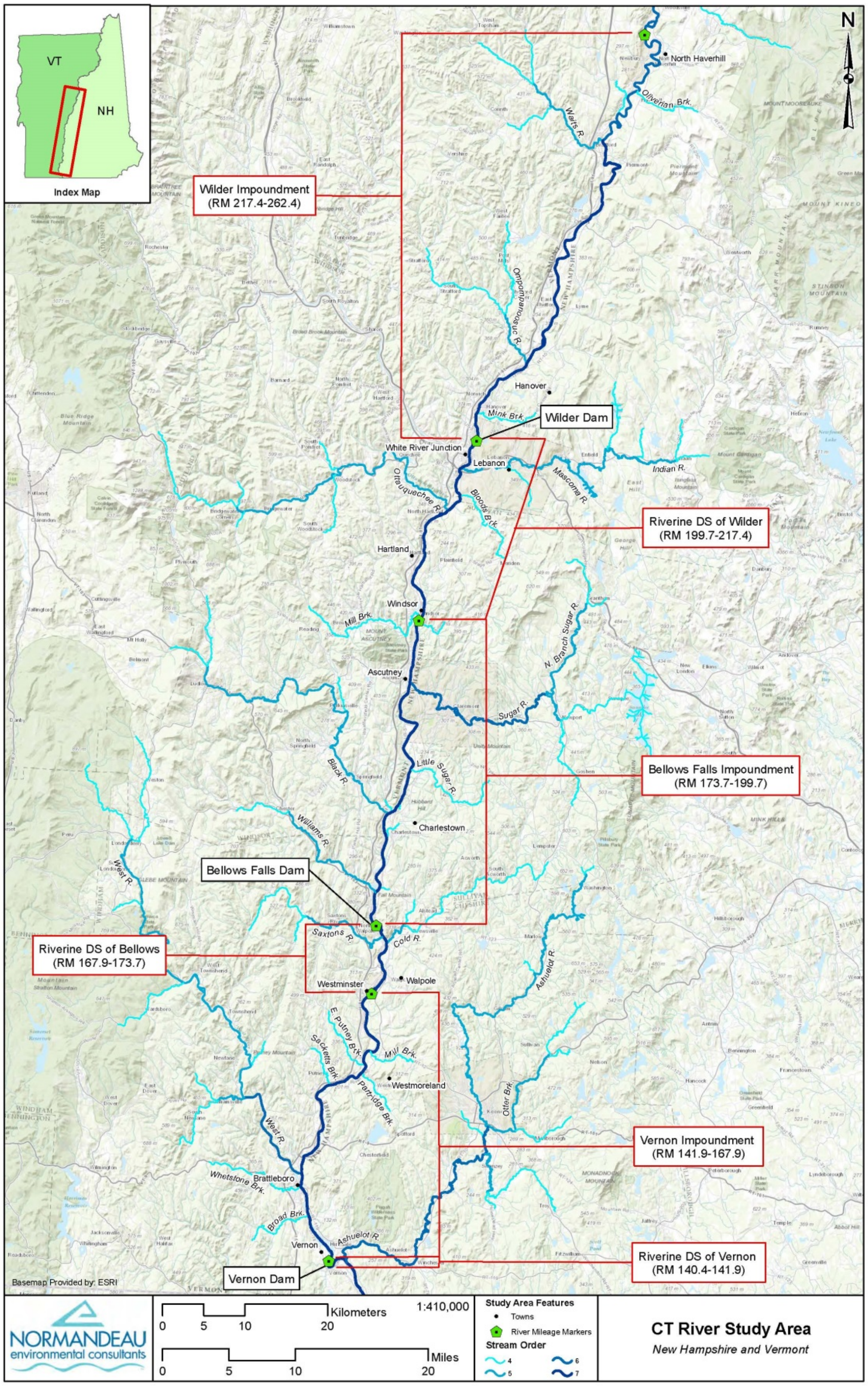


Figure 4-1. TransCanada Wilder, Bellows Falls, and Vernon hydroelectric projects study area.

5. IMPOUNDMENT BATHYMETRY

5.1 Field Methodology

Impoundment bathymetry mapping was collected using a 200-kHz Odom® Hydrotrac single-beam echosounder (<0.03-foot (~0.01-meter) vertical accuracy). Hypack hydrographic survey software was used for navigation and integration of the depth sounding and positional data collected using a Leica Viva GS14 Real Time Kinematic (RTK) unit. The RTK unit had a horizontal positioning accuracy of less than 0.03-inch (0.01-meter) and provided vertical water surface positional information at an accuracy of less than 0.1-foot (0.02-0.03 meter) to compensate for fluctuations in water levels as well as differentials in water surface elevations within each impoundment. This allowed the bathymetry survey to output river bed surface elevations by calculating the difference of the elevation of the survey vessel and the water depth while the survey was in progress.

Horizontal positioning was collected in NH state plane (NAD83, feet) coordinate system. The ping rate for the Odom Hydrotrac echosounder automatically adjusted based on sound speed and depth, but generally provided multiple soundings per second (<1m distance between soundings at a survey speed of three knots). Bathymetric data was collected along pre-determined survey lines and at a point density allowing for the determination of 1-ft contours throughout the study area.

5.2 Data Analysis and Processing

Bathymetric contours were constructed for the Wilder, Bellows Falls and Vernon impoundments using a combination of: 1) geo-referenced elevation data collected from wetted, boatable areas using a single-beam echosounder, 2) geo-referenced elevation data collected by RTK from wetted, wadeable areas, and 3) geo-referenced elevation data collected by aerial LiDAR sampling. LiDAR data was provided to Normandeau by U.S. Imaging. In addition to the LiDAR data set, U.S. Imaging supplied Normandeau with a geo-referenced "waterline" for each of the three impoundment areas. This "waterline" was created by U.S. Imaging based on the wetted area during their aerial photography of the project impoundments during early-May 2013.

Raw depth soundings were processed using HYPACK software to generate smoothed gridded XYZ coordinates in ASCII format. LiDAR data was subset to contain only points classified by U.S. Imaging as "ground" within a 300-ft buffer of the waterline. Sonar and LiDAR data were imported into Arc GIS software and an interpolation process based on the inherent spatial correlation structure of the data was used to generate 1-ft contours throughout the three project impoundments. Normandeau utilized ESRI's Advanced Arc GIS license, as well as their 3D and Spatial Analyst extensions to combine, process, and extrapolate the Sonar and LiDAR data. Data was converted to points and then a raster for each impoundment. From there, bathymetric contours were extracted from the rasters. All data was created in UTM Zone 18N, WGS84 Meters since the data from U.S. Imaging came in that coordinate system. However, all contour data elevations are in feet. The full pond polygons for each impoundment were a merge of the "waterline", which was created from the LiDAR interpolation by U.S. Imaging, and a contour polygon at the full pond elevation for each pond derived from LiDAR point data and Sonar point data by Normandeau. The final Wilder elevation was 385 feet, Bellows Falls elevation was 291.6 feet, and Vernon was 220 feet.

5.3 Results and Discussion

Bathymetry survey data was collected by boat between the dates of July 8 –July 25, 2013 in Vernon impoundment, July 26 – August 2, 2013 in Bellows Falls impoundment and August 7 – September 5, 2013 in Wilder impoundment. Additional bathymetric data was collected on foot from shallow water tributary and backwater confluence areas during September 2013 within all three project impoundments. Figures 5-1 through 5-3 present the bathymetry for Wilder, Bellows Falls and Vernon impoundments in raster format, which provides a color-coded view of each project impoundment broken down into 20-ft elevations. Bathymetric data is presented from an elevation of 385 feet in Wilder, 291.6 feet in Bellows Falls and 220 feet in Vernon down to the lowest elevation mapped in each impoundment (289' in Wilder, 206' in Bellows Falls, and 159' in Vernon). More detailed bathymetric data is provided electronically in association with this report.

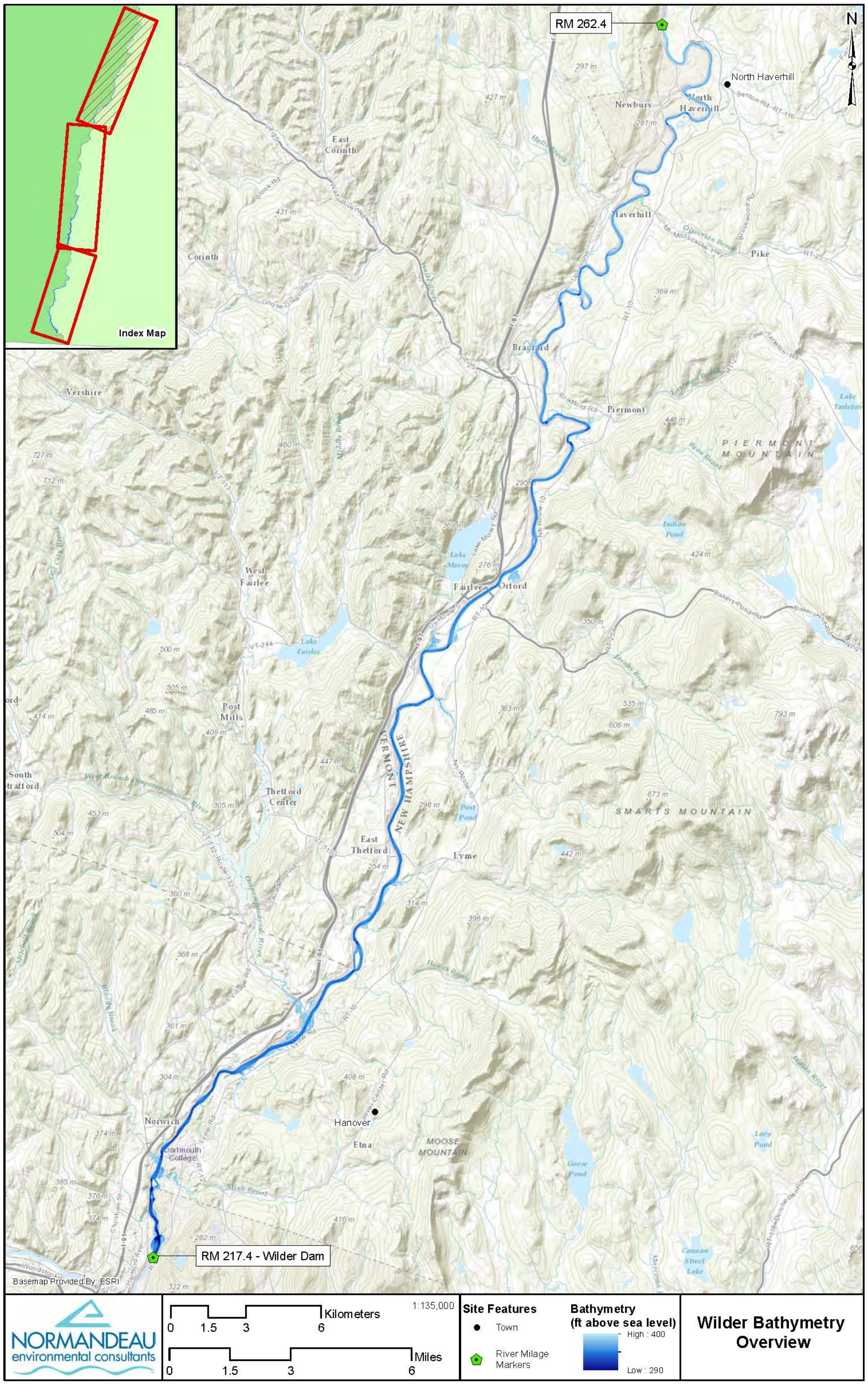


Figure 5-1. Wilder impoundment bathymetry depicted in 20-ft raster intervals.

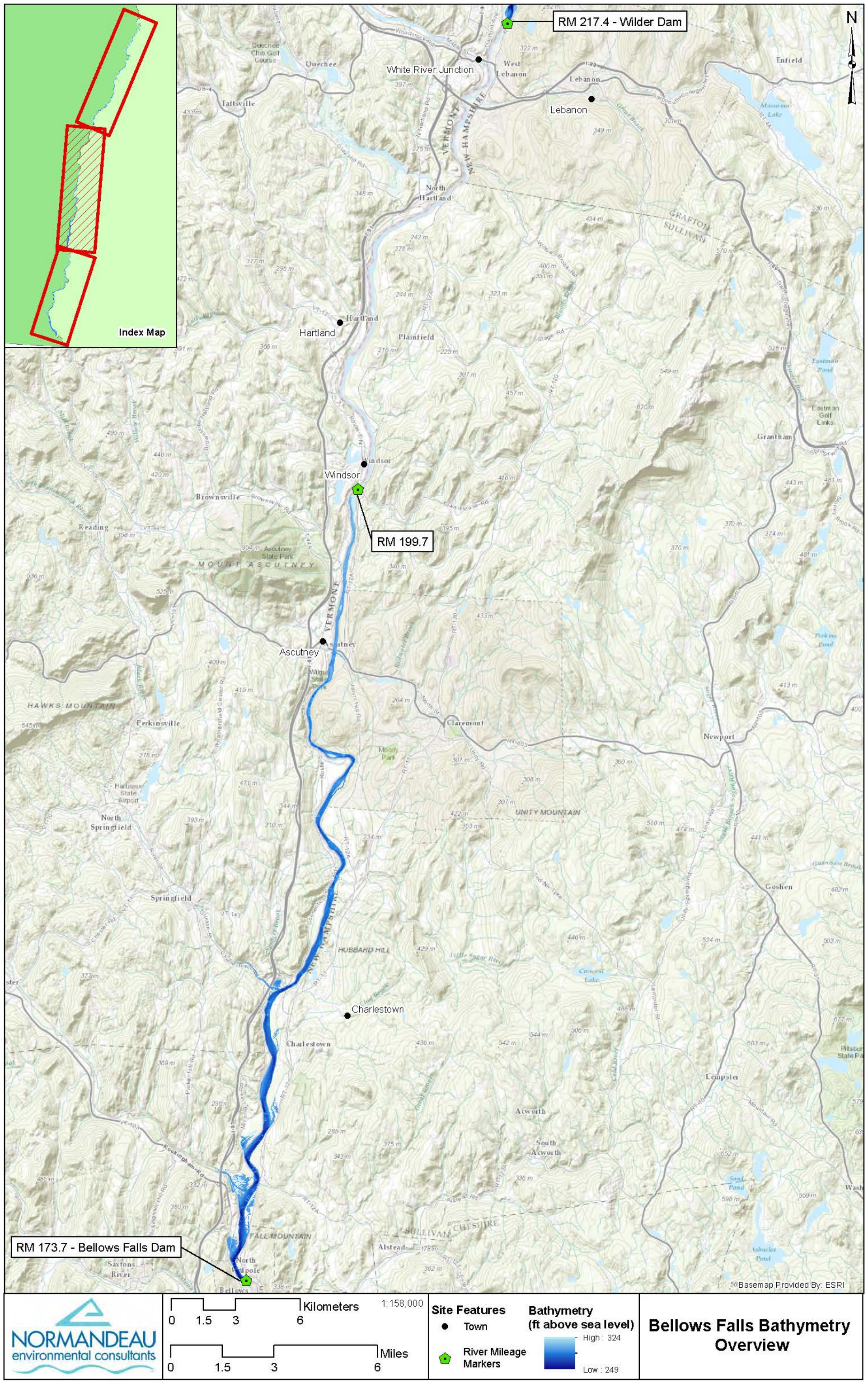


Figure 5-2. Bellows Falls impoundment bathymetry depicted in 20-ft raster intervals.

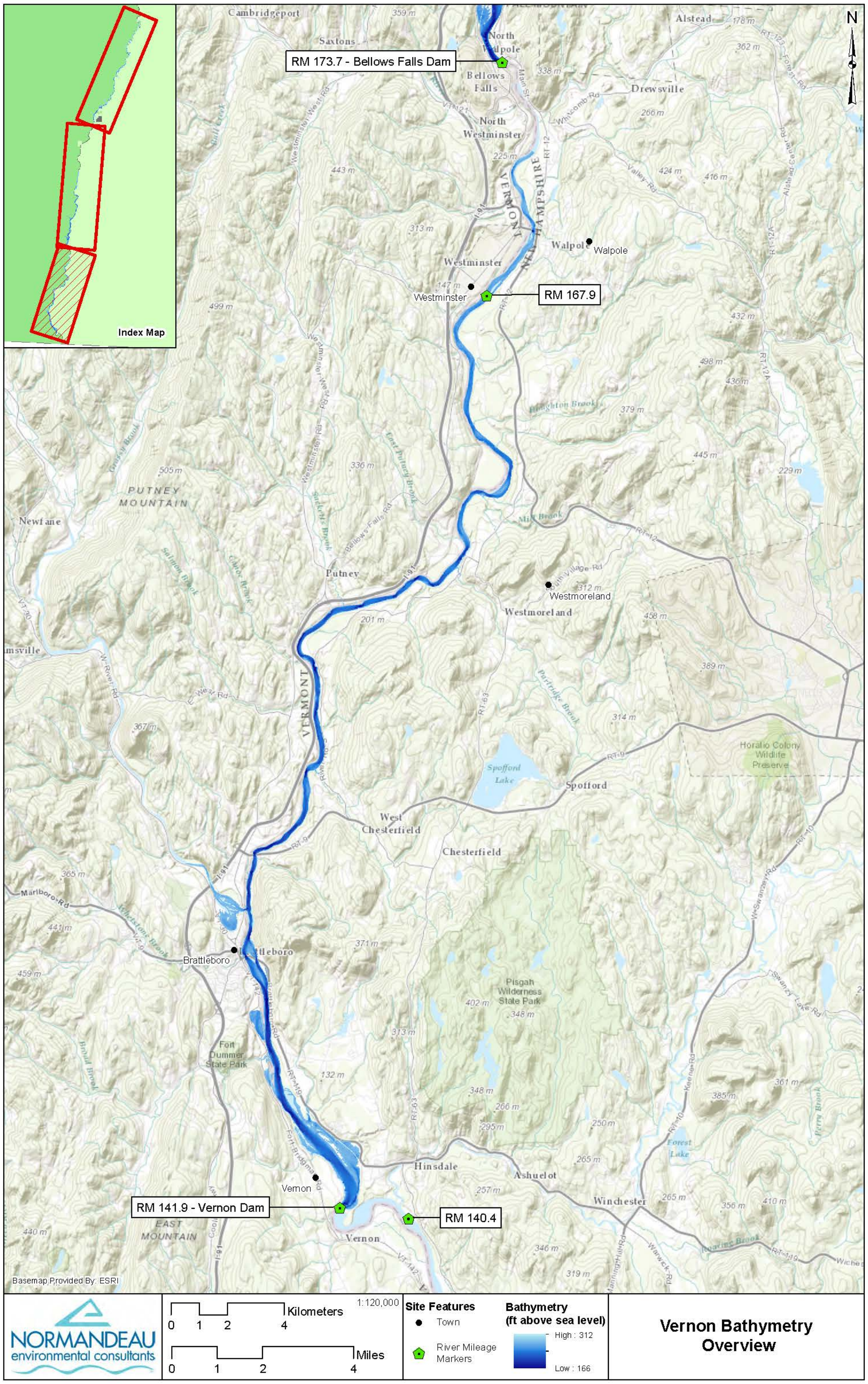


Figure 5-3. Vernon impoundment bathymetry depicted in 20-ft raster intervals.

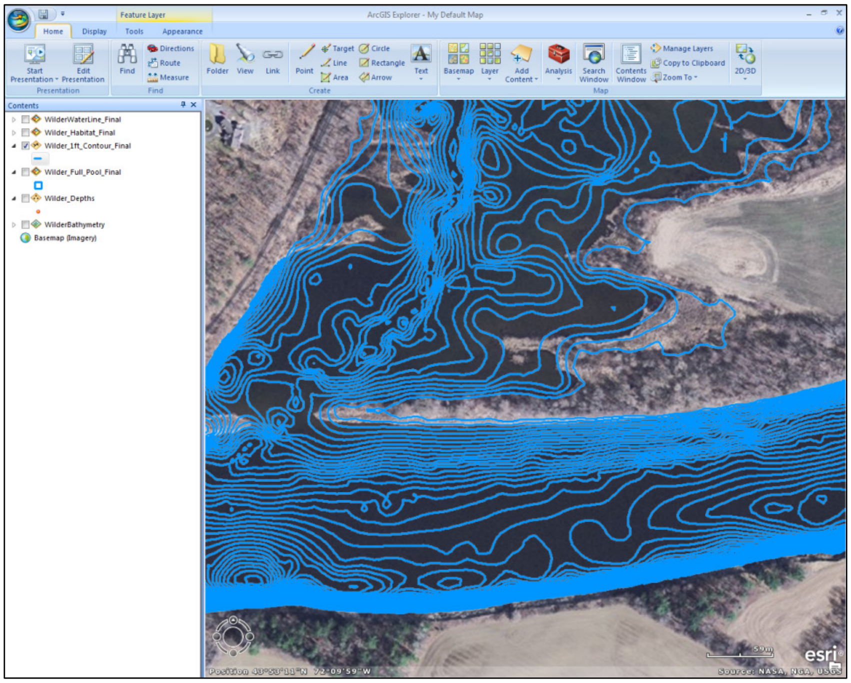


Figure 5-4. Example screen shot depicting content of the "1-ft-countour" layer contained within the geodatabase file for Wilder, Bellows Falls and Vernon impoundments.

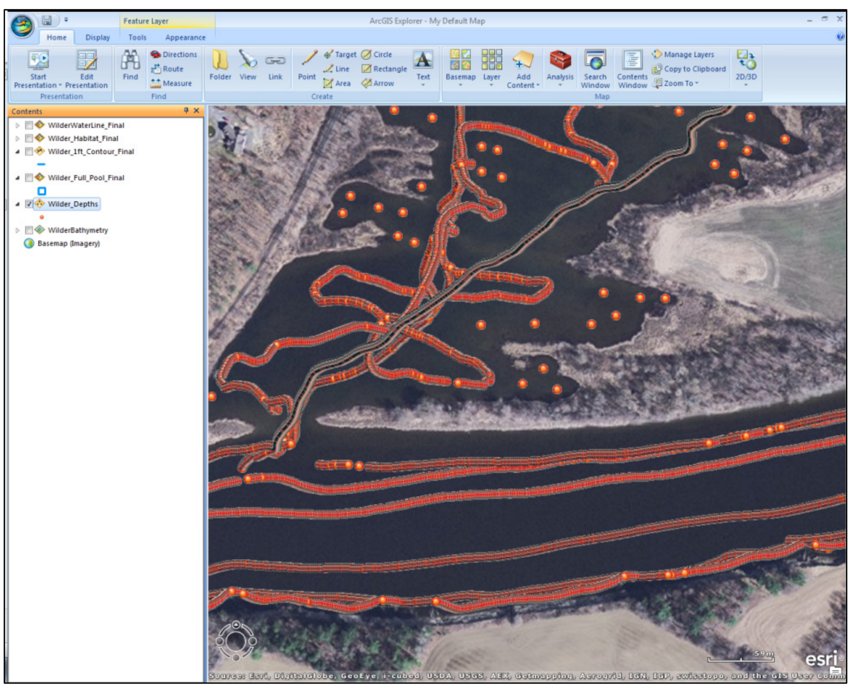


Figure 5-5. Example screen shot depicting content of the "depths" layer contained within the geodatabase file for Wilder, Bellows Falls and Vernon impoundments.

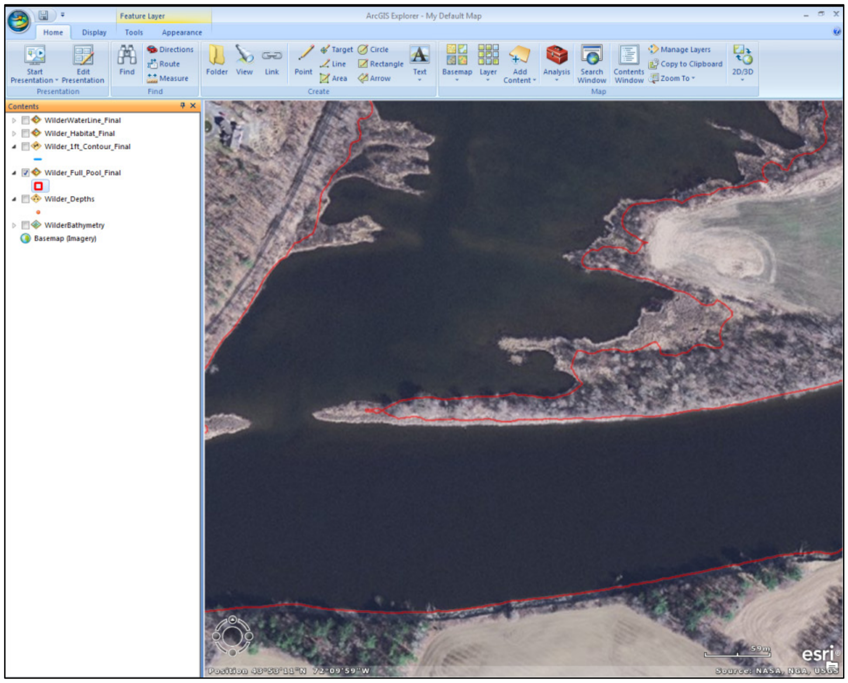


Figure 5-6. Example screen shot depicting content of the "Full Pool" layer contained within the geodatabase file for Wilder, Bellows Falls and Vernon impoundments.

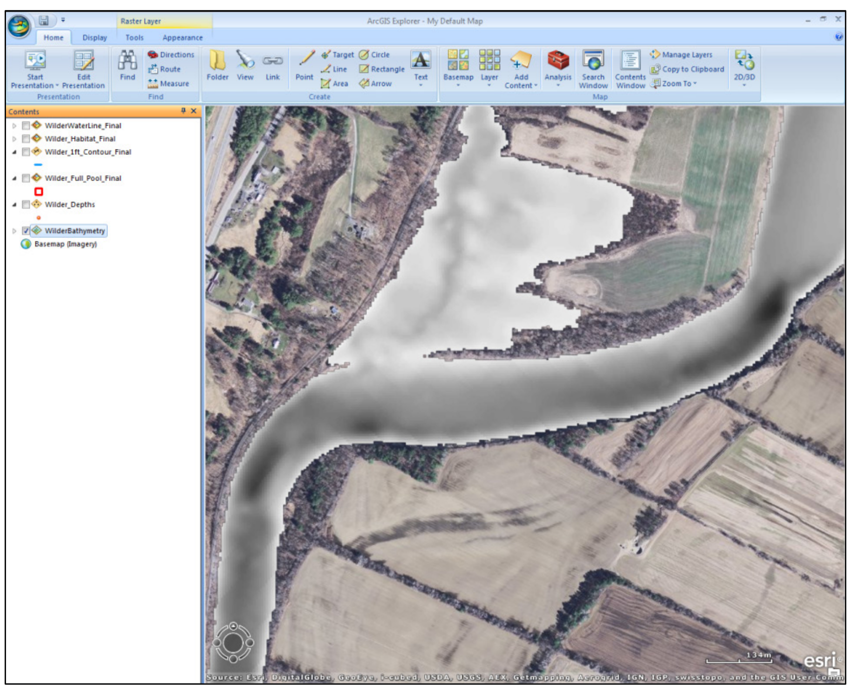


Figure 5-7. Example screen shot depicting content of the "Bathymetry" layer contained within the geodatabase file for Wilder, Bellows Falls and Vernon impoundments.

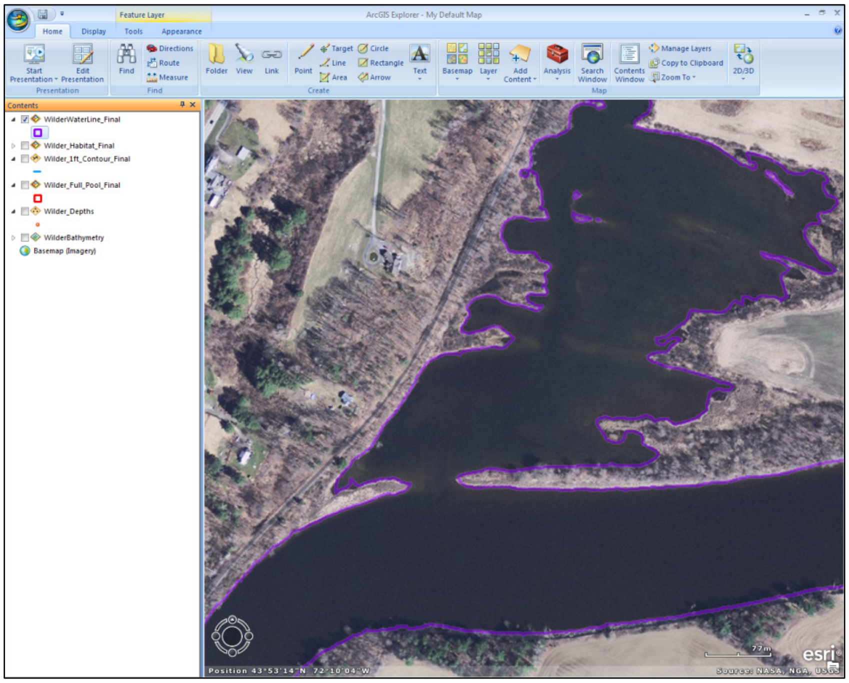


Figure 5-8. Example screen shot depicting content of the "Water Line" layer contained within the geodatabase file for Wilder, Bellows Falls and Vernon impoundments.

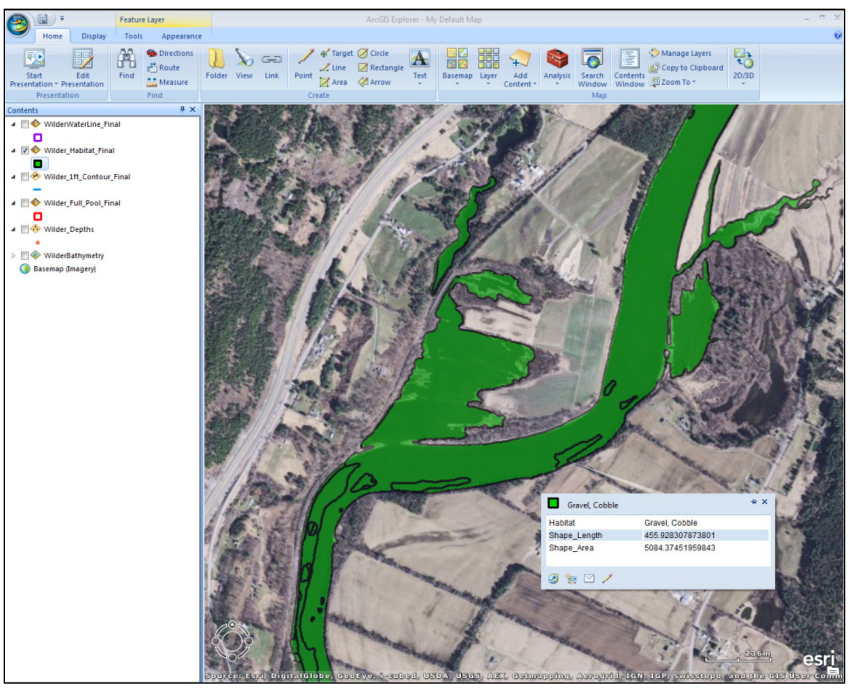


Figure 5-9. Example screen shot depicting content of the "Habitat" layer contained within the geodatabase file for Wilder, Bellows Falls and Vernon impoundments.

6. IMPOUNDMENT AQUATIC HABITAT MAPPING

6.1 Field Methodology

Sonar data was collected from the Wilder, Bellows Falls and Vernon impoundments using a Humminbird™ 1197c, side imaging unit. The Humminbird unit was used in conjunction with a Leica Viva GS14 Real Time Kinematic (RTK) unit to provide the precise coordinate information (horizontal positional accuracy of less than 0.03-inch (0.01-meter) necessary for geo-referencing captured images in the horizontal plane. The Humminbird transducer was positioned at the bow of a flat-bottom work-boat and was secured to a rigid mount. The operating frequency for the unit was set at 455 kHz for all surveys. Prior to data collection, survey lines within each impoundment were established in ArcGIS and were laid out in a manner which would provide full coverage of the bottom substrate within each impoundment during data collection. The number of survey lines needed for a particular reach of river was based on a combination of river width and the transducer's effective range. Data collection along shoreline areas for each impoundment was conducted by using a single side beam set at a range of 90 to 100 feet and along survey lines within the central portions of the three impoundments with the side beam range set at 100 to 140 feet per side. Collected data images were allowed to overlap to ensure full coverage of the bottom habitat. Boat speed was maintained at 2.5 to 4.5 knots during all data collection.

Portions of the Wilder, Bellows Falls and Vernon impoundments could not be mapped using side scan sonar due to shallow water depths or dense beds of aquatic vegetation. These areas included the majority of backwater and tributary confluence areas over the entire project reach. In cases where habitat could not be mapped by boat-mounted sonar, habitat was mapped manually. Geo-referenced substrate classifications were recorded using a method appropriate to the site-specific conditions (e.g., view tube, ponar sample, wading and visual determination).

6.2 Data Analysis and Processing

Sonar image data was processed by placing each individual sonar image into its geo-spatially correct map location, interpreting their content and finally, creating polygons representing each unique habitat area. Sonar images were geo-rectified using a combination of ArcGIS, IrfanView graphic editor and scripted software tools developed at the Georgia Department of Natural Resources (Kaeser and Litts, 2010).

Sonar images were processed by cropping to remove display information, and then cropped again based on overlap with the adjacent images along the boat's path. Accurate waypoint and track data were imported into ArcGIS and were cropped to reflect the areas where valid data was obtained. The positional information was used to accurately reference the sonar imagery to its proper place along the river bottom. The positional information and the distance from the center of the boat was entered into one of the scripted sidescan processing tools to create a network of points for each image. This resulted in a text file for each habitat survey image containing points used to rectify each image to their corresponding location on the ground. The text files and images were then merged into mosaic groups of 10-15 images. The SPLINE transformation solution (Powell, 1995) was applied to these mosaics so that they fit with the points assigned to the images along the curve of the tracks. Each group of georectified images became a 2-4 inch resolution GIS layer file in JPEG format with an associated word file that contains information used to project the image onto a map. The resulting layer files were subjected to visual quality control inspection for positional accuracy and image quality.

Lines were drawn as borders between the habitat types as observed from scales ranging from 1:300 to 1:427 (Figure 6-1). Borders were interpreted by observing changes in surface texture, signal amplitude, and habitat indicator patterns (e.g. sand waves). Slant range correction was not performed on sonar imagery to correct distortion. The dark area in the center of the side scan image represents the water column and the total dark area has a direct relationship with the depth. Distortion occurs near the beams interface with the bottom as the image is compressed to represent the area near the boat path and the water column in the same space. Therefore, in deeper areas (>10 feet) it became necessary to interpret substrates that appear just outside the water column as if they extended under the boat's position. Border lines were converted into polygons and habitat types were assigned to each created polygon unit. A total of six substrate types were identified based on dominant habitat types: 1) sand/silt/clay, 2) gravel/cobble, 3) boulder, 4) rip-rap, 5) ledge, and 6) woody debris. Figures 6-2 through 6-7 provide examples for the six habitat types classified from the sonar imagery. The habitat types were delimited with a predetermined precision of ±100 square feet (0.0023 acres). However, in most cases habitats smaller than this area or habitat borders were discernable at a greater resolution and were mapped at a higher precision.

The final product produced from this process was a GIS layer containing the aquatic habitat types for each of the three impoundments. Figure 6-8 provides an example screenshot of the polygon creation process and the corresponding GIS habitat layer. The total area (acres) for the six habitat types found in each of the three surveyed impoundments was quantified. When the aquatic habitat shapefile is combined with the bathymetric data collected in the Wilder, Bellows Falls and Vernon impoundments (Section 5.0), total square area (by habitat type) watered or dewatered can be determined for elevations at one-ft increments.

6.3 Results and Discussion

Sonar habitat data was collected by boat between the dates of July 8 –July 25, 2013 in Vernon impoundment, July 26 – August 2, 2013 in Bellows Falls impoundment and August 7 – September 5, 2013 in Wilder impoundment. Additional habitat data was collected on foot from shallow water tributary and backwater confluence areas during September 2013 within all three project impoundments. Figures 6-9 through 6-17 present the mapped habitat within the

Wilder, Bellows Falls and Vernon impoundments. More detailed data is provided electronically in association with this report.

Within the Wilder impoundment, a total of 3,028 acres of total aquatic habitat was delineated during the 2013 survey (Table 6-1, Figures 6-9 through 6-11). The majority (76.2%) of the mapped area consisted of the sand/silt/clay habitat type. Gravel-cobble (14.9% of total aquatic habitat area), boulder (3.3% of total aquatic habitat area), and woody debris (3.0% of total aquatic habitat area) were present in lesser amounts. Artificially created rip-rap habitat comprised a total of 52 acres (1.7% of total aquatic habitat area) within the Wilder impoundment.

Within the Bellow Falls impoundment, a total of 2,921 acres of total aquatic habitat was delineated during the 2013 survey (Table 6-2, Figures 6-12 through 6-14). The majority (83.9%) of the mapped area consisted of the sand/silt/clay habitat type. Gravel-cobble (11.9% of total aquatic habitat area), boulder (1.7% of total aquatic habitat area), and woody debris (1.5% of total aquatic habitat area) were present in lesser amounts. Artificially created rip-rap habitat comprised a total of 25 acres (0.9% of total aquatic habitat area) within the Bellows Falls impoundment.

Within the Vernon impoundment, a total of 3,137 acres of total aquatic habitat was delineated during the 2013 survey (Table 6-3, Figures 6-15 through 6-17). The majority (72.5%) of the mapped area consisted of the sand/silt/clay habitat type. Gravel-cobble (20.8% of total aquatic habitat area), woody debris (2.7% of total aquatic habitat area), and boulder (1.7% of total aquatic habitat area), were present in lesser amounts. Artificially created rip-rap habitat comprised a total of 44 acres (1.4% of total aquatic habitat area) within the Vernon impoundment.

Table 6-1. Total area (acres) and percent of total area for six aquatic habitat types mapped using sonar imagery within the Wilder impoundment.

Habitat Type	Area (acres)	% of Total
sand/silt/clay	2,308.9	76.2%
gravel/cobble	450.1	14.9%
boulder	100.0	3.3%
rip rap	52.6	1.7%
ledge	26.1	0.9%
woody debris	90.7	3.0%
TOTAL	3,028.5	100.0%

Table 6-2. Total area (acres) and percent of total area for six aquatic habitat types mapped using sonar imagery within the Bellows Falls impoundment.

Habitat Type	Area (acres)	% of Total
sand/silt/clay	2,450.9	83.9%
gravel/cobble	348.7	11.9%
boulder	49.9	1.7%
rip rap	25.4	0.9%
ledge	3.8	0.1%
woody debris	43.0	1.5%
TOTAL	2,921.8	100.0%

Table 6-3. Total area (acres) and percent of total area for six aquatic habitat types mapped using sonar imagery within the Vernon impoundment.

Habitat Type	Area (acres)	% of Total
sand/silt/clay	2,273.1	72.5%
gravel/cobble	653.6	20.8%
boulder	53.8	1.7%
rip rap	44.3	1.4%
ledge	27.2	0.9%
woody debris	85.2	2.7%
TOTAL	3,137.2	100.0%

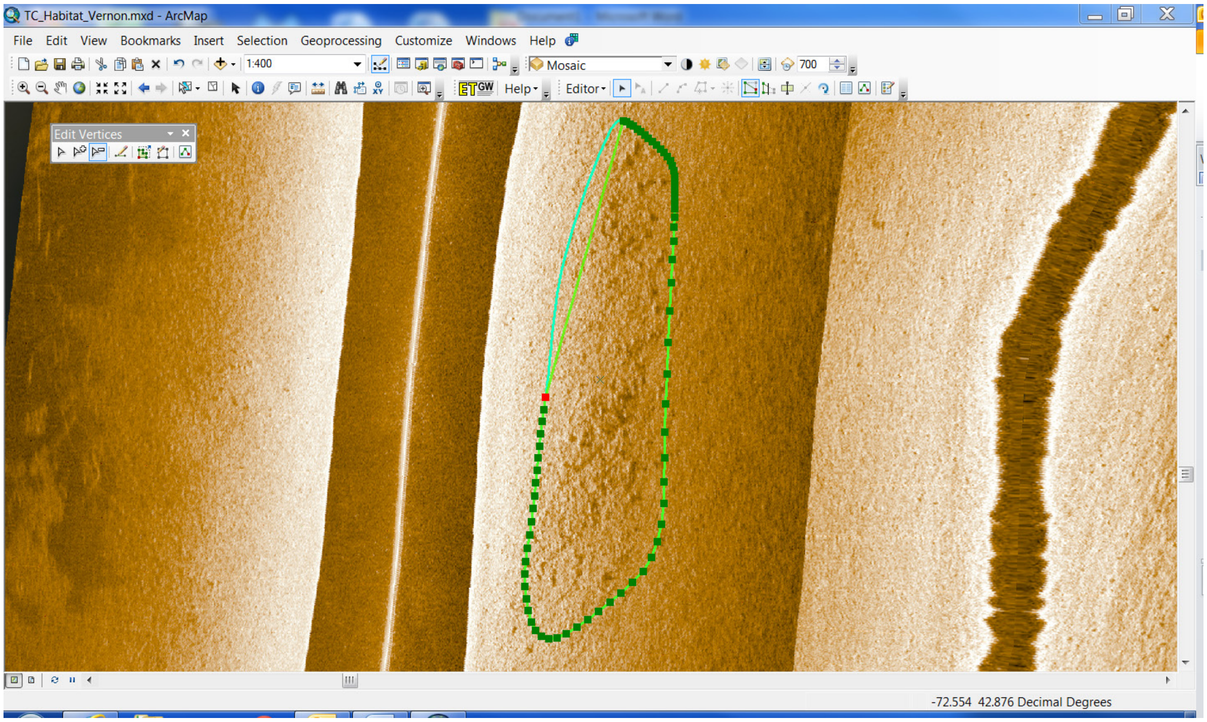


Figure 6-1. Example screen shot showing the creation of polygon units as borders around unique habitat types. Example showing boulder outcrop within gravel-cobble habitat.

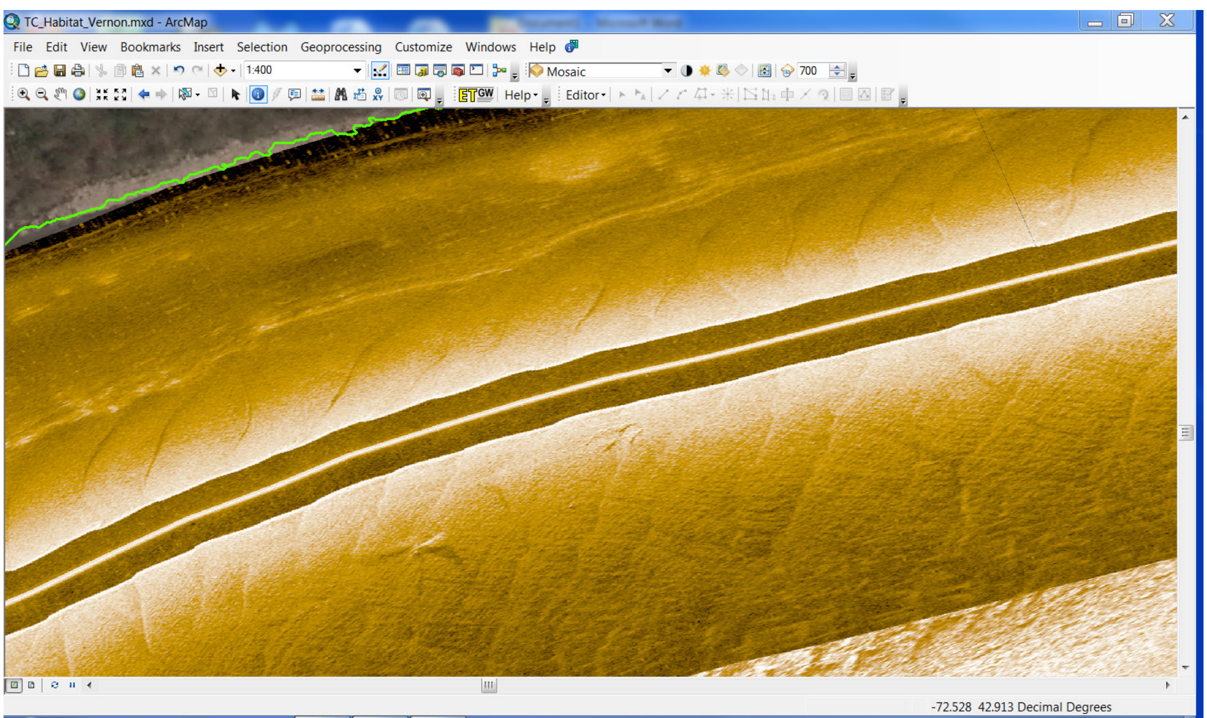


Figure 6-2. Example of sand/silt/clay as classified from sonar imagery for the Wilder, Bellows Falls and Vernon habitat surveys.

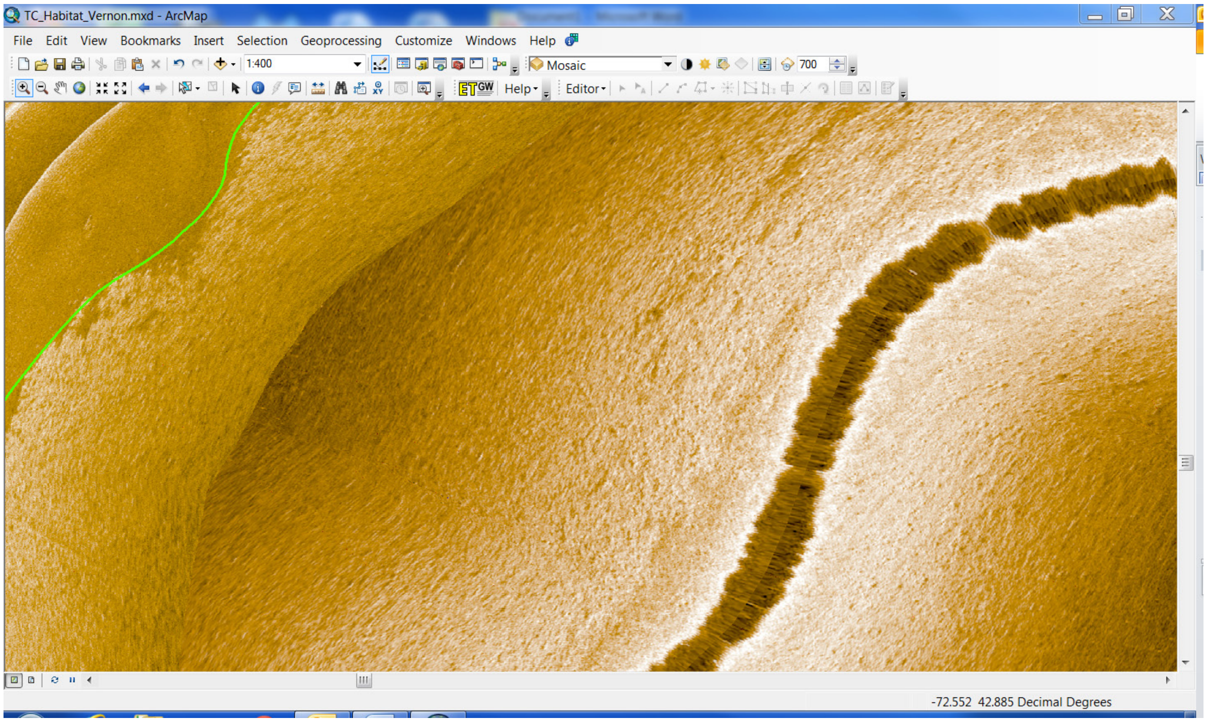


Figure 6-3. Example of gravel/cobble as classified from sonar imagery for the Wilder, Bellows Falls and Vernon habitat surveys.

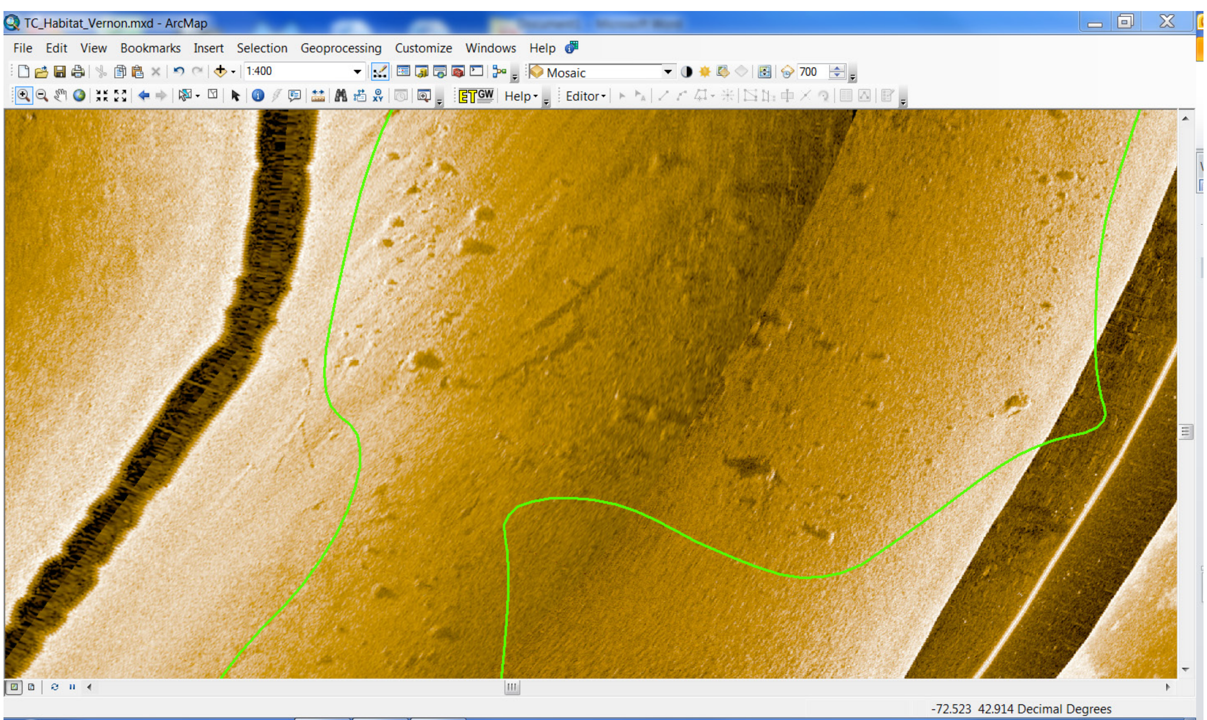


Figure 6-4. Example of boulder as classified from sonar imagery for the Wilder, Bellows Falls and Vernon habitat surveys.

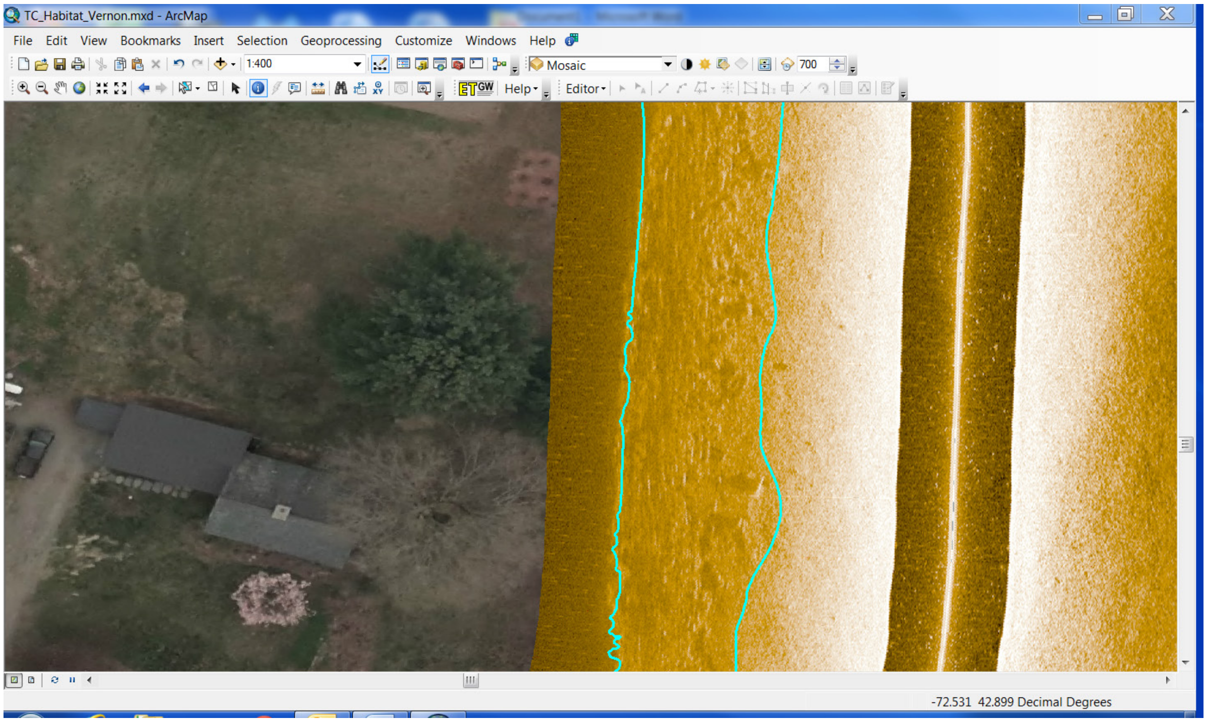


Figure 6-5. Example of rip-rap as classified from sonar imagery for the Wilder, Bellows Falls and Vernon habitat surveys.

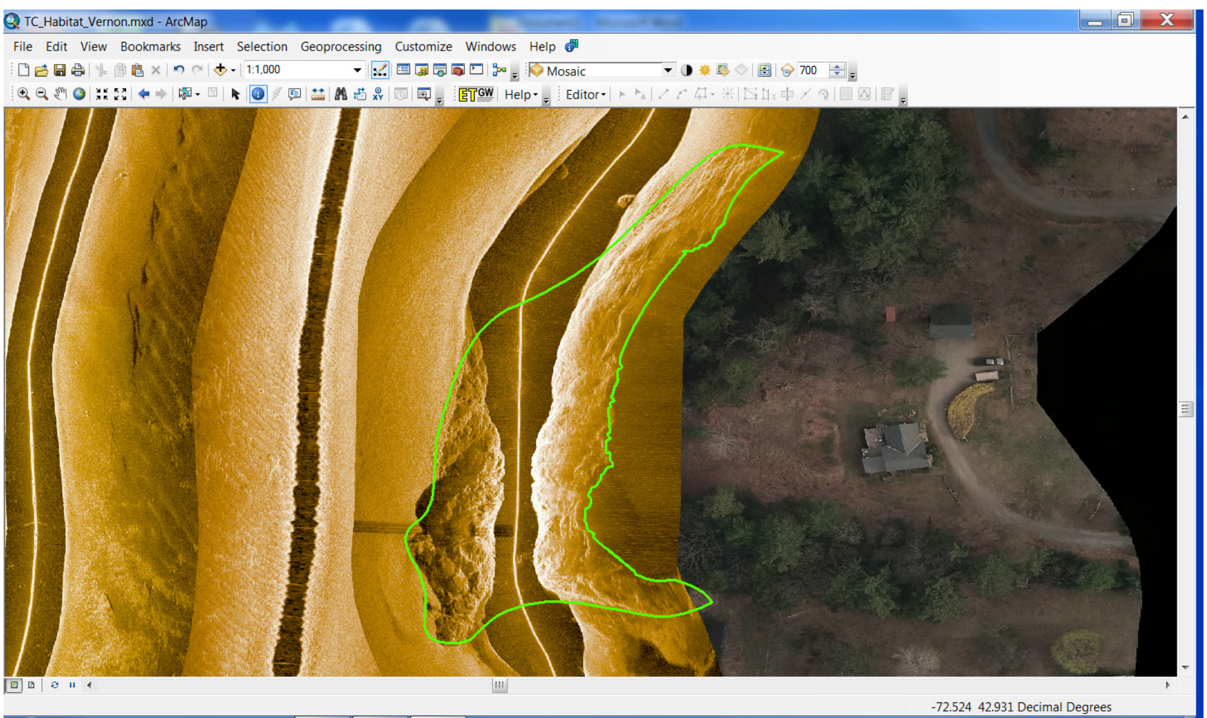


Figure 6-6. Example of ledge as classified from sonar imagery for the Wilder, Bellows Falls and Vernon habitat surveys.

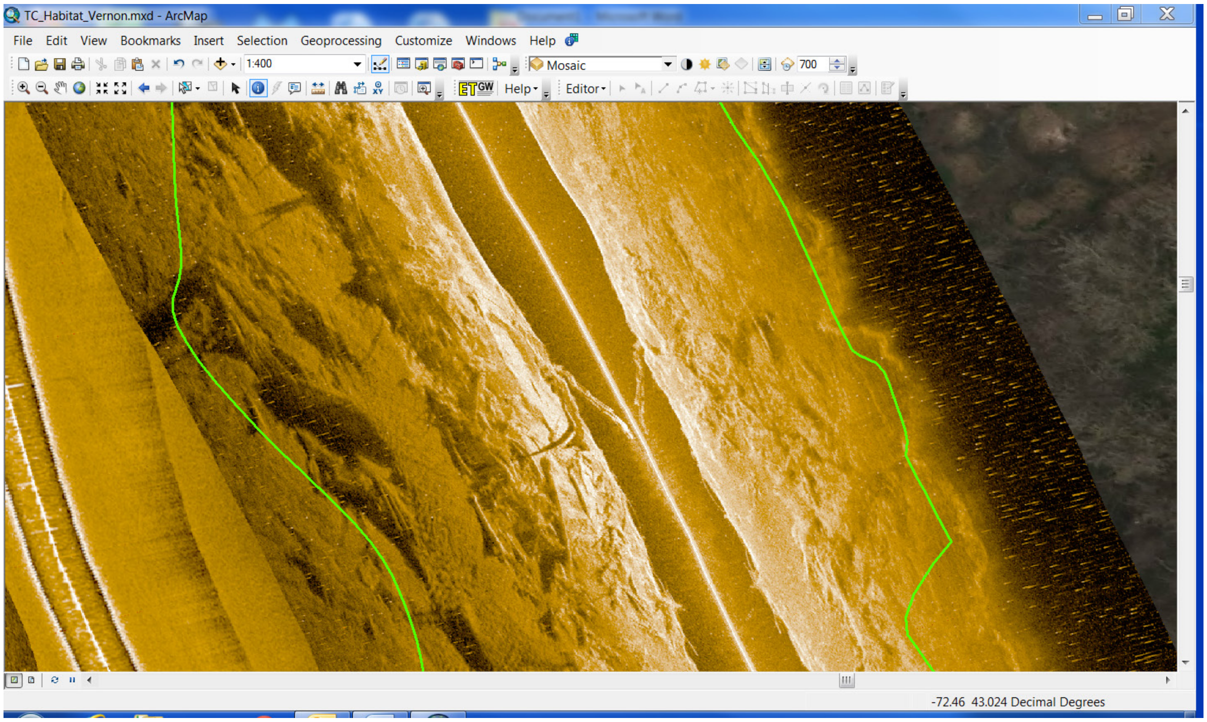


Figure 6-7. Example of woody debris as classified from sonar imagery for the Wilder, Bellows Falls and Vernon habitat surveys.

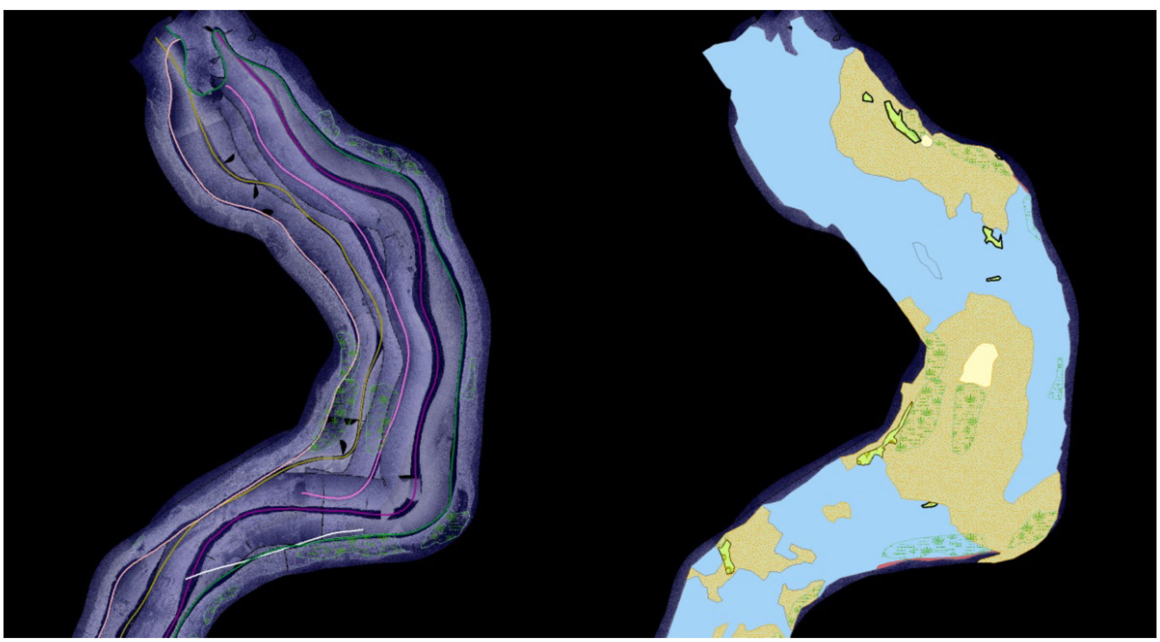


Figure 6-8. Screen shots showing polygon creation overlaying stitched sonar data files (left image) and resulting GIS habitat product (right image) created from sonar imagery for the Wilder, Bellows Falls and Vernon habitat surveys.

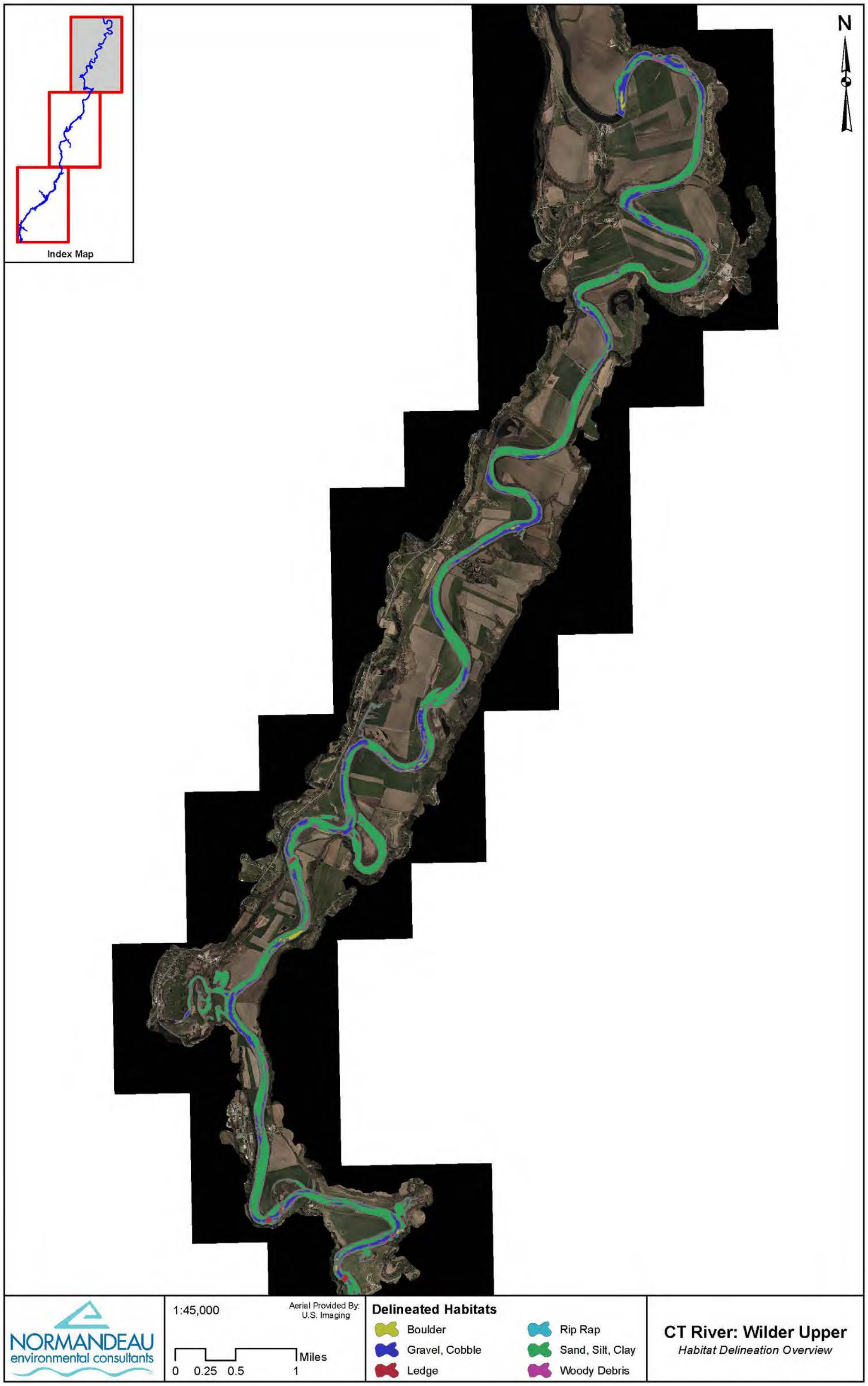


Figure 6-9. Overview of upper Wilder impoundment aquatic habitat.

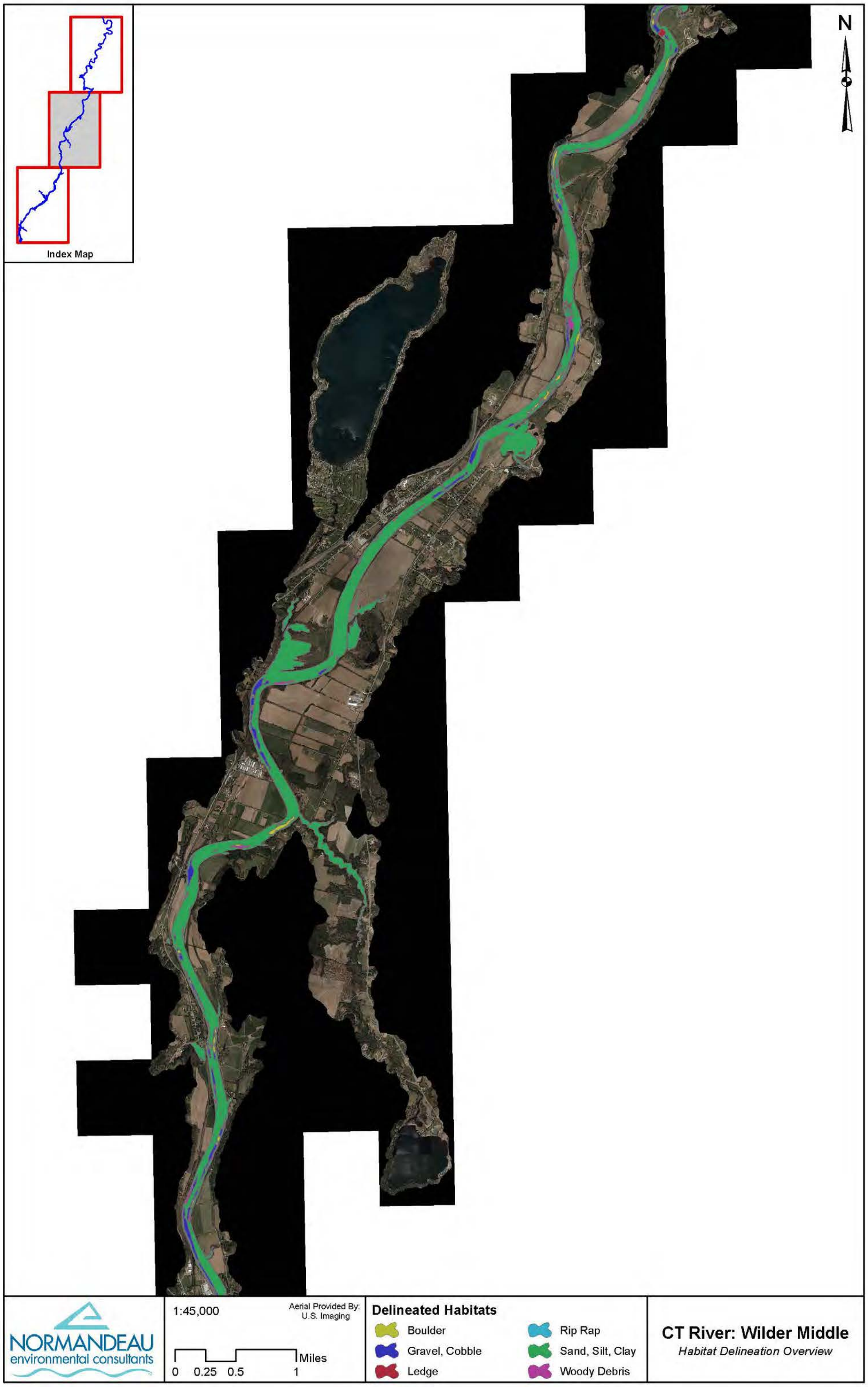


Figure 6-10. Overview of middle Wilder impoundment aquatic habitat.

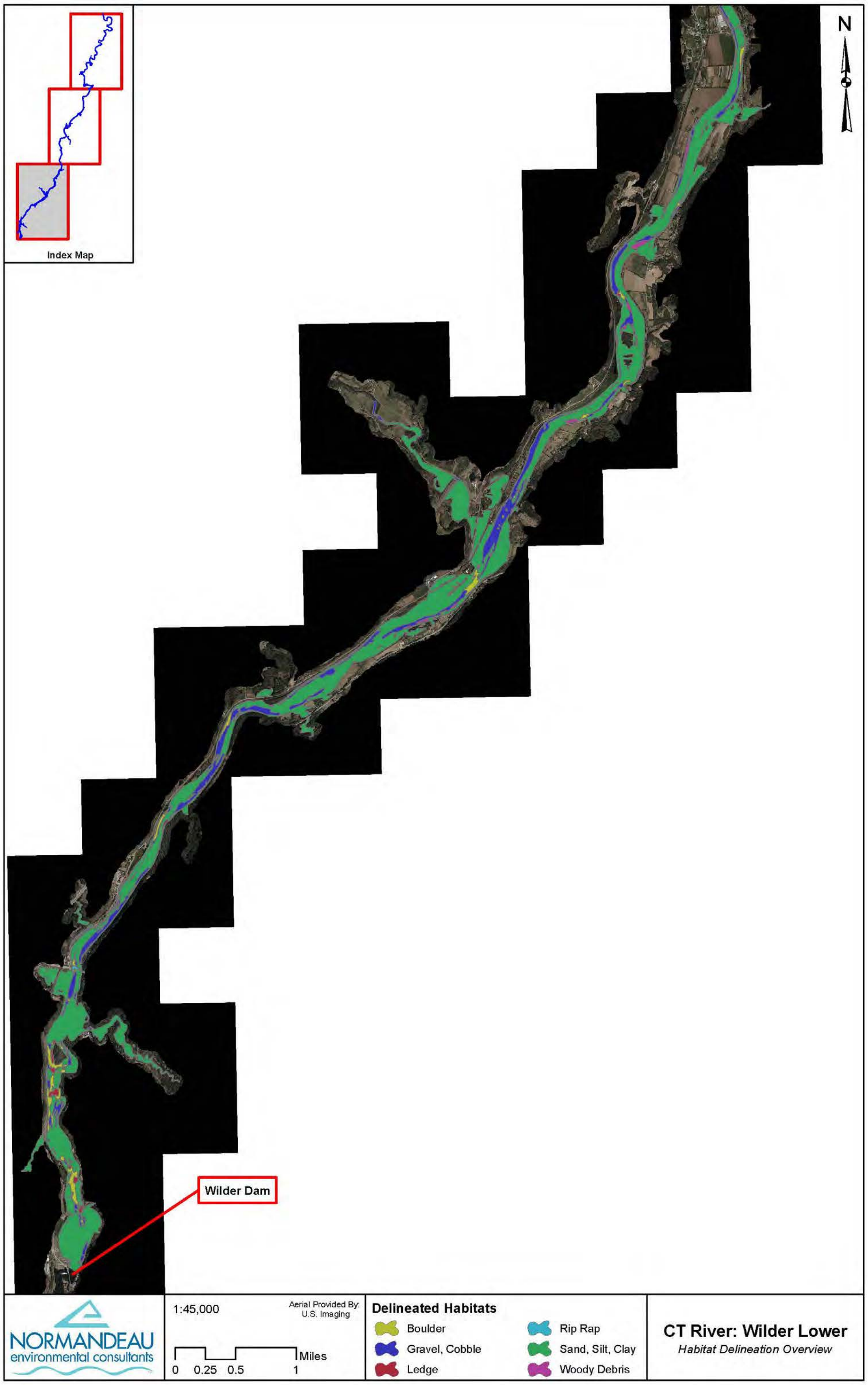


Figure 6-11. Overview of lower Wilder impoundment aquatic habitat.

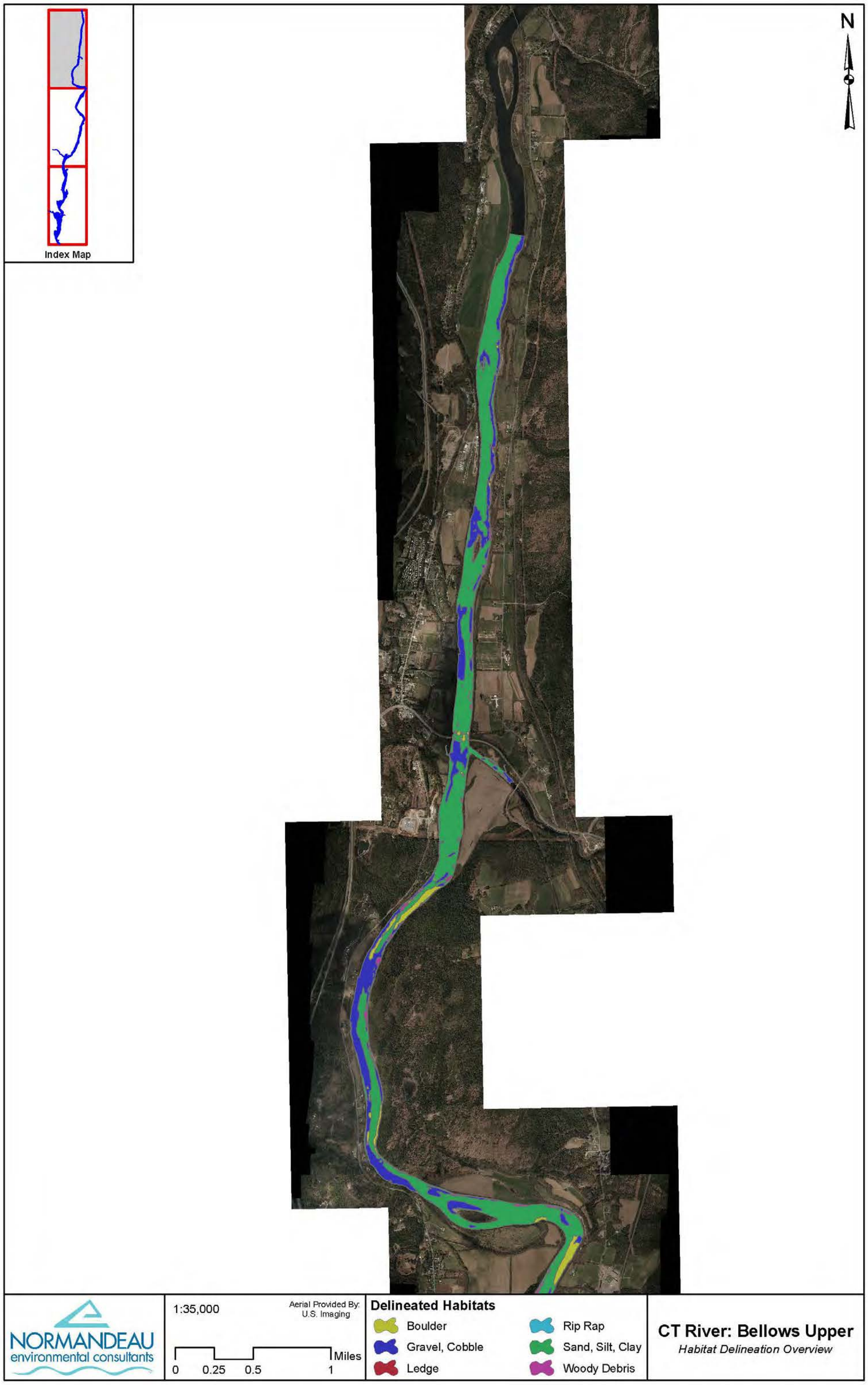


Figure 6-12. Overview of upper Bellows Falls impoundment aquatic habitat.

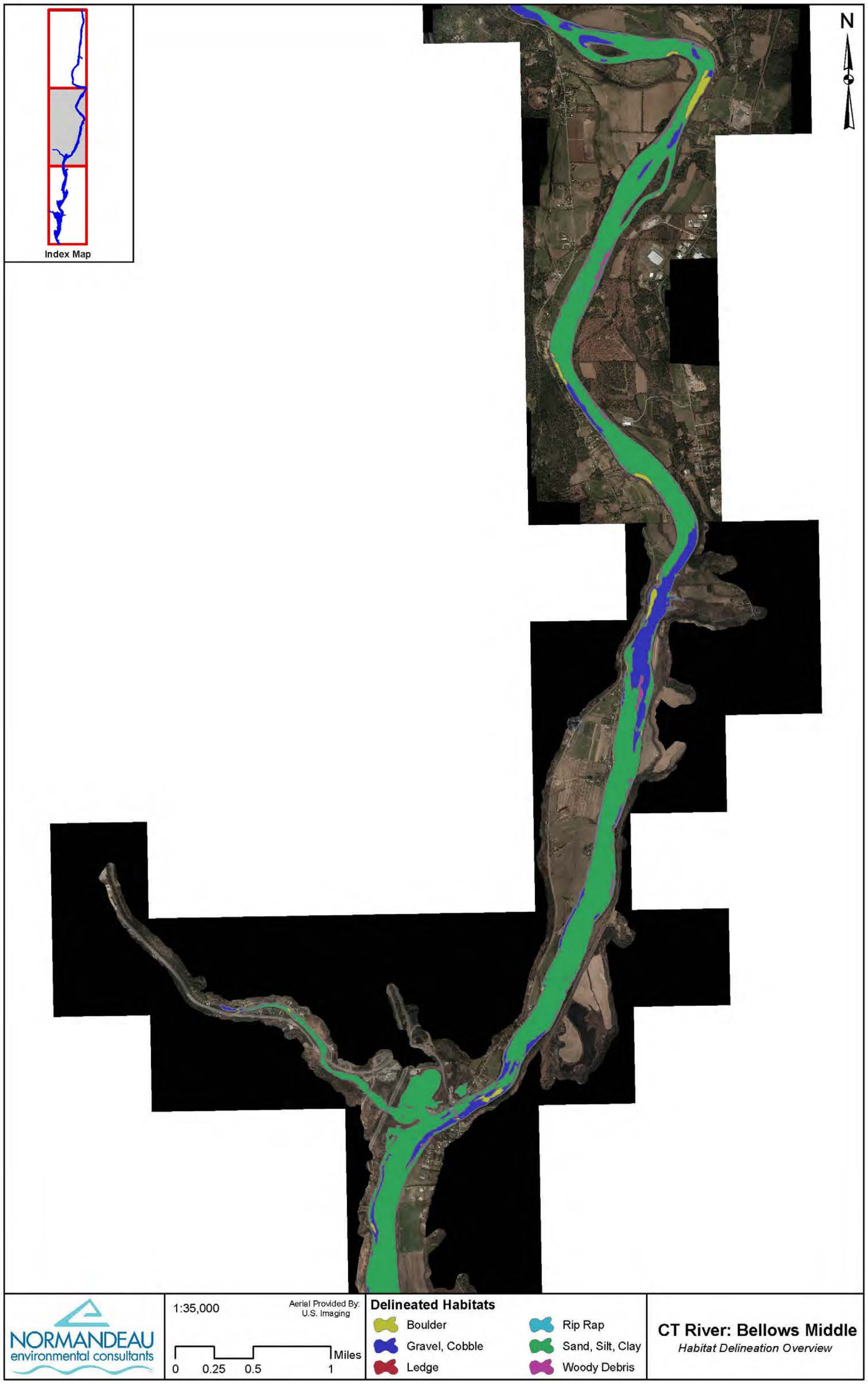


Figure 6-13. Overview of middle Bellows Falls impoundment aquatic habitat.

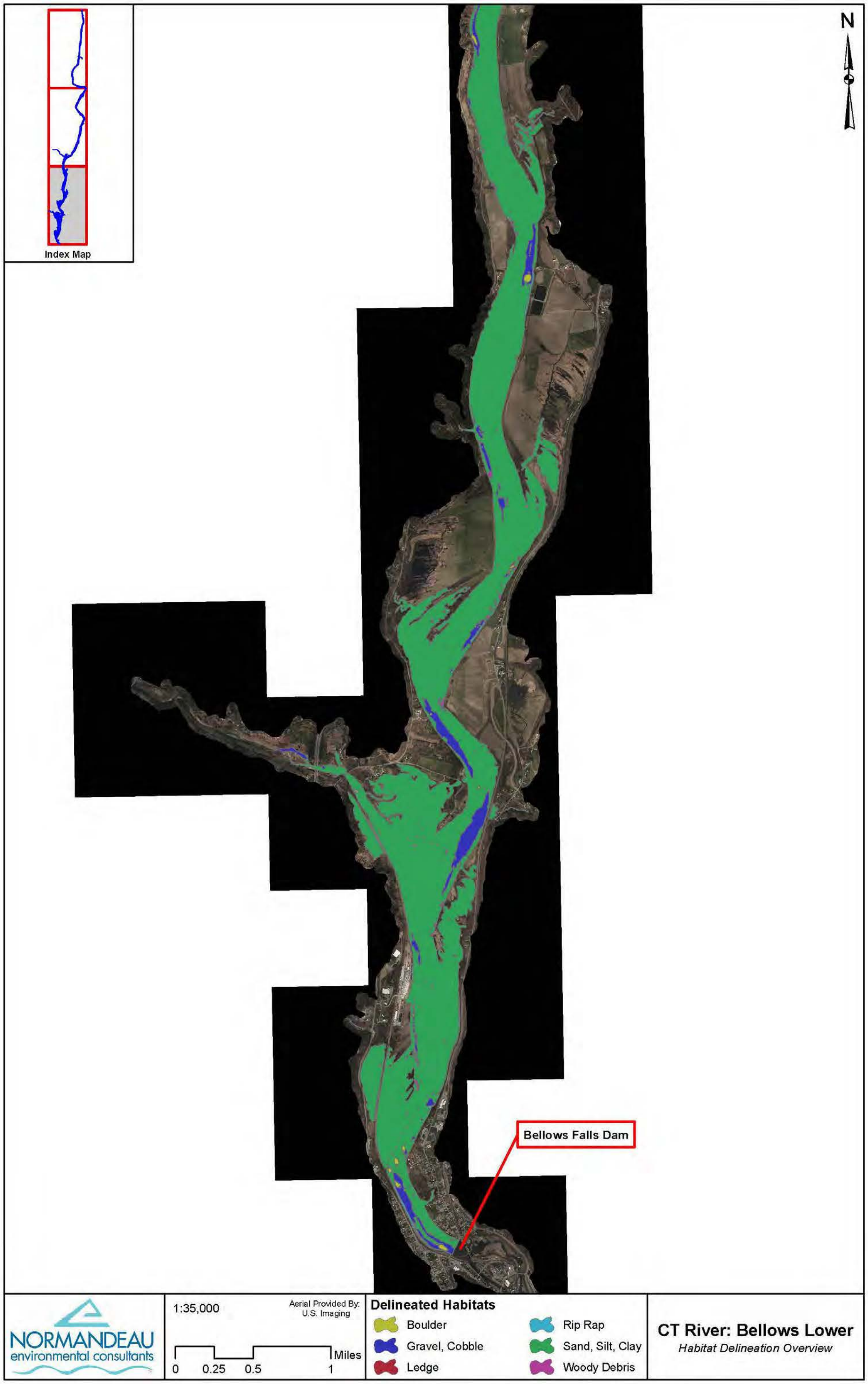


Figure 6-14. Overview of lower Bellows Falls impoundment aquatic habitat.

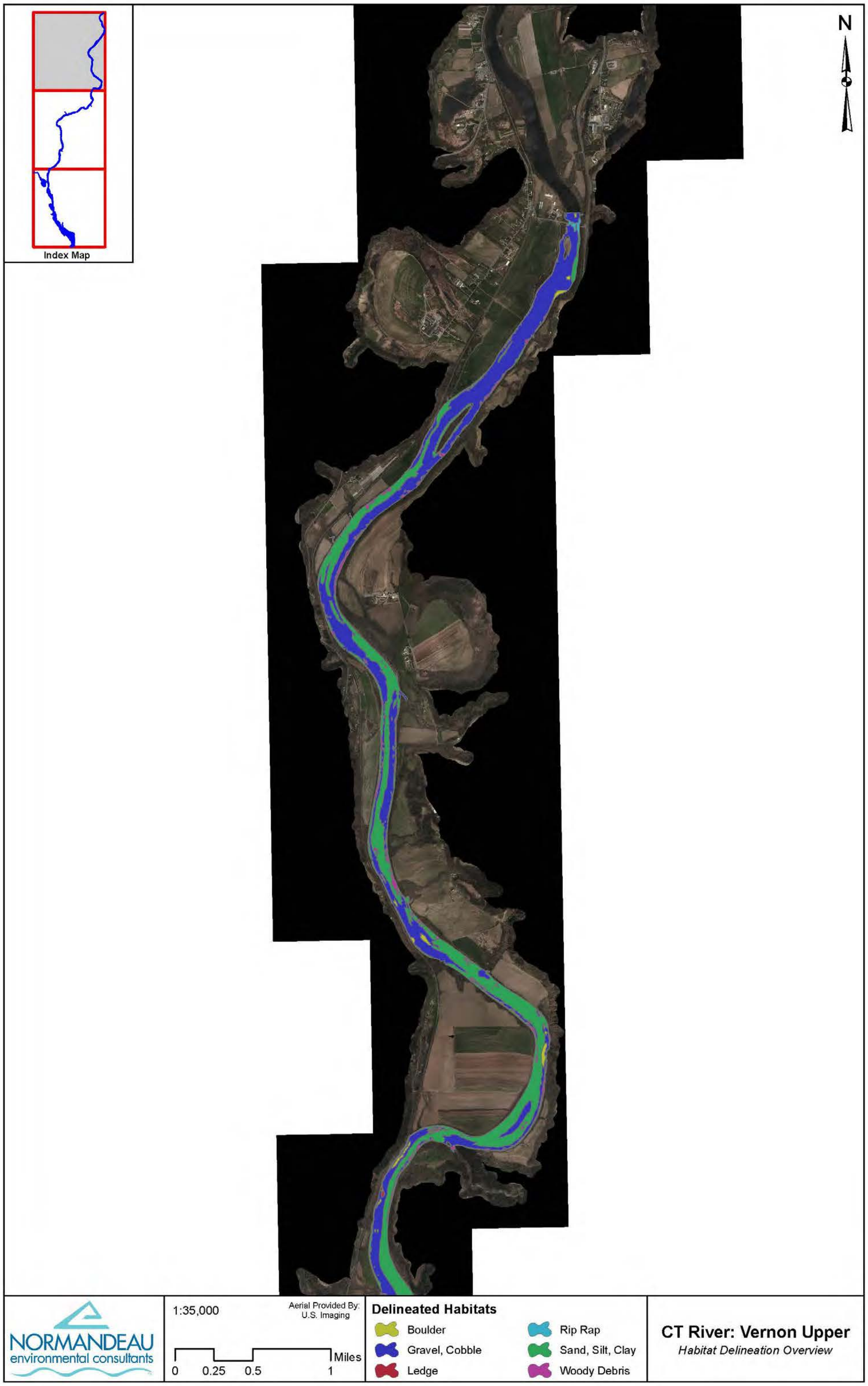


Figure 6-15. Overview of upper Vernon impoundment aquatic habitat.

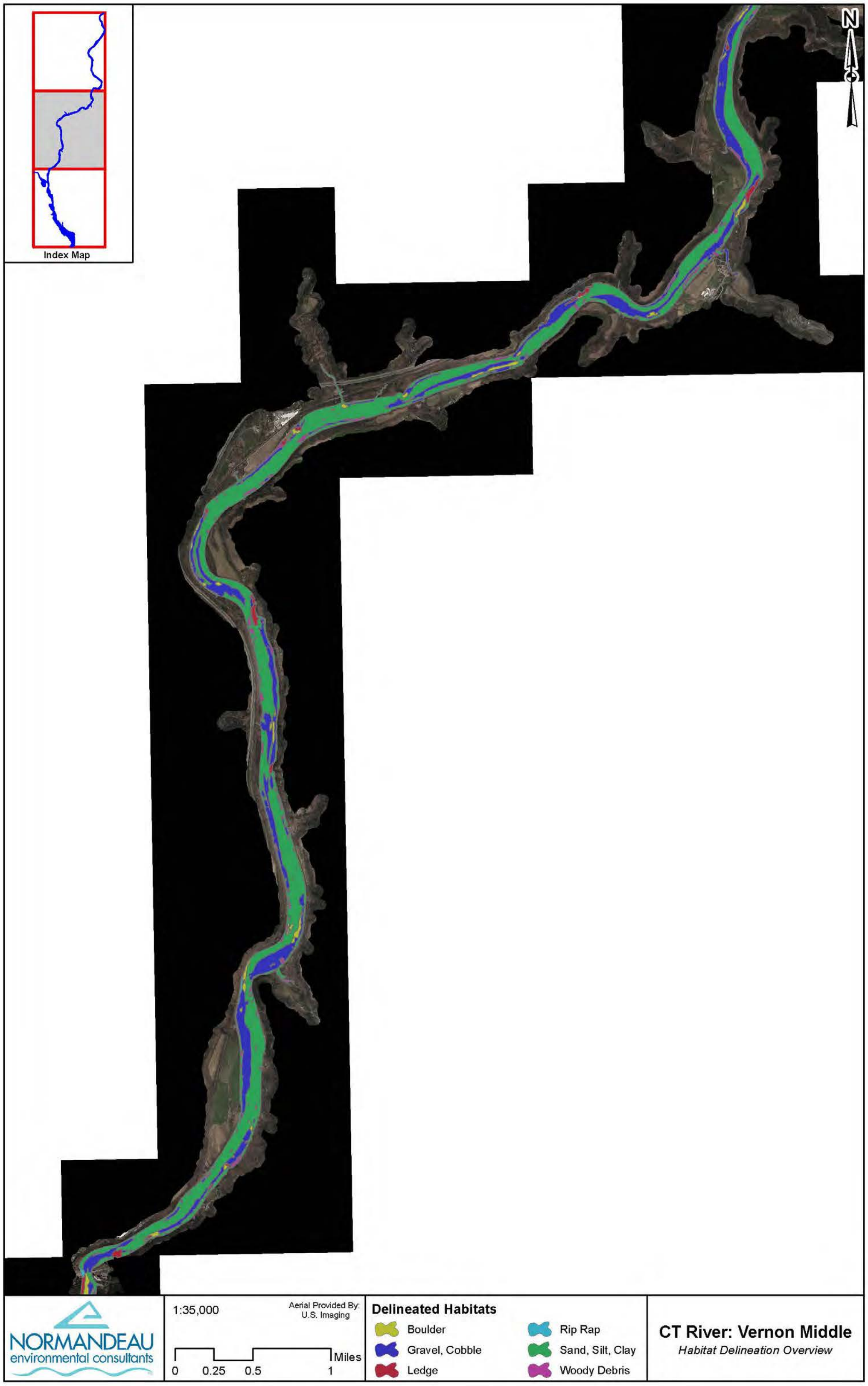


Figure 6-16. Overview of middle Vernon impoundment aquatic habitat.

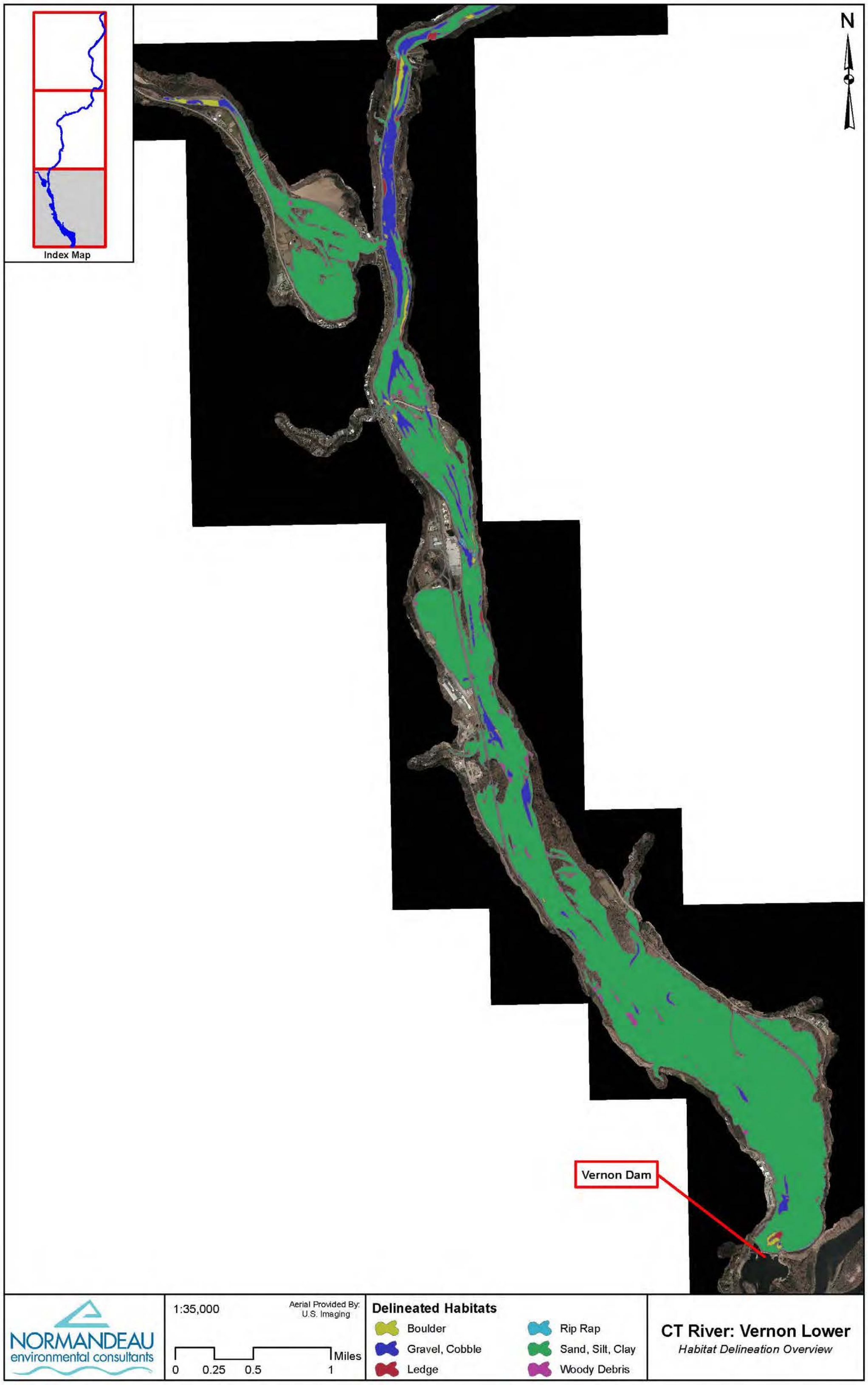


Figure 6-17. Overview of lower Vernon impoundment aquatic habitat.

7. RIVERINE AQUATIC MESOHABITAT MAPPING

7.1 Field Methodology

Riverine segments were mapped at flow levels within bounds of project operations at the time of the field effort, generally the lowest available flow. Visibility is normally improved at lower flows, allowing for easier classification of substrate. In addition, identification of shallow water mesohabitats (e.g. riffles), gravel bars and shoals is also enhanced, as many of these features could be inundated at higher operational flows and not recognizable.

Riverine habitat mapping was performed moving downstream in a 14-ft Porta-Bote equipped with a 6 hp outboard motor and oars. An Airmar 60 235 kHz digital depth transducer mounted to the side of the boat and a GPS unit connected to a Toughbook C-19 laptop computer were used to record depth and time-stamped GPS positions. Locations of habitat boundaries and other features such as top and bottom of islands, side channels and locations of exposed gravel bars were recorded on a hand-held Garmin GPS unit. Depths were recorded at 15-second intervals and logged as text files for importation into spreadsheets or a GIS database.

The survey generally followed a meandering path down the channel, detecting changes in depth and locating the thalweg (deepest part) of the channel. Tracking channel depth aids in identifying mesohabitat unit transitions from deep to shallow areas (pools to glides for example) or runs which typically have a well-defined thalweg. In instances of islands or split channels, both channels were mapped by boat unless flow or depth was limited, in which case mapping was conducted on foot. The Bellows Falls bypassed reach was mapped on foot since flows are typically low and boat access is difficult, particularly in the upper portion of the reach.

Riverine mesohabitat types were identified and delineated based on the following descriptions:

- **Pool** – deep, low velocity with a generally well-defined control and retains water at zero discharge.
- **Glide** – shallow with moderate velocity distributed across the channel, without a well-defined thalweg, sometimes referred to as shallow pool if velocities are low.
- **Run** – deep to moderately deep with fast velocity in a well-defined thalweg, surface may be turbulent, substrate variable.
- **Riffle** – shallow with gravel, cobble, or boulder substrate, fast water with turbulent flow or white-water, possible exposed substrate.
- **Rapid** – shallow bedrock, boulder with turbulent white-water flow and possible exposed substrate, may be brief and abrupt across the stream channel or extend for a greater distance.

- **Other** – may include backwaters or other mesohabitat types if primary types are believed to be insufficient for characterization. The mapping protocol allowed for additional types or sub-types to be added according to the best judgment of the field personnel.

In some instances mesohabitat units were classified as a combination of two types, run/riffle for example, if characteristics of both types were observed. Typically this occurred where certain features such as a cobble bar split the channel or extended into the channel from the bank. Subsequent descriptions and analysis include only the primary mesohabitat type.

Additional information collected for each mesohabitat unit included dominant and subdominant substrate and bank or instream cover type (ledges, boulders, woody debris, etc.), if any. Substrate was classified into (1) organics, (2) mud and clay, (3) silt, (4) sand, (5) gravel, (6) cobble, (7) boulder, and (8) bedrock (Table 7-1). Substrate composition was visually identified where depths and water visibility allowed. In deeper areas, a collapsible hollow fiberglass stadia rod was used to "feel" and "listen" to determine firmness and size of the substrate. Prior to field data collection crew members calibrated this technique by employing it in areas of known substrate composition. Soft indicated sand and silt while hard areas identified rocky substrates. Substrate size was determined by feeling the degree of bounce, the larger the substrate the more bounce. This technique was restricted to depths less than 15 feet due to physical limits and capabilities and consequently, substrate composition in deep pools may not always be accurate. Substrate was recorded for most habitat units unless lack of visibility and/or depth, primarily in pools, limited identification.

7.2 Data Analysis and Processing

Upon completion of the field data collection effort, data were entered into spreadsheets for review and summary. The final mapping results are presented in Appendix A (a complete database spreadsheet with additional notes and waypoints is available upon written request to TransCanada). Distances between mesohabitat unit boundaries were calculated from GPS coordinates. Minor adjustments were made to a few mesohabitat unit boundaries and subsequent lengths based on examination of changes in the depth profile, location of GPS coordinates relative to banks and bends in the channel, or from notes recorded during mapping. For example, it may have been noted that a waypoint was not recorded in the correct location based on depths acquired during mapping and should be moved upstream. Maximum depths were noted and average depths were calculated for most habitat units. Exceptions included some riffles which were too shallow to safely deploy the depth sounder and those habitat units that were mapped on foot. Depths were plotted and overlaid on orthographic photos using ArcGIS along with mesohabitat unit boundaries.

Maximum and average depth frequencies for pool and run habitat were evaluated to determine if it would be appropriate to further refine these mesohabitats into deep and shallow types. Only main channel and the larger of split channels around islands were used to calculate total length of reaches, number of units and percent composition. In most instances both channels around islands contained similar mesohabitat types so that final proportions were not affected to any degree by this process.

7.3 Results and Discussion

In the course of mapping, waypoints were taken at apparent habitat unit boundaries based on mesohabitat definitions, changes in depth, substrate composition or general change in channel character (e.g. velocity, slope). In some cases this resulted in a series of two or more consecutive units of the same mesohabitat type as shown in Table 7-2. As a result, the actual number of mesohabitat unit types, primarily pool and glide, is less than indicated. However, the relative mesohabitat proportions remain the same and noted variation in depth and substrate composition is maintained. Mesohabitat orthographic overlays for all reaches are presented in Appendix B. Photographs are presented in Appendix C. More detailed data is provided electronically in association with this report.

7.3.1 Wilder

The Wilder riverine segment was mapped between August 15 and August 18, 2013. Mapping from Wilder dam to Sumner Falls took place on August 15 between 0900 and 1500 hrs during which time project flows were increasing from about 900 cfs to 5,000 cfs (1,700 to 5,610 cfs recorded at the USGS West Lebanon gage, Figure 7-1). Peak flows at the gage occurred between 1300 and 1900 hours. The difference in water surface elevation between low flow and peak operation flows for the day was approximately 2.0 feet based on the USGS gage.

The segment from Sumner Falls downstream to the Cornish boat launch near Windsor, Vermont was mapped on August 17, 2013 at a flow of 1,470 cfs as measured at the USGS West Lebanon gage. Flows from Wilder dam began increasing at 1100 hours from 850 cfs to a peak of 5,000 cfs between 1500 and 1900 hours (1,470 to 5,490 cfs as measured at the USGS West Lebanon gage, Figure 7-1). However, due to water travel time of approximately 2 hours to Sumner Falls and 4 hours to Cornish, the higher operational flow wasn't perceptible during mapping. Similar to the Sumner Falls to Cornish segment, flow between Cornish and the upper end of the Bellows Falls impoundment at Chase Island was not affected by Wilder operations due to water travel time. This segment was mapped on August 18, 2013 at a flow of 1,420 cfs as recorded at the USGS West Lebanon gage.

An evaluation of pool depth frequency in the Wilder riverine segment between Wilder dam and Chase Island revealed that of the 46 pools with maximum depth readings, 29 were 15 feet or less in depth (Figure 7-2). Of the remaining 17 pools, 11 had maximum depths between 16 and 25 feet with 6 pools greater than 30 feet maximum depth. A review of run habitat types found that the overall range in maximum depths (3.5 to 10.9 feet with an average of 7.7 feet) was not broad enough to provide a sufficient level of separation. Based on pool depth frequency a decision was made to apply a depth of 15 feet or less to represent shallow pools and depths greater than 15 feet to represent deep pools.

Overall mesohabitat proportions for the Wilder segment from Wilder dam to Chase Island (17.6 miles) are presented in Table 7-3. Pools account for 55.5 percent of mesohabitats, with 25 percent of that attributed to deep pools. Glides accounted for 23.4 percent, followed by runs at 14.7 percent and riffles at 5.0 percent. General trends noted during mapping from Wilder dam to Chase Island included a transition in mesohabitat distribution from deep pools and runs to shallow pools and glides and a slight increase in riffle habitat. In addition, the dominant substrate trended from cobble to gravel moving downstream. With the exception of the occasional piece of large woody debris along the banks, instream cover was absent.

7.3.2 Wilder Reaches

Based primarily on hydrology and flow accretion from major tributaries and noted differences in mesohabitat distribution, the Wilder riverine segment was broken into three reaches:

- Reach 1 Wilder Dam to White River – 1.5 miles
- Reach 2 White River to Ottauquechee River – 5.2 miles
- Reach 3 Ottauquechee River to Chase Island – 11.0 miles

Reach 1 is short in length, 1.5 miles, and contains two major islands (Photo 1 and 2). Deep pool accounts for 59 percent of the reach with run making up 24 percent and glide 15 percent (Table 7-4). A single short riffle of 125 feet was noted at the transition from the pool immediately below the dam. This would likely be inundated at flows above those experienced during mapping.

Reach 2 from the White River to the Ottauquechee River contains a complex of multiple channels known as Johnston Island. Almost all riffle habitat identified in this reach is found within this island complex (Photo 3). A large cobble/gravel bar at the mouth of Bloods Brook persists under normal project operations (Photo 4 and 5). Overall pool is the dominant habitat type accounting for 63 percent of the reach, 36 percent of which was classified as deep pool (Table 7-5). Run accounts for 22 percent of the reach followed by glide at 11 percent and riffle at 4 percent.

Reach 3 from the Ottauquechee River to Chase Island includes a bedrock rapid known as Sumner Falls (Photos 6-10). The 2.5 mile stretch between the Ottauquechee River and Sumner Falls is composed of pool and glide habitat with little complexity, though two small side channels were noted in this section. Reach 3 is dominated by pools (52 percent) and glides (30 percent) with the majority of pool habitat classified as shallow (Table 7-6). Riffles make up almost 6 percent of the reach and are clustered around two locations - a large gravel bar area approximately 1.0 mile downstream of Sumner Falls (Photo 11) and near the lower end of Hart Island. The entrance to the right channel of Hart Island consists of a gravel bar which restricts flow into the channel under low flow conditions, such as that encountered during mapping (Photo 12). Mapping of the right channel of Hart Island was completed and potential habitat types identified, even though there was minimal flow (Photos 13 and 14). The small amount of flow observed in the channel at the time originated from Lulls Brook, a tributary near the top of the right channel. It was noted that the entire length of the channel would probably be classified as run at a two unit operation flow level. A hydrologic study conducted in 2012 indicated river discharge would need to exceed approximately 3,000 cfs before water would begin to flow down the channel (Normandeau, 2013).

7.3.3 Bellows Falls Segment

The Bellows Falls riverine segment was mapped on August 16, 2013. Mapping was initiated at the bottom of the Bellows Falls bypassed channel, approximately 600 feet downstream of the powerhouse. Discharge from the project was 2,070 cfs at the beginning of the day, increasing gradually to 3,500 cfs by 1030 hours at which point flow remained steady until 1300 hours (Figure 7-3). Discharge increased again beginning at 1300 hours to 6,800 cfs. However, mapping was completed under the lower flow conditions of 2,070 to 3,500 cfs prior to the arrival the higher flow in the lower end of the river segment.

The purported influence of the Vernon impoundment is near the Walpole Bridge, identified in the Preliminary Application Document as being approximately 6 miles downstream of the Bellows Falls Project. However, mapping results indicate the bridge is 4 miles downstream of the powerhouse. Mapping of the reach was continued downstream of Dunshee Island, approximately 6.3 miles from the powerhouse. The mapping summary is based on data collected to the downstream end of Dunshee Island, a distance of 5.6 miles. Below Dunshee Island the influence of the Vernon impoundment is apparent as this 3,700- ft segment was classified as pool with silt and sand substrate.

Because the Bellows Falls river segment is relatively short, minor accretion sources only occur in the first mile downstream of the dam and there were no notable changes in channel character, it is considered a single reach. Splitting of deep and shallow pools is based on the maximum depth frequency analysis conducted for the Wilder riverine segment with shallow pools less than 15 feet in depth. Pools make up 59 percent of the Bellows Falls reach (shallow pool accounts for 36 percent of this total), followed by glide at 24 percent and run at 15 percent (Table 7-7).

The Bellows Falls reach contains two tributaries, Saxtons River and Cold River within the upper mile of the reach, both sources of large alluvial cobble/gravel bars that extend out into the channel (Photos 15 and 16). The single riffle identified in the reach is just downstream of Saxtons River and is likely a product of the downstream movement of sediment from the alluvial fan (Photo 17). The bar at Cold River constricts the channel into a deep run along the right bank at lower flows. However, it is likely that at higher operational flows than those experienced during mapping, this bar may become inundated and exhibit riffle characteristics over half the channel. A small side channel just upstream of the Walpole Bridge was dry at the flow levels encountered during mapping (Photo 18 and 19), but a side channel of the unnamed island downstream of the bridge retained flow (Photo 20).

7.3.4 Bellows Falls Bypassed Reach

The Bellows Falls bypassed reach was mapped on August 19, 2013. Flow in the reach was 400 cfs, higher than normal due to a gate being partially open due to debris. The upper part of the reach was accessed near the base of the dam (Photo 21). Immediately below the dam the channel is over 400 feet wide and consists of a large pool with some backwater areas (Photo 22). Downstream of this are a series of runs and riffles (Photo 23) which terminate at the top of a large pool immediately upstream of the fish barrier (Photo 24). Substrate in the upper part of the reach is primarily bedrock and boulder, though some large cobble exists in the riffle and run habitat units.

The lower part of the reach was mapped on foot beginning in a backwater pool formed by operations of the project. Flow from the project was approximately 6,000 cfs at the time. Access within the lower section of the reach under Villas Bridge and a railroad bridge is limited due to the sheer bedrock walls on both banks and steepness of the channel (Photo 25). The lower part of the reach is primarily pool all the way up to the base of a steep bedrock area just downstream of the fish barrier (Photos 26-28). Substrate in the lower part of the reach is composed of bedrock and large boulders.

Overall pool makes up 73 percent of the reach, run 16 percent and riffle 8.5 percent (Table 7-8). Due to safety concerns depths were not measured in this reach.

7.3.5 Vernon Reach

The Vernon reach was mapped on August 13, 2013. Project flows were 3,500 cfs prior to mapping, increasing to approximately 9,600 cfs during the time mapping occurred. This was the only reach mapped at a high flow level. Tailrace elevation at 9,600 cfs was 184.6 feet, the median elevation that can be experienced at this flow level depending on operations at Turners Falls (range of 183 to 186 feet). Mapping was initiated at the downstream end of the pool below Vernon dam, excluding the pool from the database (Photos 29 and 30). A small side channel at the top of the reach contained minimal flow at discharge of 3,500 cfs but was flowing at discharge of 9,600 cfs (Photos 31 and 32). Mapping was terminated at the downstream end of Stebbins Island, a distance of 1.3 miles.

Splitting of deep and shallow pools was based on the maximum depth frequency analysis conducted for the Wilder riverine segment with shallow pools less than 15 feet in depth. Overall pools account for 39.5 percent of the reach followed by run (34.9 percent) and glide at 25.6 percent (Table 7-9). No riffles were identified in the reach.

Table 7-1. Aquatic habitat mapping substrate codes, descriptions and particle size.

Code	Description	Particle Size (mm)	Particle Size (in)
OR	Detritus/Organic		
MUD	Mud/ Clay		
SI	Silt	<0.06	<0.002
SA	Sand	0.06 – 2.0	0.002 – 0.08
GR	Gravel	2.0 – 64.0	0.08 – 2.5
CB	Cobble	64.0 – 150.0	2.5 – 12.0
BD	Boulder	>250.0	12+
BR	Bedrock		

Source: Bovee 1982

Table 7-2. Example of consecutive mesohabitat units of the same type with boundaries based on depth (pool) and substrate (glide).

