TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 27

FLOODPLAIN, WETLAND, RIPARIAN, AND LITTORAL VEGETATION HABITATS STUDY

Final 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)

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EXECUTIVE SUMMARY

Introduction

The goal of this study was 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-related water-level fluctuations on those habitats. The objectives of this study were to describe and map riparian, floodplain, and wetland habitats; describe and map shallow-water aquatic habitat types within the zone of normal project operations water-level fluctuations; 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. This final study report incorporates assessment of potential project effects based on the Hydraulic Modeling Study (GEI, 2016) and the Operations Modeling Study (Hatch, 2016).

The study area extended from the uppermost extent of the Wilder impoundment to the area downstream of Vernon Dam, including the Wilder, Bellows Falls, and Vernon impoundments and the riverine sections downstream of Wilder and Bellows Falls dams, and extending approximately 1.5 miles below Vernon dam. All of the shorelines in Vermont and New Hampshire, including the river's edge, islands, sand and gravel bars, and portions of tributaries that appeared (based on review of LiDAR and aerial photos) to be within the influence of the projects, were mapped. The terrestrial extent of the study area encompassed at least 200 feet from the river's edge. Where wetlands and floodplains extended farther inland than 200 feet, the study encompassed either the entire wetland or floodplain, or to where the topography or site features indicated the river is no longer a significant influence on the habitat.

Cover Type Map

Natural features and land uses mapped within the study area covered a total of 8,250 acres, and were comprised of upland vegetation cover (70% cover), wetlands and tributary streams (15% cover), developed lands (13% cover), and riverine features (2% cover). Upland vegetation cover was predominantly forest (64% cover) followed by agricultural land (29% cover). Large tracts of deciduous, coniferous, and mixed deciduous and coniferous forest extended across much of the study area. Agricultural uses, primarily cropland and pasture/hayfield, were the predominant cover type over much of the more level terrain adjacent to the river, and especially in the Wilder impoundment. The remaining vegetated upland cover was largely shrub communities, maintained grass such as parklands and golf courses, and old fields.

Wetlands were widely distributed across the study area with the majority consisting of emergent (40% cover), deciduous forested (34% cover) and scrub/shrub (10% cover) cover types. A variety of intermixed cover types, open water and aquatic bed habitat comprised the balance (16% cover). Infrastructure, consisting of

dams and dam facilities, boat launches, roads and railroads, comprised the largest single cover type in the developed lands category.

Additional features mapped in the study area included tributary streams, steep unconsolidated slopes, visibly eroding banks and river channel structures. Most of the tributary streams, eroding banks and steep unconsolidated slopes were associated with the three impoundments. Channel features including bedrock in the Bellows Falls bypass reach and along the riverbank, boulders and cobble in shallows, gravel bars, and sand and mud, were concentrated in the free flowing sections of the river downstream of the project dams.

The most prevalent vegetation communities characterized across the study area were: hardwood forest including upland and riparian forest types, mixed hardwood-softwood forests, softwood forest, emergent wetlands, scrub/shrub wetlands, scrub/shrub & emergent wetlands, deciduous forested wetlands, deciduous forest & scrub/shrub wetlands, aquatic beds and riverbank.

Floodplains

Approximately 3,218 acres of floodplains were delineated based on a combination of elevation and evidence of flooding. Floodplains were more prevalent along the shores of the three impoundments compared to the riverine sections. Almost half of all floodplains occurred in the Bellows Falls impoundment. Wilder and Vernon impoundments had approximately 28% and 24% of the total floodplains, respectively.

The cover types of the floodplains were predominantly in natural cover or agriculture; approximately 48% were in wetland cover, 27% were in agriculture, and 20% were in natural upland cover. Typically, floodplains were confined to less than ten feet above local average high water level, were relatively flat, and often showed flooding features such as wet depressions and evidence of scour and deposition. In some instances, evidence of flooding on the aerial photos indicated floodplains occurred above the relative ten foot contour and were consequently mapped as such.

Wetland Assessment

Function and values assessments were performed for the six most common wetland types in the study area to determine the principal functions and values provided by each of these habitats using the 1999 US Army Corps of Engineers Highway Methodology (USACE, 1999). Widely occurring principal functions consisted of flood flow alteration, sediment/toxicant retention, nutrient removal, sediment/shoreline stabilization, wildlife habitat, and endangered species habitat. Occurring less commonly at a principal level were the groundwater recharge/discharge, fish/shellfish habitat and production export functions, and the visual quality/aesthetics value. The recreation, educational/scientific, and uniqueness/heritage values were not determined to occur at a principal level in any of the study area wetlands.

Emergent wetlands provided the most functions at a principal level in the study area followed by aquatic bed, scrub/shrub, and forested wetlands. Scrub/shrub-emergent and forested- scrub/shrub wetlands provided the least number of principal functions, but were also uncommon habitats in the study area, and therefore, fewer of these habitats were available for assessment. Aquatic beds were the only wetland type to provide a wetland value at a principal level.

Rare, Threatened, and Endangered Species

One-hundred-sixty-three (163) State-listed plant species and exemplary communities were to be incidentally investigated during this study, if the Element Occurrences were located on public or TransCanada-owned or leased land. Of those 163 Element Occurrences, 88 had been located since 1990 and 75 had not been observed since that date. This study's analysis focused on the 88 more recent (post-1990) observations. Of the 88 recent Element Occurrences, 46 occurred within the 2014 study area, and 42 occurred more landward of the study area. Seven Element Occurrences were confirmed during the 2014 field verification, including five silver maple-wood nettle-ostrich fern floodplain communities, and three rare species, black maple (*Acer nigrum*), obedient plant (*Physostegia virginiana*), and southern naiad (*Najas flexilis*). Another Element Occurrence of silver maple-wood nettle-ostrich fern floodplain community recorded in the study area was noted within a very marginal cover type of mixed hardwood and conifers. Located in association with a small drainage, this Element Occurrence was determined to be too small and too marginal to include as a confirmed record. Also, in addition to the recorded obedient plant Element Occurrence, this species was frequently observed on much of the riverbank and on many of the sparsely vegetated bars during vegetation field surveys conducted in 2012 (Normandeau, 2013a) and in 2014.

Invasive and Exotic Species

Twenty-seven (27) plant species designated as invasive, non-native species and one additional plant considered potentially invasive were documented in the study area as a result of this study's habitat mapping and TransCanada's 2012 rare species and exemplary community survey (Normandeau, 2013a). Over 163 acres of discrete stands of invasives were mapped. The majority of species occurred in more than one impoundment.

Japanese knotweed (*Fallopia japonica*) was the most widespread species (79 acres), with dense stands mapped along the shoreline and on islands throughout the study area and in a variety of habitats. Approximately 35 acres of Phragmites-dominated scrub/shrub and emergent cover were mapped in the study area. Approximately two-thirds of the Phragmites found in the study area occurred in the Vernon impoundment, with lesser amounts, and smaller stands in the Wilder and Bellows Falls impoundments. This species was relatively infrequent in the riverine reaches. Purple loosestrife (*Lythrum salicaria L.*) was widespread in a variety of open habitats throughout the study area, including emergent wetlands, riverbanks, and gravel bars. Where it occurred, this species was typically low in density, and

seldom dominated the plant community. Reed canary grass (*Phalaris arundinacea L.*) was also widely distributed throughout the study area in dense, small patches, predominantly on riverbanks and in emergent and scrub/shrub wetlands. Forget-me-not (*Myosotis scorpioides L.*) was prevalent on many riverbanks and wetland edges throughout the study area.

Common invasive shrub species included the bush honeysuckles (*Lonicera spp*), glossy buckthorn (*Frangula alnus Mill.*), multiflora rose (*Rosa multiflora Thunb. ex Murr.*), and Japanese barberry (*Berberis thunbergii DC.*). One or more of these species were encountered in most forested and shrub stands, including both wetlands and uplands. Oriental bittersweet (*Celastrus orbiculatus Thunb.*) occurred along much of the riverbank throughout the forested cover types. It was prevalent in both wetlands and uplands, forming dense, climbing vines in the tree canopy along the open edges of stands.

The aquatic invasive, Eurasian milfoil (*Myriophyllum spicatum L.*) was prevalent in all three impoundments, particularly in quiet coves. Where it occurred, it tended to be abundant and dominated the mid-column flora. Brittle naiad (*Najas minor*) was also widespread in quiet coves.

Bald Eagle Nesting and Winter Roosting Habitat

In the 2014 breeding season, New Hampshire Audubon (NHA) documented nine bald eagle nests within the study area, eight of which were active (NHA 2012a). This was an increase from six nests (five active) in 2012 when NHA began tracking nests on the Connecticut River, and seven nests (six active) in 2013. Productivity of the nests in the study area was 0.8, 0.7, and 0.6 fledged young per nest in 2012, 2013, and 2014, respectively. While the overall productivity of these nests was lower than for nests throughout the entire watershed in all three years, the decrease in 2014 was reflected across the entire watershed, most likely due to cold weather and heavy snow in March.

All known locations of nests are within approximately 125 feet of the Connecticut River shoreline. There are no conserved lands within 250 feet of any nest, but five of the known locations are essentially on the river bank, which is partially protected from new development by statute in both Vermont and New Hampshire.

The NH Natural Heritage Bureau data identified one known winter roosting area within the study area, located in Hinsdale, NH, near Vernon Dam. Aerial photo interpretation followed by field verification identified 12 additional softwood stands that appear to offer suitable winter roosting conditions: six in Vermont; and six in New Hampshire. They are all located essentially on the riverbank, with two located on tributary inlets, and two located on islands. These potentially suitable winter roosting sites are relatively evenly distributed throughout the study area, and although the distribution is not extensive in comparison to the entire size of the study area, winter roosting habitat is unlikely to be a limiting resource.

Wildlife

A total of 87 species of wildlife were recorded during incidental observations in this study, as well as other species specific surveys (Studies 26 and 28, for Tiger Beetles and Fowler's Toad, respectively). Twelve species of wading birds and waterfowl were recorded between April and August, 2014. Common waterfowl species throughout the study area included common merganser (*Mergus merganser*), wood duck (*Aix sponsa),* mallard (*Anas platyrhynchos),* Canada goose (*Branta Canadensis)* and double crested cormorant (*Phalacrocora auritus)*.

Other common species included spotted sandpiper (*Actitis macularia)* along the water's edge, bank swallow (*Riparia riparia*) colonies on eroded banks in Bellows and Wilder projects, and belted kingfisher (*Ceryle alcyon*), great blue heron (*Ardea herodias*), and green heron (*Butorides virescens*) were common throughout the study area.

Bald eagle juveniles and adults were observed in multiple locations throughout the study area, as were numerous other species of raptors: turkey vulture (*Cathartes aura*), osprey (*Pandion haliaetus*), red-tailed hawk (*Buteo jamaicensis*), broad-winged hawk (*Buteo platypterus*), American kestrel (*Falco sparverius*), and a peregrine falcon (*Falco peregrinus*) in the Vernon impoundment.

Other wildlife observations included beaver lodges and dams in backwaters and evidence of bank dens on the mainstem, mostly in the three impoundments. Muskrat were observed in the larger emergent marshes, primarily in the lower Vernon impoundment. American toads, spring peepers, green frogs and bullfrogs were observed or heard in most of the quieter waters with emergent wetlands and aquatic beds. A white-tailed deer fawn was observed on Chase Island and tracks of raccoon, deer, mink, possum, and mice were frequently observed along the shorelines.

Vegetation Communities and Hydrology

Wetland vegetation communities within the three project impoundments appear to respond to both the water level regime associated with normal project operations and exposure to high water and flood events. The most extensive wetland development exists in the lower sections of the impoundments, where the typical range of water level fluctuation is less, in protected coves and backwaters away from river currents, and subject to less scour during flood conditions. As is true with most wetland communities, wetlands in the project-affected areas are established at elevations relative to normal average water levels. Forested wetlands and floodplains are located a foot or more above normal project operations water surface elevations (WSEs). These habitats are affected by high water levels and provide important buffers during flood conditions. Emergent and low scrub-shrub wetlands are located within the elevation range affected by normal project operations. Both emergent marshes and low shrub communities can tolerate frequent inundation, with emergent marsh communities showing a gradation from deep marsh at the lower limits of the mapped marsh to shallow marsh at slightly higher elevations. Submerged aquatic vegetation is typically located below the lower WSE limit of normal project operations. These truly aquatic species are intolerant of desiccation and exposure.

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Abbreviations:

DBH	diameter at breast height
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
GPS	Global Positioning System
GSD	ground sample distance
ILP	Integrated Licensing Process
IPANE	Invasive Plant Atlas of New England
LiDAR	Light detection and ranging
NAIP	National Agriculture Imagery Program
NHA	New Hampshire Audubon
NHFGD	New Hampshire Fish and Game Department
NHNHB	New Hampshire Natural Heritage Bureau
QC	quality control
SAV	submerged aquatic vegetation
SPD	Study Plan Determination
USACE	U.S. Army Corps of Engineers
VTNHI	Vermont Fish and Game Department's Natural Heritage Inventory
WSE	Water surface elevation

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1.0 INTRODUCTION

In their study requests, stakeholders indicated that Wilder, Bellows Falls, and Vernon project operations may affect the distribution and composition of vegetation, the structure of riparian, floodplain, wetland, and littoral habitats, and the wildlife that utilize these areas. The Connecticut River provides habitat for vegetation communities ranging from upland to submerged aquatic systems. Groundwater and surface water close to the river are potentially influenced by daily and seasonal project operations, which in turn may affect the substrates, species composition, and structure of the vegetation communities bordering the river, particularly those in lower topographic settings such as wetlands and floodplains. Natural riparian habitat provides valuable ecological functions including water quality protection and maintenance, bank stabilization, and wildlife travel corridors.

During the Integrated Licensing Process (ILP), Study 27 was developed to investigate vegetation communities and habitats along the Connecticut River within the affected areas of the three projects. The Revised Study Plan (RSP) 27 was approved without modification in FERC's September, 13, 2013, Study Plan Determination (SPD).

The initial study report was filed on September 14, 2015. No comments were received on that report. This final study report incorporates assessment of project effects based on data from the Hydraulic and Operations Models (Study 4 [GEI, 2016] and Study 5 [Hatch, 2016]) that were unavailable at the time of the initial study report.

2.0 STUDY GOALS AND OBJECTIVES

The goal of this study was 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-related water-level fluctuations on those habitats.

The objectives of this study were 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 the normal project operations water-level fluctuations and where water level depths at the lowest operational range are wetted to a depth of less than 1 foot (flats, near shore 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.

3.0 STUDY AREA

The study area (Figure 3.1) extends from the uppermost extent of the Wilder impoundment to the area downstream of Vernon Dam including the Wilder, Bellows Falls, and Vernon impoundments and the riverine sections downstream of Wilder and Bellows Falls dams, and extending approximately 1.5 miles below Vernon dam. All of the shoreline in Vermont and New Hampshire, including the river's edge, islands, sand and gravel bars, and portions of tributaries that appeared to be within the influence of the impoundments (based on review of LiDAR and aerial photos), were mapped. The terrestrial extent of the study encompassed at least 200 feet from the river's edge. Where wetlands and floodplains extended farther inland than 200 feet, the study encompassed either the entire wetland or floodplain, or to where the topography or site features indicated the river is no longer a significant influence on the habitat.

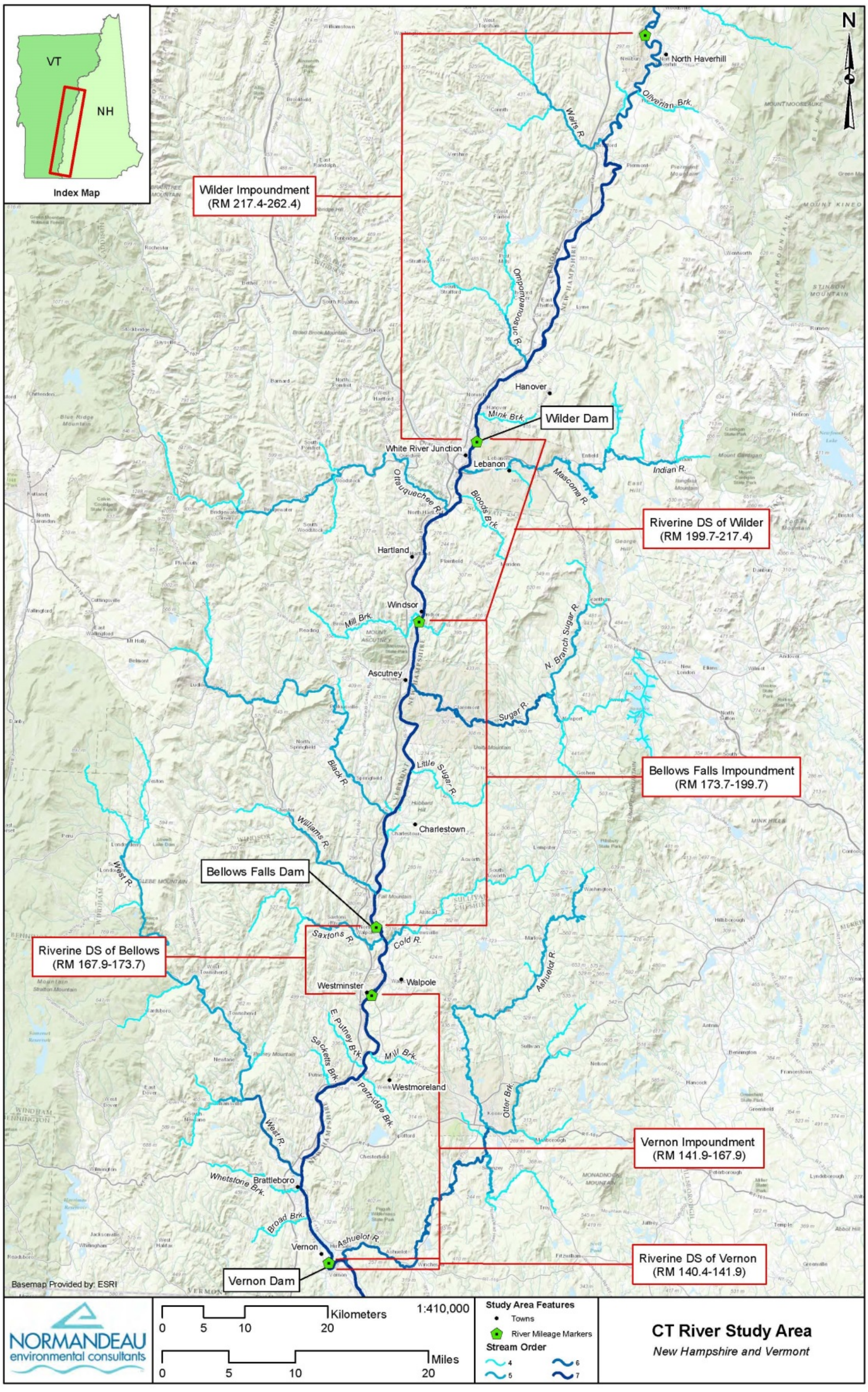

Figure 3.1. Wilder, Bellows Falls, and Vernon study area.

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4.0 METHODS

Information regarding terrestrial habitats was obtained for six natural resource features: vegetation mapping and characterization, wetland assessment, floodplain mapping, wildlife observations, and invasive and rare species observations. The methods for this study followed those that were described in the RSP with adjustments for local conditions.

4.1 Vegetation and Land Use

4.1.1 Cover Type Mapping

Vegetation and land use mapping and cover typing were performed using light detection and ranging (LiDAR) survey data, true color, and color infrared, stereo imagery of the study area. The LiDAR and photoimagery were flown between April 29, 2013 and May 7, 2013 at a resolution of 7.9 cm average ground sampling distance (GSD), during leaf-off, and under snow- and ice-free conditions.

Study staff digitally photo-interpreted upland and wetland cover type boundaries within the riparian, floodplain, and wetland habitats by using stereo imaging software. Cover types were delineated at least 200 feet from the Connecticut River shoreline in each impoundment and riverine section. The edge of water was determined initially using the LiDAR data, and refined in areas of discrepancy using the photoimagery. Because aquatic vegetation was not visible at the time of the imagery flight, aquatic beds were mapped from true color orthophotos (US Department of Agriculture National Agriculture Imagery Program [NAIP], 2009) and refined during field work. During photointerpretation, other resources were referenced for supporting information including hydric soil maps, National Wetland Inventory maps, hydrology maps, topographic maps, and additional publicly available aerial photographs as needed to confirm a feature.

The minimum mapping unit size for wetlands and uplands was ½ acre although distinct communities or cover types smaller than ½ acre were delineated if relevant. Cover types included both wetland and upland habitats. The following definitions were applied to the various categories. Wetland cover types were classified according to the US Fish and Wildlife Service (FWS) wetland classification (Cowardin et al., 1979).

Wetlands

Code	FWS Classification	Study Term
PFO1	Palustrine Forested Deciduous	Deciduous Forested Wetland
PFO4	Palustrine Forested Coniferous	Coniferous Forested Wetland
PSS1	Palustrine Scrub-shrub Wetland	Shrub Swamp
PEM1	Palustrine Emergent Wetland	Emergent Wetland
PEM5	Palustrine Emergent Phragmites Wetland	Emergent Wetland
PUB	Palustrine Unconsolidated Bottom	Open Water
RAB	Riverine Aquatic Bed	Aquatic Bed

Other wetland features included:

PVP Possible Vernal Pool (small seasonal open water body)

Stream- Categorized as perennial or intermittent

Other riverine and shoreline map categories included:

Ledge - exposed on bank, may extend into aquatic habitat

Rocky - boulders and cobble immersed or visible in shallows

Riprap - Large boulders set in place to protect shorelines from scour

Gravel - bars immersed or visible in shallows

S-M - Sand and mud, if not typed by aquatic habitat mapping

Eroding Bank - Areas of riverbank where material is actively eroding

Riverbank - Steep, unconsolidated slopes at the edge of the river

Upland habitats

H - Hardwood forest-intermediate or mature deciduous forest with less than 20% softwoods,

S - Softwood forest- intermediate or mature coniferous forest with less than 20% hardwoods,

HS - mix of hardwood and softwood forest- including intermediate or mature deciduous forest with more than 20% cover of both types

Shr - shrub dominated

F - old field

AGc - Agriculture, cropland

AGp - Agriculture, pasture/hayfield

G - Grassland, including large maintained lawns, golf courses, ball fields, etc.

I – Infrastructure - Roads, railroads, boat launches, Hydro dams, etc.

R - Residential, isolated or low density homes

Sub- Suburban, higher density housing

Com - Commercial/urban development

M – Mineral - Sand and gravel pits.

An additional field check notation was added to sites that were difficult to photo interpret. These sites were field checked to confirm the boundaries and cover types present.

4.1.2 Field Review

Field visits were conducted to confirm the accuracy of the mapped cover type boundaries and classification. Most of the dominant natural cover types were visited by one or more wetland scientists, and the cover type and boundary were evaluated and adjusted if necessary, based on field observations. Dominant wetland and upland cover types within each impoundment were characterized by visiting at least three examples of each cover type. At each site, data were collected on the plant community species composition and structure, soil characteristics, invasive species presence and abundance, ground features such as amount of litter, and substrate/rockiness. We also made notes on evidence of flooding or scour, or if inundated at the time of the visit, the depth of water to estimate the influence of the river on the vegetation community.

4.1.3 Quality Control

Quality control (QC) was applied throughout the photo-interpretation process. As cover type delineations in impoundment sections were completed, 30% to 100% of the section was reviewed by a different delineating scientist for consistency and completeness. As errors, inconsistencies, or differences of opinion were encountered, notations were made in the attribute tables for review, discussion, and final modifications by the original delineator. Unresolved areas were marked for ground-truthing.

Cover type maps were revised in GIS to reflect changes made during the field review. The final maps were subjected to another round of QC by an independent scientist comparing field notes to the cover type map. The approved maps were then analyzed in GIS to provide the acreages of the various cover types within the 200-foot shoreline study area, or more for wetlands and floodplains, prescribed by the study plan.

4.2 Floodplains

Floodplains were defined in the RSP based on ecological function, occurrence in the regularly flooded lowlands of the Connecticut River and its tributaries, and dominated by silver maple or sugar maple with a sparse shrub layer and a lush herbaceous layer of either ostrich fern or sensitive fern depending on the gradient of the river (NHFGD, 2005: Kart et al., 2005). Floodplains that have been converted to other uses, such as agriculture, development, or recreation, or that have been affected by riverine erosion process were mapped as well.

Reconnaissance visits were made to silver maple-wood nettle-ostrich fern floodplain communities mapped by the New Hampshire Natural Heritage Bureau (NHNHB) and Vermont Fish and Game Department's Natural Heritage Inventory (VTNHI). These visits were used to assess the current conditions of the sites and estimate the elevation of these floodplains relative to the river. Based on LiDAR data collected in the spring of 2013, the range of elevations was approximately five and ten feet above the water surface where these known floodplains occur. This elevation range was used in conjunction with site vegetation communities and topography to map the approximate extent of other floodplain areas along the impoundments and riverine sections in the study area. Floodplains were mapped within the 200-foot buffer and extended beyond this buffer where applicable. Verification of floodplain mapping was conducted during field review.

4.3 Aquatic Vegetation

Floating and submerged aquatic vegetation (SAV) was mapped using GIS at an approximate scale of 1"=300". NAIP orthorectified images flown between July 6 and September 20, 2009 were used to map the limits of aquatic beds. SAV habitats that were visible on the orthophotos were often defined by floating species such as fragrant water lily (*Nymphaea odorata)* and water shield (*Brasenia schreberi).* The approximate boundaries of SAV beds dominated by submerged vegetation were mapped in the field during ground truthing.

4.4 Wetland Assessment

Wetland function and value assessments were conducted for each dominant or important wetland cover type to determine the functions and values provided by these wetlands. The wetland types were selected based on frequency of occurrence and uniqueness of the type. The "representative wetlands" assessed included fringe emergent marsh, emergent marsh/scrub-shrub wetland, scrub-shrub wetland, deciduous forested wetland, and deciduous/coniferous forested wetland.

The functional assessment utilized the New England Army Corps of Engineers Highway Methodology Descriptive Approach (USACE 1999). This method provides an assessment of the functions being provided, and which of those functions are most important.

In most wetland assessment methods, including the Highway Methodology, wetland functions relate to the ecological significance of wetlands without regard to subjective human values. Functions are self-sustaining properties of a wetland ecosystem that result from both living and non-living components, and include all processes necessary for self-maintenance such as primary production and nutrient cycling. Wetland values are the societal benefits derived from the functions and physical characteristics of a specific wetland. Values are based on human judgment of the worth, merit, quality, or importance attributed to those functions. Principal functions and values are those that are an important physical component of a wetland ecosystem (function only) and/or are considered of special value to society, from a local, regional, and/or national perspective (USACE New England District, 1999).

The representative wetlands identified for this study were evaluated for thirteen functions and values as defined in the Highway Methodology as follows:

Wetland Functions

1. Groundwater recharge/discharge which considers the potential for a wetland to serve as either an area of groundwater recharge or discharge. Both of these functions pertain to the fundamental interaction between wetlands and aquifers, regardless of the size or importance.
2. Flood flow alteration (storage and desynchronization) which considers the effectiveness of the wetland in reducing flooding and erosion damage by water retention for prolonged periods following precipitation events and the gradual release of floodwaters.
3. Fish and shellfish habitat (freshwater) which considers the effectiveness of seasonal or permanent watercourses associated with the wetland in question for fish and shellfish habitat.
4. Sediment/toxicant retention which considers the effectiveness of the wetland in reducing or preventing degradation of water quality by trapping sediments, toxicants, and/or pathogens in runoff water from surrounding uplands or upstream eroding wetland areas.
5. Nutrient removal which considers the effectiveness of the wetland to retain nutrients in runoff water from surrounding uplands or contiguous wetlands and the ability of the wetland to transform these nutrients into other forms or trophic levels.
6. Production export which evaluates the effectiveness of the wetland in producing food or usable products for humans or other living organisms.
7. Shoreline stabilization which considers the effectiveness of a wetland to stabilize stream banks and shorelines against erosion.

8. Wildlife habitat which considers the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge including resident and/or migrating species.

Wetland Values

1. Recreation which considers the suitability of the wetland and associated watercourses to provide recreational opportunities such as hiking, canoeing, boating, fishing, hunting, and other active or passive recreational activities.
2. Educational/science value which considers the suitability of the wetland as a site for an outdoor classroom or as a location for scientific study or research.
3. Uniqueness/heritage which considers the effectiveness of the wetland or its associated waterbodies to provide certain special values. These may include archaeological sites, critical habitat for endangered species, its overall health and appearance, its role in the ecological system of the area, its relative importance as a typical wetland class for this geographic location.
4. Visual quality/aesthetics considers the visual and aesthetic quality or usefulness of the wetland.
5. Endangered/threatened species considers the suitability of the wetland to support threatened or endangered species.

4.5 Rare, Threatened and Endangered Species

Study staff worked with the NHNHB and the VTNHI to develop a database of all known records of rare species in the vicinity of the three projects. Most of these element occurrences were visited during a rare species survey conducted in 2012 (Normandeau, 2013a). A total of 345 plant and exemplary natural community Element Occurrences (234 in New Hampshire and 117 in Vermont) are listed in the two states' rare species and community databases as being within 1,000 feet of the river's edge. Of these, 182 were actively surveyed in 2012 (Normandeau, 2013a). That study focused on Element Occurrences which were potentially affected by project operations. Also in 2012, a separate study was conducted for Jesup's milk vetch (*Astragalus robinsii* var *jesupii*), a Federal and State-Endangered species (Normandeau, 2013b).

A second Federal and State-Endangered species, Northeastern bulrush (*Scirpus ancistrochaetus*), was identified as potentially occurring in the project-affected area. The survey for this species was conducted in 2014 under a separate Study Plan (Study 29).

The remaining 163 listed plant species and exemplary communities were to be incidentally investigated during this study, if the Element Occurrences were located on public or TransCanada-owned or leased land. The objective for rare, threatened and endangered plants and communities in this study was to identify the locations of Element Occurrences within the study area which were not surveyed in 2012. A subset of recent (post-1990) Element Occurrences was to be visited to assess their current status, but not to conduct detailed inventories. To accomplish this, a

desktop analysis of the remaining 163 plant and exemplary natural community Element Occurrences from the New Hampshire and Vermont lists was conducted to identify those records that occur within the 200-foot riparian zone and floodplains of this study. These data were used to assess the presence of, or the potential for, individual plant or community Element Occurrences. In several instances, new records of several species and communities were noted.

4.6 Invasive and Exotic Species

Non-native invasive plant species were observed and noted within the study area during mapping and field work. A species was considered invasive if it was listed in the The Invasive Plant Atlas of New England (IPANE, 2012; Appendix A).

Some dominant stands of "clumping" invasive species (Phragmites and Japanese knotweed (*Fallopia japonica))* were visible in the aerial photos and could be mapped remotely. Other stands of those species were mapped in the field using a GPS and sketch maps during groundtruthing. Invasive species with more diffuse growing habits were noted for approximate location and by the cover type within which they occurred.

4.7 Wildlife Observations

All wildlife observations and signs were noted during field verification, with particular emphasis on birds and aquatic mammals that could be most influenced by project operations. Species of special interest included waterfowl, wading birds, shorebirds, bank nesting birds, reptiles, and amphibians. Wildlife observations were recorded during field work and if possible, the location, species, age and gender, and activity were noted. Incidental wildlife encountered during other terrestrial field studies (Cobblestone and Puritan tiger beetle (Study 26), Fowler's toad (Study 28), and Northeastern bulrush (Study 29)) were also noted and included in this report.

4.8 Bald Eagle Winter Habitat

The location and condition of existing bald eagle nests within the study area were summarized from data provided by New Hampshire Audubon's ongoing Connecticut River Bald Eagle Restoration and Habitat Protection Project, which is funded by TransCanada (NHA 2012, 2013, 2014). Known and potential bald eagle wintering habitats were assessed using both desktop and field methods. Wintering bald eagles require suitable roost sites and proximity to open water areas that offer foraging opportunities. Suitable roosting habitat in the Northeast generally consists of softwood stands that offer thermal protection from prevailing winds and well-spaced branches that can be easily accessed by eagles in flight. Additionally, stands with an eastern aspect are preferred and stands near human activities are generally avoided. Nearby ice-free water where eagles can forage may also make a stand more attractive for winter roosting (Beuhler, 2000). Ice formation on rivers is governed by a wide range of variables and the location and extent of open water may vary throughout the winter (Normandeau, unpublished data).

One winter roost was identified as an Element Occurrence in the NH NHB data base. To identify additional softwood stands with the potential to offer suitable roosts, softwood stands depicted on the stereo imagery acquired by TransCanada were analyzed for size, density, aspect, and proximity to developed areas. These stands were mapped and then inspected in the field. Field observations were conducted by boat from the river during the 2014 growing season. In the field, the following variables were assessed:

- General stand composition (white pine vs. eastern hemlock, proportion of softwoods vs. hardwoods)
- Average diameter at breast height (DBH) of the trees and average height (visually estimated)
- Access to branches large enough for perching (clear or not)
- Wind protection (large stand, hill behind, or a combination of the two)
- The likely amount of disturbance, and the distance to disturbance sources. The location, type and, severity of disturbance was largely inferred from the desktop aerial photo interpretation and/or by listening to the levels of anthropogenic noise in the vicinity of the stand. The dense softwood stands generally prevented visual assessment of adjacent development.

Based on these variables observed in the field, each assessed stand was categorized as either suitable or unsuitable for winter roosting. Stands that were categorized as suitable were photographed and a GPS point of the location was recorded.

5.0 RESULTS AND DISCUSSION

5.1 Vegetation Mapping and Characterization

5.1.1 Cover Type Map

Natural features and land uses mapped within the study area covered a total of 9,153 acres, and were comprised of upland vegetation cover (62% cover), wetlands and tributary streams (23% cover), developed lands (12% cover), and riverine features (2% cover) (Table 5.1-1).

Upland vegetation cover was predominantly forest (64% cover) followed by agricultural land (29% cover) (Table 5.1-2). Large tracts of deciduous, coniferous, and mixed deciduous and coniferous forest extended across much of the study area. Agricultural uses, primarily cropland and pasture/hayfield, were the predominant cover type over much of the more level terrain adjacent to the river, and especially in the Wilder impoundment. The remaining upland cover was largely shrub communities, maintained grass such as parklands and golf courses, and old fields.

Table 5.1-1. Acreage of cover types and land use by broad categories.

Cover type	Wilder	Wilder Riverine	Bellows Falls	Bellows Falls Riverine	Vernon	Total	% of Total
Upland Vegetated	2296.8	778.1	1139.7	92.0	1449.0	5755.7	62.8
Wetland and Stream	701.5	17.4	737.2	0.7	657.3	2114.2	23.10%
Developed	338.9	180.7	242.5	42.2	305.6	1109.9	12.1
Riverine Features	32.2	58.2	31.4	26.8	25.2	173.8	1.9
Total	**3369.4**	**1034.5**	**2150.9**	**161.8**	**2437.0**	**9153.6**	**100.0**

Wetlands were widely distributed across the study area with the majority consisting of aquatic vegetation (43%), emergent (25% cover), deciduous forested (22% cover) and scrub/shrub (10% cover) cover types (Table 5.1-2). A variety of intermixed cover types and open water comprised the balance (3% cover).

Infrastructure, consisting of dams and dam facilities, boat launches, roads and railroads, comprised the largest single cover type in the developed lands category (Table 5.1-2). Other developed lands within the study area included portions of the municipalities of Bellows Falls and Brattleboro in Vermont, and Hanover and West Lebanon in New Hampshire, as well as residential areas dispersed along the Connecticut River. These areas accounted for the bulk of the commercial, urban, residential and suburban land uses. Sand and gravel mines located in the free-

flowing section of the river downstream of Wilder dam comprised most of the mineral land use.

Riverine features mapped in the study area included steep unconsolidated slopes, eroding banks and river channel features (Table 5.1-2). Most of the eroding banks and steep unconsolidated slopes were associated with the three impoundments. Channel features, including bedrock in the Bellows Falls bypass reach and along the riverbank, boulders and cobble in shallows, and exposed bars of gravel, sand and mud, were concentrated in the free flowing sections of the river downstream of Wilder and Bellows Falls dams.

Table 5.1-2. Acreages of cover types within the 200-foot study area.

Cover Code	Cover type	Wilder	Wilder Riverine	Bellows Falls	Bellows Falls Riverine	Vernon	Total	% of Total
Upland								
H	Hardwood	486.3	379.2	469.8	59.1	812.1	2206.4	24.10%
H/S	Hardwood/softwood	364.3	134.9	193.9	5.7	235.3	934.2	10.21%
S	Softwood	328.2	61.7	69.1	1.2	48.1	508.2	5.55%
SHR	Shrub	126.6	12.2	84.3	6.6	40.9	270.6	2.96%
H/SHR	Hardwood/shrub	3.1	5.2	0.4	0.6	6.1	15.3	0.17%
SHR/G	Shrub/Grassland						0.0	0.00%
OLD FIELD	Old field	21.2	3.5	15.3		2.9	42.9	0.47%
GRASS	Maintained Grassland	62.0	19.9	43.5	1.2	34.2	160.8	1.76%
CROP	Crop	597.3	146.2	188.9	17.6	215.9	1166.0	12.74%
PASTURE	Pasture/hayfield	307.8	15.3	74.6		53.4	451.2	4.93%
	Total	**2296.8**	**778.1**	**1139.7**	**92.0**	**1449.0**	**5755.7**	62.88%
Wetland								
PFO1	Deciduous Forested	141.3	7.7	142.2		124.1	415.3	4.54%
PFO4	Coniferous Forested	0.7				0.0	0.7	0.01%
PFO1/4	Mixed Forested	5.3		0.4		3.6	9.3	0.10%
PFO1/PSS	Deciduous Forested/shrub	1.7		26.8		7.6	36.0	0.39%
PFO1/PEM	Deciduous Forested/Emergent			1.0		0.7	1.7	0.0%
PSS	Scrub-shrub	48.3	1.8	35.3		33.9	119.3	1.30%
PSS/PEM	Scrub-shrub/Emergent	25.6	0.6	16.1		7.9	50.3	0.55%
PEM	Emergent	133.1	4.7	241.0		108.2	486.9	5.32%
PEM5	Phragmites	7.3		4.7		22.8	34.8	0.38%
PERENN	Perennial Stream	7.1	1.9	4.6	0.7	10.9	25.2	0.27%
INTERMIT	Intermittent Stream	1.2	0.4	1.9		2.1	5.6	0.06%
PUB	Pond	11.6		3.7		7.1	22.4	0.25%
PVP	Possible vernal pool	0.5	0.3	1.3		1.5	3.6	0.04%
PAB/RAB	Submerged Aquatic Vegetation	318.0	0.0	258.3	0.0	326.9	903.2	9.87%
	Total	**383.5**	**17.4**	**478.9**	**0.7**	**330.4**	**1211.0**	23.10%

Cover Code	Cover type	Wilder	Wilder Riverine	Bellows Falls	Bellows Falls Riverine	Vernon	Total	% of Total
Developed								
Comm	Commercial	47.5	47.4	31.3	24.1	73.4	223.7	2.44%
Res	Residential	135.5	36.6	108.9	1.0	81.7	363.6	3.97%
Sub	Suburban			9.3		19.2	28.5	0.31%
Mineral/dams	Dams	1.4	25.8	3.4		2.1	32.8	0.36%
Infra	Infrastructure	154.6	70.9	89.6	17.0	129.1	461.3	5.04%
	Total	**338.9**	**180.7**	**242.5**	**42.2**	**305.6**	**1109.9**	12.13%
Riverine Features								
Ledge	Bedrock ledge	0.2	4.1	0.5	20.1	2.1	26.9	0.29%
Rocky	Rocks and Boulders	0.4	3.1	0.2		1.9	5.6	0.06%
Gravel	Gravel	0.3	19.0	1.9	6.8	3.5	31.6	0.34%
Sand-mud	Sand-mud	0.9	27.3	2.7		10.3	41.1	0.45%
Riverbank	Riverbank	9.2	4.5	18.9		5.7	38.3	0.42%
Eroding bank	Eroding bank	20.9		7.2		1.4	29.5	0.32%
Riprap	Riprap	0.3	0.2			0.3	0.9	0.01%
	Total	**32.2**	**58.2**	**31.4**	**26.8**	**25.2**	**173.8**	1.90%
Grand Total		3369.4	1034.5	2150.9	161.8	2437.0	9153.6	**100.0%**
% of Total		36.81%	11.30%	23.50%	1.77%	26.62%	100.00%	

5.1.2 Vegetation Community Characterization

Hardwood Forest

Upland Hardwood

Upland hardwood forest was the predominant cover type in the study area and was most abundant within the Vernon impoundment (Table 5.1-1). The forest canopy was composed of a relatively homogenous group of trees dominated by sugar maple (*Acer saccharum*), northern red oak (*Quercus rubra*), American beech (*Fagus grandifolia*), and basswood (*Tilia americana*). Other common overstory species included big-tooth aspen (*Populus grandidentata*), paper birch (*Betula populifolia*), red maple (*Acer rubrum*), yellow birch (*Betula allegheniensis*), American hornbeam (*Carpinus caroliniana*), bitternut hickory (*Carya cordiformis*) and black birch (*Betula lenta*).