Waypoint	Habitat Type	Length (ft)	Maximum Depth (ft)	Average Depth (ft)	Substrate[a] Dom/Sub
101	Pool	2,291	11.8	6.8	SA/GR
102	Pool	1,858	16.4	8.6	??
103	Pool	654	39.6	22.0	??
104	Pool	705	26.4	13.3	??
190	Glide	646	3.2	2.3	CB/GR
191	Glide	374	3.1	2.1	GR/SA
192	Glide	1686	4.9	3.4	CB/GR
193	Glide	381	5.0	4.2	GR/CB

[a] Substrate codes from Table 5.1-1; Dom = Dominant, Sub= Sub-dominant

Table 7-3. Summary of mesohabitat types and percentages in the Wilder project riverine segment.

Wilder Segment (Wilder Dam to Chase Island)			
Habitat Type	**Number**	**Length (ft)**	**Percent**
Pools	43	51,642	55.5
Deep Pool (>15')	*16*	*23,382*	*25.1*
Shallow Pool	*27*	*28,260*	*30.4*
Glide	25	21,782	23.4
Run	20	13,681	14.7
Riffle	12	4,623	5.0
Rapid	1	1,284	1.4
Totals	100	93,012	100.0

Table 7-4. Summary of mesohabitat types and percentages in Reach 1 of the Wilder project riverine segment.

Wilder Reach 1: Wilder Dam to White River Reach			
Habitat Type	**Number**	**Length (ft)**	**Percent**
Pools	4	4,601	59.2
Deep Pool (>15')	*4*	*4,601*	*59.2*
Shallow Pool	*0*	*0*	*0*
Glide	2	1,196	15.4
Run	2	1,846	23.8
Riffle	1	125	1.6
Rapid	0	0	0
Totals	9	7,768	100.0

Table 7-5. Summary of mesohabitat types and percentages in Reach 2 of the Wilder project riverine segment.

Wilder Reach 2: White River to Ottauquechee River Reach			
Habitat Type	**Number**	**Length (ft)**	**Percent**
Pools	13	17,123	62.6
Deep Pool (>15')	*6*	*9,886*	*36.2*
Shallow Pool	*7*	*7,237*	*26.5*
Glide	3	2,939	10.7
Run	9	6,131	22.4
Riffle	3	1,149	4.2
Rapid	0	0	0
Totals	28	27,342	100.0

Table 7-6. Summary of mesohabitat types and percentages in Reach 3 of the Wilder project riverine segment.

Wilder Reach 3: Ottauquechee River to Chase Island Reach			
Habitat Type	**Number**	**Length (ft)**	**Percent**
Pools	26	29,918	51.7
Deep Pool (>15')	*6*	*8,896*	*15.4*
Shallow Pool	*20*	*21,022*	*36.3*
Glide	20	17,647	30.5
Run	8	5,703	9.8
Riffle	8	3,349	5.8
Rapid	1	1,284	2.2
Totals	63	57,902	100.0

Table 7-7. Summary of mesohabitat types and percentages in the Bellows Falls Reach from Bellows Falls powerhouse to Dunshee Island.

Bellows Falls Reach: Bellows Falls Dam to Dunshee Island			
Habitat Type	**Number**	**Length (ft)**	**Percent**
Pools	13	17,250	58.8
Deep Pool (>15')	*4*	*6,559*	*22.4*
Shallow Pool	*9*	*10,691*	*36.4*
Glide	9	7,134	24.3
Run	5	4,448	15.2
Riffle	1	509	1.7
Totals	28	29,341	100.0

Table 7-8. Summary of mesohabitat types and percentages in the Bellows Falls bypassed reach.

Bellows Falls Bypass Reach			
Habitat Type	**Number**	**Length (ft)**	**Percent**
Pools[a]	8	2,824	72.6
Deep Pool (>15')	----	----	----
Shallow Pool	----	----	----
Glide	0	0	0
Run	4	638	16.4
Riffle	3	332	8.5
Cascade	1	98	2.5
Totals	16	3,892	100.0

[a] No depths taken in Bellows Falls bypassed reach

Table 7-9. Summary of mesohabitat types and percentages in the Vernon reach.

Vernon Reach			
Habitat Type	**Number**	**Length (ft)**	**Percent**
Pools	3	2,631	39.5
Deep Pool (>15′)	*2*	*1,653*	*24.8*
Shallow Pool	*1*	*978*	*14.7*
Glide	3	1,701	25.6
Run	4	2,325	34.9
Riffle	0	0	0
Totals	10	6,657	100.0

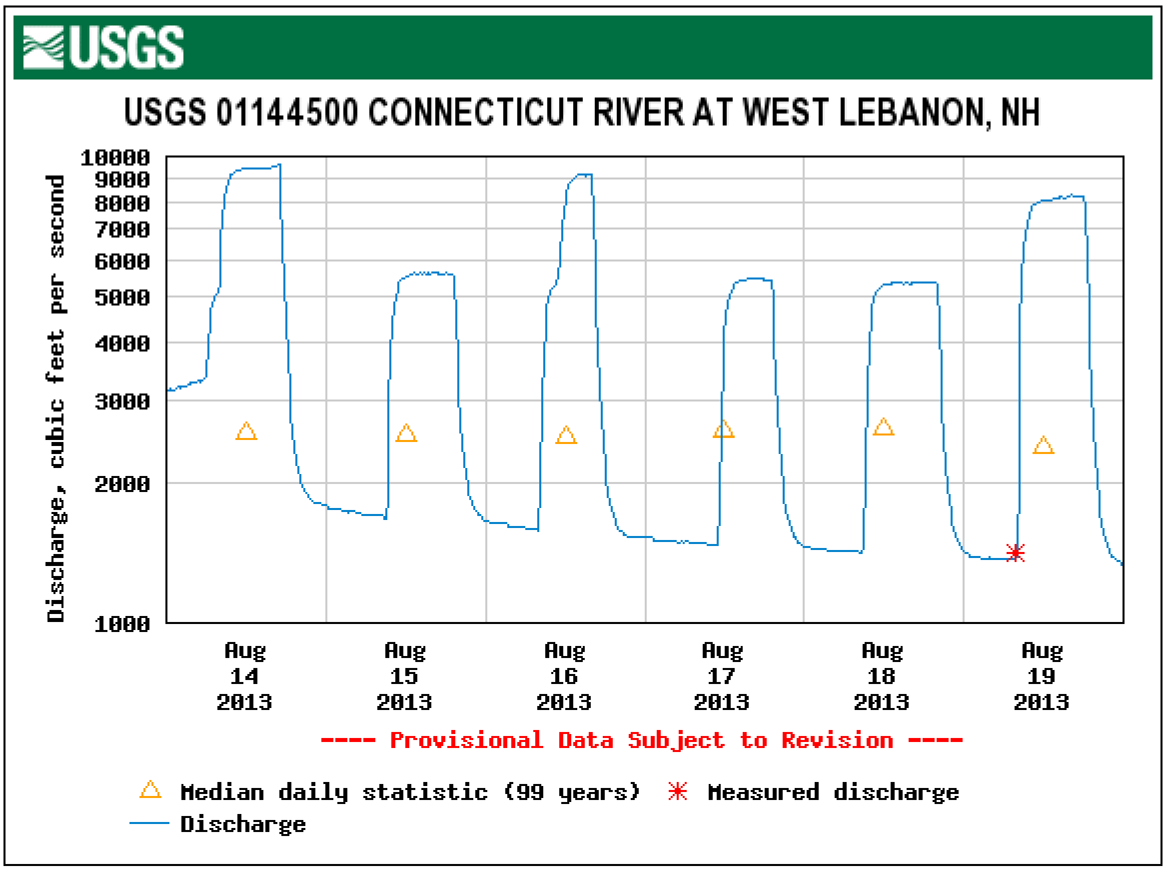


Figure 7-1. Discharge recorded at the USGS West Lebanon gage between August 14 and August 19, 2013.

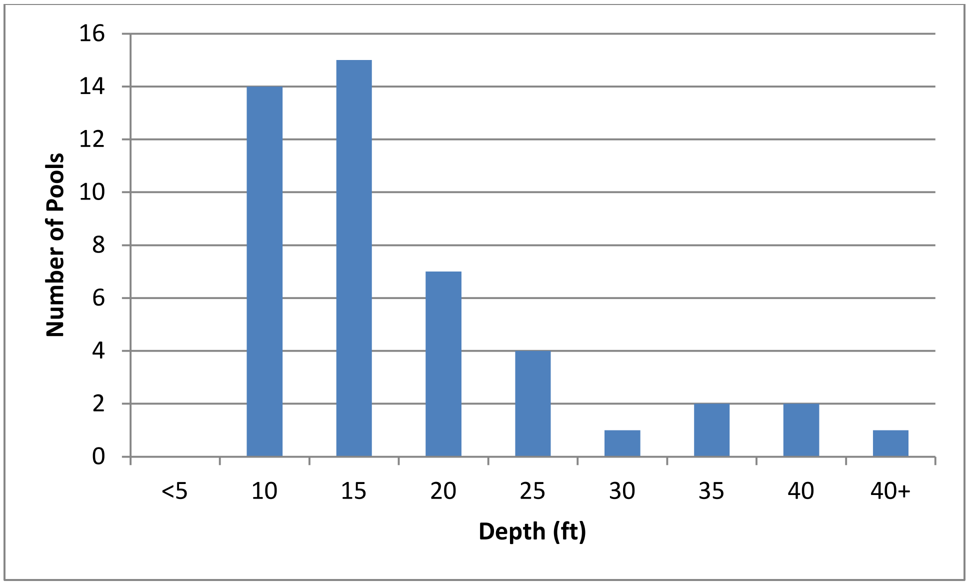


Figure 7-2. Pool maximum depth frequency in the Wilder project riverine segment from Wilder Dam to Chase Island.

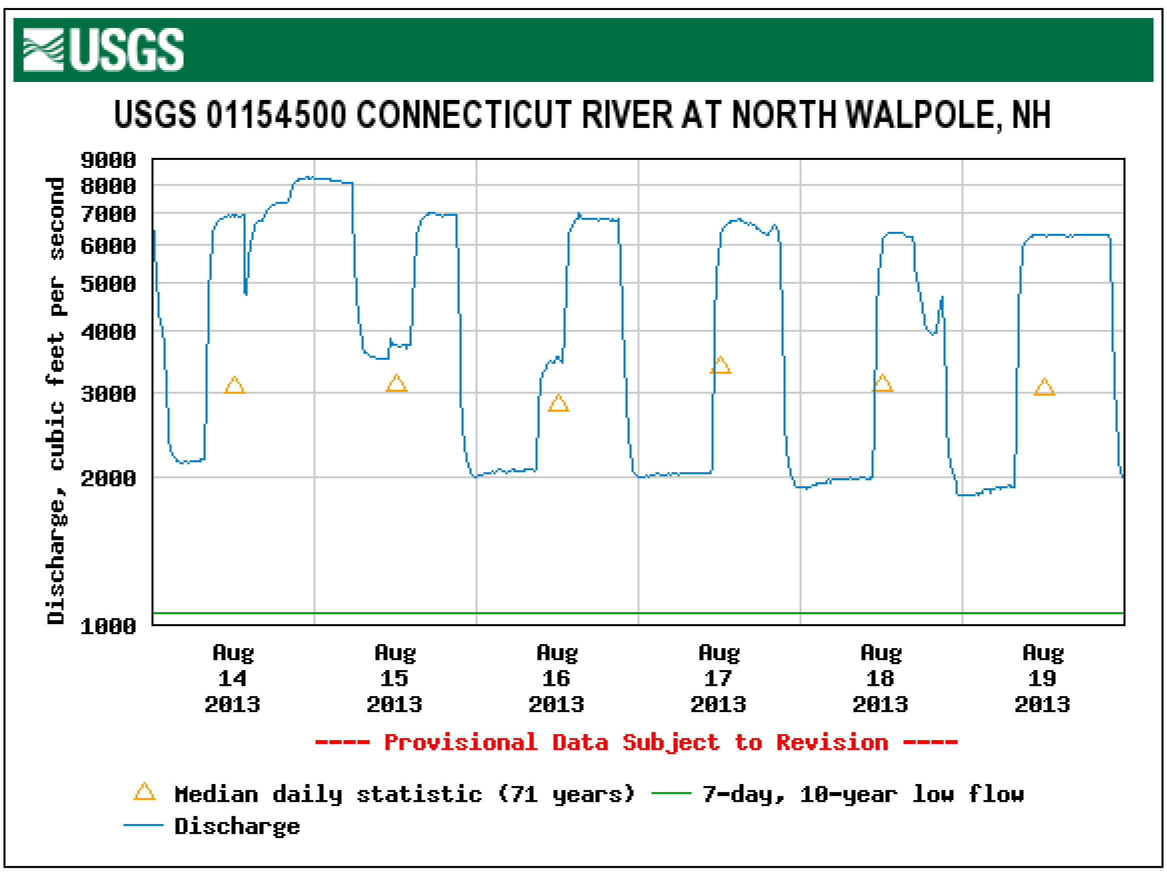


Figure 7-3. Discharge recorded at the USGS North Walpole gage between August 14 and August 19, 2013.

8. WATER SURFACE ELEVATION MONITORING

8.1 Field Methodology

Onset HOBO water-level data loggers (vertical accuracy of ± 0.1 inch) were installed at selected locations over the entire 120.5 mile study area in 2013 (Figures 8-1 through 8-3). Level loggers were installed during July 2013 within the confluence areas of some tributaries and backwater areas as well as throughout the mainstem Connecticut River (Table 8-1). Locations selected for monitoring during 2013 were provided to the resource agencies as part of Study Plan 7 and were intended to provide data for one or more of the following objectives:

- Hydraulic modeling simulating river flow through project impoundments and riverine reaches (Study 4);
- Assessment of project-related erosion (Studies 1, 2, and 3);
- Assessment of changes in water surface elevations associated with project operations on backwater habitat;
- Assessment of changes in water surface elevations associated with project operations on tributary confluence area habitat; and
- Data collection of air barometric pressure required for the processing and calculation of level logger water depths.

During installation, the exact position of each unit (latitude, longitude and elevation relative to the project structures) was recorded using a Leica GS-14 Real Time Kinematic (RTK) unit. Level loggers were maintained at their set elevations by being set inside a perforated well pipe structure which was affixed to a piece of ¾-inch rebar and set vertically into the bottom substrate (Figure 8-4). Each unit was programmed to record pressure at 15 minute intervals. A total of six barometric reference loggers were installed over the study reach for use in processing logger data collected at mainstem, tributary and backwater locations.

Following logger installation, each monitoring location was visited once monthly (August-November). During each visit, the logger was removed from the well pipe holding structure and data was downloaded using to a laptop computer loaded with HOBOware Pro Software. Following download, the level logger was returned to the well pipe. The "pull" and "set" times bracketing the period of time the logger was out of water were recorded.

8.2 Data Analysis and Processing

Downloaded data files were imported into HOBOware Pro Software and sensor depths at each 15-minute interval were determined based on the relationship between recorded pressure values at the in-water logger and in-air barometric reference location. Following determination of water depth values, each individual record was assigned a use code which defines its collection status and subsequent use in analytical tasks (Table 8-2).

8.3 Results and Discussion

The majority of level loggers (80 out of 81) were installed between July 22 and August 6, 2013. A single station (#77) was not installed until August 15, 2013. A total of 75 level loggers were installed in aquatic habitat and six in-air barometric data loggers or "reference loggers" were installed over the study reach. The reference loggers collected background barometric pressure readings at the same 15-minute intervals as programmed for the level loggers. The atmospheric pressure values were used by the Onset HOBOware Pro software to process pressure data collected by the level loggers and providing calculated water depth values.

Pressure data was successfully recorded for the duration of the July through November period at 73 of the 81 logger locations. No data or an incomplete data set was collected at five locations (Station 3 – Oliverian Brook, Wilder impoundment, Station 5 – mainstem, Wilder impoundment, Station 24 – mainstem, Wilder impoundment, Station 76 – mainstem, riverine reach downstream of Bellows Falls, and Station 84 – backwater, Vernon impoundment) due to malfunctions associated with the HOBO level logger units. Incomplete data sets were obtained at Station 39 (mainstem, Bellows Falls impoundment) and Station 40 (Mill Brook, Bellows Falls impoundment) due to vandalism issues and at Station 57 (Cobb Brook, riverine reach downstream of Bellows Falls) due to logger loss associated with repeated bank collapses within the confluence area.

Table 8-3 presents the minimum, maximum, median and mean values of the daily change in water depth at each location. Daily change in water depth was calculated as the difference between the maximum and minimum calculated water depths at each logger station for all records within a single calendar date. When all mainstem loggers are considered, the average daily change in water depth was greater at logger stations established in the riverine sections downstream of Wilder and Bellows Falls than those established in the project impoundments (only one logger was located in the riverine reach downstream of Vernon).

Table 8-1. Summary of HOBO level logger locations within the Wilder, Bellows Falls and Vernon study areas, July–November 2013.

River Reach	Description	Tributary	Backwater	Mainstem	Total
RM 217.4-262.4	Wilder Impoundment	6	9	12	27
RM 199.7-217.4	Riverine Downstream of Wilder Dam	4	0	3	8
RM 173.7-199.7	Bellows Falls Impoundment	4	5	5	14
RM 167.9-173.7	Riverine Downstream of Bellows Falls Dam	3	0	3	7
RM 141.9-167.9	Vernon Impoundment	7	4	5	16
RM 140.4-141.9	Riverine Downstream of Vernon Dam	0	0	3	3
RM 141.9-262.4	Total	24	19	32	75

Table 8-2. Use code definitions assigned to individual depth readings determined for HOBO level logger data, 2013.

Use Code	Description
1	Valid for all analytical tasks
2	Logger out of water (act of downloading)
3	Logger out of water (not yet deployed)
4	Sensor potentially out of water (based on depth readings)
5	Sensor depth exceeds reported instrument range
6	Manually flagged during data review: bad pressure data due to malfunction
7	Manually flagged during data review: ice formation in sensor
8	Manually flagged during data review: ice formation in barometer
9	Manually flagged after time series review

Table 8-3. Minimum, maximum, median and mean values of the daily change in water depth at each HOBO logger location within the Wilder, Bellows Falls and Vernon study areas, July–November 2013.

Station ID	River Reach	Purpose	Daily Change in Water Depth (ft)			
			Min	Max	Mean	Median
1	Wilder	Mainstem	0.2	4.3	1.3	1.0
2	Wilder	Mainstem	0.3	3.4	1.0	0.9
3	Wilder	Tributary	0.1	3.1	0.9	0.7
4	Wilder	Mainstem	0.3	3.1	0.9	0.8
5	Wilder	Mainstem	0.5	1.9	0.9	0.8
6	Wilder	Backwater	0.3	2.8	0.9	0.9
7	Wilder	Backwater	0.2	2.5	1.0	0.9
9	Wilder	Backwater	0.2	2.4	1.0	1.0
10	Wilder	Tributary	0.2	2.3	1.0	1.0
11	Wilder	Mainstem	0.2	2.2	1.1	1.0
12	Wilder	Mainstem	0.5	2.4	1.1	1.0
13	Wilder	Backwater	0.2	2.2	1.1	1.1
14	Wilder	Mainstem	0.2	2.5	1.2	1.1
15	Wilder	Backwater	0.4	2.3	1.1	1.0
16	Wilder	Backwater	0.3	2.3	1.1	1.0
17	Wilder	Mainstem	0.3	2.3	1.0	1.0
18	Wilder	Mainstem	0.3	2.3	1.0	0.9
19	Wilder	Mainstem	0.2	2.3	1.0	1.0

Station ID	River Reach	Purpose	Daily Change in Water Depth (ft)			
			Min	Max	Mean	Median
20	Wilder	Backwater	0.2	2.3	1.0	0.9
21	Wilder	Tributary	0.2	2.4	1.0	0.9
23	Wilder	Tributary	0.2	3.2	1.0	0.9
74	Wilder	Backwater	0.2	2.3	1.0	0.9
25	Wilder	Backwater	0.2	2.5	1.1	0.9
26	Wilder	Mainstem	0.3	2.5	1.1	1.0
27	Wilder	Tributary	0.3	2.5	1.1	1.0
28	Wilder	Tributary	0.3	2.5	1.1	1.0
29	Wilder Riverine	Mainstem	0.0	7.0	3.2	3.4
30	Wilder Riverine	Tributary	0.0	4.0	0.9	0.7
32	Wilder Riverine	Mainstem	0.3	6.1	3.3	3.5
33	Wilder Riverine	Backwater	0.3	5.7	3.0	3.1
35	Wilder Riverine	Mainstem	0.3	5.5	2.9	3.0
36	Wilder Riverine	Tributary	0.3	4.5	2.2	2.3
37	Wilder Riverine	Tributary	0.2	4.2	2.1	2.2
38	Wilder Riverine	Tributary	0.0	2.7	0.6	0.4
39	Bellows	Mainstem	0.2	4.2	1.7	1.6
40	Bellows	Tributary	0.0	2.3	0.7	0.6
41	Bellows	Mainstem	0.2	3.6	1.2	1.1
78	Bellows	Mainstem	0.1	2.9	1.0	0.9
42	Bellows	Tributary	0.0	1.1	0.1	0.0
43	Bellows	Mainstem	0.2	1.8	1.0	1.0
45	Bellows	Tributary	0.2	1.7	0.9	1.0
46	Bellows	Tributary	0.2	2.2	1.1	1.1
48	Bellows	Backwater	0.2	2.3	1.2	1.1
49	Bellows	Mainstem	0.2	3.0	1.1	1.1
50	Bellows	Backwater	0.2	2.3	1.2	1.1
80	Bellows	Backwater	0.2	2.1	0.9	0.8
79	Bellows	Backwater	0.2	1.9	0.9	0.9
51	Bellows	Backwater	0.2	2.1	1.1	1.1
76	Bellows Riverine	Mainstem	1.1	4.4	2.6	2.6
77	Bellows Riverine	Mainstem	0.3	5.2	2.8	2.9
52	Bellows Riverine	Tributary	0.1	4.0	2.0	1.8
53	Bellows Riverine	Mainstem	0.1	5.9	3.9	3.7

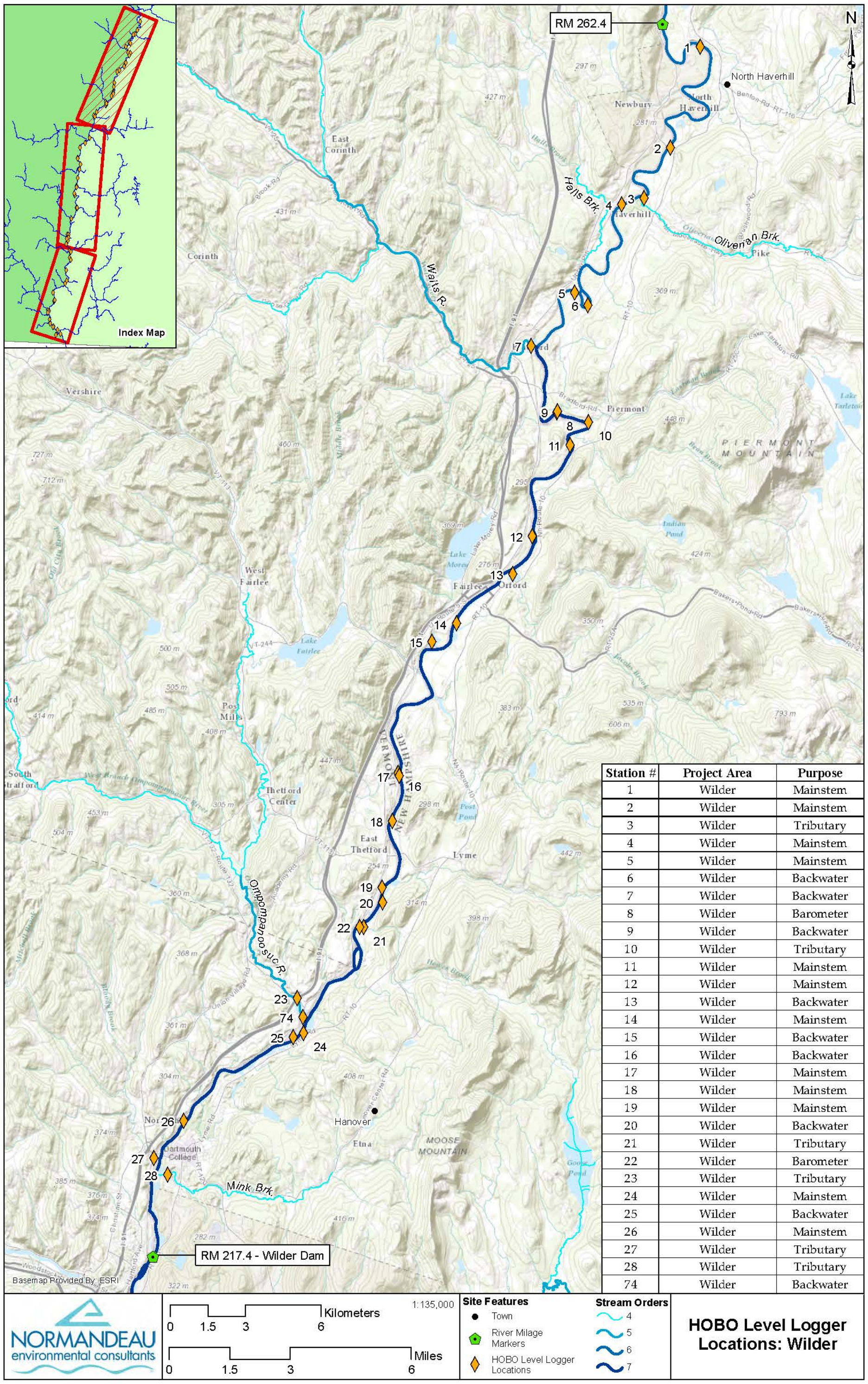
Station ID	River Reach	Purpose	Daily Change in Water Depth (ft)			
			Min	Max	Mean	Median
55	Bellows Riverine	Tributary	0.0	2.4	0.5	0.5
56	Bellows Riverine	Mainstem	0.2	4.8	2.7	2.5
57	Bellows Riverine	Tributary	0.0	4.5	1.6	1.4
58	Vernon	Tributary	0.0	2.2	0.6	0.6
59	Vernon	Tributary	0.0	2.2	0.2	0.1
60	Vernon	Mainstem	0.0	2.1	0.6	0.6
61	Vernon	Tributary	0.1	2.2	0.6	0.5
62	Vernon	Tributary	0.0	1.5	0.1	0.0
82	Vernon	Mainstem	0.1	1.5	0.7	0.7
63	Vernon	Tributary	0.1	1.7	0.8	0.7
65	Vernon	Mainstem	0.1	1.6	0.8	0.8
66	Vernon	Tributary	0.1	1.6	0.8	0.8
67	Vernon	Tributary	0.1	1.6	0.8	0.8
68	Vernon	Backwater	0.1	1.3	0.6	0.6
83	Vernon	Backwater	0.0	0.4	0.1	0.0
69	Vernon	Backwater	0.1	1.6	0.8	0.8
70	Vernon	Mainstem	0.1	1.7	0.8	0.8
72	Vernon Riverine	Backwater	0.4	6.4	3.0	3.0
73	Vernon Riverine	Mainstem	0.4	6.2	2.9	2.9
71	Vernon Riverine	Mainstem	0.6	6.0	2.6	2.5

Nine level loggers were overwintered in place. Data from these loggers are not included in this Initial Study Report as described in Section 2.2, but will be included in the Final Study Report. Divers went out to retrieve the over-wintered level loggers in June 2014 and were able to retrieve five units, and re-install eight.

Table 8-4. Status of over-wintered level loggers.

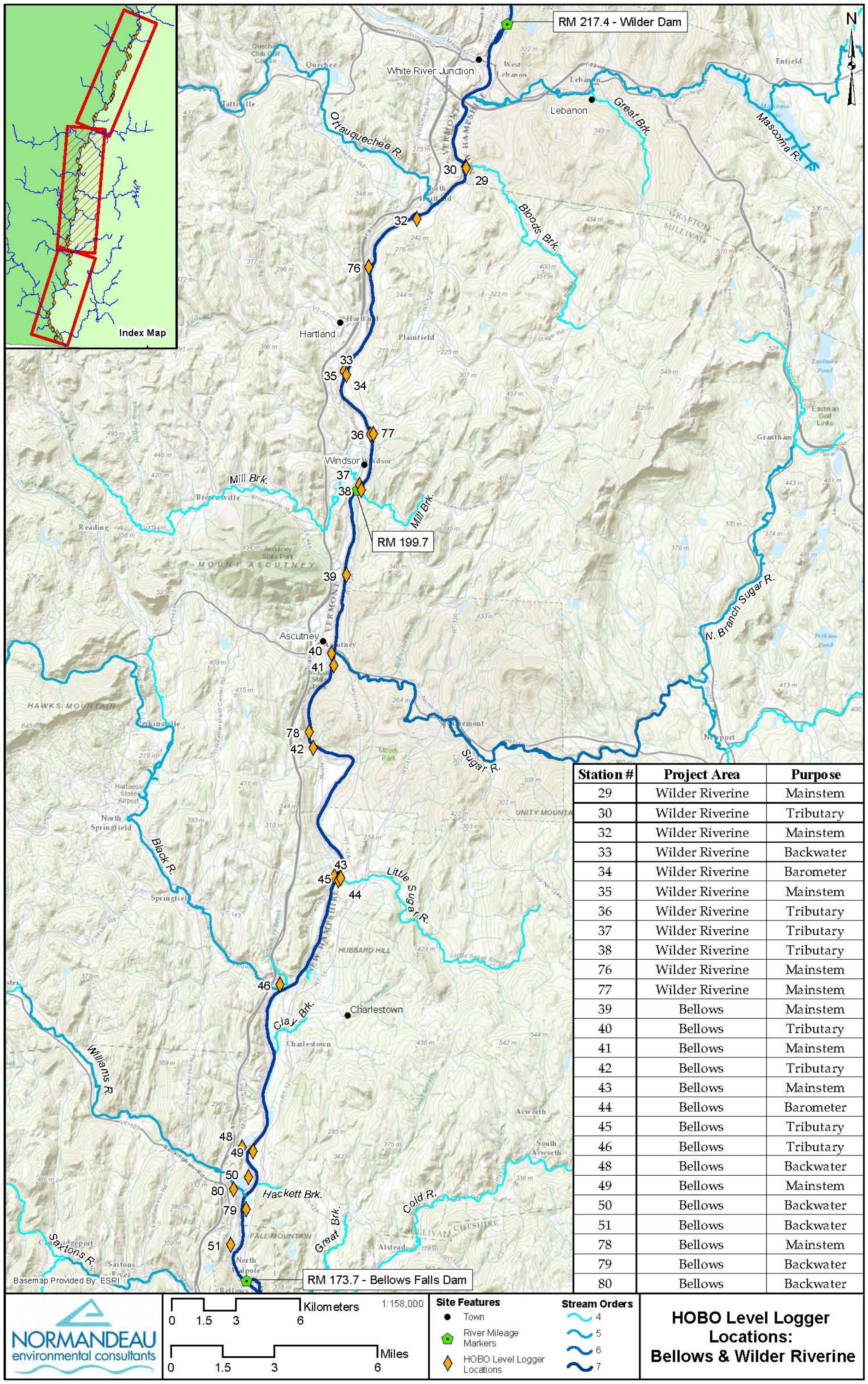
Logger Station	Searched for July 2014	Found and Downloaded July 2014	Logger Installed July 2014
2	Yes	Yes	Yes
26	Yes	Yes	Yes
29	Yes	Yes	Yes
32	Yes	No	Yes
49	Yes	Yes	Yes
53	Yes	No	Yes

Logger Station	Searched for July 2014	Found and Downloaded July 2014	Logger Installed July 2014
56	No	-	Original Still in place
70	Yes	No	Yes
73	Yes	Yes	Yes



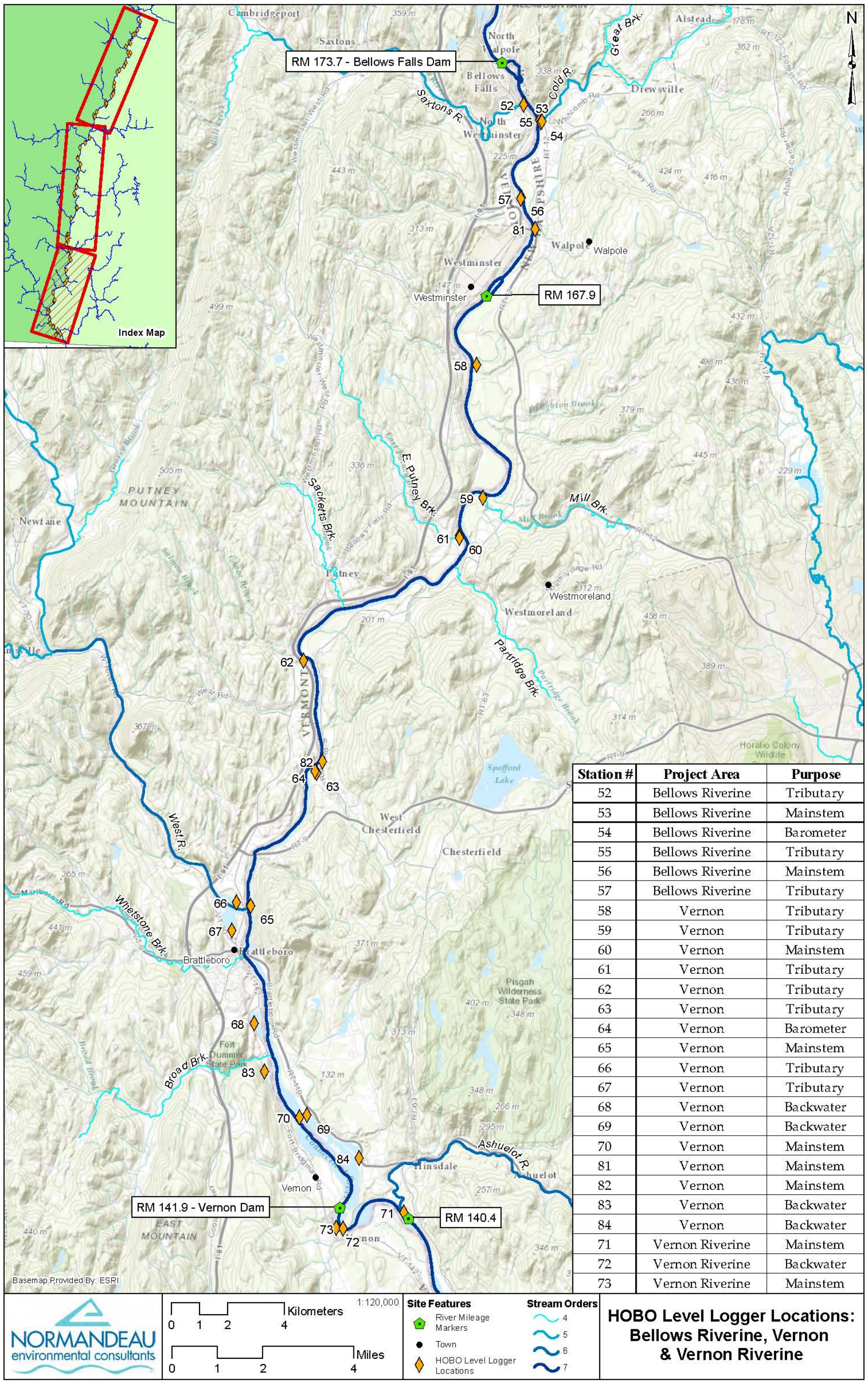
Station #	Project Area	Purpose
1	Wilder	Mainstem
2	Wilder	Mainstem
3	Wilder	Tributary
4	Wilder	Mainstem
5	Wilder	Mainstem
6	Wilder	Backwater
7	Wilder	Backwater
8	Wilder	Barometer
9	Wilder	Backwater
10	Wilder	Tributary
11	Wilder	Mainstem
12	Wilder	Mainstem
13	Wilder	Backwater
14	Wilder	Mainstem
15	Wilder	Backwater
16	Wilder	Backwater
17	Wilder	Mainstem
18	Wilder	Mainstem
19	Wilder	Mainstem
20	Wilder	Backwater
21	Wilder	Tributary
22	Wilder	Barometer
23	Wilder	Tributary
24	Wilder	Mainstem
25	Wilder	Backwater
26	Wilder	Mainstem
27	Wilder	Tributary
28	Wilder	Tributary
74	Wilder	Backwater

Figure 8-1. Installation locations of HOBO level loggers within the Wilder impoundment during July through November 2013.



Station #	Project Area	Purpose
29	Wilder Riverine	Mainstem
30	Wilder Riverine	Tributary
32	Wilder Riverine	Mainstem
33	Wilder Riverine	Backwater
34	Wilder Riverine	Barometer
35	Wilder Riverine	Mainstem
36	Wilder Riverine	Tributary
37	Wilder Riverine	Tributary
38	Wilder Riverine	Tributary
76	Wilder Riverine	Mainstem
77	Wilder Riverine	Mainstem
39	Bellows	Mainstem
40	Bellows	Tributary
41	Bellows	Mainstem
42	Bellows	Tributary
43	Bellows	Mainstem
44	Bellows	Barometer
45	Bellows	Tributary
46	Bellows	Tributary
48	Bellows	Backwater
49	Bellows	Mainstem
50	Bellows	Backwater
51	Bellows	Backwater
78	Bellows	Mainstem
79	Bellows	Backwater
80	Bellows	Backwater

Figure 8-2. Installation locations of HOBO level loggers within the riverine reach downstream of Wilder and Bellows Falls impoundment during July through November 2013.



Station #	Project Area	Purpose
52	Bellows Riverine	Tributary
53	Bellows Riverine	Mainstem
54	Bellows Riverine	Barometer
55	Bellows Riverine	Tributary
56	Bellows Riverine	Mainstem
57	Bellows Riverine	Tributary
58	Vernon	Tributary
59	Vernon	Tributary
60	Vernon	Mainstem
61	Vernon	Tributary
62	Vernon	Tributary
63	Vernon	Tributary
64	Vernon	Barometer
65	Vernon	Mainstem
66	Vernon	Tributary
67	Vernon	Tributary
68	Vernon	Backwater
69	Vernon	Backwater
70	Vernon	Mainstem
81	Vernon	Mainstem
82	Vernon	Mainstem
83	Vernon	Backwater
84	Vernon	Backwater
71	Vernon Riverine	Mainstem
72	Vernon Riverine	Backwater
73	Vernon Riverine	Mainstem

Figure 8-3. Installation locations of HOBO level loggers within the riverine reach downstream of Bellows Falls, Vernon impoundment, and riverine reach downstream of Vernon during July through November 2013.

Figure 8-4. Installation set-up used for HOBO level loggers.

9. DATA SETS

The completion of the data collection and processing of the 2013 data sets has resulted in work products available for application in other ILP studies that will conducted in 2014 and 2015. Content contained within the ArcGIS geodatabase file was provided to the aquatics working group at a May 23, 2014 consultation meeting, and is provided separately in association with this report. Data can be viewed using ArcGIS Explorer (a free program available online from ESRI). ArcGIS (version 10 or higher) is required to utilize the created layers beyond simple viewing.

9.1 Impoundment Data

The final work product consists of an ArcGIS geodatabase file (.gdb) for each of the three impoundments. Each geodatabase file is composed of six GIS layers. These layers are:

- *1ft-countours*: contains 1-ft contour lines for all mapped elevations (see Figure 5-4 for example)
- *Depths*: contains the measured depth points used in bathymetric interpolation process (see Figure 5-5 for example)
- *Full Pool*: contains line representing upper extent of mapped bathymetry (see Figure 5-6 for example)
- *Bathymetry*: contains impoundment bathymetry in raster format (see Figure 5-7 for example)
- *Water Line*: contains the "waterline" created by U.S. Imaging based on wetted area at the time of their aerial survey (see Figure 5-8 for example)
- *Habitat*: contains results of habitat mapping (see Figure 5-9 for example and Section 6.0 of this report for detailed information). The "habitat" layer contained in each geodatabase file contains all habitat polygons created based on sonar imagery.

9.2 Riverine Mesohabitat Data

The final work products for riverine segments and the Bellows Falls bypassed reach include:

- Excel spreadsheet of the habitat mapping database and summary.
- ArcGIS database and shape files of depth and mesohabitat type layers that were used to create the mesohabitat maps in Appendix B.

9.3 Level Logger Data

The level logger work product is a data set comprised of multiple variables including station ID, logger serial number, logger coordinates, logger elevation relative to project structures, date and time of reading, recorded water temperature, recorded sensor pressure, calculated sensor depth and use code. Additional level logger data was collected at some locations where equipment was overwintered in 2013-2014, and additional level logger data will be collected in 2014 and 2015 for purposes of the erosion studies and some aquatic studies. These data will be incorporated into the Final Study Report and the final ArcGIS geodatabase file.

10. LITERATURE CITED

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Appendix A

2013 Riverine Aquatic Habitat Mapping Data

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Table A-1. Wilder Reaches Habitat Mapping Data

Habitat Type[a]	Length (ft)	Maximum Depth (ft)	Average Depth (ft)	Substrate[b] Dom/Sub	Note
Pool	849	24.4	11.0	CB/GR	Below Wilder Dam
Riffle	125	3.4	3.2	CB/GR	
Pool	779	39.4	12.3	-----	
LC Run	854	7.7	5.1	GR/CB	First Island
LC Glide	783	10.3	5.2	CB/GR	
RC Run	1576	8.7	5.0	GR/SA	
Pool	1093	41.0	14.1	-----	
LC Run	730	5.8	4.2	BR/GR	Second Island
RC Run	992	10.4	5.7	CB/GR	
SC Run	345	6.0	5.0	BR/SA	Small Island SC
Pool	1880	15.1	7.8	SA/CB	
Glide	413	6.3	4.2	GR/CB	White River
					End Reach 1
Run/Riffle	407	4.8	3.8	GR/SA	
Run	643	8.0	5.5	GR/SA	
Riffle	277	5.2	4.8	GR/SA	
Run	977	6.7	5.1	GR/SA	
Glide	1702	7.8	5.0	CB/GR	
Pool	2291	11.8	6.8	SA/GR	
Pool	1858	16.4	8.6	-----	Mascoma River
Pool	654	39.6	22.0	-----	
Pool	705	26.4	13.3	-----	
Glide	823	7.5	4.1	CB/GR	
RC Riffle	195	-----	-----	CB/GR	Johnston Island RC
RC Run	694	9.2	5.1	CB/GR	
RC Riffle	677	2.1	1.7	CB/GR	
LC Riffle	511	3.9	3.1	CB/GR	Johnston Island LC
LC Run	445	3.5	2.8	-----	
LC Riffle	166	3.5	-----	CB/GR	
LC Pool	496	31.3	16.1	CB/GR	
LC Run	784	9.9	4.6	CB/GR	
SC Riffle	621	-----	-----	GR/SA	
SC Pool	189	-----	-----	SA/MUD	
Pool	1381	15.7	8.4	-----	
Pool	1076	10.2	6.4	BR/??	
Run/Pool	709	10	4.8	BR/CB	
Run	683	8.3	6.2	CB/GR	
Pool	1102	11	5.4	GR/CB	
Run/Glide	811	8.2	5.6	GR/CB	
Pool	686	13.2	7.1	CB/GR	
Run	534	10	6.6	CB/BD	Blood's Brook
Pool	1150	13.2	9.4	-----	

Habitat Type[a]	Length (ft)	Maximum Depth (ft)	Average Depth (ft)	Substrate[b] Dom/Sub	Note
Pool	4241	20.6	9.1	CB/ST	
Glide	414	7.5	4.1	CB/GR	
LC Run	673	9.6	8.0	CB/GR	Burnaps Island LC
LC Pool	580	9.4	7.1	GR/SA	
LC Pool	353	13.8	10.5	SA	
RC Run	644	7.7	6.4	CB/GR	Burnaps Island RC
RC Pool	528	8.2	5.1	-----	
Pool	1045	20.2	11.6	-----	Ottauquechee River
					End Reach 2
Pool	1682	17.6	8.5	-----	
Pool	736	13.9	5.8	-----	
Glide	488	7.8	5.9	CB/GR	Small SC RB
Pool	2711	15.6	6.2	-----	
Glide	3221	9.9	5.7	SA/GR	
Pool	2904	8.8	4.1	SA/SI	
Pool	970	9.1	6.4	SI/CB	
Run	549	7.0	-----	BR/CB	
Rapid	1284	-----	-----	BR	Sumner Falls
Pool	1361	31.6	12.7	SA/SI	BW Pool
Glide	973	10.6	3.9	CB/CB	
Pool	1589	8.0	5.4	CB/CB	
Glide	507	5.3	3.4	CB/GR	
Riffle	828	2.8	2.0	GR/CB	
Run/Glide	1152	10.9	4.9	CB/GR	
Riffle	548	2.0	-----	GR/CB	
Run	1286	9.8	4.8	GR/CB	
Pool	158	10.8	7.7	GR/SA	
Riffle	320	3.0	-----	GR/CB	
Run	455	4.3	3.3	CB/GR	
Glide	680	6.7	4.2	GR/CB	
Pool	302	7.9	6.0	CB/BD	
Pool	435	6.6	4.5	GR/CB	
Glide	1017	5.6	4.0	CB/GR	
Pool	3168	12.5	7.8	BD/CB	
Glide	871	5.6	3.9	CB	
RC Riffle	271	-----	-----	GR/CB	Hart Island RC
RC Run	579	-----	-----	SA/GR	Mapped at no flow
RC Pool	262	-----	-----	SA/SI	Habitat types assumed
RC Run	200	-----	-----	SA/GR	
RC Pool	987	-----	-----	SA/SI	
RC Run/Glide	383	-----	-----	GR/CB	
RC Riffle	173	-----	-----	GR/CB	
RC Run	228	-----	-----	GR/CB	
RC Glide	249	-----	-----	GR/SA	
RC Pool	369	-----	-----	SI/SA	

Habitat Type[a]	Length (ft)	Maximum Depth (ft)	Average Depth (ft)	Substrate[b] Dom/Sub	Note
LC Pool	296	8.6	6.4	-----	Hart Island LC
LC Glide	887	5.0	3.2	CB/GR	
LC Riffle	553	2.5	-----	CB/GR	
LC Pool	875	11.4	8.0	CB/GR	
LC Glide	211	6.6	4.4	CB/CB	
Riffle	201	3.9	3.1	CB/GR	
Riffle/Run	246	4.3	2.7	GR/CB	
Pool	1045	11.4	5.2	CB/SA/GR	
Glide	862	4.5	3.0	CB/SA/GR	
Riffle	88	-----	-----	CB/GR	
Run	340	7.2	5.2	CB/GR	
Pool	1380	17.5	6.5	GR/CB/SA	
Pool	505	10.2	5.8	CB/GR/SA	
Pool	964	12.9	6.2	CB/CB	
Glide	646	3.2	2.3	CB/GR	
Glide	374	3.1	2.1	GR/SA	
Glide	1686	4.9	3.4	CB/GR/SA	
Glide	381	5.0	4.2	GR/CB/SA	
Pool	583	7.2	5.0	CB/SA/GR	
Glide	1246	5.5	3.5	GR/CB/SA	
Pool	1033	8.0	5.0	GR/SA/CB	
Glide	390	5.2	3.8	GR/CB	
Pool	1206	12.9	6.4	GR/CB	
Pool	1066	6.3	4.0	GR/SA/CB	
Glide	881	4.7	3.1	GR/SA	
Pool	430	5.6	3.7	SA/GR	
Glide	1378	4.5	2.9	GR/SA	Cornish Boat Launch
Pool	1805	9.6	5.0	SA/GR/CB	
Pool	687	21.0	10.5	CB/SA	Covered Bridge
Glide	485	8.0	4.1	GR/CB	
Run	728	7.5	4.1	CB/GR	
Pool	953	11.5	7.0	SA/SI	
Glide	461	4.5	3.4	CB/GR/SA	
LC Riffle	356	-----	-----	GR/CB	Chase Island LC
LC Run	471	-----	-----	GR/SA	
LC Glide	256	-----	-----	GR/SA	
LC Pool	138	-----	-----	GR/SA	
LC Pool	1342	7.9	3.8	GR/SA	
RC Riffle	565	3.1	2.0	GR/SA/CB	Chase Island RC
RC Run	650	4.2	2.5	GR/CB	
RC Run	543	5.4	4.1	CB/GR	
RC Pool	1075	17.1	5.9	CB/SA/GR	
					End Reach 3

a RC = Right Channel, LC = Left Channel, SC = Side Channel
b Substrate codes from Table 7-1; Dom = Dominant, Sub= Sub-dominant

Table A-2. Bellows Falls Reach Habitat Mapping Data

Habitat Type[a]	Length (ft)	Maximum Depth (ft)	Average Depth (ft)	Substrate[b] Dom/Sub	Note
Pool	975	36.7	13.3	CB/GR	Below Dam
Glide	1392	20.3	5.4	GR/CB	
Run	513	13.0	7.2	CB/BD	Saxtons River
Glide	228	6.9	4.9	CB/GR	
Riffle	509	4.9	2.7	CB/GR	
Run	1536	9.9	4.8	CB	
Run	904	7.1	6.1	CB	Cold River
Pool	484	9.8	6.0	CB	
Glide	848	5.0	3.4	CB	
Run	919	8.0	5.5	CB/GR	
Pool	1003	9.4	5.6	GR/SA	
Glide	1374	7.3	4.5	GR/CB	
Pool	2793	29.6	8.9	GR/SA	
Pool	587	11.4	6.9	GR/SA	
Glide	200	4.5	4.3	GR/SA	
Run	576	5.0	3.2	CB/GR	
Pool	1942	13.8	6.3	GR/SA	
Glide	719	8.9	5.2	GR/CB	
SC Run	370	-----	-----	SA/GR	Side Channel
Pool	2414	16.7	9.9	CB/GR	
Pool	376	49.8	24.7	-----	Walpole Bridge
RC Run	161	3.2	-----	GR/SA	Island
RC Pool	213	5.5	-----	GR/SA	
RC Glide	550	2.3	-----	GR/SA	
LC Pool	886	9.8	6.4	GR/SA	
Glide	481	5.4	3.1	GR/SA	
Glide	699	5.2	3.7	GR/CB	
Pool	860	8.4	4.2	GR/SA	
Pool	2995	8.8	6.1	GR/CB	
Pool	820	8.7	5.4	GR/SA	
RC Pool	1613	7.3	5.1	GR/SA	Dunshee Island RC
RC Pool	702	8.2	6.5	SA/GR	
LC Pool	1192	5.0	3.1	GR/SA	Dunshee Island LC
LC Pool	1114	8.9	5.9	-----	End of Reach
Pool	3712	14.5	8.7	SI/SA	Vernon Impoundment Influence

[a] RC = Right Channel, LC = Left Channel, SC = Side Channel
[b] Substrate codes from Table 7-1; Dom = Dominant, Sub= Sub-dominant

Table A-3. Bellows Falls Bypassed Reach Habitat Mapping Data

Habitat Type[a]	**Length (ft)**	**Maximum Depth (ft)**	**Average Depth (ft)**	**Substrate[b] Dom/Sub**	**Note**
Start	-----	-----	-----	-----	Base of Dam
Pool	553	-----	-----	BD/BR	
Run	201	-----	-----	BD/BR	
Riffle	51	-----	-----	BD/BR	
Riffle	193	-----	-----	BD/CB	
Run	127	-----	-----	BD/CB	Corner
Riffle	88	-----	-----	BD/CB	
Pool	258	-----	-----	BD/CB	
Run/Riffle	119	-----	-----	BD/CB	Corner
Pool	606	-----	-----	BD/BR	
Fish Barrier	98	-----	-----	-----	Cascade
Pool	242	-----	-----	BD/BR	
Pool	180	-----	-----	BD/BR	
Pool	164	-----	-----	BD/BR	Trench Pool
Pool	449	-----	-----	BD/BR	
Run	191	-----	-----	BD/BR	
BW Pool	372	-----	-----	BD/CB	
					End of Reach

[b] Substrate codes from Table 7-1; Dom = Dominant, Sub= Sub-dominant

Table A-4. Vernon Reach Habitat Mapping Data

Habitat Type[a]	Length (ft)	Maximum Depth (ft)	Average Depth (ft)	Substrate[b] Dom/Sub	Note
SC Pool	370	-----	-----	GR/CB	SC at top of reach
SC Run/Riffle	354	-----	-----	CB/GR	Mapped at low flow
SC Run	193	-----	-----	CB/GR	Channel all Run
SC Riffle	71	-----	-----	CB/GR	at Higher Flows
SC Pool	720	9.2	6.6	SA/BR	
Pool Below Dam	-----	-----	-----	-----	Start at Control
Run	493	21.2	5.7	CB/GR	
Run	468	15.6	9.6	CB/GR	
Pool	1147	44.9	19.6	SA	
Pool	506	38.5	23.3	SA	
Glide	354	11.4	9.1	CB	
RC Pool	276	15.5	13.1	-----	Stebbins Island RC
RC Run	382	-----	-----	CB/GR	
RC Pool	1476	27.2	14.0	SA	
RC Run	563	7.7	5.5	CB/GR	
RC Pool	742	6.2	4.5	-----	
LC Run	693	10.2	7.7	GR/CB	Stebbins Island LC
LC Glide	713	6.8	6.1	GR/SA	
LC Run	671	14.2	7.5	-----	
LC Glide	634	7.7	5.6	GR/SA	
LC Pool	978	11.8	7.7	GR/SA	
					End of Reach

[a] RC = Right Channel, LC = Left Channel, SC = Side Channel
[b] Substrate codes from Table 7-1; Dom = Dominant, Sub= Sub-dominant

Appendix B

2013 Aquatic Mesohabitat Maps

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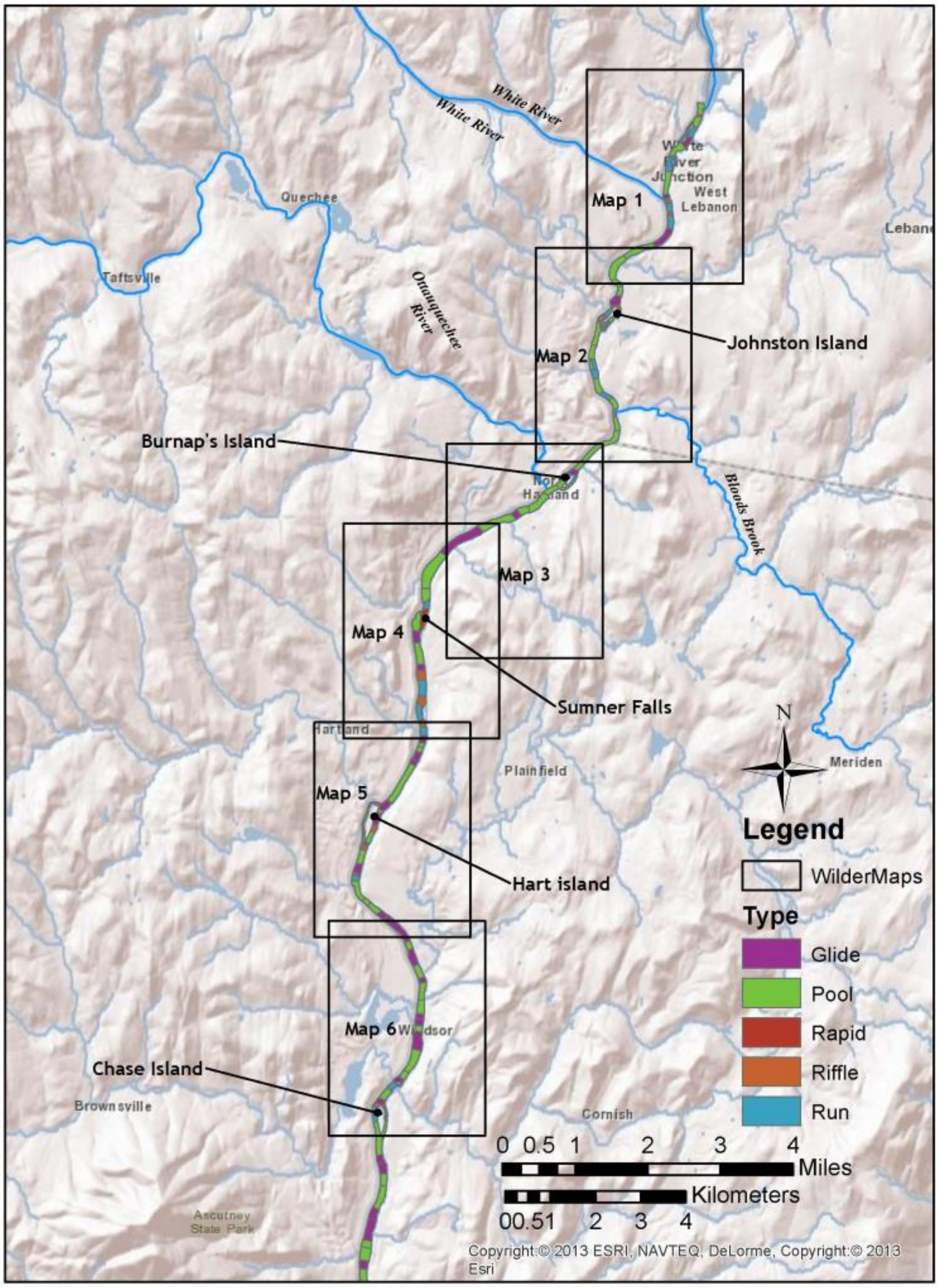

Figure B.1. Wilder riverine segment aquatic habitat mapping index.

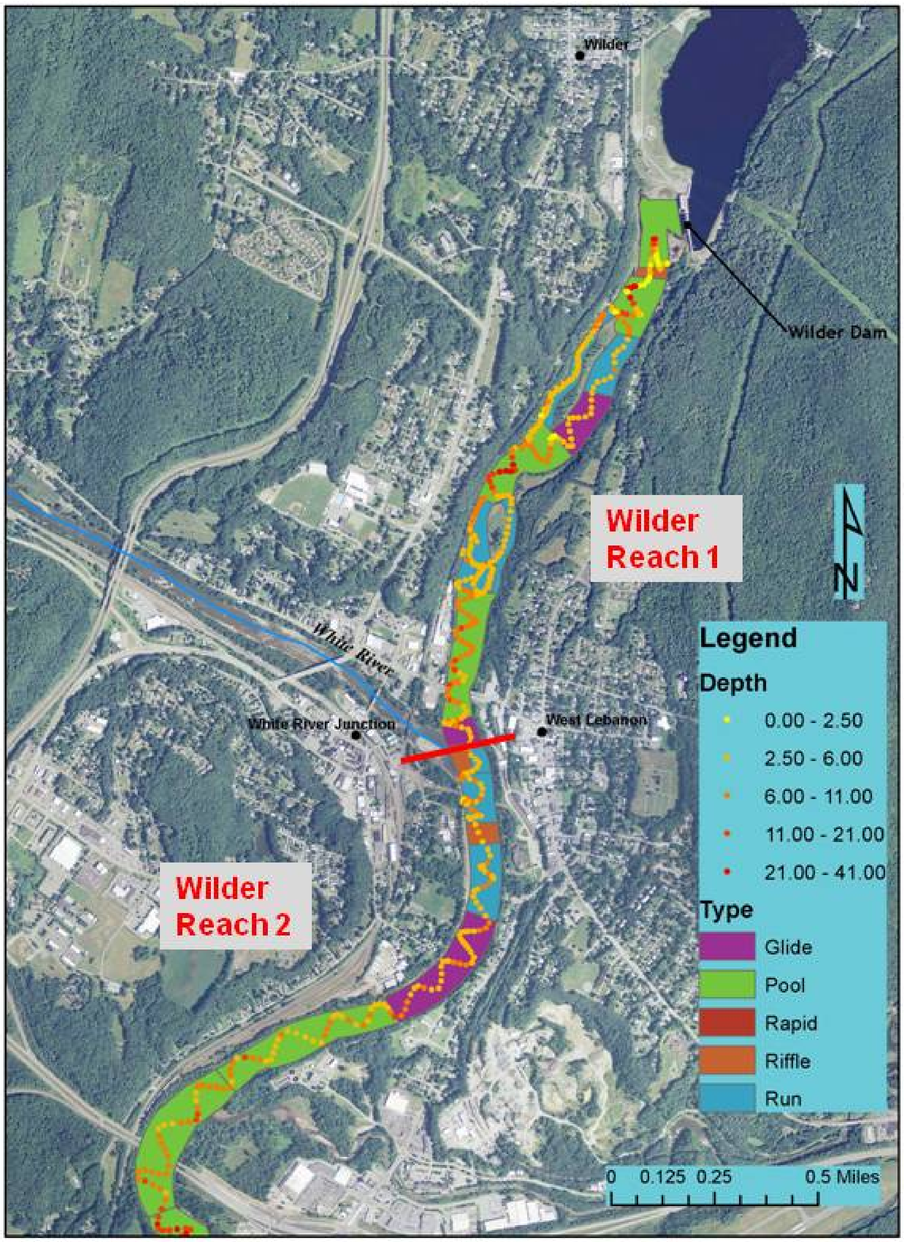

Figure B.2. Wilder Map 1, Wilder reach 1 and 2.

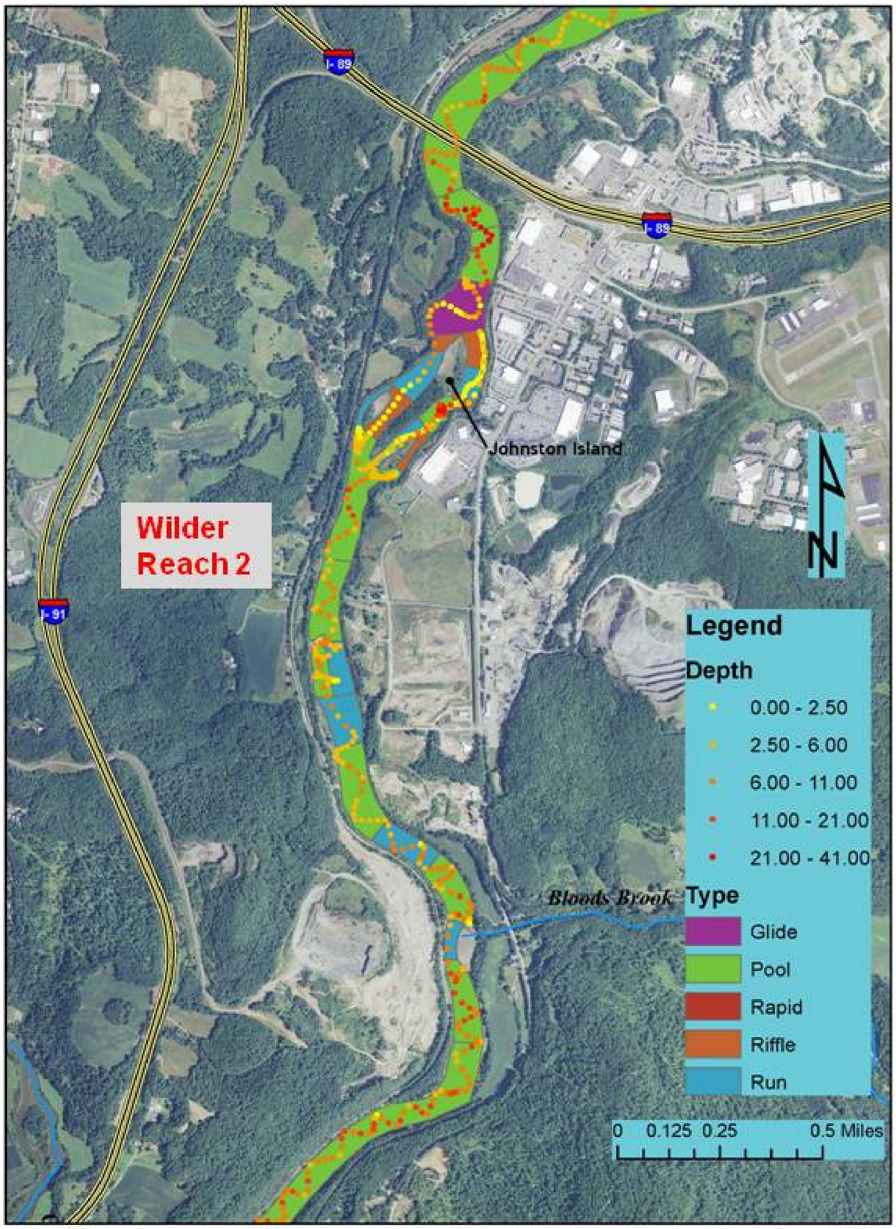

Figure B.3. Wilder Map 1, Wilder reach 2.

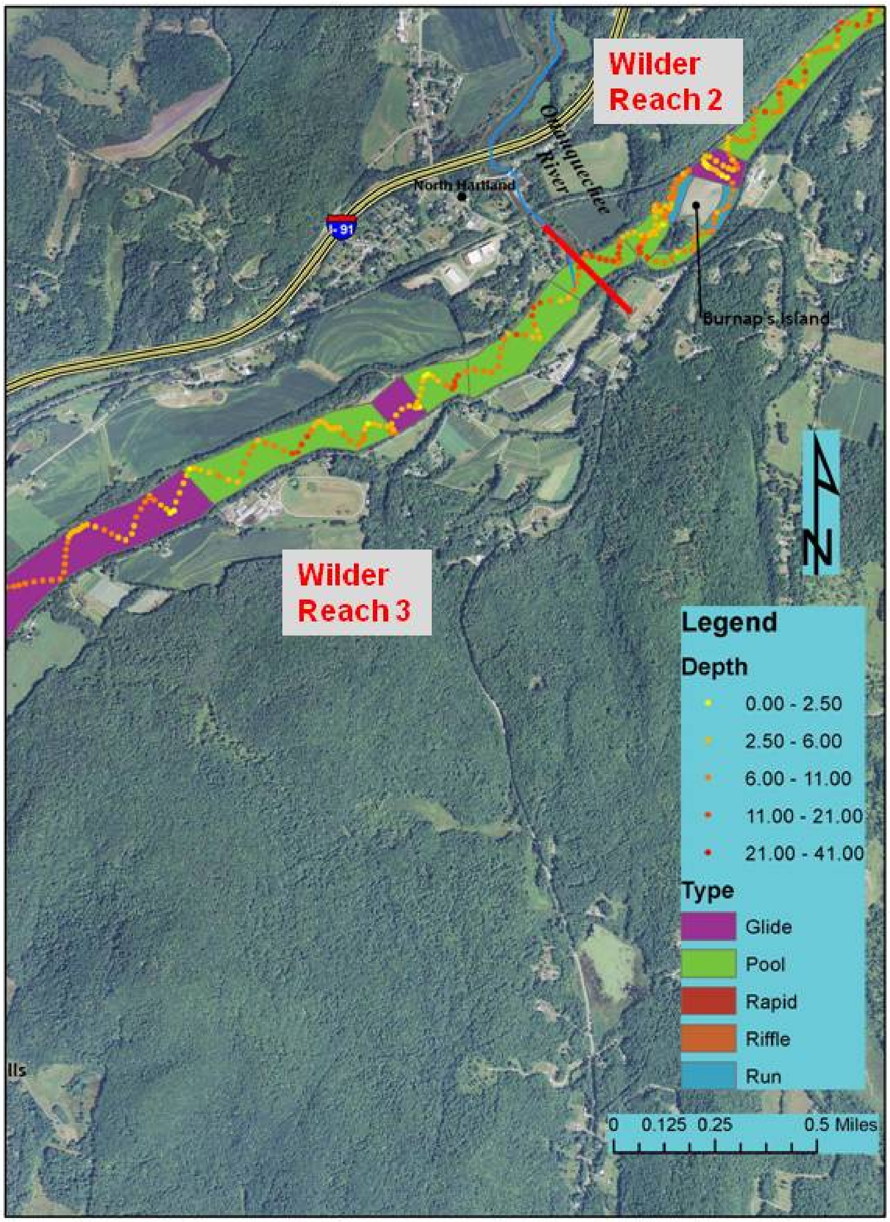

Figure B.4. Wilder Map 1, Wilder reach 2 and 3.

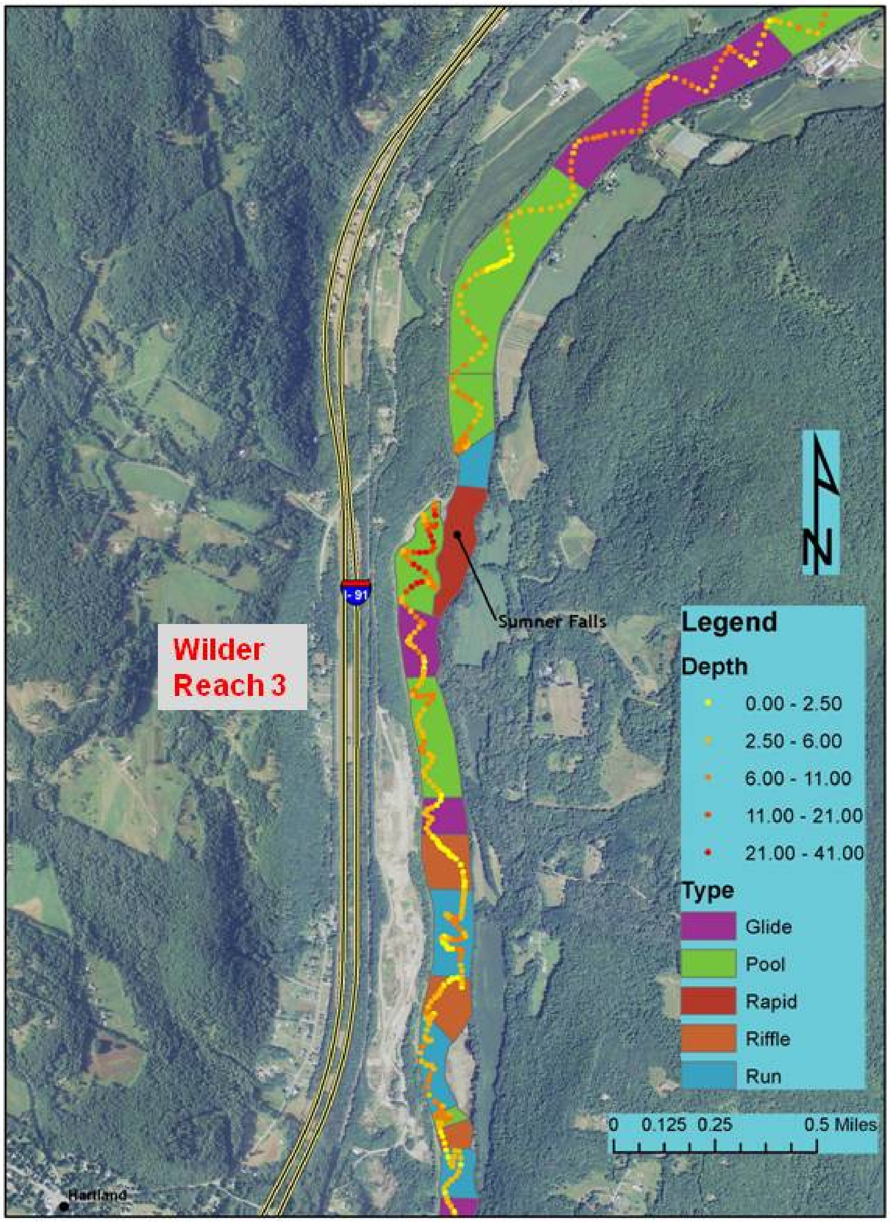

Figure B.5. Wilder Map 1, Wilder reach 3.

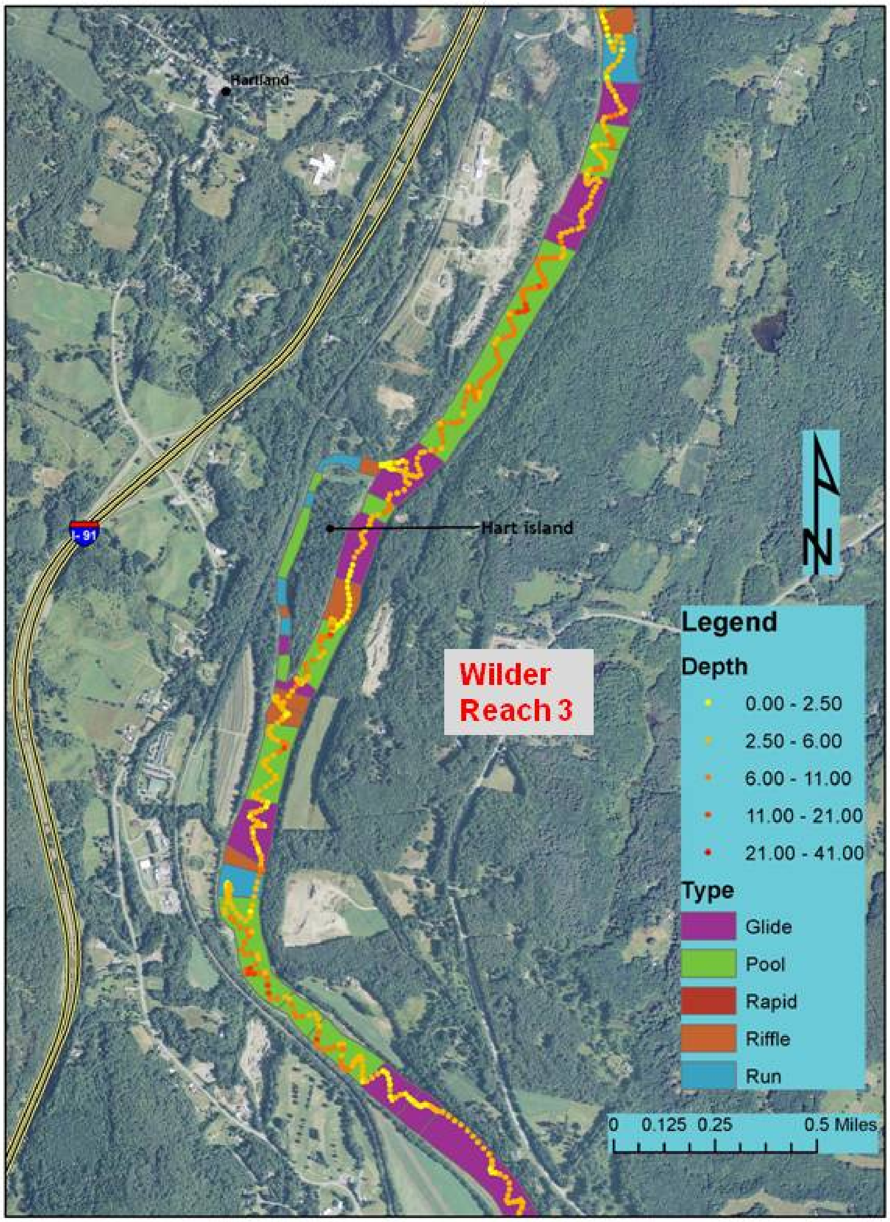

Figure B.6. Wilder Map 1, Wilder reach 3.

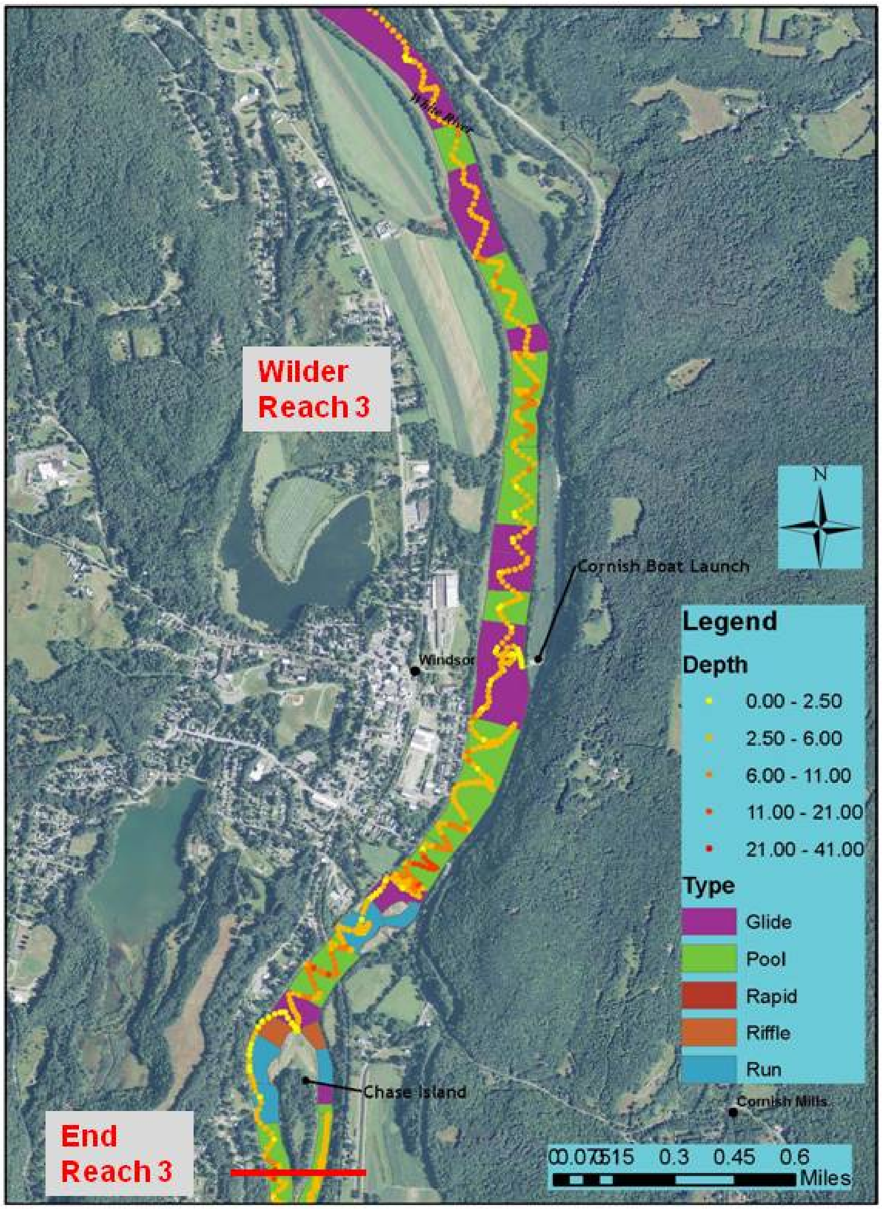

Figure B.7. Wilder Map 1, Wilder reach 3.

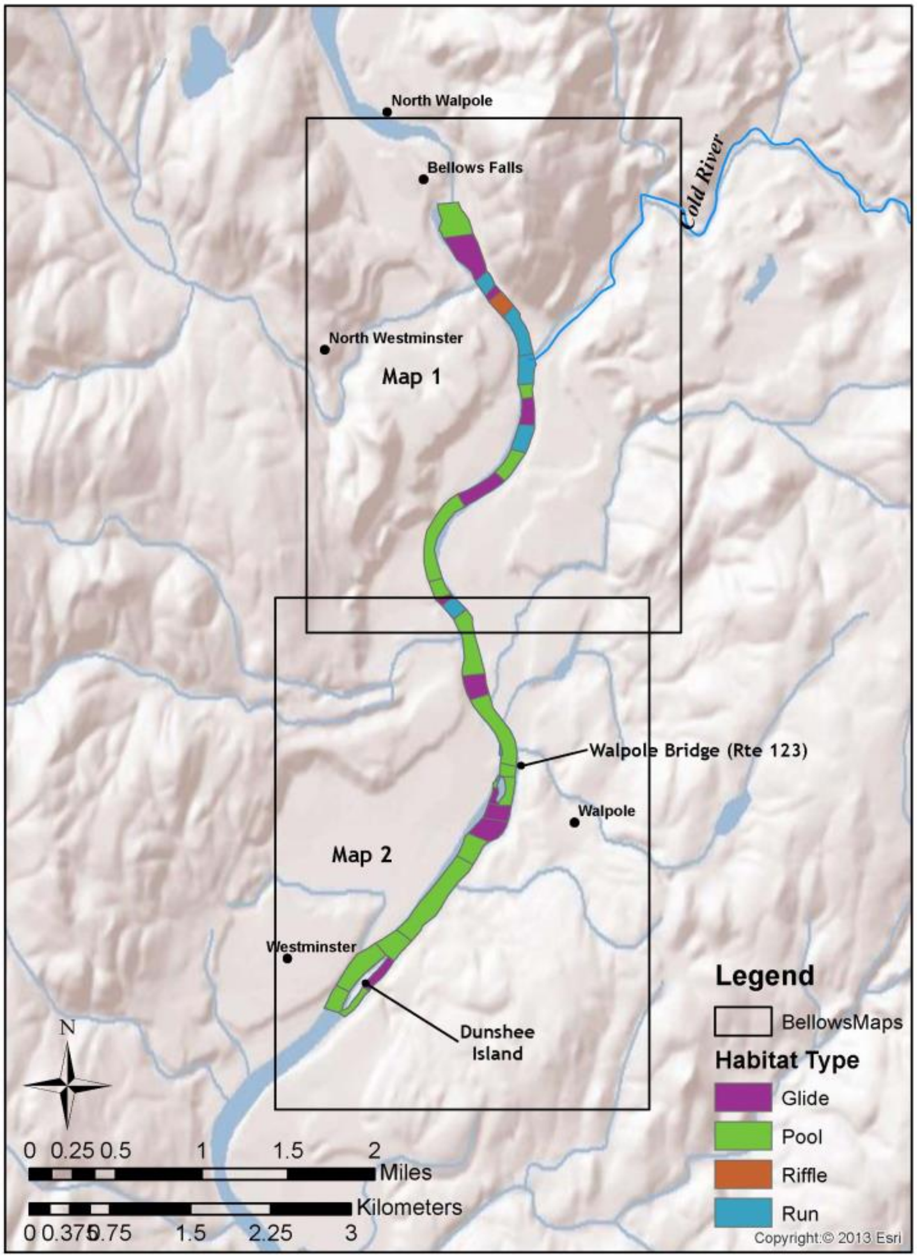

Figure B.8. Bellows Falls reach aquatic habitat mapping index.

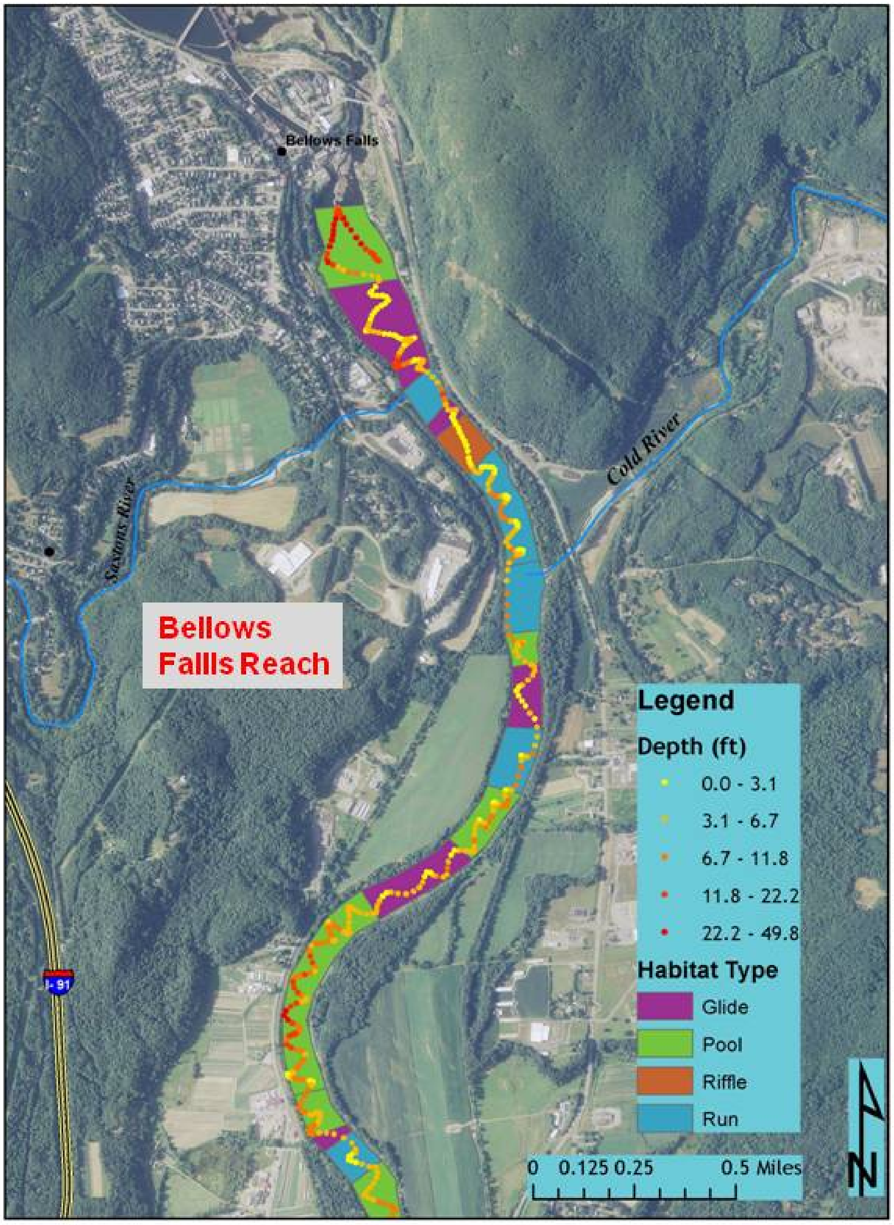

Figure B.9. Bellows Falls Map 1.

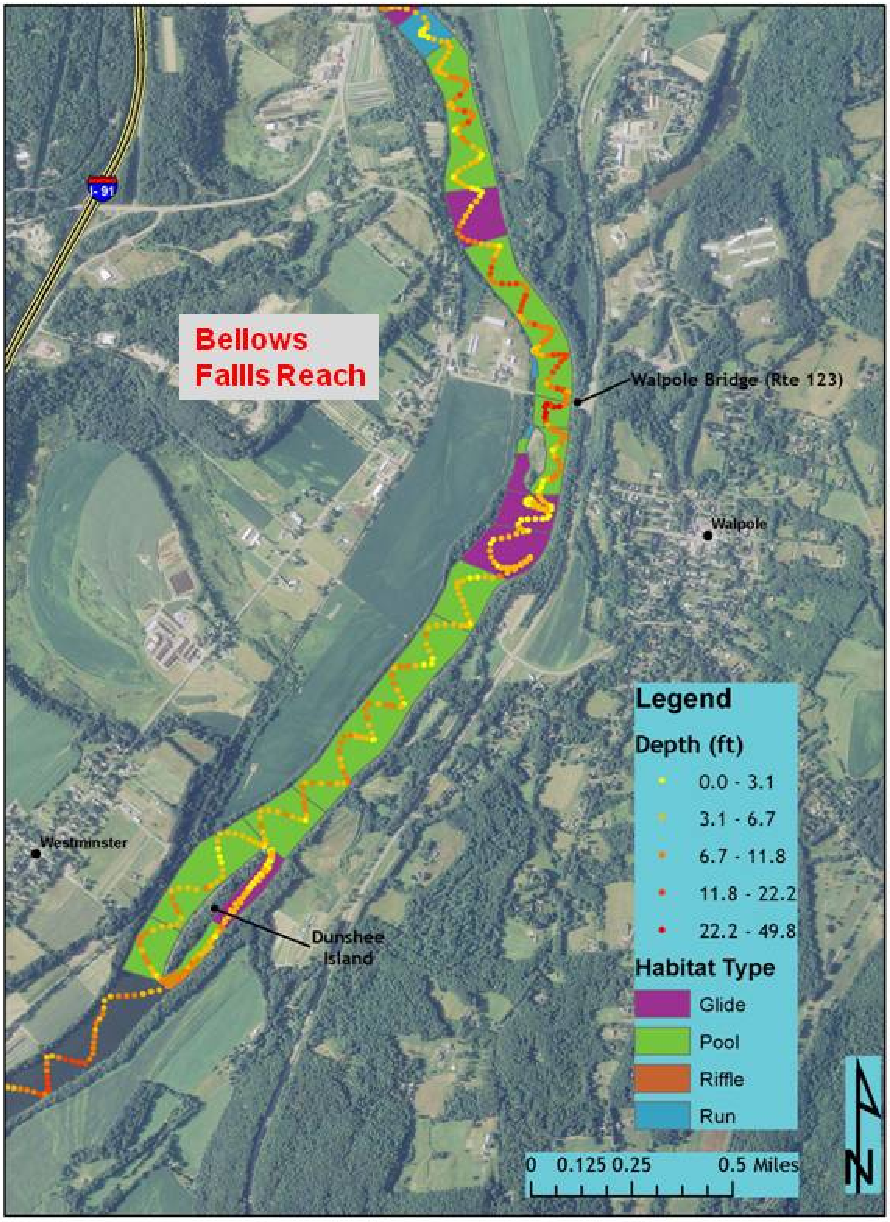

Figure B.10. Bellows Falls Map 2.

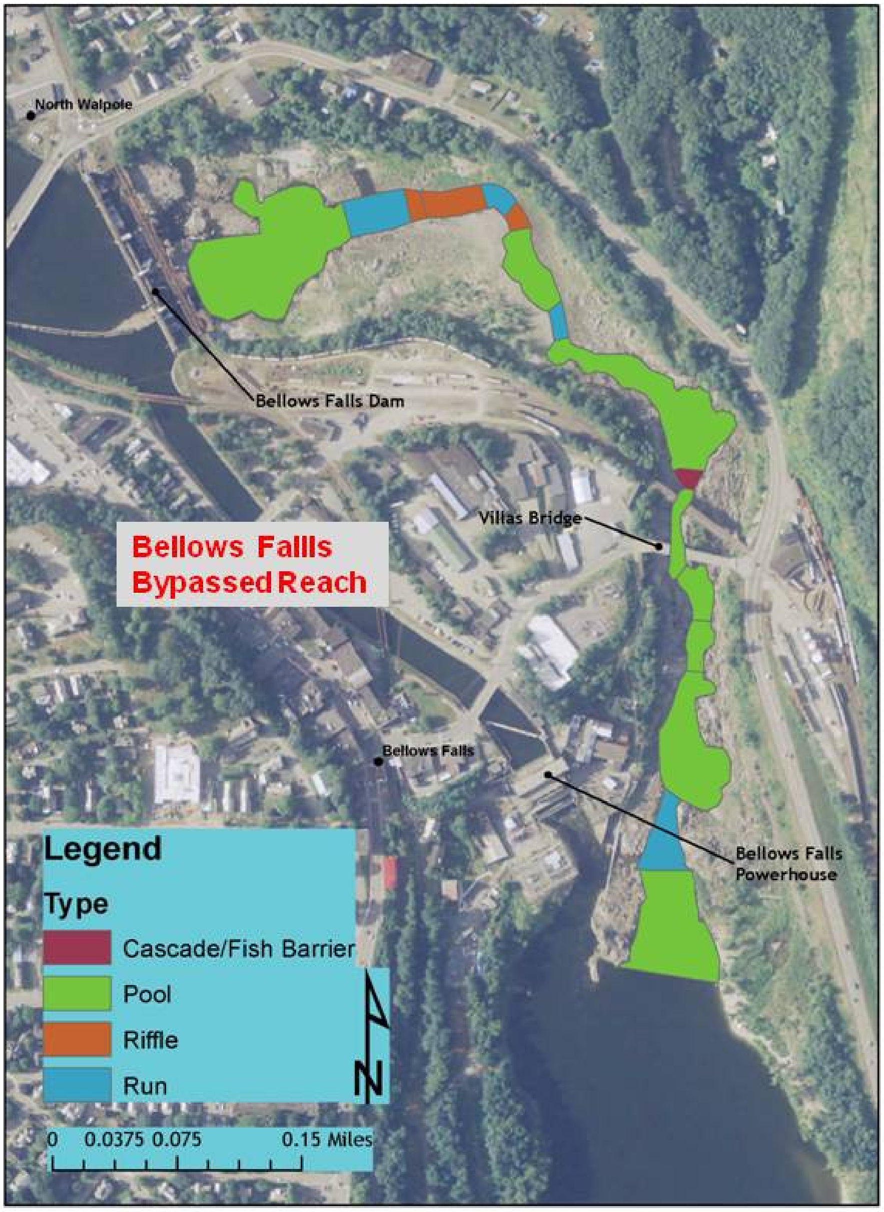

Figure B.11. Bellows Falls Bypassed reach.

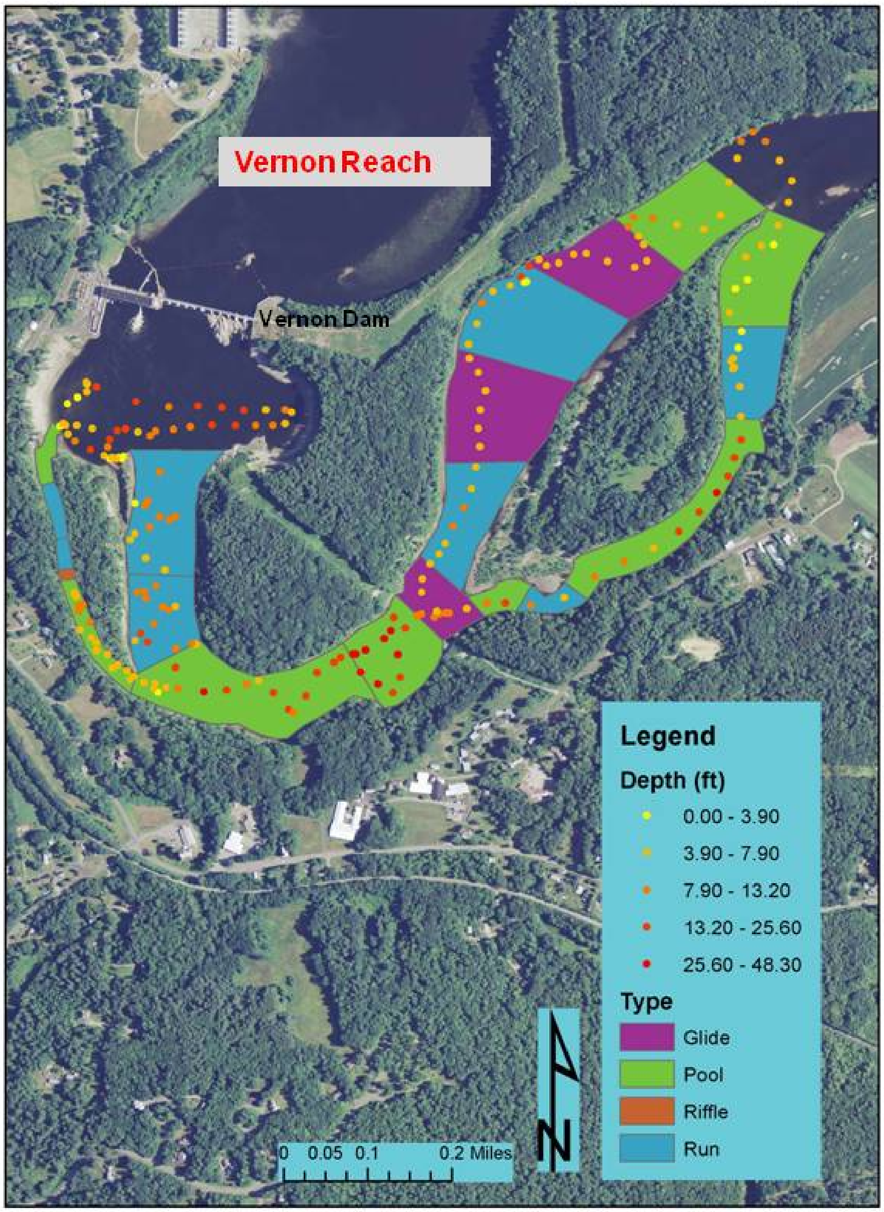

Figure B.12. Vernon reach.

Appendix C

2013 Aquatic Habitat Mapping Photos

Photo 1. Wilder Reach 1; upstream view of Wilder dam (to right) at ~1,000 cfs.

Photo 2. Wilder Reach 1; 1st island below Wilder dam, right channel at ~1,000 cfs.

Photo 3. Wilder Reach 2; Upstream view of right channel Johnston Island at ~5,000 cfs.

Photo 4. Wilder Reach 2; Bloods Brook cobble bar at ~9,500 cfs, right bank.

Photo 5. Wilder Reach 2; Blood's Brook bar at ~9,500 cfs, left bank

Photo 6. Wilder Reach 3; Upper Sumner Falls at ~9,500 cfs

Photo 7. Wilder Reach 3; Upper Sumner Falls at ~5,000 cfs

Photo 8. Wilder Reach 3; Upper Sumner Falls at ~1,500 cfs.

Photo 9. Wilder Reach 3; Lower Sumner Falls at ~5,000 cfs.

Photo 10. Wilder Reach 3; Lower Sumner Falls at ~1,500 cfs

Photo 11. Wilder Reach 3; Riffle ~0.8 miles downstream of Sumner Falls.

Photo 12. Wilder Reach 3; Hart Island bar at entrance to right channel at ~1,500 cfs

Photo 13. Wilder Reach 3; Hart Island right channel at ~1,500 cfs, upstream.

Photo 14. Wilder Reach 3; Hart Island right channel at ~1,500 cfs, downstream.

Photo 15. Bellows Falls Reach; Saxtons River bar at ~2,000 cfs.

Photo 16. Bellows Falls Reach; Cold River bar at ~3,500 cfs.

Photo 17. Bellow Falls Reach; Riffle downstream of Saxtons River ~3,500 cfs.

Photo 18. Bellows Falls Reach; Dry side channel upstream of Walpole Bridge at ~3,500 cfs.

Photo 19. Bellows Falls Reach; Dry side channel upstream of Walpole Bridge at ~3,500 cfs.

Photo 20. Bellows Falls Reach; Right channel of unnamed island downstream of Walpole Bridge at ~3,500 cfs

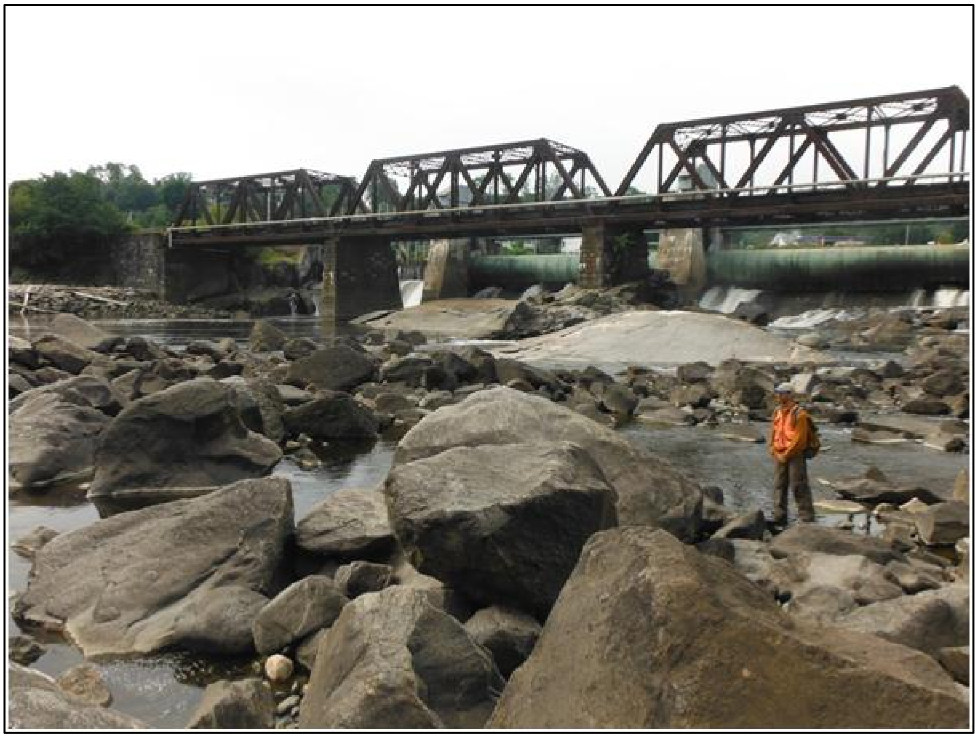

Photo 21. Bellows Falls Bypassed Reach; below dam.

Photo 22. Bellows Falls Bypassed Reach; pool downstream of dam.

Photo 23. Bellows Falls Bypassed Reach; run riffle section downstream of dam.

Photo 24. Bellows Falls Bypassed Reach; pool immediately upstream of fish barrier and cascade.

Photo 25. Bellows Falls Bypassed Reach; right and left channels under Vilas Bridge (top stadia rod 25 feet).

Photo 26. Bellows Falls Bypassed Reach; looking upstream right channel toward fish barrier from Vilas Bridge.

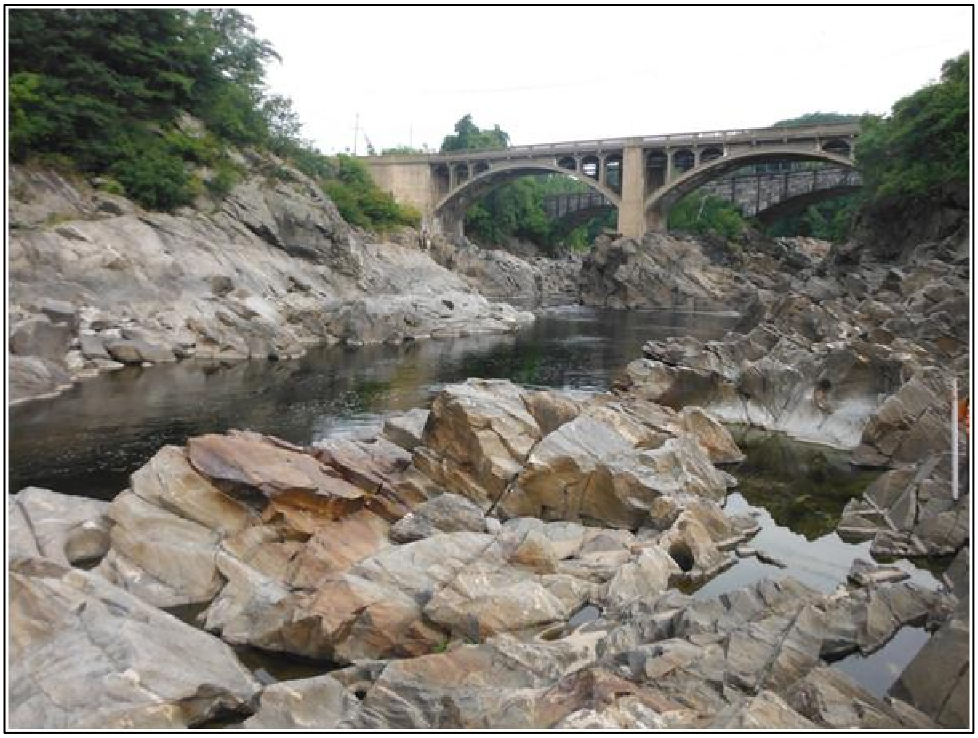

Photo 27. Bellows Falls Bypassed Reach; looking upstream toward Vilas Bridge.

Photo 28. Bellows Falls Bypassed Reach; looking downstream from Vilas Bridge.

Photo 29. Vernon Reach; upstream view of dam and pool at ~3,500 cfs

Photo 30. Vernon Reach; downstream view from downstream end of pool below dam at ~3,500 cfs.

Photo 31. Vernon Reach; downstream view of side channel near top of reach at ~3,500 cfs.

Photo 32. Vernon Reach; downstream view of side channel near top of reach at ~9,600 cfs.

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Initial Study Report

Volume III – Containing Sub Volumes III.A – III.D

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Volume III.A

Study 8 – Channel Morphology and Benthic Habitats Study Site Selection Report

Initial Study Report

September 15, 2014

TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 8
Channel Morphology and Benthic Habitats

Site Selection Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Prepared for
TransCanada Hydro Northeast Inc.
4 Park Street, Suite 402
Concord, NH 03301

Prepared by

Stantec Consulting Services Inc.
and
Normandeau Associates, Inc.

May 9, 2014

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1. INTRODUCTION

Operations at TransCanada's Wilder, Bellows Falls and Vernon hydroelectric projects (projects) may affect fish and aquatic resources. The goal of ILP Study 8 - Channel Morphology and Benthic Habitats Study, developed in support of the relicensing for these three hydroelectric projects, is to understand how project operations affect bedload distribution, particle size, and composition in relation to habitat availability for different life-history stages of anadromous and riverine fish, and for invertebrates.

The Revised Study Plan (RSP) for Study 8, as supported by stakeholders in 2013 and approved by FERC in its February 21, 2014, Study Plan Determination, provides an overview of the methodology that will be employed in 2014 to assess channel morphology in relation to habitat availability in the project-affected Connecticut River reaches. The objectives of this study are to:

- Assess the distribution and extent of the existing substrate types including gravel and cobble bars within the project-affected areas; and
- Identify the current conditions of the channel and determine the stability of the present substrate/benthic habitat and potential project-related effects on these habitats.

The purpose of this Site Selection Report is to identify potential study sites and present recommendations for selection of study sites for Study 8 field work. Following on the approach described in the RSP, this report identifies potential study sites along the project-affected reaches of the Connecticut River (mainstem sites) and potential tributary study sites along and adjacent to the project-affected reaches of the Connecticut River (tributary sites), and presents recommendations for selection of 12 mainstem study sites and 6 tributary study sites. This document provides a summary of the data analysis and criteria used to select the sites that will be examined in detail during 2014.

2. STUDY AREA

The study area includes areas that may be project-affected along the Connecticut River from the upstream limit of the Wilder impoundment to approximately 1.5 miles downstream of Vernon dam. In addition, the study area includes tributaries that discharge to this reach of the Connecticut River.

The RSP described three types of study sites located in three general areas:

- Upstream (US)-type study sites are located on riverine reaches of the Connecticut River upstream from the TransCanada Project impoundments;
- Downstream (DS)-type study sites are located on riverine reaches of the Connecticut River downstream from the Wilder and Bellows Falls dams; and

- Tributary study sites are located on selected tributaries to the Connecticut River in the riverine reaches downstream from the Wilder and Bellows Fall dams and in tributaries to the TransCanada Project impoundments.

Study site selection excluded the riverine reach upstream of the upper extent of the Wilder impoundment and portions of tributaries upstream of project influence of the influence as these are outside of areas affected by the projects and are influenced by non-project related inflow. The approximate 1.5 mile reach downstream of Vernon dam was included, to be consistent with the geographic scope other ILP studies.

The RSP calls for establishing approximately 12 US- and DS-type study sites (collectively referred to as mainstem study sites) and up to 6 tributary study sites. Mainstem study sites may be representative of both DS-type and US-type study sites. For this reason, this report does not distinguish between US- and DS-type mainstem sites. Consistent with other studies, this report refers to mainstem riverine sites in relation to the nearest upstream TransCanada Project dam.

There are more than 100 tributaries to the project-affected reach of the Connecticut River. The RSP describes selection of tributaries with and without flood control dams and selection of tributary sites at representative locations in the vicinity of confluences of tributaries to the project-affected reaches of the Connecticut River. Five tributaries were specifically suggested by the working group during meetings as part of the development of the RSP:

- White River (Vermont) — The confluence is 2.3 miles downstream of Wilder dam and upstream of the Bellows Falls impoundment.
- Mascoma River (New Hampshire) — The confluence is 3.2 miles downstream of Wilder dam and upstream of the Bellows Falls impoundment.
- Williams River (Vermont) — The confluence is within the Bellows Falls impoundment, 2.7 miles upstream of the Bellow Falls dam.
- Saxtons River (Vermont) — The confluence is 1.2 miles downstream of the Bellows Falls dam and upstream of the Vernon impoundment.
- Cold River (New Hampshire) — The confluence is 1.8 miles downstream of the Bellows Falls dam and upstream of the Vernon impoundment.

No flood control facilities were identified on these five tributaries, though dams are present on some of the tributaries, including some dams with storage reservoirs.

3. METHODS

Site selection was based on desktop studies and was conducted in consultation with Field Geology Services (FGS). This work relied on review of:

- Aerial photographic imagery;
- U.S. Geological Survey (USGS) topographic maps;

- Observations by FGS as a part of implementation of ILP Study 2 – Riverbank Transect Study;
- Flood control facilities on tributaries to the Connecticut River within the study area; and
- Available, applicable substrate data collected as a part of ILP Study 7 – Aquatic Habitat Mapping.

3.1 Site Selection Criteria

Primary selection criteria included observation of apparent depositional areas of coarse-grain sediments. Other criteria included apparent site access, apparent ability to obtain relevant information, and apparent site safety. Site access confirmation was not a component of site selection work, and it is expected that the following items will need to be resolved as a part of final site selection:

- Receipt of permissions to cross private land where necessary; and
- Approvals and permissions to cross railroad tracks where necessary.

3.2 Site Selection Methodology

The primary method for selection of study sites was identification of areas with accumulations of apparently coarse sediment using aerial photographs. Aerial photographs depicting periods of lower water surface elevations were used to identify sites that are expected to be exposed or at shallow depths (less than knee deep) to allow for field sampling. Following desktop identification of potential study sites, available substrate information collected as a part of Study 7 was reviewed to qualitatively evaluate the identified sites and confirm their apparent suitability in relation to relevant Study 8 substrate criteria.

Potential mainstem and tributary study sites identified as a part of desktop studies were documented in plan view on aerial imagery, and in tabular format. Site descriptors include latitude, longitude, site type, location relative to nearest TransCanada Project dam and/or impoundment, channel position, mapped substrate category (for sites where applicable data was available from Study 7), and site description.

Following identification of potential mainstem and tributary sites, these sites were reviewed, compared, and assessed to inform the selection of 12 representative mainstem sites and 6 representative tributary sites as specified in the RSP. The site selection process considered the site selection criteria identified in the RSP and described above, and also considered selection of a suite of sites that, as a whole, are generally spatially and physically representative of the study area. In addition to the 12 mainstem and 6 tributary sites identified in this process, additional sites meeting the site selection criteria were identified as “contingency” sites for potential use if it is determined that one or more of the recommended sites is not suitable for use as a part of the study. For the purposes of site selection, the upstream limit of each impoundment was assumed to be coincident with the upstream limit of the respective TransCanada Project boundary.

3.2.1 Mainstem Site Selection

Identification of potential mainstem sites included consideration of the riverine reaches downstream of each of the three project dams, including the riverine reaches extending:

- Approximately 17 miles below Wilder dam;
- Approximately 6 miles below Bellows Falls dam; and
- Approximately 1.5 miles below Vernon dam.

3.2.2 Tributary Site Selection

Identification of potential tributary sites included consideration of tributaries to the riverine reaches and to the impoundments. Potential tributary site identification also included consideration of the five tributaries listed in the RSP; the apparent sediment supply based on the apparent presence of exposed bars and submerged bedforms on aerial photographs; and observation of locations where accumulated sediment appear to have been deposited by tributaries.

Flood control facilities on tributaries to the study area were also reviewed. The basis for considering flood control facilities only (rather than all tributary dams) is that flood control facilities have the capability to capture large volumes of sediment, whereas smaller dams have a limited capacity to capture sediment. Five flood control facilities were identified on tributaries to the project-affected reaches, all of which are owned and operated by the U.S. Army Corps of Engineers (USACE) and located in Vermont (Table 1). While no flood control facilities were identified on the 5 tributary sites listed in the RSP, dams that may affect movement of sediment are present on some of the selected tributaries.