Shrubs were generally sparse with the exception of the invasive species glossy buckthorn (*Frangula alnus*) and bush honeysuckle (*Lonicera spp.)* at a few sites. However dense growths of saplings, particularly American beech, were sometimes present. The herbaceous component was diverse and included wild-lily-of–the-valley (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), sensitive fern (*Onoclea sensibilis*), ostrich fern (*Matteuccia struthiopteris*), white wood aster (*Eurybia divaricata*), marginal woodfern (*Dryopteris marginalis*), rough horsetail (*Equisetum hymale*), hayscented fern (*Dennsteadtia punctilobula*), New York fern (*Parathelypteris noveboracensis*) and hog peanut (*Amphicarpaea bracteata*).

The majority of the upland hardwood forest was at a mid-successional stage, with most trees at an intermediate age and height, a few large trees and a limited shrub and sapling layer. The canopy reached heights of 60 to 90 feet and canopy closures ranged from 60 to 90 percent. Structural diversity and patchiness were generally moderate to high. Few snags were present. Fine litter consisted of several inches of twigs and leaves and coarse litter, when present, was made up of many deadfalls and downed limbs. Most of this cover type was relatively high in elevation and showed little evidence of flood scour or deposition.

Riparian Hardwood

Riparian hardwood forest differed from upland hardwood forest primarily in respect to plant species and the potential for flooding. Typically, dominant canopy species in this cover type included silver maple (*Acer saccharinum*), eastern cottonwood (*Populus deltoides*), slippery elm (*Ulmus rubra*), green ash (*Fraxinus pennsylvanica*), and boxelder (*Acer negundo*). Bush honeysuckle and glossy buckthorn were common in the understory, and cinnamon fern (*Osmunda cinnamomea*), Japanese knotweed (*Fallopia japonica*), ostrich fern, and rough horsetail were abundant in the herbaceous layer. These forests appeared to be flooded on a seasonal or annual basis. As evidence of the river's influence on these communities, fine litter was absent or sparse in areas subject to periodic flooding but was replaced by alluvial sediment deposits. Coarse litter was abundant in the form of trees, limbs and other wrack washed in during high water events.

Mixed Hardwood/Softwood Forest

Upland hardwood/softwood forest was also common in the study area and was most abundant in the reach encompassing the Wilder impoundment and the free flowing section of the river downstream of Wilder Dam (Table 5.1-2). White pine (*Pinus strobus*) and eastern hemlock (*Tsuga canadensis*) made up the softwood component of the canopy, and the hardwoods were predominantly northern red oak and sugar maple. In addition, many other canopy species from the hardwood cover type were present including American beech, paper birch, red maple, yellow birch, bitternut hickory and black birch.

The understory was generally lacking in shrubs with the exception of glossy buckthorn and witch hazel (*Hamamelis virginiana*). However, saplings of striped maple (*Acer pennsylvanicum*), American beech and other canopy species were abundant in many areas. The herbaceous layer was diverse but sometimes sparse or patchy. Frequently occurring species included cinnamon fern, evergreen woodfern (*Dryopteris intermedia*), Christmas fern (*Polystichum acrostichoides*), poison ivy (*Toxicodendron radicans*), and lady fern (*Athyrium felix-femina*). Many hardwood forest herbs were also present such as wild lily-of–the-valley, marginal woodfern, New York fern, ostrich fern, hayscented fern, wild sarsaparilla, and hog peanut.

Most of this cover type was at a mid-successional stage with most trees at an intermediate age and height, a few large trees and a limited shrub and sapling layer. Canopy species reached heights of 80 to 100 feet and canopy closures ranged from 60 to 90 percent. Structural diversity was generally moderate to high and patchiness was low to moderate. A few snags occurred in this cover type. Fine litter was comprised of up to several inches of leaves, and coarse litter ranged from a few to many deadfalls and downed limbs. Nearly all of this cover type was located on higher elevation terraces and slopes with little evidence of flood scour or deposition.

Softwood Forest

Softwood forest was very abundant along the periphery of the Wilder impoundment. The largest expanse of this cover type was along the eastern side of the impoundment between the dam and Hanover, New Hampshire. Softwood forest was overwhelmingly dominated by eastern hemlock and white pine, and many times included a variety of common hardwood species. Due to the dense canopy cover, the understory and herbaceous layers were usually very sparse. As a result, this vegetation was limited to a few saplings of eastern hemlock and American beech along with scattered herbs such as wild lily-of-the-valley and evergreen woodfern.

Most of this cover type was at a medium successional stage with most trees at an intermediate age and height, a few large trees and a limited shrub and sapling layer. Canopy species reached heights of 60 to 100 feet and canopy closures were 80 percent or higher. Structural diversity and patchiness were low due to the generally homogenous canopy, and lack of shrub and herbaceous cover. Snags were either absent or few in number. Fine litter was composed of several inches of leaves, and coarse litter ranged from a few to many deadfalls and downed limbs.

Most of this cover type was located on steep slopes and terraces with little evidence of flood scour or deposition.

Emergent Wetlands

Emergent marshes were the most abundant wetland cover type in the study area and were located in coves, protected shorelines, old river channels and deltas at the mouths of tributary streams (Table 5.1-2). Emergent wetlands in the Wilder impoundment were located primarily in the upstream reach from the vicinity of Fairlee, Vermont to Bradford, Vermont. At Bellows Falls, which accounted for nearly 50 percent of the study area total for this cover type, large expanses of emergent wetlands were present in the lower third of the impoundment. In the Vernon impoundment, this cover type was found primarily in the broad delta at the mouth of the West River and downstream of Brattleboro.

The larger emergent wetland stands were vegetated by dense stands of broad-leaved cattail (*Typha latifolia*) and softstem bulrush. Other dominant emergents included rice cutgrass (*Leersia orizoides*), woolgrass (*Scirpus cyperinus*), American bur-reed (*Sparganium americanum*), water-horsetail (*Equisetum fluviatile*), narrow-leaf cattail (*Typha angustifolia*), pickerel weed, duck potato, and numerous sedges including fringed sedge (*Carex crinita*), hop sedge (*Carex lupulina*), and soft fox sedge (*Carex conjuncta*). Invasive non-native wetland species such as reed canary grass, purple loosestrife (*Lythrum salicaria*), and Phragmites (*Phragmites australis*) were also abundant (see Section 5.4). In particular, large stands of Phragmites were intermixed with native emergent cover in the lower section of the Vernon impoundment.

Emergent wetlands were typically located within one foot of estimated high water levels and were typically saturated or subject to frequent flooding. Water stains on the stems indicated that the marshes were periodically inundated from 6 to 18 inches. Overall structural diversity and patchiness tended to be low due to the relatively uniform cover of many wetlands. Litter was absent or minimal and was composed of small amounts of herbaceous material and woody debris deposited as wrack. Substrates were largely silt and sand with moderate accumulations of organic matter, and were characterized by gleying, low chroma matrix colors, and redox concentrations, which were indicative of hydric conditions.

Scrub/shrub Wetlands

The distribution of scrub/shrub wetlands in the study area was similar across the impoundments and occurred in backwaters, along shorelines, on islands and peninsulas, and in the lower reaches of tributary streams (Table 5.1-2). This cover type was found throughout the Wilder impoundment but primarily in the lower half of the Bellows Falls and Vernon impoundments.

Much of the scrub/shrub cover was dominated by the invasive non-native glossy buckthorn; however, speckled alder (*Alnus incana*), black willow (*Salix nigra*), and silky dogwood (*Cornus amomum*) were also common. Canopy height ranged from six to 20 feet and canopy cover ranged widely from 20 to 100 percent. The overall herbaceous component was relatively diverse and consisted of species such as wrinkled goldenrod (*Solidago rugosa*), jewelweed (*Impatiens capensis*), false nettle

(*Bohmeria cylindrica*), cleavers (*Galium aparine*), common horsetail (*Equisetum pretense*), meadow horsetail (*Equisetum arvense*), climbing nightshade (*Solanum dulcumara*), giant goldenrod, sensitive fern, and ostrich fern. Structural diversity and patchiness were low in areas of dense shrub cover, but were moderate to high in the communities with more open cover that enabled a more robust herbaceous growth.

This cover type was frequently located slightly higher in elevation above the emergent marshes, but still showed signs of frequent inundation as exhibited by multiple wrack lines and water stains on lower trunks and leaves. In larger coves, the scrub/shrub cover type often formed a band between the emergent marshes and the upland or forested wetland. The substrate ranged from silt to sandy-silt and soil characteristics were indicative of hydric conditions. Litter was generally minimal; however, wrack made up of herbaceous plant material and small to medium sized woody debris was present in a few areas.

Scrub/shrub and Emergent Wetlands

The scrub/shrub and emergent wetlands cover type comprised a small component of the overall wetland acreage and was found in backwaters, along the river shoreline, and adjacent to tributary streams (Table 5.1-2). The majority was concentrated within the Wilder impoundment but was otherwise geographically distributed across the study area in a pattern that was very similar to that of scrub/shrub wetlands. Scrub/shrub and emergent wetlands were very similar to scrub/shrub wetlands in respect to plant cover, canopy height, and substrate. Presumably the hydrologic regime was intermediate between emergent marsh and scrub/shrub wetlands. A few new dominant plant species were noted including wild raisin (*Viburnum cassinoides*), purple loosestrife, and forget-me-not (*Myosotis scorpiodes*). However, the major difference was that the scrub/shrub and emergent cover typically had a more open canopy that enabled a more diverse and robust herbaceous component. This enhanced herbaceous cover in combination with an intermixing of shrub/shrub and emergent cover tended to result in higher structural diversity and patchiness.

Deciduous Forested Wetlands

Deciduous forested wetlands were the second-most abundant cover type in the study area (Table 5.1-2). These wetlands were evenly distributed across the three impoundments and were generally found in medium to large tracts in backwaters, along point bars, and in the lower reaches of tributary streams. These wetlands were found in the upper reaches of the Wilder impoundment, largely in the lower part of the Bellows Falls impoundment, and throughout the Vernon impoundment.

This cover type was characteristic of the floodplain forest communities that are found along large northeastern rivers. Eastern cottonwood, silver maple, boxelder, green ash, and slippery elm were prominent in the overstory, and saplings of these species were also common in the understory. Ostrich fern was particularly abundant in the herbaceous cover which also included sensitive fern, jewelweed, rough horsetail, and Canada nettle (*Laportia canadensis*). In addition, non-native

invasive plants such glossy buckthorn, stilt grass, and Japanese knotweed were present in abundance at some locations.

The deciduous forested wetlands were at an early to mid-successional stage. Canopy species reached heights of 60 to 80 feet and canopy closures ranged widely from 30 to 80 percent. Structural diversity was generally moderate and patchiness was generally low. Snags were few. Fine litter consisted of leaves and herbaceous plant debris. Coarse litter was common and included deadfalls and downed limbs as well as woody debris and herbaceous material deposited as wrack. Substrates were mostly silt and indicative of hydric soil conditions. Most of this cover type appeared to be periodically flooded as indicated by alluvial soil that had been deposited at one site by a recent high water event. However, some of these wetlands were located at higher elevations and were more likely to be flooded on a less frequent basis.

Deciduous Forested and Scrub/shrub Wetlands

The deciduous forest and scrub/shrub wetland cover type formed a small part of the total study area wetlands, and was associated with backwater areas and tributary streams (Table 5.1-2). Three-quarters of the total acreage was located in the lower part of the Bellows Falls impoundment and most of the remainder was spread out across the lower half of the Vernon impoundment. The Wilder impoundment contained just a fraction of this cover type.

Vegetation cover was a mixture of common species with silver maple, red maple green ash, eastern cottonwood, and American sycamore (*Platanus occidentalis*) in the overstory; glossy buckthorn in the understory; and an herbaceous cover of ostrich fern, moneywort (*Lysimachia nummularia*), and sensitive fern. Glossy buckthorn overwhelmingly dominated the shrub layer of this cover type and this characteristic was the main difference between the deciduous forested wetlands, and deciduous forested and scrub/shrub wetlands.

This cover type was at an early to mid-successional stage with canopy heights of 60 to 90 feet and canopy closures of 60 to 80 percent. Structural diversity ranged from medium to high and patchiness ranged from low to high. Very few snags were present. Fine litter consisted of a thin cover of leaves and coarse litter when present, and was composed of scattered deadfalls and downed limbs. Substrates were silt and sandy-silt, and indicative of hydric soil conditions. Elevations of these wetlands relative to the estimated high water level ranged from 1 foot or less up to 3 feet, but all appeared to be periodically flooded based on evidence of scour and flood debris.

Aquatic Bed

The aquatic bed cover type was the most abundant wetland cover type, comprising 903 acres (Table 5.1-2). Aquatic beds were typically composed of floating and submerged aquatic vegetation and grew abundantly in shallow water zones in the lower ends of all three impoundments as well as in the mouths of the larger tributary streams. Aquatic bed vegetation also occurred in the upper reaches of the impoundments as small patches and narrow discontinuous bands in shallow water along the edges of the river. Many of these more riverine aquatic beds were too

small to map. Most species were found in all three impoundments and many of the same species predominated in the three impoundments including white water lily (*Nymphaea odorata*), Eurasian water-milfoil (*Myriophyllum spicatum*), water celery (*Vallisneria americana*), waterweed (*Elodea canadensis*), and water stargrass (*Heteranthera dubia*). Also common were coontail (*Ceratophyllum demersum*), chara (*Chara vulgaris*), clasping-leaved pondweed (*Potamogeton perfoliatus*), large-leaved pondweed (*Potamogeton amplifolius*), snailseed pondweed (*Potamogeton spirillus*), and brittle naiad (*Najas flexilis*). Emergent wetland plants such as pickerel weed (*Pontederia cordata*), duck potato (*Sagittaria latifolia*), soft-stem bulrush (*Schoenoplectus tabernaemontani*), and wild rice (*Zizania palustris*) were common in shallow water along the margins of this cover type.

Aquatic beds typically were found in silty-sandy substrates, with vegetative cover varying from dense floating and mid-column cover with 100 percent canopy closure to relatively sparse cover with little or no floating-leaved canopy. Species composition varied between areas and was influenced by factors such as water depth and current. For example, white water lily was usually found in more protected areas with slower currents and shallow depths, whereas water celery was able to grow abundantly in areas with faster currents to observed water depths of up to eight feet.

Riverbank

The upland riverbank cover type was typically located along the river at the edge of an agricultural field. Most of these areas were regularly to annually flooded and actively eroding along the base. Vegetation cover was frequently uncommon at the base of the bank within the zone that appeared to correspond with water level fluctuations associated with project operations. The vegetation became more dense above that zone, and typically consisted of early successional species. This cover type resembled an old field community but included both upland and hydrophytic plants. Invasive plant species were often found along the riverbanks. Commonly occurring species were boxelder, staghorn sumac (*Rhus typhina*), bush honeysuckle, multiflora rose (*Rosa multiflora*), Canada goldenrod (*Solidago canadensis*), rough bluegrass (*Poa trivialis*), evening primrose (*Oenothera biennis*), giant goldenrod (*Solidago gigantea*), crown-vetch (*Securigera varia*), and reed canary grass (*Phalaris arundinacea*). Upland riverbanks were also characterized by silty and sandy substrates, an absence of litter, and low structural diversity and patchiness. Some of the riverbank communities included steep slopes, occasionally undercut at the top of the bank, that provided nesting locations for belted kingfishers (*Ceryle alcyon*) and bank swallows (*Riparia riparia*).

In Bellows Falls impoundment, the riverbank often consisted of a near monoculture of reed canary grass, starting at the lower vegetated edge and extending between 5 and 8 feet upslope. Along the free flowing reach of the river below Wilder Dam, the riverbank was typically dominated by common scrub/shrub and emergent wetland species. Plant species present included speckled alder, heart-leaved willow (*Salix rigida*), blue joint (*Calamagrostis canadensis*), deer tongue grass (*Dichanthelium clandestinum*), reed canary grass, meadow horsetail, fringed sedge, and purple loosestrife. This cover type began at the lower vegetated edge and extended 10 to 15 feet upslope. The shoreline along this zone was frequently rocky

and deposits of various sized drift wood and other wrack were common. Of particular note was the abundance of obedient plant (*Physostegia virginiana*) that were observed in bloom along the lower scour zone on both the Vermont and New Hampshire shorelines in the riverbank cover type (see Appendix B).

5.2 Floodplains

Approximately 3,218 acres of floodplains were delineated based on a combination of elevation and evidence of flooding (Table 5.2-1). In most areas, floodplains extended beyond the 200-foot study zone (see example in Panel 6 of the Maps). Floodplains were more prevalent along the shores of the three impoundments compared to the riverine sections. Almost half of all floodplains occurred in Bellows Falls impoundment. Wilder and Vernon impoundments had approximately 28% and 24% of the total floodplains, respectively.

Table 5.2-1. Acres of floodplain in the study area.