Table 1. Flood Control Facilities on Tributaries within the Study Area

TRIBUTARY	DAM NAME	LOCATION
Ompompanoosuc River	Union Village Dam	Thetford, Vermont
Ottauquechee River	North Hartland Lake Dam	Hartland and Hartford, Vermont
Black River	North Springfield Dam	North Springfield, Vermont
West River	Ball Mountain Dam	Jamaica, Vermont
West River	Townshend Dam	Townshend, Vermont

4. SITE SELECTION RECOMMENDATIONS

This section presents recommendations for selection of 12 mainstem and 6 tributary study sites as well as for "contingency" sites suitable for use if any of the primary sites are subsequently determined to be unsuitable for use.

4.1 Potential Mainstem Study Sites

Desktop studies identified a total of 20 potential mainstem study sites within the study area, including 13 sites in the riverine reach downstream of Wilder dam, 5 sites in the riverine reach downstream of Bellows Falls dam, and 2 sites in the riverine reach downstream of Vernon dam. Twelve of these sites were selected for recommendation as mainstem study sites (8 sites downstream of Wilder, 3 sites downstream of Bellows Falls, and 1 site downstream of Vernon).

Identification of recommended sites was based on the site selection criteria described above and the apparent diversity and distribution of potential sites within the study area. Because all 20 identified potential mainstem sites appear to meet the study selection criteria identified in the RSP, sites that are not identified as "recommended" are suggested for consideration as "contingency sites," for use in the event that any of the recommended sites are determined unsuitable in the course of future project work (e.g., due to site access restrictions or other site characteristics). Locations and descriptions of the potential sites are presented from upstream to downstream in Table 2. Figures that depict the locations of the recommended and contingency sites are included in Appendices A and B.

4.2 Potential Tributary Study Sites

Desktop studies identified a total of 18 potential tributary sites within the study area, including locations in the 5 tributaries described in the RSP. The site selection process identified one potential tributary site upstream of Wilder dam, 12 sites between Wilder dam and Bellows Falls dam, and 6 sites between Bellows Falls dam and Vernon dam. No tributary sites were identified in the study reach downstream of Vernon dam. Three of the identified sites have flood control facilities and are located on the Ompompanoosuc River, the Ottauquechee River, and the West River, which has two flood control facilities in series on the mainstem of this tributary.

All potential tributary sites identified along riverine reaches are located in the immediate vicinity of the confluence of the tributary with the Connecticut River. All potential sites identified on tributaries to impounded reaches of the river are located upstream from the confluence, but within the project-affected reach.

Six of the identified potential tributary sites are recommended, based on the site selection criteria (including the presence of flood control facilities); consideration of the 5 tributaries that are identified in the RSP; and the apparent diversity and distribution of potential sites within the study area. Because all 18 identified potential sites appear to meet the study selection criteria, potential sites that are not identified as "recommended" are suggested for consideration as "contingency sites," for use in the event that any of the recommended sites are determined unsuitable in the course of future project work (e.g., due to site access restrictions or other site characteristics). Locations and descriptions of the identified sites, including the 6 recommended sites and 12 contingency sites, are presented from upstream to downstream in Table 3. Figures that depict the locations of the recommended and contingency tributary study sites are included in Appendices A and B.

Table 2. Potential Mainstem Study Sites

MAINSTEM STUDY SITES

Project	PSS #	Recommended or Contingency Site? (R / C)	Longitude	Latitude	Distance (mi. DS from Dam)	Site Position (MC / RR / RL)	Site Description	Substrate Classification from Study 7 (parentheses indicate subdominant substrate)	Location in Relation to Adjacent Tributary
WILDER DAM									
(Riverine reach approx. 17 mi).	**M1**	**R**	43.666824	-72.304411	0.05 DS / W	MC	260 ft. DS from W spillway	Cobble (Gravel)	-
	M2	C	43.663821	-72.306967	0.29 DS / W	MC	US end of island	Gravel (Sand)	-
	M3	C	43.645001	-72.313616	1.72 DS / W	RR	Side bar	Gravel (Sand)	0.25 mi DS from White River
	M4	**R**	43.622265	-72.330956	2.91 DS / W	MC	US end of island	Sand (Mud)	-
	M5	**R**	43.593215	-72.339922	6.28 DS / W	MC	US end of island	ND	0.36 mi US from Ottauquechee River
	M6	C	43.585495	-72.356067	7.27 DS / W	MC	MC bar	ND	0.62 mi DS from Ottauquechee River
	M7	**R**	43.573896	-72.378234	8.67 DS / W	MC	MC bar	Sand (Silt)	-
	M8	**R**	43.545437	-72.379890	10.7 DS / W	MC	MC bar	ND	-
	M9	C	43.512647	-72.397665	13.2 DS / W	MC	MC bar	Cobble (Gravel)	0.12 mi. US from Bashan Brook
	M10	**R**	43.501061	-72.385435	14.2 DS / W	RR	Point bar	ND	-
	M11	C	43.471767	-72.385710	16.5 DS / W	MC	MC bar	ND	0.04 mi. US from Mill Brook (VT) and Mill Brook (NH)
	M12	**R**	43.466903	-72.390753	16.9 DS / W	MC	US end of island	ND	0.39 mi DS from Mill Brook (VT) and Mill Brook (NH)
	M13	**R**	43.455823	-72.389735	17.7 DS / W	MC	MC bar	Cobble (Gravel)	0.11 mi US from unnamed tributary
(Impounded reach approx. 26 mi.)	*[Study 8 does not include mainstem study sites within impounded reaches]*								
BELLOWS FALLS DAM									
(Riverine reach approx. 6 mi.)	M14	C	43.137975	-72.442729	0.20 DS / BF	RR	1.050 ft. DS from BF spillway	ND	-
	M15	**R**	43.129942	-72.438829	0.83 DS / BF	RL	Side bar	Cobble (Gravel)	-
	M16	**R**	43.111681	-72.432414	2.19 DS / BF	MC	MC bar	Cobble (Gravel)	0.44 mi. DS from Cold River
	M17	**R**	43.085374	-72.434129	4.34 DS / BF	RR	Point bar	Cobble (Gravel)	-
	M18	C	43.083276	-72.434308	4.49 DS / BF	MC	US end of island	ND	Located at US limit of impoundment
(Impounded reach approx. 26 mi.)	*[Study 8 does not include mainstem study sites within impounded reaches]*								
VERNON DAM									
(Riverine reach approx. 1.5 mi.)	M19	C	42.768558	-72.514265	0.2 DS / V	MC	US end of island	ND	-
	M20	**R**	42.769045	-72.505054	1.0 DS / V	MC	Point bar at Stebbins Island	Gravel (Sand)	-

Notes: In the "PSS #" column of this table, "Recommended" sites are identified in bold.

Abbreviations: PSS (Potential Study Site); MS (Mainstem); Trib. (Tributary); Conf. (Confluence); ND (no data); mi. (mile); ft. (feet); MC (Mid-channel); RL (River Left); RR (River Right); W (Wilder Dam); BF (Bellows Falls Dam); V (Vernon Dam); R (Recommended Site); C (Contingency Site).

Table 3: Potential Tributary Study Sites

TRIBUTARY STUDY SITES									
Project	**PSS #**	**Recommended or Contingency Site? (R / C)**	**Latitude**	**Longitude**	**Distance** (mi. US / DS from Dam)	**Site Position** (MC / RR / RL)	**Site Description**	**Substrate Classification from Study 7** (parentheses indicate subdominant substrate)	**Tributary**
(Impounded reach approx. 45 mi.)	**T1**	**R**	43.765737	-72.239085	7.78 US / W	RR	Point bar; 1.34 mi. US from conf.	Sand / Silt / Clay	Ompompanoosuc River
WILDER DAM									
(Riverine reach approx. 17 mi.)	**T2**	**R**	43.648747	-72.315703	1.46 DS / W	MC of Trib	MC bar at conf.	ND	White River (Trib. identified in RSP)
	T3	**R**	43.635832	-72.325845	2.71 DS / W	RR of Trib	Point bar at conf.	ND	Mascoma River (Trib. identified in RSP)
	T4	C	43.635913	-72.322871	2.71 DS / W	MC of Trib	MC bar; 0.16 mi. US from conf.	ND	Mascoma River (Trib. identified in RSP)
	T5	C	43.613981	-72.334072	4.43 DS / W	RR of MS	Delta bar at conf.	Cobble (Gravel)	Trib. name unknown
	T6	C	43.605848	-72.327247	5.10 DS / W	RL of MS	Delta bar at conf.	ND	Bloods Brook
	T7	C	43.591191	-72.346726	6.64 DS / W	RR of Trib.	Point bar just US from conf.	ND	Ottauquechee River
	T8	C	43.510737	-72.398427	13.3 DS / W	RR of MS	Delta bar at conf.	ND	Bashan Brook
	T9	C	43.471798	-72.387464	16.45 DS / W	RR of MS	Delta bar at conf.	ND	Mill Brook (VT)
	T10	C	43.470624	-72.386323	16.45 DS / W	RL of MS	Delta bar at conf.	ND	Mill Brook (NH)
(Impounded reach approx. 26 mi.)	T11	C	43.178178	-72.455004	2.71 US / BF	MC of Trib	MC / delta bar at conf.	Sand / Silt / Clay	Williams River (Trib. identified in RSP)
	T12	**R**	43.184277	-72.464507	2.71 US / BF	MC of Trib	MC bar; 1.1 mi. US from conf.	Gravel / Cobble	Williams River (Trib. identified in RSP)
	T13	C	43.190433	-72.480242	2.71 US / BF	RR of Trib	Point bar; 2.05 mi US from conf.	ND	Williams River (Trib. identified in RSP)
BELLOWS FALLS DAM									
(Riverine reach approx. 6 mi.)	**T14**	**R**	43.124743	-72.437374	1.21 DS / BF	RR of MS	Delta bar at conf.	Cobble (Boulder)	Saxtons River (Trib. identified in RSP)
	T15	C	43.124034	-72.439617	1.21 DS / BF	MC of Trib	MC bar; 0.11 mi. US from conf.	ND	Saxtons River (Trib. identified in RSP)
	T16	**R**	43.117388	-72.431536	1.79 DS / BF	RL of MS	Delta bar at conf.	Cobble	Cold River (Trib. identified in RSP)
(Impounded reach approx. 26 mi.)	T17	C	42.986187	-72.463901	19.0 US / V	RR of MS	Delta bar at conf.	Gravel / Cobble	East Putney Brook
	T18	C	42.869794	-72.567345	7.39 US / V	MC	MC bar; 0.66 mi. US from conf.	Sand / Silt / Clay	West River
VERNON DAM									
(Riverine reach approx. 1.5 mi.)	*[No potential tributary sites identified DS from Vernon dam within the Study Area]*								

Notes: In the "PSS #" column of this table, "Recommended" sites are identified in bold.

Abbreviations: PSS (Potential Study Site); MS (Mainstem); Trib. (Tributary); conf. (Confluence); ND (no data); mi. (mile); ft. (feet); MC (Mid-channel); RL (River Left); RR (River Right); W (Wilder Dam); BF (Bellows Falls Dam); V (Vernon Dam); R (Recommended Site); C (Contingency Site).

5. FINAL SITE SELECTION

The site selection process is intended to provide a structured and informed approach to selection of study sites for Study 8. This report presents information on potential sites that were identified as part of the site selection process along with recommendations for 12 mainstem study sites and 6 tributary study sites and recommendations for contingency sites. The final selection of study sites will occur with the concurrence of the working group, confirmation of suitable access, safety considerations, and field-verification of site suitability.

5.1 Uncertainty Regarding Site Suitability, Access and Safety

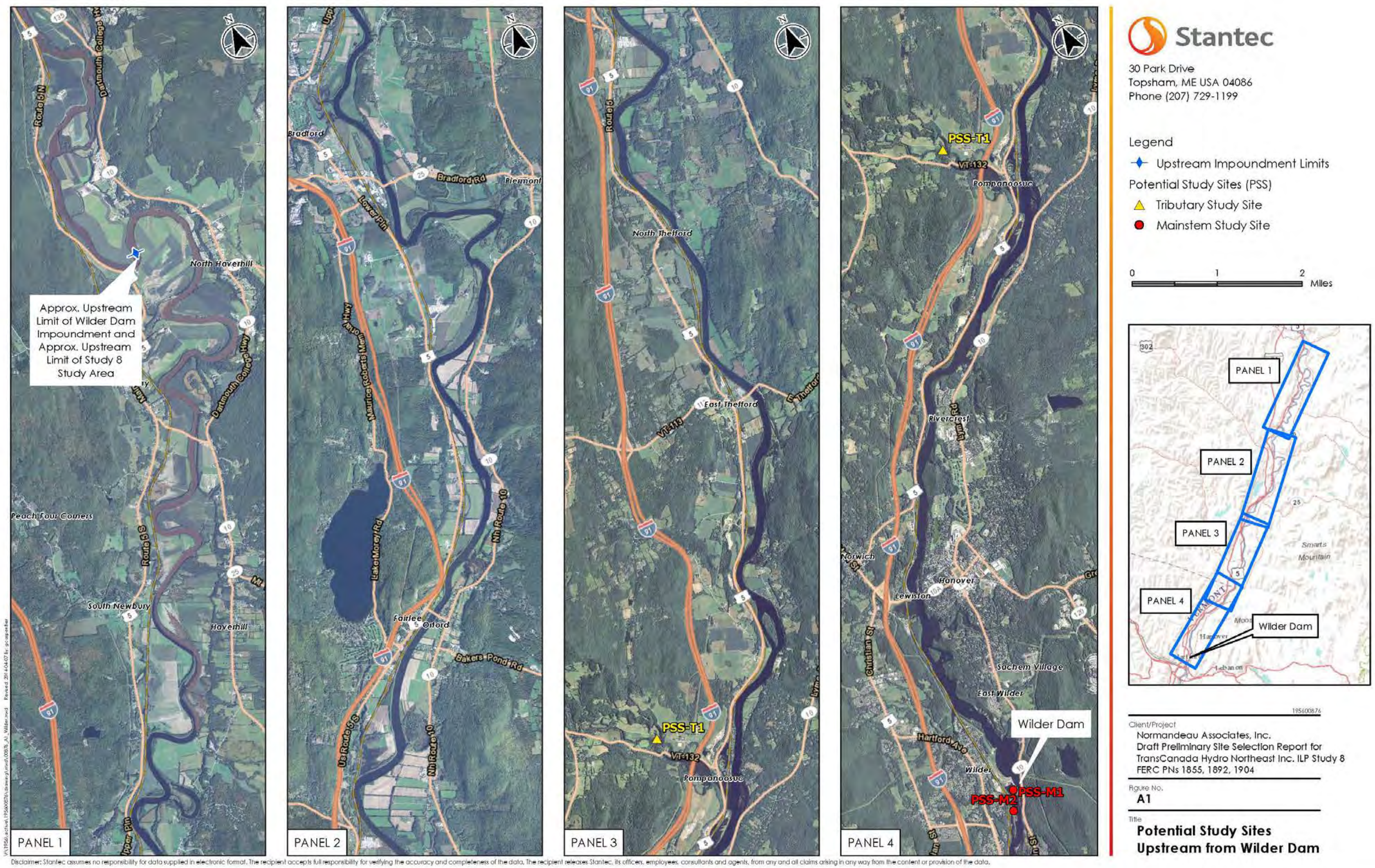
The final selection of study sites is contingent on confirmation of suitable site access, safety considerations, and field-verification of site conditions. As previously noted, the site identification process was performed using selected aerial photographic imagery that coincided with periods of relatively low water surface elevations. Performance of Study 8 field studies is contingent upon having similarly low-flow conditions during field work as necessary to allow access to selected study sites. Performance of Study 8 field studies is also contingent on securing appropriate permissions for access to selected study sites. In the event of site access restrictions, site suitability, and/or site safety concerns, field work may be delayed, modified, and/or some selected sites may be deemed unsuitable for use as a part of Study 8.

5.2 Selection and Use of Contingency Sites

Depending on factors including site conditions, safety considerations, and site access, it is possible that substitution of contingency site may be required following completion of the working group site selection review and approval process. In the event that ongoing study work indicates that one or more of the selected sites is unsuitable, inaccessible, or otherwise cannot be used, it is suggested that the site be replaced with another, representative site identified from the list of contingency sites identified in Tables 2 and 3. The recommended approach is that the working group's site selection process includes a review of the recommended and contingency sites identified in the tables and that the working group confirms contingency sites considered appropriate for use in the event that recommended sites are found to be unsuitable in the course of field work.

Appendix A

Potential Study Sites
Overview Maps



PANEL 1
PANEL 2
PANEL 3
PANEL 4
Approx. Upstream Limit of Wilder Dam Impoundment and Approx. Upstream Limit of Study 8 Study Area
North Haverhill
Peach Four Corners
South Newbury
Haverhill
Bradford
Bradford Rd
Piermont
Fairlee
Orford
Bakers Pond Rd
North Thetford
East Thetford
PSS-T1
Pompanoosuc
Rivercrest
Norwich
Hanover
Lewiston
Sachem Village
East Wilder
Wilder
Wilder Dam
PSS-M1
PSS-M2
Stantec
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Phone (207) 729-1199
Legend
Upstream Impoundment Limits
Potential Study Sites (PSS)
Tributary Study Site
Mainstem Study Site
0 1 2 Miles
195600876
Client/Project
Normandeau Associates, Inc.
Draft Preliminary Site Selection Report for TransCanada Hydro Northeast Inc. ILP Study 8
FERC PNs 1855, 1892, 1904
Figure No.
A1
Title
Potential Study Sites Upstream from Wilder Dam
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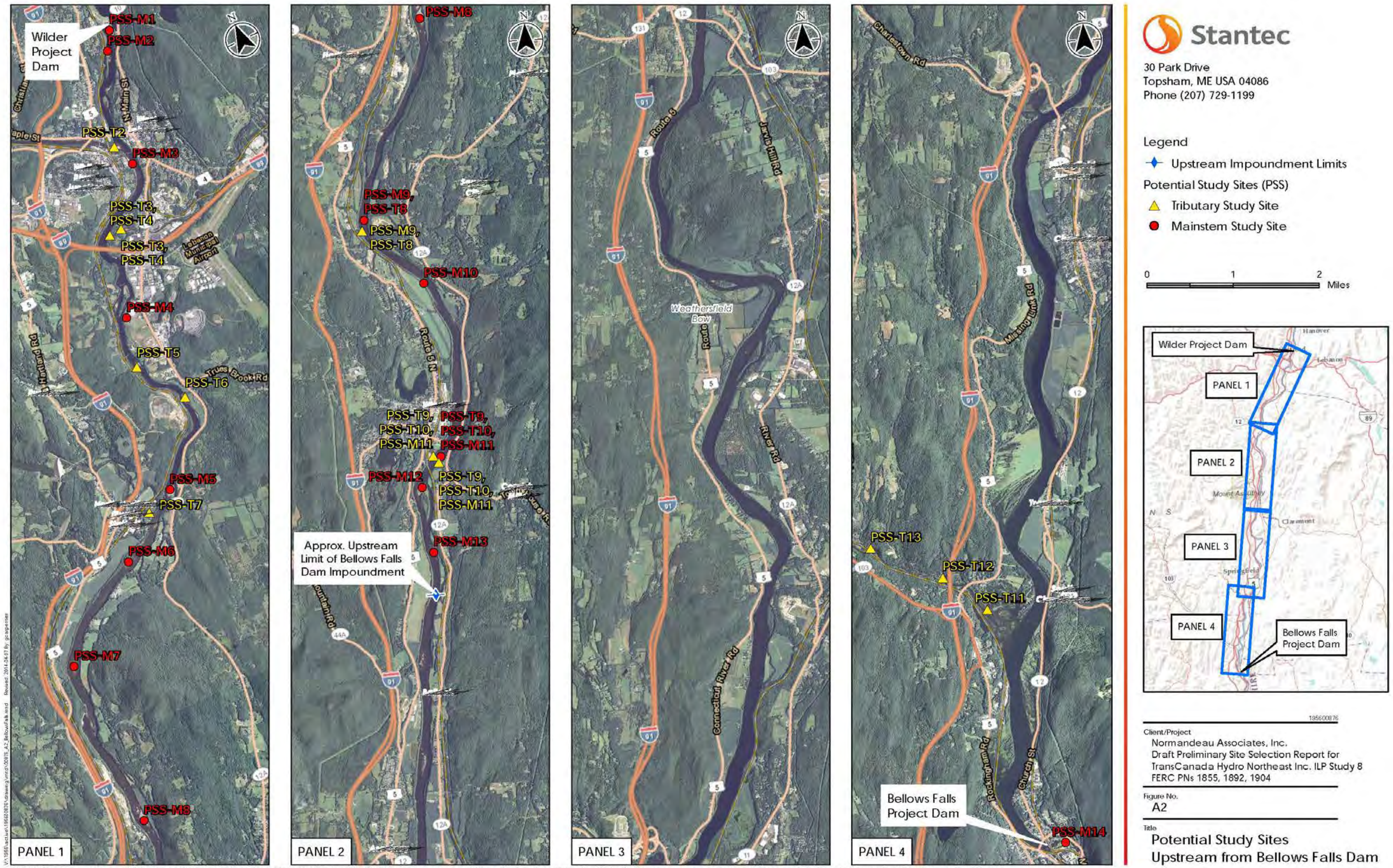

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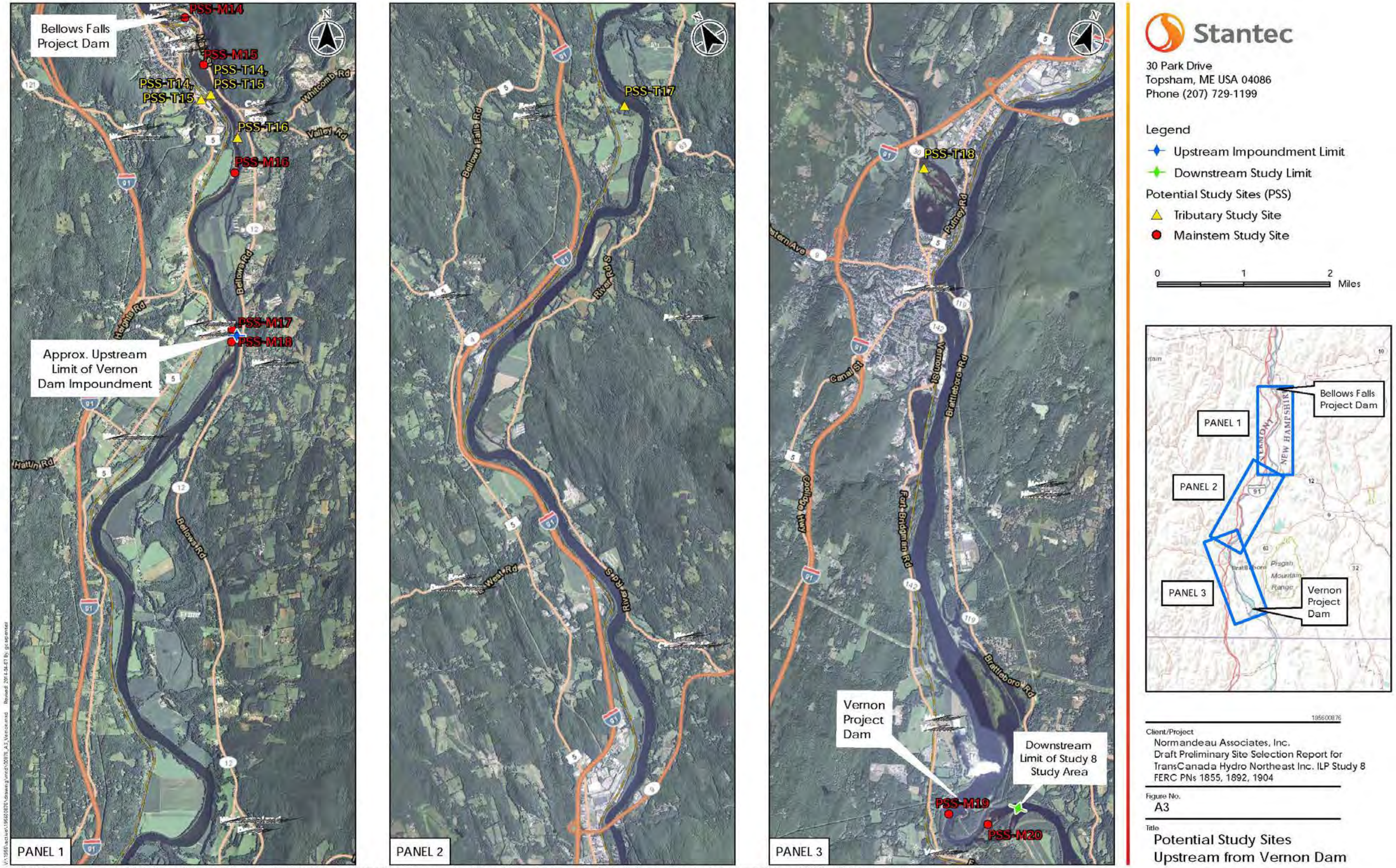

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Appendix B

Potential Study Site Maps

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Potential Study Sites (PSS)

- Mainstem Study Site
- Tributary Study Site
- Project Boundary

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Figure No.
B1

Title
PSS-T1
4/9/2014

00876_PSSMapBook.mxd

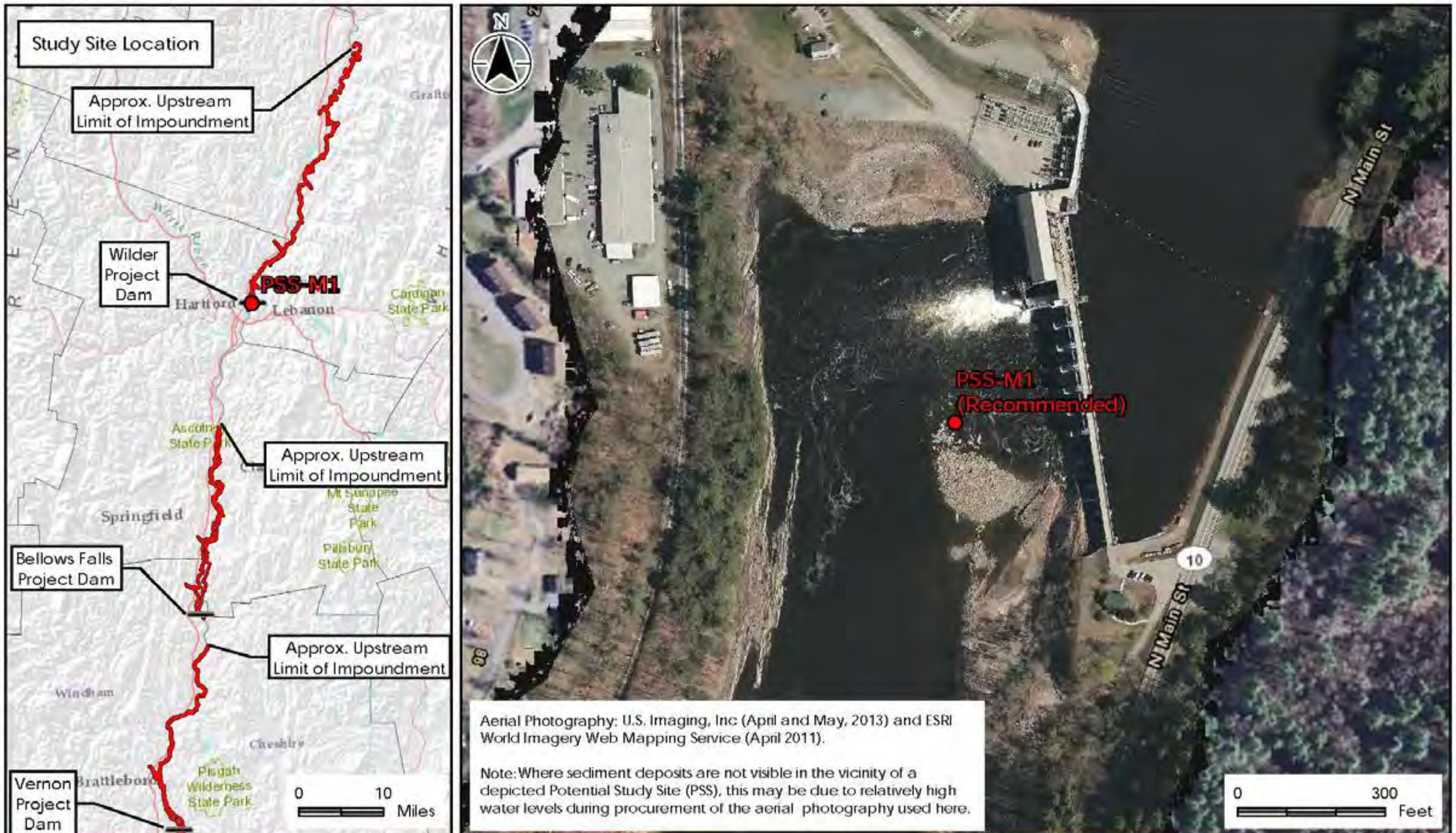

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Figure No.
B2

Title
PSS-M1
4/9/2014

00876_PSSMapBook.mxd

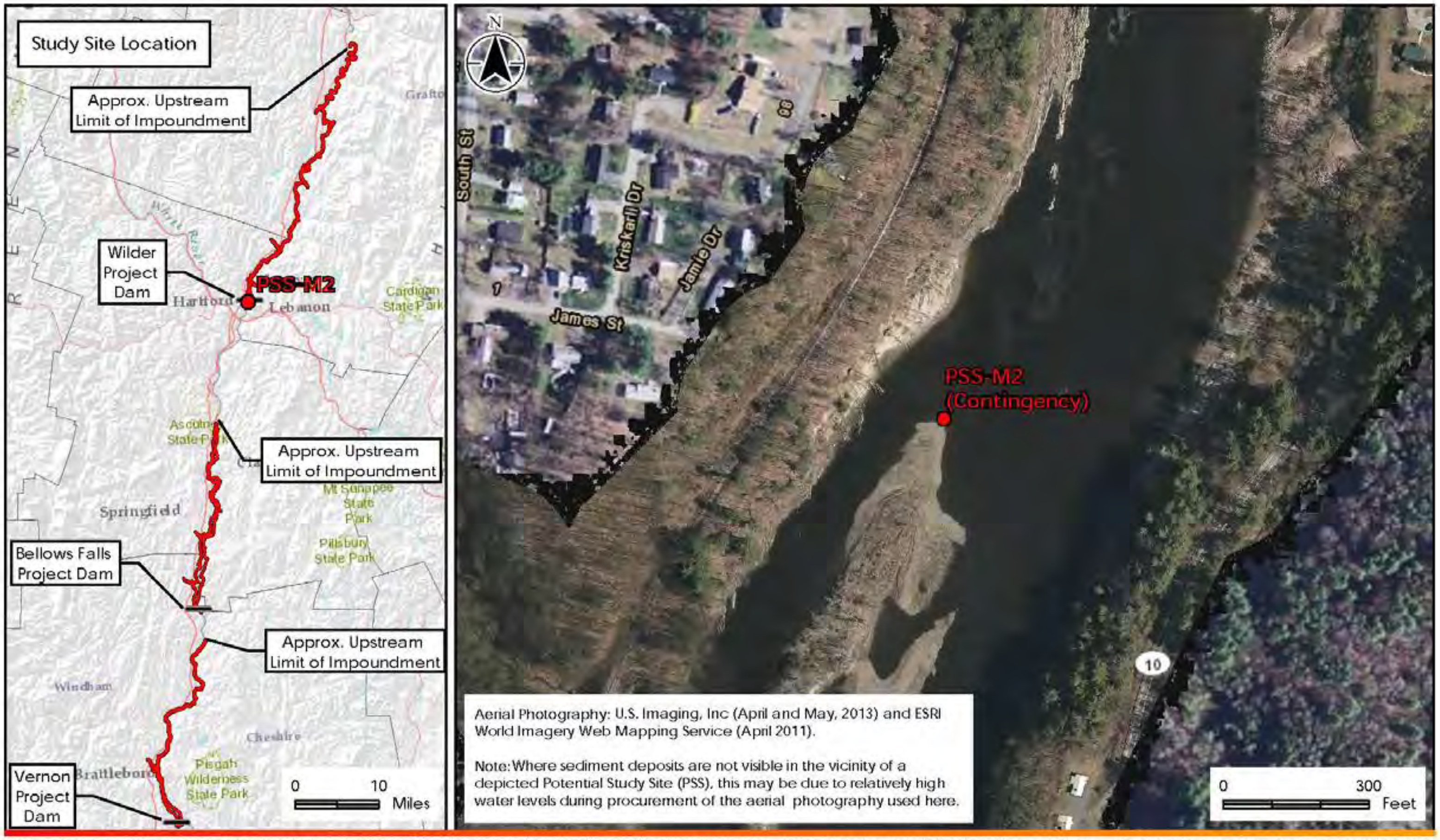

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Figure No.
B3

Title
PSS-M2
4/9/2014

00876_PSSMapBook.mxd

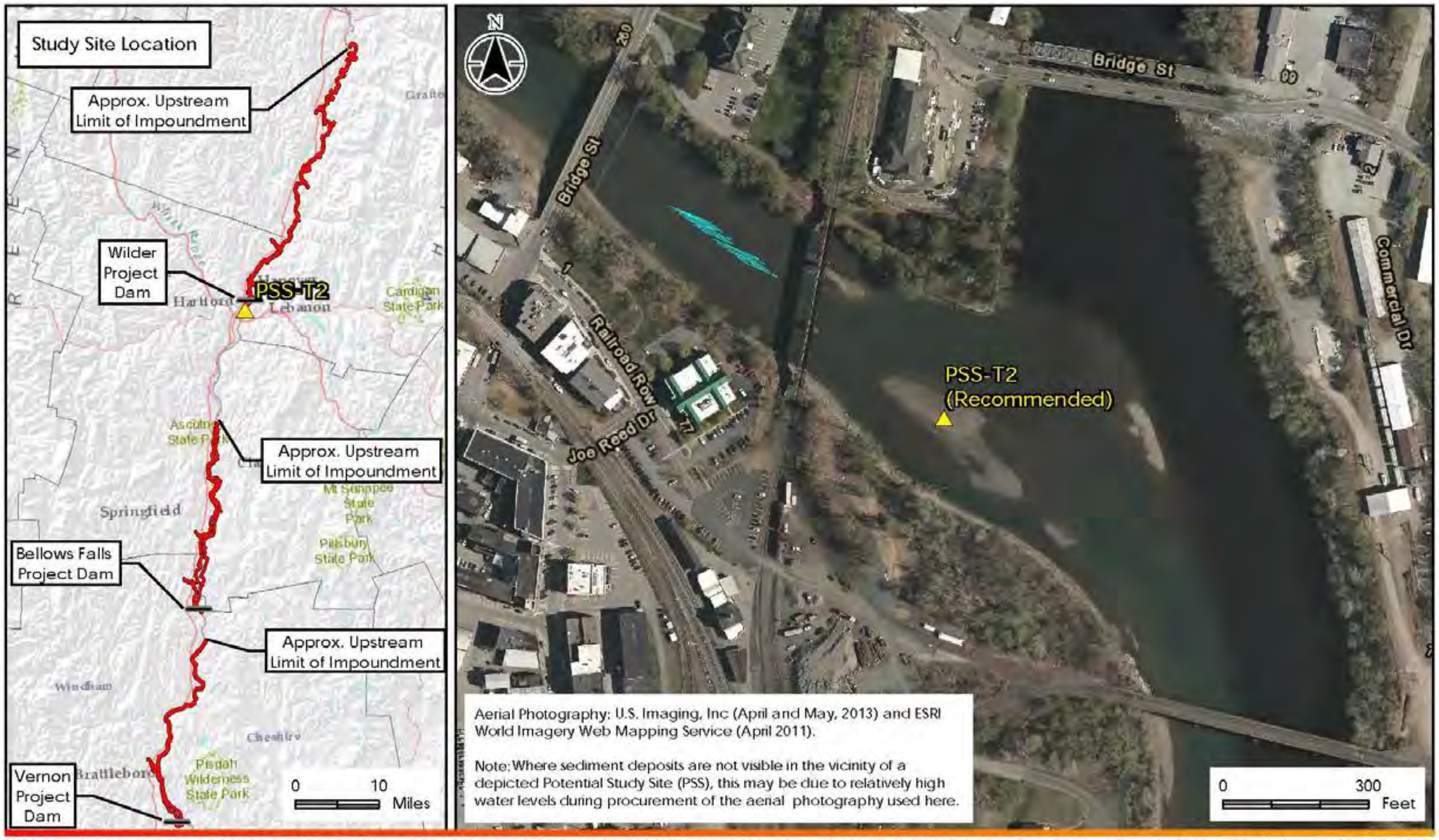

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Figure No.
B4

Title
PSS-T2
4/9/2014

00876_PSSMapBook.mxd

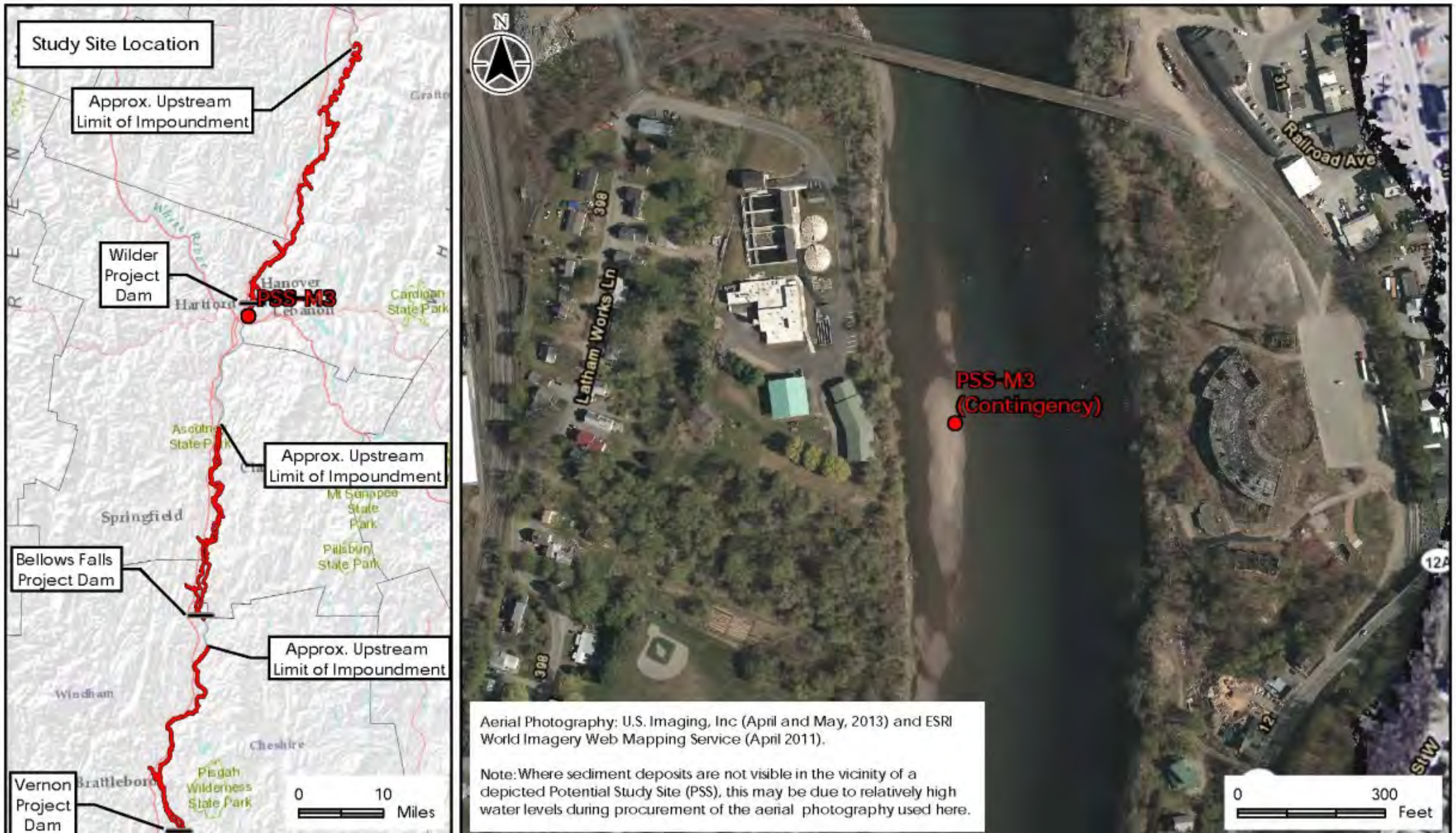

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Figure No.
B5

Title
PSS-M3
4/9/2014

00876_PSSMapBook.mxd

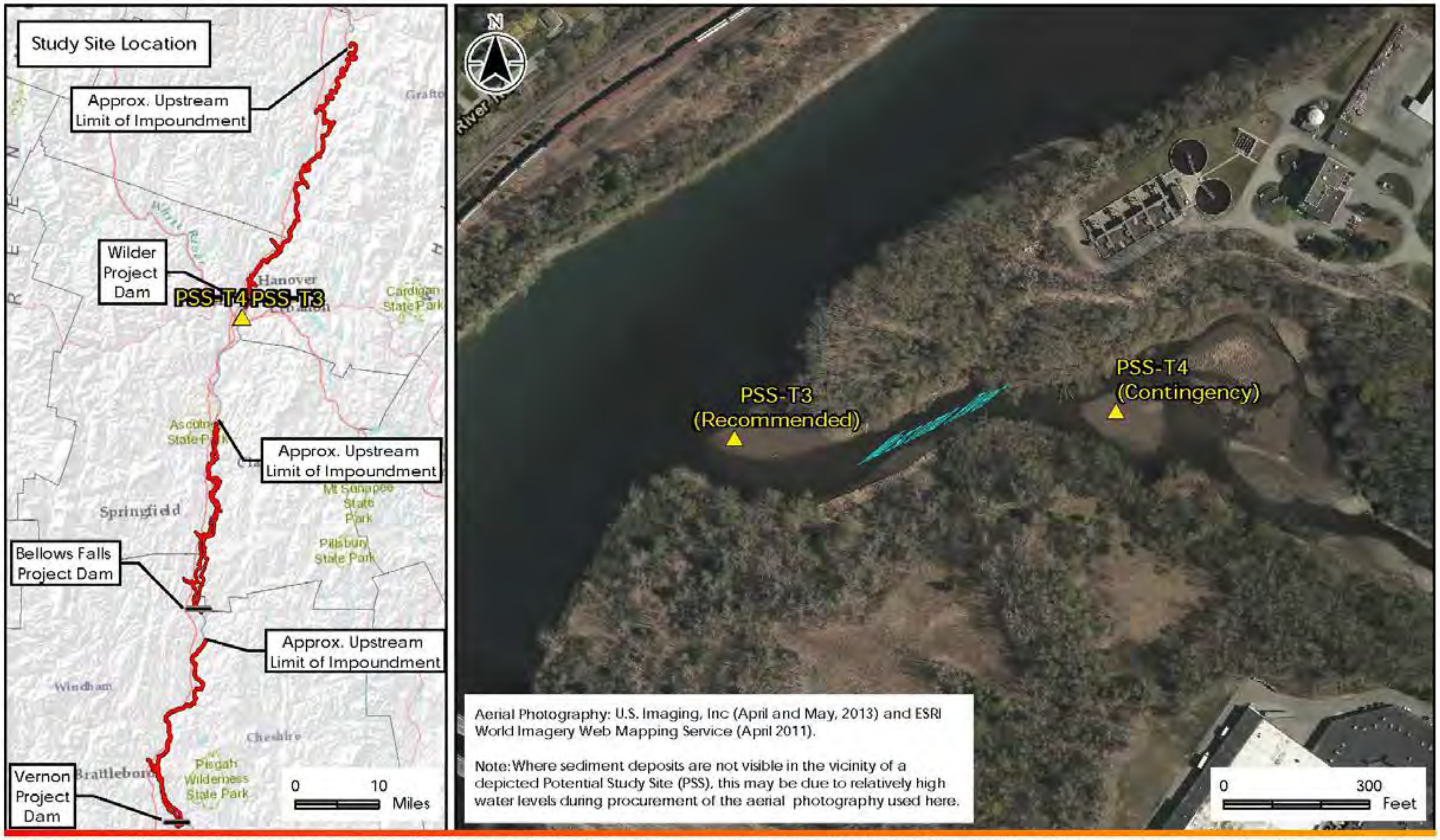

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Figure No.
B6

Title
PSS-T3, PSS-T4
4/9/2014

00876_PSSMapBook.mxd

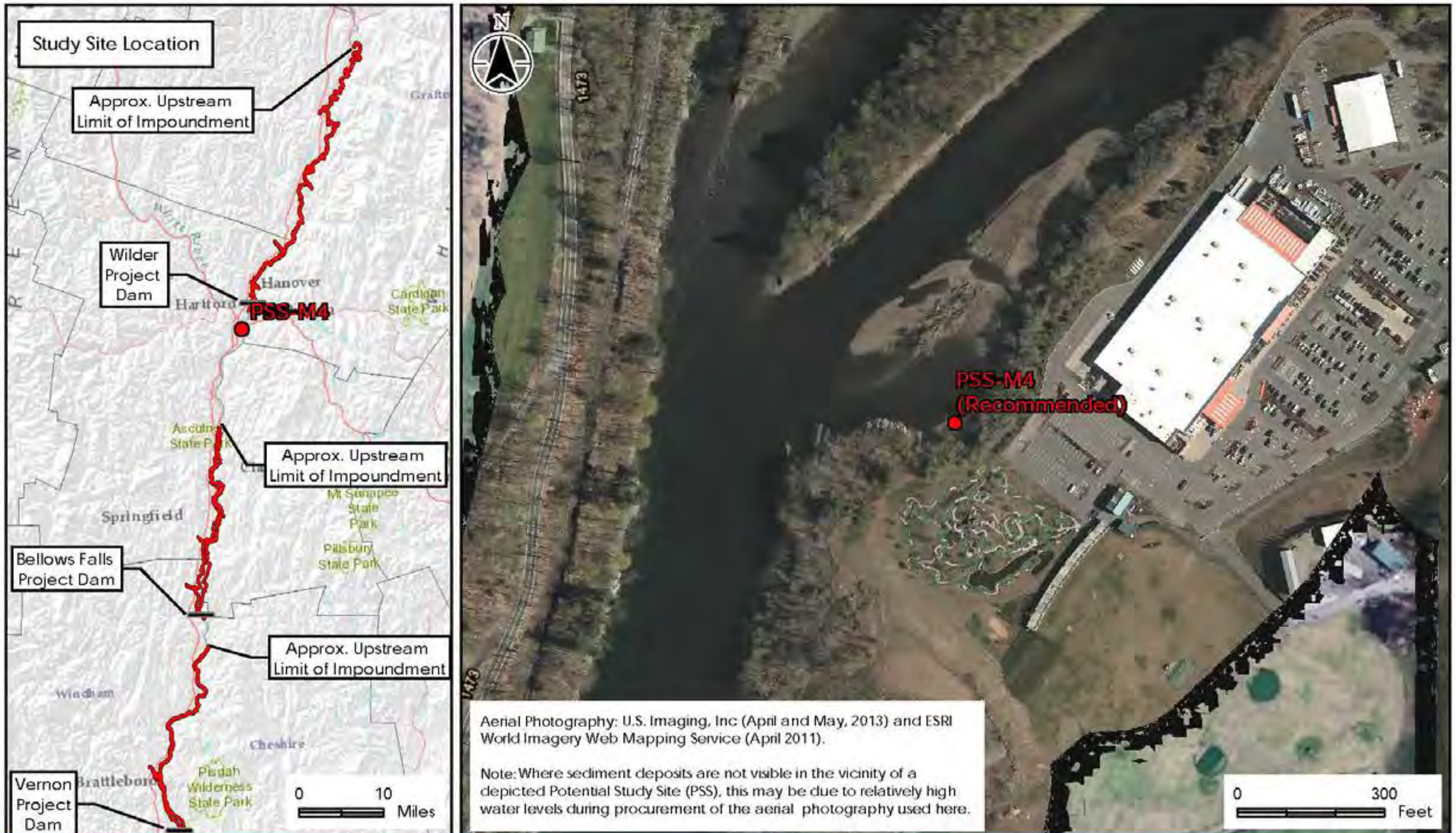

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Figure No.
B7

Title
PSS-M4
4/9/2014

00876_PSSMapBook.mxd

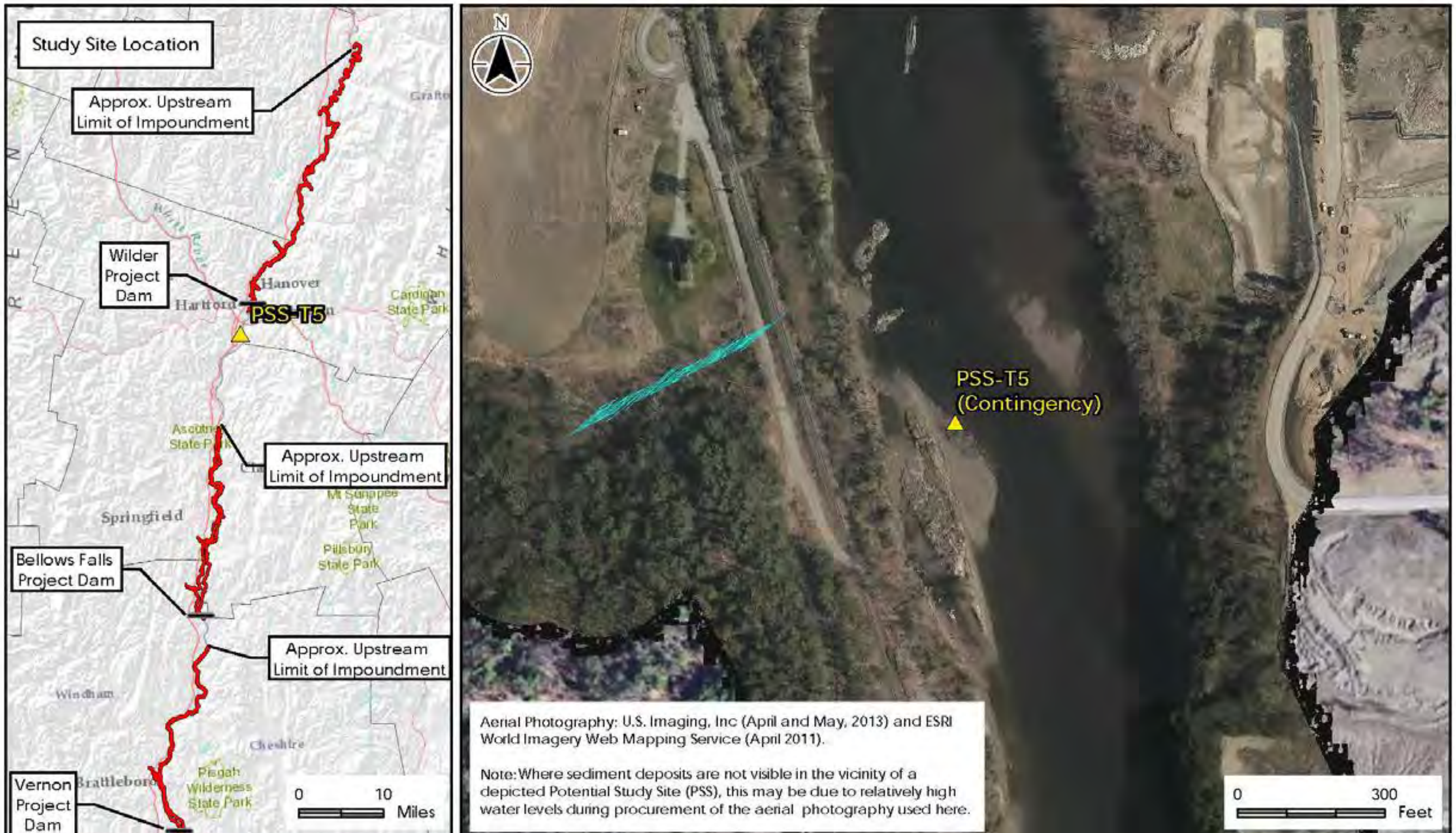

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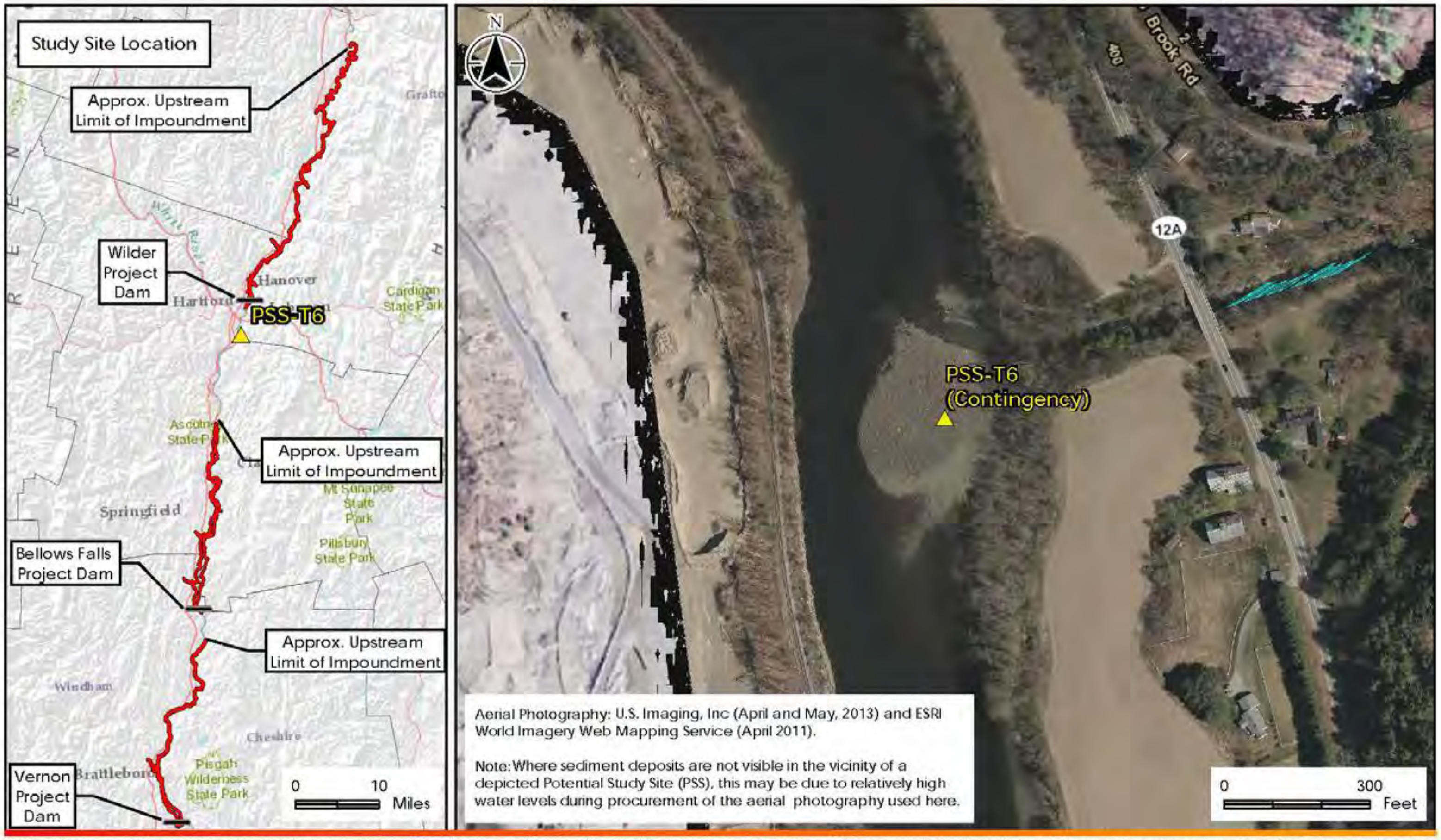
Figure No.
B8

Title
PSS-T5
4/9/2014

00876_PSSMapBook.mxd



Aerial Photography: U.S. Imaging, Inc (April and May, 2013) and ESRI World Imagery Web Mapping Service (April 2011).

Note: Where sediment deposits are not visible in the vicinity of a depicted Potential Study Site (PSS), this may be due to relatively high water levels during procurement of the aerial photography used here.

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Figure No.
B9

Title
PSS-T6
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Figure No.
B10

Title
PSS-M5
4/9/2014

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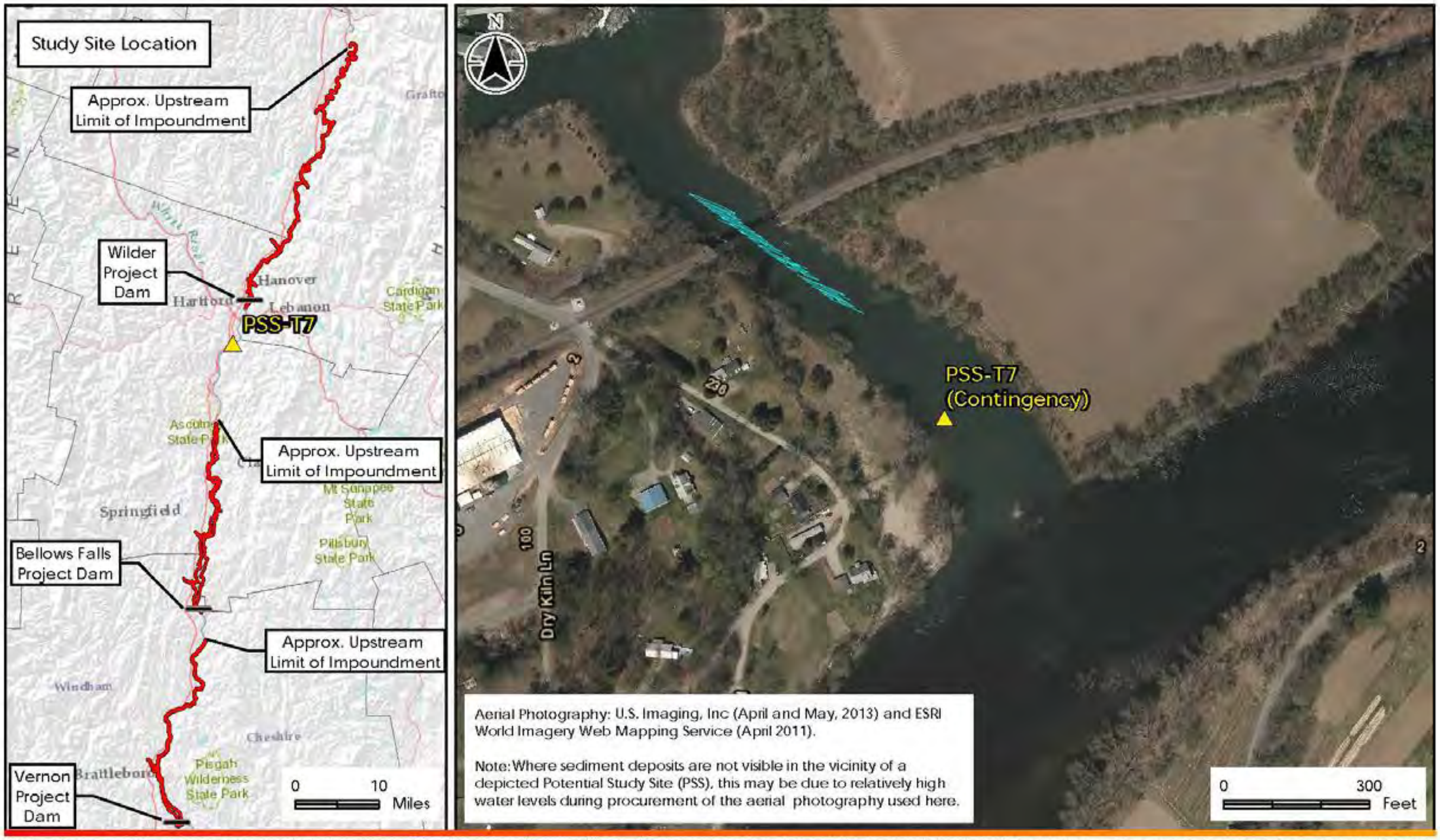

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Figure No.
B11

Title
PSS-T7
4/9/2014

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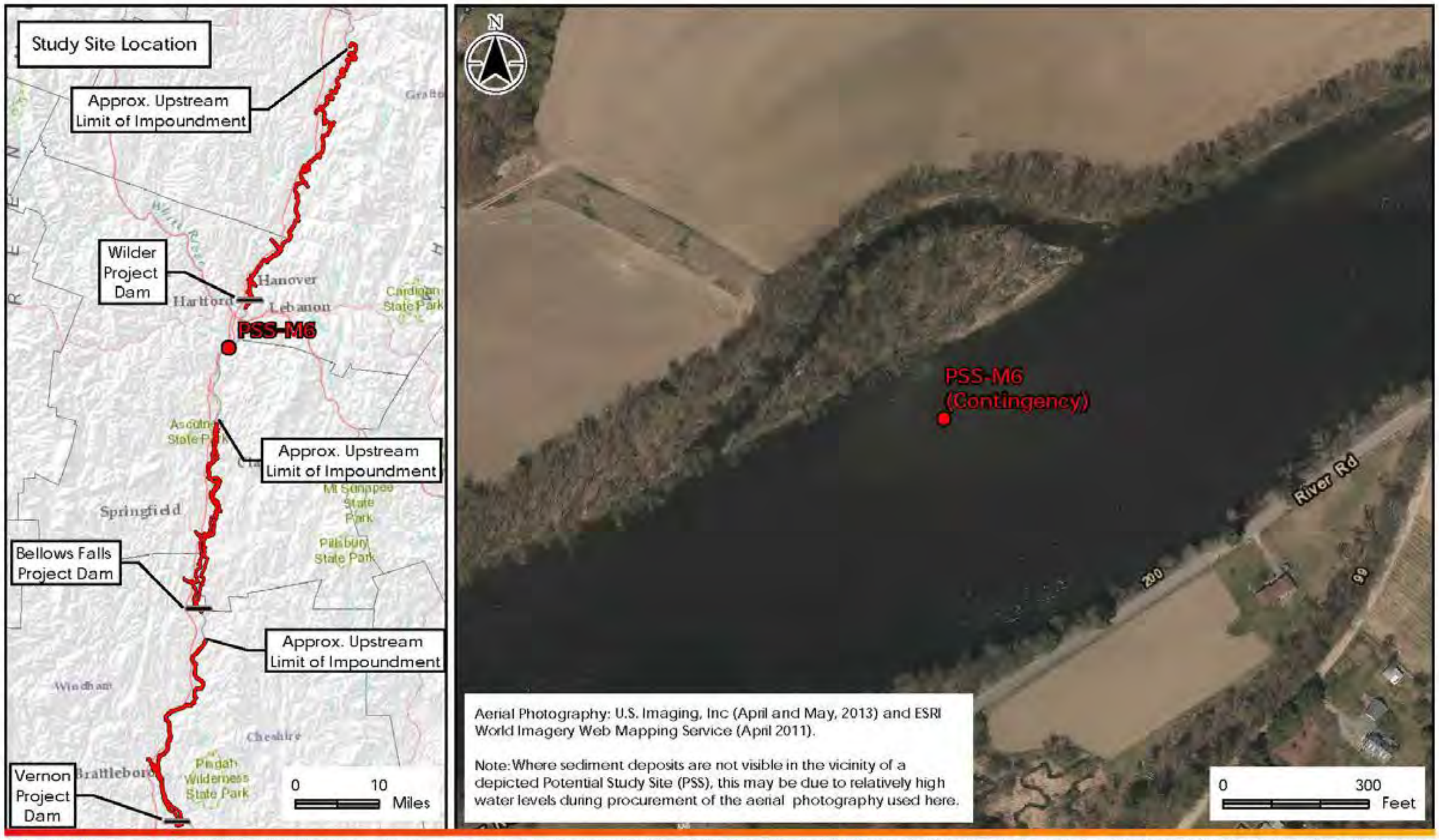

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Figure No.
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Title
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Figure No.
B13

Title
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Figure No.
B14

Title
PSS-M8
4/9/2014

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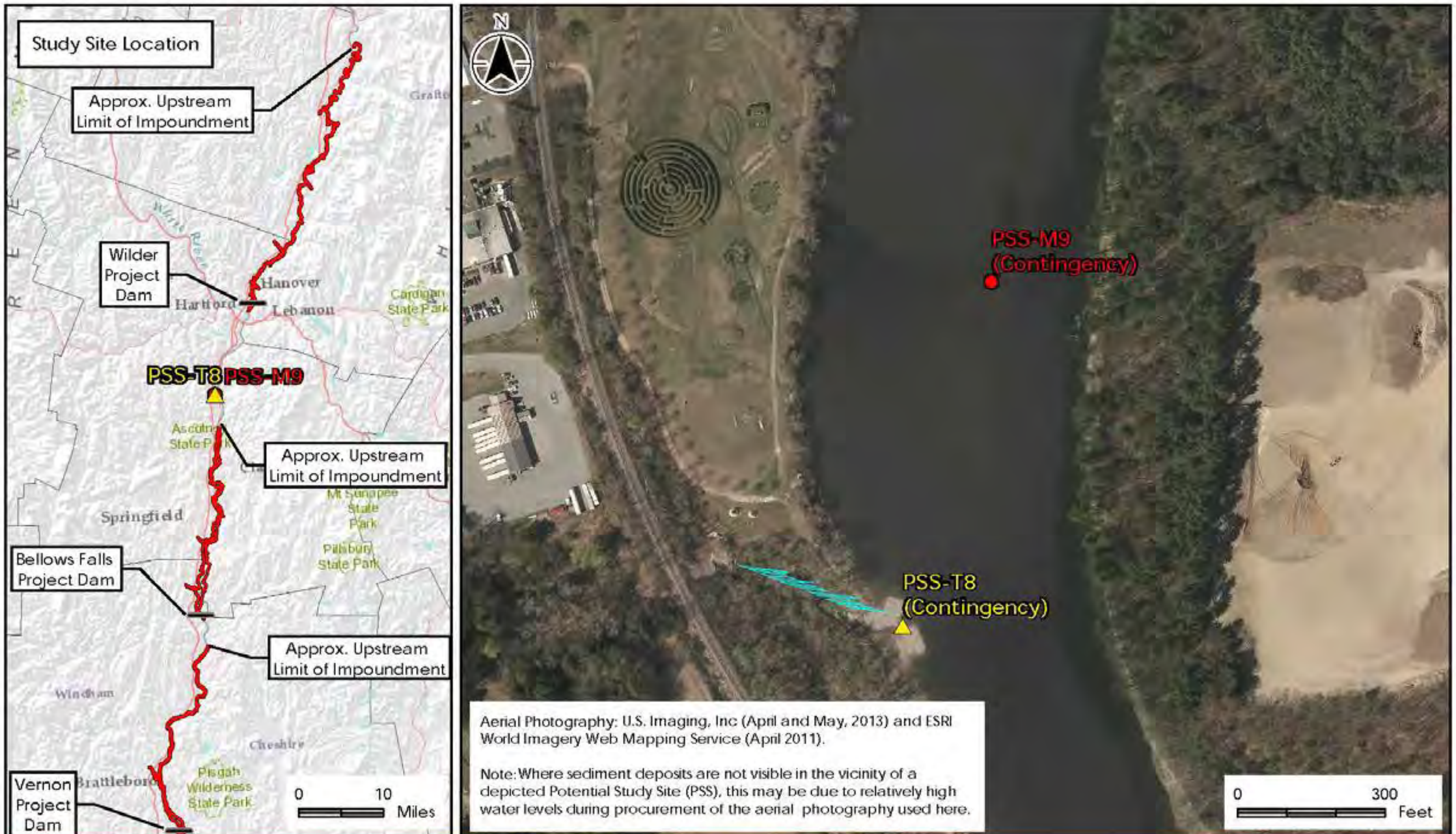

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Figure No.
B15

Title
PSS-M9, PSS-T8
4/9/2014

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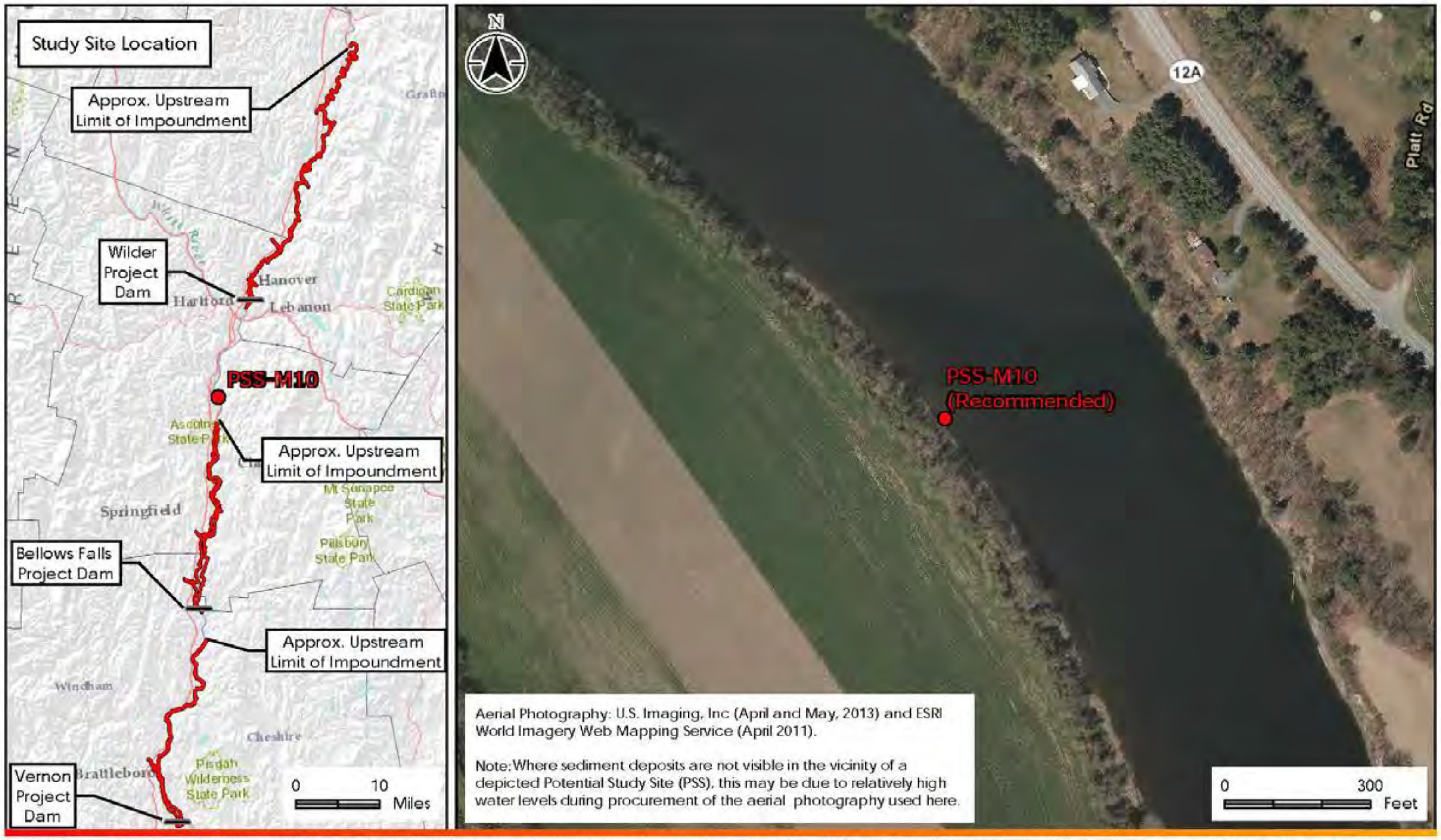

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Figure No.
B16

Title
PSS-M10
4/9/2014

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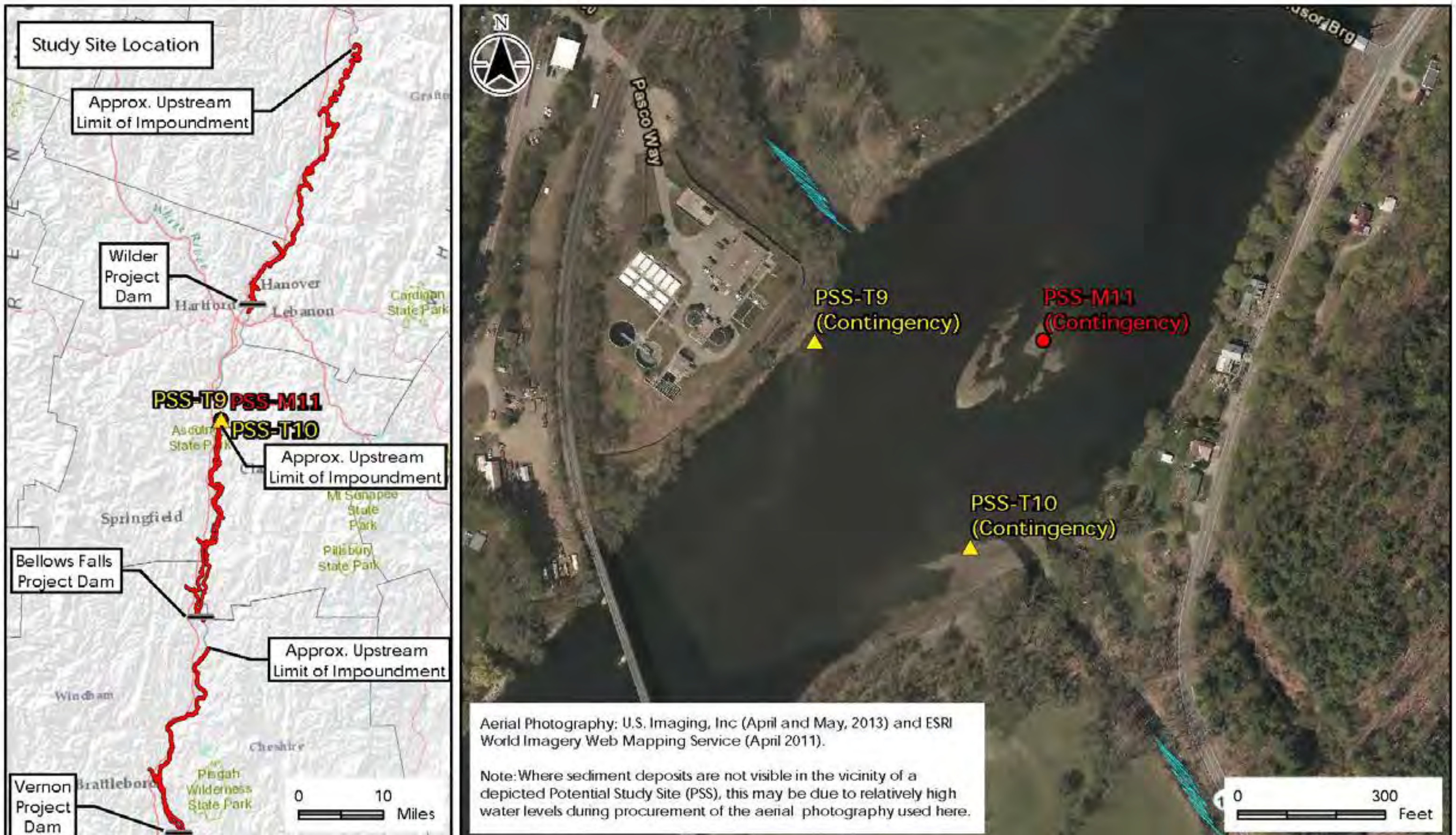

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Figure No.
B17

Title
PSS-T9, PSS-T10, PSS-M11
4/9/2014

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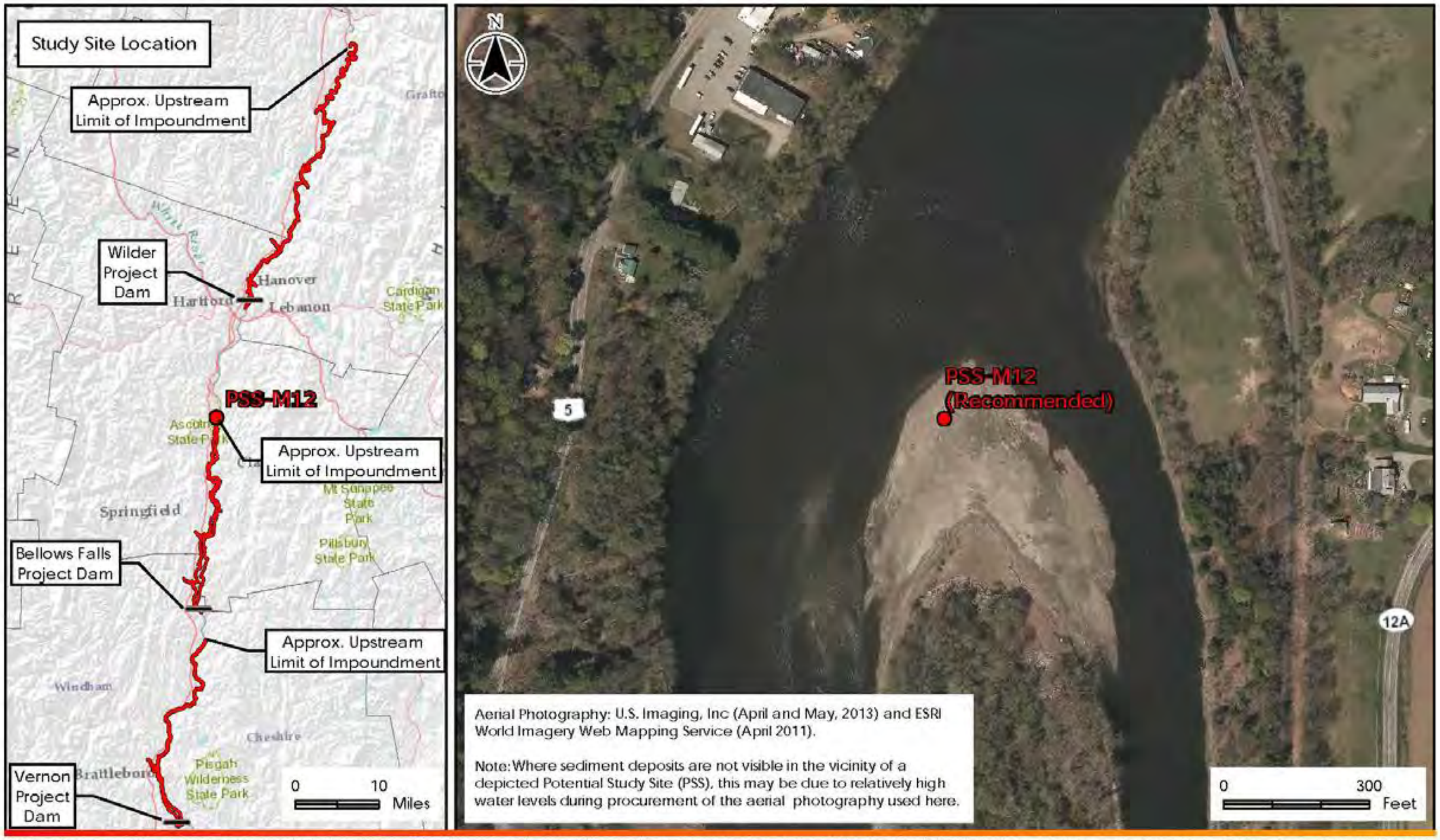

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Figure No.
B18

Title
PSS-M12
4/9/2014

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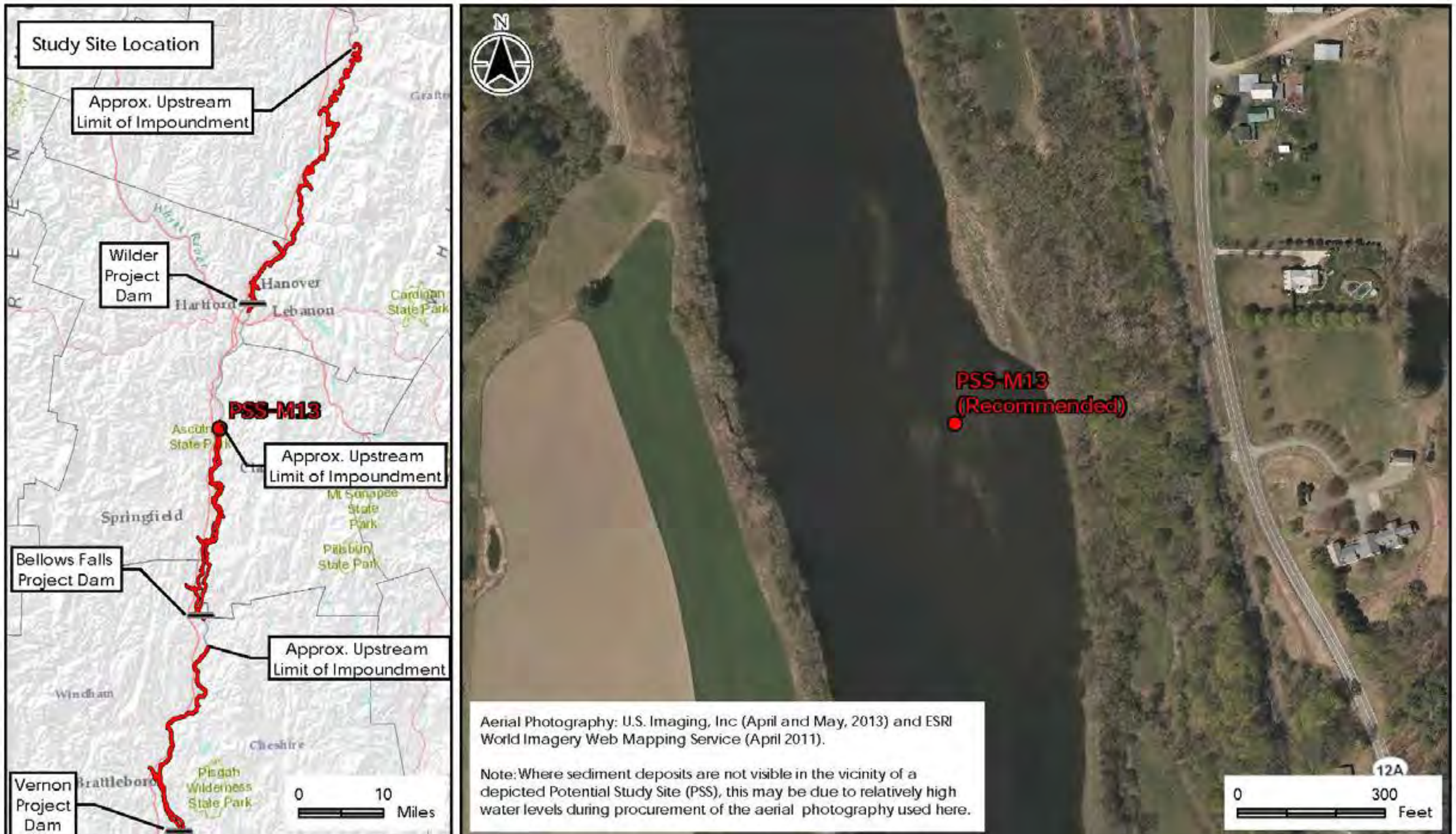

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Figure No.
B19

Title
PSS-M13
4/9/2014

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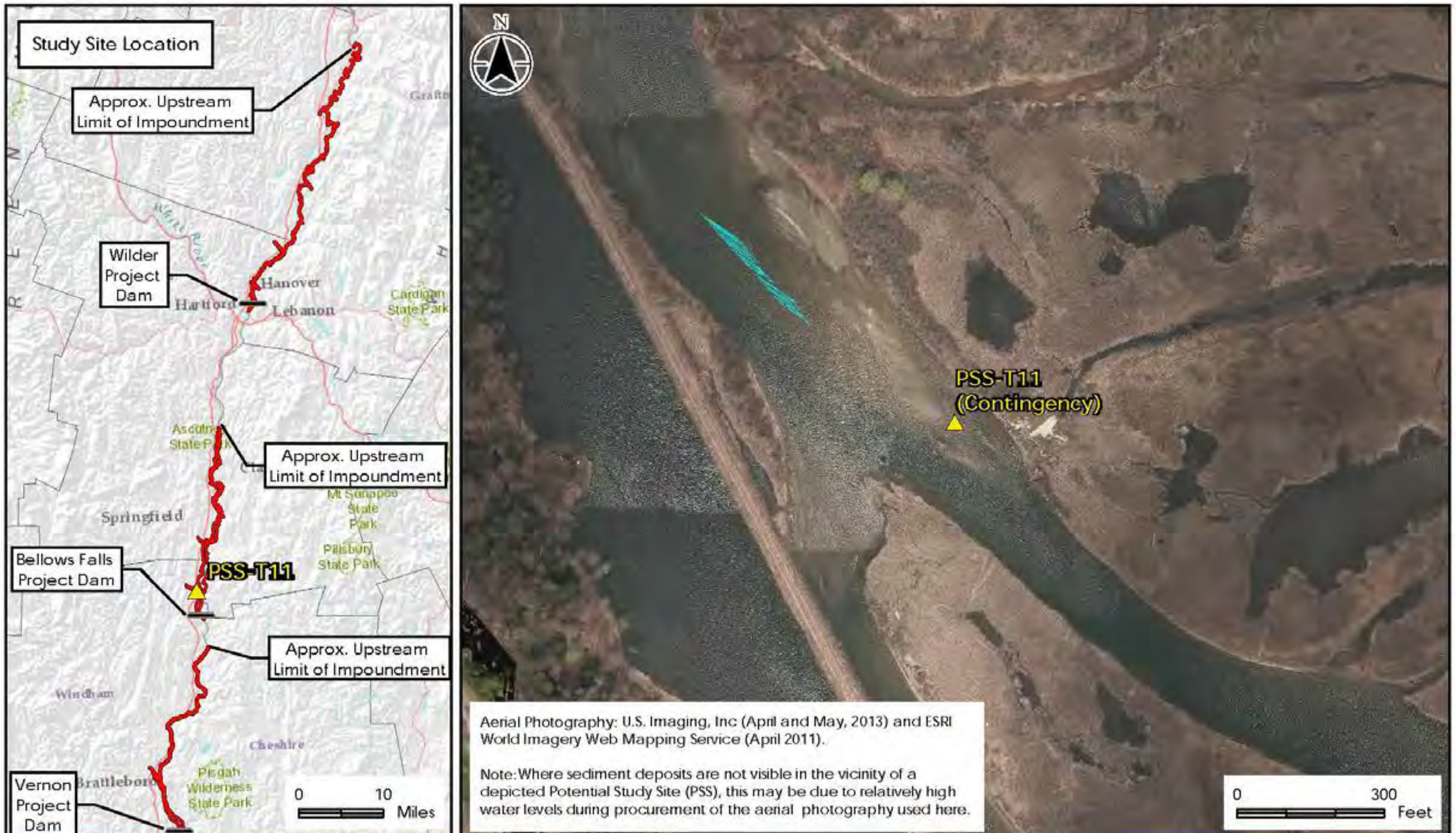

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Figure No.
B20

Title
PSS-T11
4/9/2014

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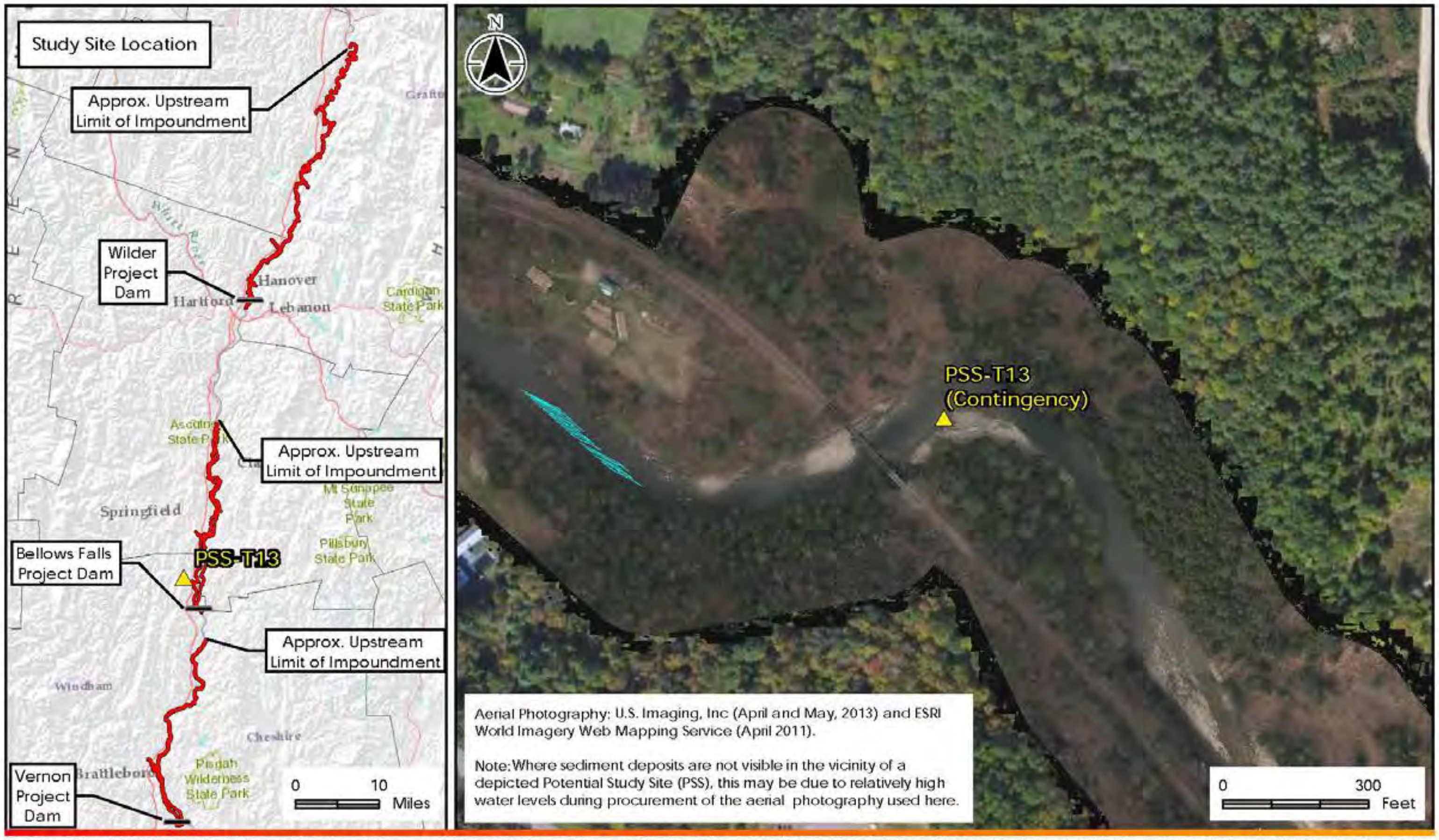
TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Initial Study Report

Volume III – Containing Sub Volumes III.A – III.

September 15, 2014



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Title
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Figure No.
B23

Title
PSS-M14
4/9/2014

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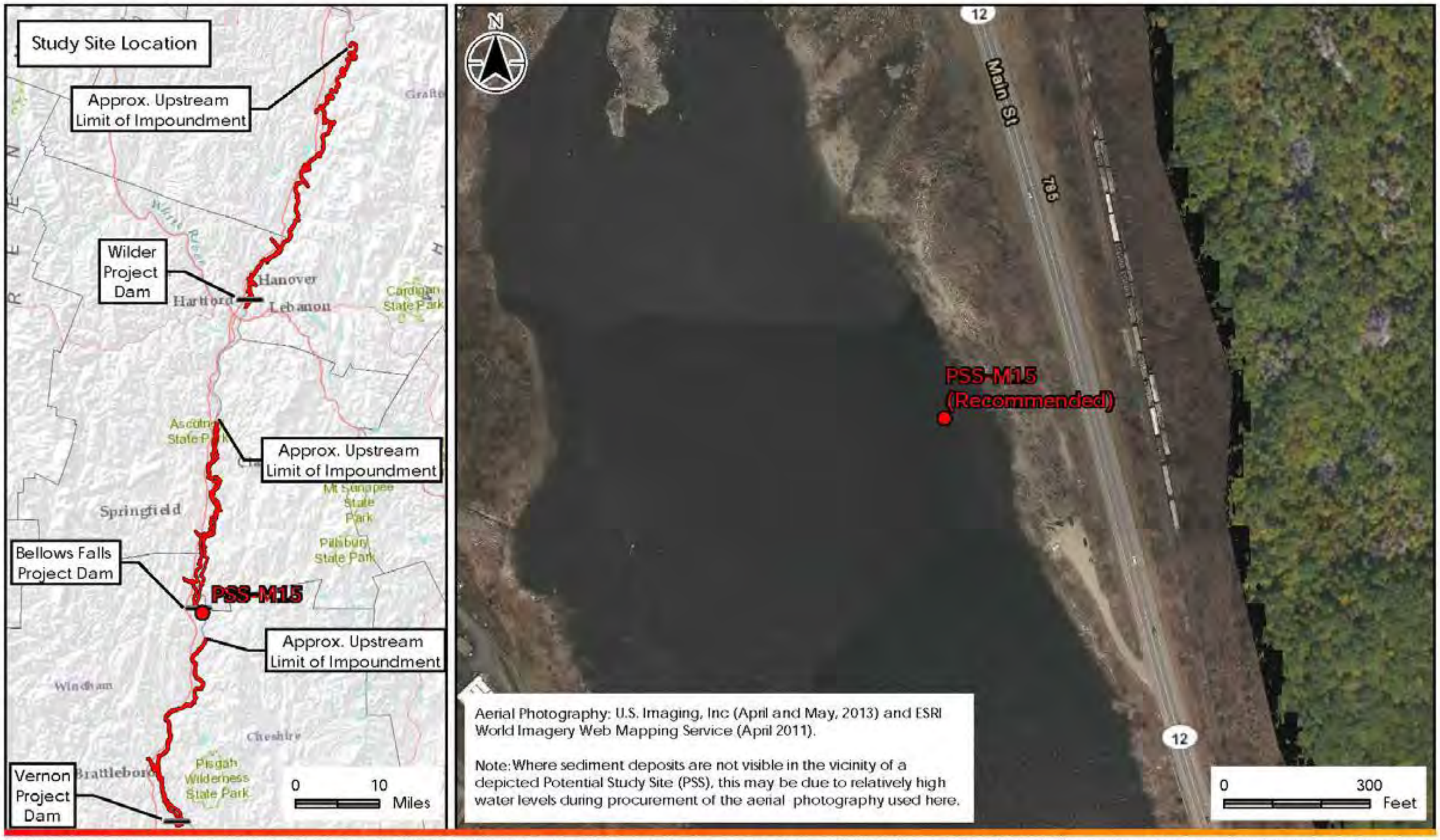

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Figure No.
B24

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PSS-M15
4/9/2014

00876_PSSMapBook.mxd

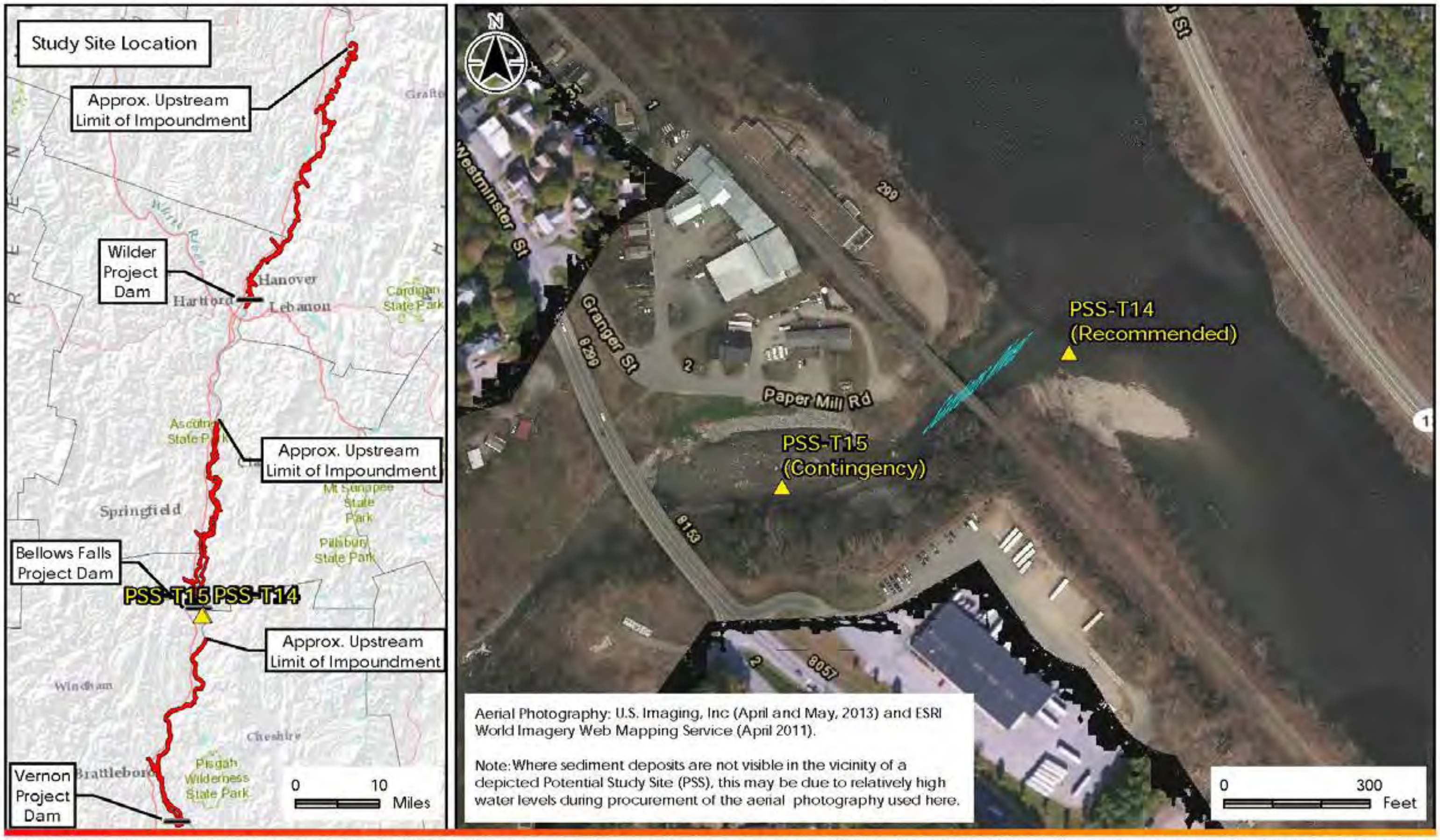

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Figure No.
B25

Title
PSS-T14, PSS-T15
4/9/2014

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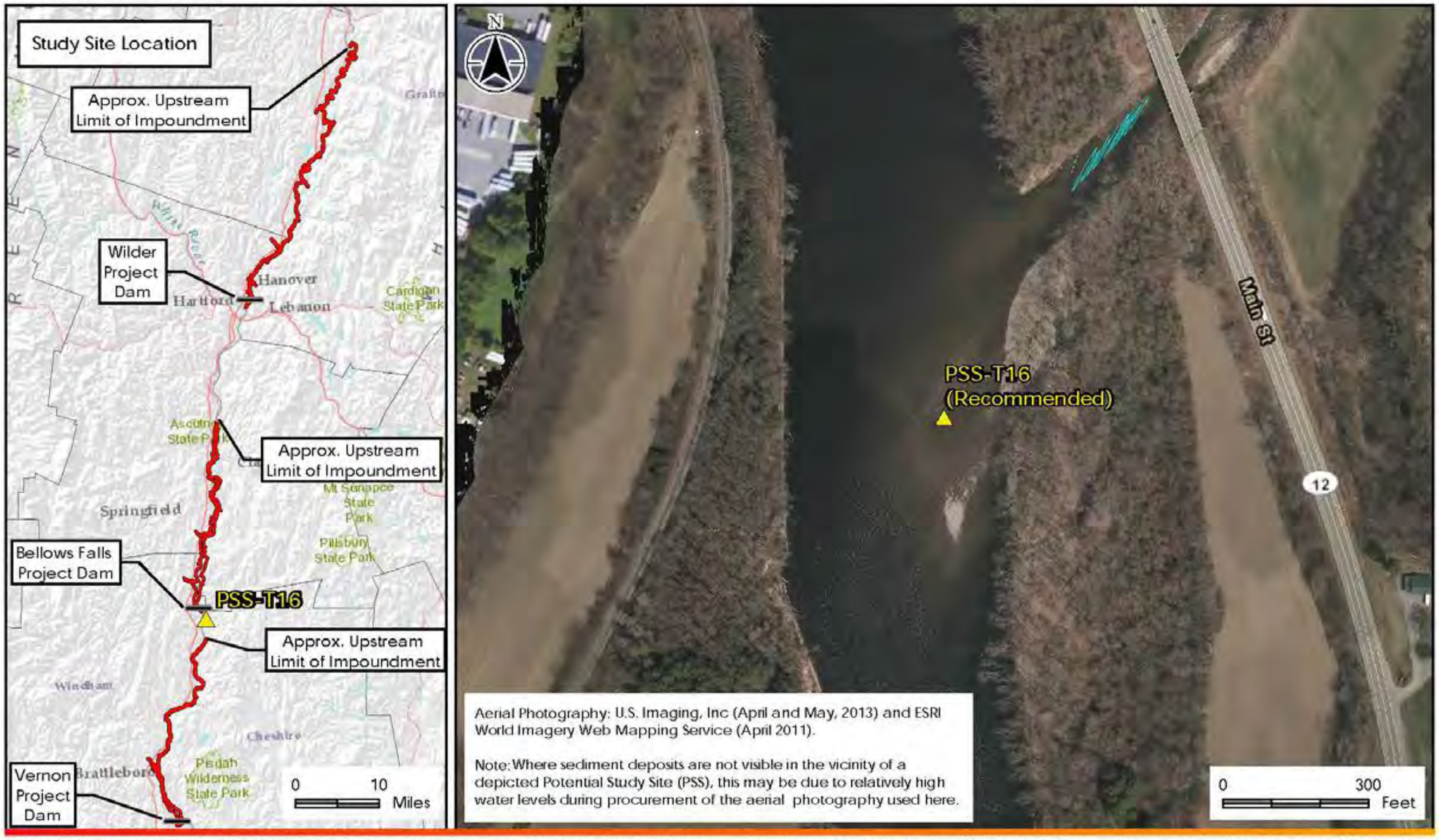

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Figure No.
B26

Title
PSS-T16
4/9/2014

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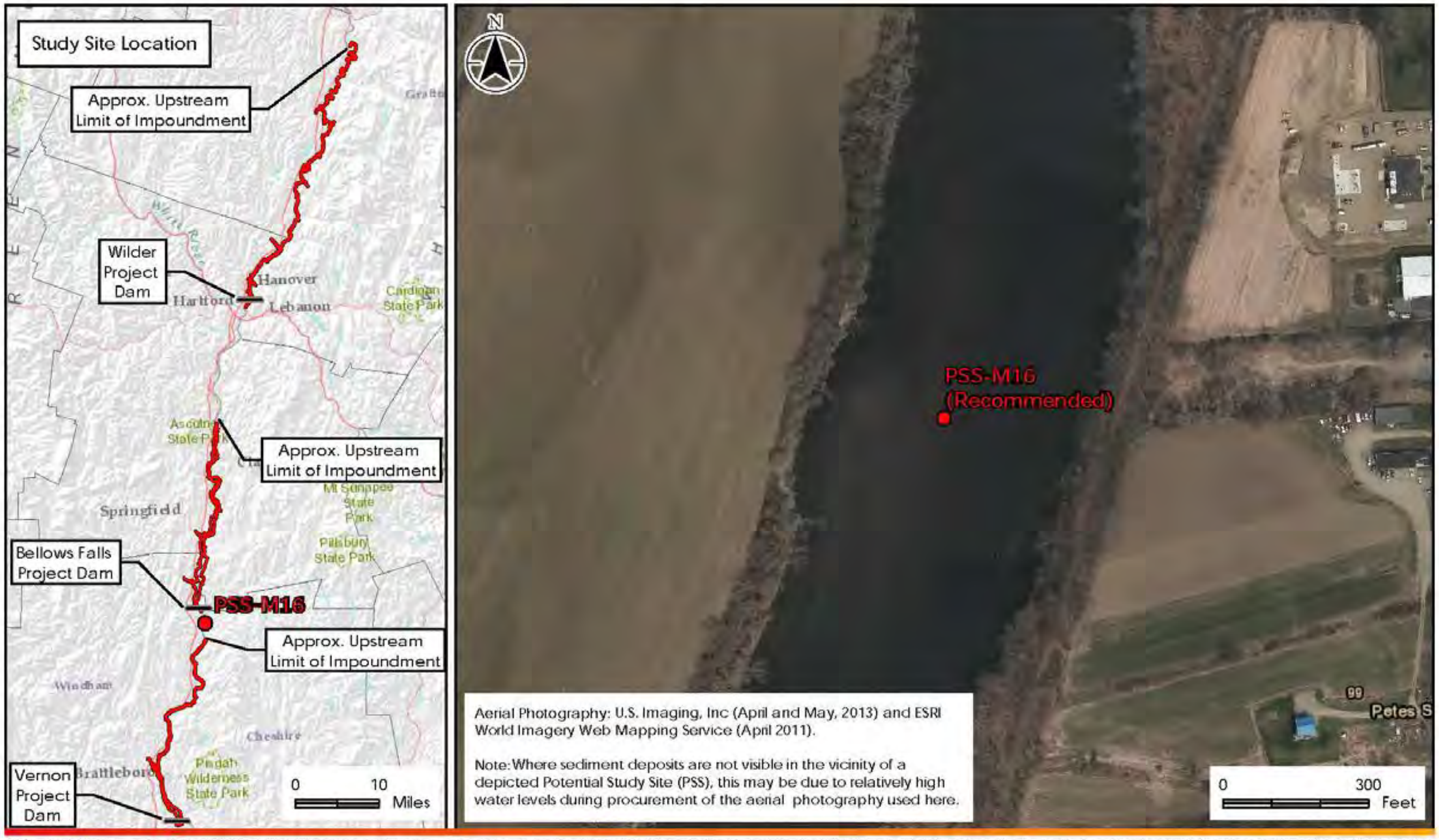

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Figure No.
B27

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PSS-M16
4/9/2014

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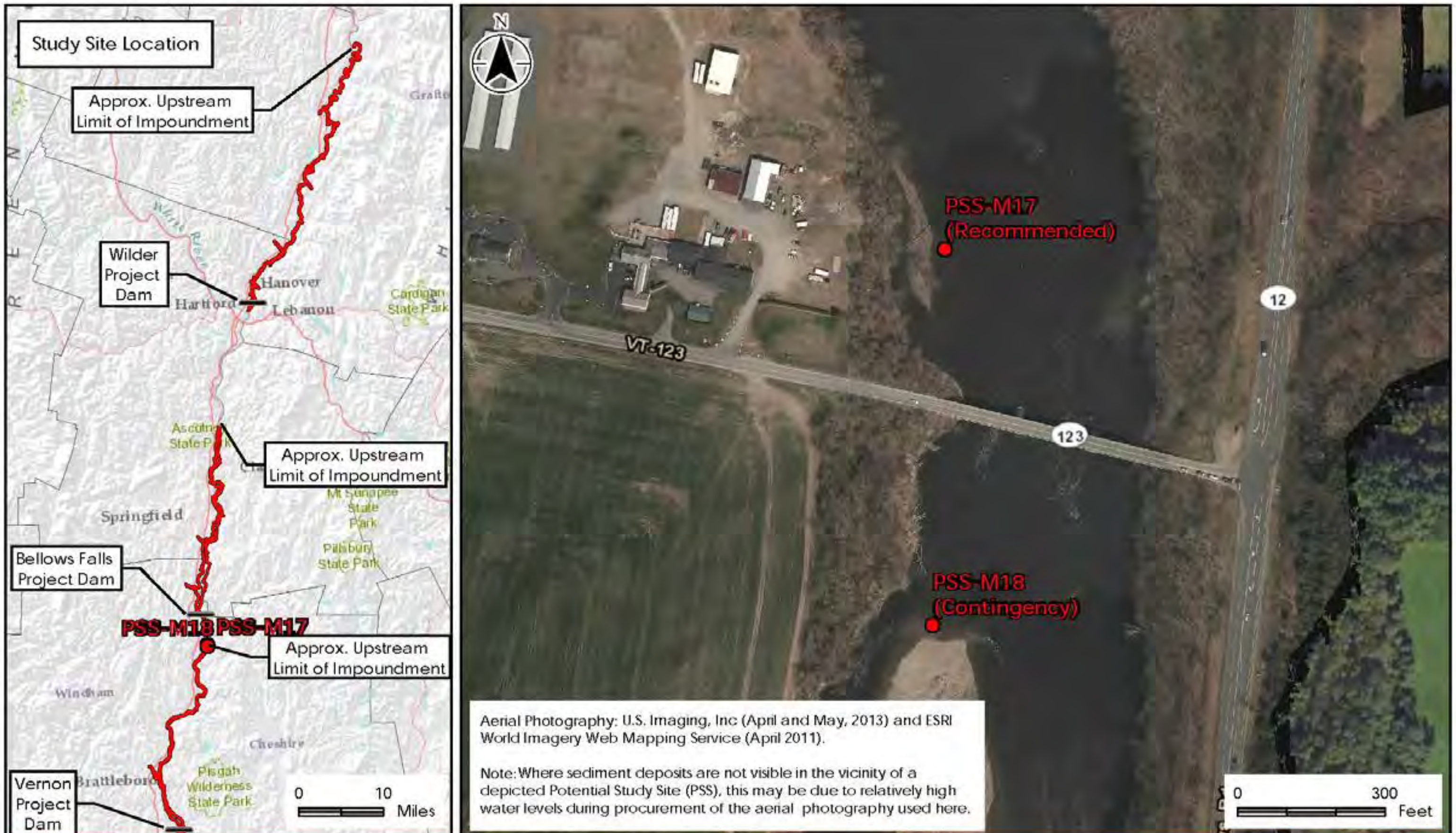

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Figure No.
B28

Title
PSS-M17, PSS-M18
4/9/2014

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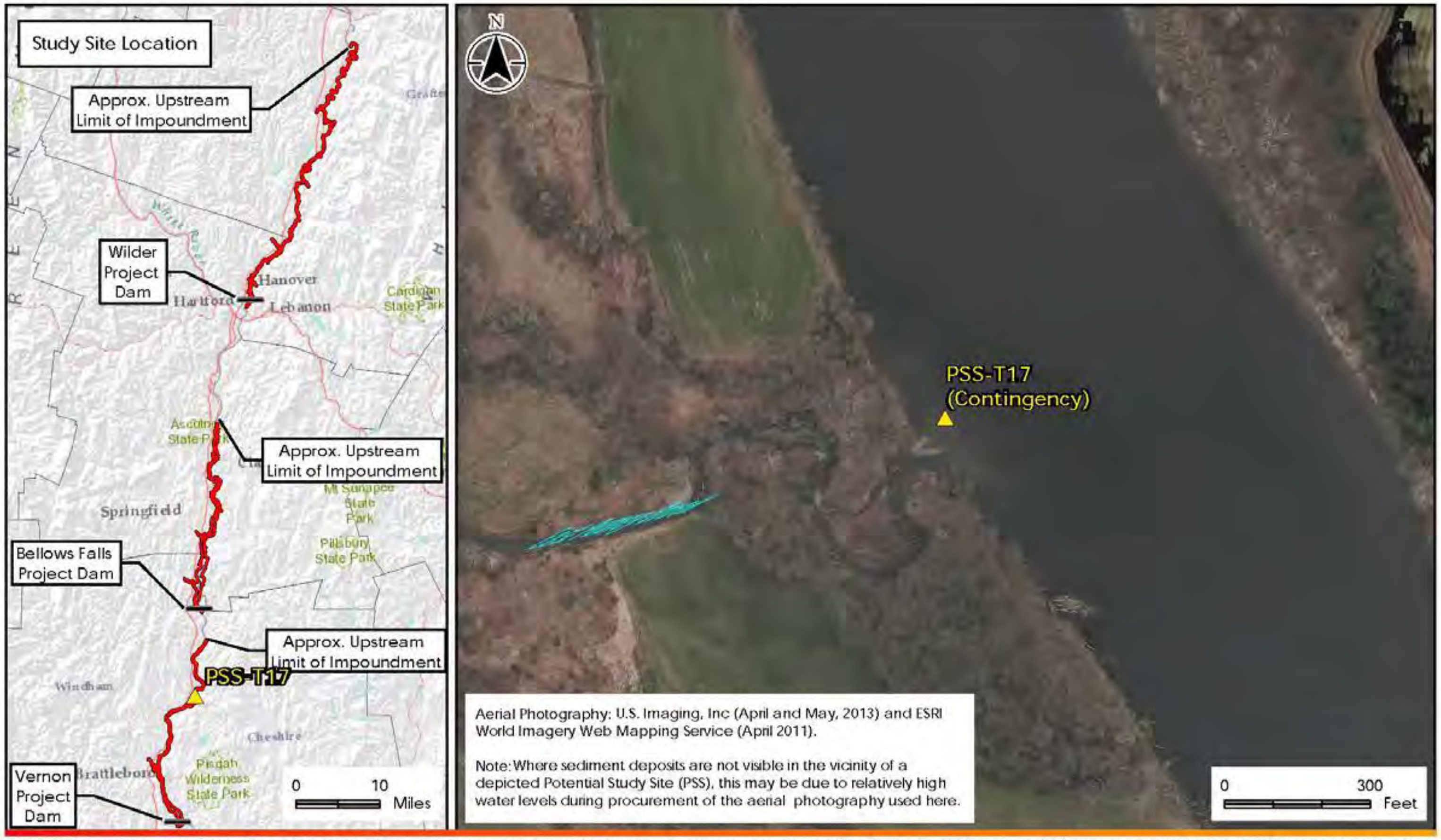

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Figure No.
B29

Title
PSS-T17
4/9/2014

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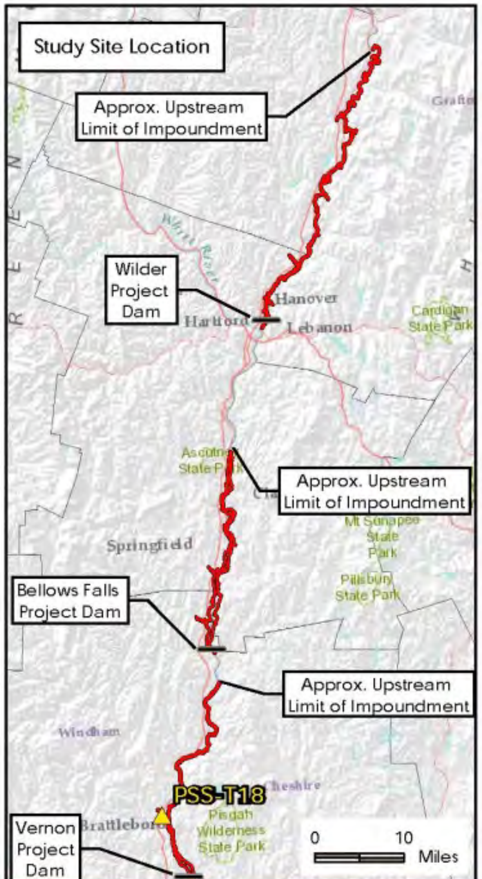

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Figure No.
B30

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PSS-T18
4/9/2014

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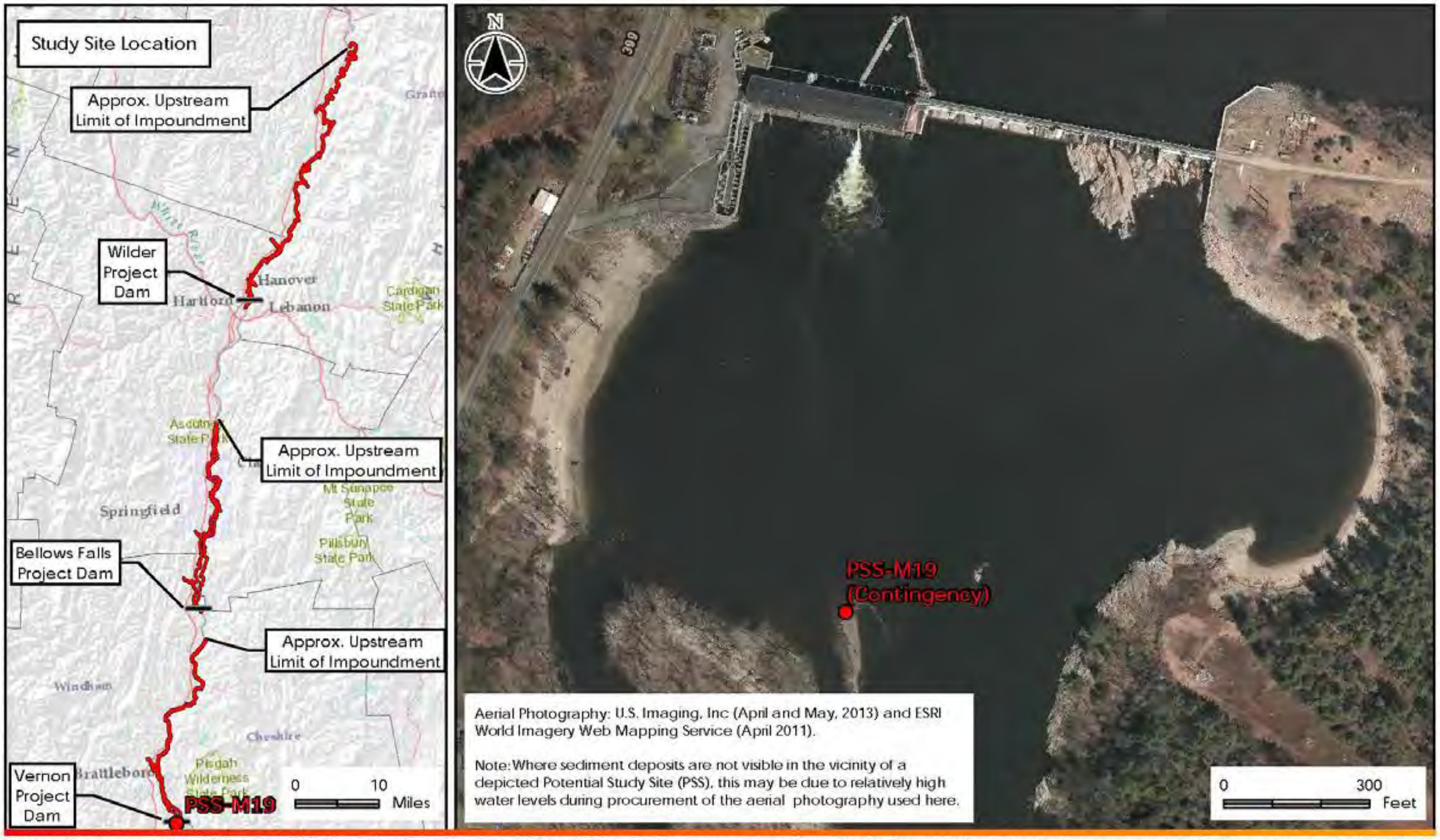

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B31

Title
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Stantec

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Potential Study Sites (PSS)

- Mainstem Study Site
- Tributary Study Site
- Project Boundary

Client/Project 195600876
Normandeau Associates, Inc.
Draft Preliminary Site Selection Report for
TransCanada Hydro Northeast Inc. ILP Study 8
FERC PNs 1855, 1892, 1904

Figure No.
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UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Volume III.B

Study 9 – Instream Flow Study Revised Site Selection Report

Initial Study Report

September 15, 2014

TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 9
Instream Flow

Revised Site and Transect Selection Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

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June 20, 2014

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1. INTRODUCTION

Operations at TransCanada's Wilder, Bellows Falls and Vernon hydroelectric projects (projects) may affect fish and aquatic resources in the riverine sections downstream of each project dam. The goal of the Instream Flow Study (Study 9) developed in support of the relicensing for these three hydroelectric projects, is to assess current project operation impacts on downstream aquatic resources and habitats. Study Plan 9, as supported by stakeholders in 2013 and approved by FERC in its February 21, 2014 Study Plan Determination, provides an overview of the methodology that will be employed during 2014 to assess the overall relationship between stream flow and resultant habitat of key aquatic species in the project-affected riverine reaches. This document provides a summary of the data analysis and criteria used to select the sites that will be examined in detail during 2014.

The purpose of this Revised Site Selection Report is to document preliminary identification of potential study sites, provide the aquatics working group with information on potential study sites, and present recommendations for selection of study sites for implementation of Study 9. A consultation meeting with the working group was held on May 23, 2014. Stakeholders requested, and TransCanada agreed to:

- Re-evaluate the selection criteria, based on sampling effort to be focused on habitat types where a species response is expected, rather than based on relative proportions of all available habitat types. For example, deep pools may have less of a species response than other habitat types and less sampling is needed in those locations even though pools make up a large percent of the overall study area habitat. It was suggested that the number of pool transects be reduced. There was agreement on re-allocation of transects rather than adding numerous additional transects.
- Re-evaluate transect selection in places where habitat type is the same but substrate is different and seek to include that diversity in transect selection.
- Provide photos/video and or a site visit to the Bellows Falls bypassed reach at different flow levels to determine what type of study should be done there (TransCanada was not proposing to study the bypassed reach given the lack of habitat for target species).
- Re-evaluate adding a transect to the Sumner Falls reach (TransCanada was not proposing to model at that location since none of the proposed target species need the type of habitat found at Sumner Falls (bedrock cascades).
- Re-map the riverine section downstream of Vernon dam since it was first mapped in 2013 for Study 7 at higher than expected flows and elevation. The area will be mapped during low flow and low elevation conditions which may result in re-distribution of some transects in that 1.5 mile reach.

This revised report includes changes to transects in Wilder reaches 2 and 3 and the Bellows Falls riverine reach (i.e., not the bypassed reach). In other reaches essentially all the habitat units will be sampled. The changes include removal of some pools, the addition of some runs or glides, and evaluation of substrate as part of the selection process.

It was noted at the consultation meeting that additional consultation on target species is needed and the working group agreed to provide any proposed changes/additions of target species that differ from the proposed list of target species (see Section 5 of this report) as included in the Revised Study Plan. HSCs will be obtained from the final selection from the First Light-Stakeholder consultation on HSC's for Turner's Falls Project. TransCanada will develop and propose HSCs for the additional species found in TransCanada's project areas (smallmouth bass and some mussels).

A critical element of the instream flow study is to establish study sites which are representative of mesohabitat type composition within the river segments under study and to ensure microhabitats used by target species and life stages are incorporated. The Aquatic Habitat Mapping Study (Study 7) completed in 2013 (Normandeau, 2014), provided the necessary information to proceed with this initial step of the field portion of the instream flow study.

A Physical Habitat Simulation PHABSIM study begins with a representative sample of hydraulic and physical habitat conditions within the study area. Generally, the samples are represented by cross sections for 1-dimensional (1D) models or a topographic grid for 2-dimensional (2D) models. The sample can be obtained in a variety of ways, including representative reaches where a small section of river is assumed to represent other unsampled portions of a reach, or through habitat mapping in which individual mesohabitats are identified and sampled in general proportion to the total. In addition, specific habitats deemed important for certain life stages (e.g. spawning) can be included in the study sample. Whatever method is chosen to represent hydraulics and habitat, it is important to have an overall picture of mesohabitat distribution and types within the study reach. This not only assists in selecting study sites, but also for weighting and proportioning the habitat indices based on habitat representation. For this study, a mesohabitat mapping approach originally described by Morhardt et al. (1983) and summarized by Bovee et al. (1998) was used.

This document is meant to serve as a proposal for the establishment of study sites, transect locations and choice of the appropriate instream flow study method for riverine portions of the project. It will assist and guide consultation and ultimately serve as a guide and map for final selection in the field.

2. STUDY AREA

The study area includes all project riverine segments of the Connecticut River from Wilder dam to just downstream of Vernon dam (Figure 2-1). Riverine segments consist of an approximate 17-mile segment from Wilder dam to near Windsor, Vermont; a 6-mile segment downstream of Bellows Falls dam to Dunshee Island near Westminster, Vermont; the Bellows Falls bypass reach; and an approximately 1.5-mile segment downstream of Vernon dam.

Study reaches were delineated based on hydrologic inputs and results from Study 7 (Aquatic Habitat Mapping):

Wilder riverine segment:

- Reach 1 – Wilder Dam to White River – 1.5 miles
- Reach 2 – White River to Ottauquechee River – 5.2 miles
- Reach 3 – Ottauquechee River to Chase Island – 11.0 miles

Bellows Falls riverine segment:

- Single reach – Bellows Falls powerhouse to Dunshee Island – 5.6 miles
- Bellows Falls bypassed reach – Bellows Falls Dam to backwater pool below powerhouse – 3,500 feet of the bypassed reach plus approximately 300 feet below the powerhouse

Vernon riverine segment:

- Single reach –Tailrace below Vernon Dam to bottom of Stebbins Island – 1.5 miles

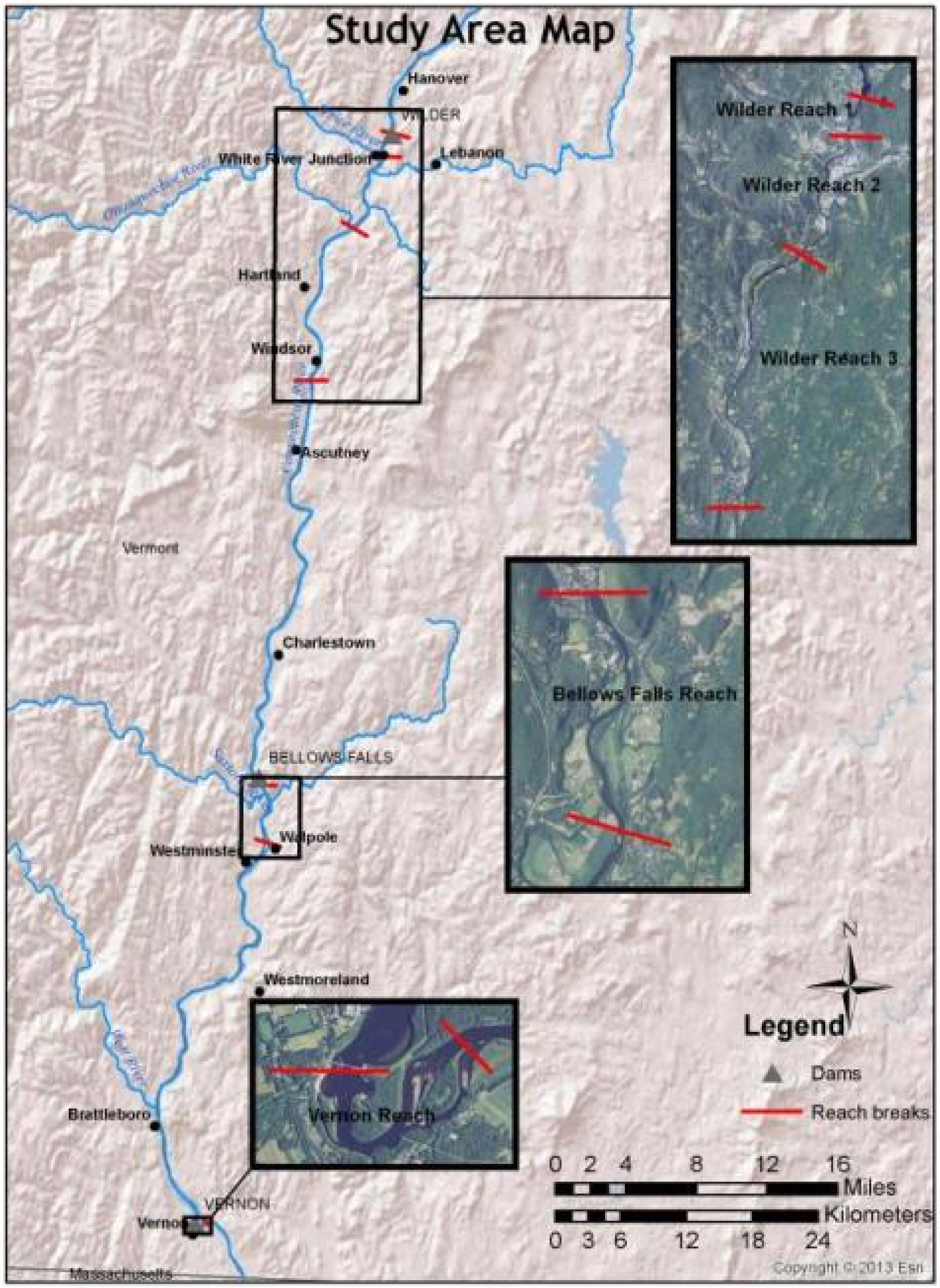

Figure 2-1. Study area.

3. METHODS

Study sites encompass a localized section of a stream or reach from which a sample of mesohabitat types, represented by 1D transects or a 2D topographic model is obtained. Though commonly termed 'transect selection', in actuality individual mesohabitat units are being chosen. Ultimately, transects are placed to represent hydraulic properties and micro-habitat characteristics of selected mesohabitat units.

The number of 1D transects needed to adequately model hydraulics and ultimately produce a habitat index is largely dependent on habitat complexity, number of habitat types present, and general preferences of the aquatic species and life stages under study. Payne et al. (2004) determined that 18-20 transects will produce a robust habitat index function that differs little from results based on 40-70 transects, assuming all strata (habitat types) are sampled in relative proportion to the total and the extent of hydraulic characteristics are included. Habitat index functions for their study were generated using generic criteria for a range of velocities and depths (shallow/fast, shallow/slow, deep/fast and deep/slow) to include all potential aquatic micro-habitat use. As few as 10 transects can provide suitable results in less complex and uniform stream channels, though at a minimum two transects should represent each mesohabitat type, particularly those occurring infrequently. These general standards were applied to the study site and transect selection process for this study.

Besides mesohabitat type and pool depth, substrate composition was also incorporated into the selection process where applicable, namely in Wilder reaches 2 and 3. In Wilder reach 1 and the Vernon reach all identified habitat units were selected for sampling precluding the need to use of substrate in the process. Similarly, all but two of the 19 habitat units in the Bellows Fall reach were selected for sampling. During working group consultation it was suggested that substrate information derived from mussel surveys in the Wilder riverine reaches may be useful (Biodrawversity and The Louis Berger Group, Inc. (LBG) 2014). However, sites for that study were specifically selected to target habitats suitable for dwarf wedgemussel (the majority of sites were in pools) and sampling areas were small relative to the size of meoshabitat units. As such, substrate data from that study may not reflect overall dominant and sub-dominant substrate composition in individual habitat types and would not provide useful information on overall substrate composition of mesohabitat units.

As described in the Instream Flow Study Plan (Study 9), study sites are to be identified using the least common mesohabitat type as derived from habitat mapping as a 'selector'. Generally very rare habitat types, those considered unmodelable (e.g. steep gradient rapids, cascades and riffles), or those which account for less than 5 percent of a reach are not included in the sample, unless they are considered biologically important to the species under study. The process of determining a selector is based on random sampling. For example, if riffle habitat accounts for the smallest percentage of all types in a reach, a randomly selected riffle mesohabitat unit would be selected and a study site established at that location. Additional meoshabitat type units would then be chosen in the vicinity in relative proportion to the overall mesohabitat distribution and pre-determined habitat representation. Depending on the number of samples needed, other selector units could be chosen through the same process to establish other study sites.

The total number of study sites in a reach is dependent on reach length, the number and distribution of mesohabitat types within the vicinity of a study site, and the potential total number of transects needed to represent all mesohabitat types. In areas with complex flow conditions such as braided or split channels, which may not be adequately modeled using 1D transects, a 2D model study site may be recommended. The general advantage of 2D models is they should provide more accurate computation of flow distribution through multiple channels and consequently better predictions of hydraulic components (depth and velocity) than 1D transect models, particularly at higher flows. However, the predictive accuracy of 2D models for depths and velocities is generally poor in areas of steep slopes and rapid changes in bed slopes (Steffler and Blackburn 2002, Kozarek et al. 2010).

This study site selection approach has the benefit of not introducing bias into the selection process and ensures that uncommon mesohabitat types are part of the sample. However, it does not preclude the use of professional judgment to reject sites and/or mesohabitat units that may be unrepresentative or unworkable. It also establishes a systematic approach and results in clusters of transects, minimizing the time required to travel between transects in the field. Final transect locations and placement will take place during consultation with the aquatics working group prior to and during the field portion of site selection.

4. RESULTS

There were 6 mesohabitat types identified from the Aquatic Habitat Mapping Study (Study 7). Pools were separated into deep and shallow categories based on evaluation of depth frequency derived from habitat mapping:

- Pool – deep, low velocity with a generally well-defined control and retains water at zero discharge.
    - Deep Pool – maximum depth > 15 ft
    - Shallow Pool – maximum depth < 15 ft
- Glide – shallow flats with moderate velocity distributed across the channel, without a well-defined thalweg, resemble shallow pool if velocities are low.
- Run – deep to moderately deep with fast velocity in a well-defined thalweg, surface may be turbulent, substrate variable.
- Riffle – shallow with gravel, cobble, or boulder substrate, fast water with turbulent flow or white-water, possible exposed substrate.
- Rapid – shallow bedrock, boulder with turbulent white-water flow and possible exposed substrate, may be brief and abrupt across the stream channel or extend for a greater distance.

- Cascade – steep, high gradient, bedrock or boulders with drops and falls.

Based upon the river conditions described in the Study 7 report, pool (deep and shallow combined) was overall the most abundant habitat type in the Wilder and Bellows Falls riverine segments, including the Bellows Falls bypassed reach. The Vernon reach did not contain any riffles, and pool, run and glide accounted for comparatively equal proportions of mesohabitats in that reach. There was a single rapid (Sumner Falls in Wilder reach 3) and a single cascade (below the fish barrier in the Bellows Falls bypassed reach) identified during habitat mapping.

In all reaches except the Vernon reach, riffle was the least common habitat type. Even though riffles accounted for less than 5 percent in most reaches, it is considered an important habitat for a number of target aquatic species and was therefore included in the selection process. However, due to the small number of riffle habitat units documented in some reaches and overall mesohabitat distribution, the study site selection process could not always be utilized. For example, a limited number of available habitat units and reach length in Wilder reach 1 and the Vernon reach did not allow for multiple study sites. Similarly, the only riffle habitat unit and all run habitats in the Bellows Falls reach are located in the upper 3 miles, resulting in, for all practical purposes, a single study site. Reference maps showing mesohabitat units and depths derived from the Study 7 (Aquatic Habitat Mapping) are presented in Appendix A.

4.1 Reach 1 - Wilder Dam to White River

Reach 1 contains 9 primary habitat units (Table 4-1). Deep pool makes up 59 percent of the reach, though one pool is only 0.1 feet above the maximum depth cutoff of 15 feet for shallow pools. The remaining habitat types consist of run (24%) and glide (15%). A total of 10 transects are proposed for this reach representing each mesohabitat unit inclusive of split channels and side channels.

Table 4-1. Mesohabitat types, proposed number of transects, and percent representation in reach 1 of the Wilder riverine segment.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Transects Proposed	Percent per Transect
All Pools	4	4,601	59.2	4	14.8
Deep Pool (>15')	*4*	*4,601*	*59.2*	*4*	*14.8*
Shallow Pool	*0*	*0*	*0*	*0*	*0.0*
Glide	2	1,196	15.4	2	7.7
Run	2	1,846	23.8	3	7.9
Riffle	1	125	1.6	1	1.6
Rapid	0	0	0	0	0.0
Cascade	0	0	0	0	0.0
Totals	9	7,768	100.0	10	----

The single short riffle of 125 feet at the transition between the pool immediately below the dam and the pool downstream could only be represented by a single transect (Table 4-2, Figures 4-1 and 4-1a). This unit, identified under the low flow release, is created by scour produced during spill at the dam and is inundated and unrecognizable at higher flows. There are two islands in this reach but overall habitat complexity is generally lacking with the exception of some boulders and woody debris in the upper portion of the reach. The majority of in-water substrate is cobble though a few bedrock outcrops do occur along banks and on islands. The proposed ten transects capture all available habitat, will adequately model walleye spawning which is known to take place below the dam and covers the range of channel widths and depths that occur in the reach.

Table 4-2. Mesohabitat types identified through habitat mapping in reach 1 of the Wilder riverine segment and representative transect ID.

Unit #[a]	Habitat Type[b]	Length (ft)	Max Depth (ft)	Avg. Depth (ft)	Substrate[c]	Note	Transect ID
1	Deep Pool	849	24.4	11.0	CB/GR	Below Wilder Dam	WR1-1
2	Riffle	125	3.4	3.2	CB/GR		WR1-2
3	Deep Pool	779	39.4	12.3	-----		WR1-3
4	LC Run	854	7.7	5.1	GR/CB	First Island	WR1-4
5	LC Glide	783	10.3	5.2	CB/GR		WR1-5
5.1	RC Run	1576	8.7	5.0	GR/SA		WR1-4/5-RC
6	Deep Pool	1093	41.0	14.1	-----		WR1-6
7	RC Run	992	10.4	5.7	CB/GR		WR1-7/8
7.1	LC Run	730	5.8	4.2	BR/GR	Second Island	WR1-7-LC
7.2	SC Run	345	6.0	5.0	BR/SA	Small Island	
8	Deep Pool	1880	15.1	7.8	SA/CB		WR1-9
9	Glide	413	6.3	4.2	GR/CB	White River	WR1-10
						End Reach 1	

a Split and side channel Unit #'s are based on association with the primary channel habitat type
b RC = Right Channel, LC = Left Channel, SC = Side Channel
c ST = Silt, SA = Sand, GR = Gravel, CB = Cobble, BD = Boulder, BR = Bedrock

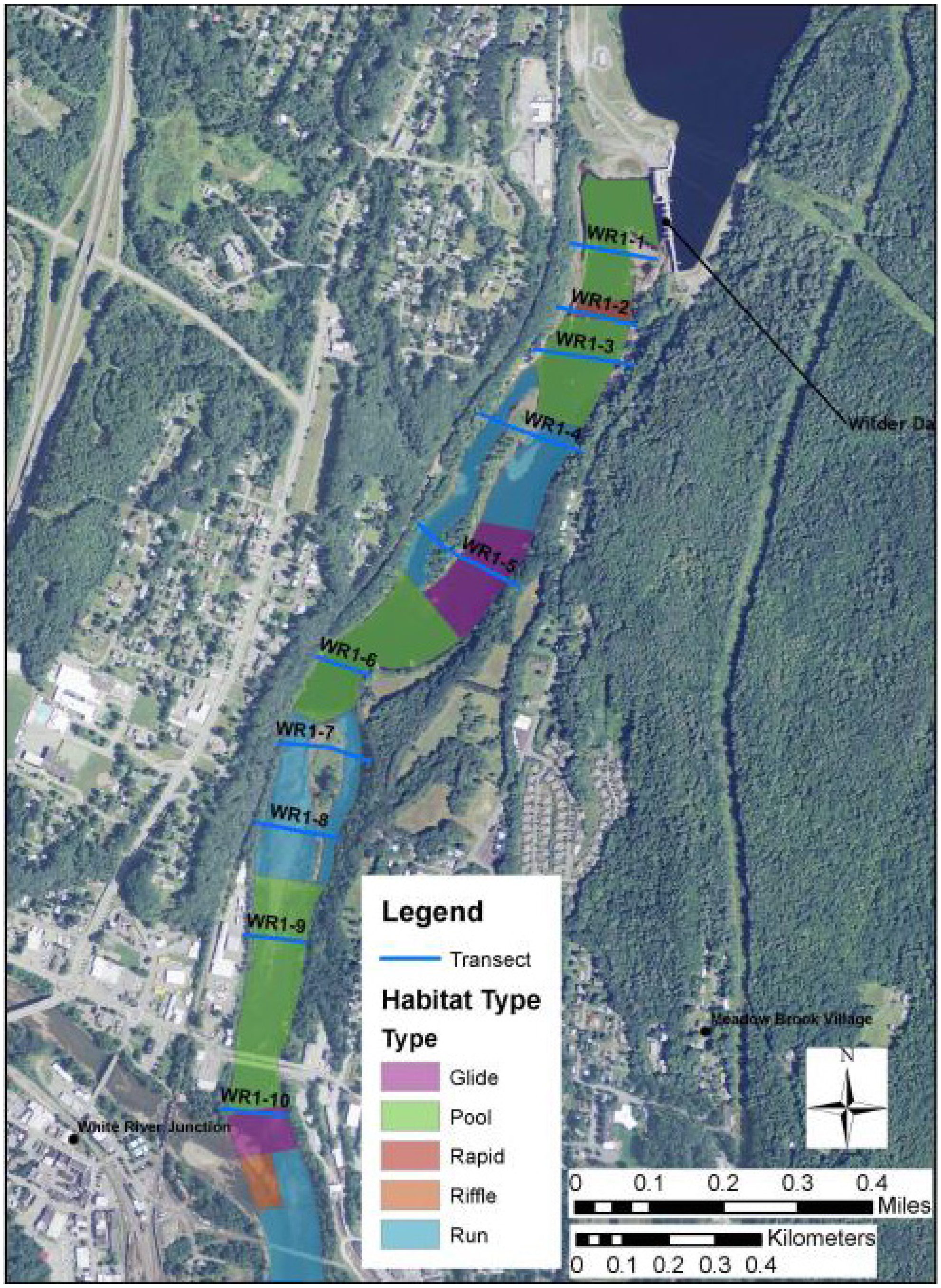

Figure 4-1. Mesohabitat types and proposed transect locations in Wilder reach 1 – Wilder dam to White River.

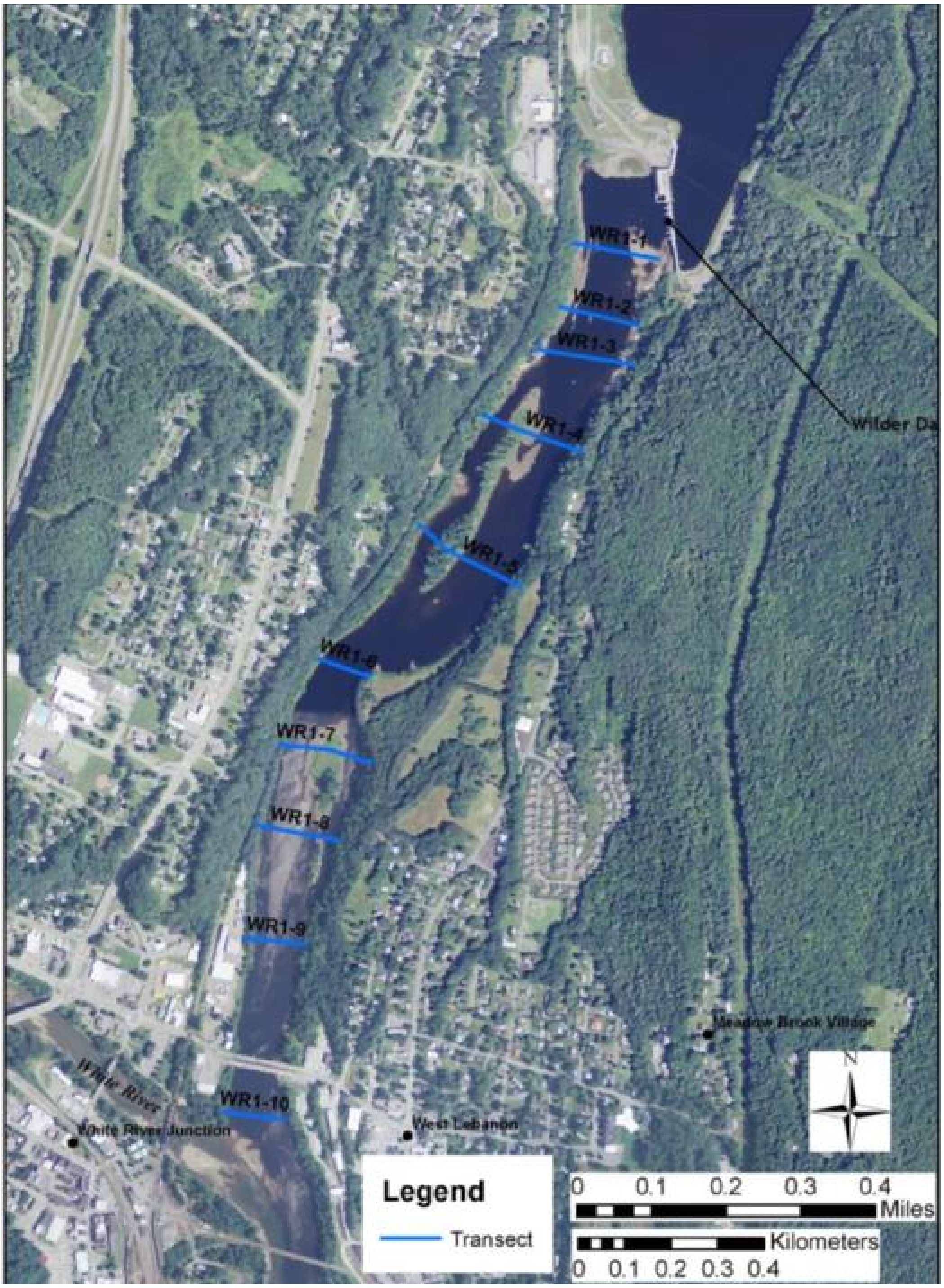

Figure 4-1a. Proposed transect locations in Wilder reach 1 – Wilder dam to White River.

4.2 Reach 2 - White River to Ottauquechee River

Overall pool is the dominant habitat type in reach 2, accounting for 63 percent, 36 percent of which was classified as deep pool (Table 4-3). Runs account for 22 percent of the reach followed by glides at 11 percent and riffles at 4 percent. Only three riffle habitat units were identified during habitat mapping, 80 percent of which are located within a complex of channels known as Johnston Island. A total of 14 transects are proposed for this reach in addition to a single 2D site.

Table 4-3. Mesohabitat types, proposed number of transects, and percent representation in reach 2 of the Wilder project riverine segment.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Transects Proposed	Percent per Transect
All Pools	13	17,123	62.6	5	12.5
Deep Pool (>15')	*6*	*9,886*	*36.2*	*3*	*12.1*
Shallow Pool	*7*	*7,237*	*26.5*	*2*	*13.2*
Glide	3	2,939	10.7	3	3.6
Run	9	6,131	22.4	5	4.5
Riffle	3	1,149	4.2	1	4.2
Rapid	0	0	0	0	0.0
Cascade	0	0	0	0	0.0
Totals	28	27,342	100.0	14	----

The riffle unit immediately downstream of the White River established the first study site and five transects representing run, glide and pool were located in the vicinity (Table 4-4, Figures 4-2 and 4-2a). Because no other habitat types except pool were in the immediate area, another site was established at the only other main channel riffle at the upstream tip of Johnston Island. Due to the complex of islands and braided channels at this site, and the fact it contains all habitat types, it was decided that a 2D model would be the most effective means to evaluate this area. Two transects, one glide at the top and one pool at the bottom of the island were selected to establish the boundaries for the 2D site and represent those two habitat types as 1D transects.

To capture additional run and glide habitat units, the lone remaining glide near the bottom of the reach was chosen and the remaining transects placed upstream and downstream (Table 4-4, Figures 4-3 and 4-3a). Three runs, one split by Burnap's Island, a deep narrow run created by the cobble bar at the mouth of Bloods Brook and a run/glide were selected along with three pools. Overall pool is represented by 5 transects, 2 deep and 3 shallow, run is represented by 5 transects, glide by 3 transects and riffle by a single transect. The addition of the 2D site effectively adds 2 riffles and 2 runs to the sample and results in 18 habitat units (equivalent to transects) selected for modeling (Table 4-3a) . The sample accounts for 38 percent of all pool habitat units, 78 percent of runs and 100 percent of glides and riffles. With the exception of two pools, where substrate composition is undetermined, all major substrate combinations are captured in the sample.

Table 4-3a. Mesohabitat types, number of habitat units represented by transects or 2D site and percent of habitat types sampled in reach 2 of the Wilder project riverine segment.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Habitat Units	Percent of Habitat Type
All Pools	13	17,123	62.6	6	38
Deep Pool (>15')	*6*	*9,886*	*36.2*	*3*	*50*
Shallow Pool	*7*	*7,237*	*26.5*	*2*	*29*
Glide	3	2,939	10.7	3	100
Run	9	6,131	22.4	7	78
Riffle	3	1,149	4.2	3	100
Rapid	0	0	0	0	0
Cascade	0	0	0	0	0
Totals	28	27,342	100.0	18	----

Table 4-4. Mesohabitat types identified through habitat mapping in reach 2 of the Wilder riverine segment and representative transect IDs.

Unit #[a]	Habitat Type[b]	Length (ft)	Max Depth (ft)	Avg. Depth (ft)	Substrate[c]	Note	Transect ID
9	Glide	413	6.3	4.2	GR/CB	White River	WR1-10
						End Reach 1	
10	Run/Riffle	407	4.8	3.8	GR/SA		
11	Run	643	8.0	5.5	GR/SA		WR2-1
12	Riffle	277	5.2	4.8	GR/SA		WR2-2
13	Run	977	6.7	5.1	GR/SA		WR2-3
14	Glide	1702	7.8	5.0	CB/GR		WR2-4
15	Pool	2291	11.8	6.8	SA/GR		WR2-5
16	Deep Pool	1858	16.4	8.6	-----	Mascoma River	
17	Deep Pool	654	39.6	22.0	-----		
18	Deep Pool	705	26.4	13.3	-----		
19	Glide	823	7.5	4.1	CB/GR		WR2-6
20	RC Riffle	195	-----	-----	CB/GR		
21	RC Run	694	9.2	5.1	CB/GR		
22	RC Riffle	677	2.1	1.7	CB/GR		
20.1	LC Riffle	511	3.9	3.1	CB/GR	Proposed 2D Site	
21.1	LC Run	445	3.5	2.8	-----	Johnston Island	
21.2	LC Riffle	166	3.5	-----	CB/GR		
21.3	LC Deep Pool	496	31.3	16.1	CB/GR		
22.1	LC Run	784	9.9	4.6	CB/GR		

Unit #[a]	Habitat Type[b]	Length (ft)	Max Depth (ft)	Avg. Depth (ft)	Substrate[c]	Note	Transect ID
22.2	SC Run (RC)	650	-----	-----	-----		
22.3	SC Riffle (LC)	621	-----	-----	GR/SA		
22.4	SC Pool (LC)	189	-----	-----	SA/MUD		
23	Deep Pool	1381	15.7	8.4	-----		WR2-7
24	Pool	1076	10.2	6.4	BR/??		
25	Run/Pool	709	10	4.8	BR/CB		
26	Run	683	8.3	6.2	CB/GR		
27	Pool	1102	11	5.4	GR/CB		
28	Run/Glide	811	8.2	5.6	GR/CB		WR2-8
29	Pool	686	13.2	7.1	CB/GR		WR2-9
30	Run	534	10	6.6	CB/BD	Blood's Brook	WR2-10
31	Pool	1150	13.2	9.4	-----		
32	Deep Pool	4241	20.6	9.1	CB/ST		WR2-11
33	Glide	414	7.5	4.1	CB/GR		WR2-12
34	LC Run	673	9.6	8.0	CB/GR	Burnaps Island	WR2-13
35	LC Pool	580	9.4	7.1	GR/SA		
36	LC Pool	353	13.8	10.5	SA		
34.1	RC Run	644	7.7	6.4	CB/GR		WR2-13-RC
35.1	RC Pool	528	8.2	5.1	-----		
37	Deep Pool	1045	20.2	11.6	-----	Ottauquechee River	WR2-14
						End Reach 2	

a Split and side channel Unit #'s are based on association with the primary channel habitat type
b RC = Right Channel, LC = Left Channel, SC = Side Channel
c ST = Silt, SA = Sand, GR = Gravel, CB = Cobble, BD = Boulder, BR = Bedrock

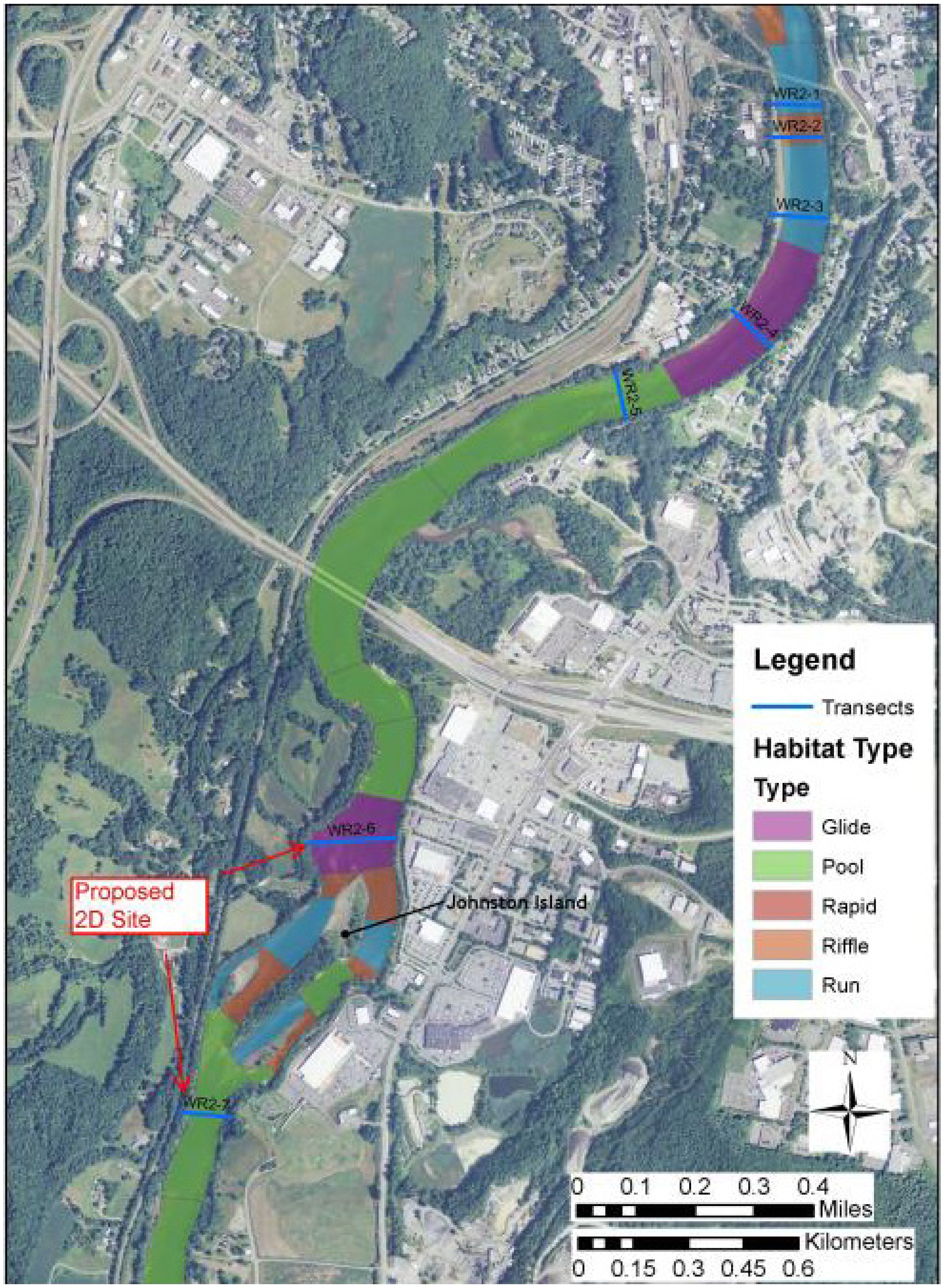

Figure 4-2. Mesohabitat types and proposed transect locations and 2D study site for the upper portion of Wilder reach 2 – White River to Ottauquechee River.

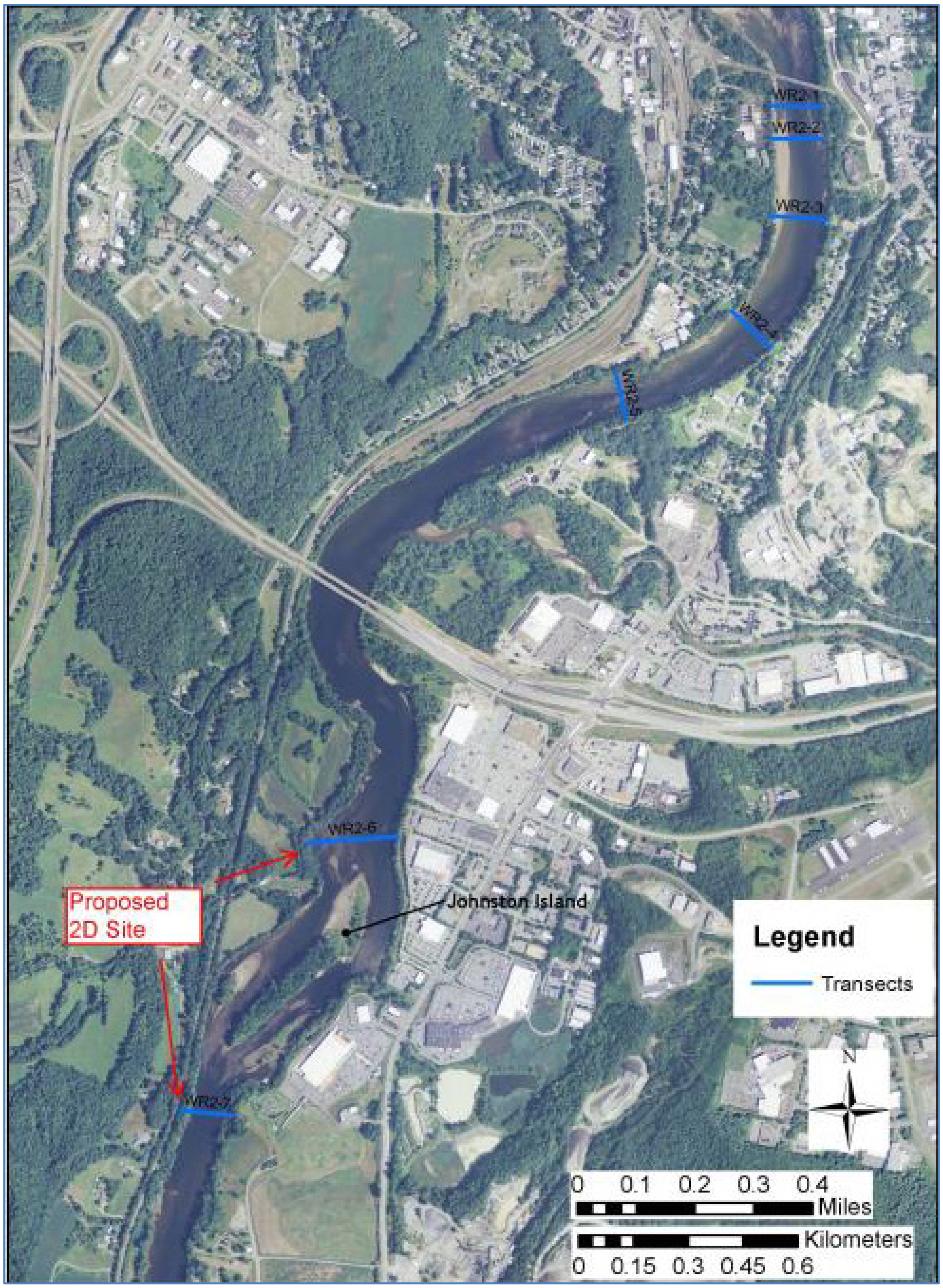

Figure 4-2a. Proposed transect locations and 2D study site for the upper portion of Wilder reach 2 – White River to Ottauquechee River.

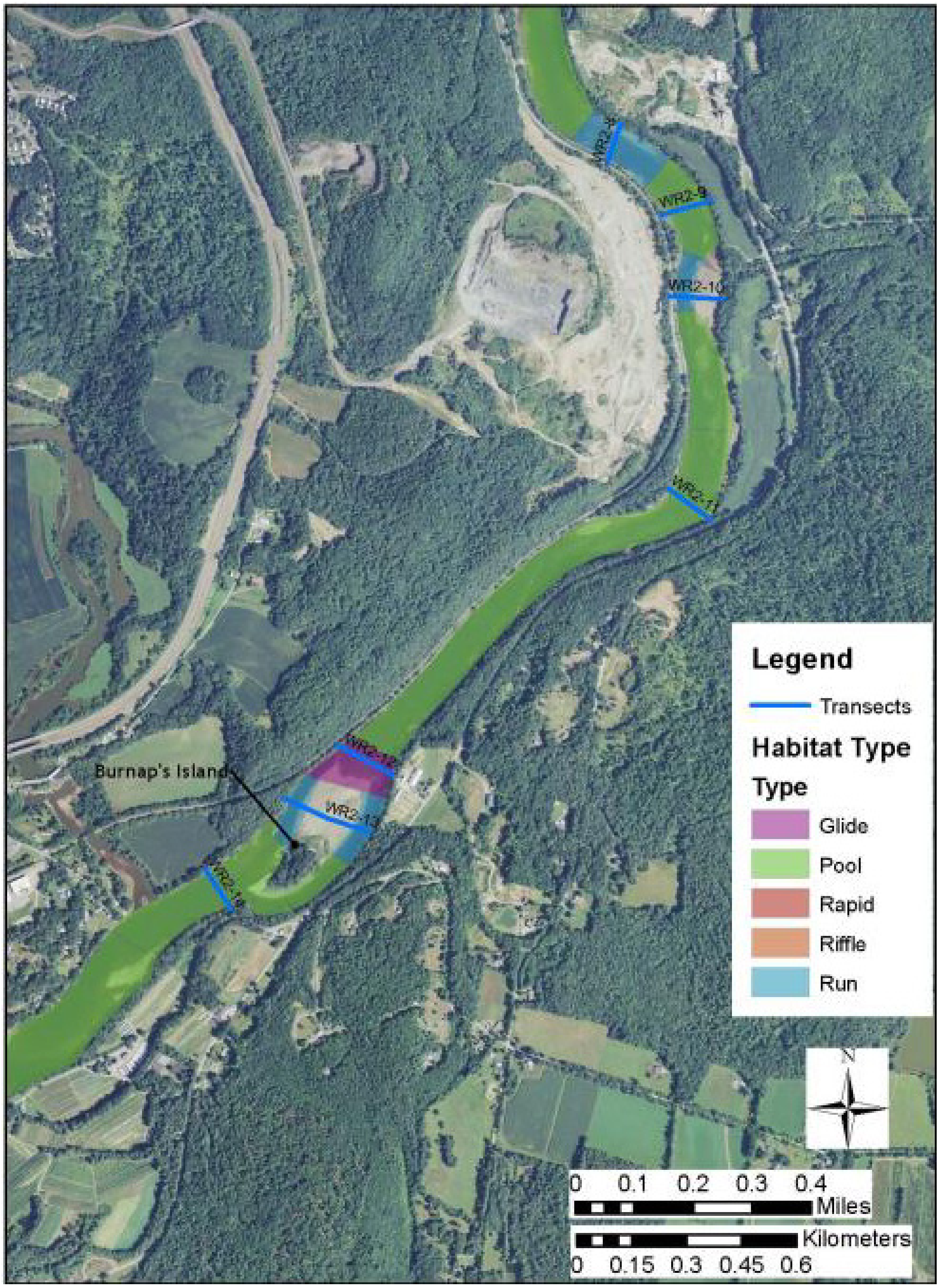

Figure 4-3. Mesohabitat types and proposed transect locations in lower portion of Wilder reach 2 – White River to Ottauquechee River.

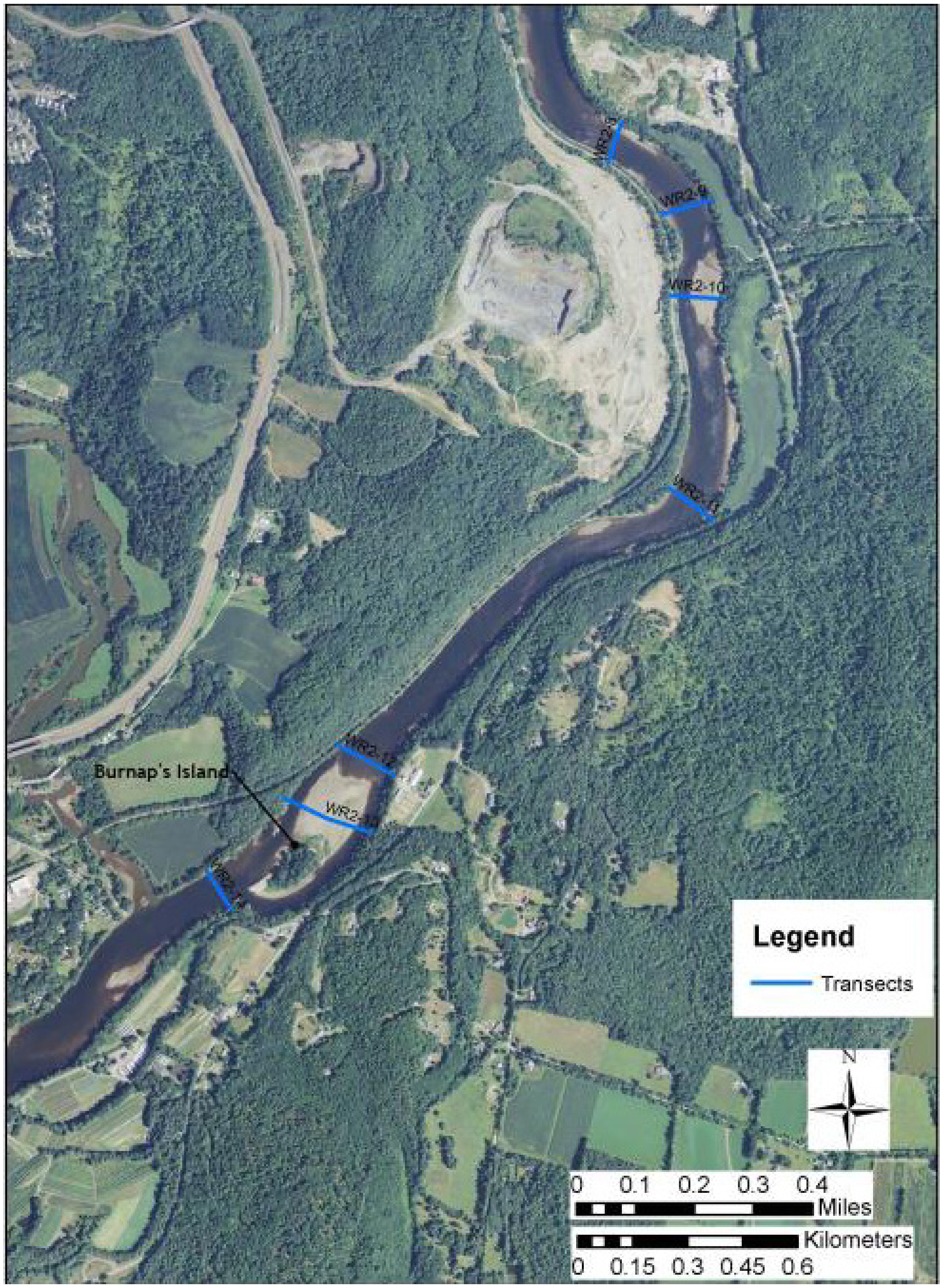

Figure 4-3a. Proposed transect locations in lower portion of Wilder reach 2 – White River to Ottauquechee River.

4.3 Reach 3 - Ottauquechee River to Chase Island

Reach 3 is dominated by pools (52 percent) and glides (30 percent) with the majority of pool habitat classified as shallow. Run makes up 10 percent and riffle 6 percent (Table 4-5). The bedrock rapid known as Sumner Falls is a series of longitudinal bedrock ridges and channels and accounts for just 2 percent of the reach. A total of 13 main channel transects, 3-4 representative side channel transects and a 2D model site are proposed for this.

Table 4-5. Mesohabitat types, proposed number of transects, and percent representation in reach 3 of the Wilder riverine segment.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Transects Proposed	Percent per Transect
All Pools	26	29,918	51.7	3	17.2
Deep Pool (>15')	*6*	*8,896*	*15.4*	*0*	*0.0*
Shallow Pool	*20*	*21,022*	*36.3*	*3*	*12.1*
Glide	20	17,647	30.5	5	6.1
Run	8	5,703	9.8	2	4.9
Riffle	8	3,349	5.8	3	1.9
Rapid	1	1,284	2.2	0	0.0
Cascade	0	0	0	0	0.0
Totals	63	57,902	100.0	13	----

The 2.5 mile stretch between the Ottauquechee River and Sumner Falls is composed of pool and glide habitat (Table 4-6). The pool below Sumner Falls is deep with a large eddy along the right bank and contains primarily bedrock and sand substrate. Though this rapid is unique to the reach and study area there is no evidence that it contains critical habitat for any target species or life stage being evaluated under the instream flow study. No habitat modeling is proposed for Sumner Falls at this time pending a site visit and additional discussion of potential aquatic habitat evaluation.

Eight riffle habitat units were identified in the reach, most clustered around two locations, a large gravel bar area approximately 1.0 mile downstream of Sumner Falls, and in the vicinity of Hart Island (Table 4-6). This is the only reach where randomly chosen riffle units were used as selectors for study site locations. Due to the length of this reach (11 miles) and number of riffle habitat units, three study sites were established.

One of the randomly selected riffle units is immediately downstream of Sumner Falls. This section of the river is dominated by a series of riffles, runs and glides. One pool, two runs and three glides were chosen for transect placement, in addition to the selected riffle (Table 4-6, Figures 4-4 and 4-4a).

Table 4-6. Mesohabitat types identified through habitat mapping in reach 3 of the Wilder riverine segment and representative transect ID.

Unit #[a]	Habitat Type[b]	Length (ft)	Max Depth (ft)	Avg. Depth (ft)	Substrate[c]	Note	Transect ID
37	Deep Pool	1045	20.2	11.6	-----	Ottauquechee River	WR2-14
						End Reach 2	
38	Deep Pool	1682	17.6	8.5	-----		
39	Pool	736	13.9	5.8	-----		
40	Glide	488	7.8	5.9	CB/GR	Small SC RB	
41	Deep Pool	2711	15.6	6.2	-----		
42	Glide	3221	9.9	5.7	SA/GR		
43	Pool	2904	8.8	4.1	SA/SI		
44	Pool	970	9.1	6.4	SI/CB		
45	Run	549	7.0	-----	BR/CB		
46	Rapid	1284	-----	-----	BR	Sumner Falls	
47	Deep Pool	1361	31.6	12.7	SA/SI	BW Pool	
48	Glide	973	10.6	3.9	CB/CB		WR3-1
49	Pool	1589	8.0	5.4	CB/CB		WR3-2
50	Glide	507	5.3	3.4	CB/GR		WR3-3
51	Riffle	828	2.8	2.0	GR/CB	Selector	WR3-4
52	Run/Glide	1152	10.9	4.9	CB/GR		WR3-5
53	Riffle	548	2.0	-----	GR/CB		
54	Run	1286	9.8	4.8	GR/CB		WR3-6
55	Pool	158	10.8	7.7	GR/SA		
56	Riffle	320	3.0	-----	GR/CB		
57	Run	455	4.3	3.3	CB/GR		
58	Glide	680	6.7	4.2	GR/CB		WR3-7
59	Pool	302	7.9	6.0	CB/BD		
60	Pool	435	6.6	4.5	GR/CB		
61	Glide	1017	5.6	4.0	CB/GR		
62	Pool	3168	12.5	7.8	BD/CB		WR3-8
63	Glide	871	5.6	3.9	CB		WR3-9
64	LC Pool	296	8.6	6.4	-----	Hart Island LC	
65	LC Glide	887	5.0	3.2	CB/GR		
66	LC Riffle	553	2.5	-----	CB/GR		WR3-10
67	LC Pool	875	11.4	8.0	CB/GR		WR3-11
68	LC Glide	211	6.6	4.4	CB/CB		
63.1	RC Riffle	271	-----	-----	GR/CB	Hart Island RC[d]	WR3RC-1
63.2	RC Run	579	-----	-----	SA/GR		
64.1	RC Pool	262	-----	-----	SA/SI		
65.1	RC Run	200	-----	-----	SA/GR		
65.2	RC Pool	987	-----	-----	SA/SI		WR3RC-2
66.1	RC Run/Glide	383	-----	-----	GR/CB		
66.2	RC Riffle	173	-----	-----	GR/CB		

Unit #[a]	Habitat Type[b]	Length (ft)	Max Depth (ft)	Avg. Depth (ft)	Substrate[c]	Note	Transect ID
67.1	RC Run	228	-----	-----	GR/CB		WR3RC-3
67.2	RC Glide	249	-----	-----	GR/SA		
67.3	RC Pool	369	-----	-----	SI/SA		
69	Riffle	201	3.9	3.1	CB/GR	Selector	WR3-12
70	Riffle/Run	246	4.3	2.7	GR/CB		
71	Pool	1045	11.4	5.2	CB/SA/GR		
72	Glide	862	4.5	3.0	CB/SA/GR		WR3-13
73	Riffle	88	-----	-----	CB/GR		
74	Run	340	7.2	5.2	CB/GR		
75	Deep Pool	1380	17.5	6.5	GR/CB/SA		
76	Pool	505	10.2	5.8	CB/GR/SA		
77	Pool	964	12.9	6.2	CB/CB		
78	Glide	646	3.2	2.3	CB/GR		
79	Glide	374	3.1	2.1	GR/SA		
80	Glide	1686	4.9	3.4	CB/GR/SA		
81	Glide	381	5.0	4.2	GR/CB/SA		
82	Pool	583	7.2	5.0	CB/SA/GR		
83	Glide	1246	5.5	3.5	GR/CB/SA		
84	Pool	1033	8.0	5.0	GR/SA/CB		
85	Glide	390	5.2	3.8	GR/CB		
86	Pool	1206	12.9	6.4	GR/CB		
87	Pool	1066	6.3	4.0	GR/SA/CB		
88	Glide	881	4.7	3.1	GR/SA		
89	Pool	430	5.6	3.7	SA/GR		
90	Glide	1378	4.5	2.9	GR/SA	Cornish Boat Launch	
91	Pool	1805	9.6	5.0	SA/GR/CB		
92	Deep Pool	687	21.0	10.5	CB/SA	Covered Bridge	
93	Glide/LC Run	485	8.0	4.1	GR/CB		
94	Run	728	7.5	4.1	CB/GR		
95	Pool	953	11.5	7.0	SA/SI		
96	Glide	461	4.5	3.4	CB/GR/SA	Proposed 2D Site	
97	RC Riffle	565	3.1	2.0	GR/SA/CB	Selector	
98	RC Run	650	4.2	2.5	GR/CB	Chase Island RC	
99	RC Run	543	5.4	4.1	CB/GR		
100	RC Deep Pool	1075	17.1	5.9	CB/SA/GR		
97.1	LC Riffle	356	-----	-----	GR/CB	Chase Island LC	
98.1	LC Run	471	-----	-----	GR/SA		
99.1	LC Glide	256	-----	-----	GR/SA		
99.2	LC Pool	138	-----	-----	GR/SA		
100.1	LC Pool	1342	7.9	3.8	GR/SA	End Reach 3	

a Split and side channel Unit #'s are based on association with the primary channel habitat type
b RC = Right Channel, LC = Left Channel, SC = Side Channel
c ST = Silt, SA = Sand, GR = Gravel, CB = Cobble, BD = Boulder, BR = Bedrock

d Hart Island RC mesohabitat types approximated – zero flow when mapped. Assume all would resemble Run at high flows

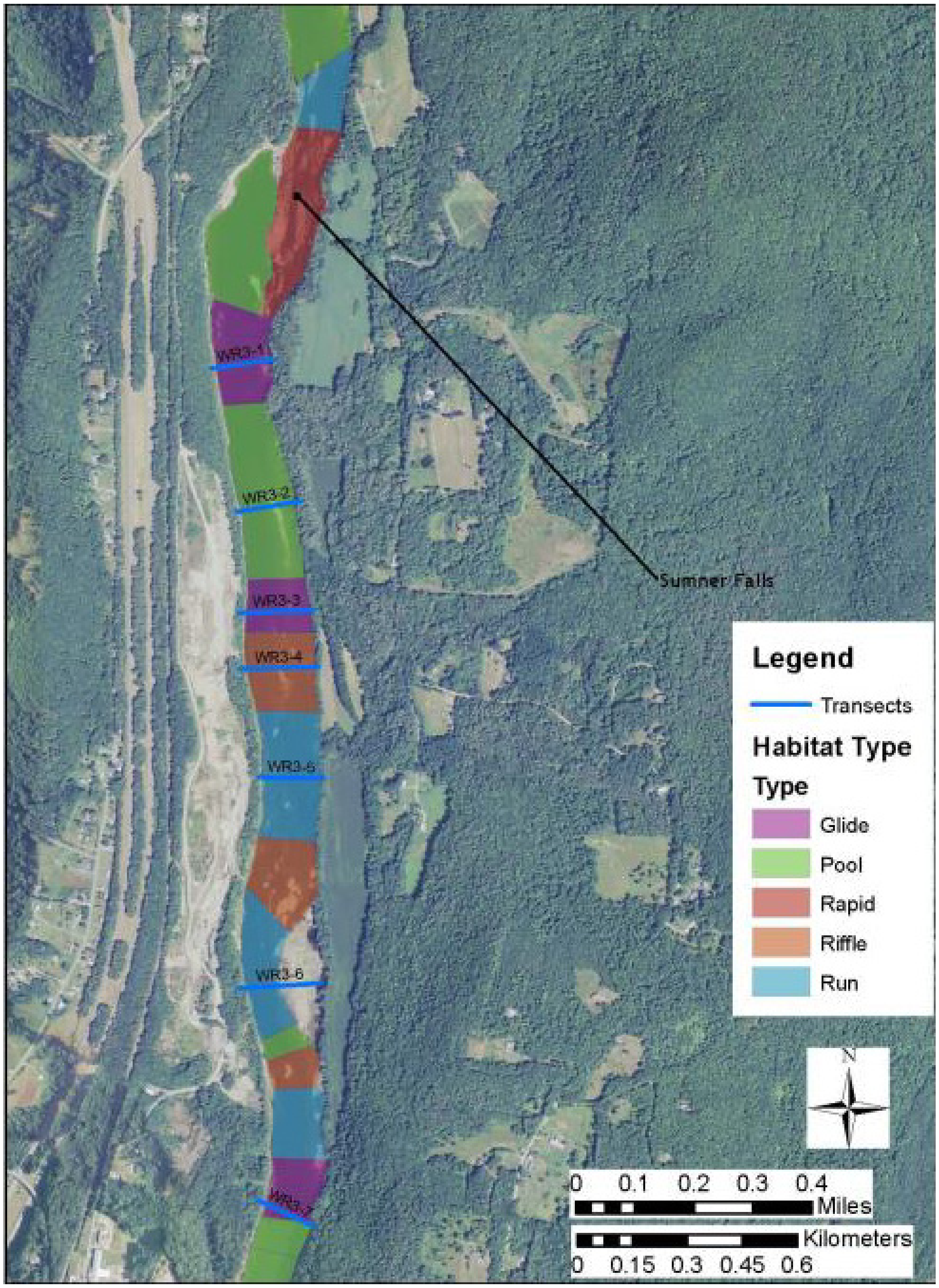

Figure 4-4. Mesohabitat types and proposed transect locations in upper portion of Wilder reach 3 – Ottauquechee River to Chase Island.

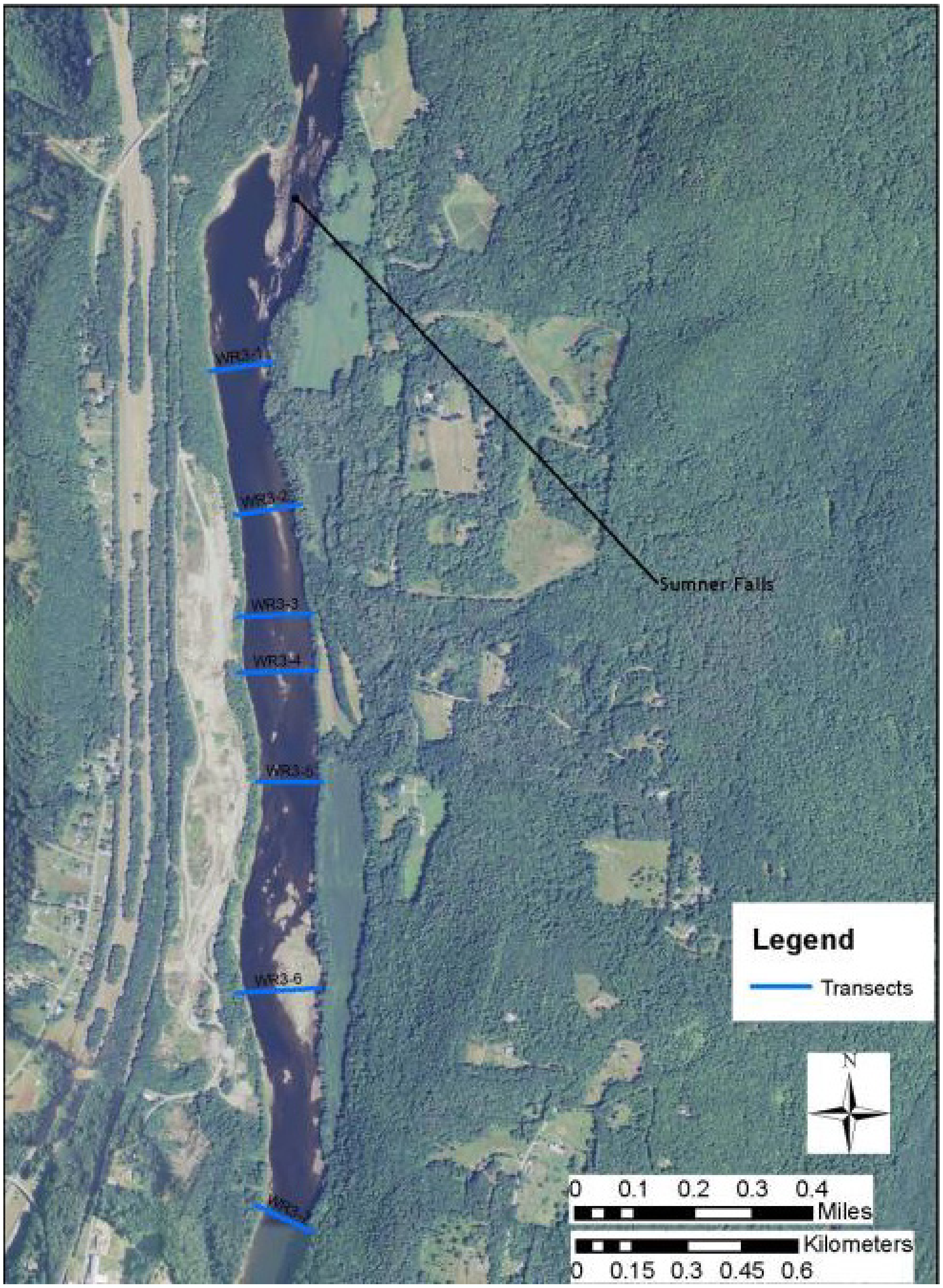

Figure 4-4a. Proposed transect locations in upper portion of Wilder reach 3 – Ottauquechee River to Chase Island.

A second randomly chosen riffle at the downstream end of Hart Island established a second study site (Table 4-6, Figures 4-5 and 4-5a). Six main channel transects and 2 to 3 side channel transects are proposed for this site. Main channel transects include 2 pools , 2 glides and 2 riffles. The entrance to the right channel of Hart Island consists of a gravel bar which restricts flow into the channel under low flow conditions. For the side channel we propose to place a transect at the entrance to establish a stage discharge rating curve for verification of flow levels at which the channel begins to fill. Two other transects will allow modeling depths and velocities in the side channel. It should be noted that since there was no flow in the channel at the time of mapping, habitat types listed for the side channel were based on visual changes in bed profile. It is assumed that the functional mesohabitat type at higher flow levels would resemble run.

A third study site was established in the approximately 1.5 mile river section from the Cornish Covered Bridge to just below Chase Island spans the transition from the free-flowing reach to the uppermost Bellows Falls impoundment. This study site includes the only riffle identified in the lower 4 miles of the reach and contains an historic dwarf wedgemussel monitoring site below Cornish Covered Bridge, though no dwarf wedgemussels were found there in 2013 surveys (Biodrawversity and LBG, 2014). However, surveys did find dwarf wedgemussel at the downstream end of Chase Island (Bellows 62 sample site identified in Figures 4-6 and 4-6a) along with four other mussel species, triangle floater, creeper, eastern elliptio and eastern lampmussel. The two most common mussels, eastern elliptio and eastern lampmussel were found at five sites identified as free-flowing (Figures 4-6 and 4-6a). In addition, tessellated darter, the host fish species for the dwarf wedgemussel, were observed at two mussel survey sites.

Though 1D transects could be used to model mesohabitat types and mussel habitat at this site, a 2D model is proposed, that in conjunction with Study 24 (Dwarf Wedgemussel and Co-Occurring Mussel Study) Phase 2 quantitative sampling, will assess changes in mussel habitat suitability/availability over a range of flows with known mussel distribution and density. This study location will be used to address stakeholder requests for an assessment of potential project effects of flow regime on dwarf wedgemussel and co-occurring mussel populations.

The addition of the 2D site effectively adds 3 pools (2 deep, 1 shallow), 2 runs, 1 glide and 1 riffle to the sample and results in 22 habitat units (equivalent to transects) selected for modeling (Table 4-5a) . The sample accounts for 23 percent of all pool habitat units, 35 percent of glides, 63 percent of runs and 50 percent of riffles. An attempt was made to capture various substrate combinations and dominant substrate types for each mesohabitat type sampled by transects or 2D, while at the same time keeping transects clustered within study sites. The exception was a single glide with substrate identified as sand/gravel (Unit # 42). This unit is not near any proposed study site (approximately one mile downstream of the bottom of reach 2 and one mile upstream of Sumner Falls). In addition, other glide units represented by transects or part of the 2D site, regardless of overall dominant substrate, will likely contain areas with sand and gravel combinations.

Table 4-5a. Mesohabitat types, number of habitat units represented by transects or 2D site and percent of habitat types sampled in reach 3 of the Wilder project riverine segment.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Habitat Units	Percent of Habitat Type
All Pools	26	29,918	51.7	6	23
Deep Pool (>15')	*6*	*8,896*	*15.4*	*2*	*33*
Shallow Pool	*20*	*21,022*	*36.3*	*4*	*20*
Glide	20	17,647	30.5	7	35
Run	8	5,703	9.8	5	63
Riffle	8	3,349	5.8	4	50
Rapid	1	1,284	2.2	0	0
Cascade	0	0	0	0	0
Totals	63	57,902	100.0	22	----

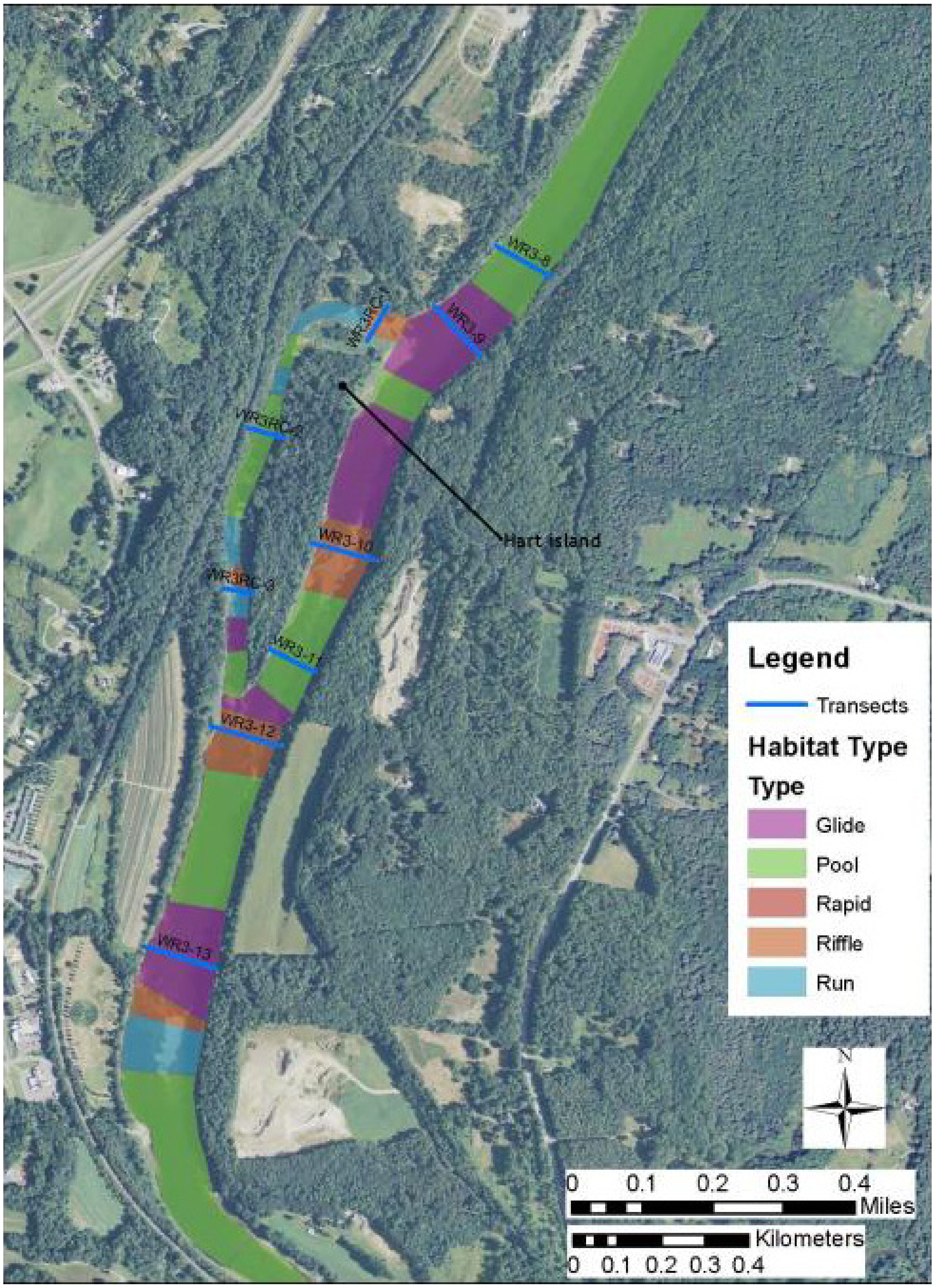

Figure 4-5. Mesohabitat types and proposed transect locations near Hart Island in the middle portion of Wilder reach 3 – Ottauquechee River to Chase Island.

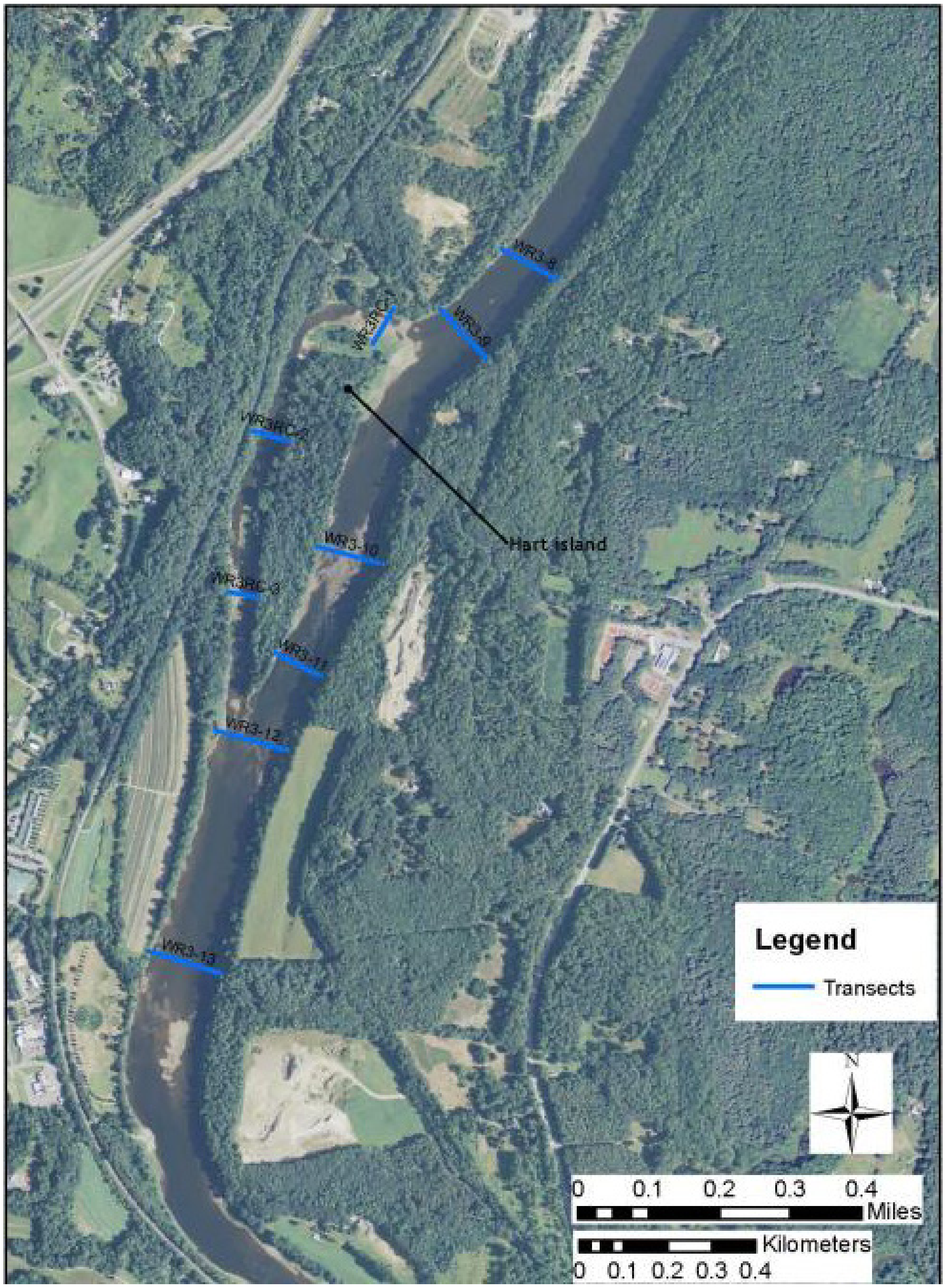

Figure 4-5a. Proposed transect locations near Hart Island in the middle portion of Wilder reach 3 – Ottauquechee River to Chase Island.

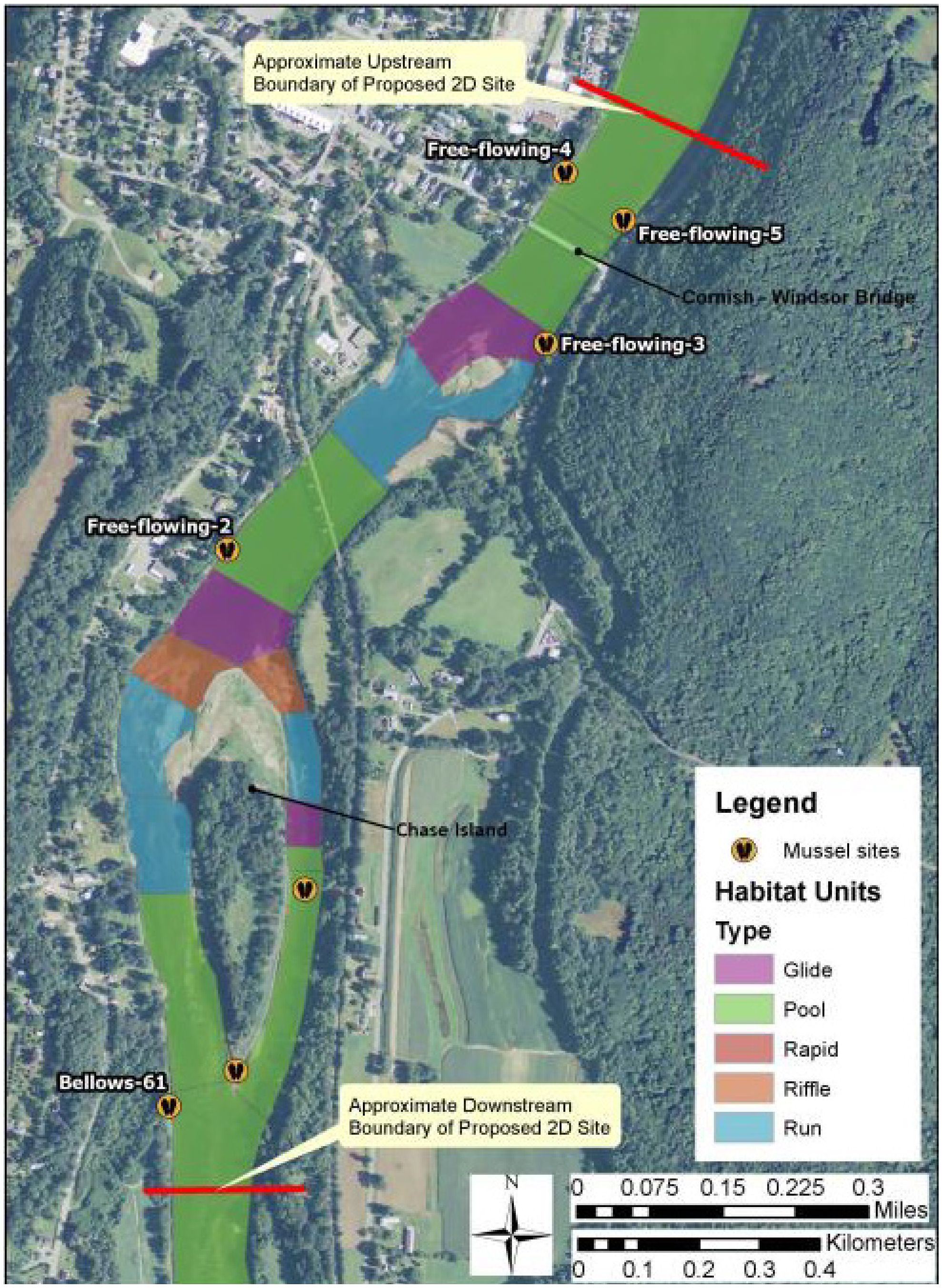

Figure 4-6. Mesohabitat types in proposed 2D model study site in the lower portion of Wilder reach 3 – Ottauquechee River to Chase Island.

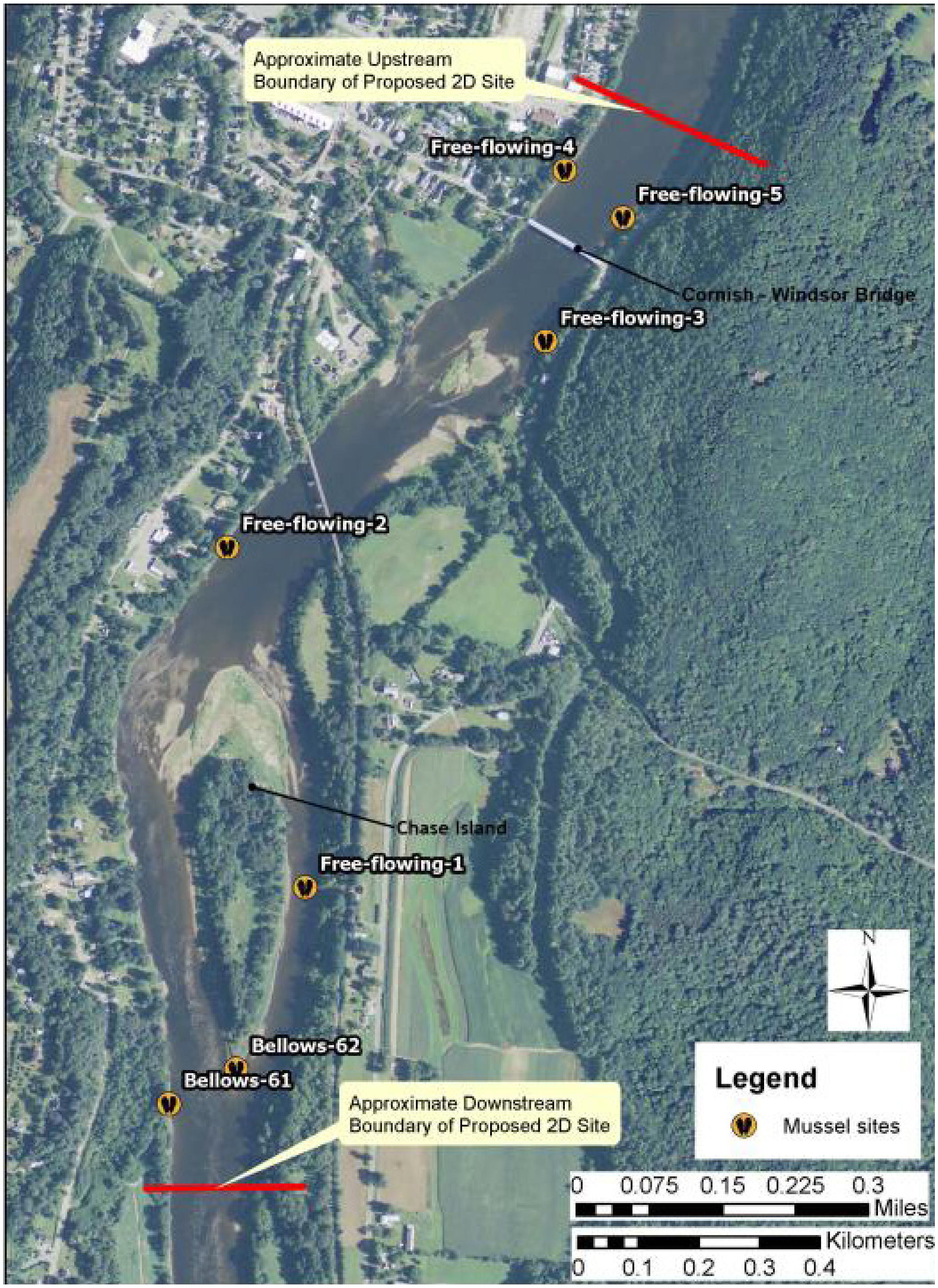

Figure 4-6a. Proposed 2D model study site in the lower portion of Wilder reach 3 – Ottauquechee River to Chase Island.

Overall 37 transects and two 2D sites are proposed in the Wilder riverine segment (Table 4-7). Seventy four percent of run habitat units, 67 percent of riffle units, 35 percent of pool units and 48 percent of glide habitat units are represented by transects or 2D model sites (Table 4-7a). This provides a thorough representation of available meso- and micro-habitat for all target species in the Wilder riverine segment.

Table 4-7. Total number of mesohabitat types, total number of proposed transects, and percent representation for the entire Wilder riverine segment, reaches 1, 2 and 3.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Transects Proposed	Percent per Transect
All Pools	43	51,642	55.5	12	4.6
Deep Pool (>15′)	*16*	*23,382*	*25.1*	*7*	*3.6*
Shallow Pool	*27*	*28,260*	*30.4*	*5*	*6.1*
Glide	25	21,782	23.4	10	2.3
Run	20	13,681	14.7	10	1.5
Riffle	12	4,623	5.0	5	1.0
Rapid	1	1,284	1.4	0	0.0
Cascade	0	0	0	0	0.0
Totals	100	93,012	100.0	37	----

Table 4-7a. Mesohabitat types, number of habitat units represented by transects or 2D site and percent of habitat types sampled in the entire Wilder riverine segment, reaches 1, 2 and 3.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Habitat Units	Percent of Habitat Type
All Pools	43	51,642	55.5	15	35
Deep Pool (>15′)	*16*	*23,382*	*25.1*	*8*	*56*
Shallow Pool	*27*	*28,260*	*30.4*	*7*	*22*
Glide	25	21,782	23.4	12	48
Run	20	13,681	14.7	14	74
Riffle	12	4,623	5.0	8	67
Rapid	1	1,284	1.4	0	0
Cascade	0	0	0	0	0
Totals	100	93,012	100.0	49	----

4.4 Bellows Falls Reach

Pools make up 59 percent of the Bellows Falls reach (deep pool accounts 22 percent of this total); followed by glide at 24 percent, run at 15 percent and riffle at 2 percent (Table 4-8). A single riffle was identified in the Bellows Falls reach just downstream of Saxtons River. Because this was the only riffle in the reach, two transects are proposed to represent this habitat unit. The majority of transects proposed are in the upper part of this reach since most glide and run habitat occurs there (Table 4-9, Figures 4-7 and 4-7a). A total of 19 transects; 2 deep pools, 4 shallow pools, 7 glides, 4 runs and 2 riffles are proposed for this reach.

Table 4-8. Mesohabitat types, proposed number of transects, and percent representation in the Bellows Falls reach.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Transects Proposed	Percent per Transect
All Pools	13	17,250	58.8	6	9.8
Deep Pool (>15')	*4*	*6,559*	*22.4*	*2*	*11.2*
Shallow Pool	*9*	*10,691*	*36.4*	*4*	*9.1*
Glide	9	7,134	24.3	7	3.5
Run	5	4,448	15.2	4	3.8
Riffle	1	509	1.7	2	0.9
Rapid	0	0	0	0	0.0
Cascade	0	0	0	0	0.0
Totals	28	29,341	100.0	19	----

The proposed transects capture the variability in depths and substrate that are found in the reach and encompass the habitat used by the various aquatic species and life stages identified in the study plan. In particular the group of shallow riffle, glide and run transects below the dam will capture known walleye spawning areas and potential American shad spawning habitat. The downstream most deep pool transect was selected in order to incorporate a small side channel just upstream of the Walpole Bridge (Figures 4-8 and 4-8a). This channel was noted as being dry during habitat mapping at a discharge of 3,500 cfs from Bellows Falls. No transects are proposed downstream to the Walpole Bridge due to potential backwater effects from the Vernon impoundment.

Table 4-9. Mesohabitat types identified through habitat mapping in the Bellows Falls reach and representative transect ID.

Unit #[a]	Habitat Type[b]	Length (ft)	Max Depth (ft)	Avg. Depth (ft)	Substrate[c]	Note	Transect ID
1	Deep Pool	975	36.7	13.3	CB/GR	Below Dam	BF1
2	Glide	1392	20.3	5.4	GR/CB		BF2/3
3	Run	513	13.0	7.2	CB/BD	Saxtons River	BF4
4	Glide	228	6.9	4.9	CB/GR		BF5

Unit #[a]	Habitat Type[b]	Length (ft)	Max Depth (ft)	Avg. Depth (ft)	Substrate[c]	Note	Transect ID
5	Riffle	509	4.9	2.7	CB/GR		BF6/7
6	Run	1536	9.9	4.8	CB		BF8
7	Run	904	7.1	6.1	CB	Cold River	BF9
8	Pool	484	9.8	6.0	CB		BF10
9	Glide	848	5.0	3.4	CB		BF11
10	Run	919	8.0	5.5	CB/GR		BF12
11	Pool	1003	9.4	5.6	GR/SA		BF13
12	Glide	1374	7.3	4.5	GR/CB		BF14
13	Deep Pool	2793	29.6	8.9	GR/SA		
14	Pool	587	11.4	6.9	GR/SA		BF15
15	Glide	200	4.5	4.3	GR/SA		BF16
16	Run	576	5.0	3.2	CB/GR		
17	Pool	1942	13.8	6.3	GR/SA		BF17
18	Glide	719	8.9	5.2	GR/CB		BF18
19	Deep Pool	2414	16.7	9.9	CB/GR		BF19
19.1	SC Run	370	-----	-----	SA/GR	Side Channel	BF19-SC
20	Deep Pool	376	49.8	24.7	-----	Walpole Bridge	
21	LC Pool	886	9.8	6.4	GR/SA	Island	
21.1	RC Run	161	3.2	-----	GR/SA		
21.2	RC Pool	213	5.5	-----	GR/SA		
21.3	RC Glide	550	2.3	-----	GR/SA		
22	Glide	481	5.4	3.1	GR/SA		
23	Glide	699	5.2	3.7	GR/CB		
24	Pool	860	8.4	4.2	GR/SA		
25	Pool	2995	8.8	6.1	GR/CB		
26	Pool	820	8.7	5.4	GR/SA		
27	LC Pool	1192	5.0	3.1	GR/SA	Dunshee Island	
28	LC Pool	1114	8.9	5.9	-----		
28.1	RC Pool	1613	7.3	5.1	GR/SA		
28.2	RC Pool	702	8.2	6.5	SA/GR	End of Reach	

a Split and side channel Unit #'s are based on association with the primary channel habitat type
b RC = Right Channel, LC = Left Channel, SC = Side Channel
c ST = Silt, SA = Sand, GR = Gravel, CB = Cobble, BD = Boulder, BR = Bedrock

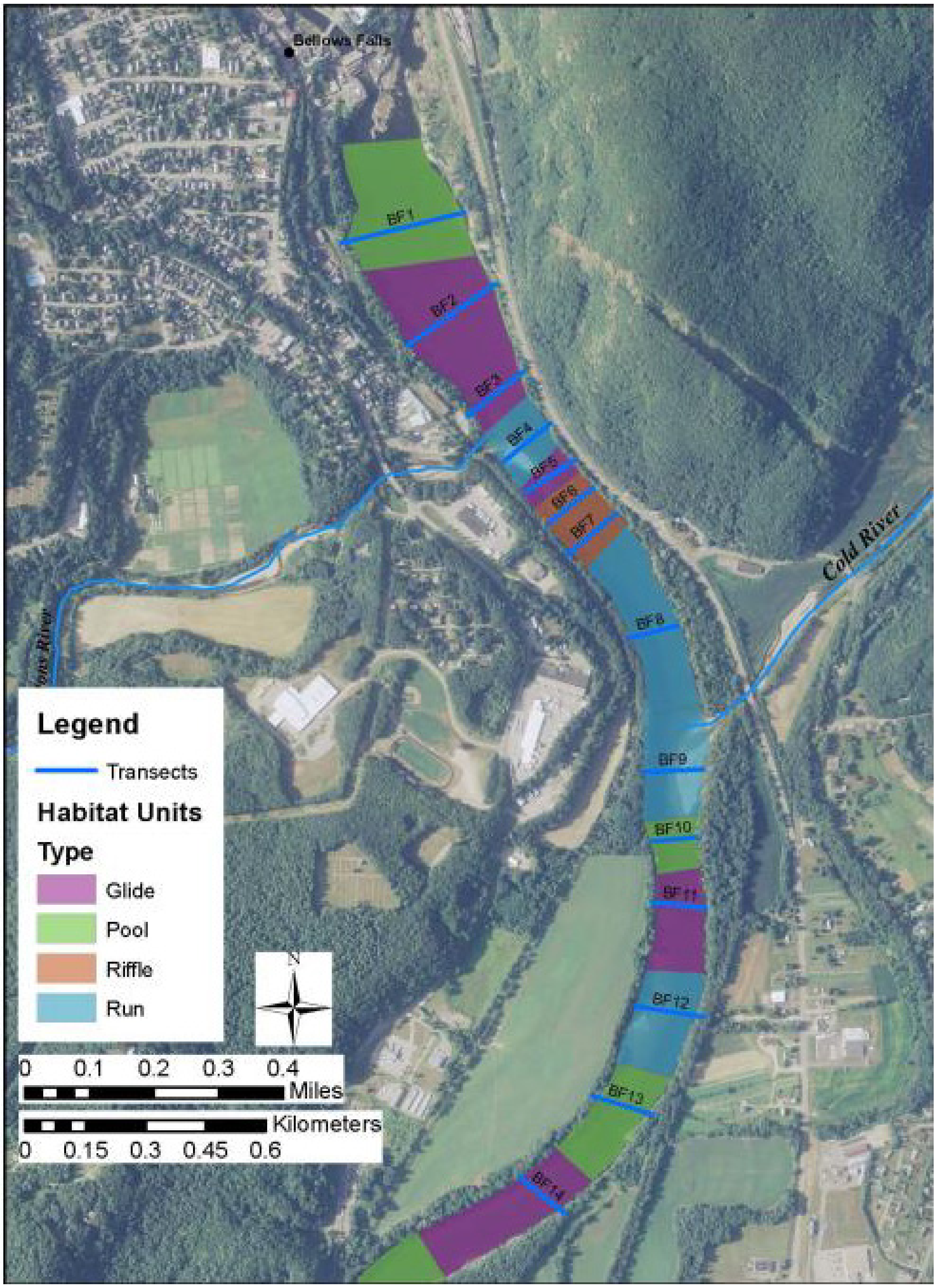

Figure 4-7. Mesohabitat types and proposed transect locations in the upper portion of the Bellows Falls reach.

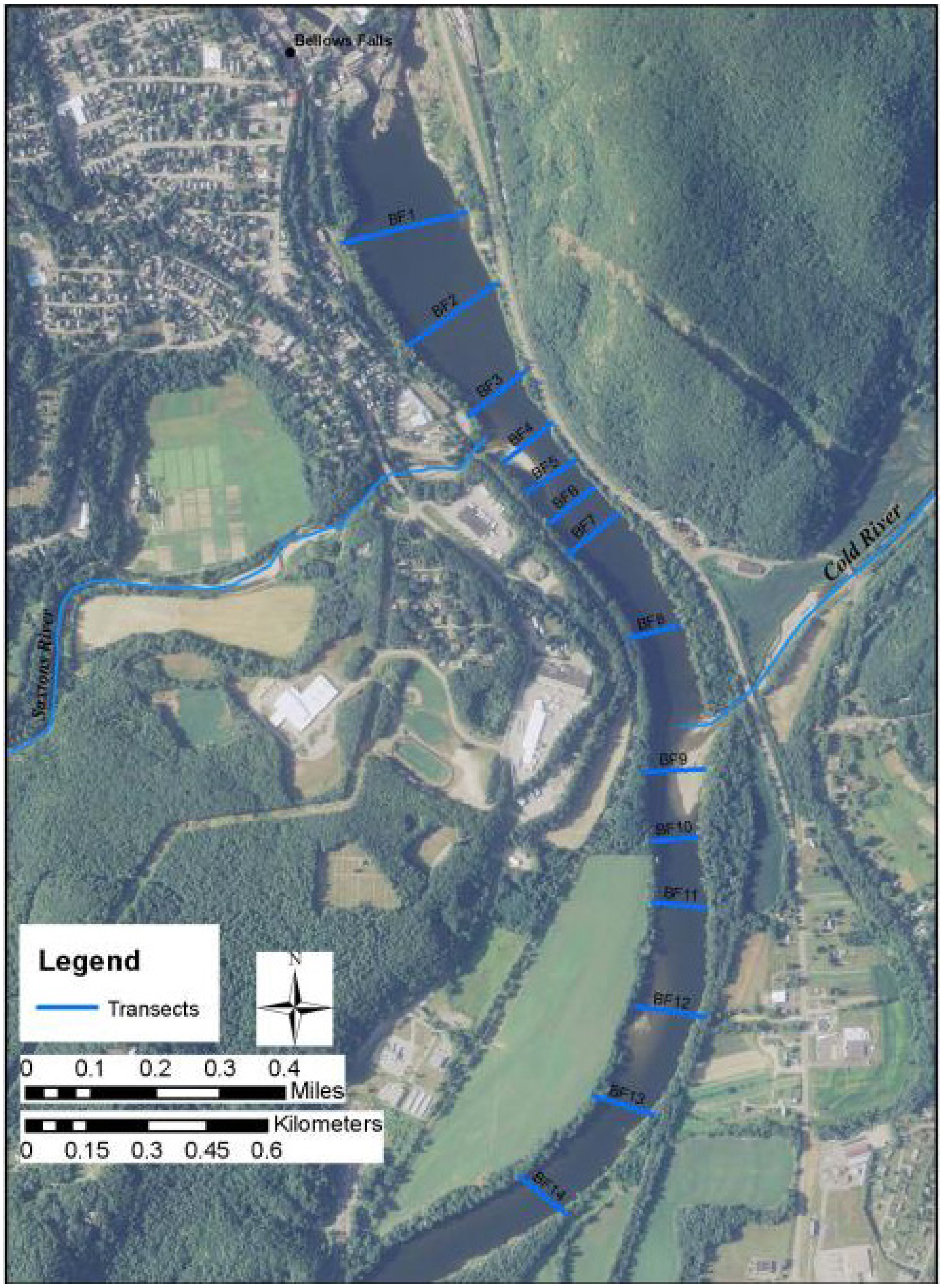

Figure 4-7a. Proposed transect locations in the upper portion of the Bellows Falls reach.

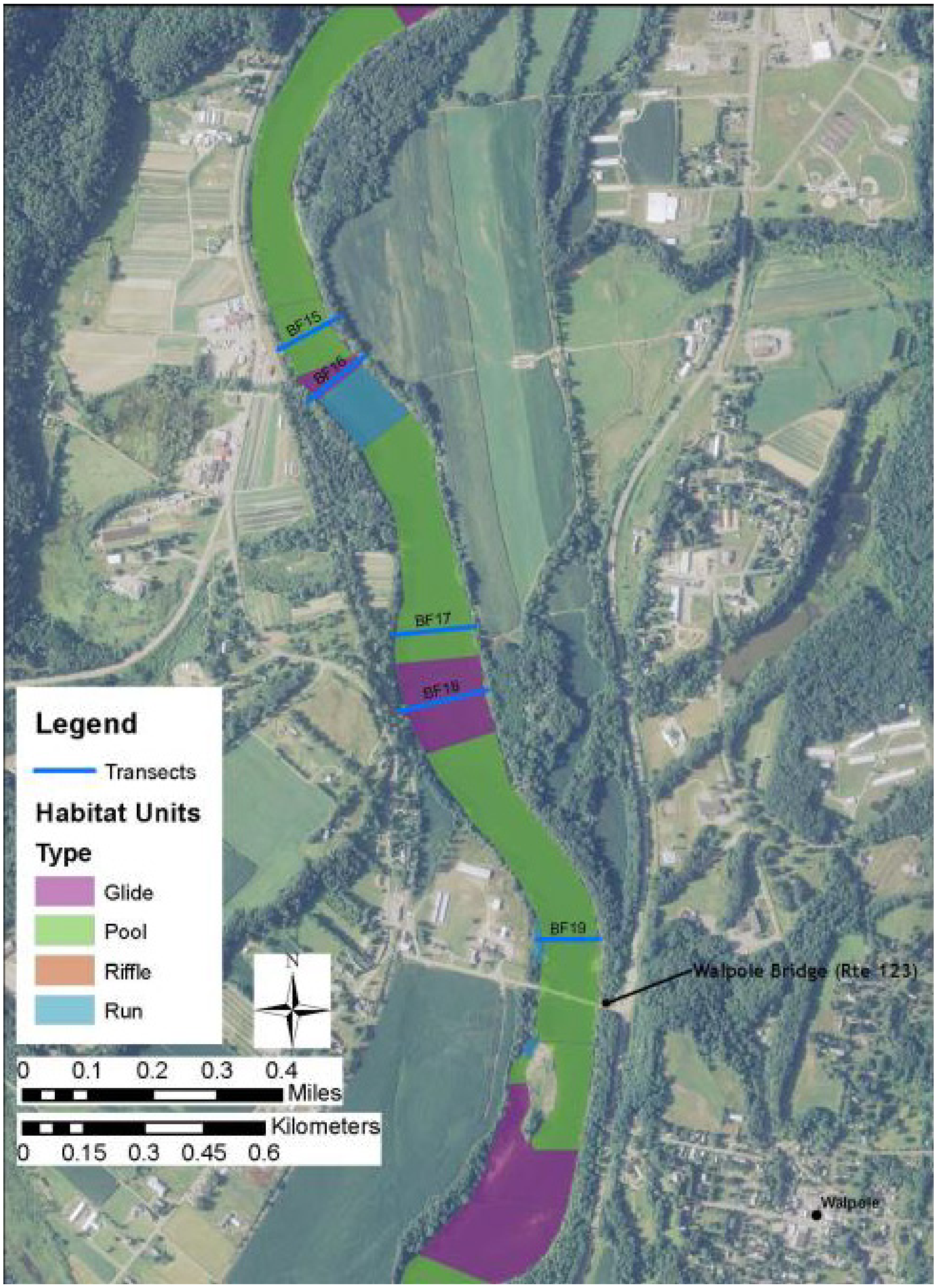

Figure 4-8. Mesohabitat types and proposed transect locations in the lower portion of the Bellows Falls reach.

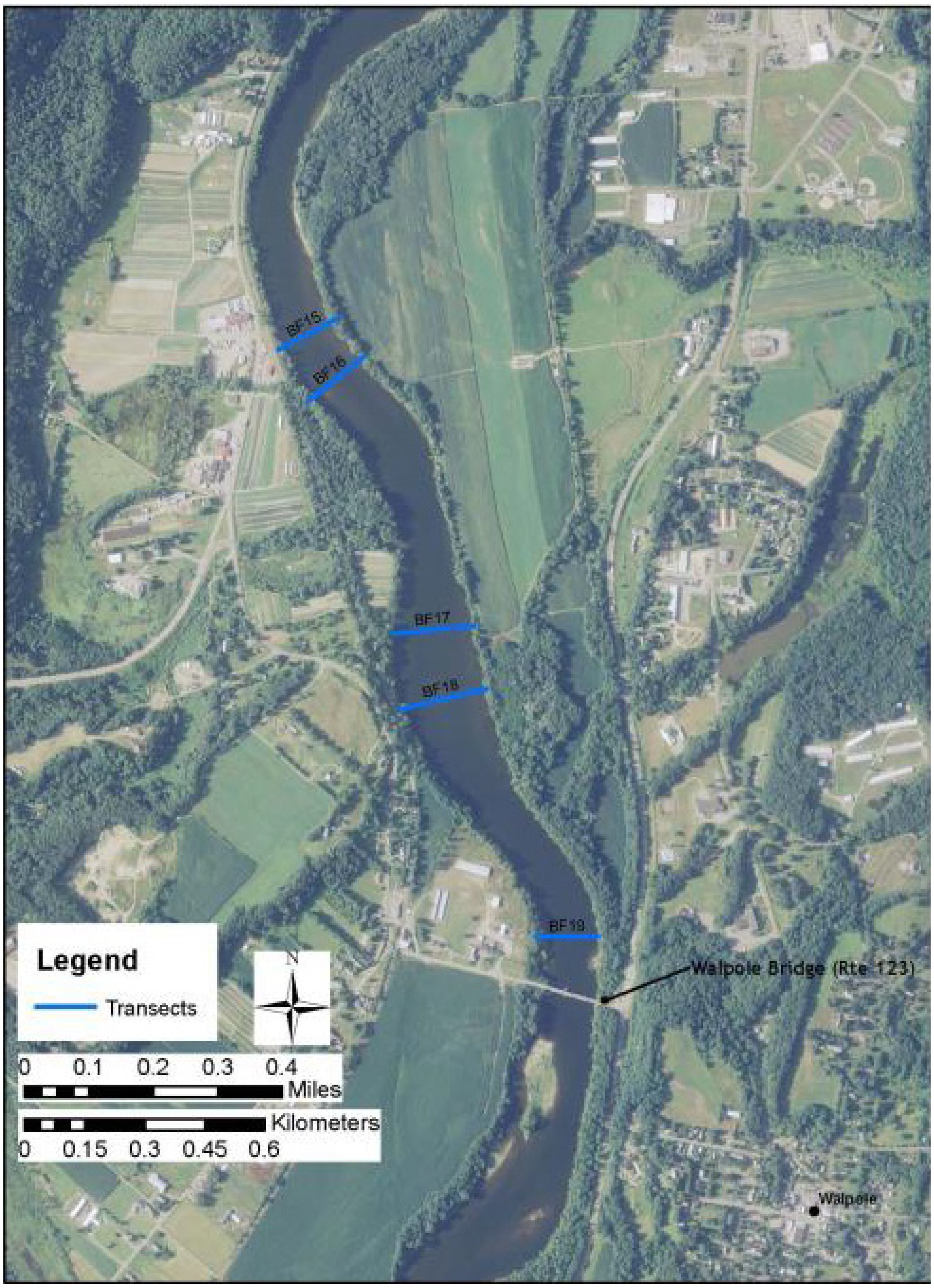

Figure 4-8a. Proposed transect locations in the lower portion of the Bellows Falls reach.