Floodplains	Wilder	Wilder Riverine	Bellows Falls	Bellows Falls Riverine	Vernon	Total	Percent of Total
Upland							
Natural	209.9	7.1	233.8	8.3	176.5	635.1	19.7%
Agriculture	178.7		498.9	27.3	3.6	860.0	26.7%
Wetland	493.1	6.9	715.1	3.9	174.3	1,548.2	48.1%
Developed	6.8		51.6		16.8	149.6	4.7%
Riverine	3.8	0.7	8.4	3.3	339.8	25.2	0.8%
Acres	892.2	14.7	1,507.7	42.8	760.6	3218.1	100.0%
Percentage of Total	27.7%	0.5%	46.8%	1.3%	23.6%	100.0%	

The cover types of the floodplains were predominantly in natural cover or agriculture; approximately 48% were in wetland cover, 27% were in agriculture, and 20% were in natural upland cover. Developed land uses formed a minor component (<5% cover, primarily in Vernon impoundment). Typically, floodplains were confined to less than ten feet above the local scour zone, which was assumed to represent average high water. The floodplains were relatively flat, and often showed flooding features such as wet depressions and evidence of scour and deposition. In some instances, evidence of flooding on the aerial photos indicated floodplains occurred above the relative ten foot contour and were consequently included in the study.

5.3 Wetland Assessment

Function and values assessments (Section 4.4) were performed for the six most common wetland types in the study area to determine the principal functions and values provided by each of these habitats. Study area wetlands provide all of the 13 functions and values evaluated by the Highway Methodology; however, not all of them occurred at a principal level (Table 5.3-1). Widely occurring principal

functions consisted of flood flow alteration, sediment/toxicant retention, nutrient removal, sediment/shoreline stabilization, and wildlife habitat. Occurring less commonly at a principal level were the groundwater recharge/discharge, fish/shellfish habitat and production export functions, and the visual quality/aesthetics value. The recreation, educational/scientific, and uniqueness/heritage values were not determined to occur at a principal level in any of the study area wetlands.

Emergent wetlands provide the most functions at a principal level in the study area followed by aquatic bed, scrub/shrub, and forested wetlands, which provide many of the same functions at principal levels. Scrub/shrub-emergent and forested-scrub/shrub wetlands provide the least number of principal functions, but are also uncommon habitats in the study area, and therefore, fewer of these habitats were available for assessment.

Table 5.3-1. Wetland functions and values provided by predominant wetland cover types in the study area.

Wetland Functions	**Aquatic Bed**	**Emergent**	**Scrub/Shrub**	**Scrub/Shrub Emergent**	**Forested**	**Forested Scrub/Shrub**
Groundwater Recharge/Discharge		✓		✓		
Flood flow Alteration		✓	✓	✓	✓	✓
Fish and Shellfish Habitat	✓	✓				
Sediment/ Toxicant Retention	✓	✓	✓		✓	✓
Nutrient Removal	✓	✓	✓		✓	
Production Export	✓	✓				
Sediment/Shoreline Stabilization	✓	✓	✓	✓	✓	
Wildlife Habitat		✓	✓		✓	✓
Wetland Values						
Recreation	These values are not provided at a Principal level by any wetland type.					
Educational/ Scientific Value						
Uniqueness/ Heritage						
Visual Quality/Aesthetics	✓	✓				
Endangered Species Habitat	✓	✓	✓		✓	

The portion of the Connecticut River watershed that drains to the project-affected area is heavily forested but also includes a considerable amount of agricultural land and urban and suburban lands. Together, these land uses and associated impervious surfaces result in an increased volume of storm runoff containing sediment, nutrients, toxicants and other contaminants. These same land uses

occur within the project-affected area along with several municipal sewage treatment plants that discharge to the Connecticut River, and are the justification for many of the wetland types having a principal rating for the sediment/toxicant retention, nutrient removal, and sediment/shoreline stabilization functions. These ratings were concentrated within the emergent and aquatic bed wetland types, which are regularly or continually in contact with river water, and predominate in the zone affected most by natural flooding and hydropower related water fluctuations. Similarly, principal ratings were given to a number of woody wetlands for the sediment/shoreline stabilization and/or flood flow alteration functions. These wetlands were located in landscape positions that were suitable for these functions such as along the river shoreline or along tributaries.

Aquatic bed and emergent wetland types accounted for all the principal ratings for the fish/shellfish habitat and production export functions. The lower reaches of all three impoundments, in particular, were characterized by a lush growth of aquatic and emergent wetland vegetation, which provides abundant biomass for the riverine food web as well as spawning, nursery and foraging areas for a wide variety of fish and invertebrates.

All of the study area wetlands provide some degree of wildlife habitat and especially as part of larger surrounding upland/wetland habitat complexes. Forested wetlands scored the most principal ratings for this function due to the generally large extent and structural diversity of these habitats.

Wetland values were provided by many of the wetlands, but not at the principal level except for the visual quality/aesthetics value for aquatic beds and emergent marshes. This principal rating resulted from the widespread abundance of the visually appealing white water lily (*Nymphaea odorata*), which is a floating-leaved aquatic plant that occurred in large numbers throughout the aquatic bed wetlands in the lower reaches of the impoundments and which was visible from many locations. Many of the large emergent wetlands were also ascribed a principal level for visual quality/aesthetic value due to their diversity of structure in the predominantly forested landscape of the region.

5.4 Rare, Threatened, and Endangered Species

Of the 163 Element Occurrences remaining on the VTNHI and NHNHB lists that were not included (due to position, rank or elevation) in the 2012 rare plant survey (Normandeau 2013a), 88 had been located since 1990 and 75 had not been observed since that date. This study's analysis focused on the 88 more recent (post-1990) observations. Of the 88 recent Element Occurrences, 46 occurred within the 2014 Study Area, and 42 occurred more landward of it. Seven Element Occurrences were confirmed during the 2014 field verification, including five silver maple-wood nettle-ostrich fern floodplain communities, and two rare species, black maple (*Acer nigrum*) and obedient plant (*Physostegia virginiana*). Another Element Occurrence of silver maple-wood nettle-ostrich fern floodplain community recorded in the study area was noted within a very marginal cover type of mixed hardwood and conifers. Located in association with a small drainage, this Element Occurrence was determined to be too small and too marginal to include as a

confirmed record. A larger component of the community may occur further inland (outside of the study area), but it was not surveyed.

Table 5.4-1. Rare species and exemplary community survey results from the 2012 rare vegetation survey (Normandeau, 2013a) and the 2014 habitat mapping effort.

State	2012 Survey	2014 Survey				Total
		Recent EOs within Study Area			Historic EOs	
		Confirmed	Did not check	Outside Study Area		
NH	118	5	32	29	50	234
VT	64	2	7	13	25	111
Total	182	7	39	42	75	345

In addition to the recorded obedient plant Element Occurrence, this species was frequently observed on much of the riverbank and on many of the sparsely vegetated bars within the study area during both the 2012 (Normandeau 2013a) and 2014 field surveys.

5.5 Invasive and Exotic Species

Invasive species are very prevalent throughout the Connecticut River valley, as indicated by the Invasive Species Atlas (IPANE 2012), and were observed in abundance along the banks and in most vegetation communities along the study corridor. Twenty-seven plant species designated as invasive, non-native species and one additional plant considered potentially invasive were documented in the study area as a result of this study's habitat mapping and the 2012 rare species and exemplary community survey (Normandeau, 2013a). Over 163 acres of discrete stands of invasives were mapped. The majority of species occurred in more than one impoundment (Table 5.5-1). The most abundant and widely distributed species were Phragmites (*Phragmites australis*), Japanese knotweed (*Fallopia japonica*), purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), bush honeysuckles (*Lonicera* sp.), glossy buckthorn (*Frangula alnus*), oriental bittersweet (*Celastrus orbiculatus*), and Eurasian water-milfoil (*Myriophyllum spicatum*). Phragmites, purple loosestrife, and reed canary grass are typically found in wetlands while Eurasian water-milfoil is an aquatic plant. Japanese knotweed and oriental bittersweet are typically upland species, and glossy buckthorn grows equally well in both wetlands and uplands.

Table 5.5-1. Invasive plants observed in the study area.[a]

Common Name	Scientific Name	Location	Growth Form
Climbing nightshade	*Solanum dulcamara*	Vernon, Wilder	Herb
Black locust	*Robinia pseudoacacia*	Vernon	Tree
Brittle naiad	*Najas minor*	Bellows, Wilder	Submerged Aquatic
Bush Honeysuckles	*Lonicera morrowii/tartarica*	All impoundments	Shrub
Canada bluegrass [b]	*Poa compressa*	Study area	Forb
Coltsfoot	*Tussilago farfara*	Bellows	Herb
Common buckthorn	*Rhamnus cathartica*	Vernon, Wilder	Tree
Phragmites	*Phragmites australis*	All impoundments	Forb
Crown-vetch [c]	*Securigera varia*	Wilder	Herb
Dames Rocket	*Hesperis matronalis*	Wilder riverine	Herb
Eurasian water-milfoil	*Myriophyllum spicatum*	All impoundments	Submerged Aquatic
Forget-me-not	*Myosotis scorpiodes*	All impoundments	Herb
Garden Loosetrife [b]	*Lysimachia vulgaris*	Study area	Herb
Glossy Buckthorn	*Frangula alnus*	All impoundments	Shrub
Japanese Barberry	*Berberis thunbergii*	All impoundments	Shrub
Japanese Knotweed	*Fallopia japonica*	All impoundments	Herb
Japanese Stilt grass	*Microstegium vimineum*	Wilder riverine	Forb
Mile-a-Minute vine	*Persicaria perfoliata*	All impoundments	Vine
Moneywort	*Lysimachia nummularia*	Vernon, Bellows	Herb
Multiflora Rose	*Rosa multiflora*	All impoundments	Shrub
Oriental Bittersweet	*Celastrus orbiculatus*	All impoundments	Vine
Purple Loosestrife	*Lythrum salicaria*	All impoundments	Herb
Reed Canary Grass	*Phalaris arundinacea*	All impoundments	Forb
Russian Olive	*Elaeagnus angustifolia*	Wilder	Shrub
Spotted knapweed	*Centaurea biebersteinii*	Vernon	Herb
Swallow-wort [b]	*Cynanchum cf louisaea*	Study area	Vine
Winged euonymus (Burning bush)	*Euonymus alata*	Vernon	Shrub
Yellow Flag Iris	*Iris pseudacorus*	All impoundments	Herb

a. Invasive Plant Atlas of New England (IPANE), 2014.
b. Observed in the study area during the 2012 rare, threatened, and endangered plant and exemplary natural community field surveys (Normandeau, 2013a).
c. New Hampshire Department of Agriculture List of Restricted Species (Watch List).

Japanese knotweed was the most widespread species, with dense stands mapped along the shoreline and on islands throughout the study area and in a variety of habitats. Seventy-nine acres were mapped in the field. In areas with minimal canopy, this species was mapped in well-defined stands. It was common along the edges of agricultural fields bordering the river, on riverbanks, and disturbed slopes. It also occurred as discrete smaller patches within larger, typically forested plant communities. In these locations, the stands were noted but not mapped.

Approximately 35 acres of Phragmites-dominated scrub/shrub and emergent cover were mapped in the study area. This species forms clonal stands in herbaceous wetlands, frequently forming dense monocultures to the exclusion of native species. These larger stands were most prevalent in the extensive emergent wetlands found

in the lower reaches of Vernon impoundment. Approximately two-thirds of the Phragmites found in the study area occurred in Vernon (22.8 acres), with lesser amounts, and smaller stands in Wilder (7.3 acres) and Bellows Falls (4.7 acres). Additional smaller stands were occasionally observed during field surveys, but were too small to be mapped. These smaller stands were more frequent in the middle reaches of Bellows Falls and Vernon impoundments. This species was relatively infrequent on the riverine reaches.

Purple loosestrife was widespread in a variety of open habitats throughout the study area, including emergent wetlands, riverbanks, and gravel bars. Where it occurred, this species was typically low in density, and seldom dominated the plant community.

Reed canary grass was also widely distributed throughout the study area in dense, small patches, predominantly on riverbanks and in emergent and scrub/shrub wetlands. Forget-me-not was also prevalent on many riverbanks and wetland edges throughout the study area.

Common invasive shrub species included the bush honeysuckles, glossy buckthorn, multiflora rose, and Japanese barberry. One or more of these species were encountered in most forested and shrub stands, including both wetlands and uplands. The distribution within a cover type was typically diffuse, but occasionally stands of an acre or more were observed, such as the dense cover of Japanese barberry on Stebbins Island.

Oriental bittersweet occurred along much of the riverbank throughout the forested cover types. It was prevalent in both wetlands and uplands, forming dense, climbing vines in the tree canopy. This is a light-limited species, and as such, became less dense or absent in the interior of the more shaded interiors of forest stands.

Eurasian milfoil was prevalent in all three impoundments, particularly in quiet coves. Where it occurred, it tended to be abundant and dominated the mid-column flora. Brittle naiad was also widespread in quiet coves.

5.6 Bald Eagle Nesting and Winter Roosting Habitat

In the 2014 breeding season, NHA documented nine nests within the study area, eight of which were active (NHA 2014a). This was an increase from six nests (five active) in 2012 when NHA began tracking nests on the Connecticut River, and seven nests (six active) in 2013. Productivity of the nests in the study area was 0.8, 0.7, and 0.6 fledged young per nest in 2012, 2013, and 2014, respectively. While the overall productivity of these nest is lower than for nests throughout the entire watershed (NHA 2012, 2013, 2014a), the decrease in 2014 was reflected across the entire watershed. Cold weather and heavy snow in March likely depressed hatching rates throughout Vermont and New Hampshire in 2014.

The current active nests are located in Piermont, Plainfield, and Hinsdale (two nests), NH; and in Newbury, Hartford, Rockingham, and Dummerston, VT (Table 5.6-1). All known locations of nests are within approximately 125 feet of the Connecticut River shoreline.

Table 5.6-1. Bald eagle nest tree locations and conditions, based on NHA data (NHA, 2014b).

Town	Dist to River	Setting	Tree Type	Tree Condition	DBH	Predator Guard?	Years Active
Newbury, VT	~ 200 ft	Bank Tributary	White Pine	Live	Unknown	No	2012, 2013, 2014
Piermont, NH	Unknown	Unknown	Unknown	Unknown	Unknown	No	2014
Hartford, VT	>25 ft	River bank	White Pine	Live	unknown	No	2012, 2013, 2014
Plainfield, NH	~ 25 ft	River bank	White Pine	Live	unknown	No	2012, 2013, 2014
Claremont, NH	>25 ft	River bank	White Pine	Live	unknown	No	none
Rockingham, VT	>125 ft	Upland	Cottonwood	Live	unknown	yes	2012, 2013, 2014
Dummerston, VT	>25 ft	River bank	White Pine	Dead	unknown	no	2014
Hinsdale, NH	>100 ft	Small island	White Pine	Live	unknown	no	2014
Hinsdale, NH	~125 ft	Upland	White Pine	Live	25 inches	yes	2012, 2013, 2014

The precise location of the Piermont nest is unknown, though activity of adults and fledgling indicate that it is in a stand of white pine on an oxbow. There are no conserved lands within 250 feet of any nest, but five of the known locations are essentially on the river bank, which is partially protected from new development by statute in both Vermont and New Hampshire. The two active nests in Hinsdale are located on land that is also essentially undevelopable. Of the known-location, active nests, six are in live white pines, one is in a dead white pine, and one is in a live cottonwood. The diameter of the nest tree at breast height is available for only one tree. Predator guards have been placed on two nest trees (Table 5.6-1).

The NHNHB data identified one known winter roosting area within the study area, located in Hinsdale, NH, near Vernon Dam. Aerial photo interpretation followed by field verification identified 12 additional softwood stands that appear to offer suitable winter roosting conditions: six in Vermont; and six in New Hampshire (Figure 5.6-1). They are all located essentially on the riverbank, with two located on tributary inlets (Mink Brook and Clay Brook) and two located on islands (Gilman Island, and an unnamed island in Lyme, New Hampshire). These potentially suitable winter roosting sites are relatively evenly distributed throughout the study area, and although the distribution is not extensive in comparison to the entire size of the study area, winter roosting habitat is unlikely to be a limiting resource. Bald eagles are highly mobile using multiple roosts in the course of a winter, and communal roosting behavior is common (Beuhler, 2000). Use of a particular potentially suitable stand would likely in part be a function of the amount and

location of winter open water on the river. The known winter roosting area mapped by NHNHB is located directly below Vernon Dam, where dam operations likely maintain open water across a range of winter temperature and weather conditions.

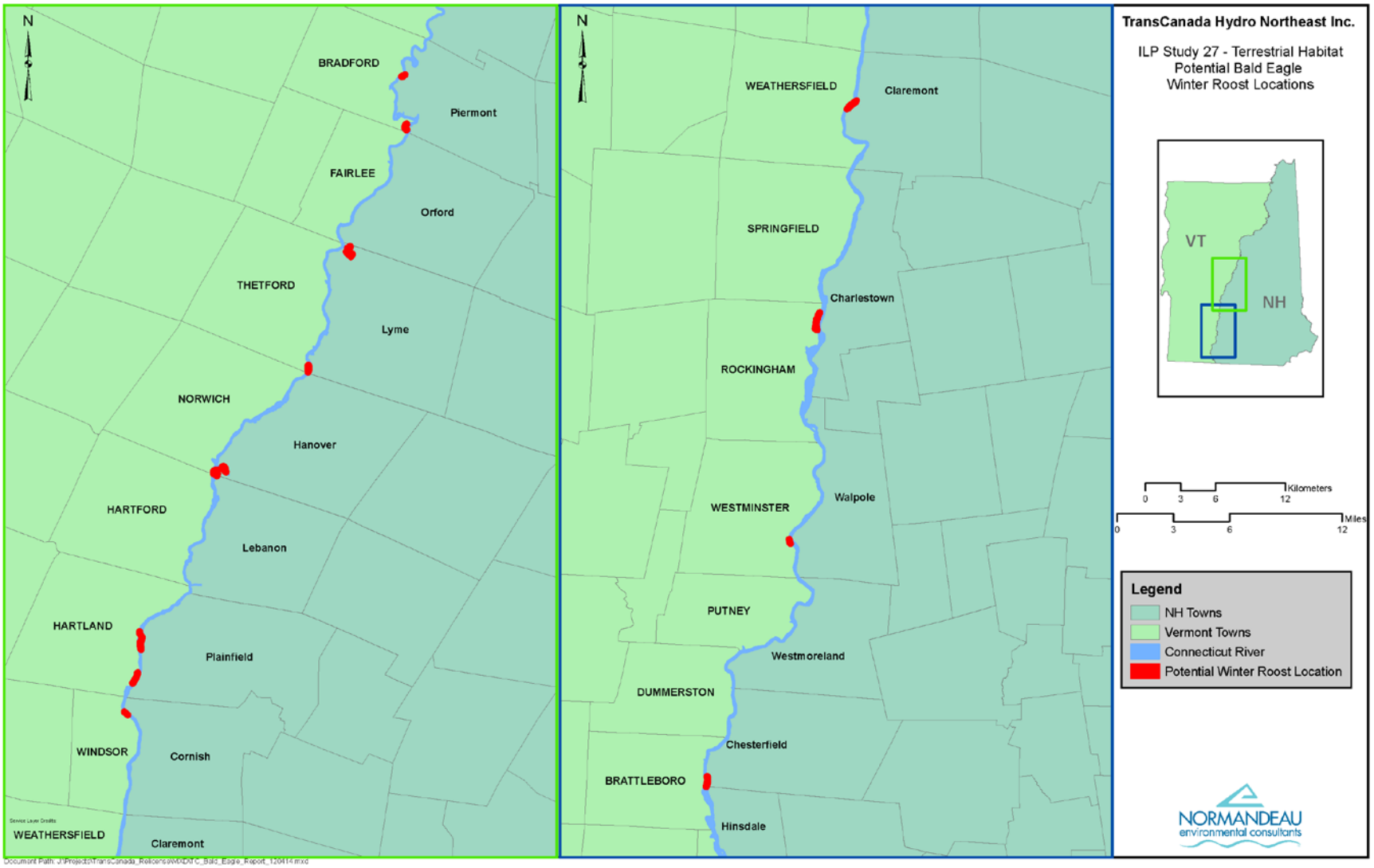

Figure 5.6-1. Approximate locations of potential bald eagle winter roosts in the study area.