4.5 Bellows Falls Bypassed Reach

Overall, pool makes up 73 percent of the Bellows Falls bypassed reach, run accounts for 16 percent, and riffle for 8.5 percent (Table 4-10). The bypassed reach consists of two distinct sections, one from the dam downstream to a fish barrier and a second from the bedrock cascade below the fish barrier to the large pool downstream of the powerhouse (Figure 4-9).

Immediately below the dam the channel is over 400 feet wide and consists of a large pool with some backwater areas (Figure 4-10). Downstream are a series of narrow runs and riffles (less than 100 feet wide) which terminate at the top of a large pool immediately upstream of the fish barrier. Substrate is primarily bedrock and boulder with some large cobble distributed in the riffle and run portion. Gradient in this section is approximately 1.5 percent. From the top of the fish barrier to the base of the cascade is a drop of approximately 15 feet. Below this is pool for approximately 1,250 feet, before entering a backwater pool below the powerhouse. Substrate in this section consists primarily of bedrock and large boulders. Gradient, not including the cascade is <0.5 percent.

Table 4-10. Summary of mesohabitat types and percentages in the Bellows Falls bypassed reach.

Habitat Type	Number of Units	Length (ft)	Percent by Length
Pools[a]	8	2,824	72.6
Deep Pool (>15')	----	----	----
Shallow Pool	----	----	----
Glide	0	0	0
Run	4	638	16.4
Riffle	3	332	8.5
Rapid	0	0	0.0
Cascade	1	98	2.5
Totals	16	3,892	100.0

a No depths taken in Bellows Falls bypassed reach

Initially, based on apparent substrate and hydraulic complexity it was thought a 2D model may be appropriate to model aquatic habitat in this reach. However, after examination of the reach during habitat mapping it was determined it is unlikely that all hydraulic features such as boulder and bedrock eddies or substrate interstices could be effectively captured, especially in the upper portion of the reach.

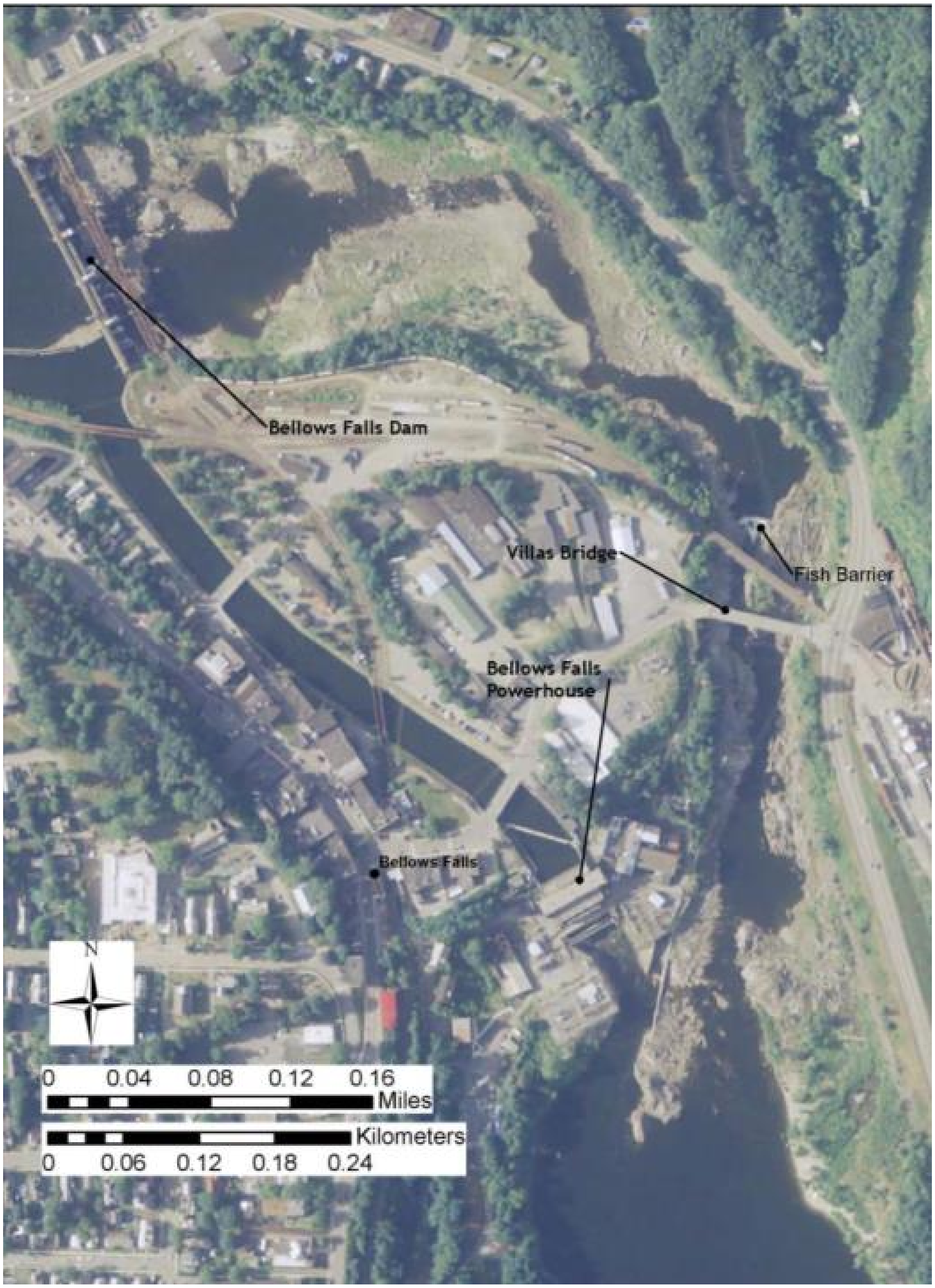

Figure 4-9. Bellows Falls bypassed reach.

Though a 2D model would probably yield adequate results, the usefulness would be questionable here because; 1) aquatic habitat in the upper portion of the reach does not appear suitable for most species and life stages under study and; 2) passage upstream of the cascade section of the falls is unlikely for most species being evaluated, with the exception of sea lamprey. However, even if sea lamprey were to access this upper section, there is no suitable sized spawning gravel or preferred sand and silt rearing habitat for ammocetes. In addition, with easy access to a ladder near the powerhouse, it is doubtful any fish would attempt to access the upper part of the bypassed reach. Aquatic habitat in the lower part of the reach may be conducive to walleye and American shad spawning and possibly smallmouth bass rearing and this section could be effectively modeled with 1D transects (Figure 4.-11).

An additional issue with the lower section of the reach is the possibility of a backwater effect, dependent on discharge from the powerhouse and flow in the bypassed reach. At what flow levels this could occur is unknown at this time, though it was noted during habitat mapping that there was no effect with 400 cfs in the bypassed channel and approximately 7,000 cfs being released from the powerhouse.

Ultimately the approach to aquatic habitat evaluation of flows in this reach will need to be determined through a site visit and consultation with the aquatics working group as part of the instream flow study.

Figure 4-10. Upper portion of the Bellows Falls bypassed reach looking downstream.

Figure 4-11. Lower portion of the Bellows Falls bypassed reach looking downstream from Villas Bridge.

4.6 Vernon Reach

Overall pools account for 40 percent of the reach followed by run at 35 percent and glide at 25 percent (Table 4-11). No riffles were identified and a large portion of the reach consists of a side channel (1,700 feet long near the top of the reach) and split channel (3,700 feet of island that makes up the lower half of the reach). Due to the limited number of habitat units and shortness of the reach it is proposed that transects be placed to represent all main channel mesohabitat units and most associated split and side channel habitat (Table 4-12, Figures 4-12 and 4-12a).

Table 4-11. Proposed number of transects and percent representation of mesohabitat types in the Vernon reach.

Habitat Type	Number of Units	Length (ft)	Percent by Length	Number of Transects Proposed	Percent per Transect
All Pools	3	2,631	39.5	3	13.2
Deep Pool (>15')	*2*	*1,653*	*24.8*	*2*	*12.4*
Shallow Pool	*1*	*978*	*14.7*	*1*	*14.7*
Glide	3	1,701	25.6	3	8.5
Run	4	2,325	34.9	4	8.7
Riffle	0	0	0	0	0
Rapid	0	0	0	0	0.0
Cascade	0	0	0	0	0.0
Totals	10	6,657	100.0	10	----

The large eddy pool downstream of Vernon dam is not included in the sample and no transects are proposed for this particular unit (Figure 4-12). Velocity patterns created by project operations would be difficult to measure or model over a range of flows due to: 1) different combinations of the 10 turbine units in operation would create different velocity magnitude and patterns; 2) release from turbines creates up-wellings which may further complicate velocity modeling; and 3) fully half the pool on the east side is not affected by normal project operations but would be by spill.

Table 4-12. Mesohabitat types identified through habitat mapping in the Vernon reach and representative transect ID.

Unit #	Habitat Type[a]	Length (ft)	Max Depth (ft)	Avg. Depth (ft)	Substrate[b]	Note	Transect ID
1.1	SC Pool	370	-----	-----	GR/CB	SC at top of reach[c]	VRSC1
1.2	SC Run/Riffle	354	-----	-----	CB/GR	Mapped at low flow	
1.3	SC Run	193	-----	-----	CB/GR	Channel all Run	VRSC2
1.4	SC Riffle	71	-----	-----	CB/GR	at Higher Flows	
1.5	SC Pool	720	9.2	6.6	SA/BR		VRSC3
1.6	Pool Below Dam	-----	-----	-----	-----	Start at Control	
1	Run	493	21.2	5.7	CB/GR		VR1
2	Run	468	15.6	9.6	CB/GR		VR2
3	Deep Pool	1147	44.9	19.6	SA		VR3
4	Deep Pool	506	38.5	23.3	SA		VR4
5	Glide	354	11.4	9.1	CB		VR5
6	LC Run	693	10.2	7.7	GR/CB	Stebbins Island LC	VR6
7	LC Glide	713	6.8	6.1	GR/SA		VR7
8	LC Run	671	14.2	7.5	-----		VR8
9	LC Glide	634	7.7	5.6	GR/SA		VR9
10	LC Pool	978	11.8	7.7	GR/SA		VR10
6.1	RC Pool	276	15.5	13.1	-----	Stebbins Island RC	
6.2	RC Run	382	-----	-----	CB/GR		VR6RC
7.1	RC Pool	1476	27.2	14.0	SA		VR7RC
8.1	RC Run	563	7.7	5.5	CB/GR		VR8RC
10.1	RC Pool	742	6.2	4.5	-----		VR10RC

a RC = Right Channel, LC = Left Channel, SC = Side Channel
b ST = Silt, SA = Sand, GR = Gravel, CB = Cobble, BD = Boulder, BR = Bedrock
c The side channels mesohabitat units are based on approximations at zero flow. Channel appeared to be all run at higher flow.

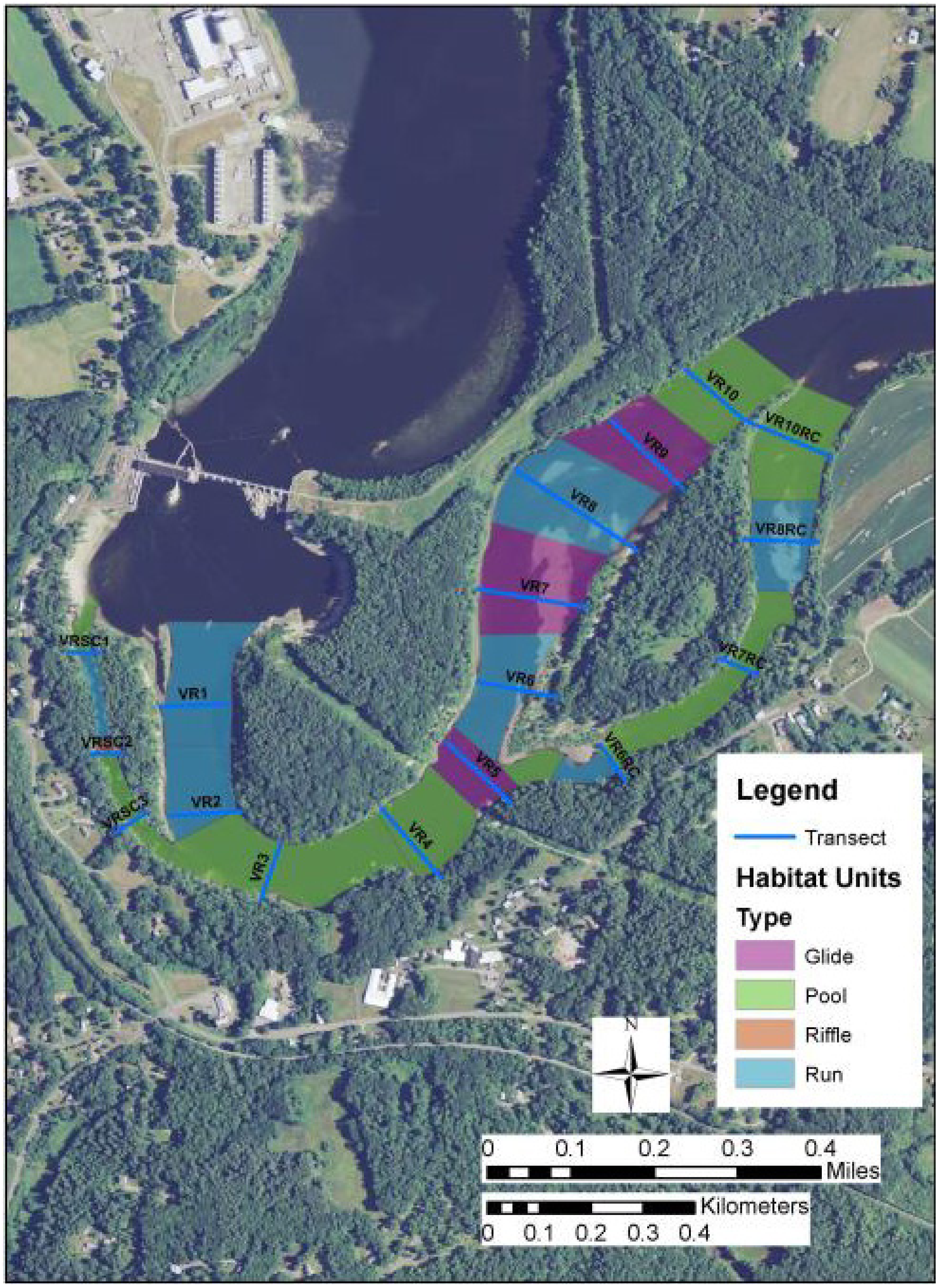

Figure 4-12. Mesohabitat types and proposed transect locations in the Vernon reach.

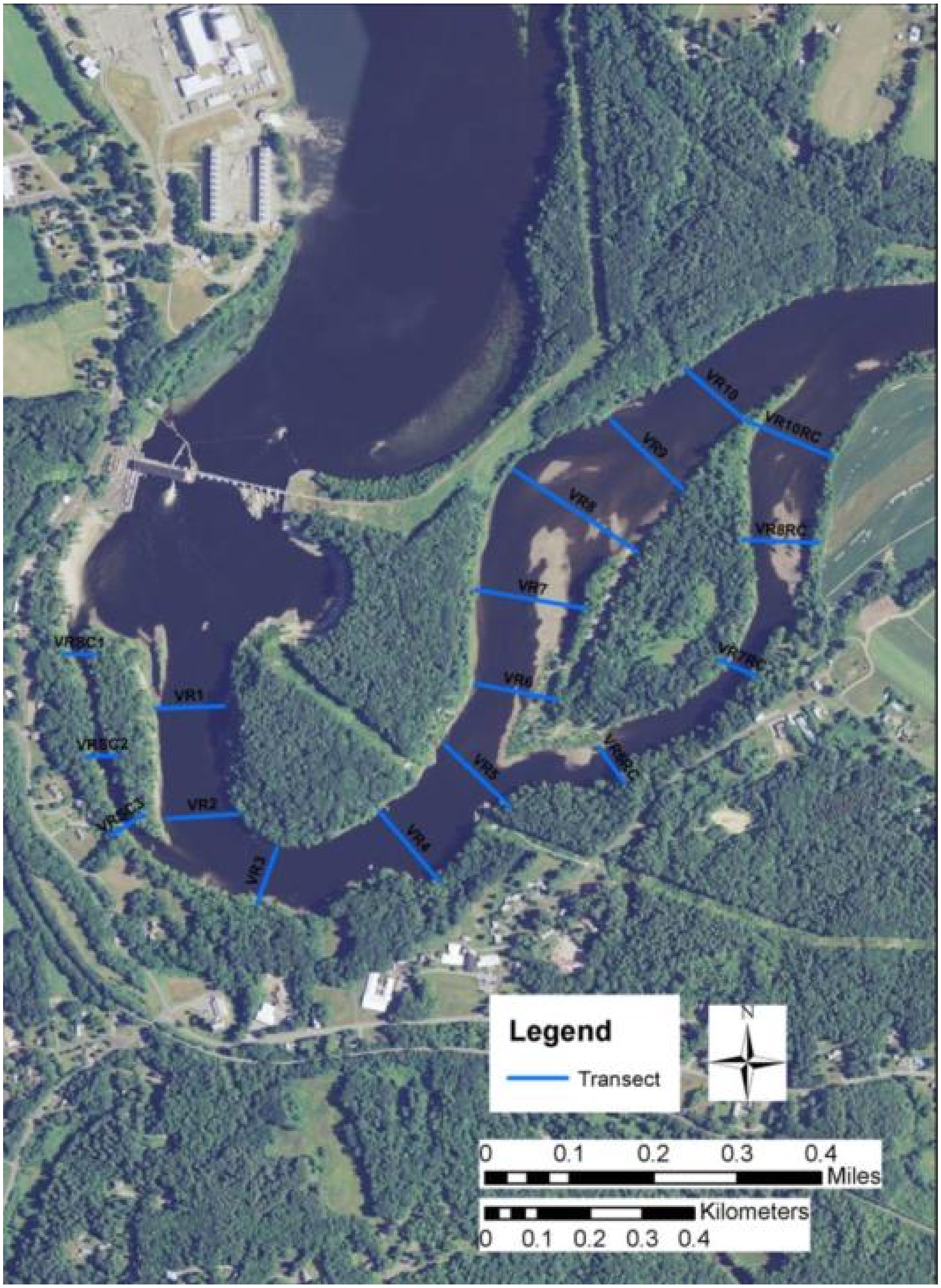

Figure 4-12a. Proposed transect locations in the Vernon reach.

5. DISCUSSION

The goal of the instream flow study is to obtain a reliable aquatic habitat index for target species and life stages over a range of flows. Ultimately this information will be applied to hydrology time series from the Operations Model (Study 5) to assess the effects of various project operations on aquatic habitat.

A sample that contains a range of all available mesohabitat types, deep and slow, shallow and slow, deep and fast, and shallow and fast will encompass all potential micro-habitat needs of the target species and life stages being evaluated in this study. Based on the representation of available habitat within study reaches and the number and type of mesohabitat units portrayed by a 2D model and 1D transects, micro-habitat needs for all proposed target species and life stages will be adequately characterized and the resulting flow habitat relationships will be robust.

A brief synopsis of life history patterns and known habitat use and data gaps of the following target fish species is provided in Appendix B:

- American shad (Alosa sapidissima)
- Walleye (Sander vitreus)
- Fallfish (Semotilus corporalis)
- Longnose dace (Rhinichthys cataractae)
- White sucker (Catostomus commersonii)
- Smallmouth bass (Micropterus dolomieu)
- Tessellated darter (Etheostoma olmstedi)
- Sea lamprey (Petromyzon marinus)
- Mussel species found in the study area
- Macroinvertebrates
- Larval fish and eggs of target species

Information related to the age and growth, timing of seasonal movements and extent of usable habitat for most of these species within project reaches has not been identified. The following studies may provide this information, but they will not be initiated until 2015 after field work for Study 9 is completed.

- Study 10 -- Fish Assemblage Study
- Study 12 -- Tessellated Darter Survey
- Study 15 -- Resident Fish Spawning in Riverine Sections Study
- Study 16 – Sea Lamprey Spawning Assessment

As a result, specific information regarding spawning, general habitat use and locations within the Project riverine reaches is lacking for some species. Walleye spawning is known to take place in tailwaters of all three projects. In addition, it is assumed that American shad spawning takes place below Bellows Falls dam and Vernon dam, though exact locations are not known. For other species, spawning and rearing habitat characteristics are known through general life history patterns.

A summary of velocity and depth combinations used by life stage for the above species is provided in Table 5-1. With the exception of deep/fast habitat, all other available habitat combinations are utilized by one or more spawning and/or rearing life stages. This table identifies preferred velocity and depth combinations, though some life stages can also utilize others. For example, adult and juvenile smallmouth bass and white sucker are often considered generalists and can occupy a wide range of habitat.

Table 5-1. Target fish species to be evaluated by the instream flow study and known general habitat use. Shallow is generally < 6 feet deep, slow <=1 ft/s.

Species	Shallow/Fast	Shallow/Slow	Deep/Fast	Deep/Slow
American shad	spawning	larvae/juvenile	spawning	juvenile
Walleye	spawning	fry/juvenile		adult
Fallfish	spawning/juvenile	spawning/fry		adult
Longnose dace	all life stages			
White sucker	spawning	fry/juvenile		adult/juvenile
Smallmouth bass		spawning/rearing		rearing
Tessellated darter	spawning	spawning/rearing		
Sea lamprey	spawning	rearing		rearing

Suitability information derived from the dwarf wedgemussel and co-occurring mussel quantitative sampling (Study 24, Phase 2) and results of 2D modeling in the lower portion of the Wilder reach 3 can be applied to 1D transects in all reaches and the 2D study site in Wilder reach 2. For example Wilder reach 1 proposed transects 1-4 overlap known mussel locations identified during 2011 surveys (Biodrawversity and The Louis Berger Group, Inc. 2012). Similarly some transects in the Bellows Falls reach and Vernon reach also overlap know mussel locations.

6. LITERATURE CITED

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Appendix A

Aquatic Mesohabitat Maps

[Maps are identical to those found in
Appendix B of ILP Study 7
Aquatic Habitat Mapping Initial Study Report]

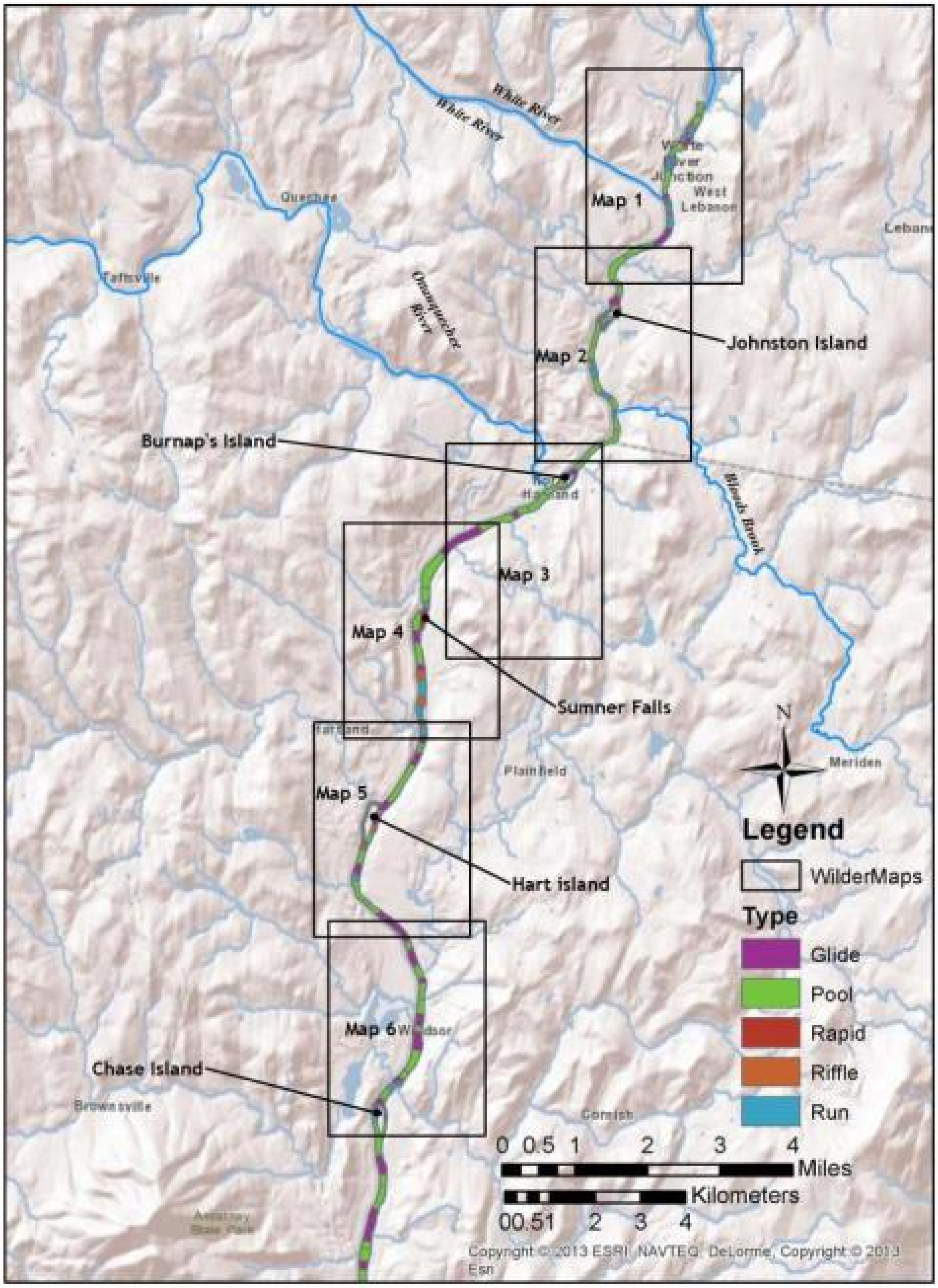

Figure A.1. Wilder riverine segment aquatic habitat mapping index.

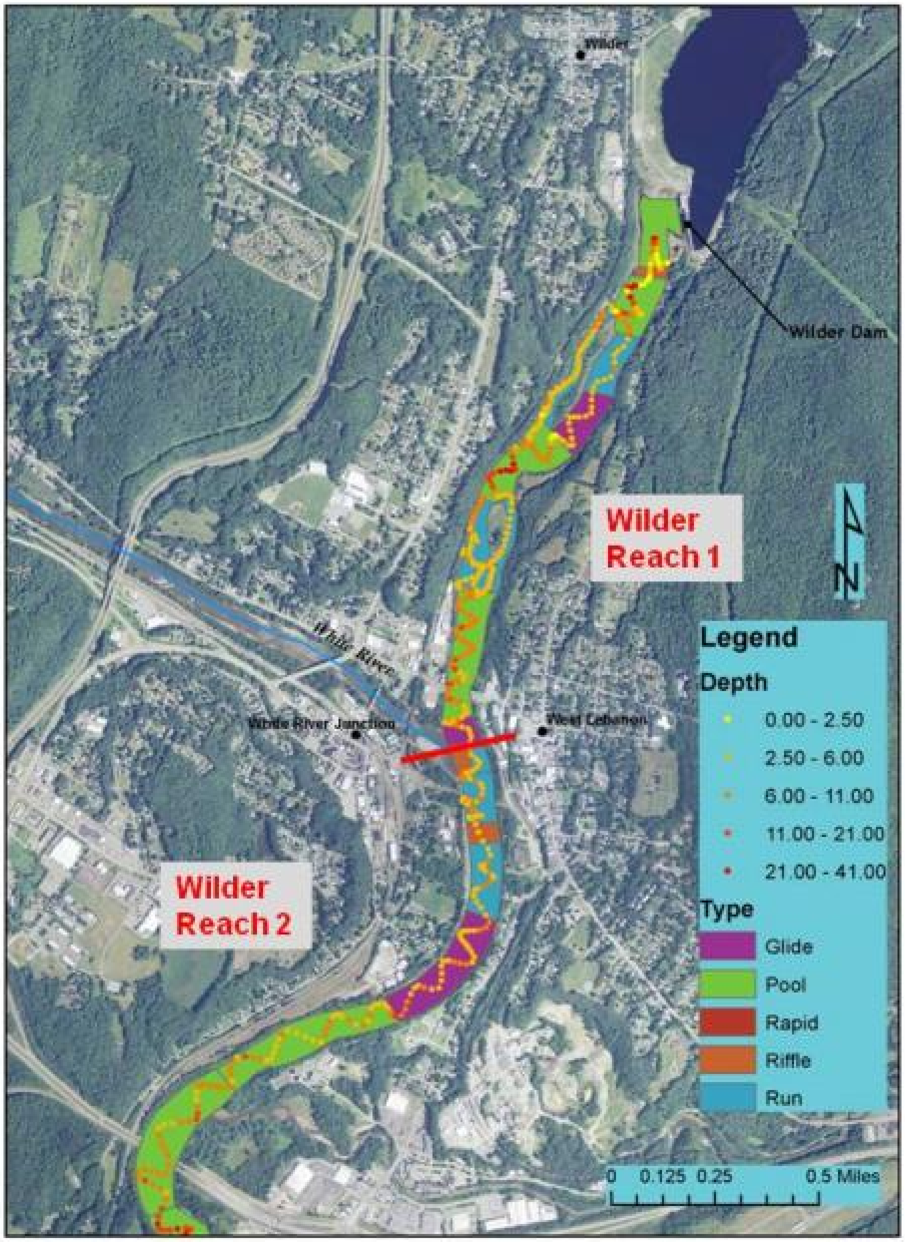

Figure A.2. Wilder Map 1, Wilder reach 1 and 2.

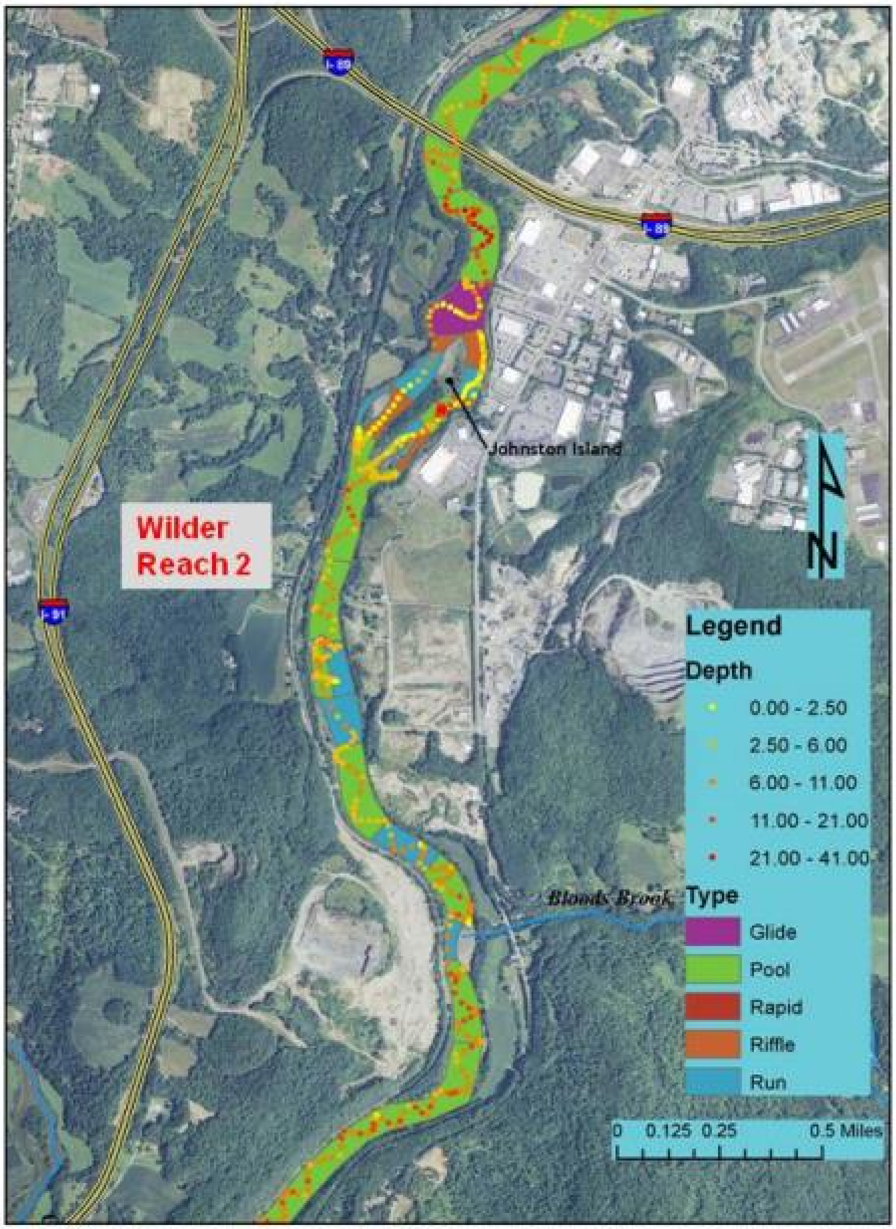

Figure A.3. Wilder Map 1, Wilder reach 2.

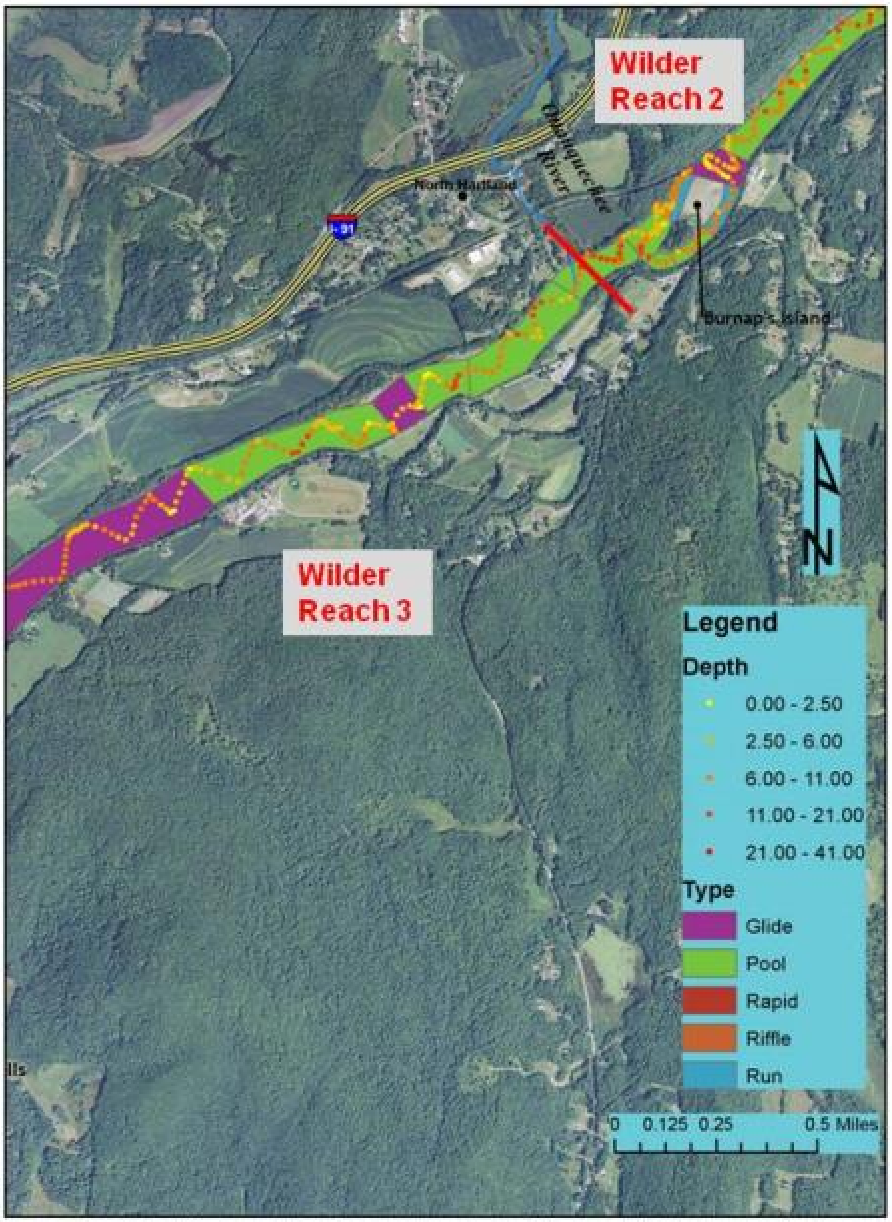

Figure A.4. Wilder Map 1, Wilder reach 2 and 3.

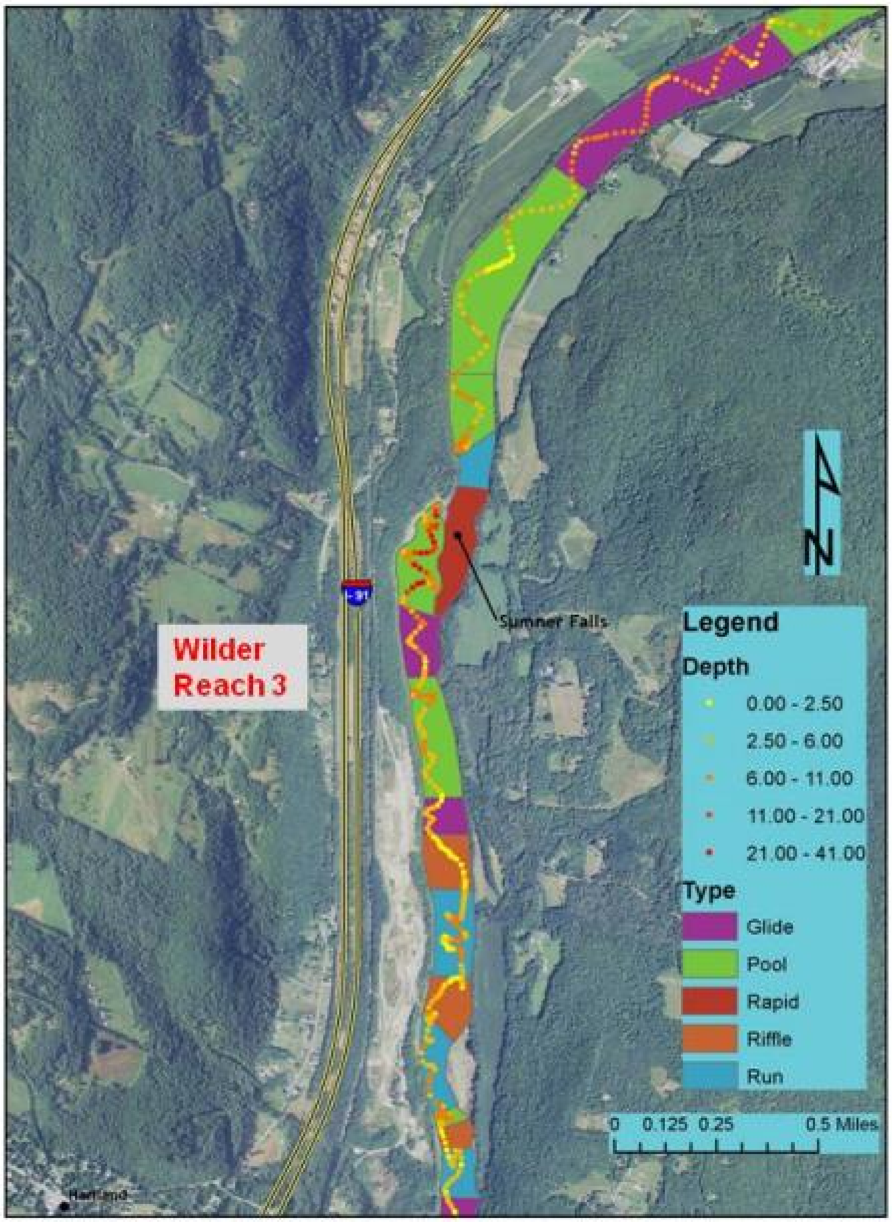

Figure A.5. Wilder Map 1, Wilder reach 3.

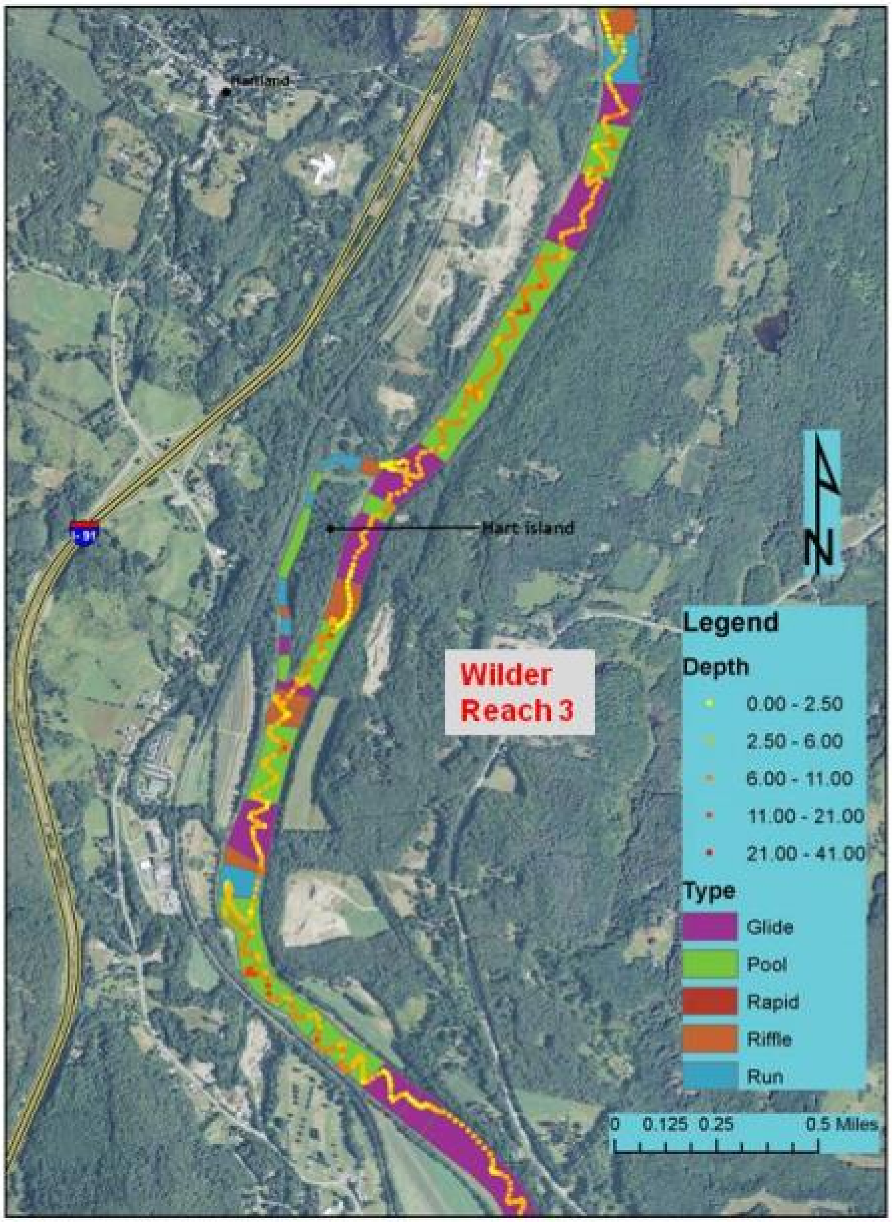

Figure A.6. Wilder Map 1, Wilder reach 3.

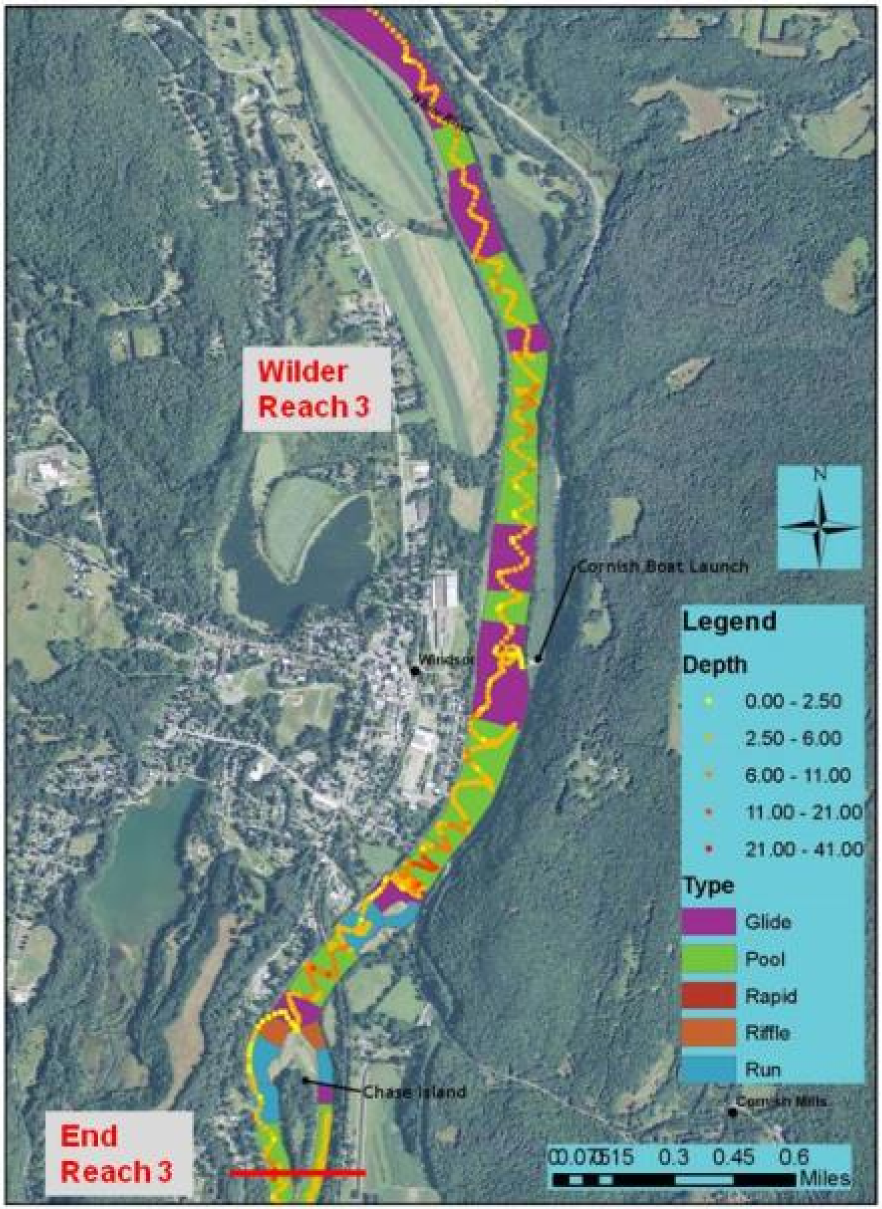

Figure A.7. Wilder Map 1, Wilder reach 3.

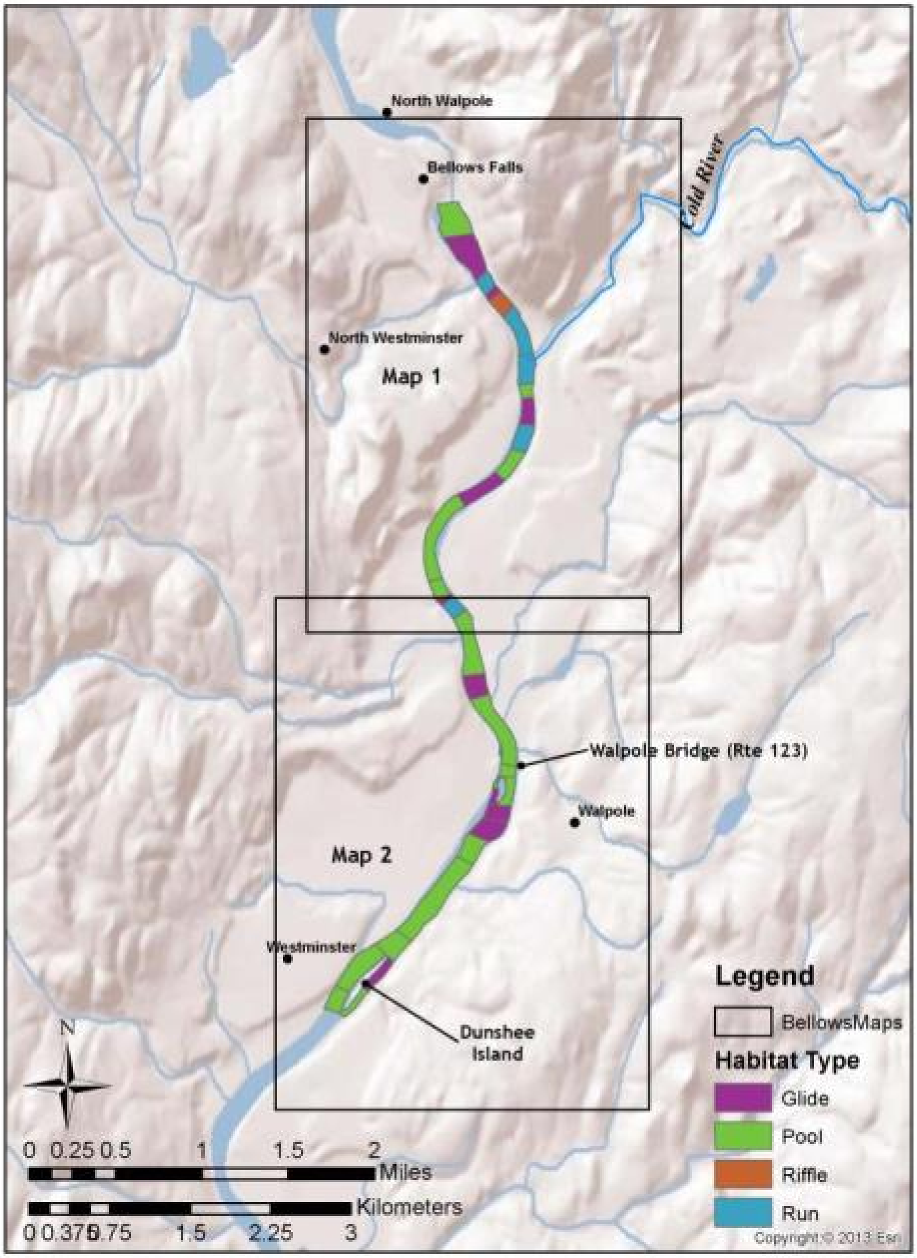

Figure A.8. Bellows Falls reach aquatic habitat mapping index.

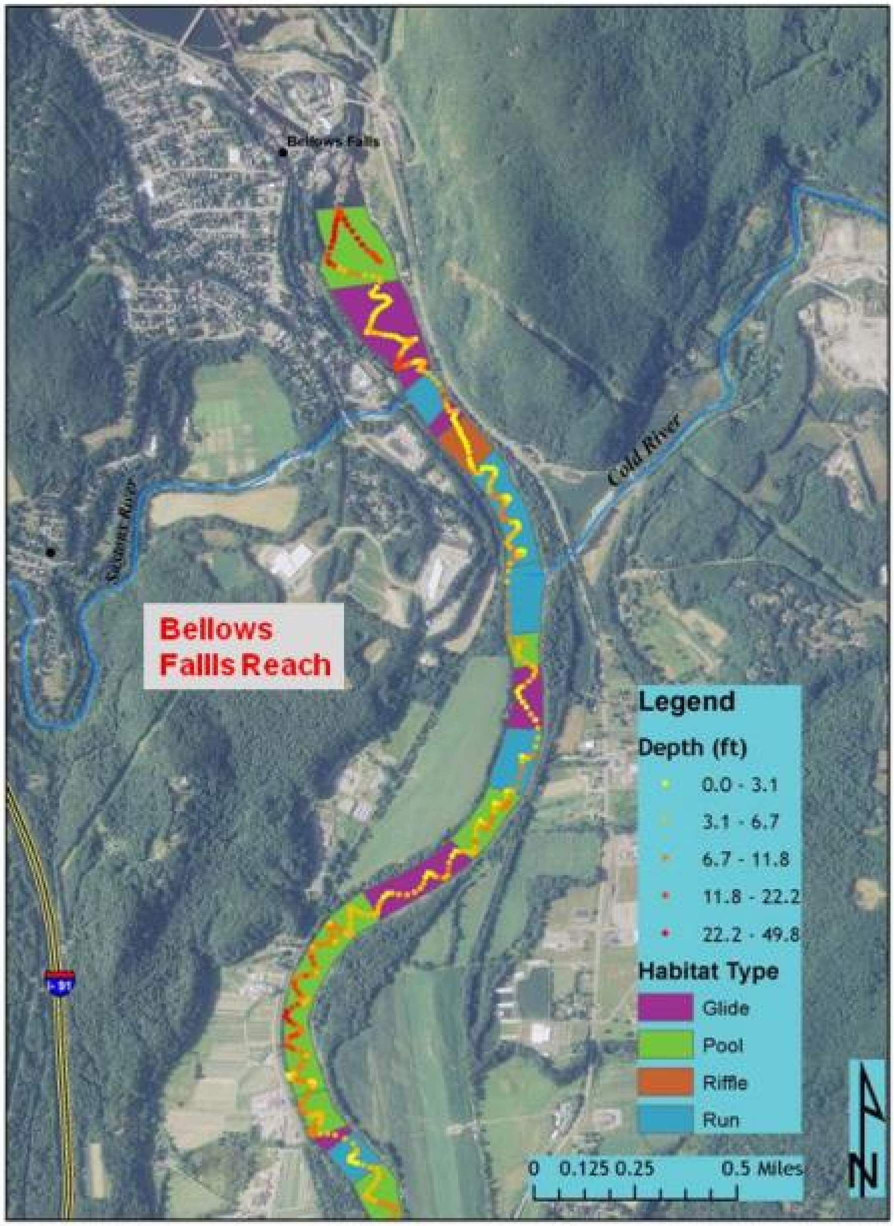

Figure A.9. Bellows Falls Map 1.

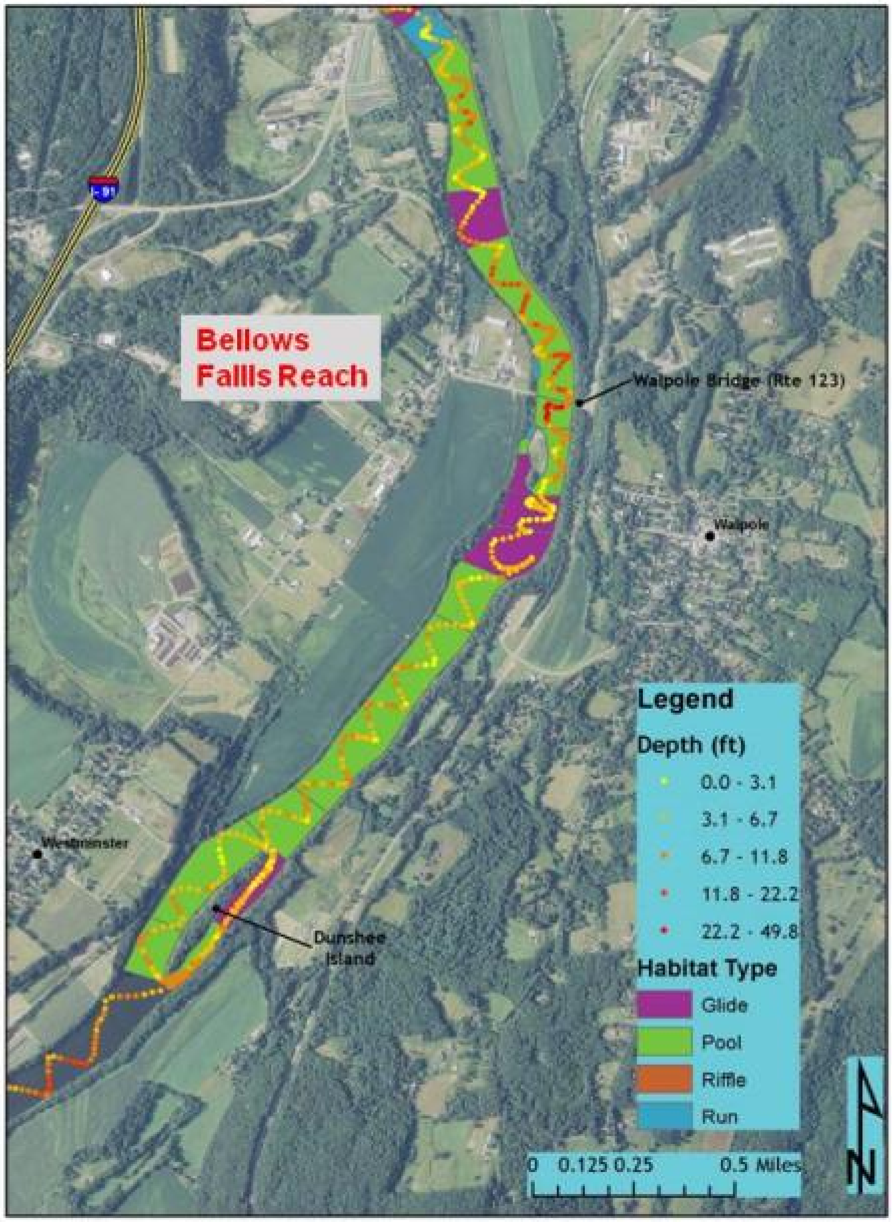

Figure A.10. Bellows Falls Map 2.

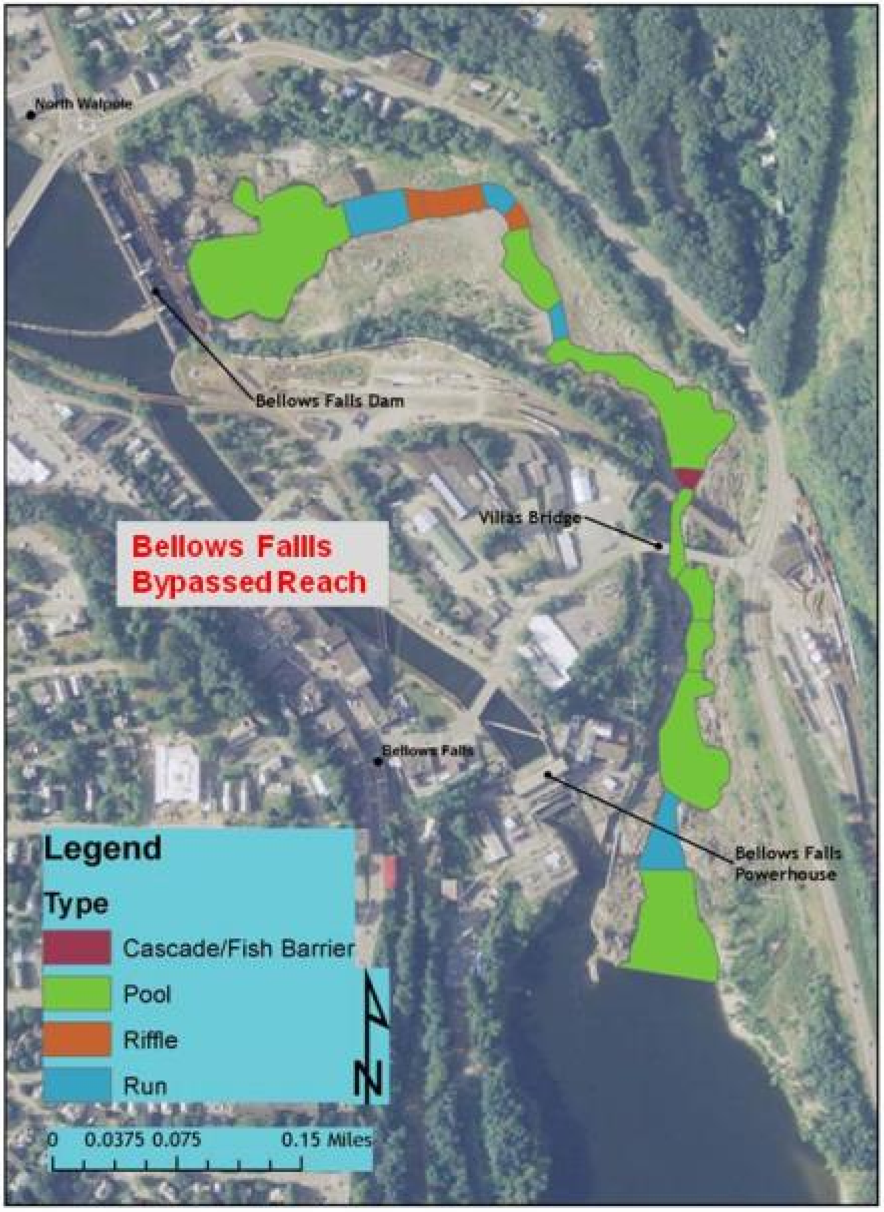

Figure A.11. Bellows Falls Bypassed reach.

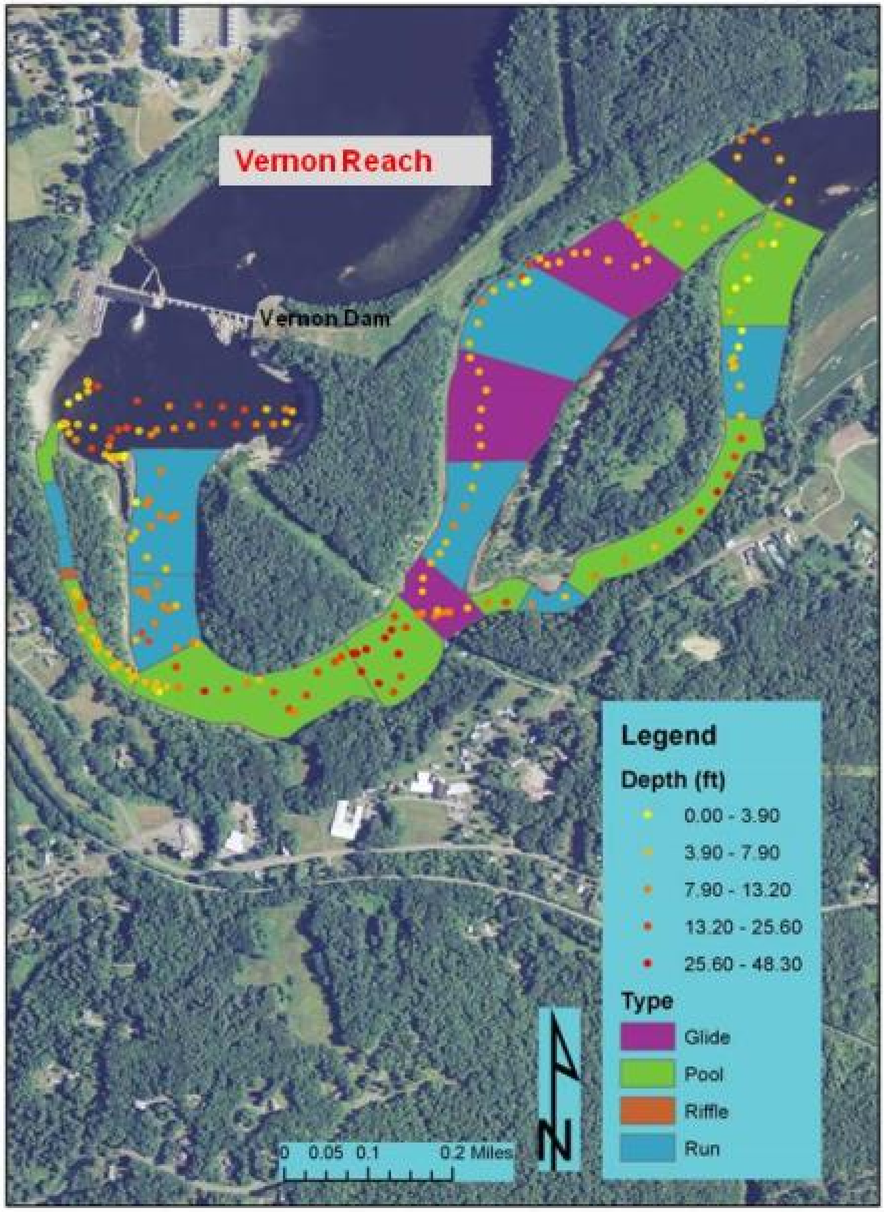

Figure A.12. Vernon reach.

Appendix B

Overview of Aquatic Species and Life Stages

The objective of site and transect selection is twofold: 1) to sample all mesohabitats in relative proportion to observed availability in a reach; and 2) attempt to encompass specific mesohabitat types and associated micro-habitat which may be utilized by target aquatic species and/or life stages identified in the instream flow study plan. This appendix provides a brief synopsis of known habitat use for target species and associated life stages, and general life history patterns of those for which local habitat use information is limited or non-existent.

American shad (Alosa sapidissima)

The historic upstream limit of American shad prior to the construction of dams on the Connecticut River was Bellows Falls. The pool below Bellows Falls (termed an 'eddy pool') was described as a favorite spawning ground and fishing location[1].

We are not aware of any recent surveys to determine American shad spawning habitat or spawning sites downstream of Bellows Falls dam or Vernon dam. Shad can currently pass Bellows Falls dam through a fishway at the powerhouse, but there is no evidence that spawning takes place in the Wilder riverine segment upstream. Spawning locations below the Turners Falls project located approximately 20 miles downstream of Vernon identified by Layzer (1974) are located primarily in run habitat. The role of substrate in determining spawning locations is debatable, with research suggesting sizes can range between sand and boulder (Greene et al., 2009). Radio-tagged American shad tended to remain in localized areas during the spawning season and generally were found in velocities between 0.20 and 0.69 m/s, depths between 1.0 and 2.9 m, and substrates that can vary from sand and gravel to boulder or bedrock (Harris and Hightower, 2011).

Adult shad return to coastal rivers to spawn during the spring when water temperatures are 6.5 – 19.0 ^{o}C. Eggs are swept downstream and lodge in the substrate. Shad develop quickly from egg to larval stage and it appears that spring river flows and water temperature are determining factors for survival (Savoy et al., 2004). Larvae drift downstream into areas of reduced velocity along shorelines and backwaters. Juvenile shad tend to be distributed throughout the lower Connecticut River in the summer and form large schools before migrating downstream in the fall (Savoy et al., 2004).

Walleye (Sander vitreus)

Walleye are known to spawn immediately downstream of all dams within the study area (Carrier and Gries, 2010; Sprankle, 1997). Timing of the spawning run is believed to be influenced primarily by water temperature and water velocity and occurs in the spring (April-June). Rocky substrate (gravel, cobble and rubble) is generally preferred and spawning depths are usually <1.0 m (Kerr et al., 1997; Bozek et al., 2011). Water depth, substrate characteristics and water temperature

[1] Journal of the Senate of the State of Vermont, Annual Session 1866. Appendix p. 302-304

were determined to be the best predictors for walleye spawning sites while water velocity was not a primary determining factor (Kelder and Farrell, 2009). Lowie et al. (2001) found that walleye spawned in conditions at or below the lower end of published optimal ranges for water depth, velocity and temperature and used what was available at the time of spawning, suggesting that these variables and published criteria (McMahon et al., 1984) alone cannot always be used to identify spawning locations of viable populations.

Adults prefer deeper water in the daylight and have an affinity for the bottom (Kerr et al., 1997). Adults tend to select low velocities while juveniles often select slightly higher velocities and shallower depths. Both juveniles and adults are known to move into shallower areas to feed at night.

Fallfish (Semotilus corporalis)

Spawning typically occurs in the spring after water temperatures reach 15° C. Males build a mounded nest of gravels for spawning which generally takes place in shallow areas <0.5 m in depth, slow velocities and usually near instream cover (Trial et al., 1983). Adults prefer pools and deep runs while juveniles can be found in higher velocities in rapid water (e.g. riffles) (Trial et al., 1983; Persinger, 2003). All life stages tend to prefer substrate ranging from sand to cobble.

Longnose dace (Rhinichthys cataractae)

Longnose dace occur throughout North America and can be found in lakes and streams. They have been found in the Connecticut River just upstream of the upper end of the Wilder impoundment, but have not been documented in any of the projects riverine segments (Yoder et al., 2009; New Hampshire Fish & Game unpublished electrofishing data). Based on literature it is unlikely that they are permanent residents in the project riverine reaches.

The peak of longnose dace spawning usually occurs in June to early July in both lakes and streams. In streams longnose dace prefer shallow, fast water with low embeddedness, cobble sized substrate, and nearby cover (Edwards et al., 1983a; Persinger, 2003). Longnose dace are most abundant in swift flowing, steep gradient, headwater streams of larger river systems (Edwards et al., 1983a). Hubert and Rahel (1989) concluded abundance was correlated with overhead cover, low width-to-depth ratio, and substantial main-channel run habitat; habitat most often located in smaller streams. All age groups of longnose dace occur in very shallow water, usually < 0.3 m deep and rarely > 1 m deep (Edwards et al., 1983a), depths that are scarce in the Connecticut River.

White sucker (Catostomus commersonii)

White suckers start their spawning migration in spring to early summer, when the daily maximum water temperature reaches 10° C. In the Saint John River in Canada individuals maintained small home ranges in the river from summer to late winter, averaging 2.6 kilometers or less each year. During the spring spawning season, upstream and downstream movements to three tributaries occurred. Distances traveled were up to 40 km and averaged 9.2 km (Doherty et al., 2010). This suggests that they may migrate into tributaries to spawn if habitat is not available in the stream or river in which they rear. White sucker spawning habitat is generally considered to be areas in streams and rivers with relatively swift shallow waters running over a gravel bottom.

White suckers are known to tolerate a broad range of environmental conditions and are considered to be habitat generalists (Twomey and Nelson, 1984). Adult white suckers (> 150 mm TL) primarily inhabit pools and are common in areas of slow to moderate velocity. Fry prefer moderate currents but generally are not found in riffles or pools. Juveniles can be found in most areas of a stream with relatively shallow depths.

Smallmouth bass (Micropterus dolomieu)

Smallmouth bass were introduced to the Connecticut River and into New Hampshire waters some time during the 1860s. They occur throughout the project reaches in riverine and impounded areas. Usually they are found around the protection afforded by the rocks of shoals and talus slopes, or submerged vegetation, and can occupy a wide range of depths (Edwards et al., 1983b). Spawning generally takes place in shallow areas with moderate current and gravel substrate. Juvenile and adult smallmouth bass both prefer low velocity water near current, but juveniles are often found in slightly shallower water than adults.

Smallmouth bass have been documented in all project reaches (Yoder et al., 2009). Information related to the age and growth, timing of seasonal movements and extent of usable habitat for smallmouth bass in the Wilder project-affected area has not been collected.

Tessellated darter (Etheostoma olmstedi)

Tessellated darters prefer areas with moderate to no current, though they can be found in areas with swifter current (Scott and Crossman, 1973). 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. 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 darters 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. 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. Tessellated darters have been documented in the Wilder and Bellows Falls project-affected areas both upstream and downstream of the dams (Yoder et al., 2009).

Sea lamprey (Petromyzon marinus)

Sea lampreys have been documented in the project-affected area downstream of Wilder dam, but not upstream (New Hampshire Fish & Game, unpublished data; Yoder et al., 2009). In certain years, hundreds to thousands of sea lamprey have been counted passing upstream at the Bellows Falls project, representing a population that may be available to access habitat in the Wilder project-affected area.

Adult sea lampreys return to coastal streams and rivers to spawn during the spring, generally in May and June. 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. Eggs hatch after 10 to 13 days and the small larvae (ammocoetes) move downstream into still water areas of streams and lakes and burrow into muddy or sandy substrate. The larval period generally lasts for up to five years after which the ammocoetes transform into juveniles over a four to six month period before beginning migration downstream to the ocean.

Dwarf wedgemussel (Alasmidonta heterodon) and other mussels

Dwarf wedgemussel have not been documented in any of the free-flowing reaches within the study area in recent surveys (Study 24, Dwarf wedgemussel and co-occurring mussel survey preliminary data). The species is generally found in hydrologically stable areas at depths greater than 5 feet, slow velocities and prefer substrate comprised of gravel, coarse sand, find sand and clay. Two species that often co-occur with dwarf wedgemussel, the triangle floater (*Alasmidonta undulata*) and creeper (*Strophitus undulatus*), are found in very low numbers in the free-flowing reaches (Biodrawversity LLC and The Louis Berger Group, Inc. 2012).

The triangle floater and creeper prefers habitats in low-gradient river reaches with sand and gravel substrates and with low to moderate water velocities, although they can occur within a broader range of habitat conditions. Host fish species for the triangle floater includes longnose dace, fallfish and white sucker. The creeper is a generalist when it comes to host fish; which includes dace, shiners, white sucker, bass and others. The triangle floater has been found below all project dams while the creeper both has only been found below Bellows Falls and Vernon dams.

Two species found only downstream of Vernon dam and Bellows Falls dam include alewife floater (*Anodonta implicata*), and eastern floater (*Pyganodon cataracta*) (Biodrawversity and The Louis Berger Group, Inc. 2012). Alewife floater exist in small streams and large rivers, without clear preference for substrate, depth, or flow conditions. Its habitat use and population density seems to be more strongly tied to where its host fish are likely to spawn or congregate. Host fish include alewife, blueback herring, and American shad. The eastern floater has the ability to thrive in silt and mud—substrates that most other mussel species seem to avoid. In streams and rivers, it is usually confined to depositional areas with finer substrates and in natural or manmade impoundments. Host fish include white sucker and sunfish.

Eastern elliptio (Elliptio complanata) and eastern lampmussel (Lampsilis radiata) are the most common and abundant species and have also been documented below all project dams. The eastern elliptio has no clear preference for substrate: it is found in clay, mud, sand, gravel, and cobble bottoms. It is the most abundant of all mussel species in all riverine reaches. A wide range of host fish includes yellow perch, alewife, white sucker, sunfish, and bass. Eastern lampmussel are often found in deeper and more stable areas of large rivers, usually in sand and gravel. Host fish include yellow perch, bass and sunfish.

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Volume III.C

Study 13 – Tributary and Backwater Fish Access and Habitats Study Final Site Selection Report

Initial Study Report

September 15, 2014

TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 13
Tributary and Backwater Fish Access and Habitats Study

Final Site Selection Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

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Final Revision - July 21, 2014

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1. INTRODUCTION

Operations at TransCanada's Wilder, Bellows Falls and Vernon hydroelectric projects (projects) may impede fish movement into and out of tributary and backwater areas in the impoundments and riverine reaches. The goals of the Tributary and Backwater Fish Access and Habitats Study (Study 13) developed in support of the relicensing for these three hydroelectric projects, are to assess whether water-level fluctuations from project operations impede fish movement into and out of tributaries and backwater areas or affect available fish habitat and water quality in the tributaries and backwaters within project-affected areas.

Study Plan 13, as supported by stakeholders in 2013 and approved by FERC in its February 21, 2014 Study Plan Determination, specified that a subset of project-affected tributaries and backwaters would be evaluated for potential effects of water-level fluctuations on fish access, habitat and water quality. An initial site selection report was posted on TransCanada's relicensing website on May 8, 2014 and comments were received during an aquatics working group meeting held on May 23, 2014, during a follow up conference call on July 1, 2014 and in email communications from US Fish and Wildlife Service and NH Fish and Game (July 2, July 8 and July 9, 2014). This "Updated" Revised Site Selection Report includes modifications that address all working group discussion and comments. Appendix D provides a responsiveness summary for the written comments received. On July 21, 2014 final comments and concurrence on the study's selected sites were received via email from FWS on behalf of FWS, NHFGD and VTDFW.

This report provides a summary of the final revised data analysis and criteria used to select the proposed subset of tributary and backwater locations to be examined in detail during 2014. Due to persistent high water conditions, minor riverine tributaries have not yet been profiled; however, each of those locations are included in the overall set of "shallow" tributaries discussed in section 4.1 of this report.

2. STUDY AREA

The study area includes all tributary and backwater confluences along the Connecticut River from the upstream end of the Wilder impoundment (approximately river mile (RM) 262.4) to a point approximately 1.5 miles downstream of Vernon dam (RM 140.4). The study area includes the three project impoundments (Wilder – RM 217.4-262.4; Bellows Falls – RM 173.7-199.7; Vernon – RM 141.9-167.9) and three riverine segments (downstream of Wilder – RM 199.7-217.4; downstream of Bellows Falls – RM 167.9-173.7; and downstream of Vernon – RM 140.4-141.9) (Figure 2-1).

Tributaries within the project-affected areas were originally identified in 2013 using the National Hydrography Dataset. During the course of revisions to this site selection document, the most recent GIS-based flow-line data provided by USGS was re-examined and the list of tributaries was updated based on that available information. Attribute information for each tributary included stream order (as determined by the Strahler method) and local name if available. Tributaries were classified as major or minor based on stream order designations. Major tributaries were those with a stream order of three or greater. Minor tributaries were those with a stream order of two or less. Backwater areas included in the original draft of this site selection report were identified based on visual examination of aerial photographs that were available online during 2013 (i.e., Google Earth). As part of the revisions to this report, data on full pond elevations was determined based on a merging of the "waterline" created from LiDAR interpolation (conducted by U.S. Imaging) and a contour polygon at the full pond elevation for each project derived from LiDAR point data collected by U.S. Imaging and sonar point data collected by Normandeau (Normandeau 2014). The use of this method (not available at the time the original backwater list was generated) allowed for enhanced identification of backwater areas.

Based on this revised evaluation of tributary and backwater locations over the entire study area, a total of 151 tributaries and 41 backwater areas were identified (Table 2-1). The number of locations presented in this revised report increased from the originally reported total of 139 locations (118 tributaries and 21 backwaters) for several reasons. The original report included a number of locations where a large backwater area was formed in conjunction with a tributary confluence. Further study of these locations relative to available full pond contours indicated that within the project-affected area a section of backwater habitat and a section of more "riverine" tributary habitat existed. In these cases, the location was split into two potential study locations; one backwater and one tributary site. Additionally, the number of backwater sites increased from the original report to this revised report due to the enhanced identification method described above. A conservative approach was taken with regards to backwater identification during review of the most recent aerial images and full pond elevation contours. This conservative approach increased the number of backwater areas as well as added a number of smaller, shallow coves not included in the original report. Intermittent and minor tributaries identified as having a short segment length in the National Hydrography Dataset were filtered during preparation of the initial report. Based on comments provided by the working group indicating that these small tributaries may be important for fish passage, those locations were included in the revised report.

A total of 49 tributaries and 28 backwaters were identified in the Wilder impoundment, 49 tributaries and five backwaters were identified in the project-affected reach between Wilder and Bellows Falls dams and 48 tributaries and eight backwaters were identified between Bellows Falls and Vernon dams. Five tributaries and no backwaters were identified in the approximate 1.5 mile study reach downstream of Vernon dam.

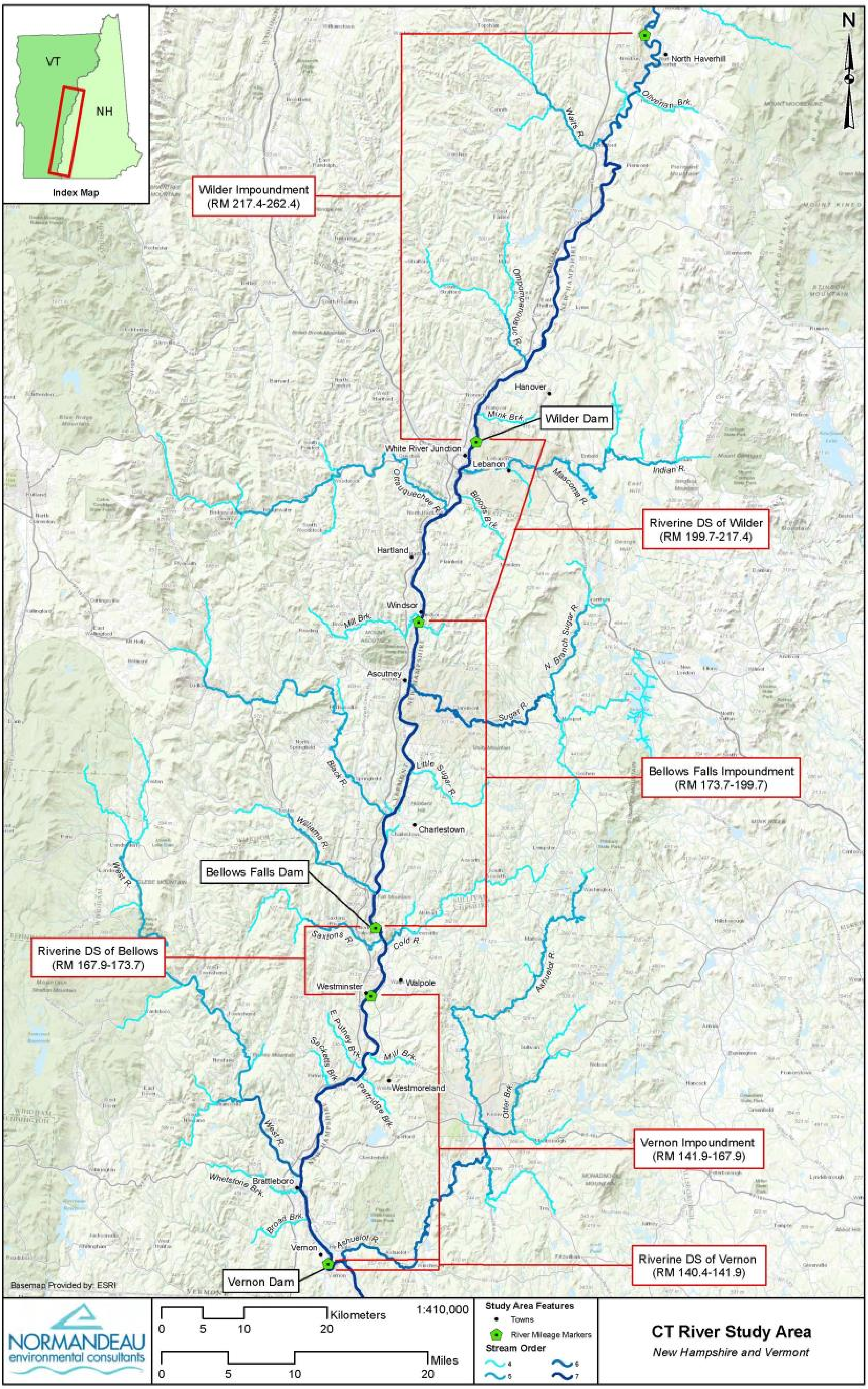


Figure 2-1. TransCanada Project study area showing Wilder, Bellows Falls and Vernon impoundments as well as riverine reaches downstream of each project.

backwaters were identified in the project-affected reach between Bellows Falls and Vernon dams. Five tributaries were located in the reach downstream of Vernon dam.

Table 2-1. Summary of tributary and backwater confluences within the project-affected areas of the Wilder, Bellows Falls, and Vernon projects.

River Reach	Description	Major Tributary	Minor Tributary	Backwater	Total
RM 217.4-262.4	Wilder Impoundment	16	33	28	77
RM 199.7-217.4	Riverine Downstream of Wilder Dam	10	9		19
RM 173.7-199.7	Bellows Falls Impoundment	15	15	5	35
RM 167.9-173.7	Riverine Downstream of Bellows Falls Dam	5	1		6
RM 141.9-167.9	Vernon Impoundment	17	25	8	50
RM 140.4-141.9	Riverine Downstream of Vernon Dam	1	4		5
RM 140.4-262.4	Total	64	87	41	192

3. 2013 PRELIMINARY DATA COLLECTION

Data collected during 2013 was used in the evaluation of water depths at the confluence of the project-affected mainstem Connecticut River and each tributary and backwater within the study area. Data sets consisted of 1) detailed impoundment bathymetric data, 2) riverine section tributary bed elevation data for major tributaries, and 3) water surface elevation (WSE) data.

Impoundment Bathymetry Data:

Bed elevation information for the project-affected portions of tributary and backwater areas in the project impoundments was collected during 2013. As described in the Study 7 Aquatic Habitat Mapping Initial Study Report (Normandeau, 2014), impoundment bathymetry data was collected using a 200-kHz Odom® Hydrotrac single-beam echosounder (<0.03-foot (~0.01-meter) vertical accuracy). Hypack hydrographic survey software was used for integration of the depth sounding and positional data collected using a Leica Viva GS14 Real Time Kinematic (RTK) unit. The RTK unit had a horizontal positioning accuracy of less than 0.03-inch (0.01-meter) and provided vertical water surface positional information at an accuracy of less than 0.1-foot (0.02-0.03 meter) to compensate for fluctuations in water levels as well as differentials in WSE within each impoundment.

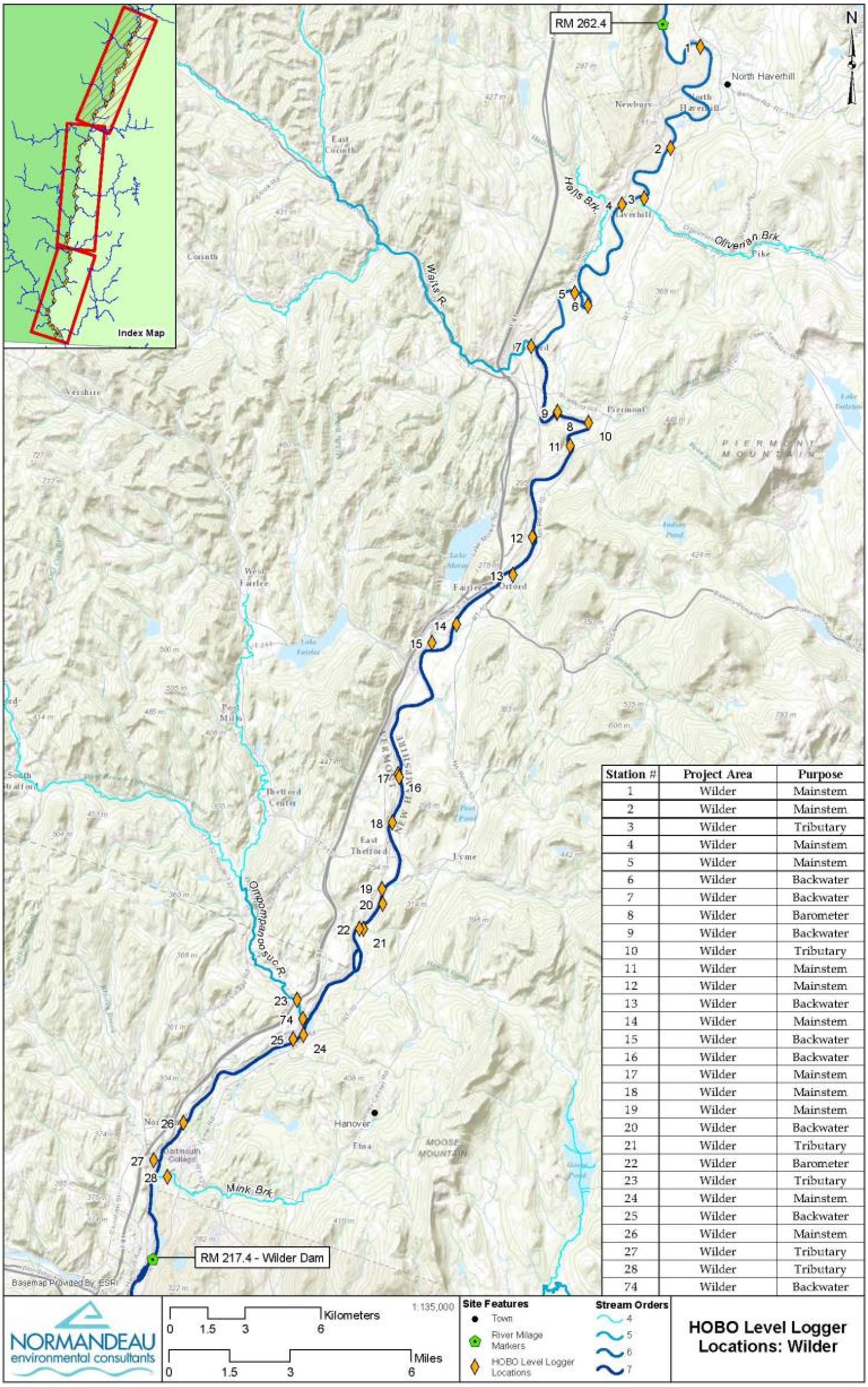
Riverine Tributary Bed Elevation Data:

Major tributaries (those with a stream order of 3 or greater) in the Wilder and Bellows Falls riverine sections were visited during periods of low to no generation during August 2013). During those visits, bed profile data was collected at the confluence using a Leica Viva GS14 RTK unit. Each recorded point consisted of horizontal and vertical position data. The RTK unit had a horizontal positioning accuracy of less than 0.03-inch (0.01-meter) and provided vertical water surface positional information with an accuracy of less than 0.1-foot (0.02-0.03 meter). The vertical position for each bed point was compared to the range of WSEs at that location to determine available depth for passage.

Water Surface Elevation Data:

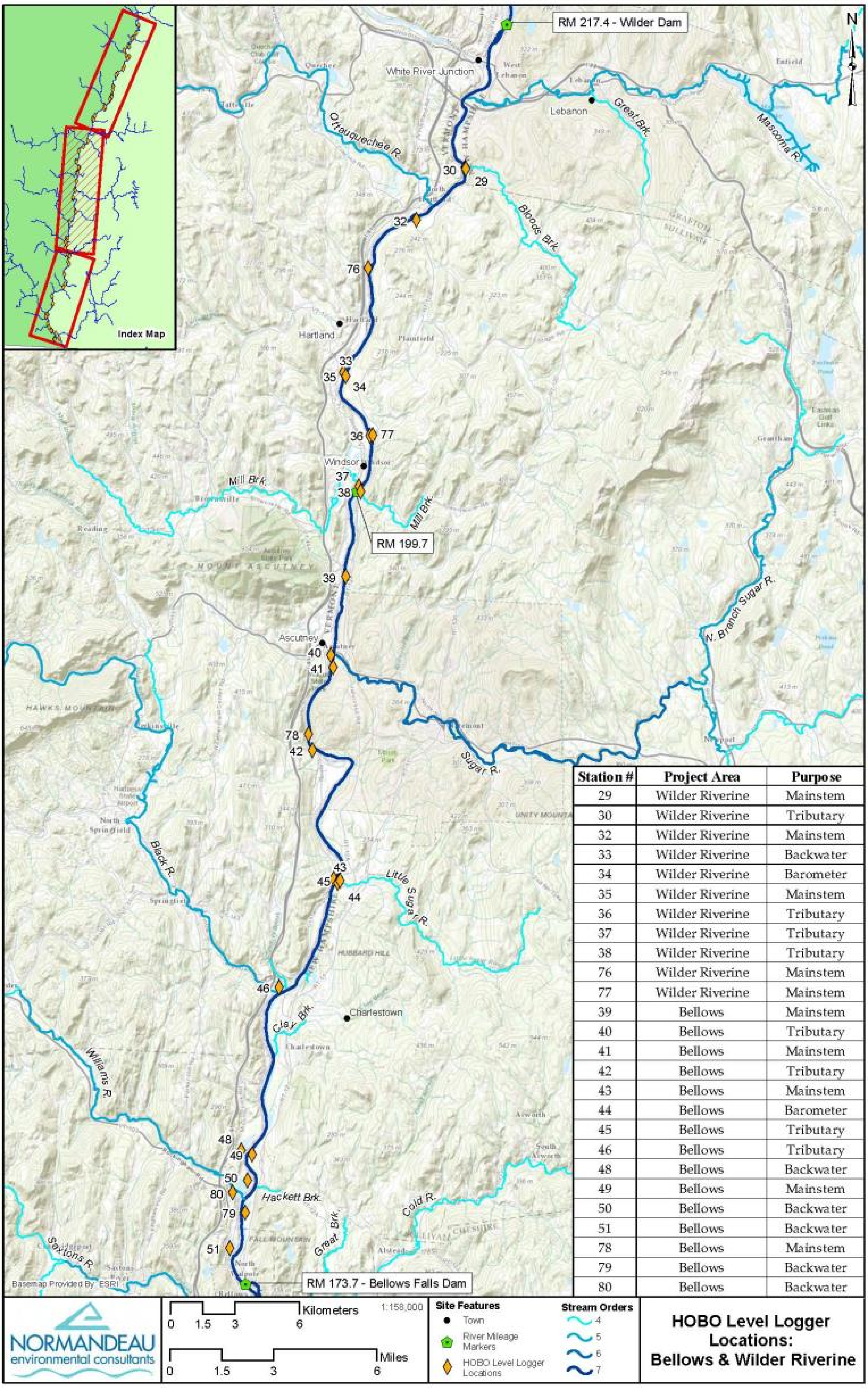
As described in Study 7 Aquatic Habitat Mapping Initial Study Report (Normandeau, 2014), Onset HOBO water-level data loggers, referred to as "level loggers" for the purpose of this report, (vertical accuracy of ± 0.1 inch) were installed at selected locations over the entire 122-mile study area in 2013 (Figures 3-1 through 3-3). Of the total of 75 level loggers deployed, 24 were within the confluence areas of tributaries and 19 were located in or adjacent to backwater areas. Thirty-two were placed throughout the mainstem Connecticut River (Table 3-1). Level loggers were installed during late July through early August 2013 and their exact position (latitude, longitude and elevation relative to the project structures) was recorded using a Leica GS-14 RTK unit. Level logger data was collected through November 2013. Level loggers were programmed to record pressure at 15 minute intervals. In addition to the 75 level loggers installed in aquatic habitat, a total of six in-air barometric data loggers, referred to as "reference loggers" for the purpose of this report, were installed over the study reach. The reference loggers collected background barometric pressure readings at the same 15-minute intervals as programmed for the level loggers. The atmospheric pressure values were used by the Onset HOBOware Pro software to process pressure data collected by the level loggers and providing calculated water depth values at the mainstem, tributary and backwater locations.

Following the removal of most level loggers from the field prior to winter ice conditions (9 units were left in place over the winter), data files were imported into Onset HOBOware Pro Software. Water depths at each 15-minute interval were calculated based on the relationship between pressure values recorded by each level logger and the closest in-air barometric reference loggers. Following determination of water depth values, each individual record was assigned a use code which defined its collection status and subsequent use in analytical tasks (Table 3-2).



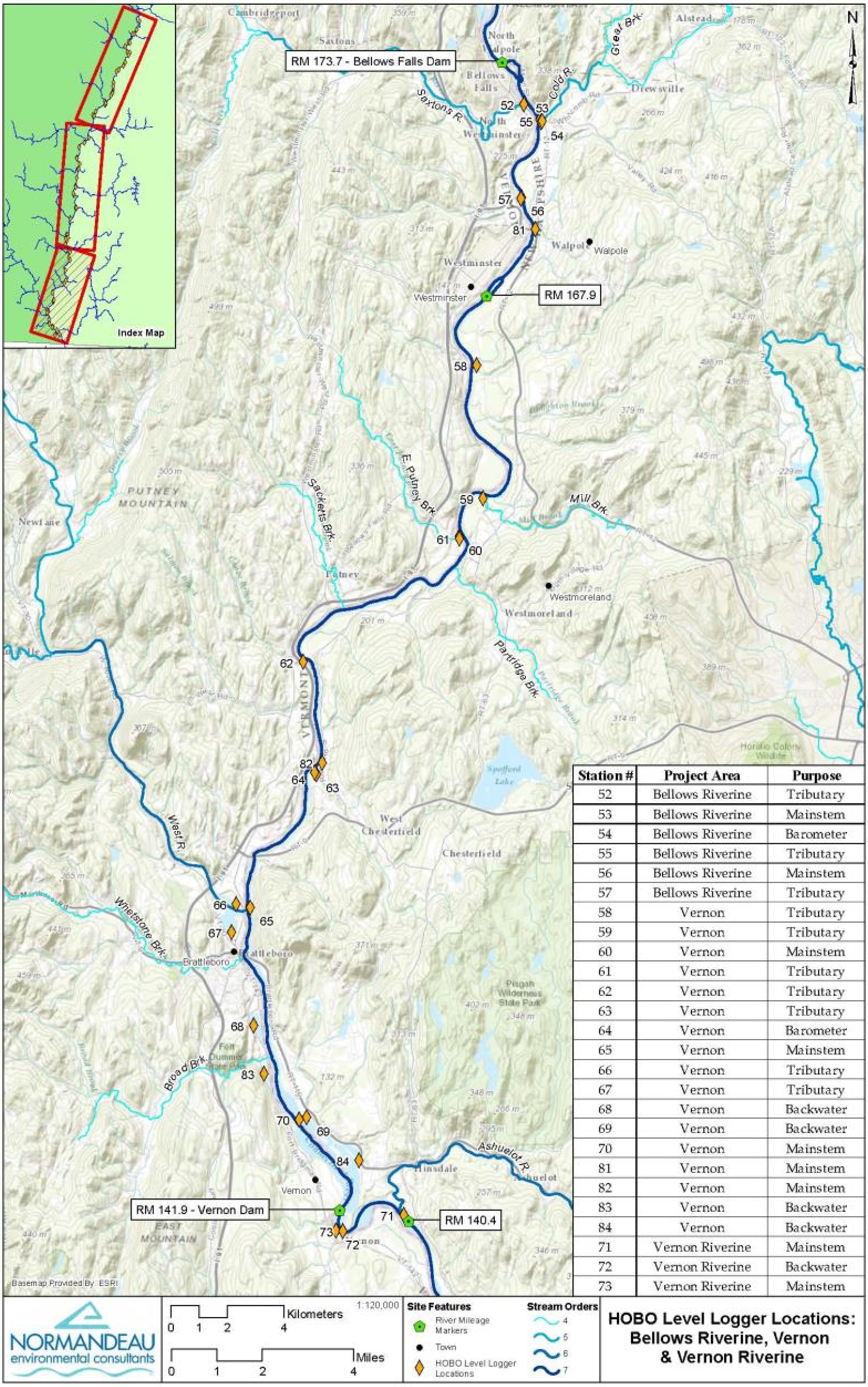
Station #	Project Area	Purpose
1	Wilder	Mainstem
2	Wilder	Mainstem
3	Wilder	Tributary
4	Wilder	Mainstem
5	Wilder	Mainstem
6	Wilder	Backwater
7	Wilder	Backwater
8	Wilder	Barometer
9	Wilder	Backwater
10	Wilder	Tributary
11	Wilder	Mainstem
12	Wilder	Mainstem
13	Wilder	Backwater
14	Wilder	Mainstem
15	Wilder	Backwater
16	Wilder	Backwater
17	Wilder	Mainstem
18	Wilder	Mainstem
19	Wilder	Mainstem
20	Wilder	Backwater
21	Wilder	Tributary
22	Wilder	Barometer
23	Wilder	Tributary
24	Wilder	Mainstem
25	Wilder	Backwater
26	Wilder	Mainstem
27	Wilder	Tributary
28	Wilder	Tributary
74	Wilder	Backwater

Figure 3-1. Installation locations of HOBO level loggers within the Wilder impoundment during July through November 2013.



Station #	Project Area	Purpose
29	Wilder Riverine	Mainstem
30	Wilder Riverine	Tributary
32	Wilder Riverine	Mainstem
33	Wilder Riverine	Backwater
34	Wilder Riverine	Barometer
35	Wilder Riverine	Mainstem
36	Wilder Riverine	Tributary
37	Wilder Riverine	Tributary
38	Wilder Riverine	Tributary
76	Wilder Riverine	Mainstem
77	Wilder Riverine	Mainstem
39	Bellows	Mainstem
40	Bellows	Tributary
41	Bellows	Mainstem
42	Bellows	Tributary
43	Bellows	Mainstem
44	Bellows	Barometer
45	Bellows	Tributary
46	Bellows	Tributary
48	Bellows	Backwater
49	Bellows	Mainstem
50	Bellows	Backwater
51	Bellows	Backwater
78	Bellows	Mainstem
79	Bellows	Backwater
80	Bellows	Backwater

Figure 3-2. Installation locations of HOBO level loggers within the riverine reach downstream of Wilder and Bellows Falls impoundment during July through November 2013.



Station #	Project Area	Purpose
52	Bellows Riverine	Tributary
53	Bellows Riverine	Mainstem
54	Bellows Riverine	Barometer
55	Bellows Riverine	Tributary
56	Bellows Riverine	Mainstem
57	Bellows Riverine	Tributary
58	Vernon	Tributary
59	Vernon	Tributary
60	Vernon	Mainstem
61	Vernon	Tributary
62	Vernon	Tributary
63	Vernon	Tributary
64	Vernon	Barometer
65	Vernon	Mainstem
66	Vernon	Tributary
67	Vernon	Tributary
68	Vernon	Backwater
69	Vernon	Backwater
70	Vernon	Mainstem
81	Vernon	Mainstem
82	Vernon	Mainstem
83	Vernon	Backwater
84	Vernon	Backwater
71	Vernon Riverine	Mainstem
72	Vernon Riverine	Backwater
73	Vernon Riverine	Mainstem

Figure 3-3. Installation locations of HOBO level loggers within the riverine reach downstream of Bellows Falls, Vernon impoundment, and riverine reach downstream of Vernon during July through November 2013.

Table 3-1. Summary of HOBO level logger locations within the project-affected areas of the Wilder, Bellows Falls and Vernon projects, July–November 2013.

River Reach	Description	Tributary	Backwater	Mainstem	Total
RM 217.4-262.4	Wilder Impoundment	6	9	12	27
RM 199.7-217.4	Riverine Downstream of Wilder Dam	4	0	3	8
RM 173.7-199.7	Bellows Falls Impoundment	4	5	5	14
RM 167.9-173.7	Riverine Downstream of Bellows Falls Dam	3	0	3	7
RM 141.9-167.9	Vernon Impoundment	7	4	5	16
RM 140.4-141.9	Riverine Downstream of Vernon Dam	0	0	3	3
RM 140.4-262.4	Total	24	19	32	75

Table 3-2. Use code definitions assigned to individual depth readings determined for HOBO level logger data, 2013.

Use Code	Description
1	Valid for all analytical tasks
2	Logger out of water (act of downloading)
3	Logger out of water (not yet deployed)
4	Sensor potentially out of water (based on depth readings)
5	Sensor depth exceeds reported instrument range
6	Manually flagged during data review: bad pressure data due to malfunction
7	Manually flagged during data review: ice formation in sensor
8	Manually flagged during data review: ice formation in barometer
9	Manually flagged after time series review

4. 2014 SITE SELECTION

As described in Study Plan 13, potential effects of water-level fluctuations on fish access, habitat and water quality will be studied in detail. The randomly selected tributary or backwater confluence areas will be examined within the study area from the upper end of Wilder impoundment to the point approximately 1.5 miles downstream of Vernon dam during 2014.

To aid in the process of randomly selecting locations with the greatest probability of having potential impacts to access related to project operations, a revised site selection process was developed. The revised site selection process consisted of four phases. Phase 1 relied on available bathymetric and WSE data to identify all locations where water depths of one foot or less are present during periods of low water. During Phase 1, each tributary or backwater confluence was classified as "shallow" (defined as the presence of one or more measured locations with a water depth of one foot or less at low water) or "adequate" (defined as a location where all measured water depths were greater than one foot at low water). Tributary and backwater locations classified as "adequate" due to all measured water depths greater than one foot at low water were excluded from the set of locations from which the 2014 study sites were randomly drawn (in Phase 3). The minor riverine tributaries not surveyed during 2013 were all included in the potential 2014 study sites (e.g., assumed to be shallow) since persistent high water precluded surveying them prior to issuance of this revised report.

Phase 2 of the revised selection process assessed the range of observed WSE fluctuations at all 2013 mainstem level logger locations to determine if further stratification of the project reaches (the Wilder impoundment, project-affected reach between Wilder and Bellows Falls, and the project-affected reach between Bellows Falls to the point approximately 1.5 miles downstream of Vernon dam) was warranted, based on the magnitude of observed fluctuations. Additional factors such as major natural hydraulic controls (e.g., Sumner Falls) were considered.

Phase 3 of the revised selection process combined results of the preliminary depth assessment (Phase 1) with results of the study area stratification determination (Phase 2). Potential tributary and backwater study locations classified as shallow due to the presence of at least one measured bathymetry point within the project-affected area during Phase 1 were further examined. Locations determined to be unlikely to have access issues due to constant inflow (e.g., large order tributaries such as the White River or West River) were excluded from the set of locations from which the 2014 study sites were randomly drawn to increase the probability of selecting locations with potential impacts to access related to project operations.

Phase 4 consisted of the random selection of locations for detailed study during 2014. The subset of locations following exclusion of locations determined to have adequate depths (Phase 1) or considered unlikely to present access issues (Phase 3) were included as potential locations during the random selection process. Random selections were distributed proportionally among the study area regions defined during Phase 2 based the contribution of the number of potential sites within a particular strata to the total number of potential sites.

4.1 Phase 1: Calculated Water Depth Assessment

Available bathymetric and WSE data were used to identify which of the full set of tributary and backwater sites (Appendix A) are most likely to impede fish movement (e.g. one foot or less of water during low impoundment water levels). To accomplish this, two methods were used.

Method 1 examined the relationship between the set of bed elevation points collected at each tributary or backwater location to fluctuations in water surface levels as recorded at the nearest mainstem level logger. Data for each mainstem level logger was reviewed and the lowest WSE during the 2013 sampling period was determined and assumed to represent a low flow condition. Each individual bed elevation value within a tributary or backwater location was compared to the lowest observed WSE. The minimum, maximum, and average bed elevation and corresponding water depth under low flow conditions for each location is presented in Appendix A. Comparison of bathymetric data to WSE information recorded at the nearest mainstem level logger was only applied to tributary and backwater confluences in the impounded portions of the project-affected area.

In the riverine reaches, bed elevation points were collected across the immediate confluence of major tributaries during a low flow period. Comparison of bed elevation data to WSE information recorded at the nearest mainstem level logger was not performed due to the uncertainty associated with applying a recorded WSE from a mainstem logger located up to several river miles away. The set of bed elevations recorded at each site was compared with the WSE measured at that location at the time of field sampling. Minimum, maximum, and average bed elevation and water depth values for each tributary sampled in the riverine reaches are presented in Appendix A. Field sampling was timed to coincide with low water (August 2013 during low to no generation).

During 2013, level loggers were installed directly into a number of tributary or backwater areas. In those cases, Method 2 examined the relationship between the set of bed elevation points collected at that location to the site-specific fluctuations in water surface levels as recorded by the local level logger. Data for each site-specific level logger was reviewed and the lowest WSE during the sampling period was determined and assumed to represent a low flow condition. Where data were available, each individual bed elevation value was compared to the lowest observed water surface elevation. The minimum, maximum, and average bed elevation and corresponding water depth under low flow conditions for each location is presented in Appendix A.

Following review of all available data, each of the 192 tributary and backwater locations were classified as either "shallow" (defined as the presence of one or more measured locations with a water depth of one foot or less at low water) or "adequate" (defined as a location where all measured water depths were greater than one foot at low water). Designations of shallow or adequate were assigned to tributaries and backwaters in the impounded reaches using values obtained via Method 1 through comparison of the minimum WSE recorded by a level logger to the maximum wetted bed elevation (i.e., the shallowest depth present). For tributaries in the riverine reaches, a Method 1 designation of shallow or adequate was assigned by comparing the WSE at the time of the 2013 field visit to the deepest point available along the bed profile, under the assumption that access would not be impeded if the channel thalweg was greater than one foot in depth. Similarly, where data was available, designations of shallow or adequate were assigned to tributaries and backwaters in the impounded reaches using values obtained via Method 2 by comparing the minimum WSE recorded by a site-specific level logger to the maximum wetted bed elevation (i.e., the shallowest depth present). In the riverine reaches, a Method 2 designation of shallow or adequate was assigned by comparing the minimum WSE recorded by a site-specific logger to the deepest point available along the bed profile.

Depth designations of shallow or adequate generated by the two methods were reviewed for all 192 locations. Locations were conservatively determined to have adequate water depth only if each applicable method indicated a minimum depth of greater than one foot was present at all sample points. If either method indicated water depths of less than or equal to one foot at one or more sample points, an overall classification of shallow was assigned and the site was placed into consideration for more detailed study during 2014. It should be noted that for tributaries and backwaters assigned a classification of shallow, access is not necessarily limited. Water depths calculated for classifying sites as shallow or adequate may not represent actual conditions within a tributary as actual water depths at those locations are dependent not only on project operations but also on inflow from the tributary itself.

Where bathymetric data was not available for a particular site, a designation of shallow was automatically assigned. This was done at 59 sites: 8 in the Wilder impoundment, 10 in the riverine reach downstream of Wilder, 11 in the Bellows Falls impoundment, 1 in the riverine reach downstream of Bellows Falls, 24 in the Vernon impoundment and 5 in the riverine reach downstream of Vernon. The majority (92%) of sites without bathymetric data were minor tributaries (stream order 2 or less). These small tributaries were identified during the desktop GIS assessment using the National Hydrography Dataset as described in section 2 above but were not always apparent to the bathymetry field crew during the summer field data collection period.

Table 4-1 presents a summary of depth classifications for the full set of tributaries and backwaters by river reach. The majority of sites (94%; 180 of the 192) received a designation of shallow due to the presence of water depths less than or equal to one foot. A total of 12 locations (eight major tributaries, two minor tributaries and two backwaters) received a designation of adequate based on the presence of water depths greater than one foot and, as a result, will not be considered as candidates for more detailed study during 2014. Appendix A contains a complete listing of available bathymetric and WSE information as well as the depth designations generated using each method for each of the 192 locations.

Table 4-1. Depth classifications for all tributary and backwater locations within the project-affected areas of the Wilder, Bellows Falls and Vernon projects.