Table 5.6-2. Characteristics of potential bald eagle winter roosts identified during field surveys.

State	Town	Aspect	Source of Wind Protection	Age Class of Stand	Canopy Height (ft) Estimated	Perch Access	Dominant Species	Largest DBH (Ft) (estimated)	Land Use Surrounding Stand	Approx. distance to nearest human activity
NH	Piermont	West	Hill Behind	Mixed	100	Moderate	white pine	1.5	Ag lands	200 ft
NH	Plainfield	East	Large Stand Behind	Even	100	Clear	white pine	4	Ag lands	250 ft
NH	Lyme	East	Hill Behind	Mixed	75	Clear	white pine	2	Softwood	0
NH	Lyme	East		Mixed	75	Moderate	white pine	3	Softwood	0.5 mi
NH	Hanover	East	Hill Behind	Mixed	75	Clear	white pine	3	Mixed forest	2 mi
NH	Claremont	West	Large Stand Behind	Even	80	Clear	white pine	2	Softwood	1 mi
VT	Hartland	East	Hill Behind	Even	100	Clear	white pine/ hemlock	3	Mixed Forest	50 ft
VT	Windsor	East	Hill Behind	Even	70	Clear	white pine	2	Railroad, golf course, gravel pit	100 ft
VT	Hartland	East	Hill Behind	Mixed	80	Clear	white pine	3	Upland slope behind	200 ft
VT	Bradford	East	Hill Behind	Even	80	Clear	white pine	3	Softwood	0.5 mi
VT	Rockingham	East	Large Stand Behind	Even	80	Moderate	white pine	3	Softwood	1 mi
VT	Westminster	East	Hill Behind	Even	70	Clear	white pine	2	Low density Residential, Route 5	325 ft

5.7 Wildlife

A total of 87 species of wildlife were recorded during incidental observations in this study, as well as other species specific surveys (Studies 26 and 28, for Tiger Beetles and Fowler's Toad, respectively). See Appendix C for a complete list of species observed in the study area.

Bird activity was relatively light throughout the field surveys throughout the study area. Twelve species of wading birds and waterfowl were recorded between April and August, 2014. Three species of waterfowl were observed throughout the impoundments. Common merganser (*Mergus merganser*) was observed in throughout the study area and a brood of six young were observed in the Vernon impoundment. Wood duck (*Aix sponsa)* was observed in multiple backwater and floodplain areas throughout the Bellows Falls impoundment and mallards (*Anas platyrhynchos)* were noted in both Wilder and Vernon impoundments. Other waterfowl species including Canada geese (*Branta Canadensis)* and double crested cormorants (*Phalacrocora auritus)* were abundant in all three impoundments.

Shoreline-dependent species were noted throughout the study area. Spotted sandpiper (*Actitis macularia)* was frequently seen along the water's edge on both protected and exposed shoreline and gravel bars throughout the river. Bank swallow colonies were relatively common throughout the Wilder and Vernon impoundments on eroded banks where protected colonies could be established. Figures 5.7-1 and 5.7-2 illustrate a typical bank swallow colony in the study area.

Belted kingfisher (*Ceryle alcyon*), great blue heron (*Ardea herodias*), and green heron (*Butorides virescens*) were common throughout the study area. These species were usually noted perching on trees and, when disturbed, would leave the roost tree and fly up or downstream from the observer's location. Great egrets (*Ardea alba)* were observed only once in the lower reaches of the Vernon impoundment near the dam.

Bald eagle juveniles and adults were observed in multiple locations throughout the study area, as were numerous other species of raptors: turkey vulture, osprey, red-tailed hawk, broad-winged hawk, American kestrel, and a peregrine falcon (Vernon impoundment). The importance of the Connecticut River corridor for bird migration was evident when flocks and individual passerines were observed, including mixed warbler flocks in May and June and common nighthawk in August. Other wildlife observations included beaver lodges and dams in backwaters and evidence of bank dens on the mainstem, mostly in the three impoundments. Muskrat were observed in the larger emergent marshes, primarily in the lower Vernon impoundment. American toads, spring peepers, green frogs and bullfrogs were observed or heard in most of the quieter waters with emergent wetlands and aquatic beds. See Study Report 28 for Fowler's toad survey results. A white-tailed deer fawn on Chase Island indicates the value of protected locations for nursery habitat. Tracks of raccoon, deer, mink, possum and mice were frequently observed along the shorelines.

Figure 5.7-1. Bank swallow holes established in an eroded riverbank in Vernon impoundment.

6.0 ASSESSMENT OF PROJECT EFFECTS

The assessment of the potential effects of project operations on vegetation communities are based on hydrologic model results, water level logger data collected as part of Study 7 (Normandeau, 2015) conducted in 2013, and field observations during this study in combination with LiDAR elevation data, collected in 2013. The hydrologic model data were obtained from the Hydraulic Modeling Study (Study 4 [GEI, 2016]) and the Operations Modeling Study (Study 5 [Hatch, 2016]).

Vegetation communities, particularly along large river systems, are hydrologically and physically influenced by the river in multiple ways, including flooding by periodic high waters due to snowmelt and precipitation; scour by ice, water and debris; short-term water level fluctuations; and low flow conditions. On a regulated system such as the Connecticut River in the study area, larger water inputs which exceed the generating capacity of the projects during snowmelt and large precipitation events determine flood levels and scour events, while impoundment water surface elevation (WSE) changes and discharge from normal project operations affect day-to-day water level fluctuations. Vegetation communities respond to high water events and normal project operations in different ways, with the lower elevation communities (marshes and scrub-shrub wetlands) largely controlled by normal project operations and the higher elevation communities (forested wetlands) controlled by high water events resulting in flooding and scour. This analysis focuses primarily on water levels that coincide with normal project operations (excluding periods of high water and spill).

6.1 Water Level Fluctuation

Within each impoundment, water level fluctuations during normal project operations vary with proximity to each dam. Based on Hydraulic Model (Study 4 [GEI, 2016]) data and selected locations mapped in this study (updated from the initial study report), in general, mainstem water levels in the lower reaches closer to the dams varied at the same magnitude as at the dams (Table 6.1-1). The upper portions of the impoundments exhibit more riverine-like characteristics and experience fluctuations due to upstream inflow rather than the smaller impoundment fluctuations. For instance, in the upper Wilder impoundment (model node # 1196), under normal Wilder project operations water levels fluctuate 9 feet while at Wilder dam water levels fluctuate only 2.5 feet. In the riverine sections downstream of the project dams, the hydraulic model predicted that mainstem water levels under normal project operations fluctuated at selected representative locations up to 6.5 ft below Wilder downstream of Burnaps Island, 7.0 feet below Bellows Falls downstream of the Cold River, and 5.6 feet below Vernon at Stebbins Island although it should be noted that the reach below Vernon is influenced by the downstream Turners Falls Project operation WSE fluctuation is a combined effect in most instances.

Data for four representative vegetation communities with nearby available water level logger data were examined more closely:

- Aquatic vegetation in impoundments of Wilder at the Lake Morey Brook confluence; Bellows Falls at the Williams River confluence; and Vernon at the West River confluence.

- Emergent and scrub-shrub wetlands in the Wilder impoundment at the Lake Morey Brook confluence; Bellows Falls impoundment at Williams Cove Confluence; and Vernon at the West River confluence.

- Forested wetland complex at Ash Swamp Brook in the lower Vernon impoundment just upstream of the dam.

Water level fluctuations at these locations were derived from water level loggers deployed from late July to November 2013 in mainstem, tributary, and backwater locations as part of ILP Study 7 – Aquatic Habitat Mapping (Normandeau, 2015). Water level fluctuations calculated from the water level loggers were typically slightly greater than those modeled for normal project operations (Table 6.1-2). The difference ranged from 0.2 feet at the Lake Morey Brook site, to 1.1 feet at the Ash Swamp Brook site. This result is to be expected since the water level logger data included periods when flows exceeded normal project operations during the July to November 2013 water level logger period of record, and the hydraulic model data evaluated herein specifically excluded water levels that were the result of flows above normal project operations.

Table 6.1-1. Water level fluctuation characteristics at selected sites under normal project operations based on Hydraulic Model (Study 4 [GEI, 2016]).

Site Model Node #	Location	Modeled Normal Project Operations			
		Site WSE Min (ft) NAVD88	Site WSE Max (ft) NAVD88	Water Level Fluctuation Range (ft) at site	Water Level Fluctuation Range (ft) at Dam
Upper Impoundment Mainstem Locations					
1196	Upper Wilder Impoundment at Haverhill NH	381.8	390.8	9.0	2.5
664	Upper Bellows Falls Impoundment below Sugar River	289.3	293.6	4.3	1.8
264	Vernon Impoundment upstream of West River	218.2	220.2	2.0	1.2
Mid-Impoundment Mainstem Locations					
1046	Wilder Impoundment below Lake Morey, Fairlee, VT	381.6	385.4	3.8	2.5
545	Middle Bellows Falls Impoundment by Lower Meadow	289.2	291.1	1.9	1.8
186	Vernon Impoundment at West River	218.2	219.8	1.6	1.2
Lower Impoundment Mainstem Locations					
878	Wilder Impoundment just above dam	381.6	384.1	2.5	2.5
525	Bellows Falls Impoundment above dam	289.2	291.0	1.8	1.8
86	Vernon Impoundment at Ash Swamp Brook	218.2	219.5	1.3	1.2
Riverine Reaches Below dams					
794	Wilder Riverine below Burnaps Island	313.1	319.6	6.5	n/a
478	Bellows Falls Riverine downstream of Cold River	220.3	227.3	7.0	n/a
123-VR	Vernon Riverine at Stebbins Island	180.1	185.7	5.6	n/a

Table 6.1-2. Water level fluctuation characteristics at representative vegetation community sites as derived from hydraulic model (Study 4; GEI, 2016) and 2013 water level logger data (July – November).

Model Node #	2013 Water Level Logger ID#	Location of Measurement	WSE min (ft) NAVD88	WSE max (ft) NAVD88	Water Level Fluctuation (ft)
Wilder - Lake Morey Brook Confluence (Figure 6.2-1)					
1046		Mainstem above Lake Morey Brook Confluence	381.6	385.4	3.8
	14	Mainstem north of Orford NH	381.4	385.2	3.8
	15	Backwater south of Fairlee VT	381.5	385.1	3.6
Bellows Falls - Williams River Confluence (Figure 6.2-2)					
525		Mainstem downstream of the Williams River	289.2	291.0	1.8
	50	Herrick's Cove backwater	288.0	290.8	2.8
	79	East side backwater across from Williams River confluence	289.5	291.5	2.0
	80	Williams River backwater adjacent to confluence	288.5	290.8	2.3
Vernon - West River Confluence (Figure 6.2-3)					
186		Mainstem at junction of West River	218.2	219.8	1.6
	65	Mainstem at junction of West River	217.4	219.6	2.2
	66	West River ~ ¼ mi upstream of confluence	217.3	219.5	2.2
	67	West River backwater	217.4	219.6	2.2
Vernon - Ash Swamp Brook Confluence (Figure 6.2-6)					
86		Mainstem just downstream of Ash Swamp Brook	218.2	219.5	1.3
	69	Ash Swamp Brook backwater	217.2	219.5	2.3
	70	Mainstem near Ash Swamp Brook	217.4	219.8	2.4

6.2 Vegetation Community Adaptations

The vascular vegetation communities bordering the river in the study area can be described according to their position relative to water level fluctuation zones. There is a wide diversity of vegetative communities along the Connecticut River that reflects the varying hydrologic conditions occurring throughout the study area (Appendix D). Submerged aquatic vegetation occurred almost exclusively below the lower limit of water level fluctuations. Emergent and scrub-shrub wetlands were most commonly found within the zone influenced by normal project operations. Wetlands higher in the hydrologic gradient, primarily forested wetlands were typically located above normal project operational WSEs, as were other riparian vegetation communities bordering the river. By virtue of location, the vegetation in the riparian zone must be able to tolerate occasional flooding, and in the case of floodplains, this vegetation is specifically adapted to periodic flood events and other high flows beyond the range of normal project operations. These various communities and their positions relative to WSEs under normal project operations are described in more detail below.

Aquatic Vegetation

Aquatic vegetation is susceptible to desiccation and scour, therefore it proliferates in areas that are protected from strong currents and are not exposed at low flow water levels. In the study area, the most well developed aquatic communities occur in backwaters and the mouths of large tributaries, where they are both protected from scour and high currents, but are situated in sufficient water depth to remain covered at low water levels. Examples are in the mouth of the Williams River in the lower Bellows Falls impoundment (Figure 6.2-2) and in the West River backwater in the lower Vernon impoundment (Figure 6.2-3). Wilder has relatively few large backwaters and protected coves and therefore has fewer large aquatic beds, but it does have a number of small ones in the mouths of tributaries, such as the Lake Morey Brook backwater (Figure 6.2-1).

As described in section 5.1.2, riverine aquatic beds were also prevalent in the upper reaches of the three impoundments. Riverine aquatic beds are typically linear in shape, forming narrow bands along the edges of the more riverine-like sections of the impoundments. These aquatic beds were dominated by species such as wild celery that are able to tolerate the stronger currents typical of the upper impoundments. Submerged aquatic vegetation is much less common, and no beds were large enough to map on the truly riverine sections below the dams, where scour and current are too strong for most aquatic species to persist.

Emergent and scrub-shrub wetlands

Emergent and scrub-shrub wetlands were observed throughout the study area in protected locations such as coves and tributaries, and on the downstream side of islands. These wetland cover types tend to be tolerant of short- and long-term inundation, but are vulnerable to scour by currents and ice, as reflected by their

prevalence in protected locations. Examples include the coves associated with the West River (Figure 6.2-1), the Williams River (Figure 6.2-2), and the Lake Morey Brook backwater (Figure 6.2-3). The modeled WSE fluctuated during normal project operations is a maximum of 3.8 ft at the Lake Morey Brook confluence, 1.8 ft at the Williams River confluence and 1.6 ft in the West River confluence.

The lower elevation of emergent or mixed emergent/scrub-shrub wetlands tended to be within the middle of the normal project operations range. At Lake Morey Brook in Wilder, the lower limit of the emergent marsh in the cove was between elevations 383 and 384 ft, in the middle of the modeled normal project operations WSE range at Wilder dam of 381.6 to 385.4 ft, and within the water level logger range of fluctuations (Table 6.1-2). At the Williams River confluence in Bellows Falls, the lower elevation limit of the emergent marsh in the cove was less consistent, but generally between elevations 288 and 289 ft, with the modeled normal project operations WSE ranging from 289.2 to 291.0 ft. At the West River confluence in Vernon, the lower limit of the emergent marsh in the cove was between elevations 218 to 219 ft, with the modeled normal project operations WSE ranging from 218.2 to 219.8 ft. At the Ash Swamp Brook confluence in Vernon, the lower limit of the emergent marsh in the cove was consistently around elevation 219 ft, with the modeled normal project operations WSE ranging from 218.2 to 219.5 ft.

As described in Section 5.1.2, deep-marsh emergent vegetation such as pickerel weed, cattail and soft-stem bulrush dominated in the lower elevations of the emergent marsh zones, anecdotally appearing to seldom be exposed at low water levels. Low scrub-shrub vegetation was often observed at slightly higher elevations (Figure 6.2-4), and was observed to experience frequent inundation and water level fluctuation. Tall scrub-shrub wetlands were yet higher in elevation, and were observed to be inundated or saturated to a lesser extent, although still periodically.

Emergent and scrub-shrub wetlands were generally absent from sections of the study area that experience strong river currents. This was evident along sections of the mainstem riverbanks, and on the leading tips of islands where vegetation was generally sparse or absent (Figure 6.2-5). Some species such as sand willows (*Salix* spp.), dogbane, obedient plant, and cardinal flower (*Lobelia cardinalis*) were found with low sparse cover across areas observed to experience frequent inundation and scour. These species have adapted to tolerate active flow conditions to some extent, although they can be periodically destroyed during flood events (e.g., above project operations flows). Such early-successional communities are less able to compete in more heavily vegetated areas.

Forested Wetlands

Forested wetlands in the Northeast are not adapted to tolerate prolonged or frequent inundation. This was observed in the study area where forested wetlands occurred either on terraces or tributary mouths above the zone of normal project operations WSEs. Within the 200-foot study limit, forested wetlands were typically small in size and seldom occurred along the riverbank. They were more frequently

found adjacent to beaver impoundments or backwaters at elevations that were several feet higher than the emergent marsh and presumably inundated only during high water events. They also were found at tributary mouths where signs of flooding were limited to larger debris and sediment deposits typically associated with high water events.

Floodplain Forests

Floodplain forests are an important resource in the study area. Most occurred on terraces that were higher in elevation than the zone of normal project operations and therefore above the influence of project-related water level fluctuations. An exception was silver maple floodplain forest, some of which occurred on several islands and low terraces adjacent to the river. For example in the lower Vernon impoundment near Ash Brook Swamp (Figure 6.2-6) where modeled WSEs fluctuated between 218.2 and 219.5 ft under normal project operations, a floodplain forest had an estimated elevation of 221 ft. Silver maple can tolerate prolonged and frequent inundation as long as the site supports well-drained soils. Several low-lying forested floodplains, including the Ash Swamp Brook example, showed evidence of periodic inundation or saturation near the zone of normal project operations. Most other silver maple floodplain forests appeared to be well above the zone of normal project operations, and demonstrated classic annual or seasonal flood evidence based on scour marks, sediment deposition in the soils, and large flood debris trapped in trees or bushes.

Upland and Riparian Habitats

The rest of the undeveloped habitats bordering the river were clearly above elevations affected by normal project operations. These included upland riverbanks, riparian habitats, and agricultural fields (Figures 6.2-7 and 6.2-8). The vegetation in these habitats is not adapted to frequent inundation or scour, but it can generally tolerate periodic flooding and infrequent scour. These communities provide important substrate stabilization when such events occur.

6.3 Summary

Wetland vegetation communities within the three project impoundments appear to respond to both the normal water level regime and exposure to extreme events. The most extensive wetland development occurred in the lower sections of the impoundments, where water level fluctuations are less, and in protected coves and backwaters away from river currents and scour under high water conditions. As is true with most wetland communities, wetlands in the project-affected areas are established at elevations relative to average normal water levels. Forested wetlands and floodplains are located a foot or more above normal project operations, as indicated by local water level data loggers. These habitats are affected by high water levels and are important buffers during flood conditions. Emergent and low scrub-shrub wetlands were located within the elevations affected by normal project operations. Both emergent marshes and low shrub communities can tolerate frequent flooding, with emergent marsh communities showing a

gradation from deep marsh to shallow marsh at higher elevation. Aquatic vegetation species are intolerant of desiccation and exposure and these communities were typically found below the lower elevation limit of normal project operations, ensuring that they remain immersed.