River Reach	Classification	Major Tributary	Minor Tributary	Backwater	Total
Wilder Impoundment	Shallow	16	32	26	74
	Adequate	0	1	2	3
Riverine Downstream of Wilder Dam	Shallow	5	9	0	14
	Adequate	5	0	0	5
Bellows Falls Impoundment	Shallow	14	15	5	34
	Adequate	1	0	0	1
Riverine Downstream of Bellows Falls Dam	Shallow	3	1	0	4
	Adequate	2	0	0	2
Vernon Impoundment	Shallow	17	24	8	19
	Adequate	0	1	0	1
Riverine Downstream of Vernon Dam	Shallow	1	4	0	6
	Adequate	0	0	0	0
Total	Shallow	53	88	39	180
	Adequate	7	3	2	12

4.2 Phase 2: Water Surface Elevation Assessment

The range of observed WSE fluctuations at all mainstem level logger locations were reviewed to determine if further stratification of the project reaches was warranted, based on the magnitude of observed fluctuations. For each 15-minute data record recorded at a mainstem level logger location, the level logger elevation (as determined by RTK during level logger installation) was summed with the calculated water depth to generate an estimate of the WSE.

The magnitude of WSE fluctuation was calculated on a daily basis (daily magnitude) as the difference between the maximum and minimum recorded WSE values (by date and mainstem level logger station) for the entire period (late July – November) of recorded water depths. Following calculation of the daily magnitude of WSE fluctuation at each level logger location, mainstem WSE fluctuations were assessed using two methods. Method 1 examined the mean daily magnitude of WSE fluctuation at each mainstem location. The 95% confidence interval range around the mean daily magnitude of WSE fluctuation at each mainstem location was plotted for the Wilder impoundment, the project-affected reach between Wilder and Bellows Falls dams, the project-affected reach between Bellows Falls and Vernon dams, and the approximate 1.5 mile reach downstream of Vernon dam. Method 2 examined the median daily magnitude of WSE fluctuation at each mainstem location. The 10^{th}, 25^{th}, 50^{th} (median), 75^{th} and 90^{th} percentiles of occurrence of daily magnitude of WSE fluctuation values were plotted for the project-affected reaches (upstream Wilder, between Wilder and Bellows Falls dams, between Bellows Falls and Vernon dams, and the 1.5 mile reach downstream of Vernon dam). Values for the minimum, maximum, 10th, 25th, median, 75th and 90th percentiles of occurrence of daily magnitude of WSE fluctuation values area also provided in Appendix B.

Based on the locations of project structures and naturally occurring river breaks as well as the magnitude of daily WSE fluctuations, the overall study reach was divided into nine sub reaches. In general, the study area was split into impounded and riverine reaches which varied based on degree of WSE fluctuation (see Figure 4-9). The Wilder impoundment was subdivided into three sub-reaches (upper, middle, and lower) based primarily on the significant length of the impounded reach (45 river miles). The Wilder riverine segment was subdivided into two sub-reaches to address differences in WSE fluctuations likely related to the presence of a major hydraulic control (Sumner Falls). Although the WSE fluctuations towards the upper end of the Bellows Falls impoundment (level logger Station 39; Figure 4-3) suggested an additional potential split, it was decided that the degree of difference in WSE fluctuation from the rest of the impoundment (~0.5 ft) was not enough to warrant doing so.

Wilder Impoundment

Values for mean daily magnitude of WSE fluctuation ranged from 0.87 – 1.27 feet over the period of record among the eleven mainstem level logger locations within the Wilder impoundment (Method 1; Figure 4-1). Values for median daily magnitude of WSE fluctuation ranged from 0.81 – 1.05 feet among the eleven mainstem level logger locations within the Wilder impoundment (Method 2; Figure 4-2). Although visual inspection of the 95% confidence intervals around the mean values (Figure 4-1) and the 25th, 50th, and 75th percentiles of occurrence (Figure 4-2) did not show clear separation among daily magnitude of WSE fluctuations, based on the significant length of the impounded reach (45 river miles) as well as recent data collected by TransCanada showing that fluctuations in the upper portion of the Wilder impoundment (~RM 247.4-262.4) are more a function of upstream influences than operations at Wilder, the Wilder impoundment was stratified into three reaches. Reach 1 (Lower Wilder) extends from Wilder dam to a point approximately 15 miles upstream (RM 217.4-232.4). Reach 2 (Middle Wilder) extends from RM 232.4-247.4 and Reach 3 (Upper Wilder) extends from RM 247.4 to the upper end of the impoundment (RM 262.4).

Wilder Dam to Bellows Falls Dam

Values for mean daily magnitude of WSE fluctuation ranged from 0.95 – 3.33 feet among the ten mainstem level logger locations within the project-affected reach between Wilder and Bellows Falls dams (Method 1; Figure 4-3). Visual inspection of the 95% confidence intervals around those mean values indicated spatial separation among mainstem locations. Values for mean daily magnitude of WSE fluctuation were higher (range 2.58 – 3.33 ft) at mainstem level logger locations located towards the upper end of the river reach between Wilder dam and the

Bellows Falls impoundment than those located further downstream in the impounded portion of the Bellows Falls project (range 0.95 – 1.17 ft). This observation supports a decision to further stratify the project-affected reach between Wilder and Bellows Falls dams into two separate reaches; an upstream "riverine" reach with mean daily WSE fluctuations of two feet or more and a downstream "impounded" reach with mean daily WSE fluctuations of 1.5 feet or less. The riverine reach was further subdivided into an upper (RM 208.0-217.4 – referred to as Upper Wilder Riverine) and lower portion (RM 199.7-208.0 – referred to Lower Wilder Riverine) with the break point located at Sumner Falls. Values for mean daily magnitude of WSE fluctuation were higher (> 3.0 feet) at mainstem level logger locations located towards the upper end of the river reach between Wilder dam and Sumner Falls than between Sumner Falls and the upper end of the Bellow Falls impoundment (2.5-3.0 feet).

Values for median daily magnitude of WSE fluctuation ranged from 0.85 – 3.49 feet among the ten mainstem level logger locations within the project-affected reach between Wilder and Bellows Falls dams (Method 2; Figure 4-4). Similar to the determination based on Method 1, visual inspection of the 25th, 50th, and 75th percentiles of occurrence supported the further stratification of the project-affected reach into the Upper Wilder Riverine, Lower Wilder Riverine, and downstream impounded reaches described above.

Bellows Falls Dam to Vernon Dam

Values for mean daily magnitude of WSE fluctuation ranged from 0.61 – 3.90 feet among the six mainstem level logger locations within the project-affected reach between Bellows Falls and Vernon dams (Method 1; Figure 4-5). Visual inspection of the 95% confidence intervals around those mean values indicated spatial separation among mainstem locations. Values for mean daily magnitude of WSE fluctuation were higher (range 2.65 – 3.90 ft) at mainstem level logger locations located towards the upper end of the riverine reach between Bellows Falls dam and the Vernon impoundment, than those located further downstream in the impounded portion of the reach (range 0.61 – 0.83 ft). This observation supports a decision to further stratify the project-affected reach into two separate reaches; an upstream riverine reach with mean daily WSE fluctuations of two feet or more and a downstream impounded reach with mean daily WSE fluctuations of 1.0 feet or less.

Values for median daily magnitude of WSE fluctuation ranged from 0.56 – 3.76 feet among the six mainstem level logger locations within this project-affected reach (Method 2; Figure 4-6). Similar to the determination based on Method 1, visual inspection of the 25th, 50th, and 75th percentiles of occurrence supported the further stratification of the project-affected reach between Bellows Falls and Vernon dams into the upstream riverine and downstream impounded reaches described above.

Downstream of Vernon Dam

Values for mean daily magnitude of WSE fluctuation ranged from 2.59 – 3.04 feet among the three mainstem level logger locations downstream of Vernon dam (Method 1; Figure 4-7). Visual inspection of the 95% confidence intervals around those mean values indicated a comparable range of fluctuation at each location and suggested no need for further stratification of that river reach for random sample selection based on daily fluctuation magnitude. Values for median daily magnitude of WSE fluctuation ranged from 0.81 – 1.05 feet among the three level logger locations downstream of Vernon dam (Method 2; Figure 4-8). Similar to the determination based on Method 1, visual inspection of the 25th, 50th, and 75th percentiles of occurrence did not show any clear separation among daily magnitude of WSE fluctuations that would support further stratification of the riverine reach downstream of Vernon.

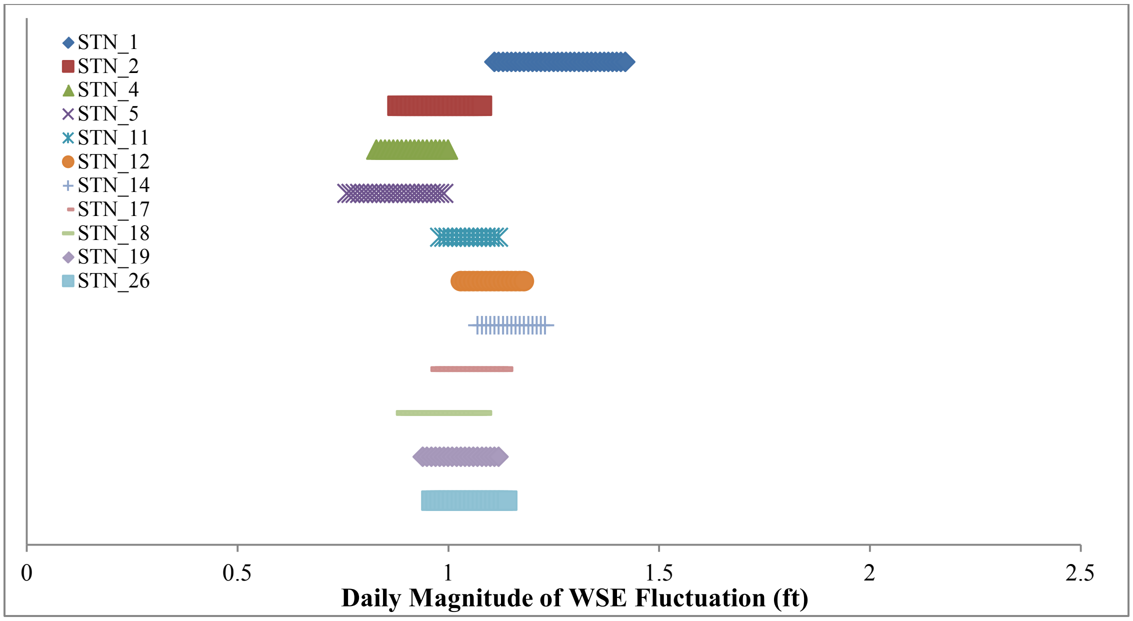


Figure 4-1. The 95% confidence interval ranges for the mean daily magnitude of WSE fluctuation at mainstem level logger stations in the Wilder impoundment. Note: Stations are arranged from upstream (top of figure) to downstream (bottom of figure).

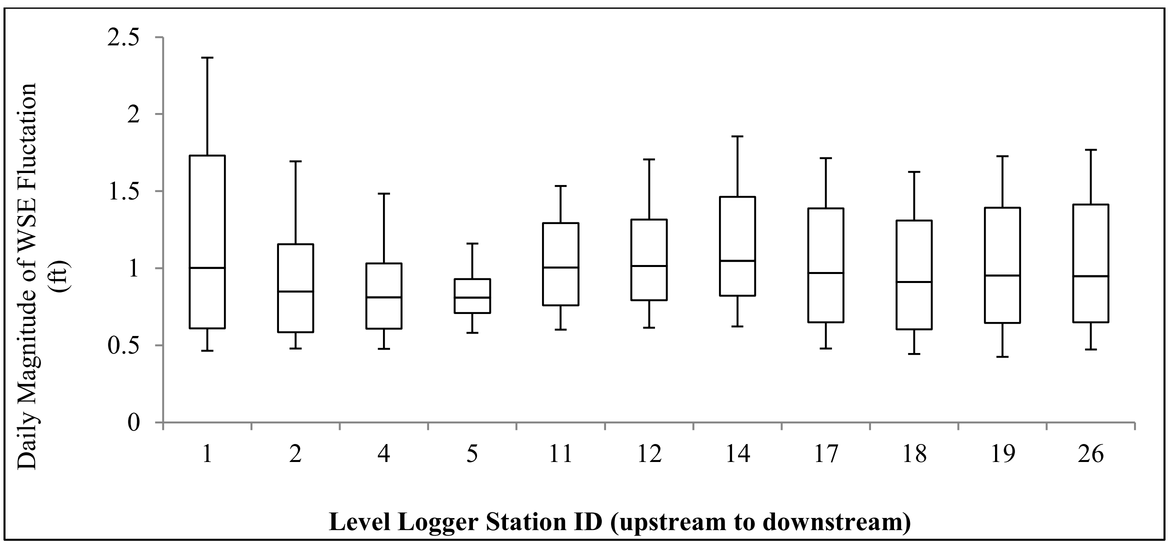


Figure 4-2. Box and whisker plot of the median daily magnitude of WSE fluctuation at mainstem level logger stations in the Wilder impoundment. Note: Boxes indicate the 25th, 50th (median) and 75th percentiles of occurrence and whiskers represent the 10th and 90th percentiles of occurrence. Stations are arranged from upstream (left side of figure) to downstream (right side of figure).

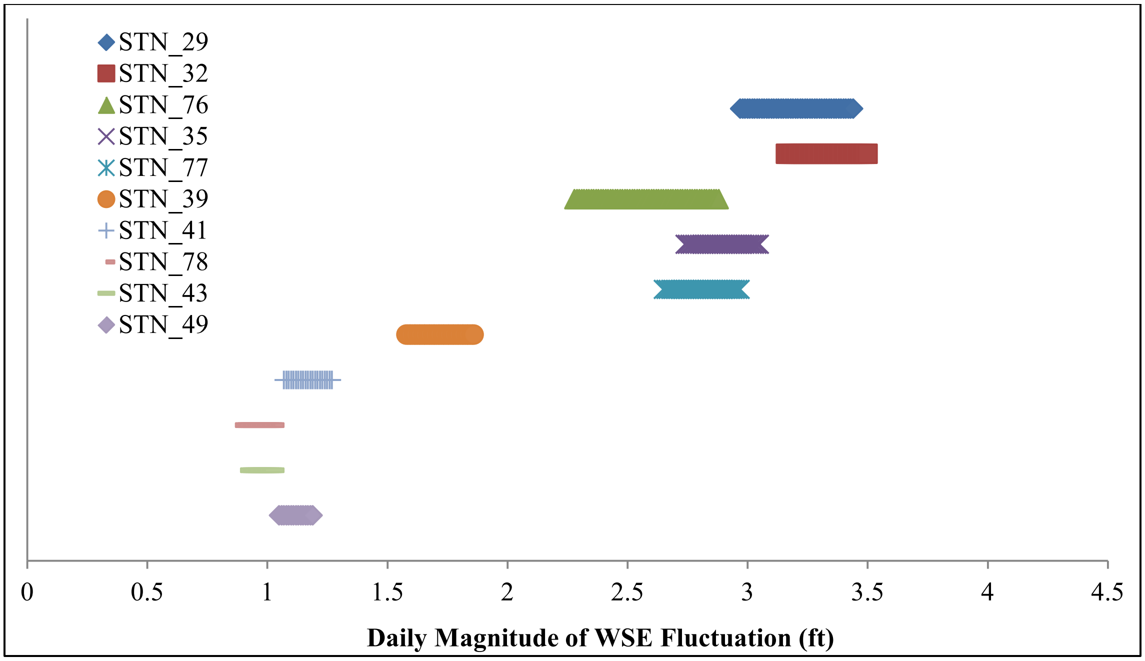


Figure 4-3. The 95% confidence interval ranges for the mean daily magnitude of WSE fluctuation at mainstem level logger stations in the project-affected reach between Wilder and Bellows Falls dams. Note: Stations are arranged from upstream (top of figure) to downstream (bottom of figure).

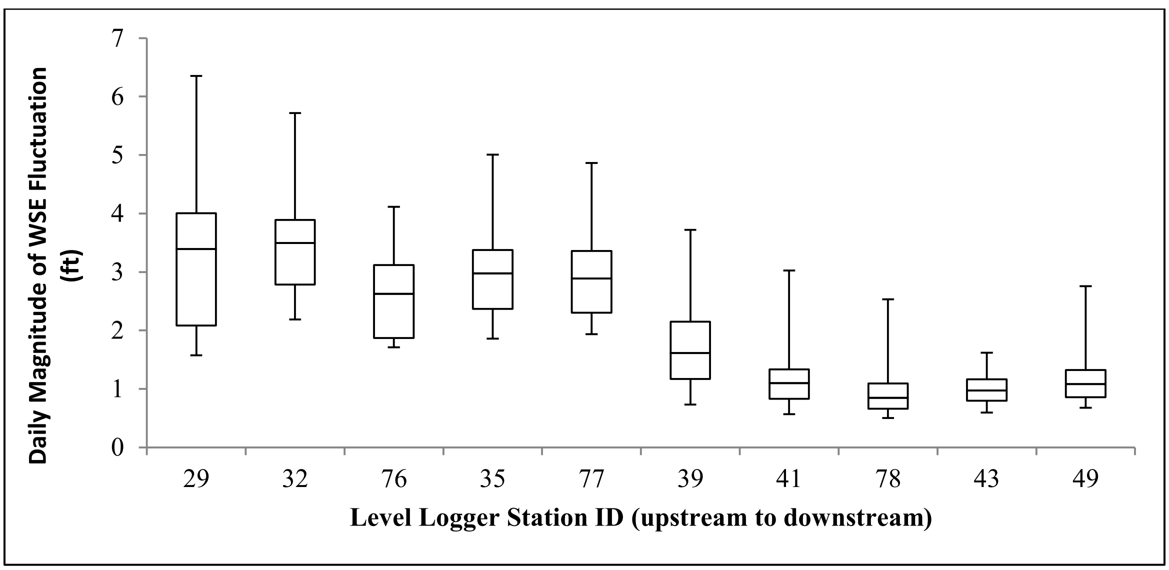


Figure 4-4. Box and whisker plot of the median daily magnitude of WSE fluctuation at mainstem level logger stations in the project-affected reach between Wilder and Bellows Falls dams. Note: Boxes indicate the 25th, 50th (median) and 75th percentiles of occurrence and whiskers represent the 10th and 90th percentiles of occurrence. Stations are arranged from upstream (left side of figure) to downstream (right side of figure).

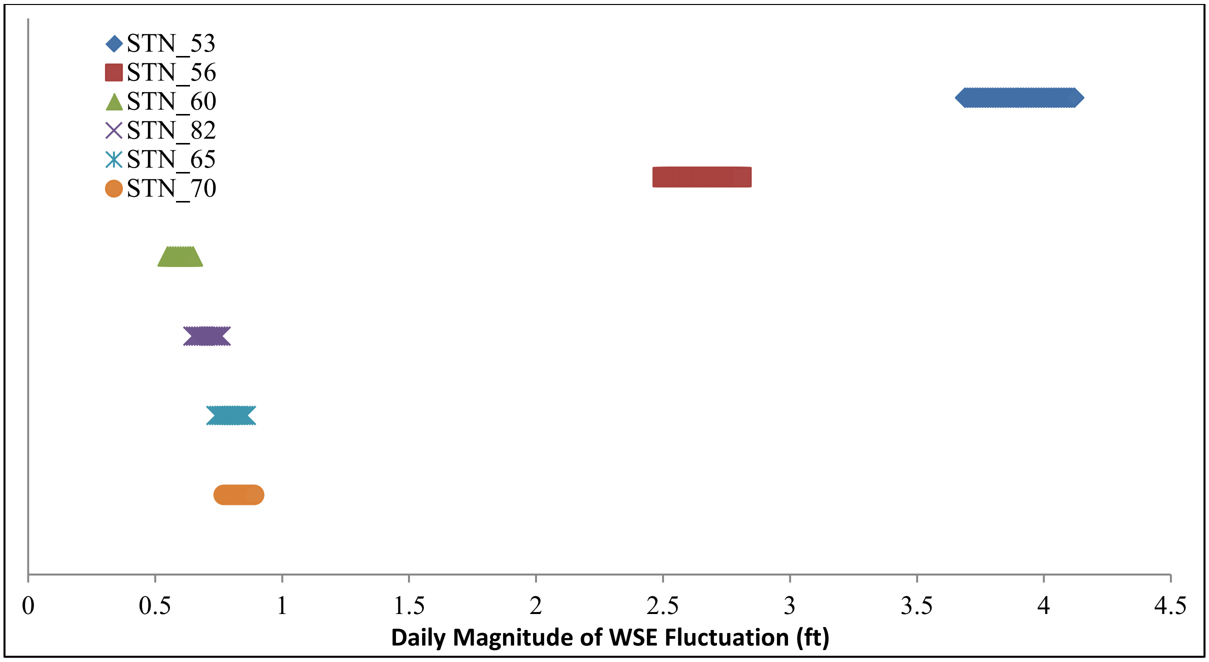


Figure 4-5. The 95% confidence interval ranges for the mean daily magnitude of WSE fluctuation at mainstem level logger stations in the project-affected reach between Bellows Falls and Vernon dams. Note: Stations are arranged from upstream (top of figure) to downstream (bottom of figure).

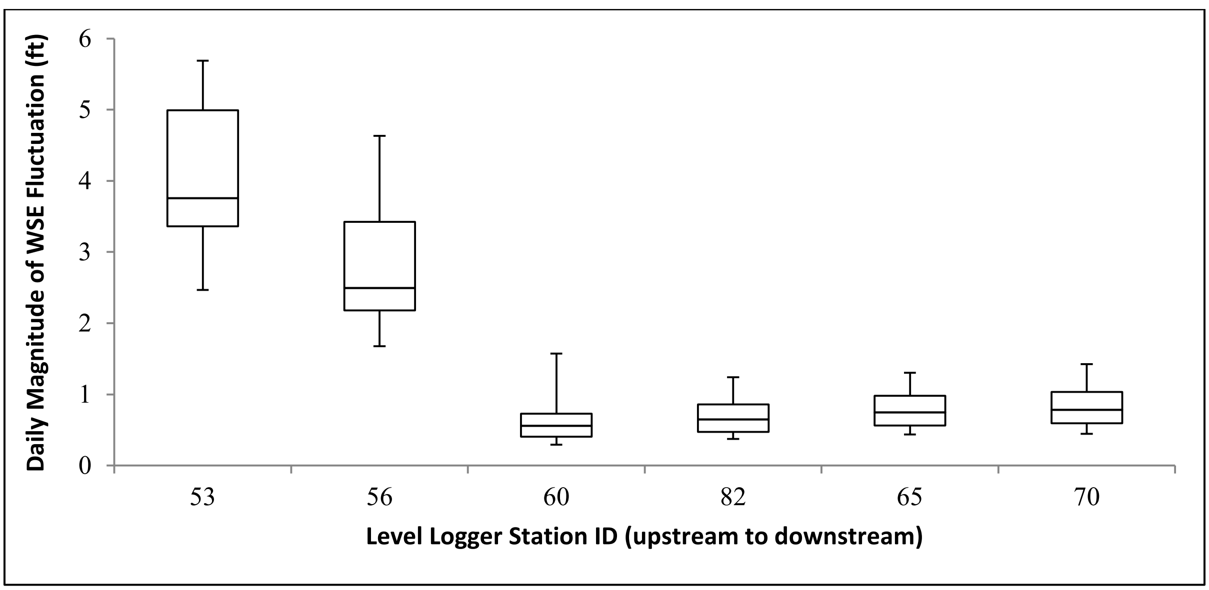


Figure 4-6. Box and whisker plot of the median daily magnitude of WSE fluctuation at mainstem level logger stations in the project-affected reach between Bellows Falls and Vernon dams. Note: Boxes indicate the 25th, 50th (median) and 75th percentiles of occurrence and whiskers represent the 10th and 90th percentiles of occurrence. Stations are arranged from upstream (left side of figure) to downstream (right side of figure).

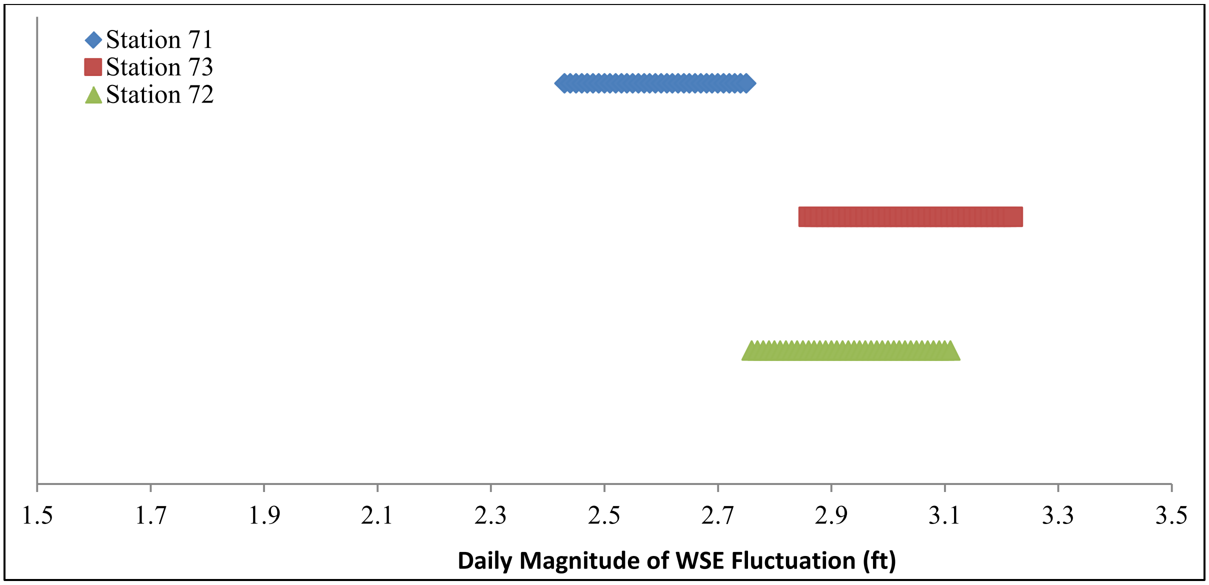


Figure 4-7. The 95% confidence interval ranges for the mean daily magnitude of WSE fluctuation at mainstem level logger stations in the 1.5 mile reach downstream of Vernon dam. Note: Stations are arranged from upstream (top of figure) to downstream (bottom of figure).

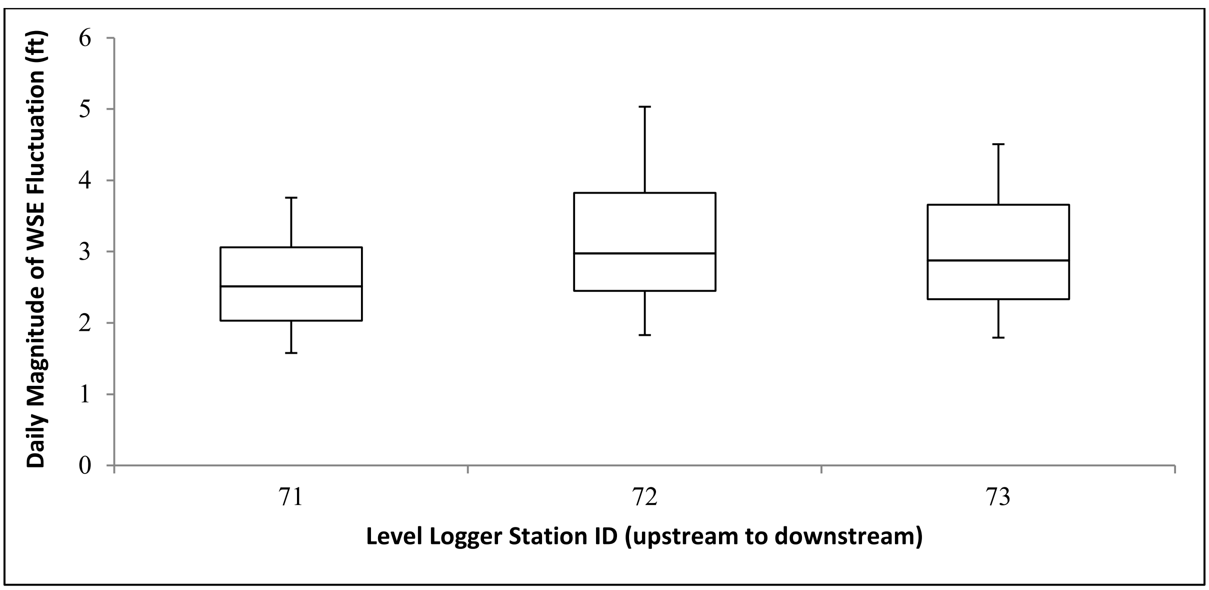


Figure 4-8. Box and whisker plot of the median daily magnitude of WSE fluctuation at mainstem level logger stations in the 1.5 mile reach downstream of Vernon dam. Note: Boxes indicate the 25th, 50th (median) and 75th percentiles of occurrence and whiskers represent the 10th and 90th percentiles of occurrence. Stations are arranged from upstream (left side of figure) to downstream (right side of figure).

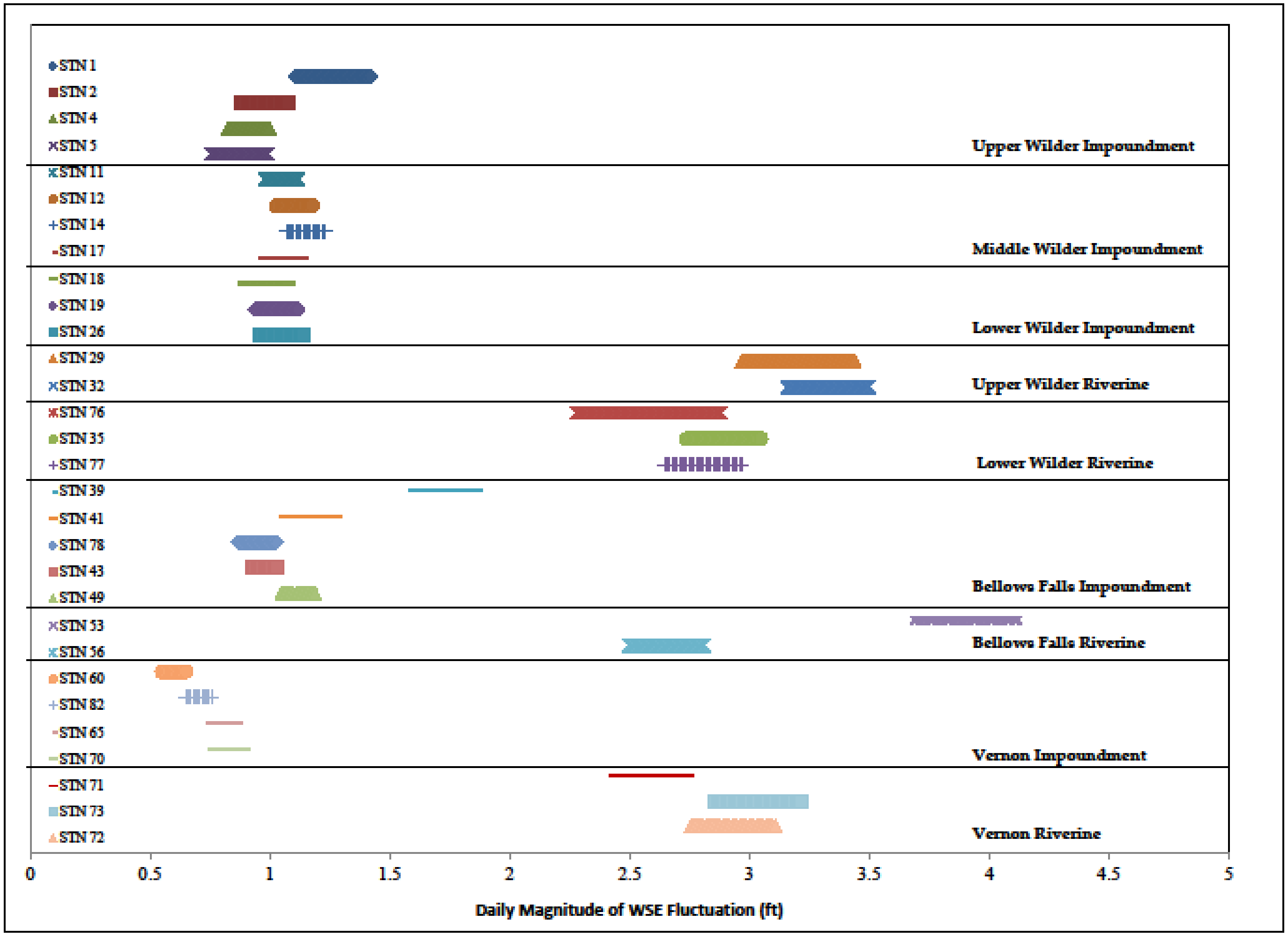


Figure 4-9. The 95% confidence interval ranges for the mean daily magnitude of WSE fluctuation at mainstem level logger stations from the upper end of the Wilder impoundment to downstream of Vernon dam showing the nine sub-reaches defined by project structures, natural breaks and WSE fluctuations.

4.3 Phase 3: 2014 Sampling Location Refinement

Table 4-2 presents the total 180 tributary and backwater locations determined to contain a water depth of less than or equal to one foot at one or more sample points under low water conditions (Section 4.1) sorted by strata defined by project structures, natural river breaks, and their magnitude of daily WSE fluctuation (Section 4.2). It should be noted that for tributaries and backwaters assigned a classification of shallow, access is not necessarily limited. Water depths calculated for classifying sites as shallow or adequate may not represent actual conditions within a tributary as actual water depths at those locations are dependent not only on project operations but also on inflow from the tributary itself. Second order streams (29% of total) and backwater areas (22% of total) comprised the majority of the potential 2014 study site locations across all stratified sections of the study area.

In an effort to ensure that study efforts during 2014 focused on tributary or backwater areas with the greatest likelihood of potential impacts to access related to project operations, available information for each tributary type (stream order -99, 1, 2, 3, 4, 5 and 6) and backwaters were reviewed.

Stream Order -99:

Tributaries assigned a stream order of -99 in the National Hydrography flowline dataset are locations which represent drainage flow and are likely ephemeral in nature. This tributary type represented <2% of the total number of potential study sites (Table 4-2). Due to their seasonal accessibility and limited contribution to the overall fisheries habitat within the study reach these sites were excluded from consideration for detailed study during 2014.

Stream Order 1:

Tributaries assigned a stream order of 1 represented 17% of the total number of potential study sites (Table 4-2). As defined in the National Hydrography flowline dataset, bodies of water assigned a stream order of 1 may be either recurrent (i.e., intermittent) or perennial and as such may only retain water within the channel for part of the year. As requested at the July 1, 2014 working group conference call, all of the tributaries assigned a stream order of 1 were included in the random selection process which selected the study sites to be sampled in detail during 2014.

Stream Order 2 and 3:

Tributaries assigned a stream order of 2 or 3 represented 29% and 18%, respectively, of the total number of potential study sites (Table 4-2). All of these locations were included in the random selection process which selected the study sites to be sampled in detail during 2014.

Stream Order 4, 5, 6:

Tributaries assigned a stream order of 4, 5, or 6 represented 8%, 3%, and 2%, respectively, of the total number of potential study sites (Table 4-2). Plan views for each tributary with a stream order of 4, 5 or 6 were constructed to display the spatial distribution of water depths within the project-affected portion of the tributary under low flow conditions (as measured by the nearest mainstem level logger; Appendix C). Based upon visual interpretation of available water depths, it was felt that when combined with natural inflow from the tributary itself, access through the project-affected area would not be impacted in the larger order tributaries (orders 4, 5, and 6). As a result, the majority of these sites were excluded from consideration for detailed study of fish access during 2014. As requested following the July 1, 2014 working group conference call, the Cold River (a major stream order 5 tributary in the Bellows Falls riverine reach, see Figure C-20 in Appendix C) was included as a site of interest for assessment of fish access. Collection of access information at the Cold River will be performed in addition to the 36 randomly selected locations chosen in section 4.4 of this report.

Backwaters:

Backwater areas represented 22% of the total number of potential study sites (Table 4-2). All of these locations were included in the random selection process which selected the study sites to be sampled in detail during 2014.

4.4 Phase 4: Randomization and Selection of 2014 Sampling Locations

Following the exclusions detailed in phases 1 and 3 of the revised selection process, a total of 154 of the 192 total tributary and backwater confluences identified along the Connecticut River from the upstream end of the Wilder impoundment to downstream of Vernon dam, were considered potential candidates for detailed study during 2014. Of the 154 potential locations, a total of 36 (~23%) sites were randomly selected. Based on working group comments, potential locations within the riverine portions of the study area were weighted two times higher than potential locations within the impounded sections during random selection. This was done to increase their likelihood of selection as the working group felt that due to the increased magnitude of WSE fluctuations in riverine sections, the probability of access issues was greater for those locations. Randomly selected locations were chosen within the nine sub-reaches defined by project structures, naturally occurring river breaks and the magnitude of daily WSE fluctuations (see Section 4.2) based on the proportion of the total number of potential locations:

- Upper Wilder Impoundment – 4 locations
- Middle Wilder Impoundment – 5 locations
- Lower Wilder Impoundment – 5 locations
- Upper Wilder Riverine – 2 locations
- Lower Wilder Riverine – 3 locations
- Bellows Falls Impoundment – 6 locations

- Bellows Falls Riverine – 2 locations
- Vernon Impoundment – 7 locations
- Vernon Riverine – 2 locations

Following the distribution of the 36 randomly selected sampling locations among the nine sub-reaches of the study area, the subset of locations assigned to a particular sub-reach were randomly distributed among potential sampling locations in proportion to stream type. For example, as stated above, 5 of the 36 study locations were assigned to the middle Wilder impoundment. Within that 15-mile reach of river, there are five stream order 1 tributaries, five stream order 2 tributaries, six stream order 3 tributaries and eleven backwaters which are potential candidates for selection (Table 4-2). Contribution of each stream type to the total number of potential locations within the middle Wilder impoundment sub-reach was determined as 19% for stream order 1 (5 of the 27 potential sites), 19% for stream order 2 (5 of the 27 potential sites), 22% for stream order 3 (6 of the potential 27 sites), and 41% for backwaters (11 of the potential 27 sites). This resulted in the random selection of one stream order 1 location, one stream order 2 location, one stream order 3 location and two backwater locations for assessment of access during 2014 in the middle Wilder impoundment sub-reach.

In the event that locations lacking detailed bed elevation data were selected for further study, a contingency site within the same river reach and of the same stream order (if available) was also selected. Should initial investigation of any randomly selected locations currently lacking elevation data indicate that access is not impeded (i.e., depths greater than one foot) the contingency site will be substituted. Table 4-3 lists the primary sampling sites identified during the random selection process. Contingency sites (where necessary) are listed in Table 4-4. As requested at the July 1, 2014 working group conference call, Table 4-5 includes stream order information for the 36 primary sampling sites. Figures 4-10 through 4-12 show both the primary and contingency site locations.

Table 4-2. Distribution (by stream order and river section) of the 180 potential study locations determined to contain a water depth of less than or equal to one foot at low water.

Description	Minor Tributaries (by stream order)			Major Tributaries (by stream order)				No. of S.O. 1-3 tribs in the reach	No. of S.O. 1-3 tribs randomly selected	No. of backwaters in the reach*	No. of backwaters randomly selected
	< 1	1*	2*	3*	4	5	6				
Upper Wilder Impoundment			6	1	2	1		7	2	6	2
Middle Wilder Impoundment		5	5	6				16	3	11	2
Lower Wilder Impoundment		9	7	4	1	1		20	4	9	1
Upper Wilder Riverine		2	2				1	4	2		0
Lower Wilder Riverine		3	2	2	2			7	3		0
Bellows Impoundment		4	11	7	4	2	1	22	5	5	1
Bellows Riverine			1	2		1		3	2		0
Vernon Impoundment	2	6	16	10	6		1	32	6	8	1
Vernon Riverine	1	1	2	1				4	2		0
Total	**3**	**30**	**52**	**33**	**15**	**5**	**3**	**115**	**29**	**39**	**7**

*Asterisk indicates potential candidate locations for assessment of access during 2014

Table 4-3. Tributary and backwater locations randomly selected for assessment as part of Study 13 during 2014.

Site ID	Sub Reach	Type	Waterbody Name	Stream Order	Coordinates	
CT-W-1.01	Upper Wilder	Minor Trib	Harriman Brook	2	-72.043789	44.087891
CT-W-1.05	Upper Wilder	Backwater		0	-72.067176	44.058021
CT-W-1.06	Upper Wilder	Minor Trib		2	-72.068263	44.057211
CT-W-1.16	Upper Wilder	Backwater		0	-72.116927	43.992195
CT-W-1.22	Middle Wilder	Major Trib	Indian Pond Brook	3	-72.096067	43.963445
CT-W-1.23	Middle Wilder	Minor Trib		1	-72.116113	43.947391
CT-W-1.28	Middle Wilder	Backwater		0	-72.128038	43.913834
CT-W-1.34	Middle Wilder	Minor Trib		2	-72.171864	43.87589
CT-W-1.44	Middle Wilder	Backwater		0	-72.183827	43.841237
CT-W-1.47	Lower Wilder	Minor Trib		1	-72.185333	43.816672
CT-W-1.48	Lower Wilder	Major Trib	Grant Brook	3	-72.186158	43.801778
CT-W-1.55	Lower Wilder	Minor Trib		1	-72.204879	43.770009

Site ID	Sub Reach	Type	Waterbody Name	Stream Order	Coordinates	
CT-W-1.59	Lower Wilder	Backwater		0	-72.227711	43.756159
CT-W-1.67	Lower Wilder	Minor Trib		2	-72.267375	43.734246
CT-WR-2.01	Upper Wilder Riverine	Minor Trib		2	-72.308929	43.6619
CT-WR-2.07	Upper Wilder Riverine	Minor Trib	Hanchetts Brook	1	-72.33718	43.595029
CT-WR-2.10	Lower Wilder Riverine	Minor Trib	McArthur Brook	2	-72.380636	43.540433
CT-WR-2.11	Lower Wilder Riverine	Major Trib	Lulls Brook	3	-72.393608	43.527828
CT-WR-2.13	Lower Wilder Riverine	Minor Trib	Bashan Brook	1	-72.398248	43.510763
CT-B-3.07	Bellows	Major Trib	Barkmill Brook	3	-72.412279	43.362394
CT-B-3.10	Bellows	Minor Trib		1	-72.394886	43.345417
CT-B-3.19	Bellows	Backwater		0	-72.431303	43.260732
CT-B-3.24	Bellows	Major Trib	Commissary Brook	3	-72.440597	43.213887
CT-B-3.27	Bellows	Minor Trib		2	-72.449136	43.192375
CT-B-3.35	Bellows	Minor Trib		2	-72.452103	43.142063
CT-BR-4.03	Bellows Riverine	Minor Trib		2	-72.440915	43.097277
CT-BR-4.04	Bellows Riverine	Major Trib	Cobb Brook	3	-72.438781	43.094376
CT-V-5.02	Vernon	Minor Trib	Mad Brook	2	-72.432666	43.085102
CT-V-5.04	Vernon	Major Trib		3	-72.450288	43.068487
CT-V-5.19	Vernon	Minor Trib		1	-72.471748	42.971787
CT-V-5.28	Vernon	Major Trib	Salmon Brook	3	-72.526038	42.933915
CT-V-5.31	Vernon	Minor Trib		2	-72.521983	42.918029
CT-V-5.36	Vernon	Minor Trib		2	-72.550993	42.882986
CT-V-5.50	Vernon	Backwater		0	-72.523771	42.795522
CT-VR-6.05	Vernon Riverine	Minor Trib		1	-72.498398	42.774687
CT-VR-6.01	Vernon Riverine	Minor Trib		2	-72.516318	42.768916

Table 4-4. Contingency site numbers for replacement of tributary and backwater locations randomly selected for assessment as part of Study 13 during 2014.

Primary Site ID	Contingency Site ID	Reach	Type	Waterbody Name
CT-W-1.06	CT-W-1.08	Upper Wilder	Minor Trib	
CT-W-1.23	CT-W-1.24	Middle Wilder	Minor Trib	
CT-WR-2.01	CT-WR-2.09	Upper Wilder Riverine	Minor Trib	Beaver Brook
CT-WR-2.07	CT-WR-2.04	Upper Wilder Riverine	Minor Trib	

CT-WR-2.10	CT-WR-2.12	Lower Wilder Riverine	Minor Trib	
CT-WR-2.13	CT-WR-2.15	Lower Wilder Riverine	Minor Trib	
CT-B-3.10	CT-B-3.23	Bellows	Minor Trib	
CT-BR-4.03	CT-BR-4.06	Bellows Riverine	Major Trib	
CT-V-5.02	CT-V-5.15	Vernon	Minor Trib	
CT-V-5.04	CT-V-5.12	Vernon	Major Trib	
CT-V-5.19	CT-V-5.33	Vernon	Minor Trib	
CT-V-5.31	CT-V-5.51	Vernon	Minor Trib	
CT-V-5.36	CT-V-5.30	Vernon	Minor Trib	Governors Brook
CT-VR-6.05	CT-VR-6.02	Vernon Riverine	Major Trib	
CT-VR-6.01	CT-VR-6.04	Vernon Riverine	Minor Trib	

Table 4-5. Stream order information for tributary and backwater locations selected for assessment as part of Study 13 (36 randomly selected locations plus the Cold River).

Study Reach	Backwater	Minor Trib (S.O. = 1)	Minor Trib (S.O. = 2)	Major Trib (S.O. = 3)	Major Trib (S.O. > 3)	Total
Upper Wilder	2		2			4
Middle Wilder	2	1	1	1		5
Lower Wilder	1	2	1	1		5
Upper Wilder Riverine		1	1			2
Lower Wilder Riverine		1	1	1		3
Bellows	1	1	2	2		6
Bellows Riverine			1	1	1*	3
Vernon	1	1	3	2		7
Vernon Riverine		1	1			2
Grand Total	**7**	**8**	**13**	**8**	**1**	**37**

* Cold River

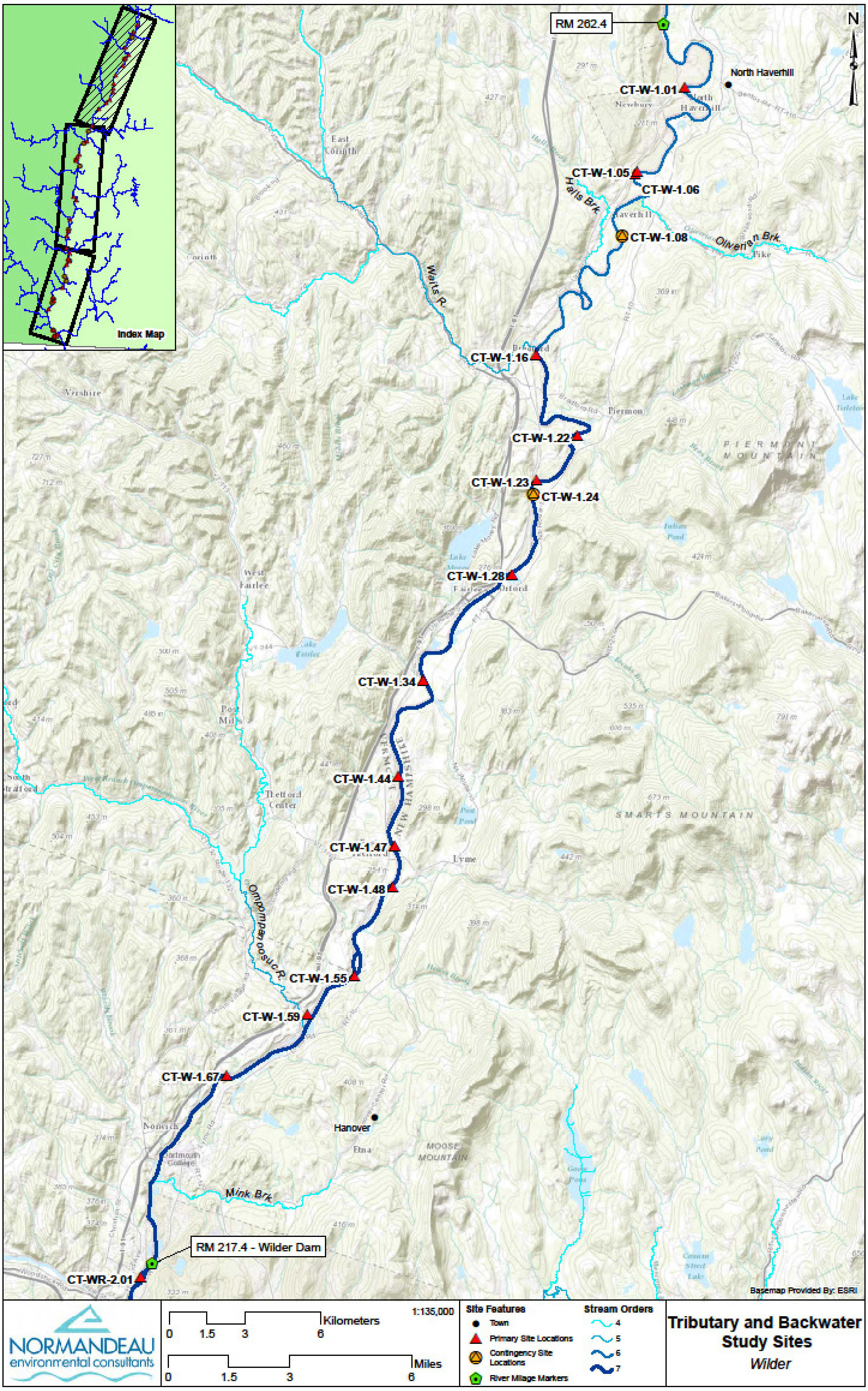


Figure 4-10. Randomly selected primary and contingency study sites within the Wilder impoundment.

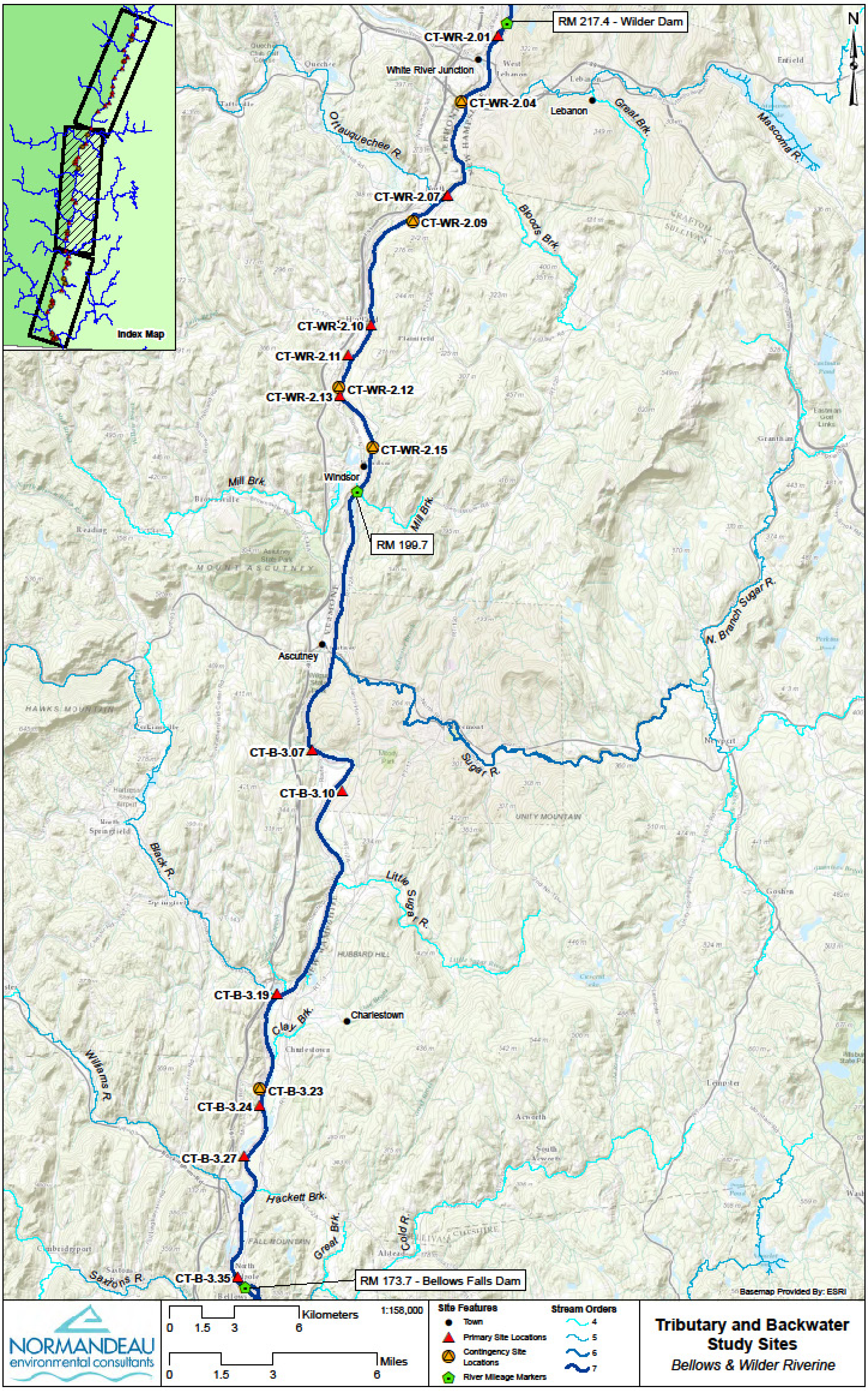


Figure 4-11. Randomly selected primary and contingency study sites within the riverine reach downstream of Wilder and Bellows Falls impoundment.

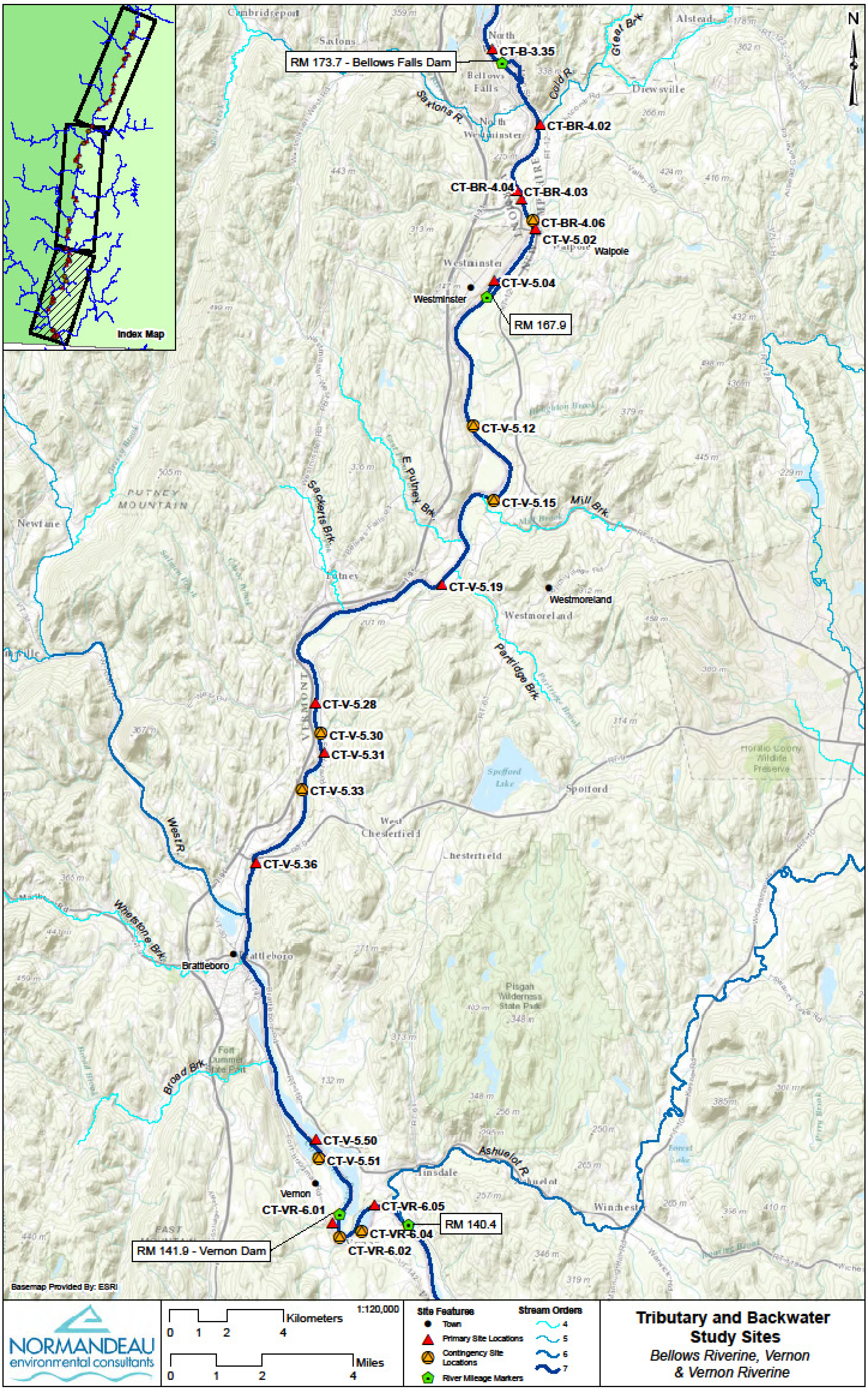


Figure 4-12. Randomly selected primary and contingency study sites within the riverine reach downstream of Bellows Falls,Vernon impoundment, and riverine reach downstream of Vernon.

5. 2014 SAMPLING PROCEDURES

Each randomly selected site and the Cold River will be initially visited during July 2014. The revised study plan approved by FERC in February 2014 assumed that initial visits would occur in May; however, delays due to persistent high water and pending outcomes from the working group meeting (as well as follow up conference call and comments on the revised site selection report) have precluded site visits so far this year. At the May 23, 2014 meeting, a participant noted that the study plan included planned field work from early spring 2014 through early spring 2015. TransCanada indicated that the timing was based on the timing of other fish spawning studies originally planned to be conducted concurrently in 2014, but now delayed until 2015 due to the closure of Vermont Yankee. The study plan stated that water level recorders would be installed to capture early spring flows; however, some water level recorders were over-wintered so that data is already available. TransCanada also noted that early spring runoff conditions and high flows are not project-based operations, so it should not affect the study if the spring field effort is excluded, nor is this study related to spring fish spawning (as one participant mentioned), but rather to physical access only. Several other studies in 2015 will be focused on spawning and additional water level recorders will be installed for those studies. Therefore, delaying initial site visits and early season monthly visits (e.g., June) will not have an impact on this study overall.

For this study two HOBO level loggers will be installed at each selected location and programmed to collect temperature and pressure information at 15-minute intervals. One level logger will be installed in the vicinity of the confluence and the second will be located in the mainstem river, adjacent to the access area of interest. The position and elevation (relative to the project structures) will be recorded for each installed level logger using an RTK unit. In addition, depth and bed elevation information at the confluence of the tributary or backwater and the mainstem will be collected during the initial site visits. Water quality data will be collected in the form of a vertical profile with a minimum of three vertical points collected (surface, mid, bottom). Recorded parameters will include temperature, dissolved oxygen, pH, conductivity and turbidity. The location will be photographed and the date/time of the visit will be recorded to associate conditions at the time of the site visit with project operations at that time.

If flows allow, each location will be visited monthly during August, September and October. Level loggers will be checked and downloaded and the same suite of parameters recorded during July will be collected (i.e., date-time of visit, water depths, water quality parameters, condition photographs). Site visits during October 2014 will represent the final data collection and level loggers will be removed at that time.

Each of the 37 study locations (36 randomly selected locations and the Cold River) examined in detail during 2014 will be included in the hydraulic model (Study 4) as locations of interest. The HEC-RAS model will provide predictions of water surface elevations at each of the tributary/backwater confluences over a range of mainstem inflows and project operations. This information will be used to construct a matrix of accessibility for each location based on river conditions.

6. LITERATURE CITED

Normandeau (Normandeau Associates, Inc.). 2014. ILP Study 7 Aquatic Habitat Mapping Initial Study Report – Draft for Stakeholder Review. Prepared for TransCanada Hydro Northeast Inc. April 25, 2014.

Appendix A

Summary Table of Tributary - Backwater Bed Elevation, Water Surface Elevation and Depth Information

EXCEL DATA FILE IS CONTAINED IN THE

TRANSCANADA INITIAL STUDY REPORT

VOLUME III.D

Appendix B

Daily Magnitude of WSE Fluctuation Values at Mainstem Level Logger Locations

Table B-1. Minimum, maximum, median, 10th, 25th, 75th and 90th percentiles of occurrence of daily magnitude of WSE fluctuation values at mainstem level logger locations (Wilder Impoundment to downstream of Vernon Dam).

	WSE Elevation (ft)							
Project Area	**Station**	**Minimum**	**10th**	**25th**	**50th**	**75th**	**90th**	**Maximum**
Wilder Impoundment	1	0.18	0.46	0.61	1.00	1.73	2.37	4.31
Wilder Impoundment	2	0.27	0.48	0.59	0.85	1.16	1.69	3.40
Wilder Impoundment	4	0.26	0.48	0.61	0.81	1.03	1.48	3.06
Wilder Impoundment	5	0.54	0.58	0.71	0.81	0.93	1.16	1.93
Wilder Impoundment	11	0.19	0.60	0.76	1.00	1.29	1.53	2.22
Wilder Impoundment	12	0.45	0.62	0.79	1.02	1.32	1.71	2.42
Wilder Impoundment	14	0.18	0.62	0.82	1.05	1.46	1.86	2.47
Wilder Impoundment	17	0.27	0.48	0.65	0.97	1.39	1.72	2.33
Wilder Impoundment	18	0.26	0.44	0.60	0.91	1.31	1.63	2.32
Wilder Impoundment	19	0.16	0.43	0.65	0.95	1.39	1.73	2.26
Wilder Impoundment	26	0.28	0.47	0.65	0.95	1.41	1.77	2.53
Riverine DS of Wilder	29	0.01	1.57	2.09	3.39	4.00	4.62	6.97
Riverine DS of Wilder	32	0.33	2.19	2.79	3.49	3.89	4.30	6.13
Riverine DS of Wilder	76	1.11	1.71	1.87	2.62	3.12	3.36	4.36
Riverine DS of Wilder	35	0.27	1.86	2.37	2.98	3.38	3.91	5.54
Riverine DS of Wilder	77	0.26	1.94	2.30	2.89	3.36	3.66	5.17
Bellows Impoundment	39	0.24	0.73	1.17	1.61	2.15	2.66	4.24
Bellows Impoundment	41	0.20	0.57	0.83	1.10	1.34	1.86	3.55
Bellows Impoundment	78	0.13	0.50	0.66	0.85	1.09	1.48	2.92
Bellows Impoundment	43	0.15	0.59	0.80	0.97	1.17	1.33	1.78
Bellows Impoundment	49	0.18	0.68	0.86	1.08	1.33	1.60	3.03
Riverine DS of Bellows	53	0.09	2.47	3.36	3.76	4.99	5.18	5.87
Riverine DS of Bellows	56	0.20	1.68	2.18	2.50	3.42	3.63	4.84
Vernon Impoundment	60	0.01	0.29	0.41	0.56	0.73	0.92	1.77
Vernon Impoundment	82	0.08	0.37	0.47	0.65	0.86	1.11	1.50
Vernon Impoundment	65	0.09	0.44	0.57	0.75	0.98	1.28	1.60
Vernon Impoundment	70	0.10	0.45	0.60	0.78	1.04	1.33	1.72
Riverine DS of Vernon	71	0.55	1.58	2.03	2.51	3.06	3.74	6.01
Riverine DS of Vernon	72	0.35	1.83	2.45	2.98	3.82	4.35	6.36
Riverine DS of Vernon	73	0.36	1.79	2.33	2.87	3.66	4.17	6.17

Appendix C

Bathymetric Plan Views for Stream Order 4, 5, and 6 Locations

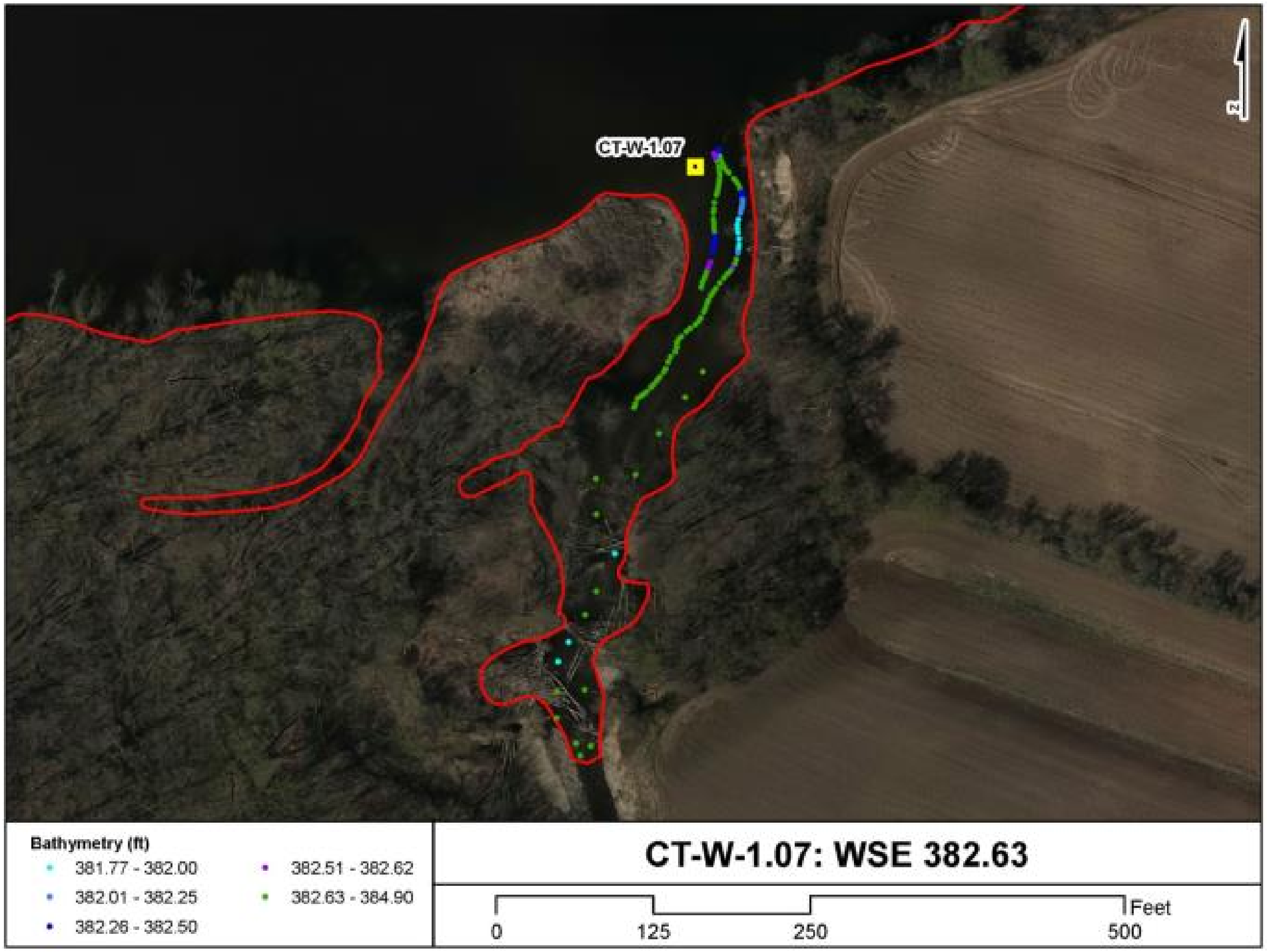


Figure C-1. Plan view of available bathymetry data at tributary site CT-W-1.07 (Oliverian Brook, Stream Order 4). Color scale is relative to the low water elevation of 382.63' as recorded at level logger station 2 (green = dry, blue-pink = deeper-shallower).

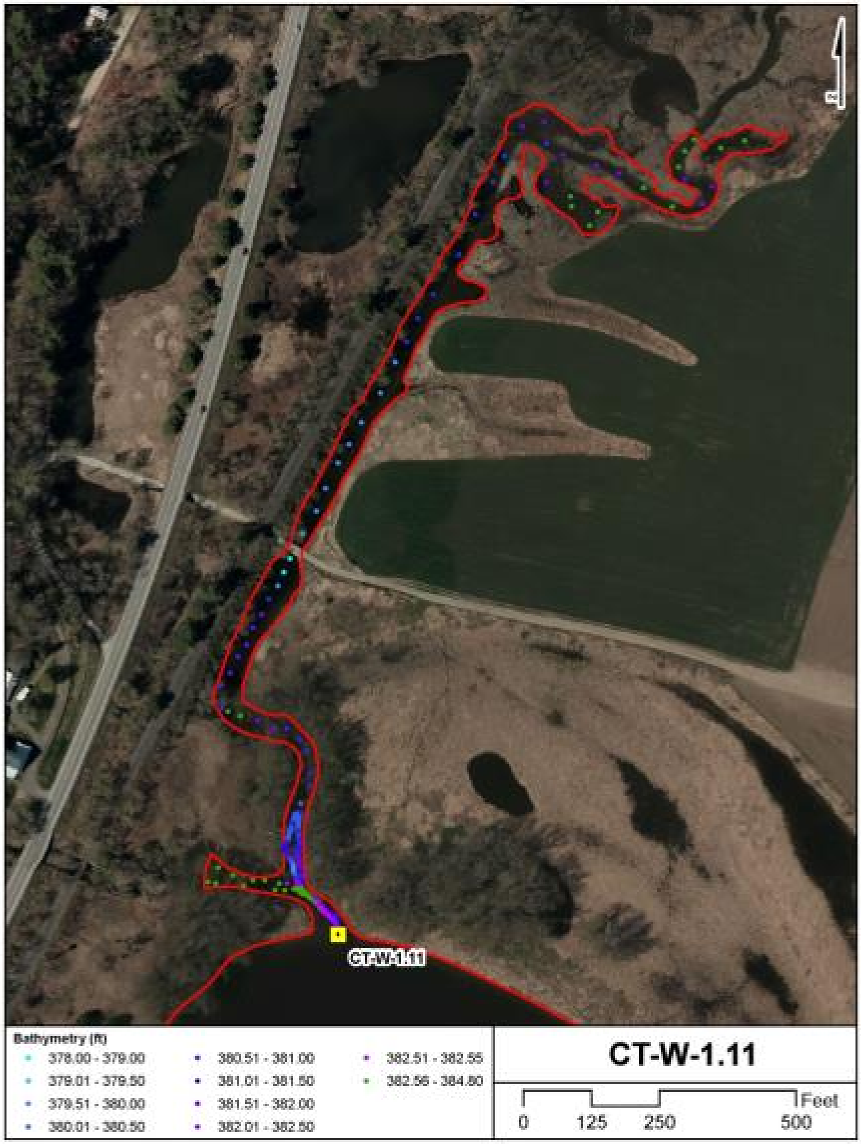


Figure C-2. Plan view of available bathymetry data at tributary site CT-W-1.11 (Halls Brook, Stream Order 4). Color scale is relative to the low water elevation of 382.56' as recorded at level logger station 5 (green = dry, blue-pink = deeper-shallower).

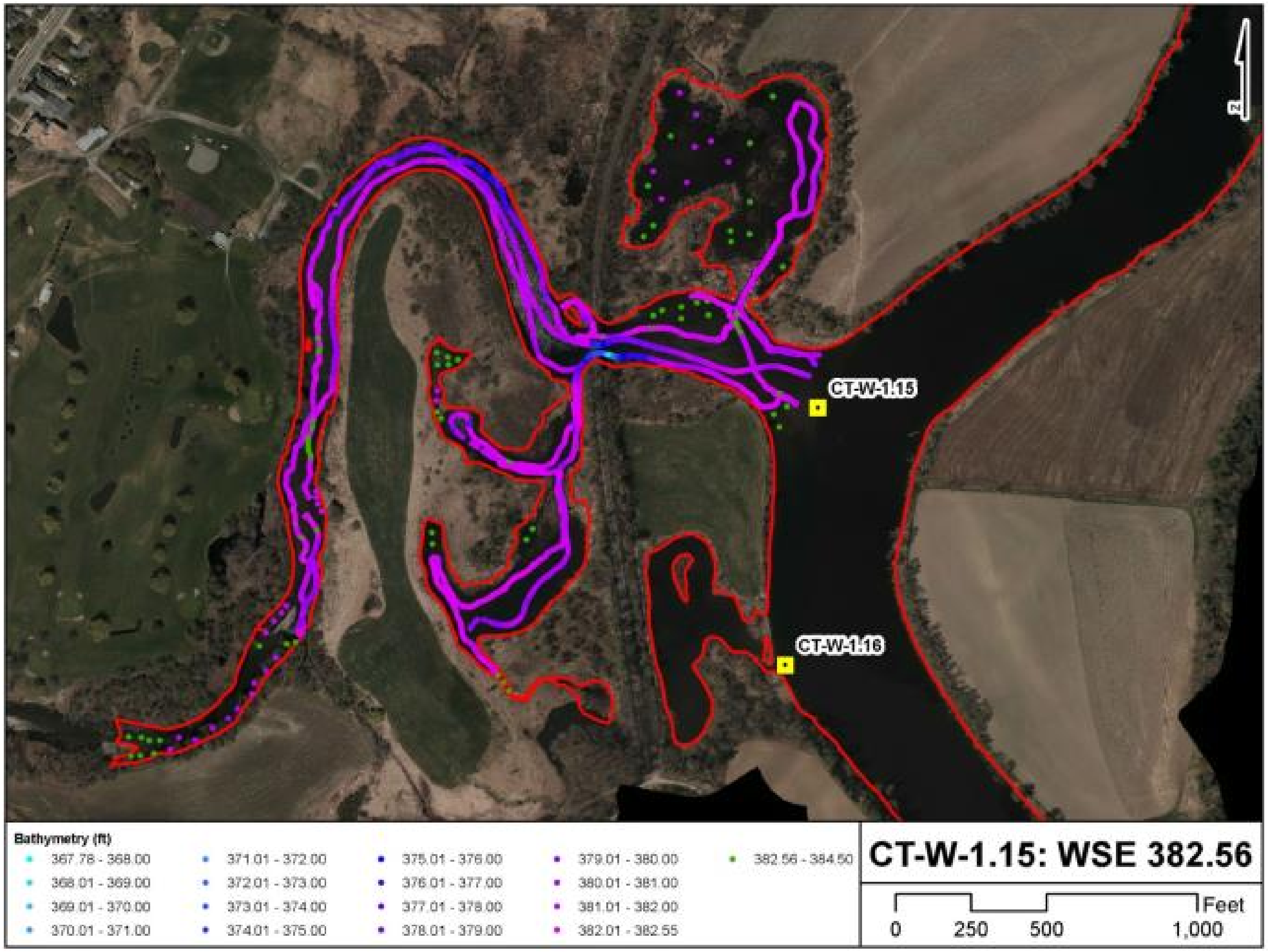


Figure C-3. Plan view of available bathymetry data at tributary site CT-W-1.15 (Waits River, Stream Order 5). Color scale is relative to the low water elevation of 382.56' as recorded at level logger station 5 (green = dry, blue-pink = deeper-shallower).

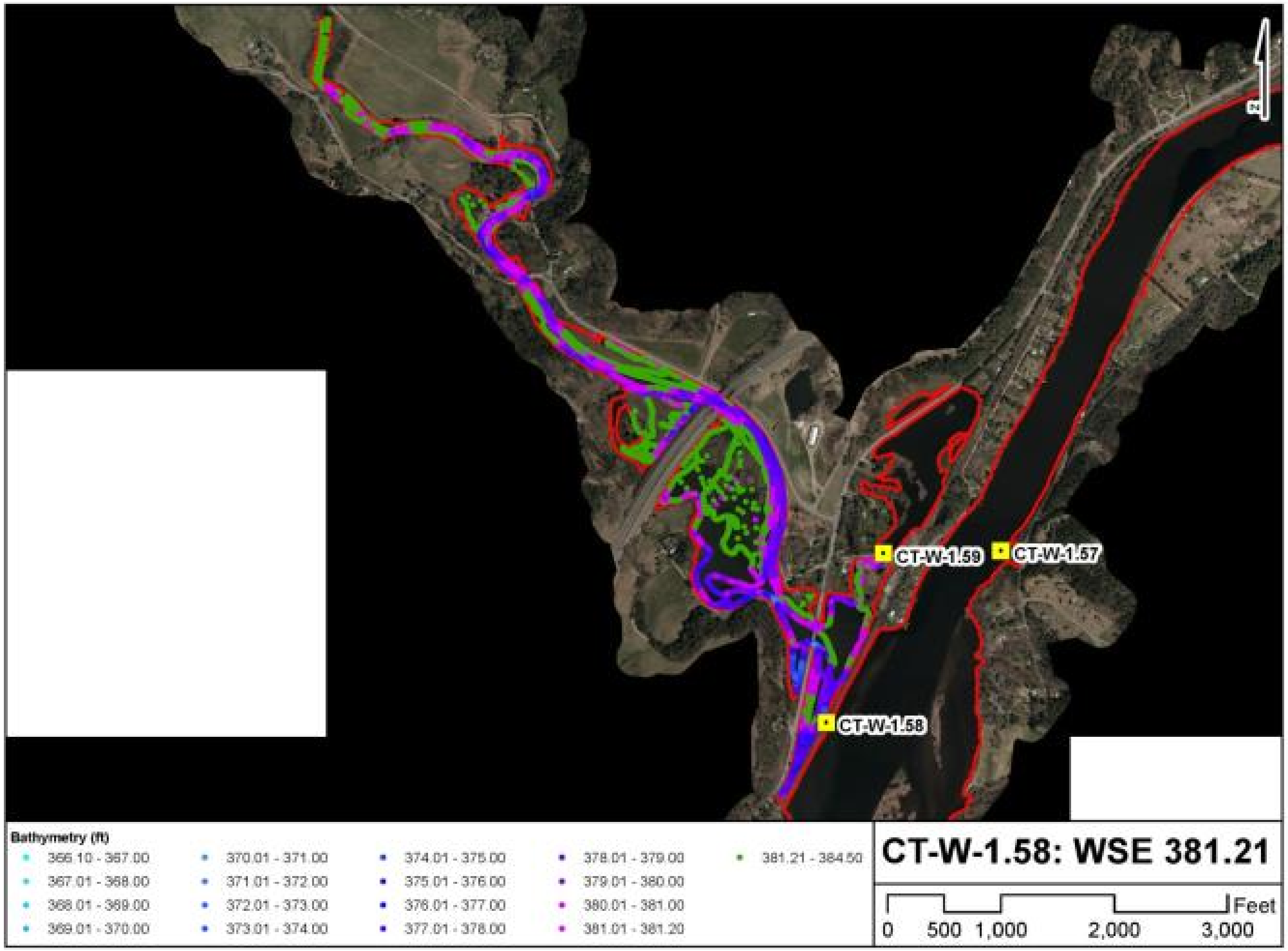


Figure C-4. Plan view of available bathymetry data at tributary site CT-W-1.58 (Ompompanoosuc River, Stream Order 5). Color scale is relative to the low water elevation of 381.21' as recorded at level logger station 19 (green = dry, blue-pink = deeper-shallower).

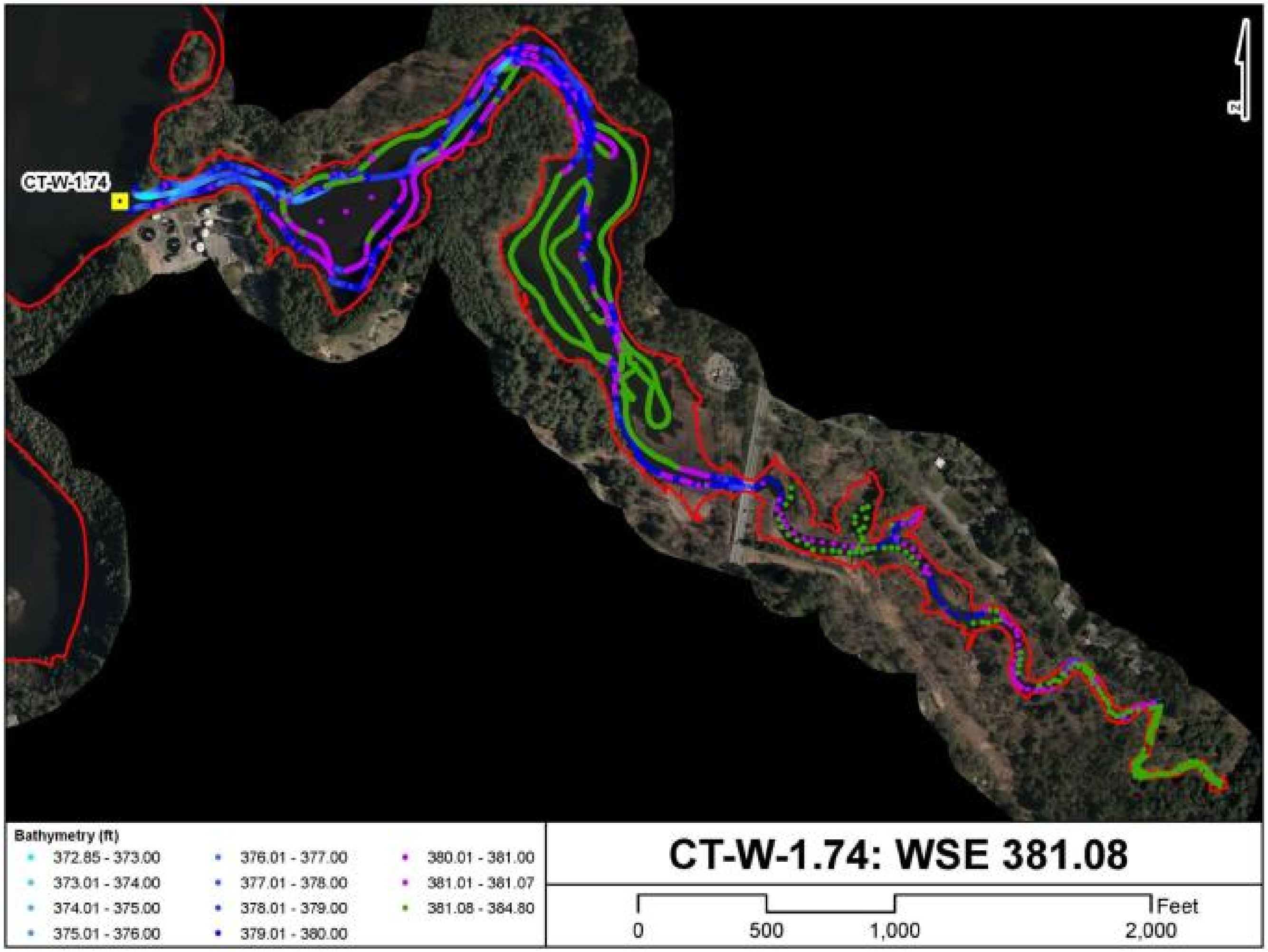


Figure C-5. Plan view of available bathymetry data at tributary site CT-W-1.74 (Mink Brook, Stream Order 4). Color scale is relative to the low water elevation of 381.08' as recorded at level logger station 26 (green = dry, blue-pink = deeper-shallower).

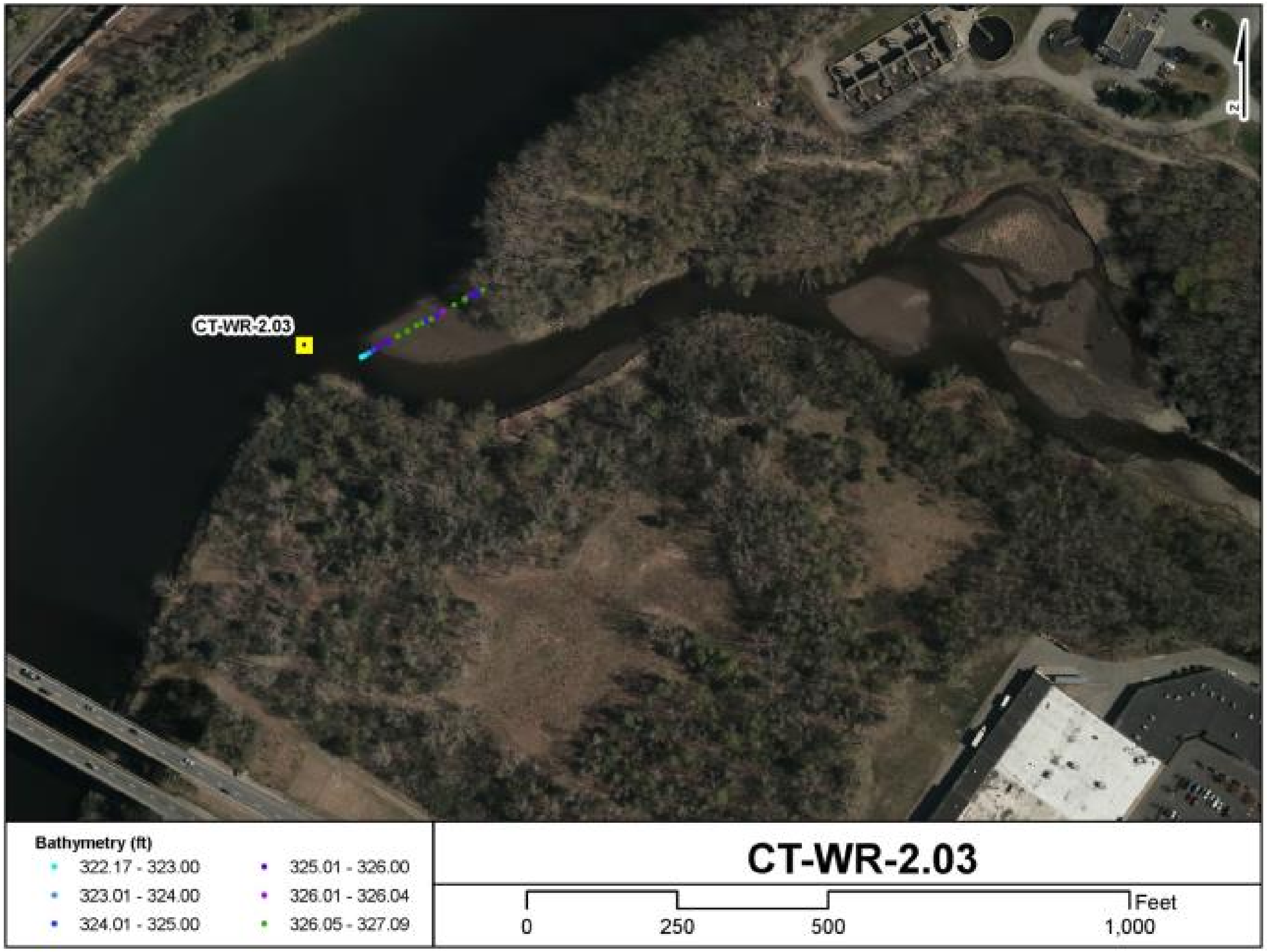


Figure C-6. Plan view of available bathymetry data at tributary site CT-WR-2.03 (Mascoma River, Stream Order 5). Color scale is relative to the low water elevation of 326.05' observed at the time of sampling (green = dry, blue-pink = deeper-shallower).

Figure C-7. Plan view of available bathymetry data at tributary site CT-WR-2.06 (Bloods Brook, Stream Order 4). Color scale is relative to the low water elevation of 322.41’ observed at the time of sampling (green = dry, blue-pink = deeper-shallower).

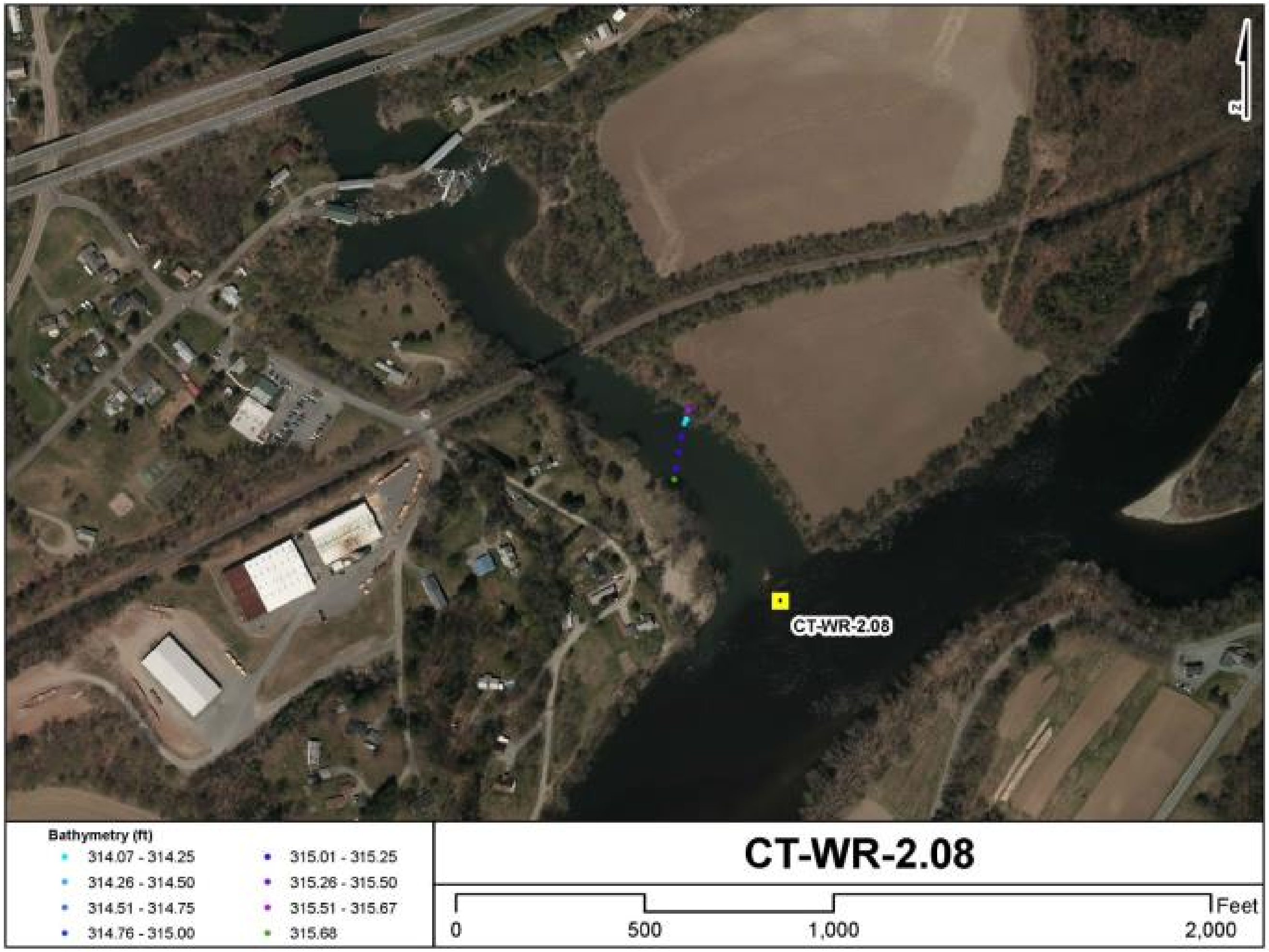


Figure C-8. Plan view of available bathymetry data at tributary site CT-WR-2.08 (Ottauquechee River, Stream Order 5). Color scale is relative to the low water elevation of 315.68' observed at the time of sampling (green = dry, blue-pink = deeper-shallower).

Figure C-9. Plan view of available bathymetry data at tributary site CT-WR-2.18 (Mill Brook (VT), Stream Order 4). Color scale is relative to the low water elevation of 296.81' observed at the time of sampling (green = dry, blue-pink = deeper-shallower).

Figure C-10. Plan view of available bathymetry data at tributary site CT-WR-2.19 (Mill Brook (NH), Stream Order 4). Color scale is relative to the low water elevation of 297.15' observed at the time of sampling (green = dry, blue-pink = deeper-shallower).

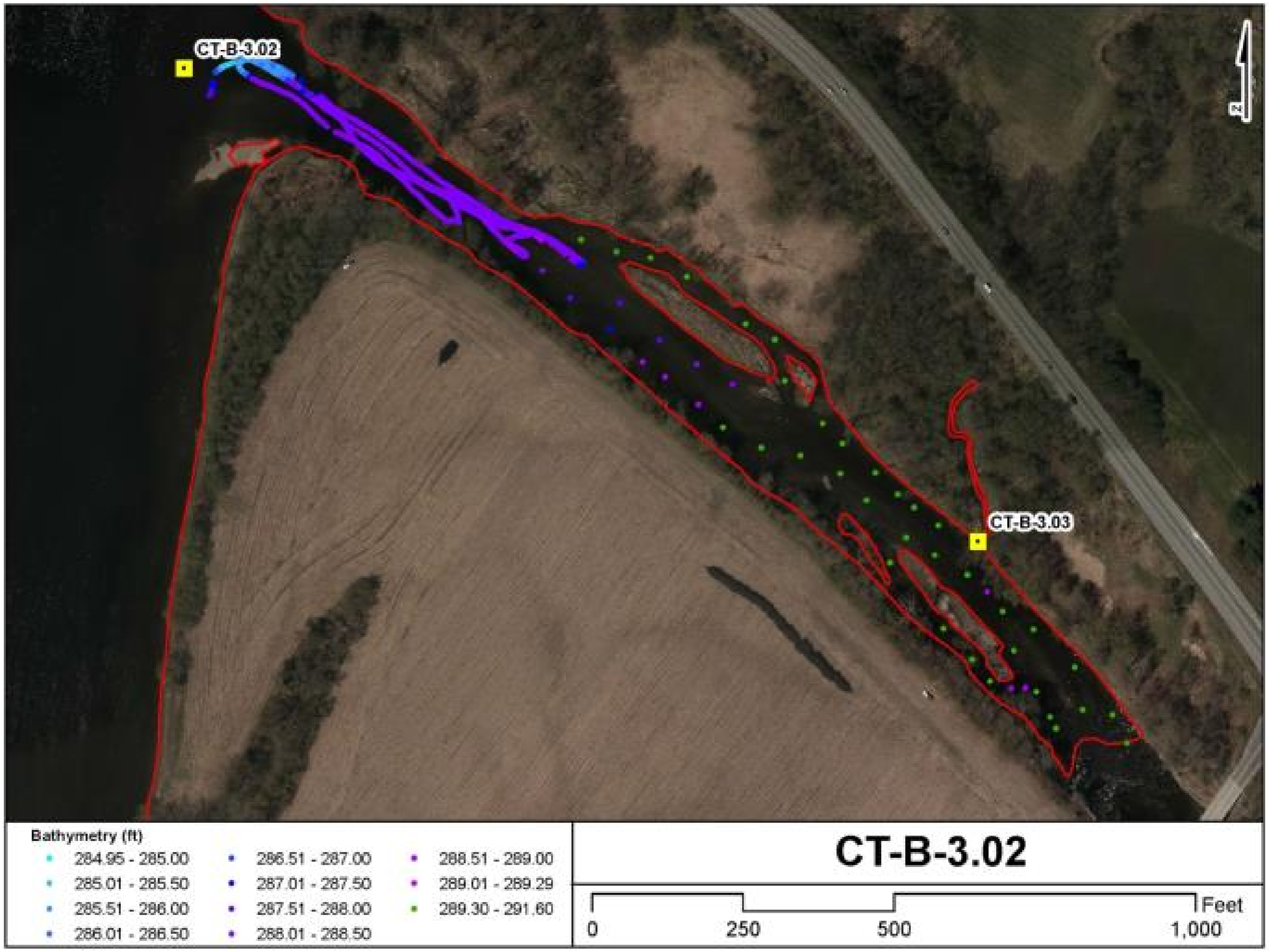


Figure C-11. Plan view of available bathymetry data at tributary site CT-B-3.02 (Sugar River, Stream Order 6). Color scale is relative to the low water elevation of 289.83’ as recorded at level logger station 41 (green = dry, blue-pink = deeper-shallower).

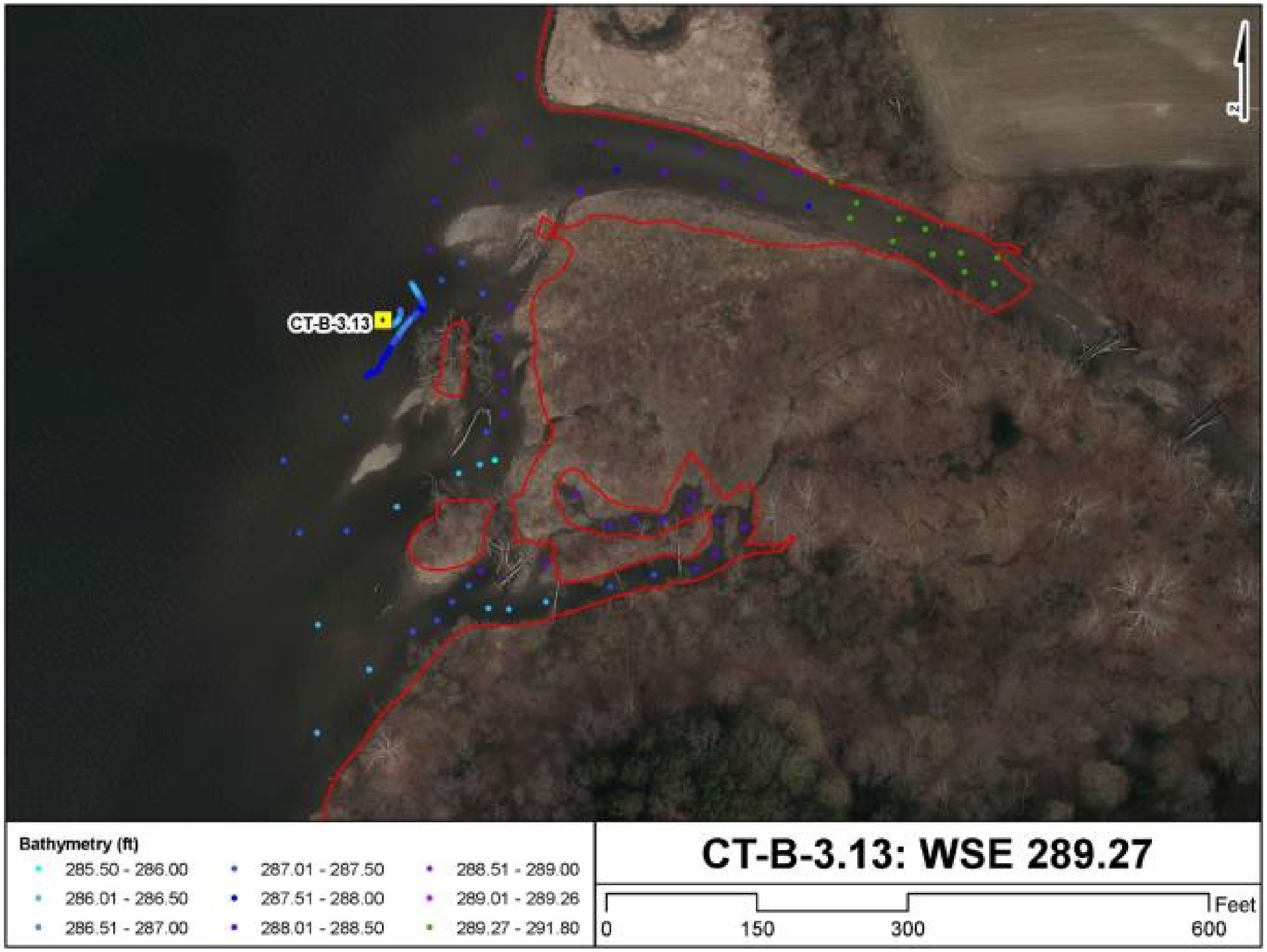


Figure C-12. Plan view of available bathymetry data at tributary site CT-B-3.13 (Little Sugar River, Stream Order 4). Color scale is relative to the low water elevation of 289.27' as recorded at level logger station 43 (green = dry, blue-pink = deeper-shallower).

Figure C-13. Plan view of available bathymetry data at tributary site CT-B-3.16 (Beaver Brook, Stream Order 4). Color scale is relative to the low water elevation of 289.27’ as recorded at level logger station 43 (green = dry, blue-pink = deeper-shallower).

Figure C-14. Plan view of available bathymetry data at tributary site CT-B-3.17 (Spencer Brook, Stream Order 4). Color scale is relative to the low water elevation of 289.27' as recorded at level logger station 43 (green = dry, blue-pink = deeper-shallower).

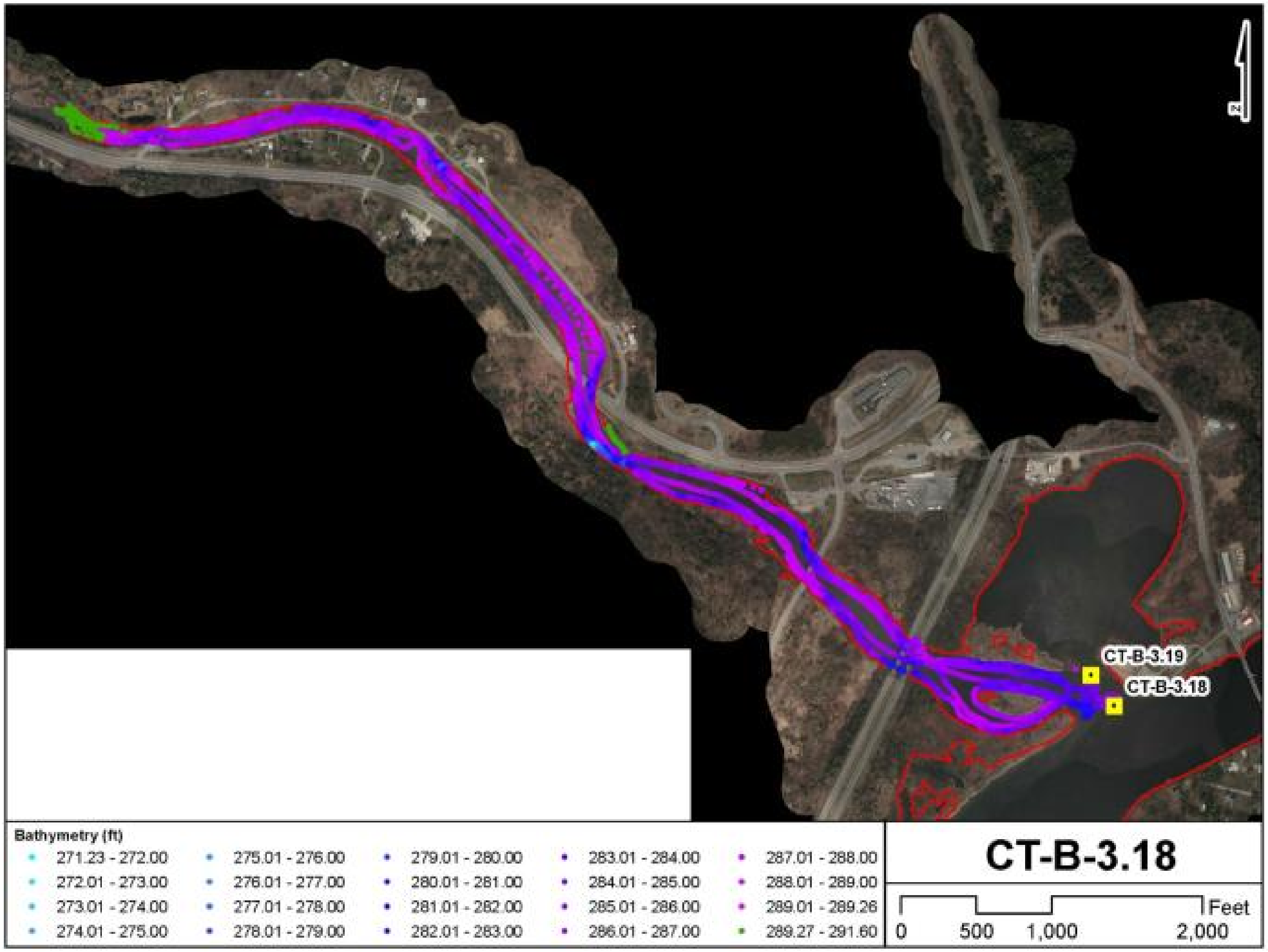


Figure C-15. Plan view of available bathymetry data at tributary site CT-B-3.18 (Black River, Stream Order 5). Color scale is relative to the low water elevation of 289.27’ as recorded at level logger station 43 (green = dry, blue-pink = deeper-shallower).

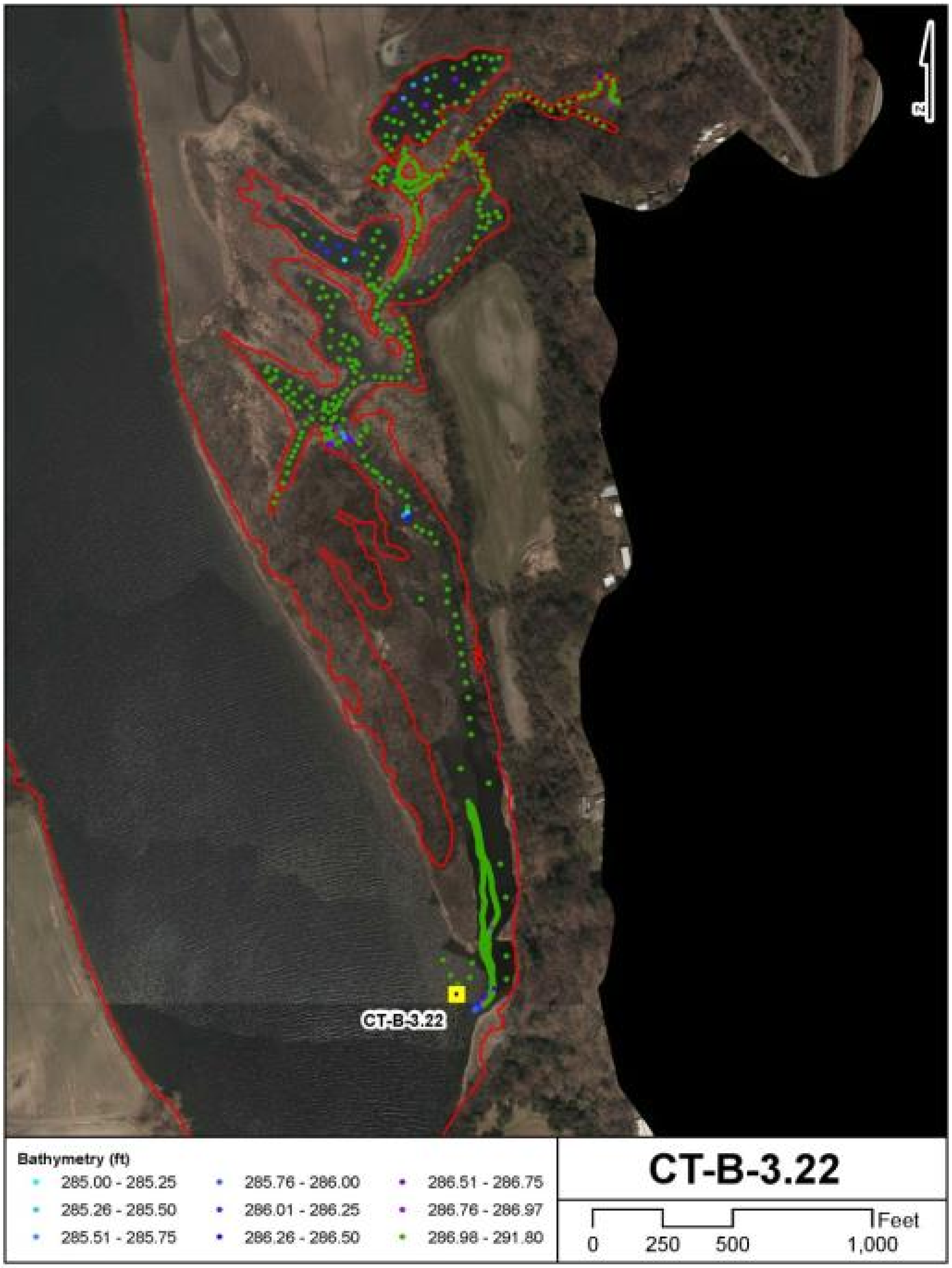


Figure C-16. Plan view of available bathymetry data at tributary site CT-B-3.22 (Clay Brook, Stream Order 4). Color scale is relative to the low water elevation of 286.98' as recorded at level logger station 49 (green = dry, blue-pink = deeper-shallower).

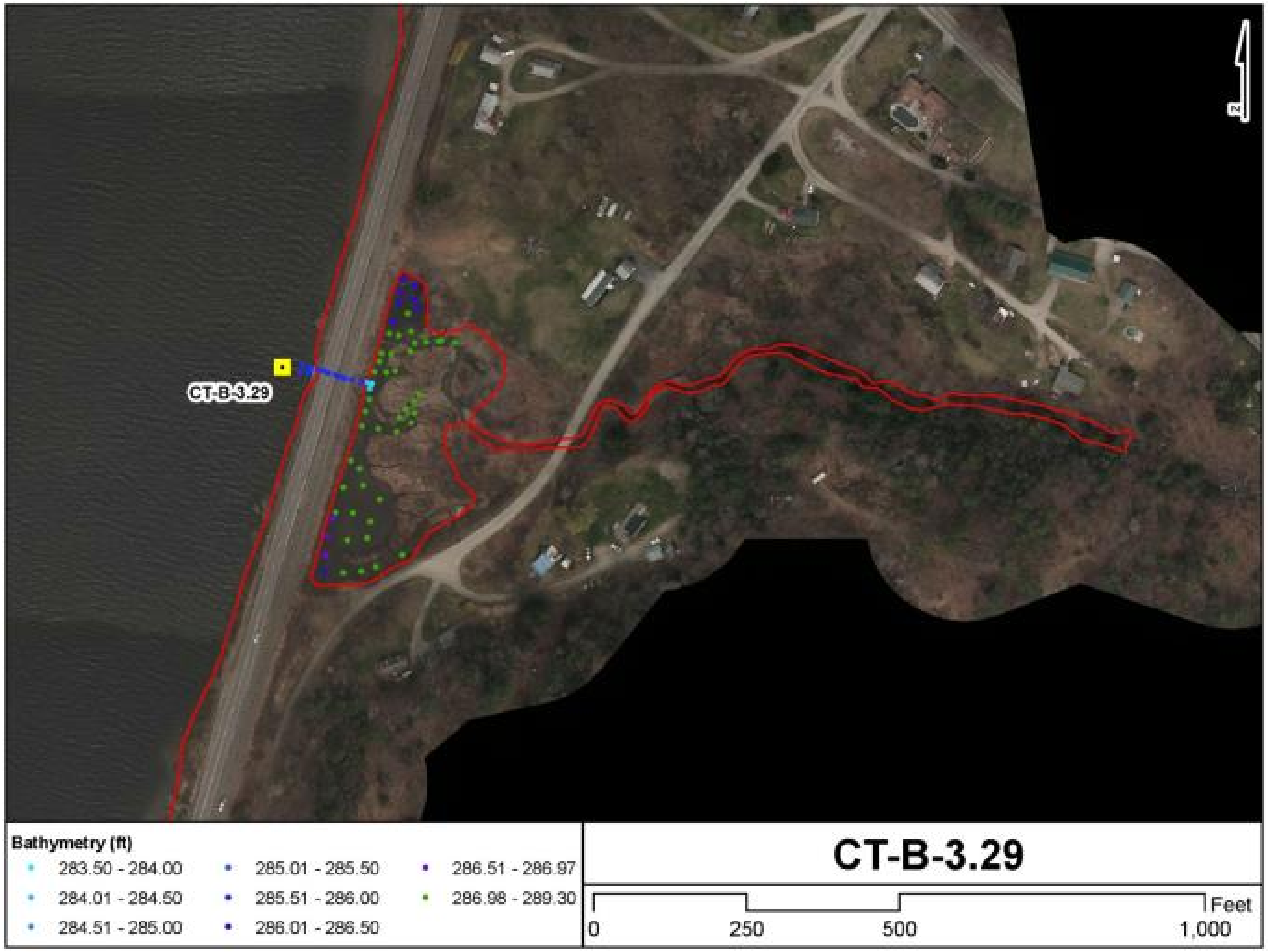


Figure C-17. Plan view of available bathymetry data at tributary site CT-B-3.29 (Jabes Hackett Brook, Stream Order 4). Color scale is relative to the low water elevation of 286.98' as recorded at level logger station 49 (green = dry, blue-pink = deeper-shallower).

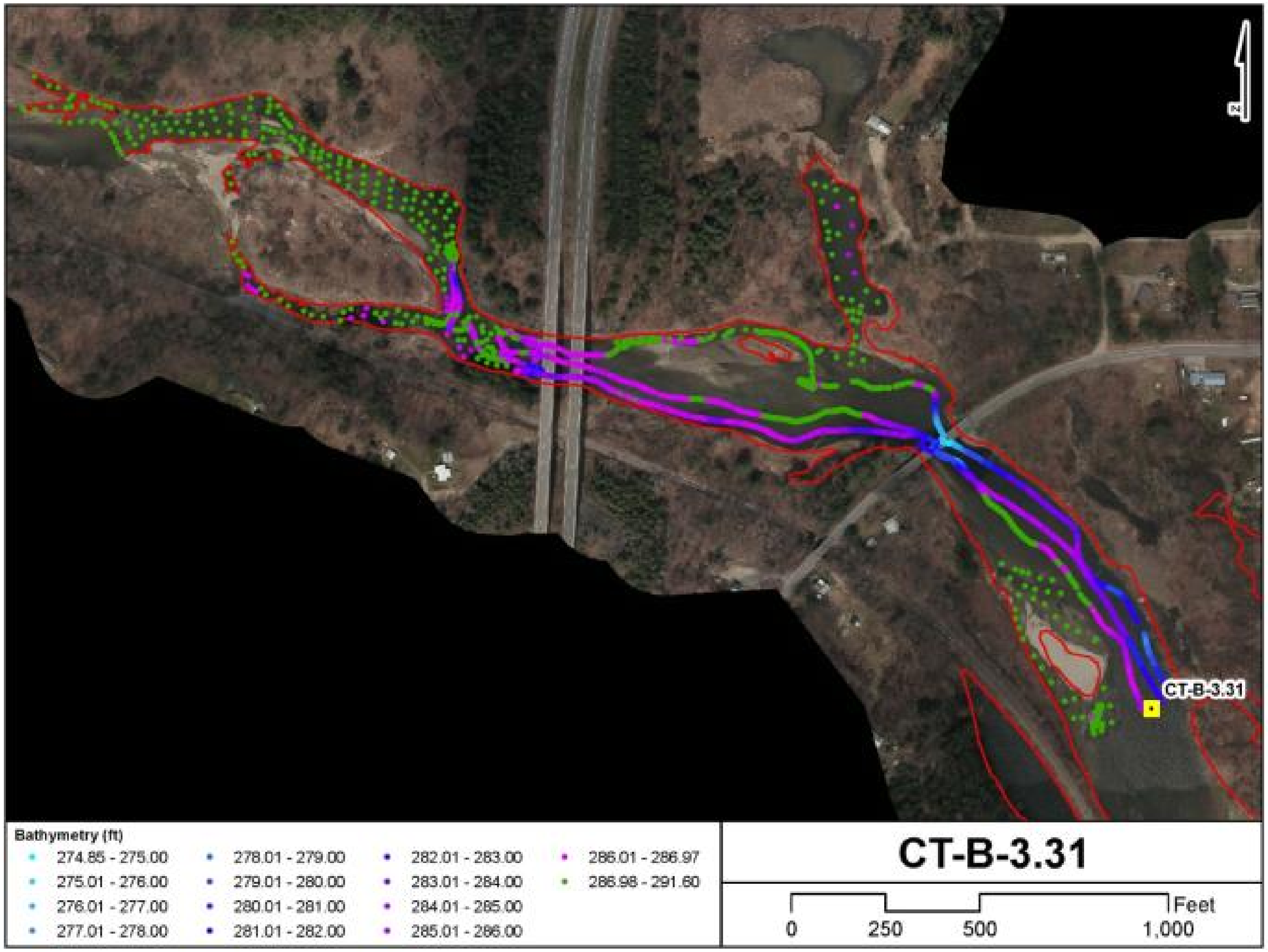


Figure C-18. Plan view of available bathymetry data at tributary site CT-B-3.31 (Williams River, Stream Order 5). Color scale is relative to the low water elevation of 286.98' as recorded at level logger station 49 (green = dry, blue-pink = deeper-shallower).

Figure C-19. Plan view of available bathymetry data at tributary site CT-BR-4.01 (Saxtons River, Stream Order 5). Color scale is relative to the low water elevation of 224.65' observed at the time of sampling (green = dry, blue-pink = deeper-shallower).

Figure C-20. Plan view of available bathymetry data at tributary site CT-BR-4.02 (Cold River, Stream Order 5). Color scale is relative to the low water elevation of 225.16' observed at the time of sampling (green = dry, blue-pink = deeper-shallower).

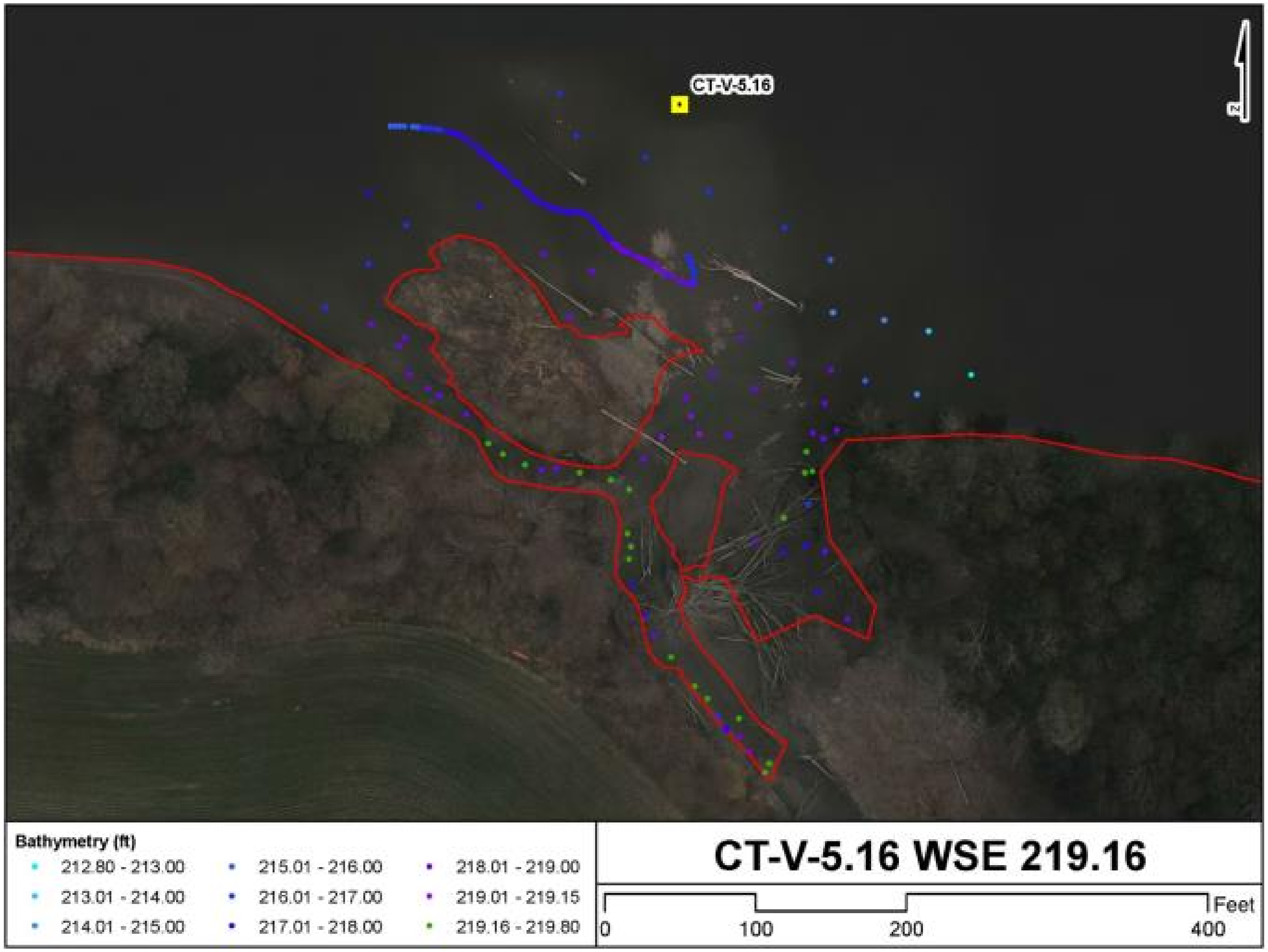


Figure C-21. Plan view of available bathymetry data at tributary site CT-V-5.16 (Mill Brook, Stream Order 4). Color scale is relative to the low water elevation of 219.16' as recorded at level logger station 60 (green = dry, blue-pink = deeper-shallower).

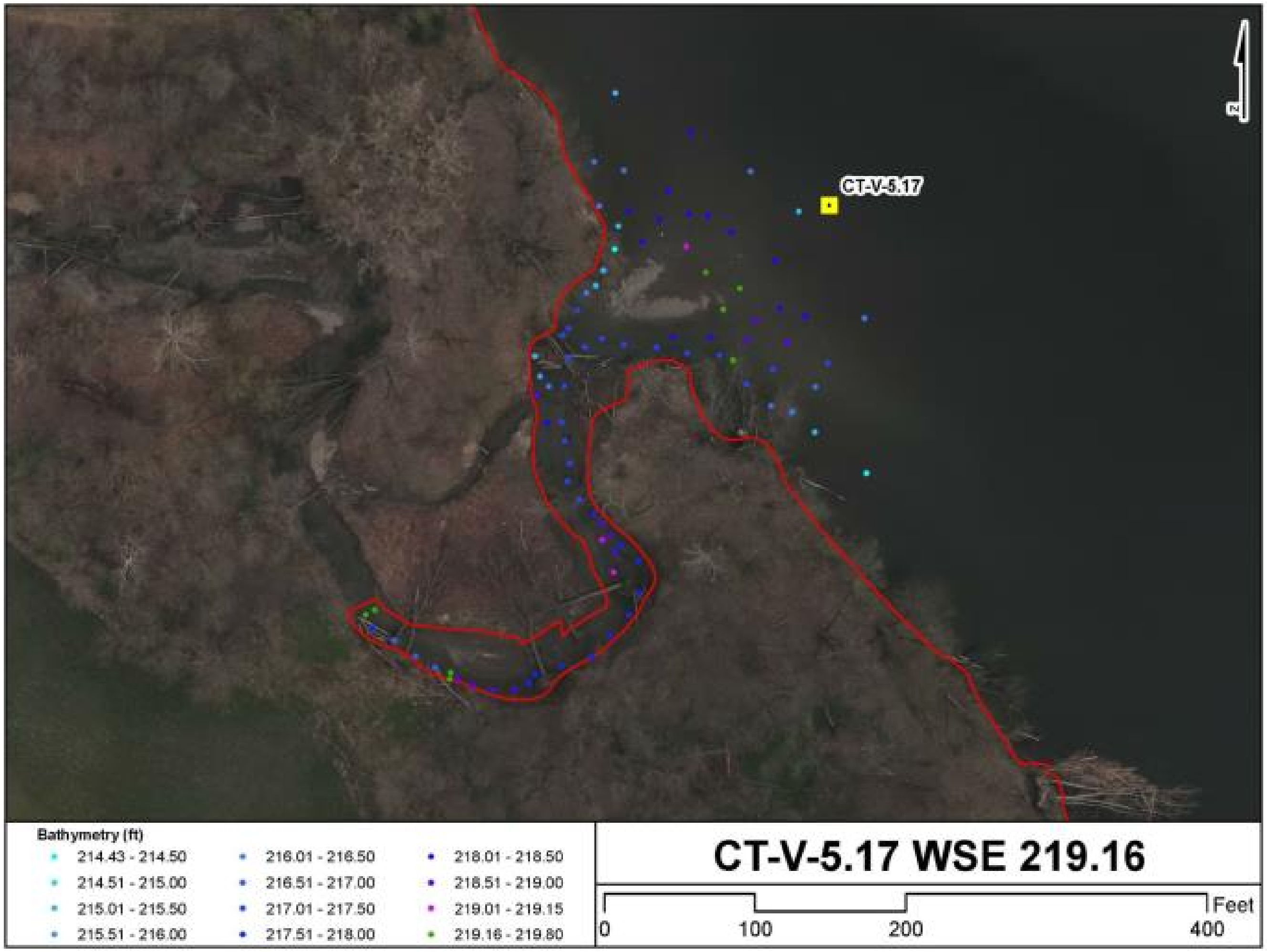


Figure C-22. Plan view of available bathymetry data at tributary site CT-V-5.17 (East Putney Brook, Stream Order 4). Color scale is relative to the low water elevation of 219.16’ as recorded at level logger station 60 (green = dry, blue-pink = deeper-shallower).

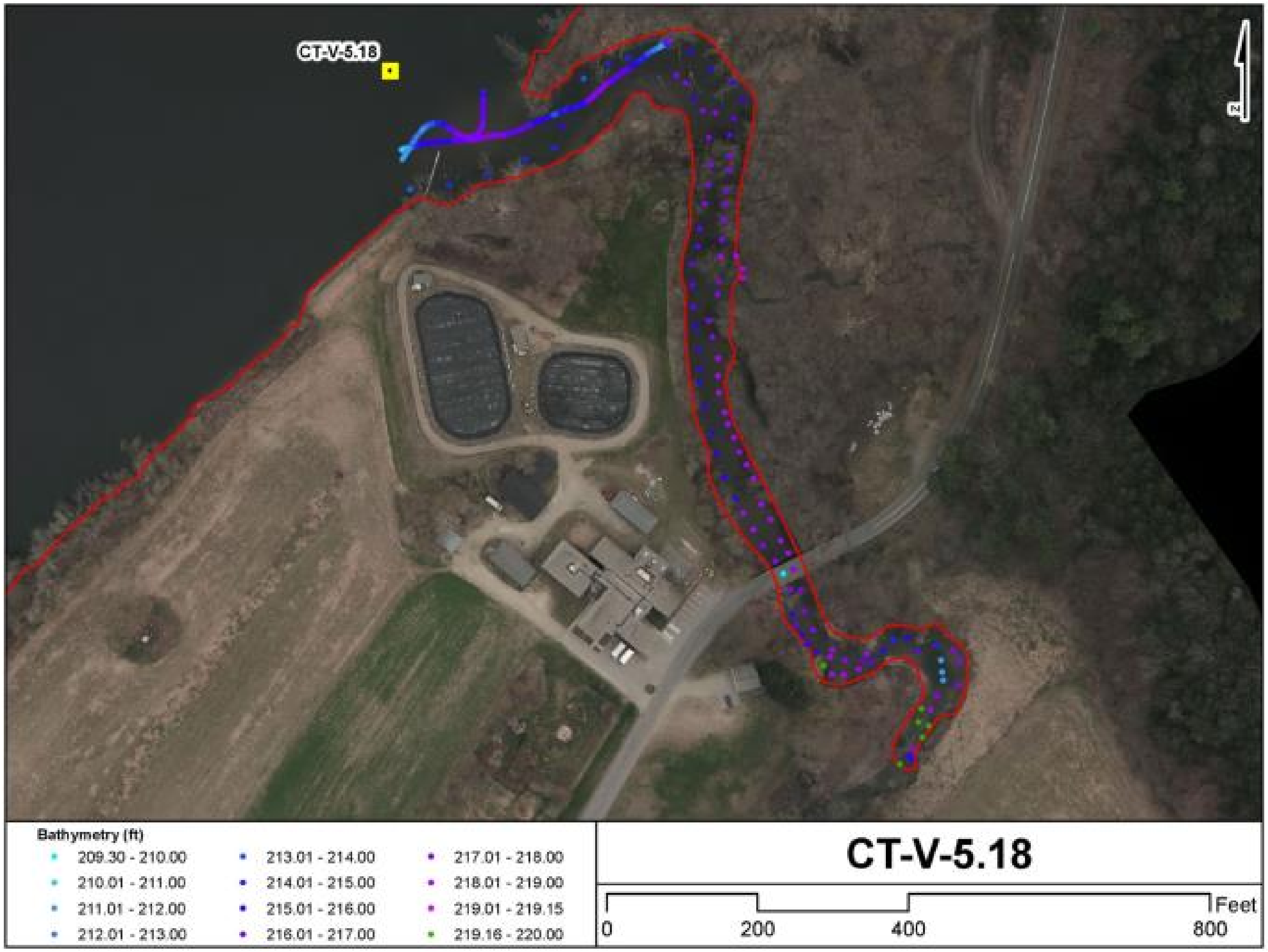


Figure C-23. Plan view of available bathymetry data at tributary site CT-V-5.18 (Partridge Brook, Stream Order 4). Color scale is relative to the low water elevation of 219.16' as recorded at level logger station 60 (green = dry, blue-pink = deeper-shallower).

Figure C-25. Plan view of available bathymetry data at tributary site CT-V-5.24 (Sacketts Brook, Stream Order 4). Color scale is relative to the low water elevation of 219.16’ as recorded at level logger station 60 (green = dry, blue-pink = deeper-shallower).

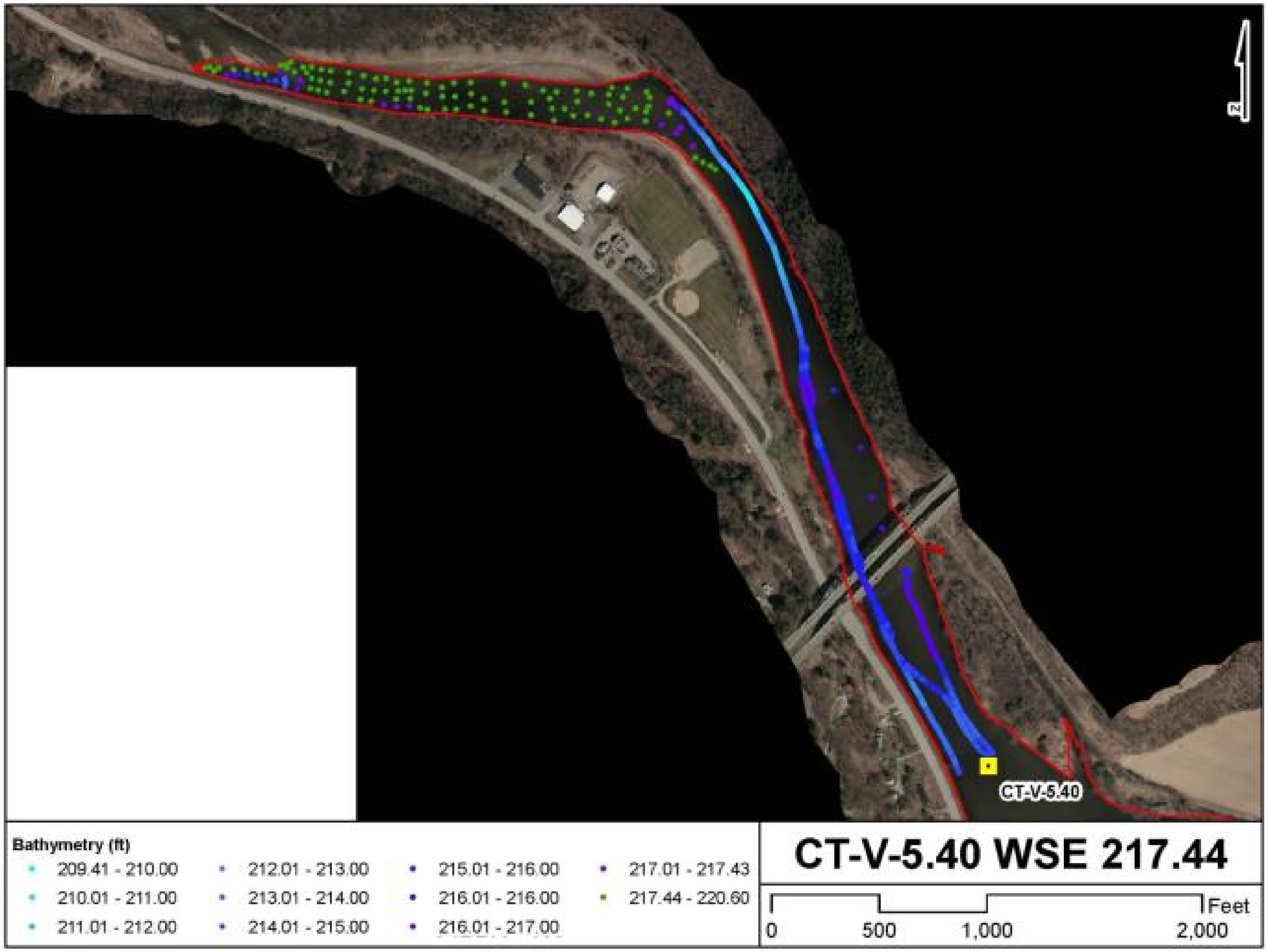


Figure C-26. Plan view of available bathymetry data at tributary site CT-V-5.40 (West River, Stream Order 6). Color scale is relative to the low water elevation of 217.44’ as recorded at level logger station 65 (green = dry, blue-pink = deeper-shallower).

Figure C-27. Plan view of available bathymetry data at tributary site CT-V-5.42 (Whetstone Brook, Stream Order 4). Color scale is relative to the low water elevation of 217.44’ as recorded at level logger station 65 (green = dry, blue-pink = deeper-shallower).

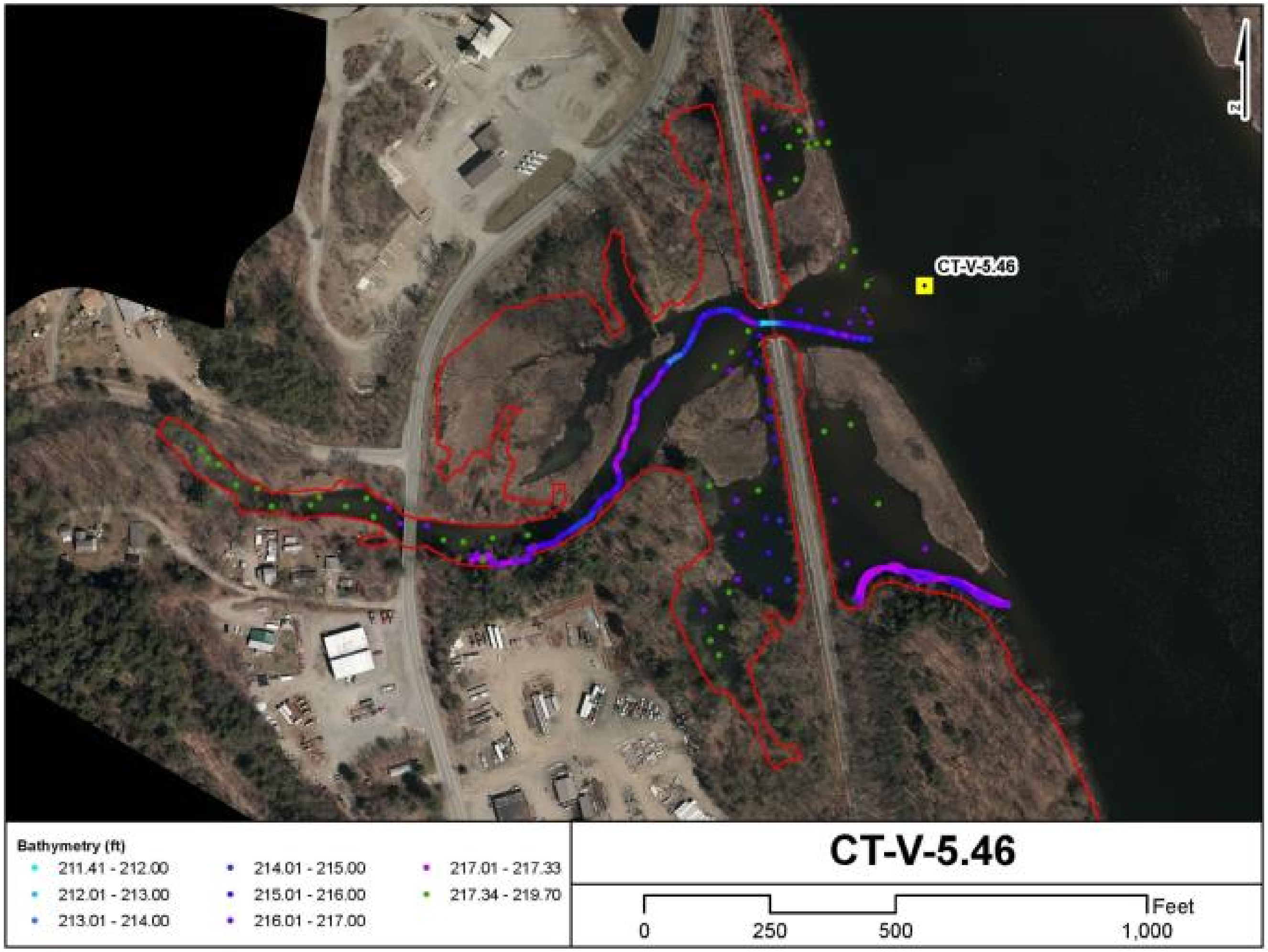


Figure C-28. Plan view of available bathymetry data at tributary site CT-V-5.46 (Broad Brook, Stream Order 4). Color scale is relative to the low water elevation of 217.34' as recorded at level logger station 70 (green = dry, blue-pink = deeper-shallower).

Appendix D

Responsiveness Summary

Study 13 Site Selection Report Responsiveness Summary.

Comments were received via email from FWS on July 2 and July 8, 2014. Additional comment on the Cold River was received from NHFG on July 9, 2014.

Comment	Response

Comment	Response
We have a concern with the limited number (two) of Stream Order 1 locations included in this study. We do not feel that excluding 20 out of 30 Stream Order 1 locations is warranted simply because they are less than 2.0 km. We have done some research and have found no instances where stream length is used to determine stream classification (perennial vs. intermittent). We have seen where threshold contributing area and/or hydrogeologic areas, as well as a suite of abiotic and biotic features assessed on a site by site basis were used to discern perennial from intermittent streams. In addition, a USGS study found that perennial streams occur in watersheds as small as 41 acres (0.06 sq. miles) and a study in New Zealand estimated there are over 6,000 km of first order permanent streams less than 500 m long (citations available upon request). Based on this evidence, we do not believe it is appropriate to assume all streams <2 km are intermittent. Further, even if some (or all) of those 20 streams are intermittent, they still could contain important habitat that could be used on a seasonal basis (e.g., in the spring for spawning). TC has stated that Study 13 is not a spawning study and that the spring time is not a concern due to runoff. However, given that the water level loggers were only deployed for a few months in late summer through fall, we have been provided with no data verifying that project operations do not potentially impact access during the spring (particularly in low order streams with relatively smaller contributing drainage areas versus major tributaries). At the level of detail that was used in this process, we cannot rely solely on stream order size/length to characterize the overall importance of that habitat. For example, there could be a larger/longer stream that has a barrier on it close to the confluence - so even though there may be a lot more potential habitat, most is inaccessible. Also, the smaller/shorter streams may be spring fed and therefore, provide important cool/cold water habitat that the larger tribs may not....we simply don't know because that level of assessment did not occur. Therefore, we recommend placing those 20 streams back into the pool (bringing the number of candidate sites up to 154) and then randomly selecting within sub reach based on the proportion of the total number available within that sub reach (as was done previously). Theoretically (and ideally), this random selection process should then provide adequate representation both across sub reaches and stream orders. If not, then the number of test sites may need to be increased (e.g., from 36 up to 40).	The 20 stream order 1's were re-incorporated into the pool of potential sites in the Updated Revised Site Selection Report. As a note, since all stream order 1's were included, it was deemed unnecessary to conduct bed profile surveys of them all prior to random selection of study sites (as had been discussed at the May 23, 2014 working group meeting). Bed profiles will be conducted on the subset of stream order 1's included in the randomized sub-sample. The idea of not including the stream order 1 streams originally, was based primarily on the contributing value of the stream to the overall watershed/habitat – therefore stream length which can reasonably translate to drainage area or amount of habitat is an important. That plus the added "likelihood" that a Stream Order 1 could be intermittent or on its own have a low water depth at dry periods in the year seemed to suggest that by adding them into the mix, we would be sampling less in the presumably more valuable streams and rivers and therefore potentially under value and assess. We have revised the site selection report to ensure that the random selection of streams is proportional to the distribution of stream types within each of the nine sub-reaches in the study area. As a result, we feel each stream order is adequately represented and do not believe the number of randomized study sites needs to be increased due to the increased number Stream Order 1 locations now included.

Comment	Response
We believe it is worth further discussion as to whether weighting by magnitude of WSE fluctuation might be appropriate. We understand that the WSE data were used to define sub reaches and then randomly select sites within each sub reach in proportion to the number available, but that is not giving any differential weighting based on magnitude of WSE fluctuation. It seems reasonable to assume that a trib within a sub reach that has WSE fluctuations of up to 6.5 ft. (Figure 4-4, station 29) might be more prone to access issues than a trib within a sub reach that only has WSE fluctuations of up to 1.5 ft. (Station 43), but it could be that with a more thorough explanation as to how the WSE data were used and relate to a given trib/backwater area, we may ultimately agree that this additional weighting is not necessary.	The use of daily magnitude of water surface elevation was first used as a tool to help us divide the whole 120-mile study reach into sub-reaches. We used that information in addition to project structures and natural river breaks (i.e., Sumner Falls) to do so. This was "Phase 2" of our approach. We did not use the daily magnitude of WSE as a filter to eliminate potential sampling locations. The filtering out of potential sampling locations relied on the lowest recorded water surface elevation at the nearest mainstem logger location to provide a conservative low flow level for us to evaluate our "shallow" versus "adequate" criteria (this was Phase 1). In our explanation in Section 4.2 of the updated revised report (and illustrated better in new Figure 4-9 showing all mainstem water level logger WSE data), the breakpoint was generally around 1 ft in impounded reaches and 2+ feet in riverine sections. Figures 4-1 through 4-8 and new Figure 4-9 were designed to illustrate the observed fluctuation differences for splitting those reaches into sub-reaches for use in our final site selection (to ensure each unique sub-reach received an appropriate portion of the random samples). Figure 4-9 for the study area is organized in order from upstream to downstream. Break points defining each of the nine sub-reaches defined during Phase 2 are identified there. The 36 randomly selected study sites were distributed among the nine sub-reaches based on the contribution of the number of potential study locations within a sub-reach to the number of potential study locations within the entire study area. During the process of proportioning the 36 randomly selected study sites among the nine defined sub-reaches, the riverine sections were weighted two times higher than those within the impounded sections. This was done to increase the percentage of the 26 randomly selected study sites placed within riverine sub-reaches as the working group felt that due to the increased magnitude of WSE fluctuations in riverine sections, the probability of access issues was greater for those locations.

Comment	Response
Based on field observations, we feel the Cold River should be included in Study 13. [from Gabe Gries]: I am interested in the having the Cold River included in this study because of the major tribs that I am familiar with, it is the only one that comes to mind as possibly having an issue with fish access (based on past field observations by me).	As requested, the Cold River has been included in the study as an additional, non-randomized (37th) site. Since it is stream order 5, it was not part of the randomization of sites to select study sites which was limited to stream orders 1 – 3.
1. Are there cases where a 1st or 2nd order stream flows into a major (4-6) trib low enough down that they could also be influenced by project operations? If so, then those major tribs should not be excluded from the final "pool" of candidate sites. 2. I think it is probably fine to use the daily magnitude of water surface elevation fluctuation as a filter for unimpounded project areas, but I'm not sure using that same criterion is appropriate for the headponds....maybe there is only a 1' fluctuation within a day, but over the course of 2, 3, 4 days, couldn't the elevation continue to go down to whatever the min. headpond elevation specified in the license is? In that case we would not be assessing the true potential for tribs/backwaters within that reach to have access potentially compromised...maybe looking at fluctuations over a longer time step would be better? (it would depend on how the projects operate....)	1. There are no instances where a tributary with a stream order of 1 or 2 enter a larger tributary (order 4, 5, or 6) within the portion of the major tributary that is influenced by project operations. In each of the plan view figures in Appendix C, the red line on those figures indicates the project influence area. The only instance where a tributary of any stream order merges with another tributary within the project affected area is in the Sugar River (Stream Order 6). In that case, the Little Sugar River (Stream Order 4) converges with the Sugar River (See Figure C-11) within the project affected area. Based on our observations during the 2013 field season, the depth of recorded bed elevations, large size and consistent inflow in those two large rivers, we did not feel that they were likely candidates to have access issues and as a result, neither were included among the potential candidates for random selection for 2014 sampling. 2. The reservoirs are daily fluctuating reservoirs, not multi-day. The degree of fluctuation in the reservoirs due to project operation is less than the degree of fluctuation in riverine areas caused by inflow and or discharge. Instance when we go to the "minimum headpond levels" are when inflows are high and therefore one should likely see tributary flows correspondingly high.

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Initial Study Report

Volume III.D. – Excel file

Study 13 – Tributary and Backwater Fish Access Site Selection Report, Appendix B – Water Surface Elevation Data

September 15, 2014

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REV_ID	Reach	Sub Reach	Type	GNIS_Name	Order	X (DD NAD83 UTM Z18N)	Y (DD NAD83 UTM Z18N)	Bathymetry Available?	Nearest Mainstem Logger Station	Min Bed Elevation (deepest)	Max Bed Elevation (shallowest)	Average Bed Elevation	Min WSE Value	Min Depth	Max Depth	Average Depth	Method 1 Depth Designation	Site-Specific Logger Station	Min Bed Elevation (deepest)	Max Bed Elevation (shallowest)	Average Bed Elevation	Min WSE Value	Min Depth	Max Depth	Average Depth	Method 2 Depth Designation	Final Depth Designation
CT-V-5.27	Vernon	Vernon	Minor Impoundment Trib		-99	-72.526305	42.936365	N	82				217.44														Shallow
CT-V-5.35	Vernon	Vernon	Minor Impoundment Trib		-99	-72.538069	42.889126	N	82				217.44														Shallow
CT-VR-6.03	Vernon Riverine	Vernon Riverine	Minor Riverine Trib		-99	-72.510738	42.763975	N	73				180.74														Shallow
CT-W-1.05	Wilder	Upper Wilder	Backwater		0	-72.067176	44.058021	Y	2	382.59	382.59	382.59	382.63	0.04	0.04	0.04	shallow										Shallow
CT-W-1.09	Wilder	Upper Wilder	Backwater		0	-72.080262	44.028859	Y	4	377.99	381.54	379.8	381.99	4.00	0.45	2.19	shallow										Shallow
CT-W-1.12	Wilder	Upper Wilder	Backwater	BW1	0	-72.094976	44.013387	Y	5	349.03	382.55	373.28	382.56	33.53	0.01	9.28	shallow	6	349.03	382.07	372.92	382.08	33.05	0.01	9.16	shallow	Shallow
CT-W-1.13	Wilder	Upper Wilder	Backwater		0	-72.100657	44.015093	Y	5	376.77	381.91	379.21	382.56	5.79	0.65	3.35	shallow										Shallow
CT-W-1.14	Wilder	Upper Wilder	Backwater		0	-72.104278	44.011908	Y	5	382.12	382.54	382.44	382.56	0.44	0.02	0.12	shallow										Shallow
CT-W-1.16	Wilder	Upper Wilder	Backwater	BW2	0	-72.116927	43.992195	Y	5	382.00	382	382	382.56	0.56	0.56	0.56	shallow										Shallow
CT-W-1.18	Wilder	Middle Wilder	Backwater	BW3	0	-72.105466	43.970984	Y	11	374.00	381.98	379.77	381.99	7.99	0.01	2.22	shallow	9	374.00	382.16	380.15	382.17	8.17	0.01	2.02	shallow	Shallow
CT-W-1.20	Wilder	Middle Wilder	Backwater		0	-72.10441	43.969669	Y	11	381.99	381.99	381.99	381.99	0.00	0.00	0.00	shallow										Shallow
CT-W-1.25	Wilder	Middle Wilder	Backwater		0	-72.11692	43.933338	Y	12	381.00	381	381	382.05	1.05	1.05	1.05	adequate										Adequate
CT-W-1.26	Wilder	Middle Wilder	Backwater		0	-72.115451	43.932537	Y	12	382.05	382.05	382.05	382.05	0.00	0.00	0.00	shallow										Shallow
CT-W-1.28	Wilder	Middle Wilder	Backwater	BW4	0	-72.128038	43.913834	Y	12	373.26	382.04	380.05	382.05	8.79	0.01	2.00	shallow	13	373.26	381.19	379.17	381.20	7.94	0.01	2.03	shallow	Shallow
CT-W-1.31	Wilder	Middle Wilder	Backwater	BW5	0	-72.15703	43.889425	Y	14	377.06	381.36	379.88	381.38	4.32	0.02	1.50	shallow										Shallow
CT-W-1.32	Wilder	Middle Wilder	Backwater	BW6	0	-72.1692	43.886159	Y	14	370.89	381.37	377.74	381.38	10.49	0.01	3.64	shallow	15	370.89	381.29	376.51	381.30	10.41	0.01	4.79	shallow	Shallow
CT-W-1.35	Wilder	Middle Wilder	Backwater		0	-72.17161	43.875585	Y	14	381.00	381	381	381.38	0.38	0.38	0.38	shallow										Shallow
CT-W-1.36	Wilder	Middle Wilder	Backwater		0	-72.16913	43.874417	Y	14	381.00	381	381	381.38	0.38	0.38	0.38	shallow										Shallow
CT-W-1.38	Wilder	Middle Wilder	Backwater		0	-72.173057	43.865874	Y	17	381.00	381	381	381.12	0.12	0.12	0.12	shallow										Shallow
CT-W-1.39	Wilder	Middle Wilder	Backwater		0	-72.179287	43.865135	Y	17	379.00	380	379.8	381.12	2.12	1.12	1.32	adequate										Adequate
CT-W-1.43	Wilder	Middle Wilder	Backwater		0	-72.181505	43.845383	Y	17	379.00	381	380.27	381.12	2.12	0.12	0.85	shallow										Shallow
CT-W-1.44	Wilder	Middle Wilder	Backwater	BW7	0	-72.183827	43.841237	Y	17	379.00	381	380.52	381.12	2.12	0.12	0.60	shallow	16	380.94	380.94	380.94	380.94	0.00	0.00	0.00	shallow	Shallow
CT-W-1.49	Wilder	Lower Wilder	Backwater	BW8	0	-72.190811	43.797224	Y	19	380.03	381.2	380.88	381.21	1.18	0.01	0.33	shallow										Shallow
CT-W-1.51	Wilder	Lower Wilder	Backwater	BW9	0	-72.196969	43.790143	Y	19	377.52	381.2	380.52	381.21	3.69	0.01	0.69	shallow										Shallow
CT-W-1.53	Wilder	Lower Wilder	Backwater	BW10	0	-72.200172	43.786889	Y	19	372.05	381.2	378.59	381.21	9.16	0.01	2.62	shallow	21	372.05	380.67	377.68	380.68	8.63	0.01	3.00	shallow	Shallow
CT-W-1.59	Wilder	Lower Wilder	Backwater	BW11	0	-72.227711	43.756159	Y	19	374.10	381.1	380.17	381.21	7.11	0.11	1.04	shallow										Shallow
CT-W-1.60	Wilder	Lower Wilder	Backwater	BW12	0	-72.238831	43.744666	Y	26	372.80	381.07	379.1	381.08	8.28	0.01	1.98	shallow	25	372.80	380.67	377.68	380.86	8.06	0.19	3.18	shallow	Shallow
CT-W-1.63	Wilder	Lower Wilder	Backwater		0	-72.248703	43.73958	Y	26	375.88	381.07	379.29	381.08	5.20	0.01	1.79	shallow										Shallow
CT-W-1.65	Wilder	Lower Wilder	Backwater		0	-72.256506	43.73509	Y	26	379.94	381.06	380.5	381.08	1.14	0.02	0.58	shallow										Shallow
CT-W-1.70	Wilder	Lower Wilder	Backwater		0	-72.291325	43.713644	Y	26	380.00	381	380.5	381.08	1.08	0.08	0.58	shallow										Shallow
CT-W-1.72	Wilder	Lower Wilder	Backwater	BW13	0	-72.301042	43.702081	Y	26	373.59	381.07	379.59	381.08	7.49	0.01	1.49	shallow	27	373.59	381.24	379.73	381.25	7.66	0.01	1.52	shallow	Shallow
CT-B-3.19	Bellows	Bellows	Backwater	BW17	0	-72.431303	43.260732	Y	43	280.50	288.7	283.84	289.27	8.77	0.57	5.43	shallow	46	280.50	288.70	283.84	288.72	8.22	0.02	4.88	shallow	Shallow
CT-B-3.25	Bellows	Bellows	Backwater	BW16	0	-72.433122	43.211338	Y	49	286.92	286.97	286.94	286.98	0.06	0.01	0.04	shallow										Shallow
CT-B-3.30	Bellows	Bellows	Backwater	BW15	0	-72.447861	43.175322	Y	49	276.06	286.97	284.66	286.98	10.92	0.01	2.32	shallow	50	276.06	287.94	285.30	287.95	11.89	0.01	2.65	shallow	Shallow
CT-B-3.32	Bellows	Bellows	Backwater		0	-72.447838	43.15668	Y	49	266.31	286.97	281.81	286.98	20.67	0.01	5.17	shallow										Shallow
CT-B-3.33	Bellows	Bellows	Backwater	BW14	0	-72.454937	43.15011	Y	49	274.08	286.97	283.65	286.98	12.90	0.01	3.33	shallow										Shallow
CT-V-5.38	Vernon	Vernon	Backwater		0	-72.554714	42.876234	N	65				217.44														Shallow
CT-V-5.39	Vernon	Vernon	Backwater	BW18add	0	-72.554978	42.866679	Y	65	185.85	217.35	214.02	217.44	31.59	0.09	3.42	shallow	67	185.85	217.35	214.02	217.43	31.58	0.08	3.41	shallow	Shallow
CT-V-5.41	Vernon	Vernon	Backwater		0	-72.552753	42.856026	Y	65	217.44	217.44	217.44	217.44	0.00	0.00	0.00	shallow										Shallow
CT-V-5.43	Vernon	Vernon	Backwater		0	-72.553478	42.847985	N	65				217.44														Shallow
CT-V-5.44	Vernon	Vernon	Backwater		0	-72.546546	42.845418	Y	65	216.00	217	216.73	217.44	1.44	0.44	0.71	shallow										Shallow
CT-V-5.45	Vernon	Vernon	Backwater	BW19	0	-72.546374	42.826744	Y	70	199.55	217.33	210.97	217.34	17.79	0.01	6.37	shallow	68	199.55	217.53	210.99	217.66	18.11	0.13	6.67	shallow	Shallow
CT-V-5.47	Vernon	Vernon	Backwater	BW20	0	-72.542266	42.814181	Y	70	206.00	217.29	215.9	217.34	11.34	0.05	1.44	shallow	83	206.00	217.90	215.96	218.36	12.36	0.46	2.40	shallow	Shallow
CT-V-5.50	Vernon	Vernon	Backwater	BW21	0	-72.523771	42.795522	Y	70	199.97	217.33	212.68	217.34	17.37	0.01	4.66	shallow	69	199.97	217.19	212.63	217.20	17.23	0.01	4.57	shallow	Shallow
CT-W-1.19	Wilder	Middle Wilder	Minor Impoundment Trib		1	-72.10408	43.970736	Y	11	379.21	381.97	381.39	381.99	2.78	0.02	0.60	shallow										Shallow
CT-W-1.23	Wilder	Middle Wilder	Minor Impoundment Trib		1	-72.116113	43.947391	N	11				381.99														Shallow
CT-W-1.24	Wilder	Middle Wilder	Minor Impoundment Trib		1	-72.117675	43.942372	Y	12	380.34	381.98	381.43	382.05	1.71	0.07	0.62	shallow										Shallow
CT-W-1.40	Wilder	Middle Wilder	Minor Impoundment Trib		1	-72.185111	43.863219	Y	17	381.00	381	381	381.12	0.12	0.12	0.12	shallow										Shallow
CT-W-1.41	Wilder	Middle Wilder	Minor Impoundment Trib	Roaring Brook	1	-72.185205	43.862778	N	17				381.12														Shallow
CT-W-1.46	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.180646	43.835086	Y	17	380.00	380	380	381.12	1.12	1.12	1.12	adequate										Adequate
CT-W-1.47	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.185333	43.816672	Y	18	379.99	381.17	380.6	381.3	1.31	0.13	0.70	shallow										Shallow
CT-W-1.50	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.191708	43.794516	Y	19	380.62	381.2	380.98	381.21	0.59	0.01	0.23	shallow	20	380.62	381.41	381.11	381.42	0.80	0.01	0.31	shallow	Shallow
CT-W-1.55	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.204879	43.770009	Y	19	372.00	381.18	379.68	381.21	9.21	0.03	1.53	shallow										Shallow
CT-W-1.56	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.210347	43.766571	Y	19	380.00	381	380.25	381.21	1.21	0.21	0.96	shallow										Shallow
CT-W-1.62	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.242727	43.742291	Y	26	374.35	381.06	378.26	381.08	6.73	0.02	2.82	shallow										Shallow
CT-W-1.64	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.254987	43.735754	Y	26	381.08	381.08	381.08	381.08	0.00	0.00	0.00	shallow										Shallow
CT-W-1.69	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.280587	43.722365	Y	26	368.46	381	373.56	381.08	12.62	0.08	7.52	shallow										Shallow
CT-W-1.76	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.299694	43.675104	Y	26	364.92	380.98	373.93	381.08	16.16	0.10	7.15	shallow										Shallow
CT-W-1.77	Wilder	Lower Wilder	Minor Impoundment Trib		1	-72.298593	43.672271	Y	26	376.17	381.06	379.97	381.08	4.91	0.02	1.11	shallow										Shallow
CT-WR-2.07	Wilder Riverine	Upper Wilder Riverine	Minor Riverine Trib	Hanchetts Brook	1	-72.33718	43.595029	N																			Shallow
CT-WR-2.09	Wilder Riverine	Upper Wilder Riverine	Minor Riverine Trib	Beaver Brook	1	-72.357069	43.583882	N																			Shallow
CT-WR-2.13	Wilder Riverine	Lower Wilder Riverine	Minor Riverine Trib	Bashan Brook	1	-72.398248	43.510763	N																			Shallow
CT-WR-2.15	Wilder Riverine	Lower Wilder Riverine	Minor Riverine Trib		1	-72.378889	43.489022	N																			Shallow
CT-WR-2.17	Wilder Riverine	Lower Wilder Riverine	Minor Riverine Trib	unnamed	1	-72.381229	43.48399	N																			Shallow
CT-B-3.09	Bellows	Bellows	Minor Impoundment Trib		1	-72.388016	43.356433	N	78				288.88														Shallow
CT-B-3.10	Bellows	Bellows	Minor Impoundment Trib		1	-72.394886	43.345417	N	78				288.88														Shallow
CT-B-3.20	Bellows	Bellows	Minor Impoundment Trib		1	-72.435063	43.258022	Y	43	287.70	289.2	287.98	289.27	1.57	0.07	1.29	shallow										Shallow
CT-B-3.23	Bellows	Bellows	Minor Impoundment Trib		1	-72.440432	43.220499	N	49				286.98														Shallow
CT-V-5.05	Vernon	Vernon	Minor Impoundment Trib		1	-72.449439	43.065153	N	60				219.16														Shallow
CT-V-5.09	Vernon	Vernon	Minor Impoundment Trib		1	-72.458593	43.042864	N	60				219.16														Shallow
CT-V-5.19	Vernon	Vernon	Minor Impoundment Trib		1	-72.471748	42.971787	N	60				219.16														Shallow
CT-V-5.29	Vernon	Vernon	Minor Impoundment Trib		1	-72.527014	42.928258	N	82				217.44														Shallow
CT-V-5.33	Vernon	Vernon	Minor Impoundment Trib		1	-72.531376	42.906364	N	82				217.44														Shallow
CT-V-5.34	Vernon	Vernon	Minor Impoundment Trib		1	-72.529424	42.897733	N	82				217.44														Shallow
CT-VR-6.05	Vernon Riverine	Vernon Riverine	Minor Riverine Trib		1	-72.498398	42.774687	N	71				179.58														Shallow
CT-W-1.01	Wilder	Upper Wilder	Minor Impoundment Trib	Harriman Brook	2	-72.043789	44.087891	Y	1	382.60	382.6	382.6	382.60	0.00	0.00	0.00	shallow										Shallow
CT-W-1.03	Wilder	Upper Wilder	Minor Impoundment Trib		2	-72.047111	44.069415	N	2				382.63														Shallow
CT-W-1.04	Wilder	Upper Wilder	Minor Impoundment Trib		2	-72.055893	44.058089	N	2				382.63														Shallow
CT-W-1.06	Wilder	Upper Wilder	Minor Impoundment Trib		2	-72.068263	44.057211	N	2				382.63														Shallow
CT-W-1.08	Wilder	Upper Wilder	Minor Impoundment Trib		2	-72.074246	44.03483	Y	4	381.00	381.99	381	381.99	0.99	0.00	0.99	shallow										Shallow
CT-W-1.10	Wilder	Upper Wilder	Minor Impoundment Trib		2	-72.082268	44.020677	N	4				381.99														Shallow
CT-W-1.17	Wilder	Middle Wilder	Minor Impoundment Trib		2	-72.114059	43.96778	N	11				381.99														Shallow
CT-W-1.27	Wilder	Middle Wilder	Minor Impoundment Trib		2	-72.115321	43.925177	Y	12	382.05	382.05	382.05	382.05	0.00	0.00	0.00	shallow										Shallow
CT-W-1.30	Wilder	Middle Wilder	Minor Impoundment Trib		2	-72.156523	43.891773	Y	14	379.03	381.37	380.31	381.38	2.35	0.01	1.07	shallow										Shallow
CT-W-1.34	Wilder	Middle Wilder	Minor Impoundment Trib		2	-72.171864	43.87589	Y	14	381.00	381	381	381.38	0.38	0.38	0.38	shallow										Shallow
CT-W-1.42	Wilder	Middle Wilder	Minor Impoundment Trib		2	-72.188138	43.855213	Y	17	381.00	381	381	381.12	0.12	0.12	0.12	shallow										Shallow
CT-W-1.52	Wilder	Lower Wilder	Minor Impoundment Trib	Zebedee Brook	2	-72.198257	43.790828	Y	19	379.86	381.19	380.84	381.21	1.35	0.02	0.37	shallow										Shallow

REV_ID	Reach	Sub Reach	Type	GNIS_Name	Order	X (DD NAD83 UTM Z18N)	Y (DD NAD83 UTM Z18N)	Bathymetry Available?	Nearest Mainstem Logger Station	Min Bed Elevation (deepest)	Max Bed Elevation (shallowest)	Average Bed Elevation	Min WSE Value	Min Depth	Max Depth	Average Depth	Method 1 Depth Designation	Site-Specific Logger Station	Min Bed Elevation (deepest)	Max Bed Elevation (shallowest)	Average Bed Elevation	Min WSE Value	Min Depth	Max Depth	Average Depth	Method 2 Depth Designation	Final Depth Designation
CT-W-1.57	Wilder	Lower Wilder	Minor Impoundment Trib		2	-72.2238	43.75613	Y	19	376.54	381.2	380.38	381.21	4.67	0.01	0.83	shallow										Shallow
CT-W-1.61	Wilder	Lower Wilder	Minor Impoundment Trib		2	-72.23844	43.74329	Y	26	370.36	381.06	375.58	381.08	10.72	0.02	5.50	shallow										Shallow
CT-W-1.66	Wilder	Lower Wilder	Minor Impoundment Trib	Camp Brook	2	-72.260977	43.733682	Y	26	366.53	380.99	375.1	381.08	14.55	0.09	5.98	shallow										Shallow
CT-W-1.67	Wilder	Lower Wilder	Minor Impoundment Trib		2	-72.267375	43.734246	Y	26	375.14	381.05	379.31	381.08	5.94	0.03	1.77	shallow										Shallow
CT-W-1.68	Wilder	Lower Wilder	Minor Impoundment Trib		2	-72.280562	43.724666	N	26				381.08														Shallow
CT-W-1.71	Wilder	Lower Wilder	Minor Impoundment Trib		2	-72.296774	43.708324	Y	26	377.00	381	379.95	381.08	4.08	0.08	1.13	shallow										Shallow
CT-WR-2.01	Wilder Riverine	Upper Wilder Riverine	Minor Riverine Trib		2	-72.308929	43.6619	N																			Shallow
CT-WR-2.04	Wilder Riverine	Upper Wilder Riverine	Minor Riverine Trib		2	-72.329612	43.634162	N																			Shallow
CT-WR-2.10	Wilder Riverine	Lower Wilder Riverine	Minor Riverine Trib	McArthur Brook	2	-72.380636	43.540433	N																			Shallow
CT-WR-2.12	Wilder Riverine	Lower Wilder Riverine	Minor Riverine Trib	unnamed	2	-72.398681	43.51395	N																			Shallow
CT-B-3.01	Bellows	Bellows	Minor Impoundment Trib		2	-72.395869	43.437736	N	41				289.83														Shallow
CT-B-3.03	Bellows	Bellows	Minor Impoundment Trib	Walker Brook	2	-72.394813	43.399695	N	41				289.83														Shallow
CT-B-3.05	Bellows	Bellows	Minor Impoundment Trib		2	-72.41589	43.378275	N	78				288.88														Shallow
CT-B-3.06	Bellows	Bellows	Minor Impoundment Trib	Blood Brook	2	-72.414299	43.364458	Y	78	287.00	288.5	287.89	288.88	1.88	0.38	0.99	shallow										Shallow
CT-B-3.14	Bellows	Bellows	Minor Impoundment Trib		2	-72.399617	43.299422	N	43				289.27														Shallow
CT-B-3.15	Bellows	Bellows	Minor Impoundment Trib		2	-72.402244	43.291186	N	43				289.27														Shallow
CT-B-3.21	Bellows	Bellows	Minor Impoundment Trib	Gravel Brook	2	-72.438531	43.249921	N	43				289.27														Shallow
CT-B-3.26	Bellows	Bellows	Minor Impoundment Trib		2	-72.435067	43.203049	Y	49	280.30	286.97	285.39	286.98	6.68	0.01	1.59	shallow										Shallow
CT-B-3.27	Bellows	Bellows	Minor Impoundment Trib		2	-72.449136	43.192375	Y	49	267.43	286.97	282.65	286.98	19.55	0.01	4.33	shallow	48	267.43	288.60	283.14	288.75	21.32	0.15	5.61	shallow	Shallow
CT-B-3.28	Bellows	Bellows	Minor Impoundment Trib		2	-72.442084	43.183897	Y	49	286.98	286.98	286.98	286.98	0.00	0.00	0.00	shallow										Shallow
CT-B-3.35	Bellows	Bellows	Minor Impoundment Trib		2	-72.452103	43.142063	Y	49	285.19	286.97	286.03	286.98	1.79	0.01	0.95	shallow										Shallow
CT-BR-4.03	Bellows Riverine	Bellows Riverine	Minor Riverine Trib		2	-72.440915	43.097277	N																			Shallow
CT-V-5.02	Vernon	Vernon	Minor Impoundment Trib	Mad Brook	2	-72.432666	43.085102	N	60				219.16														Shallow
CT-V-5.03	Vernon	Vernon	Minor Impoundment Trib		2	-72.439323	43.074299	N	60				219.16														Shallow
CT-V-5.06	Vernon	Vernon	Minor Impoundment Trib		2	-72.463223	43.057964	N	60				219.16														Shallow
CT-V-5.07	Vernon	Vernon	Minor Impoundment Trib	Mill Brook	2	-72.465602	43.055809	N	60				219.16														Shallow
CT-V-5.08	Vernon	Vernon	Minor Impoundment Trib	Fullam Brook	2	-72.464688	43.046113	Y	60	206.56	219.14	210.11	219.16	12.60	0.02	9.05	shallow										Shallow
CT-V-5.11	Vernon	Vernon	Minor Impoundment Trib		2	-72.46094	43.03847	N	60				219.16														Shallow
CT-V-5.13	Vernon	Vernon	Minor Impoundment Trib	Chase Brook	2	-72.454087	43.016471	N	60				219.16														Shallow
CT-V-5.15	Vernon	Vernon	Minor Impoundment Trib		2	-72.44967	42.998726	N	60				219.16														Shallow
CT-V-5.21	Vernon	Vernon	Minor Impoundment Trib		2	-72.478756	42.973089	N	60				219.16														Shallow
CT-V-5.22	Vernon	Vernon	Minor Impoundment Trib		2	-72.504262	42.963891	N	60				219.16														Shallow
CT-V-5.23	Vernon	Vernon	Minor Impoundment Trib		2	-72.510069	42.964054	N	60				219.16														Shallow
CT-V-5.25	Vernon	Vernon	Minor Impoundment Trib	Mill Brook	2	-72.527898	42.956935	Y	60	217.13	219	218.13	219.16	2.03	0.16	1.03	shallow										Shallow
CT-V-5.30	Vernon	Vernon	Minor Impoundment Trib	Governors Brook	2	-72.52353	42.924106	N	82				217.44														Shallow
CT-V-5.31	Vernon	Vernon	Minor Impoundment Trib		2	-72.521983	42.918029	N	82				217.44														Shallow
CT-V-5.36	Vernon	Vernon	Minor Impoundment Trib		2	-72.550993	42.882986	N	65				217.44														Shallow
CT-V-5.49	Vernon	Vernon	Minor Impoundment Trib	Liscomb Brook	2	-72.523921	42.798361	Y	70	215.00	215	215	217.34	2.34	2.34	2.34	adequate										Adequate
CT-V-5.51	Vernon	Vernon	Minor Impoundment Trib		2	-72.522527	42.789282	Y	70	208.21	217.33	215.36	217.34	9.13	0.01	1.98	shallow										Shallow
CT-VR-6.01	Vernon Riverine	Vernon Riverine	Minor Riverine Trib		2	-72.516318	42.768916	N	73				180.74														Shallow
CT-VR-6.04	Vernon Riverine	Vernon Riverine	Minor Riverine Trib		2	-72.503818	42.766165	N	73				180.74														Shallow
CT-W-1.02	Wilder	Upper Wilder	Major Impoundment Trib	Clark Brook	3	-72.030968	44.077717	Y	2	381.30	382.61	382.13	382.63	1.33	0.02	0.50	shallow										Shallow
CT-W-1.21	Wilder	Middle Wilder	Major Impoundment Trib	Eastman Brook	3	-72.090587	43.967195	Y	11	378.29	381.98	381.19	381.99	3.70	0.01	0.80	shallow	10	378.29	382.23	381.35	382.24	3.95	0.01	0.89	shallow	Shallow
CT-W-1.22	Wilder	Middle Wilder	Major Impoundment Trib	Indian Pond Brook	3	-72.096067	43.963445	Y	11	376.02	381.98	380.92	381.99	5.97	0.01	1.07	shallow										Shallow
CT-W-1.29	Wilder	Middle Wilder	Major Impoundment Trib	Jacobs Brook	3	-72.127425	43.910746	Y	12	374.41	382	379.54	382.05	7.64	0.05	2.51	shallow	13	374.41	381.19	379.30	381.20	6.79	0.01	1.90	shallow	Shallow
CT-W-1.33	Wilder	Middle Wilder	Major Impoundment Trib		3	-72.167219	43.891085	Y	14	374.90	380.9	378.64	381.38	6.48	0.48	2.74	shallow	15	367.78	380.90	378.64	381.30	13.52	0.40	2.66	shallow	Shallow
CT-W-1.37	Wilder	Middle Wilder	Major Impoundment Trib	Clay Brook	3	-72.16642	43.869146	Y	14	367.00	381.18	377.26	381.38	14.38	0.20	4.12	shallow										Shallow
CT-W-1.45	Wilder	Middle Wilder	Major Impoundment Trib		3	-72.185038	43.841715	Y	17	381.00	381	381	381.12	0.12	0.12	0.12	shallow	16	380.94	380.94	380.94	380.94	0.00	0.00	0.00	shallow	Shallow
CT-W-1.48	Wilder	Lower Wilder	Major Impoundment Trib	Grant Brook	3	-72.186158	43.801778	Y	19	370.90	381.2	379.24	381.21	10.31	0.01	1.97	shallow										Shallow
CT-W-1.54	Wilder	Lower Wilder	Major Impoundment Trib	Hewes Brook	3	-72.198335	43.78525	Y	19	381.21	381.21	381.21	381.21	0.00	0.00	0.00	shallow	21	380.68	380.68	380.68	380.68	0.00	0.00	0.00	shallow	Shallow
CT-W-1.73	Wilder	Lower Wilder	Major Impoundment Trib	Bloody Brook	3	-72.305154	43.703158	Y	26	376.87	381.07	379.96	381.08	4.21	0.01	1.12	shallow	27	376.87	381.22	380.08	381.25	4.38	0.03	1.17	shallow	Shallow
CT-W-1.75	Wilder	Lower Wilder	Major Impoundment Trib	Dothan Brook	3	-72.306479	43.683514	Y	26	369.40	380.4	378.21	381.08	11.68	0.68	2.87	shallow										Shallow
CT-WR-2.05	Wilder Riverine	Upper Wilder Riverine	Major Riverine Trib	Kilburn Brook	3	-72.330028	43.626219	Y	n/a	324.17	325.65	324.62	325.67	1.50	0.02	1.05	adequate										Adequate
CT-WR-2.11	Wilder Riverine	Lower Wilder Riverine	Major Riverine Trib	Lulls Brook	3	-72.393608	43.527828	Y	n/a	299.57	299.92	299.69	300.05	0.48	0.13	0.36	shallow										Shallow
CT-WR-2.14	Wilder Riverine	Lower Wilder Riverine	Major Riverine Trib	Blow-me-down Brook	3	-72.379393	43.494023	Y	n/a	295.33	295.61	295.51	295.86	0.53	0.25	0.35	shallow	36	295.33	295.61	295.51	295.99	0.66	0.38	0.48	shallow	Shallow
CT-WR-2.16	Wilder Riverine	Lower Wilder Riverine	Major Riverine Trib	Hubbard Brook	3	-72.380482	43.488232	Y	n/a	294.29	294.89	294.67	296.47	2.18	1.58	1.80	adequate										Adequate
CT-B-3.04	Bellows	Bellows	Major Impoundment Trib	Mill Brook	3	-72.401286	43.401488	Y	41	286.60	289.6	288.19	289.83	3.23	0.23	1.64	shallow										Shallow
CT-B-3.07	Bellows	Bellows	Major Impoundment Trib	Barkmill Brook	3	-72.412279	43.362394	Y	78	288.88	288.88	288.88	288.88	0.00	0.00	0.00	shallow	42	289.90	289.90	289.90	290.08	0.18	0.18	0.18	shallow	Shallow
CT-B-3.08	Bellows	Bellows	Major Impoundment Trib	Meadow Brook	3	-72.392633	43.359371	N	78				288.88														Shallow
CT-B-3.11	Bellows	Bellows	Major Impoundment Trib		3	-72.409091	43.33408	N	78				288.88														Shallow
CT-B-3.12	Bellows	Bellows	Major Impoundment Trib	Ox Brook	3	-72.395968	43.309573	Y	43	288.89	289.2	289.05	289.27	0.38	0.07	0.22	shallow										Shallow
CT-B-3.24	Bellows	Bellows	Major Impoundment Trib	Commissary Brook	3	-72.440597	43.213887	Y	49	286.98	286.98	286.98	286.98	0.00	0.00	0.00	shallow										Shallow
CT-B-3.34	Bellows	Bellows	Major Impoundment Trib		3	-72.45712	43.152808	Y	49	281.70	286.7	285.73	286.98	5.28	0.28	1.25	shallow	51	281.70	288.20	286.14	288.25	6.55	0.05	2.11	shallow	Shallow
CT-BR-4.04	Bellows Riverine	Bellows Riverine	Major Riverine Trib	Cobb Brook	3	-72.438781	43.094376	Y	n/a	219.51	220.16	219.80	220.31	0.8	0.15	0.51	shallow	57	219.51	220.16	219.80	220.44	0.93	0.28	0.64	shallow	Shallow
CT-BR-4.05	Bellows Riverine	Bellows Riverine	Major Riverine Trib	Blanchard Brook	3	-72.435189	43.089057	Y	n/a	219.12	220.15	219.67	220.54	1.42	0.39	0.87	adequate										Adequate
CT-BR-4.06	Bellows Riverine	Bellows Riverine	Major Riverine Trib		3	-72.433801	43.087675	Y	n/a	219.24	220.07	219.79	220.07	0.83	0	0.28	shallow										Shallow
CT-V-5.04	Vernon	Vernon	Major Impoundment Trib		3	-72.450288	43.068487	N	60				219.16														Shallow
CT-V-5.10	Vernon	Vernon	Major Impoundment Trib	Great Brook	3	-72.458572	43.041899	Y	60	217.00	219.1	218.57	219.16	2.16	0.06	0.59	shallow	58	217.00	220.00	219.05	222.02	5.02	2.02	2.97	adequate	Shallow
CT-V-5.12	Vernon	Vernon	Major Impoundment Trib	Houghton Brook	3	-72.458772	43.022242	Y	60	215.97	218.97	217.69	219.16	3.19	0.19	1.47	shallow										Shallow
CT-V-5.14	Vernon	Vernon	Major Impoundment Trib	Aldrick Brook	3	-72.449569	43.015152	Y	60	216.95	218.95	218.44	219.16	2.21	0.21	0.72	shallow										Shallow
CT-V-5.20	Vernon	Vernon	Major Impoundment Trib	Ox Brook	3	-72.477905	42.970949	Y	60	213.90	219.1	217.04	219.16	5.26	0.06	2.12	shallow										Shallow
CT-V-5.26	Vernon	Vernon	Major Impoundment Trib	Canoe Brook	3	-72.530961	42.946975	Y	82	213.67	217.41	216.08	217.44	3.77	0.03	1.36	shallow	62	213.67	219.57	217.09	220.58	6.91	1.01	3.49	adequate	Shallow
CT-V-5.28	Vernon	Vernon	Major Impoundment Trib	Salmon Brook	3	-72.526038	42.933915	Y	82	215.27	216.77	216.27	217.44	2.17	0.67	1.17	shallow										Shallow
CT-V-5.32	Vernon	Vernon	Major Impoundment Trib	Catsbane Brook	3	-72.526188	42.911684	Y	82	211.52	217.14	215.26	217.44	5.92	0.30	2.18	shallow	63	211.66	217.64	215.66	218.41	6.75	0.77	2.75	shallow	Shallow
CT-V-5.37	Vernon	Vernon	Major Impoundment Trib		3	-72.554108	42.877883	Y	65	214.31	217.36	216.7	217.44	3.13	0.08	0.74	shallow										Shallow
CT-V-5.48	Vernon	Vernon	Major Impoundment Trib	Ash Swamp Brook	3	-72.52757	42.801549	Y	70	209.38	217.3	214.77	217.34	7.96	0.04	2.57	shallow										Shallow
CT-VR-6.02	Vernon Riverine	Vernon Riverine	Major Riverine Trib		3	-72.513136	42.764308	N	73				180.74														Shallow
CT-W-1.07	Wilder	Upper Wilder	Major Impoundment Trib	Oliverian Brook	4	-72.06342	44.048331	Y	2	381.77	382.62	382.18	382.63	0.86	0.01	0.45	shallow	3	381.77	382.51	382.12	382.53	0.76	0.02	0.41	shallow	Shallow
CT-W-1.11	Wilder	Upper Wilder	Major Impoundment Trib	Halls Brook	4	-72.091649	44.024377	Y	5	378.00	382.54	381.2	382.56	4.56	0.02	1.36	shallow										Shallow
CT-W-1.74	Wilder	Lower Wilder	Major Impoundment Trib	Mink Brook	4	-72.299582	43.696193	Y	26	372.85	381.07	379.1	381.08	8.23	0.01	1.98	shallow	28	372.85	381.03	379.08	381.04	8.19	0.01	1.96	shallow	Shallow
CT-WR-2.06	Wilder Riverine	Upper Wilder Riverine	Major Riverine Trib	Bloods Brook	4	-72.327478	43.606535	Y	n/a	319.45	321.68	320.36	322.41	2.96	0.73	2.05	adequate	30	319.45	321.11	320.27	321.44	1.99	0.33	1.17	adequate	Adequate
CT-WR-2.18	Wilder Riverine	Lower Wilder Riverine	Major Riverine Trib	Mill Brook Vt	4	-72.38701	43.47221	Y	n/a	293.14	296.79	294.46	296.81	3.67	0.02	2.35	adequate	37	293.14	294.06	293.40	294.13	0.99	0.07	0.73	shallow	Shallow
CT-WR-2.19	Wilder Riverine	Lower Wilder Riverine	Major Riverine Trib	Mill Brook NH	4	-72.386094	43.470803	Y	n/a	295.60	297.11	296.11	297.15	1.55	0.04	1.04	adequate	38	295.60	295.84	295.73	295.87	0.27	0.03	0.14	shallow	Shallow
CT-B-3.13	Bellows	Bellows	Major Impoundment Trib	Little Sugar River	4	-72.397391	43.307044	Y	43	285.50	288.5	287.4	289.27	3.77	0.77	1.87	shallow	45	285.50	288.50	287.40	288.53	3.03	0.03	1.13	shallow	Shallow
CT-B-3.16	Bellows	Bellows	Major Impoundment Trib	Beaver Brook	4	-72.414353	43.268439	Y	43	277.11	283.77	279	289.27	12.16	5.50	10.27	adequate										Adequate
CT-B-3.17	Bellows	Bellows	Major Impoundment Trib	Spencer Brook	4	-72.425695	43.261823	Y	43	285.60	288.6	287.51	289.27	3.67	0.67	1.76	shallow										Shallow
CT-B-3.22	Bellows	Bellows	Major Impoundment Trib	Clay Brook	4	-72.431264	43.234287	Y	49	285.00	286.97	286.35	286.98	1.98	0.01	0.63	shallow										Shallow

REV_ID	Reach	Sub Reach	Type	GNIS_Name	Order	X (DD NAD83 UTM Z18N)	Y (DD NAD83 UTM Z18N)	Bathymetry Available?	Nearest Mainstem Logger Station	Min Bed Elevation (deepest)	Max Bed Elevation (shallowest)	Average Bed Elevation	Min WSE Value	Min Depth	Max Depth	Average Depth	Method 1 Depth Designation	Site-Specific Logger Station	Min Bed Elevation (deepest)	Max Bed Elevation (shallowest)	Average Bed Elevation	Min WSE Value	Min Depth	Max Depth	Average Depth	Method 2 Depth Designation	Final Depth Designation
CT-B-3.29	Bellows	Bellows	Major Impoundment Trib	Jabes Hackett Brook	4	-72.441475	43.178613	Y	49	283.50	286.8	285.79	286.98	3.48	0.18	1.19	shallow										Shallow
CT-V-5.16	Vernon	Vernon	Major Impoundment Trib	Mill Brook	4	-72.454413	42.999953	Y	60	212.80	219.1	217.68	219.16	6.36	0.06	1.48	shallow	59	212.80	219.80	217.91	219.99	7.19	0.19	2.08	shallow	Shallow
CT-V-5.17	Vernon	Vernon	Major Impoundment Trib	East Putney Brook	4	-72.46362	42.986186	Y	60	214.43	219	217.4	219.16	4.73	0.16	1.76	shallow	61	214.43	218.83	217.29	218.88	4.45	0.05	1.59	shallow	Shallow
CT-V-5.18	Vernon	Vernon	Major Impoundment Trib	Partridge Brook	4	-72.466342	42.976335	Y	60	209.30	219	216.04	219.16	9.86	0.16	3.12	shallow										Shallow
CT-V-5.24	Vernon	Vernon	Major Impoundment Trib	Sacketts Brook	4	-72.514281	42.963625	Y	60	210.57	218.5	216.52	219.16	8.59	0.66	2.64	shallow										Shallow
CT-V-5.42	Vernon	Vernon	Major Impoundment Trib	Whetstone Brook	4	-72.556527	42.851768	Y	65	210.50	217	215.28	217.44	6.94	0.44	2.16	shallow										Shallow
CT-V-5.46	Vernon	Vernon	Major Impoundment Trib	Broad Brook	4	-72.544266	42.820078	Y	70	211.41	217.33	216.14	217.34	5.93	0.01	1.20	shallow										Shallow
CT-W-1.15	Wilder	Upper Wilder	Major Impoundment Trib	Waits River	5	-72.116406	43.994523	Y	5	367.78	382.55	381.07	382.56	14.78	0.01	1.49	shallow	7	367.78	381.72	380.16	381.73	13.95	0.01	1.57	shallow	Shallow
CT-W-1.58	Wilder	Lower Wilder	Major Impoundment Trib	Ompompanoosuc River	5	-72.229812	43.75205	Y	19	366.10	381.2	379.26	381.21	15.11	0.01	1.95	shallow	74	366.10	381.76	379.66	381.77	15.67	0.01	2.11	shallow	Shallow
CT-WR-2.03	Wilder Riverine	Upper Wilder Riverine	Major Riverine Trib	Mascoma River	5	-72.326427	43.635817	Y	n/a	322.17	326.03	324.65	326.05	3.88	0.02	1.40	adequate										Adequate
CT-WR-2.08	Wilder Riverine	Upper Wilder Riverine	Major Riverine Trib	Ottauquechee River	5	-72.346058	43.590471	Y	n/a	314.07	315.58	314.91	315.68	1.61	0.10	0.77	adequate										Adequate
CT-B-3.18	Bellows	Bellows	Major Impoundment Trib	Black River	5	-72.430747	43.260163	Y	43	271.23	288.7	285.62	289.27	18.04	0.57	3.65	shallow										Shallow
CT-B-3.31	Bellows	Bellows	Major Impoundment Trib	Williams River	5	-72.45725	43.180528	Y	49	274.85	286.97	284.01	286.98	12.13	0.01	2.97	shallow										Shallow
CT-BR-4.01	Bellows Riverine	Bellows Riverine	Major Riverine Trib	Saxtons River	5	-72.437392	43.124848	Y	n/a	223.74	224.64	224.40	224.65	0.91	0.01	0.25	shallow	52	223.74	224.64	224.40	231.89	8.15	7.25	7.49	adequate	Shallow
CT-BR-4.02	Bellows Riverine	Bellows Riverine	Major Riverine Trib	Cold River	5	-72.431083	43.118314	Y	n/a	223.95	224.98	224.47	225.16	1.21	0.18	0.69	adequate	55	223.95	224.98	224.47	225.96	2.01	0.98	1.49	adequate	Adequate
CT-WR-2.02	Wilder Riverine	Upper Wilder Riverine	Major Riverine Trib	White River	6	-72.31521	43.648842	N																			Shallow
CT-B-3.02	Bellows	Bellows	Major Impoundment Trib	Sugar River	6	-72.399662	43.401959	Y	41	285.00	289.8	287.93	289.83	4.83	0.03	1.90	shallow										Shallow
CT-V-5.40	Vernon	Vernon	Major Impoundment Trib	West River	6	-72.568873	42.871931	Y	65	209.41	217.4	214.6	217.44	8.03	0.04	2.84	shallow	66	209.41	217.27	214.59	217.28	7.87	0.01	2.69	shallow	Shallow

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Initial Study Report

Volume IV

September 15, 2014

TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 24
Dwarf Wedgemussel and Co-Occurring Mussel Study, Phase 1 Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

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May 8, 2014

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EXECUTIVE SUMMARY

In 2011 and 2013, Biodrawversity LLC conducted freshwater mussel surveys in the Connecticut River and tributaries within the boundary of the Wilder, Bellows Falls, and Vernon Hydroelectric Projects (projects), and in the 17-mile free-flowing reach between the Wilder and Bellows Falls projects ("free-flowing reach"). There were three primary objectives of the fieldwork: (1) assess the distribution, abundance, demographics, and habitat of dwarf wedgemussel (*Alasmidonta heterodon*), a federally endangered species known to occur in the Connecticut River, (2) gather similar information on co-occurring mussel species and, (3) record incidental observations of tessellated darter (*Etheostoma olmstedi*) (2013 only). These data were necessary to plan later phases of a comprehensive mussel study, including possible quantitative sampling, *in situ* observations of dwarf wedgemussel behavior, and an analysis of the effects of flow regime on dwarf wedgemussel populations and their habitat.

The 2011 field research provided information for pre-application documents (PADs) for the relicensing of each hydroelectric project, and the 2013 field research accomplished the first phase of a multi-phase relicensing mussel study that had been approved by stakeholders in 2013 (TransCanada ILP Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study). This report is a comprehensive summary of the 2011 and 2013 field data.

Mussel surveys were conducted at 210 sites, including 72 in the Wilder project, 39 in the free-flowing reach downstream of Wilder dam, 69 in the Bellows Falls project, and 30 in the Vernon project. A total of 147 sites were in impoundments and 24 were located immediately downstream from dams (eight sites below each dam). Surveys were carried out between May and October, and included semi-quantitative mussel sampling (i.e., timed searches) and documentation of habitat conditions. Surveys were typically conducted by SCUBA diving in deep (>5 feet) water and snorkeling in shallow areas.

A total of 69 dwarf wedgemussel were counted in the Wilder and Bellows Falls impoundments; none were found in the Vernon project or in the free-flowing reach. In the Wilder impoundment, 45 dwarf wedgemussel were found among 17 survey sites, for an average of 0.7 mussels/site and a maximum catch-per-unit-effort (CPUE) of 8.0 mussels/hour. These 45 mussels were found between Sites W-29 and W–62, located between 27 and 41 miles upstream from the Wilder dam. In the Bellows Falls impoundment, 24 dwarf wedgemussel were found among 14 survey sites, for an average of 0.4 mussels/site and a maximum CPUE of 3.0 mussels/hour. These 24 mussels were found sporadically between Sites BF-14 and BF–62, which were located in the upper 17 miles of the impoundment. Dwarf wedgemussel in the Bellows Falls impoundment were found slightly more frequently near Wethersfield Bow, in the Connecticut River near the Black River confluence, and in the project-affected portion of the Black River. Dwarf wedgemussel were not found in the tailwaters of any of the three dams. Shell length data for dwarf wedgemussel indicated some evidence of recruitment, small average shell length compared to other known populations in the watershed, and scarcity of older mature mussels. The tessellated darter, which is the primary host for dwarf wedgemussel, was found at only 17.9 percent of sites in the free-flowing reach and always at low densities. Tessellated darters were found somewhat more frequently (22.4%) in the Wilder and Bellows Falls impoundments, especially near shorelines where habitat heterogeneity was higher than it was toward the center of the river channel.

Six other species of freshwater mussels were found during the surveys: eastern elliptio (*Elliptio complanata*), eastern lampmussel (*Lampsilis radiata*), alewife floater (*Anodonta implicata*), triangle floater (*Alasmidonta undulata*), creeper (*Strophitus undulatus*), and eastern floater (*Pyganodon cataracta*). The mussel communities were dominated by eastern elliptio and eastern lampmussel, which were found at 95.2 and 87.6 percent of survey sites, respectively. Together, these two species comprised more than 99 percent of the mussels observed at most survey sites. Alewife floater was the third most common species overall, occurring at 12.6 percent of all survey sites, and at 66.7 percent of all survey sites located downstream from the Bellows Falls dam. A total of 460 alewife floater were counted, including only two upstream from the Bellows Falls dam, 217 below the Bellows Falls dam, 166 in the Vernon impoundment, and 75 below the Vernon dam.

The other three species were far less common. Creeper was found at 22 survey sites (10.5 percent) and was usually only present at very low numbers. It was found at two sites (two animals) in the Wilder impoundment, two sites (two animals) in the free-flowing reach, 14 sites (44 animals) in the Bellows Falls impoundment (mostly in the Black River), and four sites (six animals) in the Vernon impoundment. None were found immediately downstream from any of the three dams. Triangle floater was found at 31 survey sites (14.8 percent) and usually at very low numbers, including at ten sites (19 animals) in the Wilder impoundment, and four sites (six animals) in the free-flowing reach, nine sites (18 animals) in the Bellows Falls impoundment, and two sites (two animals) in the Vernon impoundment. Triangle floater was also found downstream from the Wilder dam (three live animals) and Bellows Falls dam (five live animals). Eastern floater occurred primarily in two locations: in the lower Black River in the Bellows Falls impoundment and within the downstream half of the Vernon impoundment.

The three fluvial mussel species—dwarf wedgemussel, triangle floater, and creeper—were rare and patchily distributed. Dwarf wedgemussel were not found in the free-flowing reach where the species was historically known to occur (e.g., Sumner Falls or Cornish Covered Bridge), and densities of other fluvial species (triangle floater and creeper) were also very low in the free-flowing reach. The free-flowing reach contained the lowest species richness and mussel density (all species) among the areas surveyed, and had the poorest quality mussel habitat. Important areas for the rare fluvial species in the Wilder impoundment were primarily confined to a 14-mile reach in the upper third of the impoundment. Important areas for the three fluvial species in the Bellows Falls impoundment appear to include Wethersfield Bow, the Connecticut River near the Black River confluence, and the lower Black River. Eastern elliptio and eastern lampmussel are the only two species with robust populations throughout all study areas, although alewife floater populations may also be stable in areas of the Connecticut River downstream from the Bellows Falls dam.

The FERC-approved freshwater mussel study plan (FERC Study Plan Determination, February 21, 2014) for the relicensing of the Wilder, Bellows Falls, and Vernon Hydroelectric Projects specifies quantitative sampling of dwarf wedgemussel and co-occurring mussel species, *in situ* monitoring of dwarf wedgemussel, and an evaluation of the effects of flow regime on dwarf wedgemussel populations and habitat. The absence or scarcity of dwarf wedgemussel in the free-flowing reach and other areas that experience the most change (e.g., water depth or water velocity) during daily or sub-daily project-related flow fluctuations will greatly constrain the types of sampling, monitoring, and analyses that would be effective. Though less direct than studying dwarf wedgemussel populations, an approach that focuses on mussel communities (i.e., all species), important habitat parameters, and host fish might shed more insight than population-level research and monitoring.

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1. INTRODUCTION

The Connecticut River in the upper Bellows Falls impoundment, looking across to Mt. Ascutney.

An approximate 120-mile reach of the Connecticut River from North Haverhill, New Hampshire, to downstream of Vernon dam, is influenced by the presence and operations of three major hydroelectric facilities: Wilder, Bellows Falls, and Vernon (Figure 1-1). TransCanada owns and operates these hydroelectric facilities, and the current Federal Energy Regulatory Commission (FERC) license for these will expire in 2018. The impoundments of these three facilities are approximately 45, 26, and 26 miles long, respectively, and they include the mouths of numerous tributaries. The operations of the hydroelectric facilities influence both upstream and downstream areas with daily or sub-daily flow fluctuations. An important area subjected to sub-daily flow fluctuations is the 17-mile free-flowing reach between Wilder dam and the upper end of the Bellows Falls project, referred to as the "free-flowing reach" throughout this report.

In 2011, TransCanada completed a freshwater mussel survey in the three project areas to provide information for the projects' Pre-Application Documents (PADs). The primary objectives of the 2011 survey were to assess the distribution, abundance, demographics, and habitat of dwarf wedgemussel in the impoundments and areas a short distance downstream from Wilder and Bellows Falls dams. The survey also provided information on the diversity, abundance, and habitat of the entire freshwater mussel community in these locations. The free-flowing reach was not surveyed in 2011.

Dwarf wedgemussel from the Wilder impoundment.

In 2013, relicensing stakeholders requested a study of the potential effects of the Wilder and Bellows Falls hydroelectric operations on dwarf wedgemussel populations. Five objectives were stated in each study request: three were related to baseline population studies and long-term monitoring, and two were focused specifically on the potential effects of flow regime/water level fluctuations on mussel behavior or habitat. The study plan approved by stakeholders and FERC outlined an adaptive, two-phase plan that would benefit from collaboration with stakeholders throughout the design and implementation of the study. Specifically, mussel surveys were planned for 2013, and these results would help refine study plans for 2014 fieldwork and analyses. Primary among the tasks were to conduct a mussel survey in the 17-mile free-flowing reach using the same methods as the 2011 survey, and to integrate the 2011 and 2013 data into a comprehensive report. The 2013 field research also evaluated potential sites for quantitative mussel sampling, and evaluated the feasibility of observing behavior of dwarf wedgemussel in situ during varying flow conditions.

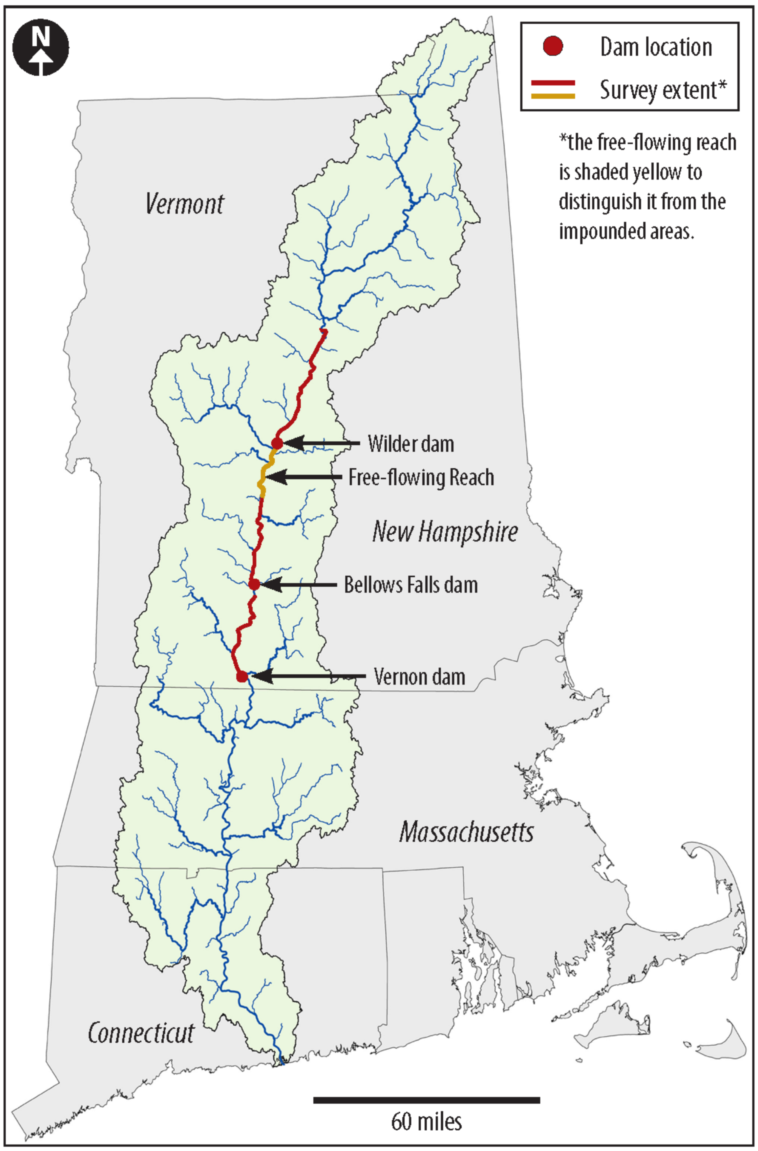


Figure 1-1: Locations of the Wilder, Bellows Falls, and Vernon hydroelectric projects in the Connecticut River watershed, and the linear extent of the 2011 and 2013 mussel surveys.

2. STUDY AREA DESCRIPTION

2.1 Wilder Project

The Wilder impoundment is approximately 45 miles long and includes 105 total miles of shoreline. Several tributaries are influenced by the impoundment, including the Ompompanoosuc and Waits Rivers from the west, as well as smaller and higher-gradient tributaries from the east. The land along the river corridor is mostly comprised of mixed farmland, residential areas, and forests, although substantially more development occurs near Fairlee, Bradford, and Hanover. In 2006, dwarf wedgemussel were documented along a 16-mile reach of the impoundment between Haverhill and Orford, New Hampshire (Nedeau 2006, 2008b).

The Wilder impoundment near the old Bedell Bridge (Haverhill, NH).

2.2 Free-flowing Reach

The “free-flowing reach” is the 17-mile-long reach between the Wilder dam and the upstream extent of the Bellows Falls impoundment, which is considered the downstream tip of Chase Island (Cornish, NH). The Connecticut River drops almost 55 feet in elevation over this distance, and contains many miles of fast-flowing runs, riffles, and rapids. The predominant substrates are gravel and cobble, though sand is transient in fast-flowing areas and accumulates in depositional areas, and there are areas where boulders and bedrock are the defining features of the stream channel. There are numerous islands and high-energy gravel and cobble bars, many of which are only evident during low-flow periods. One of the most interesting geologic features in this reach is Sumner Falls, formed by a north-south oriented bedrock outcrop. Numerous tributaries enter this reach from the east and west, the largest including the White River and Ottaquechee River from the west and the Mascoma River from the east. The land along the river is mostly comprised of urban/industrial near White River Junction and Lebanon, and mixed farmland, forests, and residential lands farther downstream. Historically, dwarf wedgemussel were documented in the pool downstream from Sumner Falls and near the Cornish Covered Bridge (Gabriel 1995).

2.3 Bellows Falls Project

The Bellows Falls impoundment is approximately 26 miles long and its upper reach ends 17 miles downstream from the Wilder dam. Land use along the river corridor is primarily mixed agriculture, forests, and residential. Several mid-sized tributaries flow into the impoundment, including Mill Brook, Sugar River, Black River, and

Williams River. Dwarf wedgemussel were already known to occur in the impoundment of the Bellows Falls dam and in the project-affected section of the lower Black River (Ferguson 1999, Nedeau 2008a-b).

2.4 Vernon Project

The Vernon impoundment is approximately 26 miles long. The upper reach of this impoundment extends to less than six miles below the dam at the Bellows Falls project. Its upper reach is located in a relatively wide and open section of the Connecticut River valley, with agricultural and residential land uses prevalent along the river corridor. Further downstream, the valley narrows and the landscape becomes more mountainous and heavily forested. Vermont's West River is the most significant tributary in this reach, although many small streams enter from both the east and west. There are historical records of dwarf wedgemussel in the Connecticut River in the lower Vernon impoundment, near Brattleboro. However, dwarf wedgemussel have not been found within this impoundment or its tributaries in at least 30 years (Nedeau 2005).

The ledges of Sumner Falls in the free-flowing reach (Hartland, VT).

Typical gravel-cobble substrate and shallow water in the free-flowing reach.

3. METHODS

3.1 Site Selection

Sites were selected to provide adequate spatial coverage of each study area, and to target habitats suitable for dwarf wedgemussel. Table 3-1 provides statistics for the number and frequency of survey sites in each study area. Site locations for each study area are shown in Appendix A.

Table 3-1: Level of survey effort allocated to the Wilder, Bellows Falls, and Vernon study areas, and to the free-flowing reach.

	Study Area				
Statistic	**Free-Flowing**	**Wilder**	**Bellows Falls**	**Vernon**	**Total**
# Sites Just Below Dam	-	8	8	8	24
# Sites in Impoundment [a]	-	64 (15)	61 (16)	22	147 (31)
Total Sites [a]	(39)	72 (15)	69 (16)	30	210 (70)
Mean Distance Between Sites [b]	0.4	0.7	0.4	1.3	0.6
Max Distance Between Sites	1.6	1.8	1.3	1.8	1.8
Total Search-Hours	42.5	68.5	71.8	25.5	208.3
Mean Search-hours Per Site	1.09	0.95	1.04	0.85	0.99

[a] Numbers in parentheses indicate 2013 sampling sites.

[b] Excluding the tight cluster of 8 sites downstream from each of the three dams.

In 2011, biologists systematically surveyed sites along the entire length of each impoundment and below each dam. More fieldwork was allocated to the Wilder and Bellows Falls impoundments because dwarf wedgemussel were known to occur in these impoundments (Nedeau 2008). The Vernon impoundment was surveyed less intensively because the likelihood of finding dwarf wedgemussel was considered low based on prior experiences (Nedeau 2008). In the Wilder and Vernon impoundments, all survey sites were confined to the Connecticut River. In the Bellows Falls impoundment, the lower reaches of the Sugar River, Black River, and Williams River were surveyed. In 2013, the 17-mile free-flowing reach was surveyed in the same manner as the 2011 surveys. Additional surveys were also conducted in the Wilder and Bellows Falls impoundments near where dwarf wedgemussel were found in 2011. These areas included a 14-mile reach in the Wilder project (from 27 to 41 miles upstream from the Wilder dam), and a 17-mile reach in the Bellows Falls project from Chase Island downstream to just below the Black River confluence. One key objective for the 2013 surveys was to determine where quantitative sampling methods and *in situ* monitoring might be most effective based on the following factors:

- Spatial extent of the dwarf wedgemussel population
- Density of dwarf wedgemussel and other species
- Habitat use by dwarf wedgemussel
- Habitat suitability for dwarf wedgemussel
- Environmental conditions (e.g., sampling constraints)
- Accessibility (e.g., potential property rights issues)
- Other factors that may influence whether a site could be used for further study.

Mussels like this one with near-complete loss of periostracum are assigned a shell condition value of 1.0.

3.2 Field Surveys

Field surveys were conducted during the period from May to September of 2011, and during September and early October of 2013. Survey methods varied according to specific habitat conditions at each site, but typically biologists used SCUBA in water deeper than five feet, and snorkeled in shallower areas. Most survey sites were accessed using a motorboat or kayaks, and a few were accessed from convenient entry points on public land (e.g., bridges, boat launches, and fishing areas). Biologists usually spent approximately one person-hour at each site searching for mussels, sometimes less if habitat was poor and few mussels were observed, and sometimes more if habitat was suitable and dwarf wedgemussel were found. Surveys typically involved two biologists each conducting a 30-minute timed search. The following information was recorded:

- Precise counts of dwarf wedgemussel, triangle floater, creeper, alewife floater, and eastern floater
- Qualitative abundance estimates (Table 3-2) for eastern elliptio and eastern lampmussel
- Shell length and shell condition for every dwarf wedgemussel, triangle floater, and creeper, and more cursory observations of the length range

and shell conditions for other species. Shell condition refers to the degree of shell erosion (i.e., loss of periostracum and other damage). This was recorded as one of five numeric scores: 0 (light), 0.25 (light-medium), 0.5 (medium), 0.75 (medium-heavy), and 1 (heavy). These scores were averaged for all mussels in a sample to produce an overall shell condition index that ranged from 0 to 1.

- In 2013, biologists noted whether tessellated darter were observed at survey sites
- General descriptions of bank condition, surrounding land use, other noteworthy observations
- Representative photographs of habitats and species
- Notes on instream habitat such as water depth, substrate, flow conditions, submerged aquatic vegetation, and woody debris at each survey site. Water velocity was not specifically measured but was subjectively recorded as light (typically less than 0.1 m/s), moderate (0.1 to 0.3 m/s), or strong (>0.3 m/s).
- GPS coordinates of the survey sites

Table 3-2: Abundance categories for eastern lampmussel and eastern elliptio.

Score	Descriptor	General Range*
0	None	0
1	Very Low	1-20
2	Low	21-50
3	Medium	51-100
4	Medium-High	101-200
5	High	201-400
6	Very High	401-800
7	Extreme	>800

3.3 Data Analysis

Data collected during field surveys were entered into a Microsoft Excel spreadsheet and GPS coordinates were imported into ArcGIS to generate maps. Catch-per-unit-effort (CPUE, expressed as mussels/hour) statistics were computed for the five species that were precisely counted. Shell length data collected for rare species (dwarf wedgemussel, triangle floater, and creeper) were used to develop length-frequency histograms (a surrogate for age-frequency; reviewed in Nedeau 2008a). Counts and descriptive statistics were tabulated, graphed, and mapped. Raw data is provided in Appendix B (privileged data).

4. RESULTS

4.1 Species Richness

Wilder Project: Mussels were encountered at every survey site in the Wilder project (Table 4-1, Figure 4-1). Three species were found downstream from the Wilder dam: eastern elliptio, eastern lampmussel, and triangle floater. Five species were found in the Wilder impoundment; these were the same species from below the dam plus dwarf wedgemussel and creeper. Downstream from the dam, average species richness (i.e., number of species) was 1.75 (range = 0–3) among the eight survey locations that comprised the single composite site. In the impoundment, average species richness was 2.39 (range = 1–4) among the 64 sites, and species richness was highest in areas between Sites W-29 and W-62 where dwarf wedgemussel were found (see Figure 4-5).

Free-flowing Reach: Mussels were encountered at 32 of 39 sites (82 percent) in the free-flowing reach (Table 4-1, Figure 4-2). Four species were found: eastern elliptio, eastern lampmussel, triangle floater, and creeper. Average species richness was 1.59, which was the lowest among all of the survey areas. Highest species richness among the 39 survey sites was four, at Site FF-32, where two of the species (triangle floater and creeper) were found only in the mouth of the Ottaquechee River. In addition to having low species richness, the free-flowing reach contained lower densities of mussels than almost anywhere else surveyed for this report. Most survey sites contained low to moderate numbers of eastern elliptio and even fewer numbers of eastern lampmussel. In addition, tessellated darters were observed at only seven (17.9 percent) of survey sites, always at very low densities (fewer than five fish per site) (Appendix B).

Bellows Falls Project: Mussels were encountered at all but two survey sites in the Bellows Falls project (Table 4-1, Figure 4-3). Five species were found downstream from the Bellows Falls dam: eastern elliptio, eastern lampmussel, alewife floater, eastern floater, and triangle floater. Seven species were found in the Bellows Falls impoundment; these were the same species from below the dam plus dwarf wedgemussel and creeper. Downstream from the dam, average species richness was 3.50 (range = 2–4) among the eight survey locations that comprised the single composite site. In the impoundment, average species richness was 2.61 (range = 0–6) among the 61 sites. Species richness was generally highest in areas between Sites BF-14 and BF-32 and Sites BF-39 and BF–54 (Figure 4-4). Three of the four highest species richness values were from survey sites in the Black River (Sites BF-26, BF-27, and BF–28). The only two locations where mussels were not found were in the lower Sugar River and Williams River.

Vernon Project: Mussels were encountered at every survey site in the Vernon project (Table 4-1, Figure 4-4). Four species were found downstream from the Vernon dam: eastern elliptio, eastern lampmussel, alewife floater, and eastern floater. Six species were found in the Vernon impoundment; these were the same species from below the dam plus triangle floater and creeper. Downstream from the dam, average species richness was 2.88 (range = 1–4) among the eight survey sites that comprised the single composite site. In the impoundment, average species richness was 3.05 (range = 2–5) among the 22 sites, and there was no apparent pattern to the species richness (Figure 4-5). Dwarf wedgemussel were not found within the Vernon project.

Table 4-1: Species richness, mean CPUE or abundance estimates, and number of occurrences for mussel species found in the Wilder, Bellows Falls, and Vernon study areas, and in the free-flowing reach.

Study Area							
	Wilder Impoundment	**Below Wilder Dam**	**Free-Flowing Reach**	**Bellows Falls Impoundment**	**Below Bellows Falls Dam**	**Vernon Impoundment**	**Below Vernon Dam**
Richness Descriptor							
Total Richness	5	3	4	7	5	6	4
Mean Richness/Site	2.39	1.75	1.59	2.61	3.50	3.05	2.88
Min Richness	1	0	0	0	2	2	1
Max Richness	4	3	4	6	4	5	4
Mean CPUE or Abundance Estimate							
AlHe (CPUE)	0.68	0.00	0.00	0.30	0.00	0.00	0.00
AlUn (CPUE)	0.31	0.75	0.17	0.29	0.63	0.09	0.00
AnIm (CPUE)	0.00	0.00	0.00	0.04	29.75	7.62	18.75
PyCa (CPUE)	0.00	0.00	0.00	0.13	0.13	0.27	5.00
StUn (CPUE)	0.03	0.00	0.04	0.73	0.00	0.27	0.00
ElCo (Estimate) a	5.25	2.38	2.10	4.98	5.38	4.27	4.50

Study Area							
	Wilder Impoundment	**Below Wilder Dam**	**Free-Flowing Reach**	**Bellows Falls Impoundment**	**Below Bellows Falls Dam**	**Vernon Impoundment**	**Below Vernon Dam**
LaRa (Estimate)[a]	2.50	1.50	1.50	3.38	2.63	2.18	1.75
# Sites Where Found							
AlHe	17	0	0	14	0	0	0
AlUn	10	2	4	9	4	2	0
AnIm	0	0	0	2	7	14	3
PyCa	0	0	0	2	1	4	5
StUn	2	0	2	14	0	4	0
ElCo	64	7	32	59	8	22	8
LaRa	60	5	24	59	8	21	7

[a] See Table 3-2 for abundance categories for ElCo and LaRa.

Species Abbreviations
AlHe = *Alasmidonta heterodon* (dwarf wedgemussel); AlUn = *Alasmidonta undulata* (triangle floater); AnIm = *Anodonta implicata* (alewife floater); PyCa = *Pyganodon cataracta* (eastern floater); StUn = *Strophitus undulatus* (creeper); ElCo = *Elliptio complanata* (eastern elliptio); LaRa = *Lampsilis radiata* (eastern lampmussel)

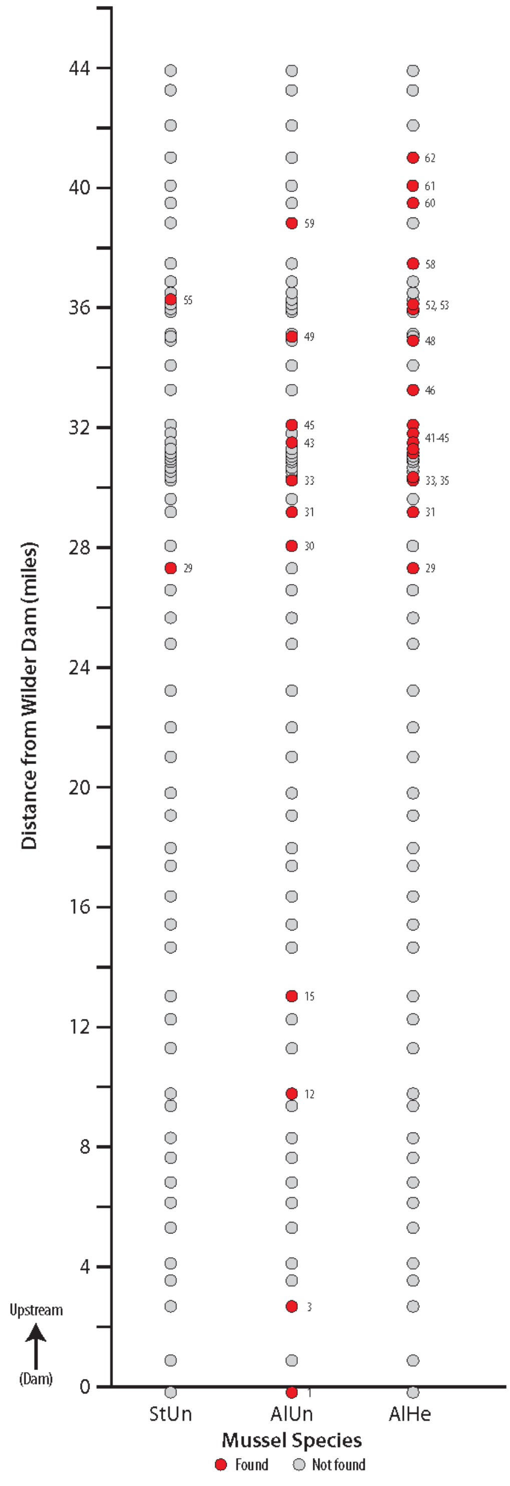


Figure 4-1. Sites where the three fluvial mussel species were encountered in the Wilder project. Sites are ordered by distance from the Wilder dam; Site 1 is downstream from the dam. Site numbers are provided only for sites where a species was found.

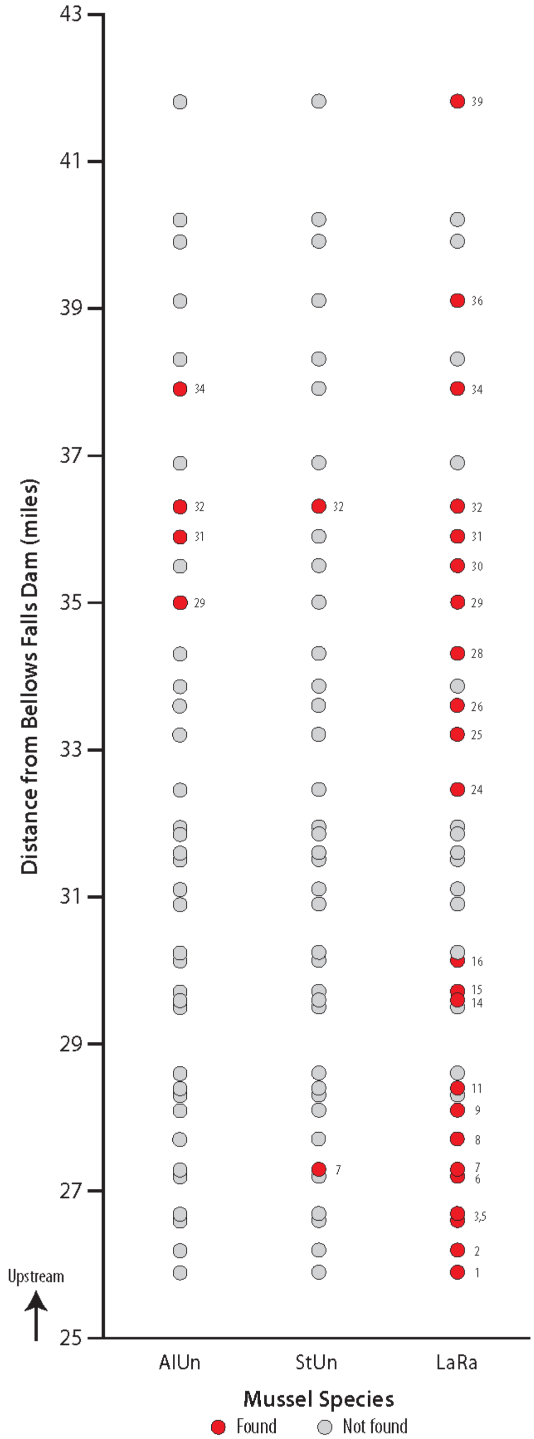


Figure 4-2. Sites where two fluvial mussel species and the eastern lampmussel were encountered in the free-flowing reach. Dwarf wedgemussel were not found in this reach. Sites are ordered by distance from the Bellows Falls dam. Site numbers are provided only for sites where a species was found.

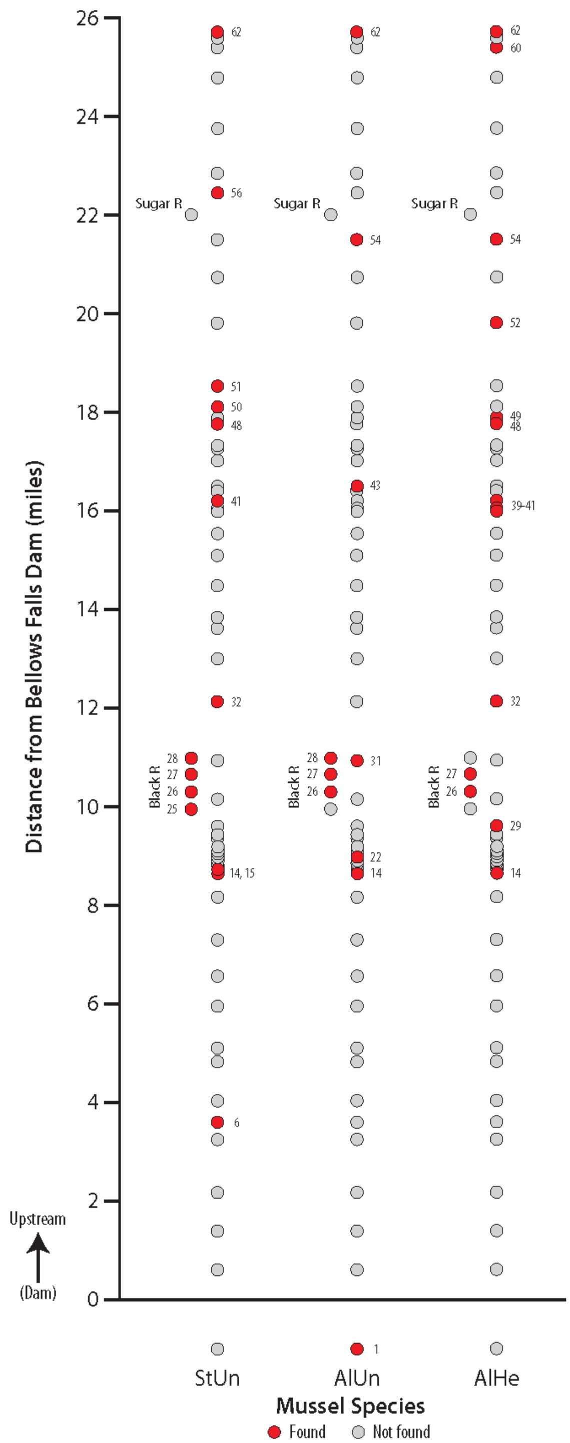


Figure 4-3. Survey sites where the three fluvial mussel species were encountered in the Bellows Falls project. Sites are ordered by distance from the Bellows Falls dam; Site 1 is downstream from the dam. Site numbers are provided only for sites where a species was found.