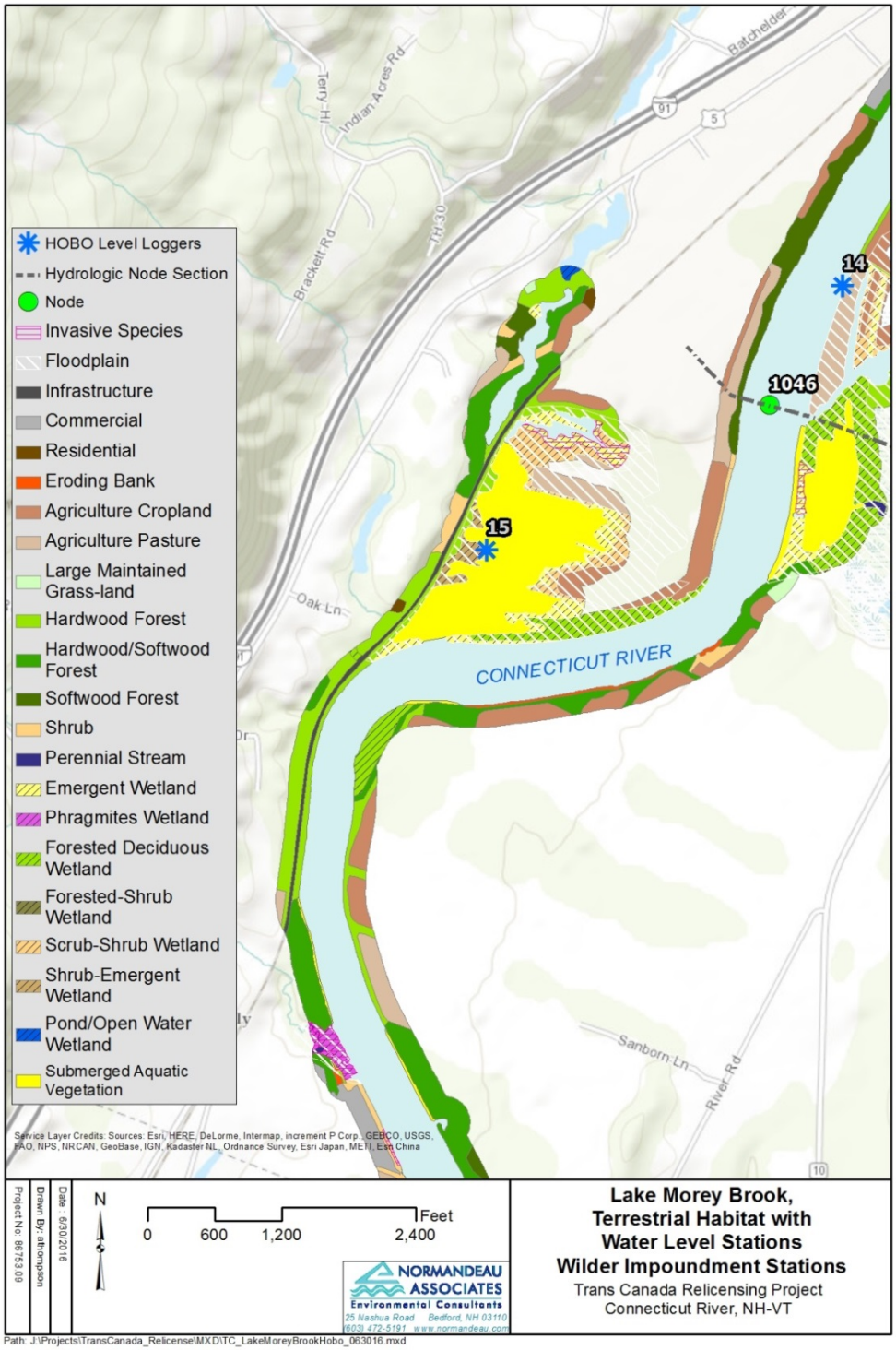

Figure 6.2-1. Aquatic, emergent and scrub-shrub development associated with the Lake Morey Brook backwater in the Wilder Project.

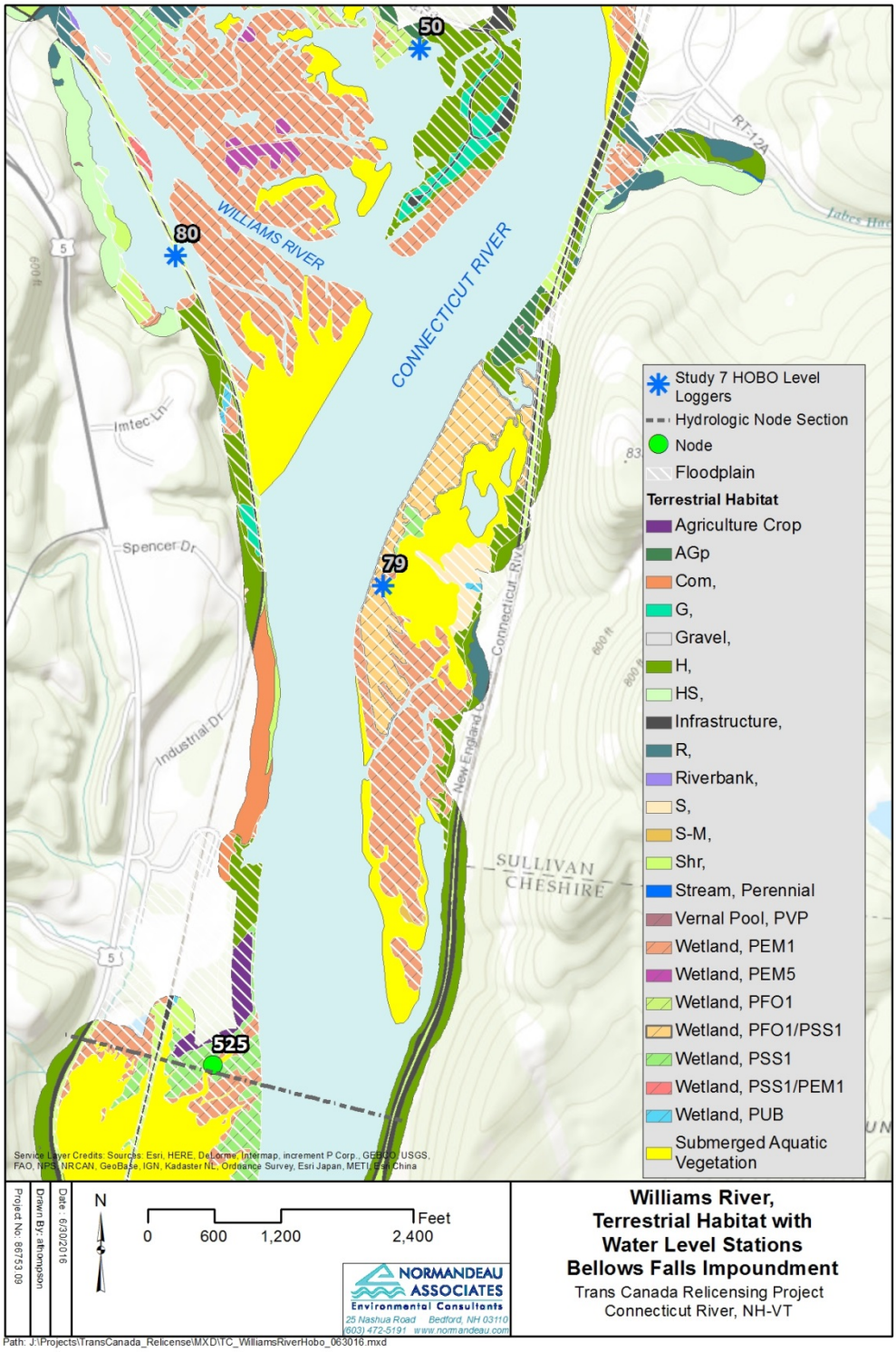

Figure 6.2-2. Aquatic, emergent and scrub-shrub development associated with the Williams River in the Bellows Falls Project.

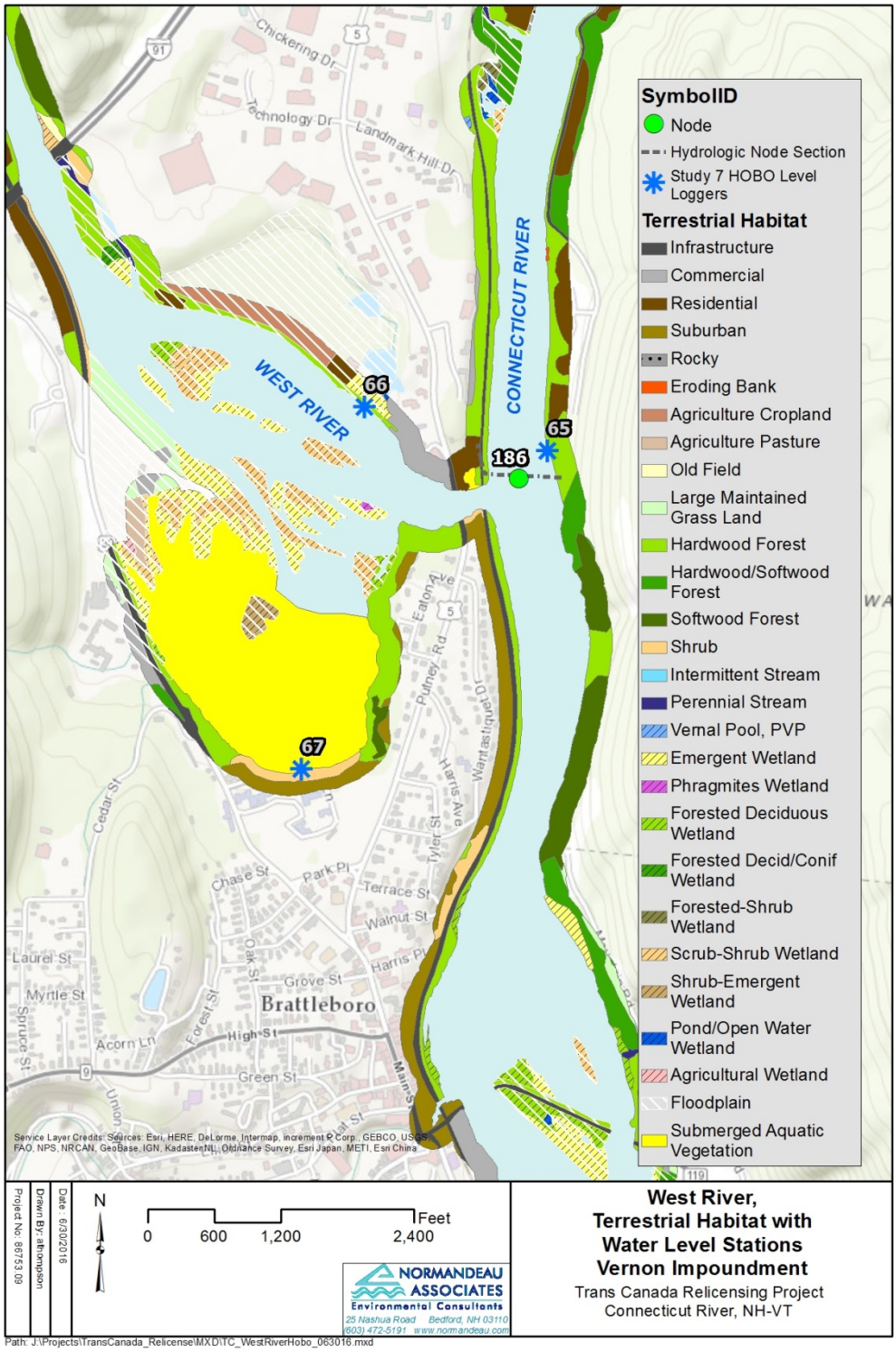

Figure 6.2-3 Aquatic, emergent and scrub-shrub development associated with the West River in the Vernon Project.

Figure 6.2-4. An example of zonation along the hydrologic gradient of aquatic, emergent and scrub-shrub communities in Hinsdale cove, lower Vernon Project.

Figure 6.2-5. An example of sparse scrub-shrub habitat observed to be frequently flooded on Chase Island in the upper Bellows Falls Project

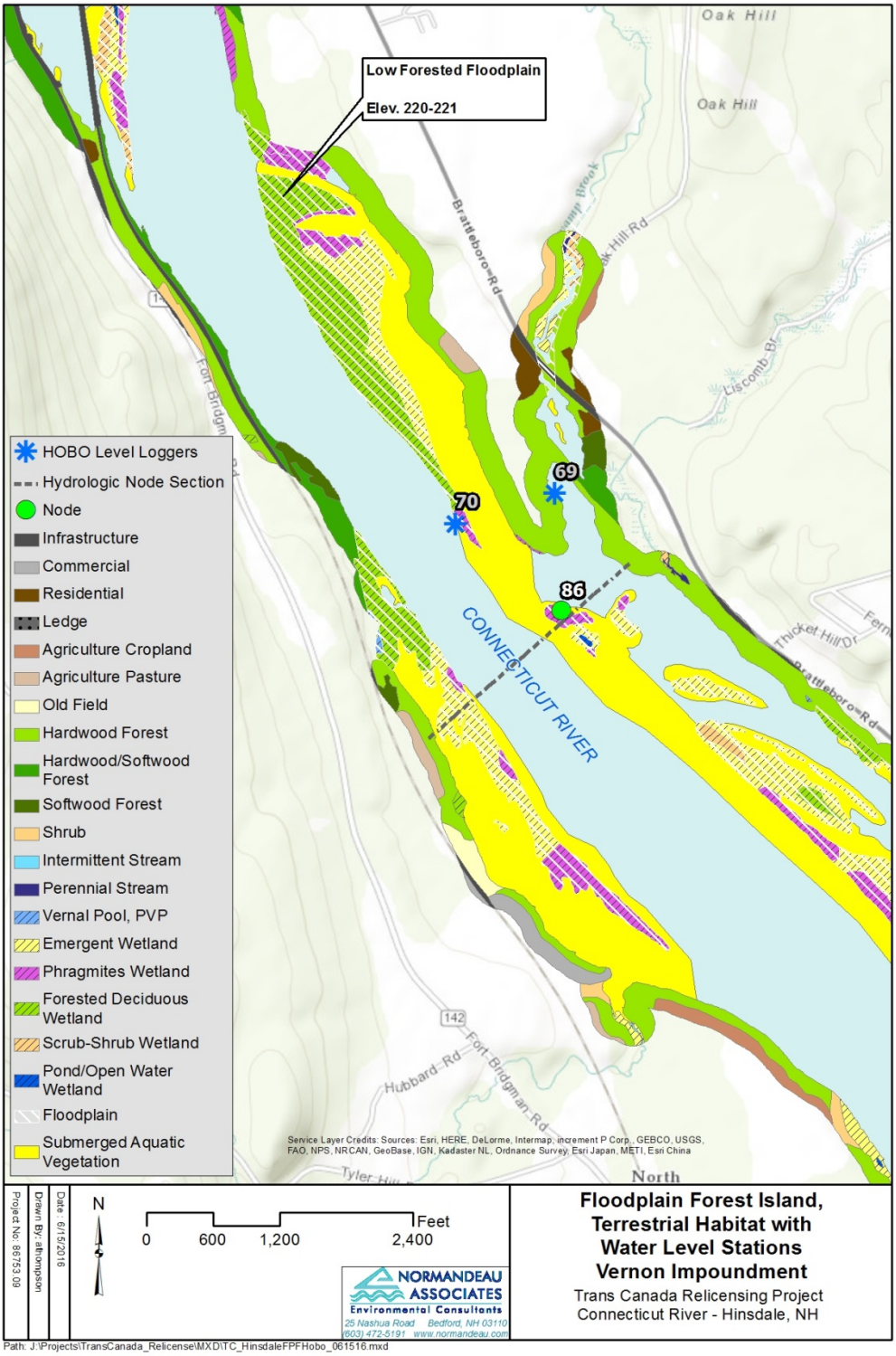

Figure 6.2-6. An example of low forested floodplain setting in Hinsdale, NH.

Figure 6.2-7. Upland riverbank community in Vernon, showing zonation of vegetation approximately associated with water level fluctuations. The effects of periodic flooding and scour are evident in the lower portion of the bank and absent in the upper.

Figure 6.2-8. Japanese knotweed-dominated upland riverbank community bordering agricultural fields in the Wilder Project.

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APPENDIX A

List of Invasive Plant Species in New England from IPANE (2012)

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List of Invasive Plant Species in New England from IPANE (2012)

*Bold indicates invasive plants observed in the study area.

Scientific Name	Common Name
Acer ginnala Maxim.	Amur maple
Acer platanoides L.	Norway maple
Acer pseudoplatanus L.	Sycamore maple
Aegopodium podagraria L.	Goutweed
Ailanthus altissima (Mill.) Swingle	Tree of heaven
Aira caryophyllea L.	Silver hairgrass
Alliaria petiolata (Bieb.) Cavara & Grande	Garlic mustard
Allium vineale L.	Wild garlic
Alnus glutinosa (L.) Gaertner	European black alder
Amorpha fruticosa L.	False indigo
Ampelopsis brevipedunculata (Maxim.) Trautv.	Porcelainberry
Anthriscus sylvestris (L.) Hoffm.	Wild chervil
Arthraxon hispidus (Thunb.) Makino	Hairy jointgrass
Berberis thunbergii DC.	**Japanese barberry**
Berberis vulgaris L.	Common barberry
Bromus tectorum L.	Drooping brome-grass
Butomus umbellatus L.	Flowering rush
Cabomba caroliniana A. Gray	Fanwort
Callitriche stagnalis Scop.	Pond water-starwort
Cardamine impatiens L.	Narrowleaf bittercress
Carex kobomugi Ohwi	Japanese sedge
Celastrus orbiculatus Thunb.	**Oriental bittersweet**
Centaurea biebersteinii DC.	**Spotted knapweed**
Chelidonium majus L.	Celandine
Cirsium arvense (L.) Scop.	Canada thistle
Cirsium palustre (L.) Scop.	Marsh thistle
Cynanchum louiseae Kartesz & Gandhi	**Black swallow-wort**
Cynanchum rossicum (Kleo.) Barbarich	Pale swallow-wort
Cytisus scoparius (L.) Link	Scotch broom
Datura stramonium L.	Jimsonweed
Egeria densa Planchon	Brazilian waterweed

Scientific Name	Common Name
Eichhornia crassipes (Mart.) Solms	Water hyacinth
Elaeagnus angustifolia L.	**Russian olive**
Elaeagnus umbellata Thunb.	Autumn olive
Elsholtzia ciliata (Thunb.) Hylander	Crested late-summer mint
Epilobium hirsutum L.	Hairy willow-herb
Euonymus alata (Thunb.) Sieb.	**Winged euonymus**
Euphorbia cyparissias L.	Cypress spurge
Euphorbia esula L.	Leafy spurge
Frangula alnus Mill.	**Glossy buckthorn**
Froelichia gracilis (Hook.) Moq.	Slender snake cotton
Geranium thunbergii Sieb. & Zucc. ex Lindl. & Paxton	Thunberg's geranium
Glaucium flavum Crantz	Yellow hornpoppy
Glechoma hederacea L.	Ground ivy
Glyceria maxima (Hartman) Holmburg	Reed mannagrass
Heracleum mantegazzianum Sommier & Levier	Giant hogweed
Hesperis matronalis L.	**Dame's rocket**
Humulus japonicus Sieb. & Zucc.	Japanese hops
Hydrilla verticillata (L. f.) Royle	Hydrilla
Hydrocharis morsus-ranae L.	European frogbit
Hypericum prolificum L.	Shrubby St. Johnswort
Impatiens glandulifera Royle	Ornamental jewelweed
Iris pseudacorus L.	**Yellow iris**
Kochia scoparia (L.) Schrader	Common kochia
Lepidium latifolium L.	Perennial pepperweed
Ligustrum obtusifolium Sieb. & Zucc.	Border privet
Ligustrum ovalifolium Hassk.	California privet
Ligustrum sinense Lour.	Chinese privet
Ligustrum vulgare L.	European privet
Lonicera japonica Thunb.	Japanese honeysuckle
Lonicera maackii (Rupr.) Herder	Amur honeysuckle
Lonicera morrowii A. Gray	**Morrow's honeysuckle**
Lonicera tatarica L.	**Tatarian honeysuckle**
Lonicera x bella Zabel	Bell's honeysuckle

Scientific Name	Common Name
Lonicera xylosteum L.	Dwarf honeysuckle
Luzula luzuloides (Lam.) Dandy & Wilmott	Oakforest woodrush
Lychnis flos-cuculi L.	Ragged robin
Lysimachia nummularia L.	**Moneywort**
Lysimachia vulgaris L.	**Garden loosestrife**
Lythrum salicaria L.	**Purple loosestrife**
Marsilea quadrifolia L.	European waterclover
Microstegium vimineum (Trin.) A. Camus	**Japanese stilt grass**
Miscanthus sinensis Anderss.	Eulalia
Myosotis scorpioides L.	**Forget-me-not**
Myriophyllum aquaticum (Vell.) Verdc.	Parrotfeather
Myriophyllum heterophyllum Michx.	Variable-leaf watermilfoil
Myriophyllum spicatum L.	**Eurasian watermilfoil**
Najas minor Allioni	**Brittle water-nymph**
Nymphoides peltata (Gmel.) Kuntze	Yellow floating heart
Onopordum acanthium L.	Scotch thistle
Ornithogalum umbellatum L.	Star-of-Bethlehem
Paulownia tomentosa (Thunb.) Sieb. & Zucc.	Princess tree
Phalaris arundinacea L.	**Reed canary grass**
Phragmites australis (Cav.) Trin. ex Steud.	**Common reed**
Pistia stratiotes L.	Water lettuce
Poa compressa L.	**Canada bluegrass**
Polygonum caespitosum Blume	Bristled knotweed
Fallopia japonica Sieb. & Zucc.	**Japanese knotweed**
Polygonum perfoliatum L.	**Mile-a-minute vine**
Polygonum sachalinense F. Schmidt ex Maxim.	Giant knotweed
Populus alba L.	White poplar
Potamogeton crispus L.	Curly-leaved pondweed
Pueraria montana var. lobata (Willd.)	Kudzu
Ranunculus ficaria L.	Fig buttercup
Ranunculus repens L.	Creeping buttercup
Rhamnus cathartica L.	**Common buckthorn**
Robinia pseudoacacia L.	**Black locust**

Scientific Name	**Common Name**
Rorippa microphylla (Boenn. ex Reichenb.) Hyl. ex A.& D. Löve	Onerow yellowcress
Rorippa nasturtium-aquaticum (L.) Hayek	Watercress
Rosa multiflora Thunb. ex Murr.	**Multiflora rose**
Rosa rugosa Thunb.	Rugosa rose
Rubus phoenicolasius Maxim.	Wineberry
Rumex acetosella L.	Sheep sorrel
Salvinia molesta Mitchell Complex	Salvinia
Senecio jacobaea L.	Tansy ragwort
Silphium perfoliatum L.	Cup plant
Solanum dulcamara L.	**Bittersweet nightshade**
Trapa natans L.	Water chestnut
Tussilago farfara L.	**Coltsfoot**
Valeriana officinalis L.	Garden heliotrope
Veronica beccabunga L.	European speedwel

APPENDIX B

Representative Cover Class Photolog

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Submerged aquatic vegetation Wilder, VT. 8/6/2014.

Emergent wetlands Charlestown, NH. 7/29/2014

Emergent wetlands, Walpole, NH. 7/29/2014

Scrub-shrub/emergent wetland, Norwich, VT. 8/7/2014

Scrub-shrub wetland, Hinsdale, NH. 7/23/2014

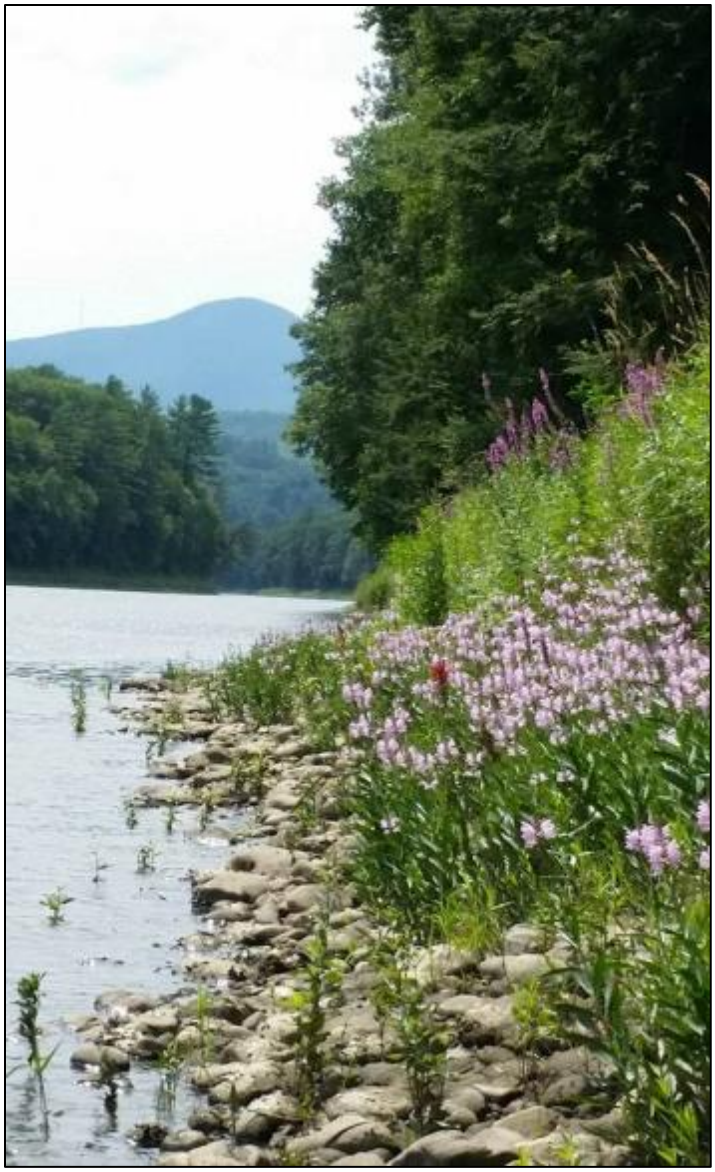
Scrub-shrub wetland, Westmoreland, NH. 7/26/2014

Deciduous forested/scrub shrub wetland, Rockingham, VT. 7/29/2014

Deciduous forested wetland, Charlestown, NH. 7/29/2014

Mixed deciduous-conifer wetland, Lyme, NH. 8/8/2014

Riverbank below agricultural field, Fairlee, VT. 8/9/2014



Riverbank, Harts Island. August 12, 2014

Riverbank, Westmoreland, NH. 7/25/2014

Shrub dominated riverbank, Charlestown, NH 7/30/2014

Hardwood forest on Wilder riverine section. Hartland, VT. 8/12/2014

Hardwood forest on Bellows Falls riverine section. Westminster, VT. 8/20/2014

Hardwood/softwood forest, Charlestown, NH. 7/30/2014

Softwood forest, Rockingham, VT. 7/29/2014

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APPENDIX C

Wildlife Species Observed throughout the Study Area

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Yellow highlighted species are typically associated with wetlands or open water in the Northeast.

Birds

Common Name	Latin Name
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Spinus tristis*
American Kestrel	*Falco sparvarious*
American Redstart	*Setophaga ruticilla*
American Robin	*Turdus migratorius*
American Woodcock	*Scolopax minor*
Bald Eagle	*Haliaeetus leucocephalus*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Belted Kingfisher	*Megaceryle alcyon*
Black-and-White Warbler	*Mniotilta varia*
Blackburnian Warbler	*Setophaga fusca*
Black-capped Chickadee	*Poecile atricapillus*
Black-throated Blue Warbler	*Setophaga caerulescens*
Black-throated Green Warbler	*Setophaga virens*
Blue Jay	*Cyanocitta cristata*
Blue-headed Vireo	*Vireo solitarius*
Bobolink	*Dolichonyx oryzivorus*
Broad-winged Hawk	*Buteo platypterus*
Brown Creeper	*Certhia americana*
Brown-headed Cowbird	*Molothrus ater*
Canada Goose	*Branta canadensis*
Cedar Waxwing	*Bombycilla cedrorum*
Chestnut-sided Warbler	*Setophaga pensylvanica*
Common Merganser	*Mergus merganser*
Common Nighthawk	*Chordeiles minor*
Common Raven	*Corvus corax*
Common Yellowthroat	*Geothlypis trichas*
Double-crested Cormorant	*Phalacrocorax auritus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tyrannus tyrannus*
Eastern Phoebe	*Sayornis phoebe*
Eastern Wood-Pewee	*Contopus virens*
European Starling	*Sturnus vulgaris*
Fish Crow	*Corvus ossifragus*
Gray Catbird	*Dumetella carolinensis*
Great Blue Heron	*Ardea herodias*

Common Name	Latin Name
Great Crested Flycatcher	*Myiarchus crinitus*
Great Egret	*Ardea alba*
Green Heron	*Butorides virescens*
Hairy Woodpecker	*Picoides villosus*
Hermit Thrush	*Catharus guttatus*
House Wren	*Troglodytes aedon*
Killdeer	*Charadrius vociferus*
Mallard	*Anas platyrhynchos*
Mourning Dove	*Zenaida macroura*
Northern Cardinal	*Cardinalis cardinalis*
Northern Flicker	*Colaptes auratus*
Northern Waterthrush	*Parkesia noveboracensis*
Osprey	*Pandion haliaetus*
Ovenbird	*Seiurus aurocapilla*
Peregrine Falcon	*Falco peregrinus*
Pileated Woodpecker	*Dryocopus pileatus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Red-eyed Vireo	*Vireo olivaceus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Rock Dove	*Columba livia*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Rough-legged Hawk	*Buteo lagopus*
Ruby-throated Hummingbird	*Archilochus colubris*
Scarlet Tanager	*Piranga olivacea*
Song Sparrow	*Melospiza melodia*
Spotted Sandpiper	*Actitis macularius*
Tree Swallow	*Tachycineta bicolor*
Turkey Vulture	*Cathartes aura*
Veery	*Catharus fuscescens*
Wild Turkey	*Meleagris gallopavo*
Winter Wren	*Troglodytes hiemalis*
Wood Duck	*Aix sponsa*
Wood Thrush	*Hylocichla mustelina*
Yellow-bellied Flycatcher	*Empidonax flaviventris*

Mammals

Common Name	Latin Name
American Beaver	*Castor canadensis*
Gray Squirrel	*Scirius carolinensis*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethicus*
Opossum	*Didelphis virginiana*
Red Fox	*Vulpes vulpes*
Red Squirrel	*Sciurus vulgaris*
White-tailed Deer	*Odocoileus virginianus*

Amphibians

Common Name	Latin Name
American Bullfrog	*Lithobates catesbeianus*
American Toad	*Anaxyrus americanus*
Fowlers Toad	*Bufo fowleri*
Gray Tree Frog	*Hyla versicolor*
Green Frog	*Lithobates clamitans melanota*
Spring Peeper	*Pseudacris crucifer*
Wood Frog	*Lithobates sylvaticus*

Reptiles

Common Name	Latin Name
Common Snapping Turtle	*Chelydra serpentina*

APPENDIX D

Cover Type Maps

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Panel: 1

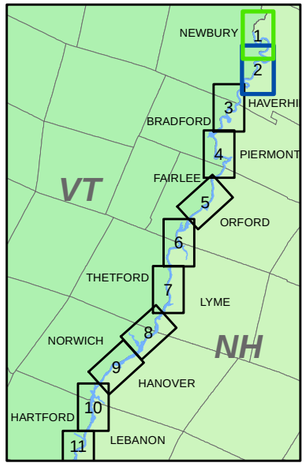
Panel: 2

Approximate Wilder Impoundment Extent

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

TransCanada Hydro Northeast Inc.

ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
- Emergent
- Phragmites
- Forested Deciduous
- Forested Decid/Conif
- Forested Coniferous
- Forested-Emergent
- Forested-Shrub
- Scrub-Shrub
- Shrub-Emergent
- Agricultural Wetland

- Aquatic Bed
- Pond/Open Water
- Potential Vernal Pool
- Intermittent Stream
- Perennial Stream
- Connecticut River

Developed
- Infrastructure
- Commercial
- Residential
- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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Panel: 3

Panel: 4

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

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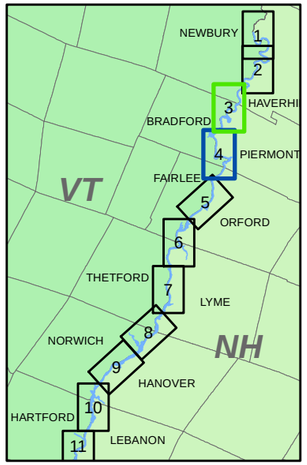
TransCanada Hydro Northeast Inc.

ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
- Emergent
- Phragmites
- Forested Deciduous
- Forested Decid/Conif
- Forested Coniferous
- Forested-Emergent
- Forested-Shrub
- Scrub-Shrub
- Shrub-Emergent
- Agricultural Wetland

- Aquatic Bed
- Pond/Open Water
- Potential Vernal Pool
- Intermittent Stream
- Perennial Stream
- Connecticut River

Developed
- Infrastructure
- Commercial
- Residential
- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

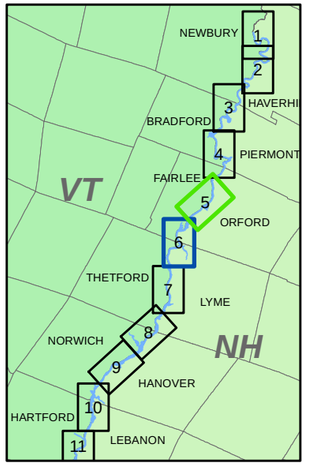
NORMANDEAU environmental consultants

Panel: 5

Panel: 6

TransCanada Hydro Northeast Inc.

ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
- Emergent
- Phragmites
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- Forested-Shrub
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Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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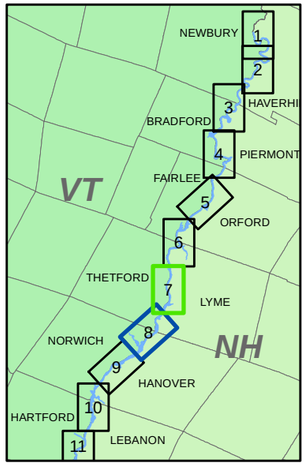
Panel: 7

Panel: 8

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

TransCanada Hydro Northeast Inc.

ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
- Emergent
- Phragmites
- Forested Deciduous
- Forested Decid/Conif
- Forested Coniferous
- Forested-Emergent
- Forested-Shrub
- Scrub-Shrub
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- Intermittent Stream
- Perennial Stream
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- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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Panel: 9

Panel: 10

Wilder Dam

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

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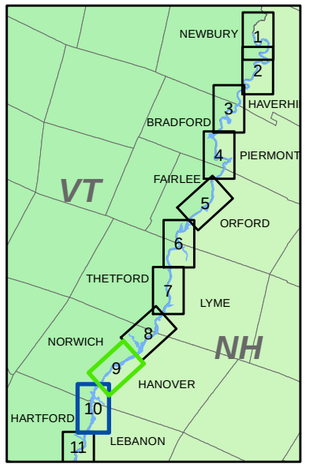
ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
- Emergent
- Phragmites
- Forested Deciduous
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- Forested-Emergent
- Forested-Shrub
- Scrub-Shrub
- Shrub-Emergent
- Agricultural Wetland

- Aquatic Bed
- Pond/Open Water
- Potential Vernal Pool
- Intermittent Stream
- Perennial Stream
- Connecticut River

Developed
- Infrastructure
- Commercial
- Residential
- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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Panel: 11

Panel: 12

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

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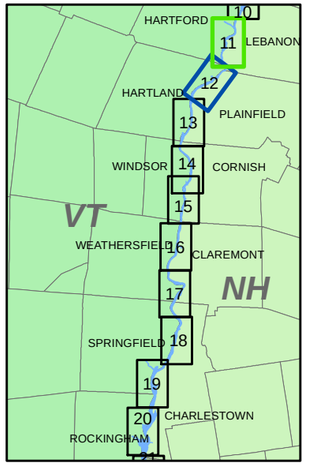
ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
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- Phragmites
- Forested Deciduous
- Forested Decid/Conif
- Forested Coniferous
- Forested-Emergent
- Forested-Shrub
- Scrub-Shrub
- Shrub-Emergent
- Agricultural Wetland

- Aquatic Bed
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- Intermittent Stream
- Perennial Stream
- Connecticut River

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- Infrastructure
- Commercial
- Residential
- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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Panel: 13

Panel: 14

Approximate Bellows Falls Impoundment Extent

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

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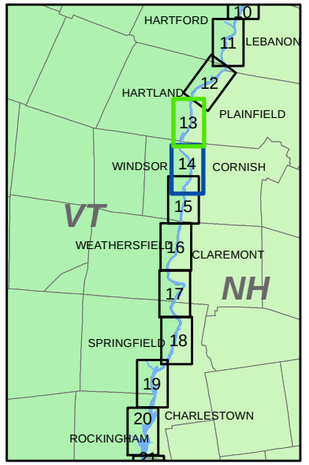
ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
- Emergent
- Phragmites
- Forested Deciduous
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- Forested Coniferous
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- Shrub-Emergent
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- Connecticut River

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- Infrastructure
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- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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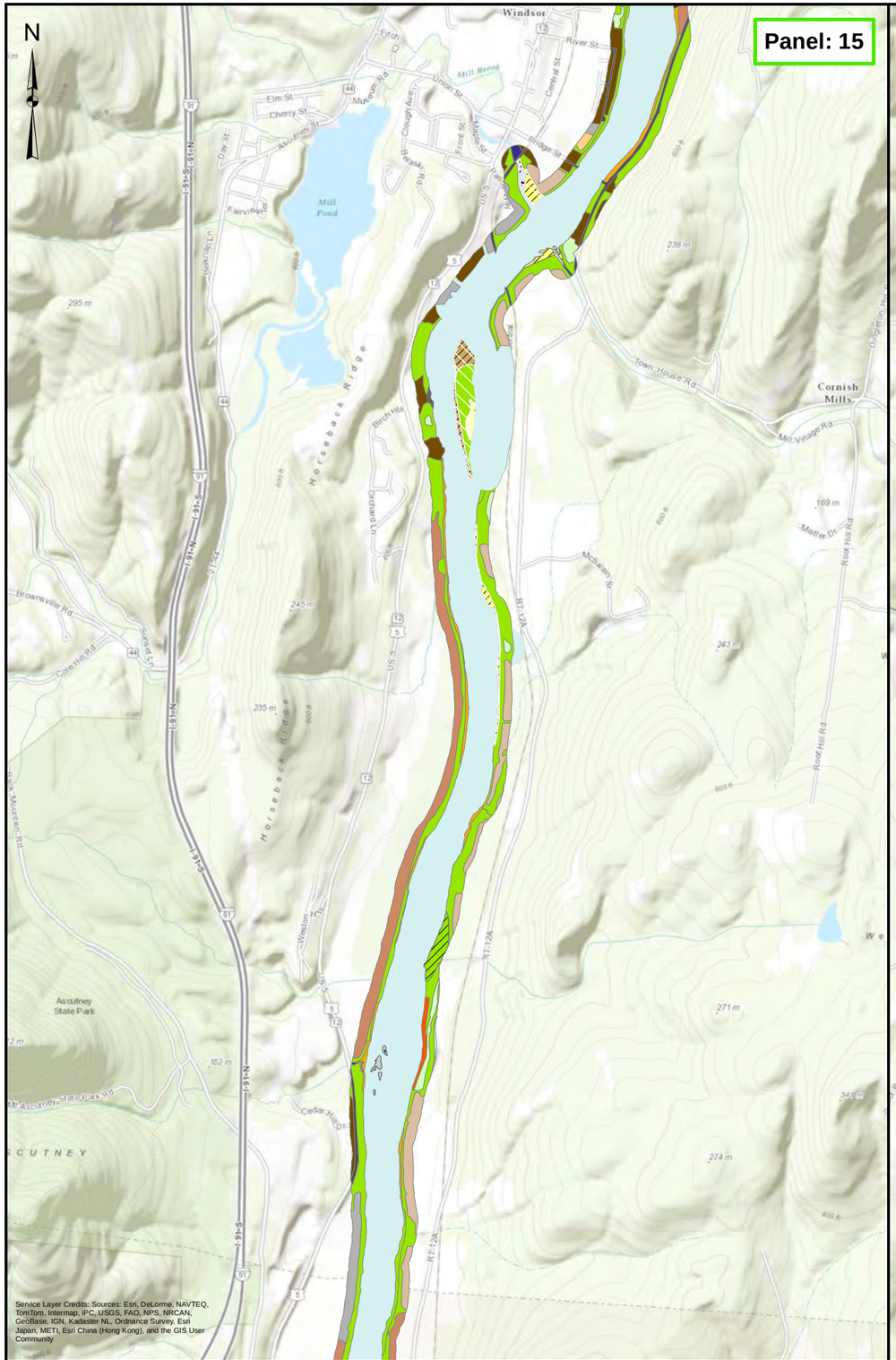