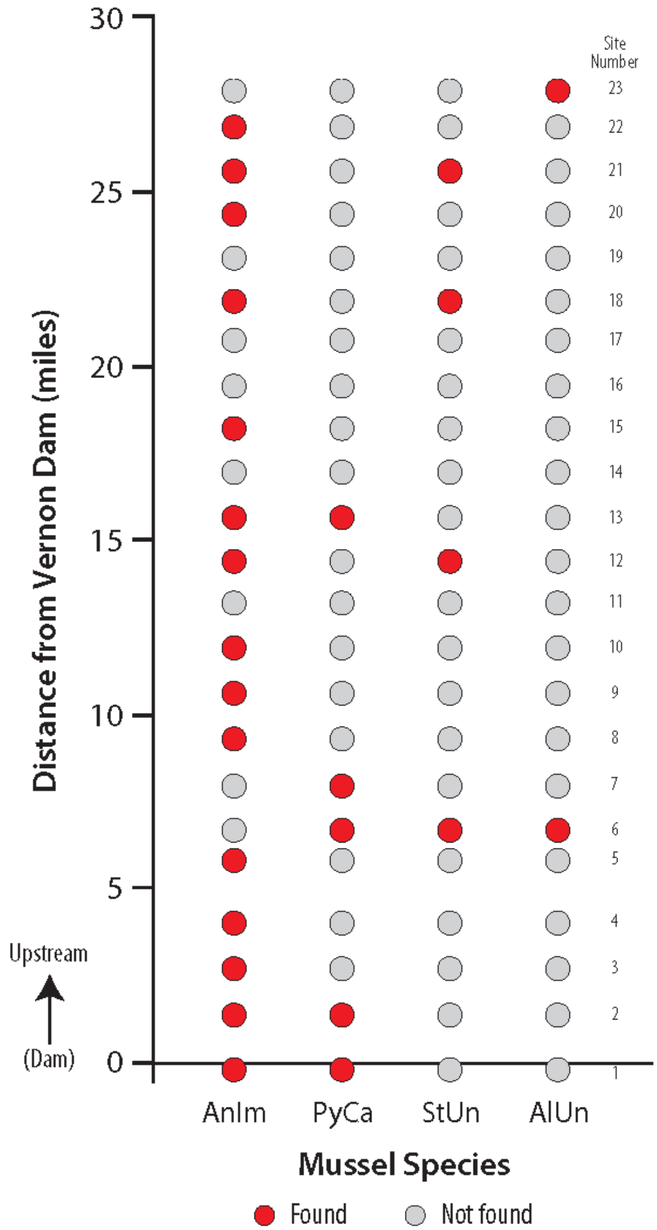


Figure 4-4. Survey sites where each mussel species were encountered in the Vernon project. Sites are ordered by distance from the Vernon dam; Site 1 is downstream from the dam.

4.2 Dwarf Wedgemussel

Distribution: Dwarf wedgemussel were only found in the Wilder and Bellows Falls impoundments (Table 4-2). In the Wilder impoundment, they were found at 17 survey sites (26.6 percent) between Sites W-29 and W-62, located 27–41 miles upstream from the Wilder dam (Figures 4-1, 4-6). In the Bellows Falls impoundment, they were found at 14 sites (23.0 percent), including two sites in the lower Black River and 12 sites in the Connecticut River between Sites BF-14 and BF-62, located in the upper 17 miles of the impoundment (Figures 4-3, 4-7). In addition, dwarf wedgemussel shells were found at three sites within this same reach. Dwarf wedgemussel in the Bellows Falls impoundment were found slightly more frequently near Wethersfield Bow, the Black River confluence, and in the Black River. Tessellated darters were usually observed where dwarf wedgemussel were found (Appendix B).

Abundance: A total of 69 dwarf wedgemussel were found (Table 4-2). A total of 45 dwarf wedgemussel were found in the Wilder impoundment, for an average of 0.70 mussels/site and an average CPUE of 0.68 mussels/hour. The highest CPUE recorded in the Wilder impoundment was 8.0 mussels/hour at Site W-58 (eight animals) (Figure 4-8). Twenty-four dwarf wedgemussel were found in the Bellows Falls impoundment, for an average of 0.39 mussels/site and an average CPUE of 0.30 mussels/hour. The highest CPUE recorded in the Bellows Falls impoundment was 3.0 mussels/hour at Site BF-26 in the Black River (three animals). Usually only one dwarf wedgemussel was found per site in the Bellows Falls impoundment. None were found in the Vernon impoundment or in the free-flowing reach.

Representative dwarf wedgemussel.

The lower Black River where dwarf wedgemussel were found.

The upper end of the Bellows Falls impoundment, looking toward the downstream tip of Chase Island, where one dwarf wedgemussel was found.

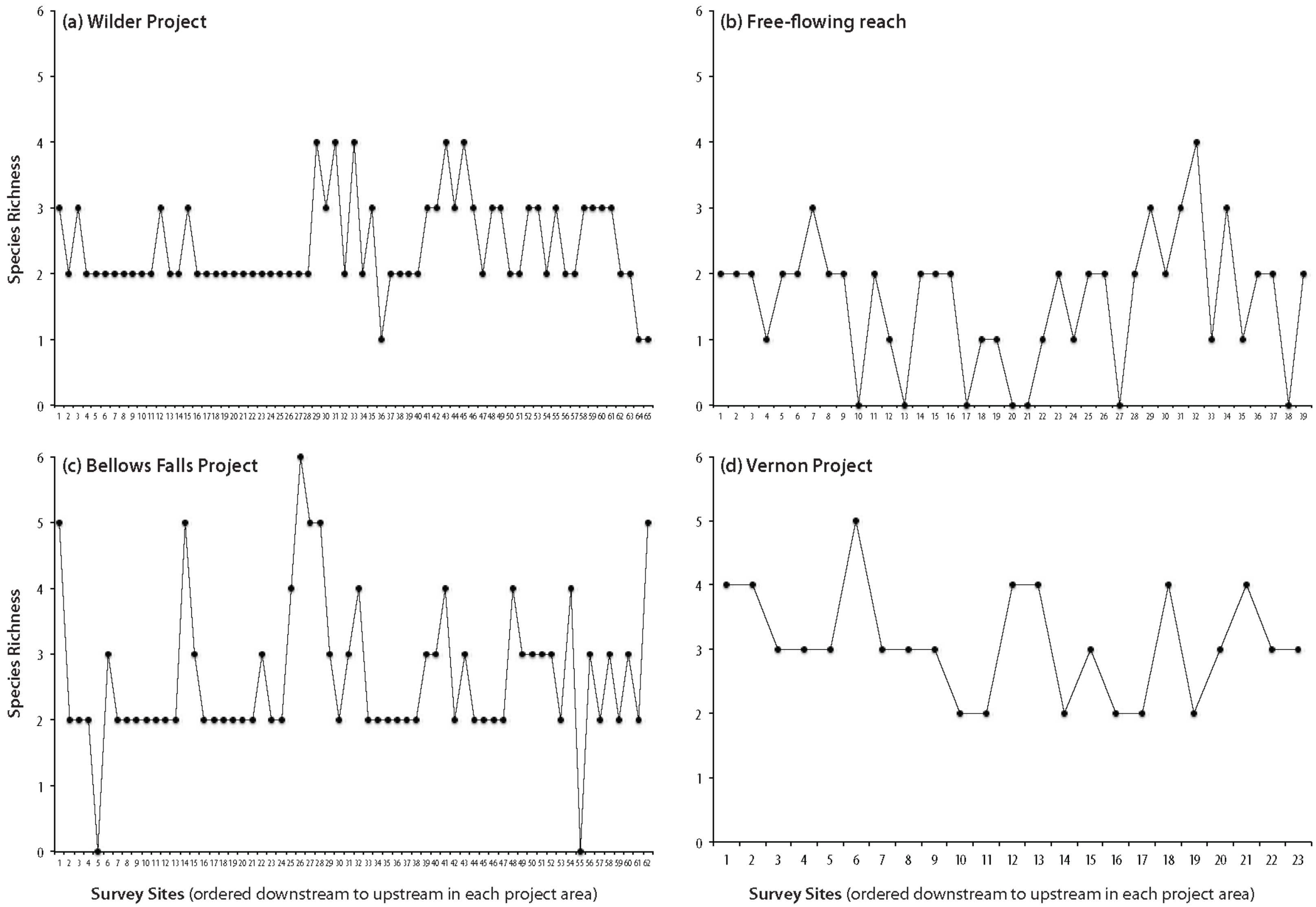


Figure 4-5. Mussel species richness at survey sites in the Wilder project (a), free-flowing reach (b), Bellows Falls project (c), and Vernon project (d). Sites are ordered downstream to upstream in each project.

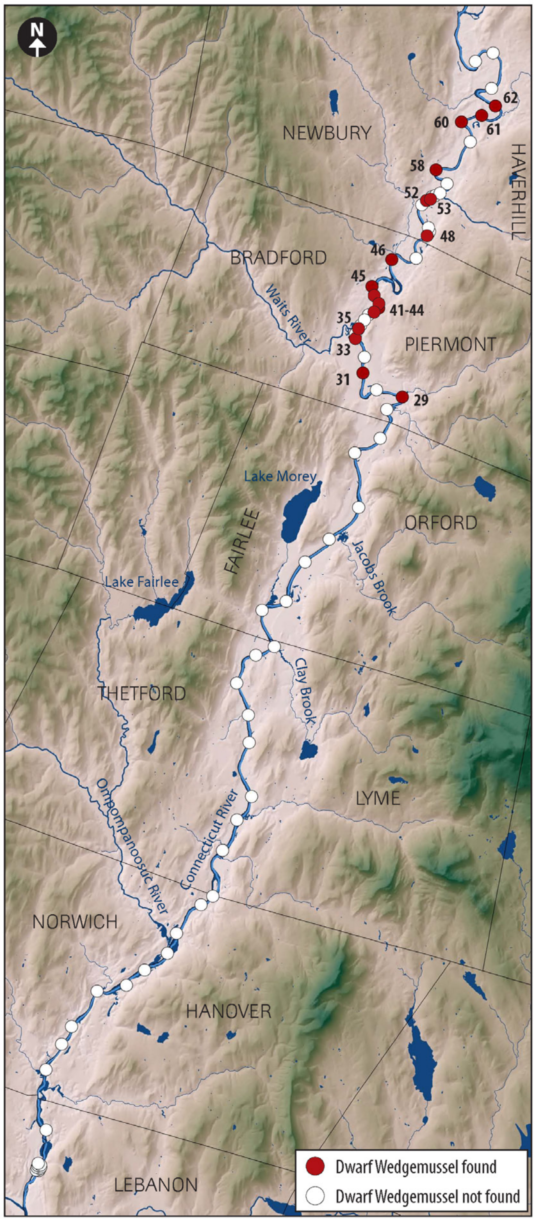


Figure 4-6. Survey sites where dwarf wedgemussel were found in the Wilder impoundment. See Appendix A for a fully labeled map.

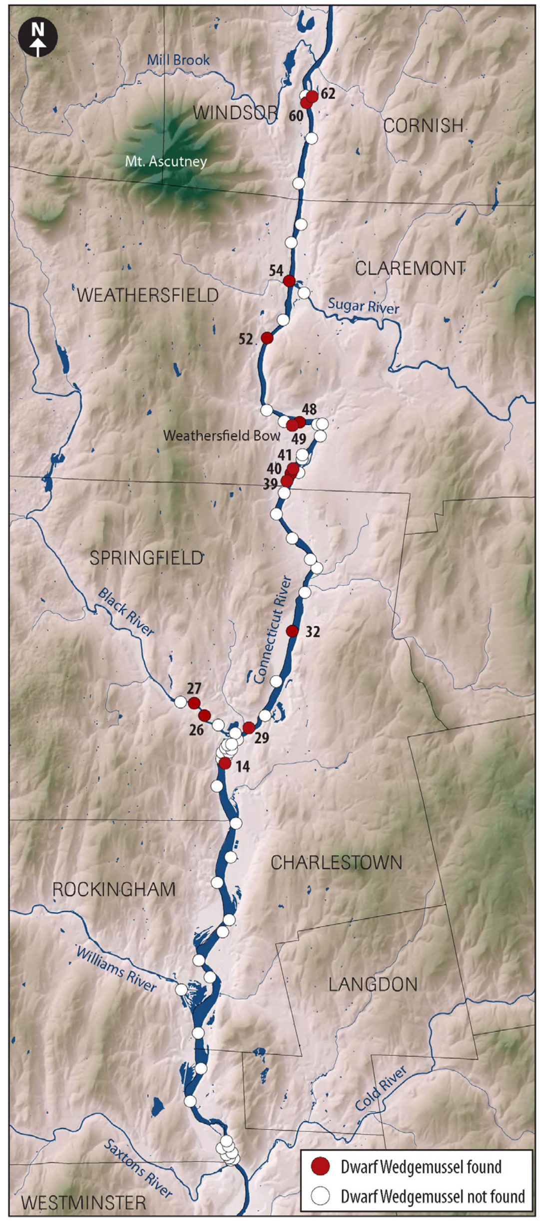


Figure 4-7. Survey sites where dwarf wedgemussel were found in the Bellows Falls impoundment. See Appendix A for a fully labeled map.

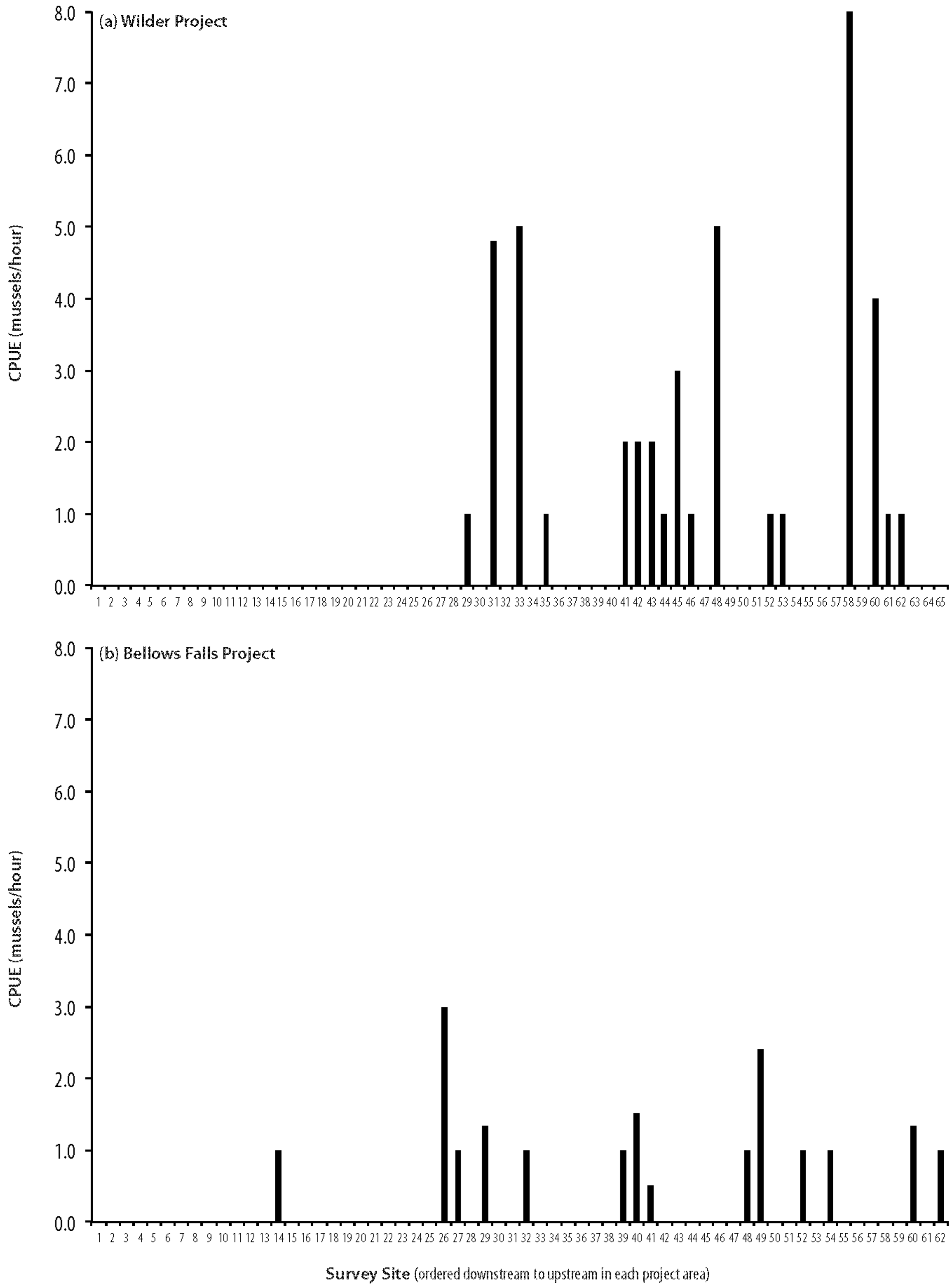


Figure 4-8. Dwarf wedgemussel CPUE for each survey site in the (a) Wilder impoundment and (b) Bellows Falls impoundment.

Table 4-2: Summary statistics for dwarf wedgemussel in areas where they were found.

Parameter	Wilder Impoundment	Bellows Falls Impoundment
Catch Statistics		
# Survey Sites	64	61
# of Sites Where Found	17	14
% of Sites Where Found	26.6	23.0
Total Count	45	24
Mean Count/Site	0.70	0.39
Max Count/Site	8	3
Mean CPUE (mussels/hr)	0.68	0.30
Max CPUE (mussels/hr)	8.00	3.00
Demographics and Condition Statistics		
Shell Condition	0.48	0.48
Average Length (mm)	26.77	31.50
Min Length (mm)	18.0	10.0
Max Length (mm)	37.0	44.5
Length Classes (mm)		
<20	2	1
20 - 24.9	14	0
25 - 29.9	14	6
30 - 34.9	14	9
35 - 39.9	1	4
40 - 44.9	0	2
45 - 49.9	0	0

Demographics and Shell Condition: Average shell length for all dwarf wedgemussel encountered was 28.4 mm, and individuals ranged from 10.0–44.5 mm (Table 4-2). There was evidence of recruitment in both impoundments. The shell condition index indicated moderate levels of shell erosion (0.48).

Habitat: Nearly all dwarf wedgemussel were found by SCUBA diving in water depths of 6-20 feet. They were found in a variety of substrate types, often with some combination of clay, silt, sand, and gravel. Some were found in pockets of these fine substrates in areas dominated by cobble, boulder, or bedrock. Most dwarf wedgemussel were found in areas with light to moderate flow velocities. They tended to be associated with two other uncommon mussel species—creeper and triangle floater.

4.3 Creeper

Distribution: Creeper were found in the Wilder, Bellows Falls, and Vernon impoundments, and in the free-flowing reach (Table 4-3); none were found immediately downstream from the three dams. In the Wilder impoundment, they were found at just two sites: W-29 and W-55, which were 27.3 and 36.3 miles upstream from the dam, respectively (see Figure 4-1). In the Bellows Falls impoundment, they were found at 14 survey sites (22.9 percent), including at all four sites in the lower Black River and ten sites in the Connecticut River widely spaced throughout much of the impoundment (see Figure 4-3). In the Vernon impoundment, they were found at four survey sites (18.2 percent) at least four miles apart (see Figure 4-4). Creeper were found at only two sites in the free-flowing reach, including at Site FF-7 and in the lower Ottaquechee River at Site FF-32 (see Figure 4-2).

Abundance: A total of 54 creeper were found (Table 4-3). Only two creeper were found in the Wilder impoundment, for an average CPUE of 0.03 mussels/hour. Forty-four creeper were found in the Bellows Falls impoundment, for an average of 0.72 mussels/site and an average CPUE of 0.73 mussels/hour. The highest CPUE recorded in the Bellows Falls impoundment was 18.0 mussels/hour at Site BF-26 in the Black River (18 animals). In fact, 75 percent (33 of 44) of the creeper found in the Bellows Falls impoundment were found in the Black River. Four creeper were found in the Vernon impoundment, for an average of only 0.27 mussels/site and an average CPUE of 0.27 mussels/hour. The highest CPUE recorded in the Vernon impoundment was 3.0 mussels/hour at Site V-21 (three animals). Only two creeper were found in the free-flowing reach, for an average CPUE of 0.04 mussels/hour. Figure 4-9 shows creeper CPUE by site.

Creeper from the Bellows Falls impoundment.

Table 4-3: Summary statistics for creeper in areas where they were found.

Parameter	Wilder Impoundment	Free-flowing Reach	Bellows Falls Impoundment	Vernon Impoundment
Catch Statistics				
# Survey Sites	64	39	61	22
# of Sites Where Found	2	2	14	4
% of Sites Where Found	3.1	5.1	23.0	18.2
Total Count	2	2	44	6
Mean Count/Site	0.03	0.05	0.72	0.27
Max Count/Site	1	1	18	3
Mean CPUE (mussels/hr)	0.03	0.04	0.73	0.27
Max CPUE (mussels/hr)	1.00	1.00	18.00	3.00
Demographics and Condition Statistics				
Shell Condition	0.00	0.25	0.27	0.29
Average Length (mm)	37.9	61.9	55.2	54.7
Min Length (mm)	31.0	60.0	31.0	47.0
Max Length (mm)	44.8	63.9	78.0	62.0
Length Classes (mm)				
<20	0	0	0	0
20 - 24.9	0	0	0	0
25 - 29.9	0	0	0	0
30 - 34.9	1	0	2	0
35 - 39.9	0	0	0	0
40 - 44.9	1	0	4	0
45 - 49.9	0	0	7	1
50 - 54.9	0	0	11	1
55 - 59.9	0	0	5	3
60 - 64.9	0	2	5	1
65 - 69.9	0	0	4	0
70 - 74.9	0	0	4	0
75 - 79.9	0	0	2	0

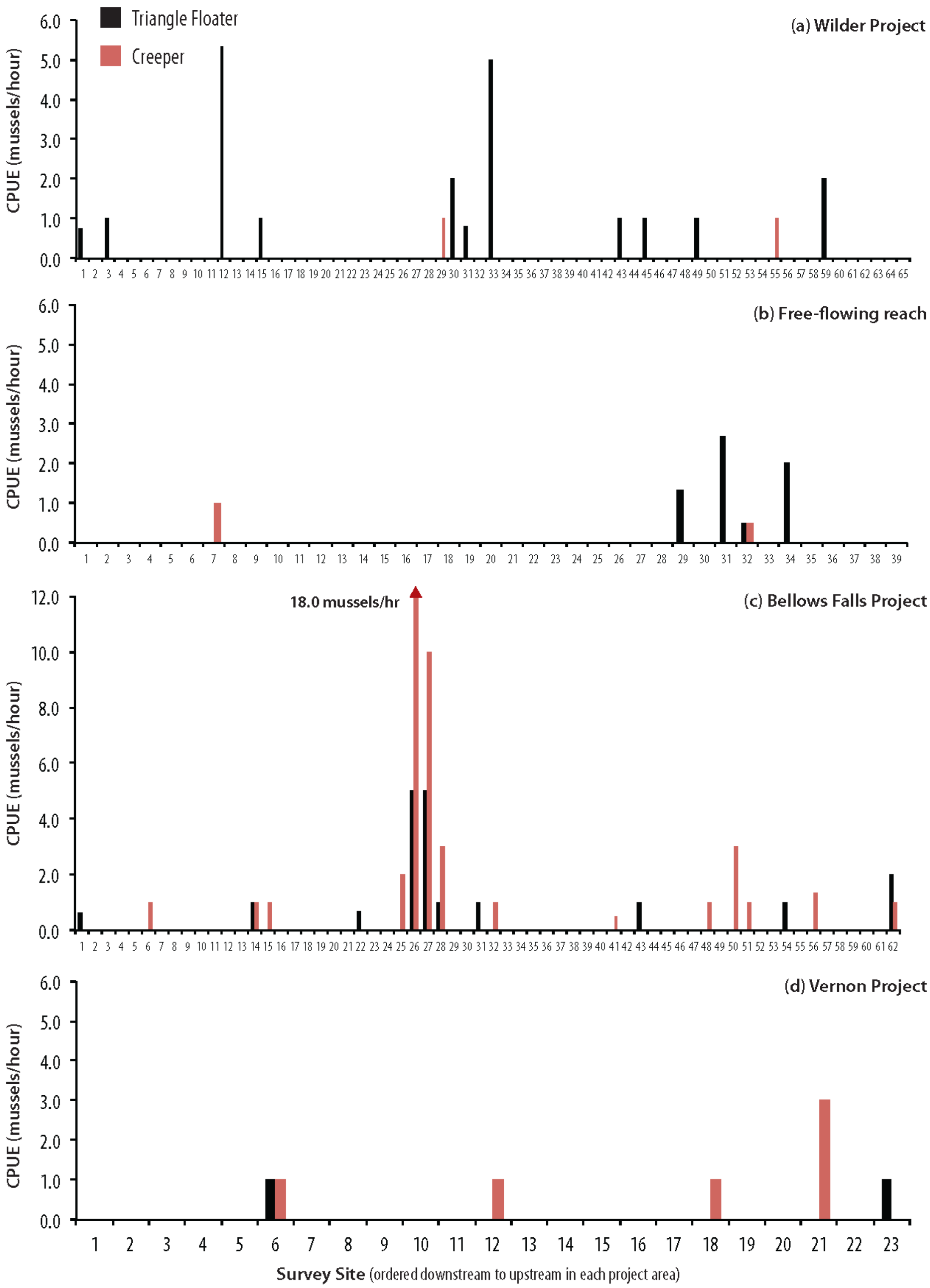


Figure 4-9. Triangle floater and creeper CPUE for each survey site in the Wilder project (a), free-flowing reach (b), Bellows Falls project (c), and Vernon project (d).

Demographics and Shell Condition: Average shell length for all creeper encountered was 54.8 mm (range = 31.0–78.0 mm) (Table 4-3). Average shell length was nearly identical in the Vernon and Bellows Falls impoundments, although there was a greater size range in the Bellows Falls impoundment (31.0–78.0 mm vs. 47.0–62.0 mm). The shell condition index was similar in both project areas (0.29 and 0.27), suggesting light-moderate levels of shell erosion. Low sample sizes precluded more robust demographic and shell condition analyses.

Habitat: Nearly all creeper were found in water depths between 3–15 feet. They were found in a variety of substrate types, often with some combination of clay, silt, sand, and gravel. Some were found in pockets of these fine substrates in areas dominated by cobble, boulder, or bedrock. All were found in areas with light to moderate flow velocities. They tended to co-occur with dwarf wedgemussel and triangle floater.

4.4 Triangle Floater

Distribution: Triangle floater were found in all three impoundments, in the free-flowing reach, and below both the Wilder and Bellows Falls dams (Table 4-4). Triangle floater were found at 11 survey sites (17.2 percent) widely spaced throughout the Wilder impoundment (see Figure 4-1). In the Bellows Falls impoundment, they were found at nine survey sites (14.8 percent), including at all three sites in the lower Black River and six sites in the Connecticut River between Site BF-14 and the upper end of the impoundment (see Figure 4-3). In the Vernon impoundment, they were found at two survey sites nearly 20 miles apart (see Figure 4-4). They were found at just four sites (10.2 percent) in the free-flowing reach between sites FF-29 and FF-34, including in the mouth of the Ottaquechee River (Site FF-32) (see Figure 4-2).

Abundance: A total of 53 triangle floater were found (Table 4-4). Nineteen triangle floater were found in the Wilder impoundment, for an average of 0.30 mussels/site and an average CPUE of 0.31 mussels/hour. The highest CPUE recorded in the Wilder impoundment was 5.3 mussels/hour (4 mussels) at Site W-12 in the lower impoundment. Eighteen triangle floater were found in the Bellows Falls impoundment, for an average of 0.30 mussels/site and an average CPUE of 0.29 mussels/hour. The highest CPUE recorded in the Bellows Falls impoundment was 5.0 mussels/hour at Sites BF-26 and BF-27, both of which were in the Black River. In fact, 61.1 percent (11 of 18) of the triangle floater found in the Bellows Falls impoundment were found in the Black River. Two triangle floater were found in the Vernon impoundment, for an average of only 0.09 mussels/site and an average CPUE of 0.09 mussels/hour. Six live triangle floater were found in the free-flowing reach, with an average CPUE of 0.17 mussels/hour. Triangle floater were also found downstream from the Wilder dam (3 mussels, average CPUE = 0.75 mussels/hour) and Bellows Falls dam (5 mussels, average CPUE = 0.63 mussels/hour). Figure 4-9 shows triangle floater CPUE by site.

Table 4-4: Summary statistics for triangle floaters in areas where they were found.

Parameter	Wilder Impound ment	Below Wilder Dam	Free-flowing Reach	Bellows Falls Impound-ment	Below Bellows Falls Dam	Vernon Impound-ment
Catch Statistics						
# Survey Sites	64	8	39	61	8	22
# of Sites Where Found	10	2	4	9	4	2
% of Sites Where Found	15.6	25.0	10.3	14.8	50.0	9.1
Total Count	19	3	3	18	5	2
Mean Count/Site	0.30	0.38	0.08	0.30	0.63	0.09
Max Count/Site	5	2	2	5	2	1
Mean CPUE (mussels/hr)	0.31	0.75	0.17	0.29	0.63	0.09
Max CPUE (mussels/hr)	5.33	4.00	2.00	5.00	2.00	1.00
Demographics and Condition Statistics						
Shell Condition	0.24	0.17	0.00	0.29	0.55	0.38
Average Length (mm)	36.07	51.00	32.42	39.67	55.00	32.00
Min Length (mm)	22.4	46.0	23.0	25.0	43.0	28.0
Max Length (mm)	47.0	58.0	41.8	51.0	65.0	36.0
Length Classes (mm)						
<20	0	0	0	0	0	0
20 - 24.9	2	0	1	0	0	0
25 - 29.9	2	0	0	3	0	1
30 - 34.9	5	0	0	3	0	0
35 - 39.9	4	0	0	2	0	1
40 - 44.9	2	0	1	4	1	0
45 - 49.9	3	2	0	4	1	0
50 - 54.9	1	0	0	2	0	0
55 - 59.9	0	1	0	0	1	0
60 - 64.9	0	0	0	0	1	0
65 - 69.9	0	0	0	0	1	0

Demographics and Shell Condition: Average shell length for all triangle floater encountered was 39.9 mm (range = 22.4–65.0 mm) (Table 4-4). The overall shell condition index was 0.30, indicating light-moderate levels of shell erosion. Low sample sizes precluded more robust demographic and shell condition analyses.

Habitat: Nearly all triangle floater were found in water depths ranging 3–15 feet. They were found in a variety of substrate types, often with some combination of clay, silt, sand, gravel, and small cobble. Most were found in areas with light to moderate flow velocities, though the animals found at the upstream end of the Wilder and Vernon impoundments, and below the Wilder and Bellows Falls dams, were in areas with stronger flows. They tended to co-occur with dwarf wedgemussel and creeper.

4.5 Alewife Floater

Distribution: Alewife floater was the third most common species overall. Alewife floater were found in the Bellows Falls and Vernon Project areas, both upstream and downstream from the dams (Table 4-5). In the Bellows Falls impoundment, they were found at only two survey sites, including at one site in the lower Black River (Site BF-26) and one site toward the upper end of the impoundment (Site BF-58). In the Vernon impoundment, they were found at 14 survey sites (63.6 percent) (see Figure 4-1). None were found at survey sites within the Wilder project boundary, or in the free-flowing reach.

Live alewife floater in its natural position, observed downstream from the Bellows Falls dam.

Abundance: A total of 460 alewife floater were found (Table 4-5). Only two alewife floater were found in the Bellows Falls impoundment, for an average of 0.04 mussels/site and an average CPUE of 0.05 mussels/hour; while 166 were found in the Vernon impoundment, for an average of 7.55 mussels/site and an average CPUE of 8.44 mussels/hour. Alewife floater were numerous downstream from the Bellows Falls dam (217 mussels, average CPUE = 29.7 mussels/hour) and Vernon dam (75 mussels, average CPUE = 18.7 mussels/hour). Figure 4-10 shows alewife floater CPUE by site in the Vernon project.

Alewife floater

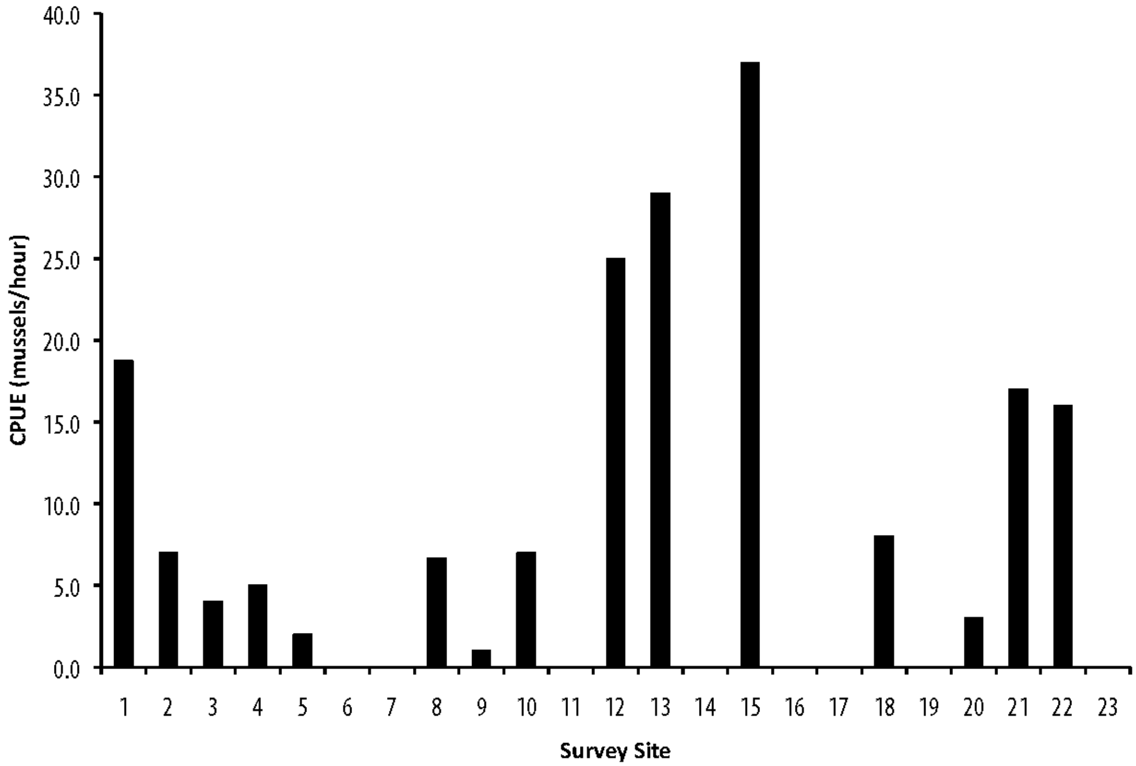


Figure 4-10. Alewife floater CPUE for each survey site in the Vernon project.

Table 4-5: Summary statistics for eastern elliptio, eastern lampmussel, eastern floater, and alewife floater in areas where they were found.

Catch Statistic	Wilder Impound-ment	Below Wilder Dam	Free-Flowing Reach	Bellows Falls Impound-ment	Below Bellows Falls Dam	Vernon Impound-ment	Below Vernon Dam
Eastern Elliptio							
# of Sites Where Found	64	7	32	59	8	22	8
% of Sites Where Found	100.0	87.5	82.1	96.7	100.0	100.0	100.0
Mean Abundance[a]	5.25	2.38	2.10	4.98	5.38	4.27	4.50
Eastern Lampmussel							
# of Sites Where Found	60	5	24	59	8	21	7
% of Sites Where Found	93.8	62.5	61.5	96.7	100.0	95.5	87.5
Mean Abundance[a]	2.50	1.50	0.90	3.38	2.63	2.18	1.75
Eastern Floater							
# of Sites Where Found	0	0	0	2	1	4	5
% of Sites Where Found	0.0	0.0	0.0	3.3	12.5	18.2	62.5
Total Count	0	0	0	8	1	6	20
Mean Count Per Site	0.00	0.00	0.00	0.13	0.13	0.27	2.50
Max Count	0	0	0	7	1	3	8
Mean CPUE (mussels/ hr)	0.00	0.00	0.00	0.13	0.13	0.27	5.00

Catch Statistic	Wilder Impound-ment	Below Wilder Dam	Free-Flowing Reach	Bellows Falls Impound-ment	Below Bellows Falls Dam	Vernon Impound -ment	Below Vernon Dam
Max CPUE (mussels/ hr)	0.00	0.00	0.00	7.00	1.00	3.00	16.00
Alewife Floater							
# of Sites Where Found	0	0	0	2	7	14	3
% of Sites Where Found	0.0	0.0	0.0	3.3	87.5	63.6	37.5
Total Count	0	0	0	2	217	166	75
Mean Count Per Site	0.00	0.00	0.00	0.03	27.13	7.55	9.38
Max Count	0	0	0	1	50	37	41
Mean CPUE (mussels/ hr)	0.00	0.00	0.00	0.04	29.75	7.62	18.75
Max CPUE (mussels/ hr)	0.00	0.00	0.00	1.33	50.00	37.00	82.00

[a] See Table 3-2 for abundance categories for eastern elliptio and eastern lampmussel.

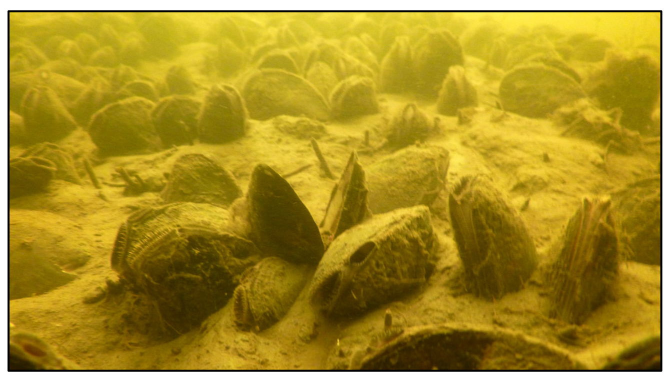
Demographics and Shell Condition: Neither shell length nor shell condition were recorded for all alewife floater. Generally, both young animals (30-50 mm) and older animals (>120 mm) were observed downstream from both the Bellows Falls and Vernon dams, and in the Vernon impoundment. The alewife floater found toward the upstream end of the Bellows Falls impoundment was 71.0 mm in length; based on annular rings it was probably 7–10 years old. Alewife floater inhabiting silt and sand substrates toward the downstream end of the Vernon impoundment exhibited light shell erosion, whereas those animals living in gravel and cobble substrates and areas with higher flow velocities exhibited moderate to heavy shell erosion.

Habitat: Alewife floater were found in water depths between 3–20 feet. They were found in a variety of substrate types, often with some combination of clay, silt, sand, gravel, and small cobble. Most were found in a broad range of flow velocities, including in strong flows downstream from the Bellows Falls and Vernon dams.

4.6 Eastern Elliptio

Eastern elliptio was the most widespread and abundant mussel species (Table 4-5). It was found at 95.2 percent of all survey sites and comprised 65–95 percent of the mussels observed. Eastern elliptio were found at only two sites in impoundments, the project-affected mouths of the Sugar River and Williams River. They were least common in the free-flowing reach, where they were found at 32 of 39 sites (82 percent).

Eastern elliptio in its natural position, observed downstream from the Bellows Falls dam.



Mussel bed comprised almost entirely of eastern elliptio

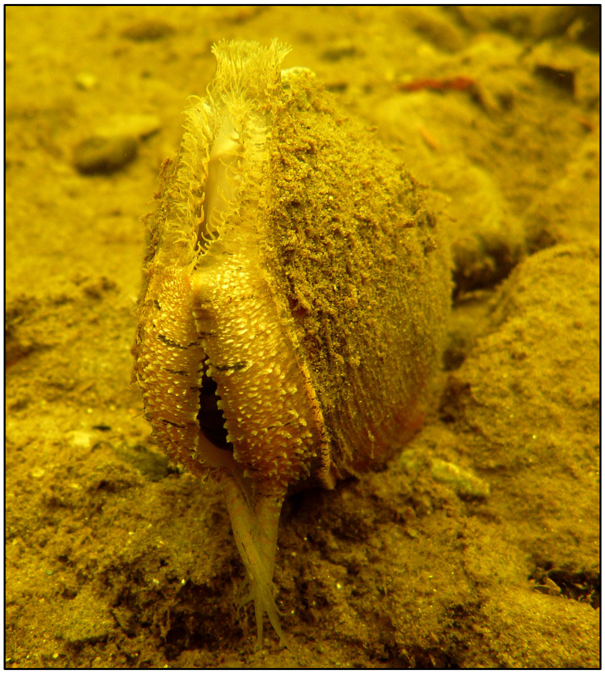
Abundance was considered High to Extremely High (abundance indices of 5, 6, or 7) at 48 sites (75 percent) in the Wilder impoundment (Figure 4-11), 41 sites (67.2 percent) in the Bellows Falls impoundment, and at eight sites (36.3 percent) in the Vernon impoundment. Elliptio were also very common downstream from the Bellows Falls and Vernon dams, but far less common downstream from the Wilder dam. Though highly variable, elliptio abundance was generally lowest toward the upper end of each impoundment. There was strong evidence of recruitment (small animals less than 30 mm in length) throughout all three impoundments and mussels typically exhibited light to moderate levels of shell erosion.

Eastern elliptio were less common in the free-flowing reach; the mean abundance index of 2.10 was less than half of that recorded for the Wilder, Bellows Falls, and Vernon projects. except immediately below the Wilder dam (where the mean index was 2.38). In the free-flowing reach, there was notably higher elliptio density just below Sumner Falls (Site FF-26) and at the mouth of the Ottaquechee River (Site FF-32). Elliptio found in the free-flowing reach tended to be larger, and exhibited moderate to high levels of shell erosion. Elliptio occupied a broad range of habitats, from near riverbanks in only 3–4 feet of water, to the middle of the channel in water depths greater than 25 feet.

4.7 Eastern Lampmussel

Eastern lampmussel was the second-most widespread and abundant mussel species (Table 4-5). They were found at 87.6 percent of the survey sites, including at all but four, two, and one survey sites in the Wilder, Bellows Falls and Vernon impoundments, respectively. They were found downstream from each of the dams, but usually at lower abundances than in impoundments. In the free-flowing reach, they were found at only 61.5 percent of the sites (24 of 39).

Abundance was considered High to Very High (abundance indices of 5 or 6) at five sites (7.8 percent) in the Wilder impoundment (Figure 4-11) and at 11 sites (18.0 percent) in the Bellows Falls impoundment. Abundance was considered Very Low to Low, or Absent (abundance indices of 0, 1, or 2) at 29 sites (45.3 percent) in the Wilder project, 16 sites (26.2 percent) in the Bellows Falls project, and 15 sites (65.2 percent) in the Vernon project. In the free-flowing reach, eastern lampmussel were not found at 15 sites, had very low abundance (index = 1) at 18 sites, had low abundance (index = 2) at three sites, and the overall average abundance index was 0.91, which was substantially lower than any of the other study areas. The only location in the free-flowing reach where eastern lampmussel were numerous (index = 4) was at Site FF-26, below Sumner Falls.



Female eastern lampmussel displaying mantle lures.

Though highly variable, eastern lampmussel were most abundant in the downstream third of the Wilder and Vernon impoundments, and also in the middle third of the Bellows Falls impoundment. Abundance generally diminished toward the upper end of all three impoundments. There was evidence of recruitment (small animals less than 50 mm in length), and large numbers of gravid females were observed luring fish and discharging glochidia. Although eastern lampmussel occupied a broad range of habitats, they seemed to be more prevalent in nearshore areas at depths of 3–10 feet, in clay, silt, sand, and gravel substrates.

Eastern lampmussel.

4.8 Eastern Floater

Eastern floater were found downstream from the Bellows Falls and Vernon dams, at two locations in the Bellows Falls impoundment and at four locations in the Vernon impoundment (Table 4-5). A total of 35 animals were found, including eight in the lower Black River in the Bellows Falls impoundment, one downstream of the Bellows Falls dam, six in the lower half of the Vernon impoundment, and 20 downstream of the Vernon dam. Some of the animals identified above or below the Vernon dam may have been alewife floater, as young animals of these two species are difficult to distinguish without sacrificing (i.e., killing) them.

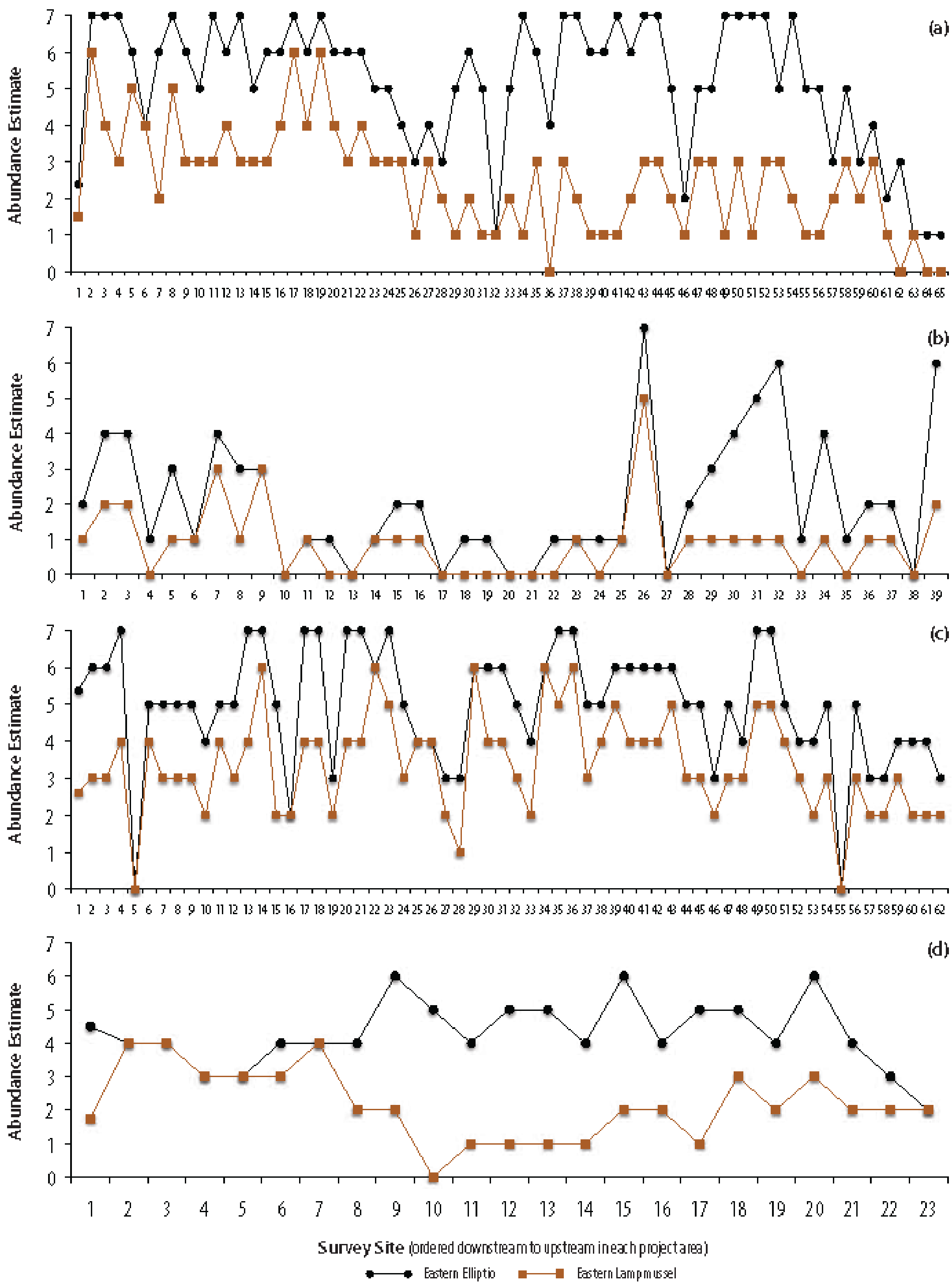


Figure 4-11. Abundance estimates for eastern elliptio and eastern lampmussel in the Wilder project (a), free-flowing reach (b), Bellows Falls project (c), and Vernon project (d). See Table 3-2 for definition of the abundance categories.

5. DISCUSSION

5.1 Wilder Project

The Wilder impoundment had the lowest species richness (5) of the three impoundments, lacking eastern floater and alewife floater, and nearly lacking creeper (just two animals were found). However, mussels were abundant in the impoundment—eastern elliptio was abundant throughout most of the impoundment and eastern lampmussel was numerous in its lower half. Triangle floater were found infrequently and at fairly low abundance throughout the impoundment.

Dwarf wedgemussel were found consistently along a 14-mile reach of the Wilder impoundment, from 27 to 41 miles upstream from the dam. This range generally corresponds to the 16-mile range documented in 2006 (Nedeau 2006), the main difference being that animals were found slightly further downstream in 2006 than in 2011 or 2013. Most of the 2011 and 2013 survey sites were in slightly different locations than the 2006 survey sites, confirming an assertion in the 2006 report that dwarf wedgemussel could be found almost anywhere within the core range with careful SCUBA surveys.

The average CPUE for dwarf wedgemussel in the Wilder impoundment was more than two times higher than it was in the Bellows Falls impoundment. Dwarf wedgemussel were usually found at water depths from 8 to 20 feet, often near the toe of the steep-sloped banks or toward the center of the river channel. Areas of the river where dwarf wedgemussel were found typically had light to moderate flow velocities, or at least featured zones of hydraulic refuge near shore, even where the flows in the middle of the channel were quite strong. All dwarf wedgemussel were found by SCUBA diving; snorkeling along the shallow shorelines proved to be ineffective for finding them. Tessellated darters were observed at most of the survey sites in the Wilder impoundment in 2013 (Appendix B), and they were typically found closer to shorelines where habitat was more complex (e.g., among or near beds of submergent vegetation, woody debris, or rocky slopes with interstitial spaces).

The mussel community immediately downstream from the Wilder dam exhibited low species richness (3) and low abundance compared to the other survey areas. Strong flows, rocky substrates, and high shear stress may limit mussel densities downstream from the dam.

5.2 Free-flowing Reach

The mussel community in the free-flowing reach exhibited low species richness and low abundance compared to the other survey areas. Dwarf wedgemussel were not found, even within two areas that historically contained them (in the pool downstream from Sumner Falls and near the Cornish Covered Bridge) (Gabriel 1995). Only one live creeper was found in the mainstem Connecticut River (at Site FF-7) and one was also found in the mouth of the Ottaquechee River (Site FF-32).

Six live triangle floater were found, mostly downstream from, or within, the mouth of the Ottaquechee River.

Eastern elliptio were absent at seven sites in the free-flowing reach and had a mean abundance index (2.10) less than half of all other study areas except immediately below Wilder dam (2.38). There was notably higher elliptio density just below Sumner Falls (Site FF-26), within and downstream from the mouth of the Ottaquechee River (Sites FF-30, FF-31, and FF-32), and at Site FF-39 at the upper end of the reach. Elliptio tended to be large, and exhibited moderate to high levels of shell erosion. Eastern lampmussel, another species common elsewhere in the Connecticut River, was absent from 15 sites in the free-flowing reach and, where found, occurred at very low densities. The area just below Sumner Falls (Site FF-26) was the only location in the free-flowing reach where eastern lampmussel were numerous. In addition, tessellated darters were observed at only seven (17.9 percent) survey sites and always at very low densities (fewer than five fish per site) (Appendix B. They were typically found closer to shorelines where habitat was more complex (e.g., among or near beds of submergent vegetation, woody debris, or rocky slopes with interstitial spaces).

The distribution of mussels in the free-flowing reach may be influenced by challenging habitat conditions, especially strong water velocities, rocky substrates, shallow water, high shear stress, and possibly ice scour during the winter. In deeper areas of the river, where fine materials (e.g., silt, sand, and fine gravel) accumulate, eastern elliptio and eastern lampmussel densities tended to be higher. This was particularly true below Sumner Falls and near the mouth of the Ottaquechee River. The reach between the Cornish Covered Bridge and Chase Island was geomorphically and hydraulically complex, and contained small patches of high-quality mussel habitat where eastern elliptio were numerous but where few other species were found.

5.3 Bellows Falls Project

Species richness in the Bellows Falls impoundment (7) was higher than it was in the other impoundments or project tailwaters, yet the density and distribution of rare species suggests that these populations may not be large. Although dwarf wedgemussel were found over a 17-mile distance, very few (24) animals were observed and the distances between them were great. The same was generally true for triangle floater and creeper, two species that have similar habitat preferences and usually co-occur with dwarf wedgemussel. Eastern elliptio and eastern lampmussel are only two species with robust populations in the Bellows Falls impoundment. The Bellows Falls impoundment contains a tributary population of dwarf wedgemussel, in the lower Black River. This population was first documented in 1999 (Ferguson 1999). Likewise, the highest concentration of creeper and triangle floater in the Bellows Falls impoundment were found in the lower Black River.

Tessellated darters were observed at most of the survey sites in the Bellows Falls impoundment in 2013 (Appendix B), and they were typically found closer to shorelines where habitat was more complex (e.g., among or near beds of submergent vegetation, woody debris, or rocky slopes with interstitial spaces).

The geography of the impoundment features two physically distinct reaches. Downstream of Wethersfield Bow, the river is wider, flow velocities are slower, the channel is deeper, and the substrate is generally finer (silt, sand, and fine gravel). Upstream of Wethersfield Bow, the dam's influence is less obvious and the river is slightly narrower, flow velocities are stronger, the channel is shallower, and there is a higher proportion of gravel, cobble, and boulder substrates.

The mussel community downstream from the Bellows Falls dam contained five of the same species that occurred throughout the Vernon impoundment, and among the highest densities of eastern elliptio and alewife floater encountered during the entire survey. This was expected, as the Bellows Falls dam is only about six miles upstream from the upper end of the Vernon impoundment, and because American shad, the primary host fish for alewife floater, reach their upstream limit in the Connecticut River in the tailwaters of Bellows Falls dam. Two alewife floater were also found in the Bellows Falls impoundment, though these were likely either the result of overland transport of American shad (carrying alewife floater glochidia) above the Bellows Falls dam by New Hampshire Fish & Game, or a small number of shad that may have ascended fishways designed for only adult Atlantic salmon.

5.4 Vernon Project

The mussel community at the Vernon project area, both in the impoundment and downstream from the dam, was dominated by eastern elliptio. This species was found at every survey location and outnumbered other species by at least 10:1, except in the lowermost part of the impoundment (Sites V-2 through V-7) near the dam, where eastern lampmussel were nearly as abundant.

Of the three impoundments surveyed, Vernon was the only one with a significant population of the alewife floater, a species that relies on American shad and alewife as hosts and whose presence in the Vernon impoundment can be attributed to anadromous fish passage at three facilities downstream: Vernon dam, Turners Falls dam, and Holyoke dam (Smith 1985, Nedeau 2008a).

The very low numbers of triangle floater and creeper in the Vernon impoundment were surprising; both of these species are often numerous in the types of habitats present in the Vernon impoundment, especially in the more free-flowing middle and upper reaches. The survey also failed to detect dwarf wedgemussel, which corroborates results of the few recent surveys conducted in the impoundment (Nedeau 2005). However, dwarf wedgemussel were found in the impoundment near Brattleboro 30 years ago (Vermont Fish and Wildlife, unpublished).

The four species found at the sites downstream from the Vernon dam were the same four species found consistently in the reach of the Connecticut River between the Vernon dam and the Turners Falls dam about 19 miles downstream (Biodrawversity 2012).

5.5 Challenges for Research and Monitoring

Background: Six stakeholders submitted similar study requests for the dwarf wedgemussel, all relating to the effects of Wilder and Bellows Falls project operations on the species. Five objectives were stated in each study request: three were related to baseline population studies, and two were focused specifically on the potential effects of flow regime/water level fluctuations on mussel behavior or habitat. The final FERC-approved study plan outlined an adaptive, two-phase plan that met the objectives of the study requests and would benefit from collaboration with resource agencies throughout the design and implementation of the study. The primary reason for a two-phase approach was that additional surveys were needed to determine if, and where, dwarf wedgemussel populations were large enough to permit quantitative sampling, behavioral studies, or certain types of flow-related analyses, especially in areas of the river where flow fluctuations are greatest. The 2011 survey did not detect any "populations" large enough to permit certain types of quantitative sampling, monitoring, or analyses. Thus, the most important task for 2013 was to identify concentrations of dwarf wedgemussel (if present) and/or high-quality habitat, to help inform the development of an effective and realistic Phase 2 study. Phase 2 (2014) might include quantitative mussel sampling, behavioral studies using underwater video (if considered feasible based on Phase 1 results), and an overall assessment of the effects of flow regime/project operations on dwarf wedgemussel, co-occurring species, and their habitat.

Sampling and Monitoring: Based on the 2011 and 2013 mussel surveys at 210 sites, and the existing mussel data from 1990-2010, dwarf wedgemussel populations are not large enough to permit certain types of quantitative sampling, monitoring, or analysis. In the free-flowing reach, no live or dead dwarf wedgemussel were found at the 39 survey sites, the fluvial mussel species commonly associated with dwarf wedgemussel (triangle floater and creeper) were also extremely rare, and very few tessellated darters were observed. Even eastern elliptio and eastern lampmussel, which are typically widespread and abundant in the Connecticut River, exhibit patchy distribution and low-density populations in the free-flowing reach. Based on the mussel survey results and documentation of habitat conditions, we do not recommend quantitative sampling or *in situ* monitoring of dwarf wedgemussel in the free-flowing reach simply because they may not even occur there, or are at such low densities that it is impractical to study them using quantitative methods. Likewise, it is impractical to plan *in situ* video monitoring of dwarf wedgemussel in the free-flowing reach because of the challenges of finding even one live animal to observe, and the challenges of adequately replicating behavioral observations while controlling for confounded variables.

The 2011 and 2013 field studies detected dwarf wedgemussel in the upper Wilder and Bellows Falls impoundments, but almost always at very low densities. They were found at only about one-fourth of the sites in both impoundments, and where they were found, a typical survey lasting 1-2 person-hours typically detected fewer than two or three animals. In contrast, at one location in the Connecticut River in the Northern Macrosite near Lunenberg (Vermont), several miles upstream from the

Moore Reservoir and well upstream of the Wilder project, biologists found more dwarf wedgemussel in one hour than were found throughout the entire Wilder and Bellows Falls projects (Nedeau 2002). Co-occurring fluvial species (i.e., triangle floater and creeper) were also rare in both impoundments, except in the lower Black River. Such low population densities precludes the use of certain types of quantitative monitoring; this same challenge was recognized in the mid-1990s when Gabriel (1995) recommended a CPUE monitoring protocol using timed searches within transects to provide comparable indices of dwarf wedgemussel population density and size class distribution. More robust quantitative sampling was discussed but not recommended due to low population densities. Almost 20 years later, we concur with this same conclusion.

Aside from a dwarf wedgemussel population that appears to be patchy and at very low density, dwarf wedgemussel appear to occur only in surveyed areas of the Connecticut River where water level fluctuations are minimal or non-existent. The shallowest depth at which dwarf wedgemussel were found was approximately 6 feet, though mussels were more typically found at depths of 10 to 20 feet. These mussels are not at risk of being dewatered during licensed operating range in either the Wilder or Bellows Falls projects, much less the normal operating range (Wilder: elevation 382.0 to 384.5 feet MSL, Bellows Falls: elevation 289.6 to 291.4 feet MSL). The channel morphometry in areas where dwarf wedgemussel were found includes steep banks, and mussels (all species) were always found at highest densities near the toe of the slope or in the flatter areas toward the deeper parts of the channel, and were never common in shallow areas. Overall, almost all dwarf wedgemussel detected in 2011 and 2013 were found in locations that may experience minimal or no changes associated with daily water level fluctuations, at least from a mussel's perspective. Therefore, *in situ* monitoring is not a promising line of inquiry, nor will certain types of sampling or analysis provide much insight into effects of project operations on dwarf wedgemussel.

Recommendations: Details of Phase 2 mussel studies should be discussed in light of the 2011 and 2013 survey results. From the FERC-approved freshwater mussel study plan, there were three objectives/tasks that were considered for Phase 2 (2014). These are as follows:

Task 3 (Phase 2): "*Collect statistically sound and repeatable data, using quantitative methods, to determine density, age-class distribution, and habitat for dwarf wedgemussel and co-occurring mussel species*." Based on low population densities, we do not recommend quadrat sampling or other rigorous quantitative methods. Instead, we recommend establishing a series of linear transects in several areas and conducting semi-quantitative (timed) searches along each transect, as described in Gabriel (1995). It is possible that dwarf wedgemussel will not be detected during this sampling; thus, the searches should also count and characterize all co-occurring mussel species to determine their density, age-class distribution, and habitat. Biologists should also conduct qualitative surveys in areas near the transects to increase chances of detecting dwarf wedgemussel.

Any dwarf wedgemussel encountered should be tagged, and data on shell length, shell condition, gravidity, habitat, and location should be recorded for each. *Potential* transect locations, based on the presence of dwarf wedgemussel and/or suitable habitat, are as follows:

Wilder Project

- Near Bedell Bridge State Park (2 transects)
- Near Waits River confluence (2 transects)

Free-flowing reach

- Sumner Falls (2 transects)
- Cornish Covered Bridge to Chase Island (4 transects)

Bellows Falls Project

- Upper Bellows Falls impoundment below Chase Island (2 transects)
- Wilgus State Park (2 transects)
- Wethersfield Bow (4 transects)
- Lower Black River (2 transects)

Task 4 (Phase 2): *"Observe and record behavior of dwarf wedgemussel and co-occurring mussel species in situ during varying flow conditions."* We do not recommend *in situ* monitoring of dwarf wedgemussel, but video monitoring of co-occurring mussel species may be appropriate in some instances. It may be more appropriate to use photo or video technology to document changes in wetted area and other key habitat parameters, rather than behavior of individual mussels, during daily flow fluctuations. This could be part of a comprehensive study of the effect of water level fluctuations on instream habitat and the mussel community (see next task).

Task 5 (Phase 2): *"Assess the potential effects of flow regime on dwarf wedgemussel, co-occurring species, and their habitat."* TransCanada proposes to use data from Phase 1 studies (this report) and Tasks 3 and 4 from Phase 2 (2014; described above), in combination with the data collection and analysis for Studies 4 (Hydraulic Modeling), 5 (Operations Modeling), 7 (Aquatic Habitat Mapping), and 9 (Instream Flow Study) to assess the effects of flow regime on dwarf wedgemussel and their habitat. Supporting information on dwarf wedgemussel habitat preference will come from other studies conducted in the Connecticut River watershed (Nedeau 2008 and references therein) and elsewhere in their range. The data collection and analysis for the other studies (4, 5, 7, and 9) may focus specifically on those areas where these mussel data are collected to allow better integration of both physical and biological data in the resulting models. Due to the complex and multidisciplinary nature of this task, TransCanada feels it is premature to plan this specific task until stakeholders have reviewed Phase 1 results. As described in the FERC-approved study plan, this is an open collaborative approach that will ensure that resource agency goals and objectives are addressed, time is used efficiently, and studies serve their intended purpose.

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Appendix A

Survey Sites

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Figure A-1
Survey Sites in the Wilder Project

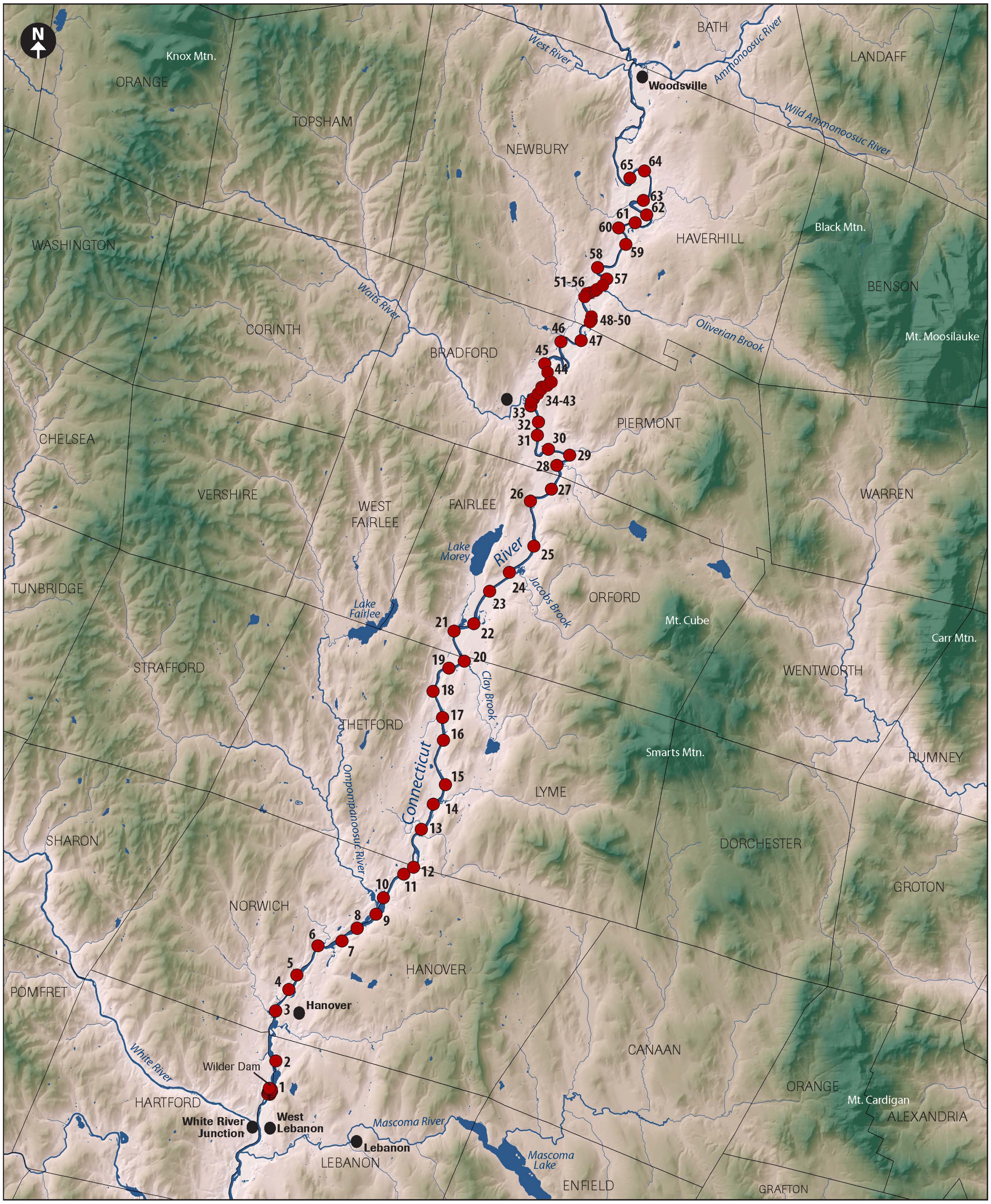


Figure A-2
Survey Sites in the Free-flowing Reach

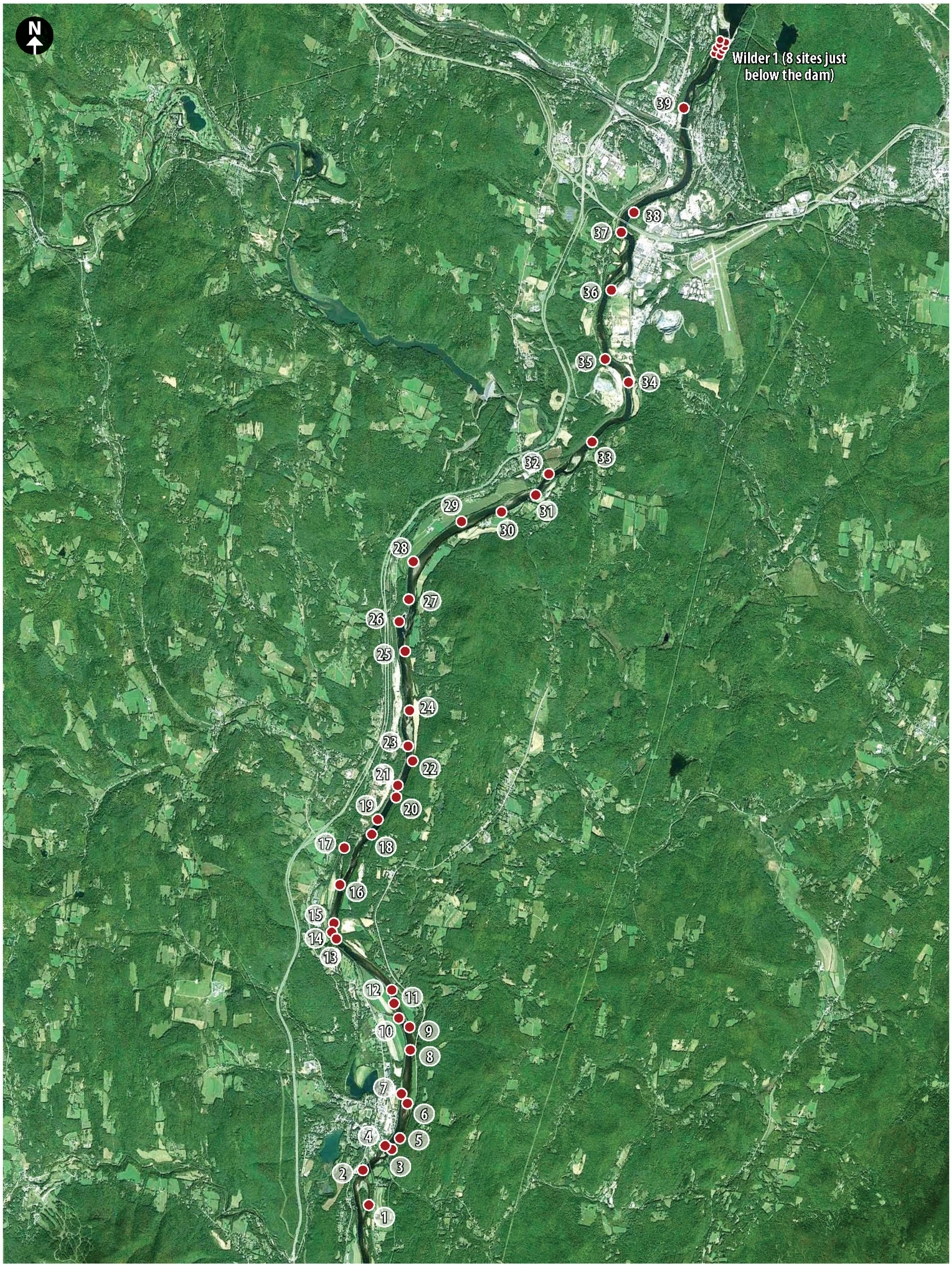


Figure A-3
Survey Sites in the Bellows Falls Project

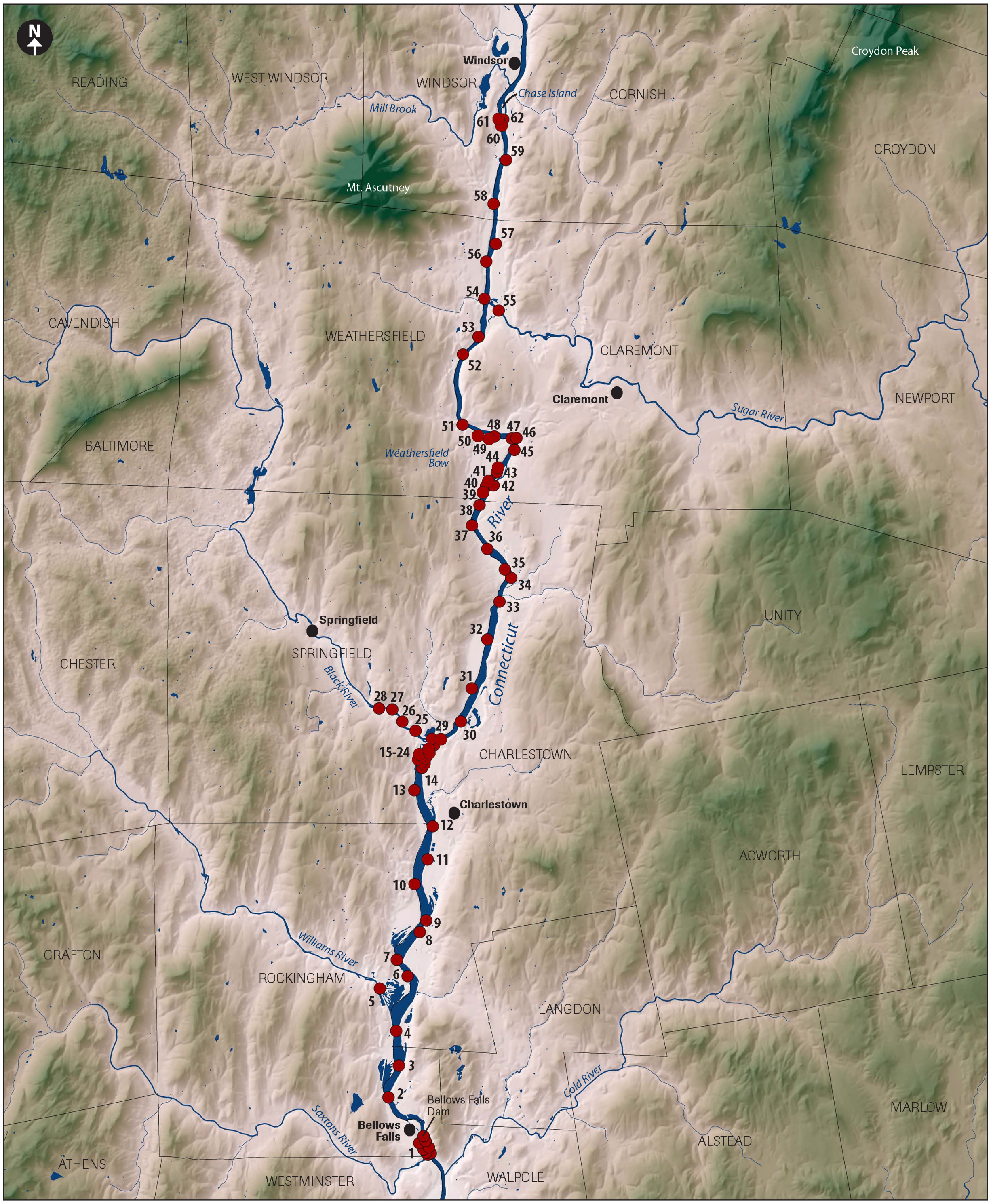
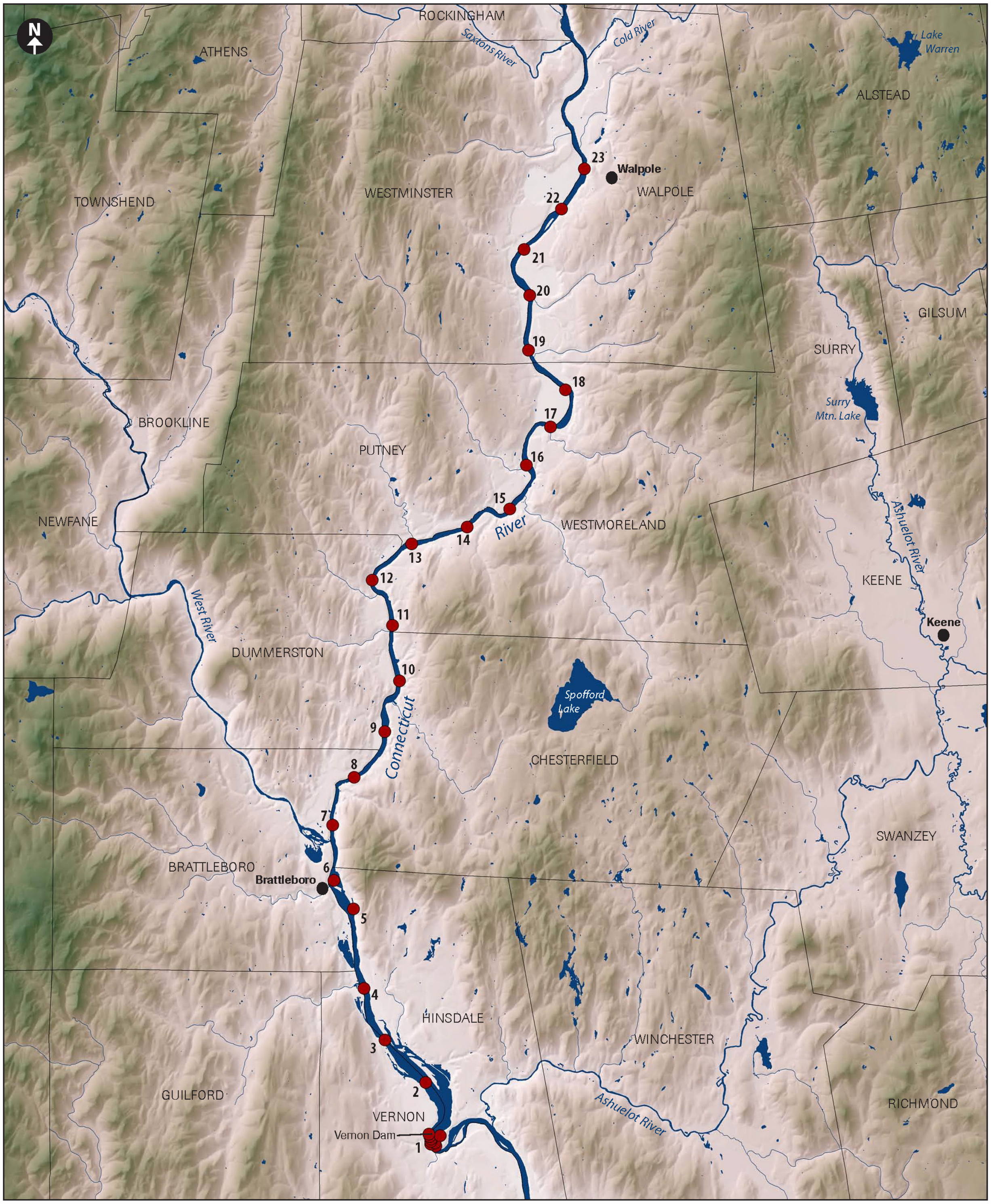


Figure A-4
Survey Sites in the Vernon Project



Appendix B

Mussel Survey Data

PRIVILEGED DATA IS CONTAINED IN

THE

TRANSCANADA INITIAL STUDY REPORT

VOLUME V AND VOLUME VII (SUPPLEMENTAL GEO DATABASE)

FILED SEPTEMBER 15, 2014

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UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Initial Study Report

Volume VI

September 15, 2014

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TRANSCANADA HYDRO NORTHEAST INC.

INITIAL STUDY REPORT - VOLUME VI

September 15, 2014

ILP Study 24
Dwarf Wedgemussel and Co-Occurring Mussel Study

Revised Phase 2 Study Plan

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Prepared by:

Biodrawversity, LLC.

The Louis Berger Group, Inc.
and
Normandeau Associates, Inc.

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STUDY 24

DWARF WEDGEMUSSEL AND CO-OCCURRING MUSSEL STUDY

REVISED PHASE 2 STUDY PLAN

INTRODUCTION

In 2013, six stakeholders to TransCanada's relicensing of the Wilder, Bellows Falls, and Vernon Hydroelectric Projects submitted similar study requests related to the federally listed as endangered dwarf wedgemussel (*Alasmidonta heterodon*). The study requests related to assessing the effects of Wilder and Bellows Falls Project operations on the species. Five objectives were stated in each study request: three related to population studies and two focused specifically on the potential effects of flow regime/water-level fluctuations on mussel behavior or habitat.

The final Federal Energy Regulatory Commission (FERC)-approved Revised Study Plan (RSP) for Study 24 outlined an adaptive, two-phase approach that met study request objectives and entailed collaboration with resource agencies throughout the design and implementation of the study. The primary reason for a two-phase approach was that additional surveys were needed to determine whether, and where, dwarf wedgemussel populations were large enough to permit quantitative sampling, behavioral studies, or certain types of flow-related analyses, especially in areas of the river where flow fluctuations are greatest. A pre-licensing 2011 survey did not detect any populations large enough to permit certain types of quantitative sampling, monitoring, or analyses (Biodrawversity and LBG, 2012). Thus, the most important task for Phase 1 of Study 24 conducted in 2013 (Biodrawversity and LBG, 2014) was to identify concentrations of dwarf wedgemussel (if present) and/or high-quality habitat to help inform the development of an effective and realistic Phase 2 study. This Revised Phase 2 Study Plan is a supplement to Study Plan 24 in the RSP, focusing solely on the Phase 2 study. It has been revised in response to comments and questions from the May 23, 2014, aquatics working group consultation meeting, email communications, and a follow-up consultation conference call on July 1, 2014. A responsiveness table summarizing the written comments received from The Nature Conservancy is included in Attachment A to this Revised Phase 2 Study Plan.

The original three tasks of the Phase 2 study included in the RSP were as follows:

Task 3: Collect statistically sound and repeatable data, using quantitative methods, to determine density, age-class distribution, and habitat for dwarf wedgemussel and co-occurring mussel species.

Task 4: Observe and record behavior of dwarf wedgemussel and co-occurring mussel species *in situ* during varying flow conditions.

Task 5: Assess the potential effects of flow regime on dwarf wedgemussel and their habitat.

Sampling and Monitoring Challenges: Based on the 2011 and 2013 mussel surveys at 210 sites, and the existing mussel data from 1990-2010 (Gabriel, 1995; Nedeau, 2009; and Vermont Fish and Wildlife references cited therein), dwarf wedgemussel populations are not large enough to permit certain types of quantitative sampling, monitoring, or analysis. In the free-flowing reach downstream of Wilder dam, no live or dead dwarf wedgemussel were found at the 39 survey sites in 2013, and the fluvial mussel species commonly associated with dwarf wedgemussel (triangle floater and creeper) were also extremely rare. The 2011 and 2013 field studies detected few dwarf wedgemussels in the upper Wilder and Bellows Falls impoundments, and almost always at very low densities. They were found at only about one-fourth of the sites in both impoundments, and where they were found, a typical survey lasting 1 to 2 hours usually detected fewer than two or three animals. Co-occurring fluvial species (i.e., triangle floater and creeper) were also rare in both impoundments, although co-occurring generalist species (i.e., eastern elliptio and eastern lampmussel) were usually common in the impoundments and in parts of the free-flowing reach.

Low population density of dwarf wedgemussels precludes certain quantitative monitoring methods. In low density populations, quantitative sampling using quadrats is difficult because detection probability is low. Quite often a species known to exist in an area is not found during a quantitative survey, and the resulting population estimate of zero has very little meaning except that densities are below the detection limits of the study design (Strayer and Smith, 2003). In these cases, investigators have used less rigorous quantitative study designs, such as transects, or semi-quantitative study designs, such as timed searches (or a combination of the two). Although transects or timed searches are inferior to quadrat sampling in terms of repeatability and precision, they do typically detect a higher number of animals and may provide better information on habitat use and population demographics.

The pros and cons of various quantitative, semi-quantitative, or qualitative sampling methods were described specifically for the dwarf wedgemussel population in the Connecticut River in a 1995 report (Gabriel, 1995), and more broadly discussed by Strayer and Smith (2003). Based on review of existing information and consultation with regional experts, Gabriel (1995) recommended a dwarf wedgemussel monitoring protocol that used timed searches within transects to provide comparable indices of dwarf wedgemussel population density and size class distribution in the areas of the Connecticut River where the species was known to occur in the Wilder free-flowing reach and in the Bellows Falls impoundment (e.g., Sumner Falls, Cornish Covered Bridge, and Weathersfield Bow). Weathersfield Bow is the reach from Wilgus State Park to Hubbard Island, which also includes Jarvis Island and Walcott Island (Claremont, New Hampshire, and Weathersfield, Vermont). More robust quantitative sampling was discussed but not recommended due to low population densities of dwarf wedgemussels. Based on the 2011 and 2013 survey results, and historical data (Gabriel, 1995; Nedeau, 2009; and Vermont Fish and Wildlife references cited therein), TransCanada generally concurs with Gabriel (1995) that transects or timed searches are appropriate for sampling dwarf wedgemussels, although TransCanada believes that quadrats can also provide important quantitative data, especially on the density of co-occurring mussel species and critical habitat parameters.

Stakeholders requested information on co-occurring mussel species, which includes eastern elliptio, eastern lampmussel, creeper, and triangle floater. One or more of these species were found at nearly every survey site in the Connecticut River, particularly eastern elliptio and eastern lampmussel. Based on observed mussel densities and habitat conditions, TransCanada believes that collecting "*statistically sound and repeatable data, using quantitative methods*" (per stakeholder study requests) is achievable for these co-occurring species and will provide additional quantitative data to accomplish Task 5 in the RSP.

In terms of *in situ* video monitoring (Task 4 in the RSP), TransCanada believes that the intent of the original stakeholder request for this type of monitoring was to observe how individual mussels responded to water-level fluctuations (i.e., was there an observable stress response?), and based on this observed response, to infer possible population-level effects of water-level fluctuations. *In situ* video monitoring of dwarf wedgemussel in the free-flowing reach is impractical because it would be difficult to find even one live animal to observe and to adequately replicate behavioral observations while controlling for confounding variables.

In the impoundments, *in situ* video monitoring of dwarf wedgemussels also would be difficult because of low-density populations. More importantly, however, it is unlikely to provide meaningful insight into the potential effects of water-level fluctuations because of the water depths that dwarf wedgemussels occupy. Dwarf wedgemussels were typically only found at depths in the Connecticut River that are not influenced by water-level fluctuations. The channel morphometry in areas where dwarf wedgemussel were found includes steep banks, and mussels (all species) were always found at highest densities near the toe of the slope or in the flatter areas toward the deeper parts of the channel and were never common in shallow areas. The shallowest depth at which dwarf wedgemussels were found was approximately 6 feet, although mussels were more typically found at depths of 10 to 20 feet. These mussels are not at risk of being dewatered, and they would not experience appreciable changes in habitat parameters (e.g., flow velocity or shear stress) during licensed operating ranges in either the Wilder or Bellows Falls Projects, much less the normal operating ranges (Wilder: elevation 382.0–384.5 feet above mean sea level [msl], Bellows Falls: elevation 289.6–291.4 msl).

REVISED PHASE TWO STUDY PLAN

Of the original three Phase 2 tasks specified in the RSP, TransCanada proposes to eliminate Task 4 as a standalone task as discussed above because of the rarity or absence of dwarf wedgemussels in the free-flowing reach downstream of Wilder dam and in other areas where they may be affected by water-level fluctuations. Video monitoring of mussel beds or habitat is a component of fieldwork for Task 3. Task 3 will be accomplished with quantitative and qualitative survey methods in multiple sites in the Wilder impoundment, free-flowing reach downstream of Wilder dam, and Bellows Falls impoundment. Task 5 is unchanged, though more details on analysis and modeling are provided in this Revised Phase 2 Study Plan, and TransCanada proposes to include co-occurring species in the analysis.

Task 3

Collect data on the density, shell length distribution, and habitat for dwarf wedgemussel and co-occurring mussel species using a combination of quantitative (transect and quadrat) and qualitative survey methods at locations in the Wilder impoundment, free-flowing reach, and Bellows Falls impoundment.

1. Quantitative + Qualitative Survey at Six Locations

Sampling Sites: In 2011 and 2013 surveys, dwarf wedgemussels were found at 29 locations in the Connecticut River and two locations in the lower Black River over a distance of approximately 34 river miles. Six locations are proposed for the quantitative and qualitative surveys in 2014, including two locations with suitable habitat and where dwarf wedgemussels were historically found (Sumner Falls and Cornish Covered Bridge) and four locations where dwarf wedgemussels were found in 2011 and 2013. Locations were selected based on current or historical presence of dwarf wedgemussels, accessibility, and environmental conditions that are conducive to conducting these types of transect surveys. These locations are also representative of habitat conditions within broader reaches where dwarf wedgemussels were consistently found in 2011 and 2013. A total of 20 transects will be established among the six locations, as follows:

Wilder impoundment

1. Near Bedell Bridge State Park (4 transects)

Free-flowing reach downstream from Wilder dam

2. Below Sumner Falls (2 transects)
3. Below Cornish Covered Bridge (4 transects)

Bellows Falls impoundment

4. Upper Bellows Falls impoundment below Chase Island (4 transects)
5. Jarvis Island (2 transects)
6. Near Walcott and Hubbard Island (4 transects)

Sampling Methods: Transects will be 50 meters long and 1 meter wide (50 square meters [m^2]) and oriented parallel to the current. Weighted ropes marked at 1-meter increments will be used to mark each side of each transect. They will be placed within the depth range where mussels (especially dwarf wedgemussels) are more common. Precise placement of these transects will be determined in the field. Ten quadrats of 1- m^2 will be established along each transect (approximately every 5 meters); these will provide a second means to quantitatively estimate density and variance for all species, especially common species that may be too numerous to count along the entire transect.

Surveys will be conducted by SCUBA diving. Divers will start at the downstream end of each transect and work methodically upstream. There is no time limit to complete the transect survey, though the time to complete the survey will be recorded. All dwarf wedgemussel, creeper, and triangle floater encountered along each transect (an area of 50 m^2) and within each quadrat (an area of 10 m^2) will be counted; shell length and shell condition of each will be recorded; and their position along the transect (0 to 50 meters), or within which quadrat, will be recorded. Mussel counts for transects and quadrats will be recorded separately.

Two of the co-occurring mussel species—eastern elliptio and eastern lampmussel—will be counted only within each of the 10 quadrats (not the entire transect, unless densities are low enough to permit it), and the shell length and shell condition of a subset (up to 50 per transect) will be recorded. The top 10 centimeters (cm) of each quadrat will be excavated and sieved through a 10-millimeter (mm) sieve to estimate density of buried mussels (all species). Counts for surface mussels versus buried mussels will be recorded separately.

Biologists will also conduct visual SCUBA surveys in areas near transects to increase the chance of detecting dwarf wedgemussel in the area, which will verify their presence at these locations, even if none are detected using quantitative methods, and will increase the sample size of individual dwarf wedgemussels to allow for a more robust analysis of shell length, shell condition, and habitat data. Data on shell length, shell condition, habitat, and location (using Global Positioning System [GPS]) will be recorded for each dwarf wedgemussel observed during the qualitative survey.

Additional data recorded for each transect will include the number of tessellated darters (*Etheostoma olmstedi*) observed because it is the primary host fish for dwarf wedgemussels, microhabitat (water depth, substrate, substrate embeddedness, visually timed estimate of flow velocity, species composition and percent cover of submerged aquatic vegetation, woody debris, and distance to shore), and GPS locations for stopping and starting locations of each transect. Water depth will be recorded with a digital depth sounder at 10 points along each transect (e.g., the quadrat locations). Substrate type and percent cover for transects and quadrats will be determined visually using the following categories: clay, silt, sand, gravel, cobble, boulder, and bedrock. Estimates of flow velocity will be determined near the sediment surface (i.e., benthic velocity) by recording the time it takes particles to drift over a fixed distance (seconds/meter, which will then be converted to meters/second). Flow velocity will be recorded at 10 points along each transect (e.g., the quadrat locations). Embeddedness will also be visually estimated for gravel, cobble, and boulder particles at each quadrat location using the five ratings described in Platts et al. (1983):

5. <5 percent of surface covered by fine sediment,

4. 5-25 percent of surface covered by fine sediment,

3. 25-50 percent of surface covered by fine sediment,

2. 50-75 percent of surface covered by fine sediment, and

1. >75 percent of surface covered by fine sediment.

2. Quadrat Survey from Chase Island to Cornish Covered Bridge

Sampling Site: A quantitative, quadrat-based survey will be conducted within a 2,400-meter (1.5-mile) reach from just upstream of the Cornish Covered Bridge to downstream of Chase Island (Figure 1). This reach spans the transition from the free-flowing reach to the uppermost extent of the Bellows Falls impoundment. It includes areas where dwarf wedgemussels were found in 2011 and 2013, contains the historical dwarf wedgemussel monitoring site below Cornish Covered Bridge where dwarf wedgemussels were not found in 2013, and includes a diversity of habitat types within an area that experiences daily water-level fluctuations. Although dwarf wedgemussels may be sparse in this reach, four other mussel species also occur in this reach and exhibit a range of densities. The data collection and analysis for other studies, especially –the Instream Flow Study (Study 9), will also include this reach as a focal point to allow better integration of both physical and biological data.

Sampling Methods: Hydromorphological units (HMUs) will be mapped within the 2,400-meter reach (Figure 1) using existing data and aerial imagery, and this map will be ground-truthed. HMUs are habitat types defined by hydraulics, substrate, and morphology (e.g., rapid, riffle, run, glide, pool, backwater, and the characteristic water depth and substrate for each). Using randomly generated numbers to provide systematic coverage, 400 sampling locations will be allocated among the HMUs proportional to their area, with additional sampling locations within areas that may be small yet disproportionately important to mussels. At each sampling location, a 1.5- x 1.5-meter (2.25 m^2) weighted quadrat fitted with two, perpendicular centerlines will be placed on the river bottom. The centerpoint of these sampling locations will be recorded with GPS. Surveys will be conducted by SCUBA diving at points deeper than 3-4 feet and snorkeling at shallower points; some quadrat locations will likely fall within dry or exposed portions of the riverbed but all of the same data will be collected at these points (except for flow velocity).

Within each quadrat, all mussels found at the surface of the sediment will be counted. One-fourth of each quadrat will be excavated and sieved using a 10-mm sieve, unless the substrate is too coarse (e.g., cobble and boulder), which would preclude the presence of buried mussels. The number of buried mussels will be recorded separately from the surface counts. The shell length and shell condition of each dwarf wedgemussel, creeper, and triangle floater will be recorded. Presence and counts of tessellated darter will also be recorded within or near each quadrat. In addition to the quadrat sampling, biologists will delineate mussel beds in this reach, recording their boundaries with GPS.

The following habitat parameters will be recorded at each quadrat location: benthic velocity within 20 cm of the bottom (using a digital flow meter or the visual method described previously as appropriate to quadrat conditions), water depth (using a meter stick or digital depth sounder), percent cover of each substrate type (i.e., clay, silt, sand, gravel, cobble, boulder, and bedrock), percent cover of aquatic vegetation, and percent cover of woody debris. Embeddedness will also be visually estimated at each quadrat location using the previously described method. Video technology (e.g., a GoPro mounted at fixed locations with a good view of the study reach) will be used to record changes in wetted area and other key habitat parameters during daily water-level fluctuations, especially areas that are shallow, cut off from main currents, or dewatered during daily low flows.

Figure 1. Reach from Cornish Covered Bridge to below Chase Island. This 2,400-meter reach of the Connecticut River at the lower end of the free-flowing reach and upper end of the Bellows Falls impoundment is where quantitative mussel sampling and two-dimensional (2-D) hydrodynamic modeling are proposed to assess and quantify the effects of water-level fluctuations on freshwater mussels and their habitat.

Task 5

Assess the potential effects of flow regime on dwarf wedgemussel, co-occurring species, and their habitat.

Task 5 will assess the potential project effects of flow regime (which includes water-level fluctuations) on dwarf wedgemussel populations and on the availability of dwarf wedgemussel habitat. TransCanada proposes to also include co-occurring species in this assessment due to the rarity or absence of dwarf wedgemussels in certain areas with the intent to use co-occurring species as surrogates for dwarf wedgemussels and mussel habitat because dwarf wedgemussels can occupy all of the same water depths and habitat types as other species.

ANALYSIS

- Mussel densities (mussels/m^2) will be computed from both transect and quadrat data. Total population size (with variance estimates) of each species will be computed from quadrat data for the reach between Chase Island and Cornish Covered Bridge.

- Quantitative habitat data for transects, quadrats, and individual dwarf wedgemussels will be entered and summarized.

- Shell length data will be summarized and used with existing age-at-length relationships (Michaelson and Neves, 1995) to provide an age-class distribution analysis for dwarf wedgemussels or a size-class distribution analysis for species for which age-at-length relationships have not been determined.

    - Logistic regression will be used to relate two response variables (species presence and species density) to key predictive habitat parameters. These regression analyses will be important for generating specific habitat suitability criteria. A wide range of predictive parameters has been proposed and tested in similar studies (Layzer and Madison, 1995; Strayer, 1999; Hastie et al., 2000; Hardison and Layzer, 2001; Morales et al., 2006; Allen and Vaughn, 2010; Maloney et al., 2012). Fine-scale (e.g., quadrat-level) and larger-scale (e.g., mussel bed, all or a portion of the river channel, a reach/segment) habitat parameters will be tested for predictive ability based on the strength of their relationship with mussel presence/density, predictive ability, and redundancy with other parameters to determine whether they should become part of the final habitat suitability criteria. Potential parameters include (where available from other studies and/or collected in this study):

    - Water depth (mean, minimum, maximum, and percent daily change).

    - Substrate composition (presence and percent composition of each type).

- Substrate embeddedness.
- Benthic velocity (mean, minimum, maximum, and percent change) [this is measured and modeled].
- Aquatic vegetation and coarse woody debris (presence and percent composition of each type).
- HMU type.
- Shear stress and relative shear stress [calculated from field data in other studies].
- Froude number [this is an output from 2-D modeling].
- Co-occurring mussel species presence.
- Mean bank height and bank slope [data from other relicensing studies].
- Wetted width and daily change in wetted width [data from other relicensing studies].
- Bed slope [data from other relicensing studies].

- Locations of dwarf wedgemussels and suitable dwarf wedgemussel habitat will be mapped, based on 2011 and 2013 semi-quantitative data and habitat characterization, 2014 quantitative and qualitative data, and associated studies.

Habitat Suitability Criteria: Quantitative, data-driven habitat suitability criteria will be developed for dwarf wedgemussels and co-occurring mussel species using field-collected mussel and habitat data (described under Task 3 and including data from Biodrawversity and LBG (2012, 2014). Other associated relicensing studies (Study 4, Hydraulic Modeling; Study 5, Operations Modeling; Study 7, Aquatic Habitat Mapping, and Study 9, Instream Flow Study) will provide important habitat data for these analyses, both for areas of the Connecticut River where dwarf wedgemussels are known to occur and for areas where they are not thought to occur. The regression analyses described above will help select, prioritize/weight, and scale the most important predictive parameters. These data will be supplemented with existing information (other publications, case studies, unpublished data, and expert review). The development of these habitat suitability criteria will be a transparent process, and stakeholders will have an opportunity to review data sources, rationale for inclusion/exclusion of certain parameters, and weighting and scaling of each parameter. Habitat suitability criteria are important for mapping and quantifying suitable habitat. They will be used with results from the associated studies to show where, and to what extent, flow regime/water-level fluctuations may affect dwarf wedgemussels, co-occurring mussel species, and mussel habitat.

Assessing Effects of Flow Regime/Water Level Fluctuations Cornish Covered Bridge to Chase Island: Two-dimensional hydrodynamic modeling and the Instream Flow Incremental Methodology that is part of Study 9, Instream Flow Study, will be used in the reach from Cornish Covered Bridge to Chase Island, where the intensive quadrat sampling is planned. These tools, combined with the mussel spatial data and the habitat suitability criteria that will be developed (described above), will be used to quantify changes in habitat suitability/availability over a range of flows (i.e., a measure of "persistent habitat;" Maloney et al., 2012). The "quantity of suitable habitat" is the total area (computed as a summation via modeling and spatial analysis) in which all of the habitat suitability criteria are met for a species within the reach. This summation is performed over a range of flows to determine the loss or gain of suitable/available habitat at different flows and to map where this loss or gain occurs. Actual mussel distribution and density determined with quadrat sampling and mapping of mussel beds will be overlaid on maps of suitable/available habitat at different flows to show where, and to what extent, water-level fluctuations affect mussels and mussel habitat.

Habitat suitability criteria will also be used to map and quantify suitable dwarf wedgemussel habitat elsewhere in the Wilder impoundment, free-flowing reach, and Bellows Falls impoundment, both where dwarf wedgemussels occur and where they are not thought to occur. Similarly, the associated relicensing studies will be used to analyze where, and to what extent, flow regime/water-level fluctuations may affect dwarf wedgemussels, co-occurring mussel species, and mussel habitat in these areas. Although there is one additional 2-D study site proposed in the free-flowing reach in Study 9 (0.5-mile river segment that encompasses Johnston Island, an area where dwarf wedgemussels are not thought to occur), the hydrodynamic modeling throughout the Wilder and Bellows Falls impoundments and most of the free-flowing reach is one-dimensional (1-D). Nevertheless, 1-D modeling from Study 4, Hydraulic Modeling, will be adequate to assess effects of water-level fluctuations on dwarf wedgemussels in these areas. In addition to water-level fluctuations, the 1-D modeling in the free-flowing reach (Study 9) can assess microhabitat through a combination of substrate composition, depth, velocity, shear velocity, and shear stress.

Methods for the associated studies that will become part of this comprehensive assessment are described within their respective study plans and will be presented in more detail in the respective study reports.

SCHEDULE

Following stakeholder review, Revised Phase 2 Study Plan fieldwork is planned to occur in August and September 2014. A progress report is being filed as part of the TransCanada Initial Study Report (ISR) – Volume I on September 15, 2014, and analysis and production of the final report will occur between September and December 31, 2014.

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Attachment A
Responsiveness Summary

Written comments and questions on the Phase 2 Study Plan were provided by Katie Kennedy of The Nature Conservancy via email on June 27, 2014. Those comments have been summarized here with TransCanada's responses to each.

Comment	**Response**
Concerning parameter estimates for low-density populations: On page 2, the plan essentially states that with low-density mussel populations (e.g., dwarf wedgemussel) densities are difficult to estimate with precision because of low detection probability. This is true. However, methods to account for this have improved substantially over the last 10 years (the documents cited in the study plan were published in 1995 and 2003). That is to say, a quantitative study or quantitative sampling can be accomplished with low-density populations. In fact, the methods described in the study plan are quantitative. Whether we will be able to achieve a robust estimate of density is what is questionable. Because robust estimates of density are unlikely, we therefore need a surrogate parameter. From MacKenzie et al. 2006: "In the case of rare species, it is sometimes practically impossible to estimate abundance, whereas estimation of occupancy is still possible. Thus, for reasons that include expense and necessity, occupancy is sometimes viewed as a surrogate for abundance." (And note that density is simply a measure of abundance per unit area). It is very possible that estimation of occupancy would not require any changes to the study design, and is simply a matter of how collected data are analyzed. See additional discussion of this in comments on the "Analysis" section of the plan below.	TransCanada agrees that the methods described in Task 3 are quantitative, including both transects and quadrats, and language in the Revised Phase 2 Study Plan (Phase 2 RSP) was changed accordingly. The multiple quantitative methods proposed in the study plan are adequate to assess density, shell length distribution, and habitat. TransCanada disagrees that "*because a robust estimate of density are unlikely…*" a surrogate parameter of "occupancy" is needed. The surrogate mentioned—"occupancy"—is not well vetted at an academic level and has not been used in Federal Energy Regulatory Commission studies. Rather than "occupancy" as a surrogate, the Phase 2 study plan proposes to use co-occurring mussel species (which are relatively more common) as surrogates for dwarf wedgemussels. Though less common, dwarf wedgemussels occupy the same types of habitats as these other mussel species.

Comment	Response
Concerning quantitative vs. semi-quantitative: Because the transect/quadrat methods are identified as semi-quantitative in the plan, it seems that they are written off as useful for addressing Task 5. Since they are indeed quantitative, the transect methods, if fleshed out properly, will result in "statistically sound and repeatable data, using quantitative methods." If this a requirement for informing Task 5 (as seems to be stated at the top of page 3, and again at the bottom of page 3), the transect/quadrat data will therefore also be useful for informing Task 5. To emphasize this, the Revised Study Plan states, "TransCanada proposes to use the distribution, density, habitat, and behavioral data collected during Tasks 2 through 4…to assess the effects of flow regime on DWM and their habitat" (p. 245). Therefore all parts of Task 3 should be used to inform Task 5. Concerning site selection: On page 4, there needs to be a more thorough explanation of site selection. • How did you arrive at the number 20 for sites? • How did you decide on the number of transects at each location? • How were the locations selected and their bounds determined? • How will the transects be selected within each location? If sites are only selected where DWM are present, we will not be able to determine habitat suitability. To be clear, sampling only where DWM are present is not "consistent with generally accepted scientific practice." Habitat suitability is described across a range. If we only look at the top of the range, we won't have a complete curve. It is also extremely important to characterize habitat where DWM are not present.	TransCanada agrees that transects and quadrats are quantitative, and each will provide information useful for Task 5. And for clarification, the Phase 2 RSP never suggested that transect data were not important – transect data will be used to develop habitat suitability criteria and to help understand the effects of flow operations in concert with the instream flow study, hydraulic modeling, and other relicensing studies. Several criteria were used to select sampling locations: ▪ Presence or historical presence of dwarf wedgemussels; ▪ Locations were representative (i.e., similar habitat) of broader reaches within which dwarf wedgemussel were consistently found; ▪ Access; and ▪ Conditions conducive to the types of sampling proposed. The number of sites and number of transects per site were selected to be representative of dwarf wedgemussel habitat and to provide a reasonable amount of replication. It is inaccurate to suggest that TransCanada is only sampling where dwarf wedgemussels are present to determine habitat suitability. TransCanada has proposed the following to determine habitat suitability: 1. 2011 and 2013 mussel survey data within the project area (210 survey sites, about 180 where dwarf wedgemussels were not found); 2. 2014 quantitative data; 3. Data from other studies in the Connecticut River and its tributaries conducted from 1990 to the present time; 4. Other publications and relevant case studies from outside the region, on this species, similar species, and that might have tried similar types of suitability analyses; and 5. Data from the other relicensing studies being done concurrent with the mussel study. Also, some of the sites were selected because of historical presence of dwarf wedgemussels even though none were found in 2013. Dwarf wedgemussels will not occur in most of the quadrats and transects that have been proposed for survey, which will help to describe habitat suitability across a range, as suggested by the reviewer. For example, the intensive quadrat sampling proposed in the reach from Chase Island to Cornish Covered Bridge covers a large area where it is not expected that dwarf wedgemussels will occur.

Comment	Response

Some suggestions about site selection for this study:
• DWM were found at 31 locations – this is actually a pretty substantial number of sites occupied by DWM. Since DWM densities are low, all 31 sites should be used to characterize habitat.
• There should be an approximately equal number of unsuitable habitat and/or locations without DWM. Here is a suggestion for additional sites:
    ○ 15 randomly-selected sites within systems with known populations of DWM (the Wilder and Bellows Falls impoundments), and
    ○ 15 randomly-selected sites within the unimpounded reaches.
	The fact that dwarf wedgemussels were found at 31 locations is irrelevant—this is an artifact of the sampling design that aimed to provide systematic surveys throughout all project areas. It is more appropriate to focus on the fact that dwarf wedgemussels were found along approximately 34 miles of the river, and within that 34 miles, dwarf wedgemussels could be found at most locations if survey duration is long enough. It is not necessary to use all 31 sites to characterize habitat using the quantitative sampling proposed in 2014 because there is nothing particularly special about the sites, and habitat was quite homogenous among them. Subsampling is a commonly accepted practice. TransCanada disagrees that it is necessary to conduct additional quantitative sampling and habitat measurements at an equal number of locations with "unsuitable habitat and/or locations without DWM." First, it is not possible to prove that dwarf wedgemussels do not exist at a location…one cannot prove absence because it is always conditional on effort. Second, it is scientifically legitimate, and achieves the objectives of Task 3 and Task 5, to focus on areas where dwarf wedgemussels occur or historically occurred for the quantitative mussel sampling and to use all of the other data sources described (see above) to help describe and model habitat suitability. In particular, TransCanada's other habitat-related studies, and 1-D and 2-D hydraulic modeling, will adequately characterize habitat in areas where dwarf wedgemussels are not thought to occur.

There also needs to be a more thorough explanation of sampling methodology: • How do you sample? • Is there a time component? • Do you methodically search from one end of the transect to the other?	Additional detail is provided in the Phase 2 RSP.
On page 5, it states, "Biologists will also conduct qualitative surveys in the areas near transects to increase the change of detecting dwarf wedgemussel…" What is the purpose of this piece of the sampling design? How will the collected information be used?	The purposes are to (1) confirm presence because there is a chance that dwarf wedgemussels will not be found in transects or quadrats, and (2) provide an opportunity to collect additional shell length, shell condition, and microhabitat data for individual dwarf wedgemussels. Low numbers of dwarf wedgemussels might weaken a demographic analysis, and this is an attempt to increase sample size. Qualitative surveys are proven to be the best way to do that.

Comment	Response
Also on page 5, there needs to be a more thorough explanation of how covariate data are collected: • The text states, "Additional data recorded for each transect…," yet the analysis section states, "…habitat data for transects, quadrats, and individual dwarf wedgemussels…" (p. 7). How will the habitat data be collected? • What is a "visual timed estimate of flow velocity"? Are these methods supported by the literature? • When describing data collection, methods need to be stated clearly – how will each measure be collected? With what equipment? What is the unit of measure? This information is important, and is standard in descriptions of study methodology. • It would be beneficial to see some justification for the habitat measures chosen.	Additional detail is provided in the Phase 2 RSP.

Based on the literature, and discussions with mussel experts, I suggest the additional following measures (or specific methods for listed measures) for collection and/or inclusion in the analyses:
• Quadrat-level measures: depth, substrate composition, substrate embeddedness, benthic velocity (it's not clear whether the measures listed on p. 5 are to be collected in each quadrat).
• Site-level measures (again, to be measured and/or included in analyses):
  ○ Depth (max and mean across quadrats)
  ○ Average daily % change in depth (fluctuations)
  ○ Average daily % change in velocity (fluctuations)
  ○ Mean substrate composition (% silt, sand, clay, gravel, cobble, boulder, bedrock)
  ○ Substrate embeddedness
  ○ Mean column velocity (can be modeled)
  ○ Mean benthic velocity across quadrats
  ○ Temperature (if appropriate to use established data loggers)
  ○ Co-occurring mussel presence
  ○ Mean bank height
  ○ Mean bank slope
  ○ Wetted width/change in wetted width (modeled)
  ○ Bed slope
	Additional detail is provided in the Phase 2 RSP. "Embeddedness" was added to satisfy the reviewer's request. Other parameters were included, either during the mussel sampling or by TransCanada's other studies.

Comment	Response
On page 7, the methods for Task 5 need to be described further before the study plan is finalized. It is not sufficient to say that "the effects of flow regime… will be assessed using field-collected data…" How is this going to be assessed? What are the methods?	Additional detail is provided in the Phase 2 RSP.
For the description of analyses, these also need to be described more thoroughly before data are collected. Some specific examples of needed clarity: In the first paragraph under the "Analysis" section, the text states, "linear or multiple regression will be used to relate mussel presence and density to key habitat suitability measures." I agree with this generally, but this is rather vague and needs to be described further. I suggest including: • Multiple logistic regression, with presence at a site as the response, informed by estimated detection probability. If detection probability is not included, estimates of presence at a site (i.e., occupancy or occurrence) will be biased. Quadrats can easily be used to estimate detection probability, which can allow for unbiased estimates of presence/absence, and avoid false absences. Note, however, that if detection is to be included, some initial analyses will need to take place to ensure that 10 quadrats at each site will be enough to estimate detection. • Logistic regression, with presence at a site as the response variable to each predictive parameter (ideally also including detection probability). This will be important for generating specific habitat suitability curves.	Additional detail is provided in the Phase 2 RSP.
In the first full paragraph on page 8, it states that an analysis will be done "similar to what is described in Maloney et al. (2012)…" What is the analysis? How is it similar/dissimilar to the cited study?	Additional detail is provided in the Phase 2 RSP.
In this same paragraph, it says "…this analysis will be the primary means of assessing the effects of flow regime on mussels in this reach…" How will this assessment be done? Continuing, "…and will allow for similar effects analysis in similar habitats…" What does this mean? What are the effects analyses? What similar habitats?	Additional detail is provided in the Phase 2 RSP.
For the "Impoundments" section, it states, "…the associated studies will be used to analyze where, and to what extent, flow regime/water level fluctuations may affect dwarf wedgemussels and suitable habitat…" What are these analyses? This needs to be explained in more detail. Similarly, what is the "effects analysis" mentioned in the following sentence.	Additional detail is provided in the Phase 2 RSP.

Comment	Response
Also, in the Revised Study Plan, it was stated that "participants in the aquatics working group will have full access to both reports" and then it mentions a confidentiality agreement (p. 244). Is there any particular reason why this hasn't been done?	All members of the aquatics working group have access to the confidential version of the 2013 study report, which includes specific location information regarding dwarf wedgemussels. The public version of the draft report, was provided to the working group via the TransCanada secure website along with the Proposed Phase 2 Study Plan, and is the same as the confidential version of the report, except specific location information is omitted.