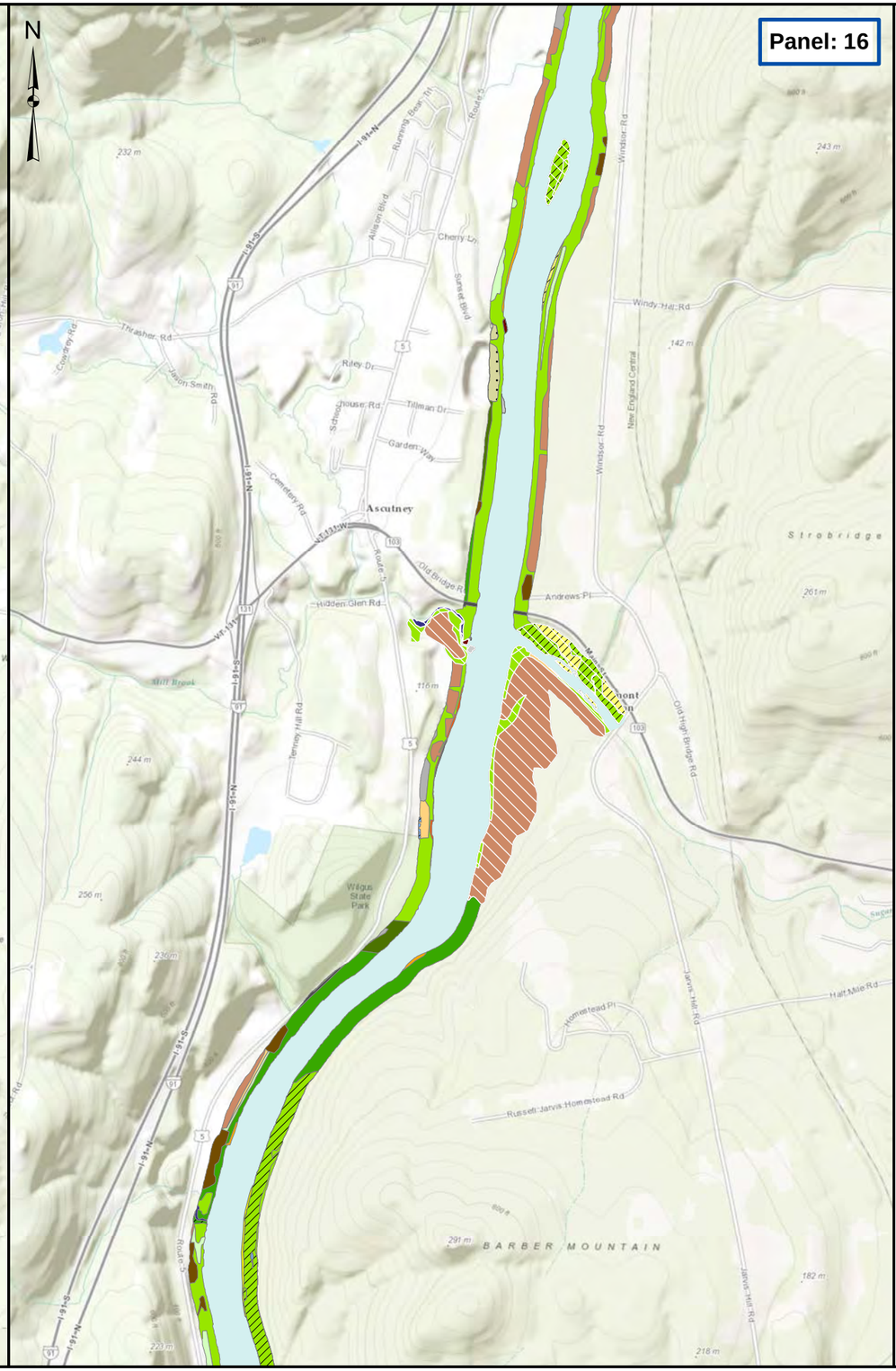

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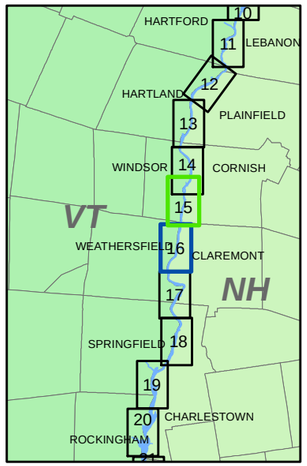
ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
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Wetland
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- Residential
- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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Panel: 17

Panel: 18

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

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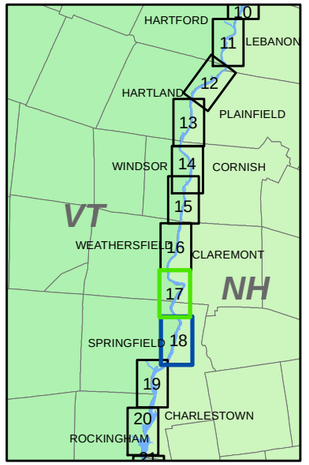
ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
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- Phragmites
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- Forested Coniferous
- Forested-Emergent
- Forested-Shrub
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- Agricultural Wetland

- Aquatic Bed
- Pond/Open Water
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- Connecticut River

Developed
- Infrastructure
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- Residential
- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

Panel: 19

Panel: 20

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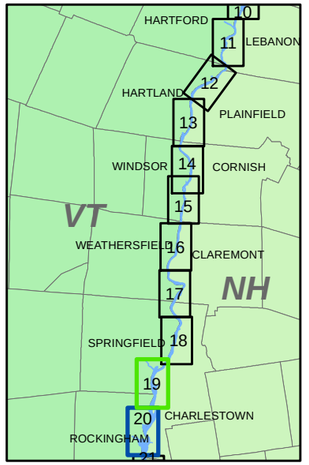
ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 Miles 1

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
- Emergent
- Phragmites
- Forested Deciduous
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- Shrub-Emergent
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- Aquatic Bed
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- Connecticut River

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- Suburban
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Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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Panel: 21

N

Bellows Falls Dam

Approximate Vernon Impoundment Extent

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, IPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

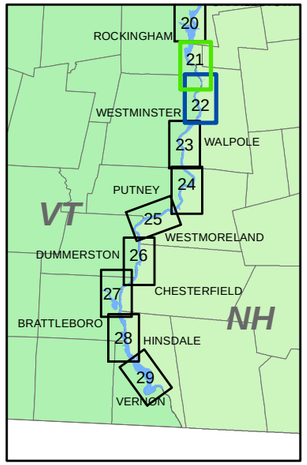
Panel: 22

N

Approximent Vernon Impoundment Extent

TransCanada Hydro Northeast Inc.

ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
- Hardwood/Softwood Forest
- Softwood Forest

Wetland
- Emergent
- Phragmites
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- Forested Decid/Conif
- Forested Coniferous
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- Forested-Shrub
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Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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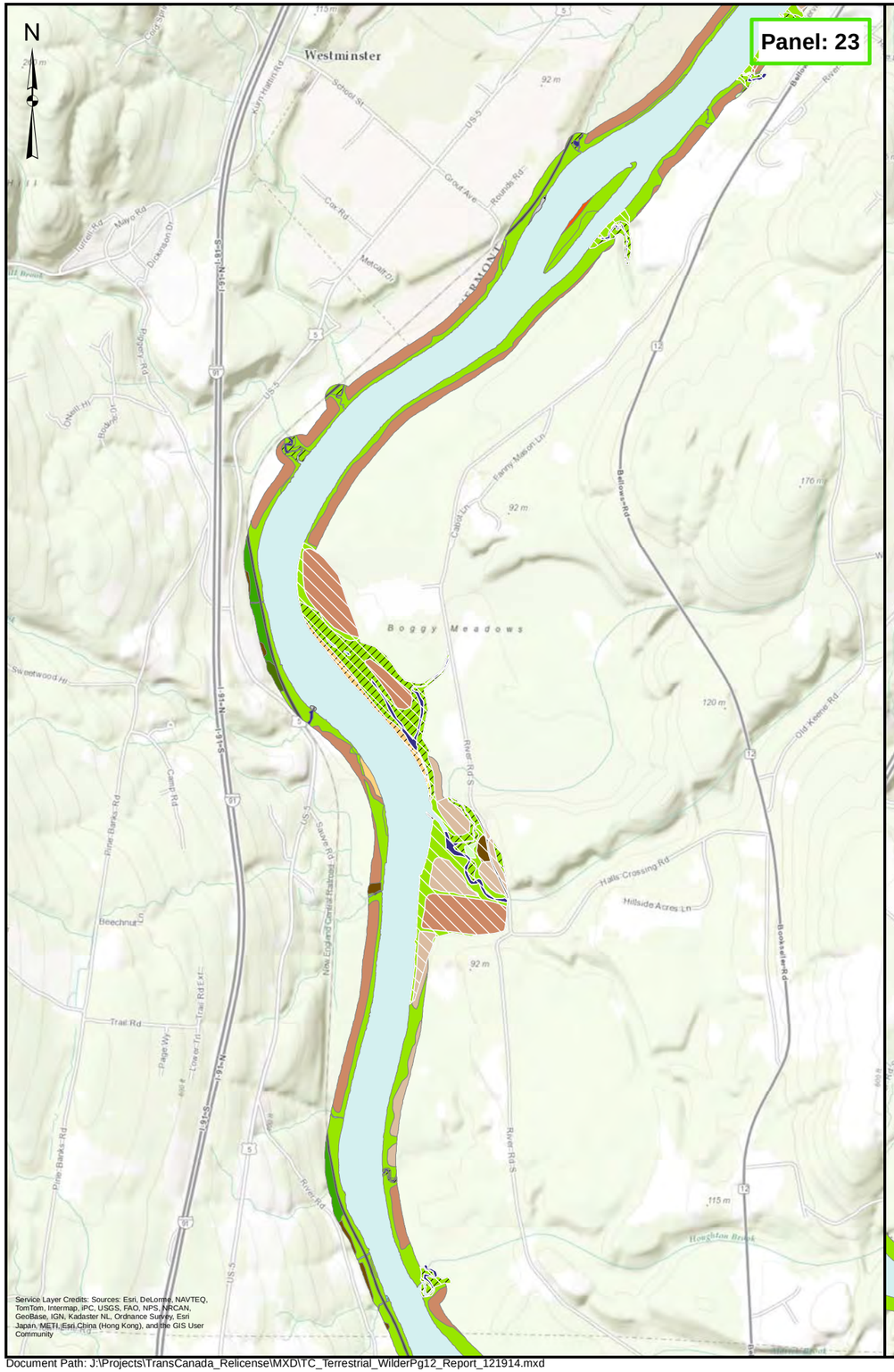
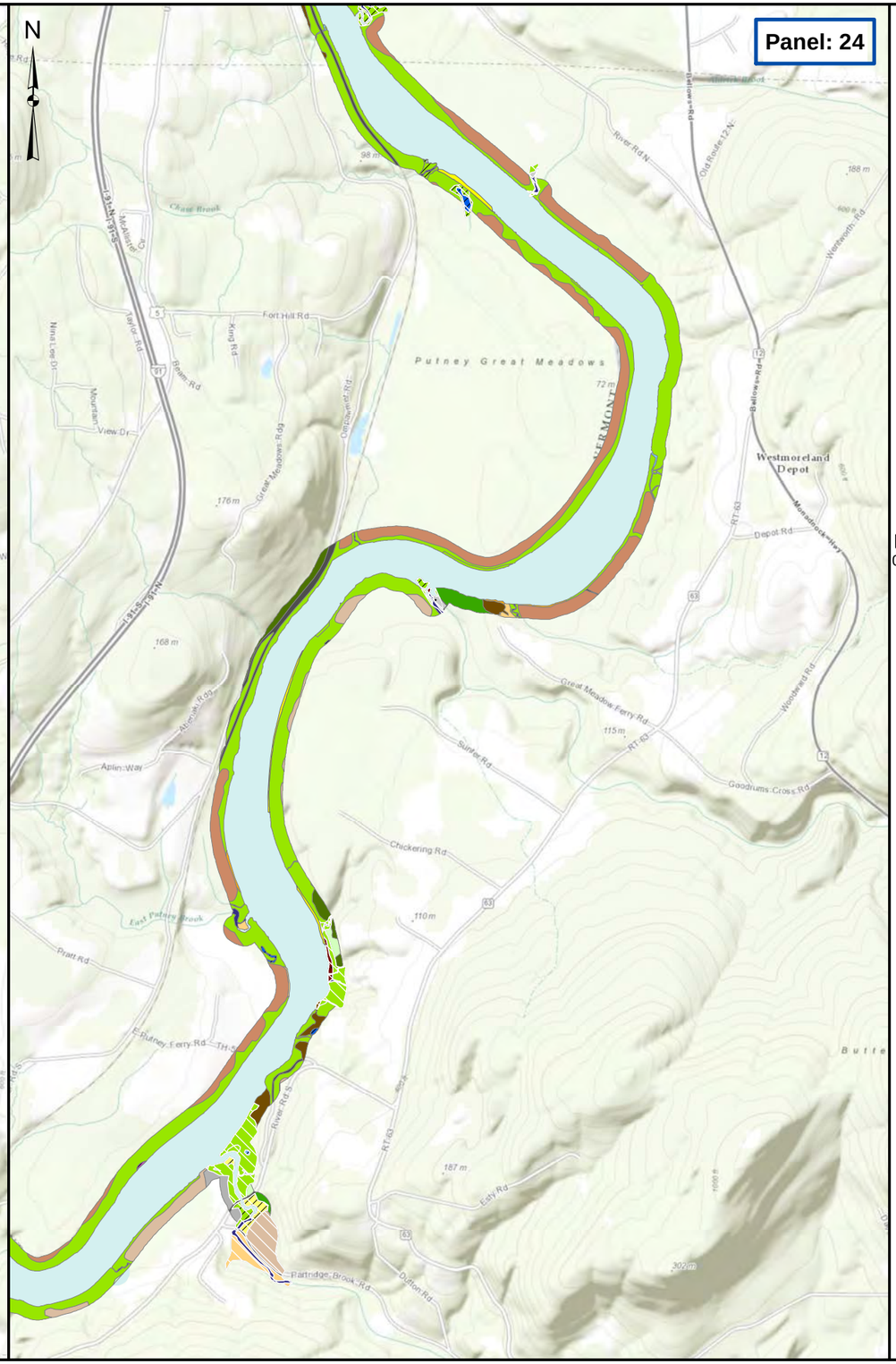
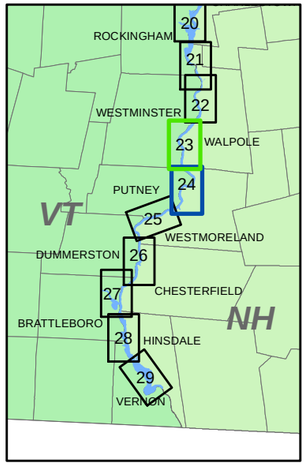




TransCanada Hydro Northeast Inc.

ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
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Wetland
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- Suburban
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- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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Panel: 25

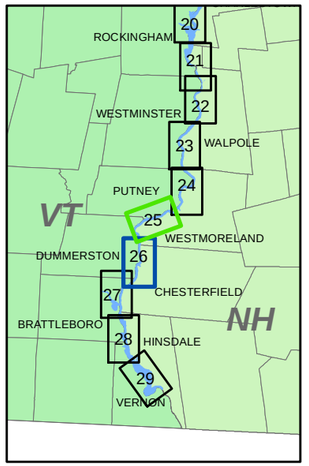
Panel: 26

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

TransCanada Hydro Northeast Inc.

ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
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Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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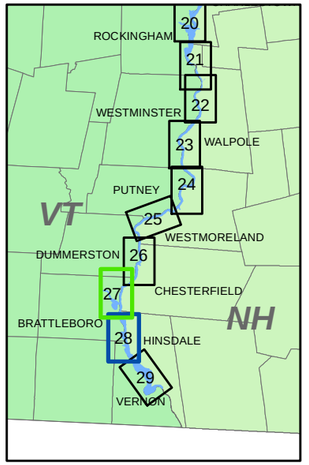
Panel: 27

Panel: 28

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

TransCanada Hydro Northeast Inc.

ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
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- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

NORMANDEAU environmental consultants

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Panel: 29

Vernon Dam

Approximate 1.5 mile downstream limit from Vernon Dam

Panel: 30

Vernon Dam

Approximate 1.5 mile downstream limit from Vernon Dam

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

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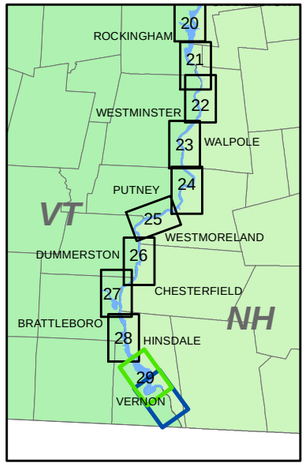
ILP Study 27 - Terrestrial Cover Type and Land Use Maps



0 0.25 0.5 1 Miles

Cover Type

Upland
- Agriculture Cropland
- Agriculture Pasture
- Old Field
- Large Maintained Grass Land
- Shrub
- Hardwood Forest/Shrub
- Hardwood Forest
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- Softwood Forest

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- Forested Deciduous
- Forested Decid/Conif
- Forested Coniferous
- Forested-Emergent
- Forested-Shrub
- Scrub-Shrub
- Shrub-Emergent
- Agricultural Wetland

- Aquatic Bed
- Pond/Open Water
- Potential Vernal Pool
- Intermittent Stream
- Perennial Stream
- Connecticut River

Developed
- Infrastructure
- Commercial
- Residential
- Suburban
- Mineral

Riverine
- Sand-Mud
- Gravel
- Rocky
- Ledge
- Riprap
- Riverbank
- Eroding Bank

Overlay
- Invasive Species
- Floodplain

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