Wetland Mitigation Technical Report

Baggett Property (Site #38) and Highway Median Site #24

Salem to Manchester, IM-IR-93-1(174)0, 10418-C New Hampshire

Prepared for New Hampshire Department of Transportation and Federal Highway Administration

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1.0 Introduction

The Baggett Property and Highway Median sites are two of five wetland mitigation sites identified in the Final Environmental Impact Statement (FEIS) for the Salem-Manchester Project. [1] These sites along with an extensive package of land preservation, as well as funding for the purchase of watershed lands around Lake Massabesic and technical planning assistance to affected towns are intended to fully compensate for the unavoidable wetland impacts of the project. The complete history and additional details of the mitigation package are provided in the Wetland Mitigation Report – Interstate 93 Improvements Salem to Manchester (VHB, July 2004).

The Baggett Property (Site #38) is approximately 6.20 acres in size and includes approximately 1 acre of wetland creation. It is located immediately adjacent to the expanded southbound barrel of I-93 in the southwest quadrant of where I-93 and Lowell Road (NH Route 38) cross (see Figures 1 and 2). The site is primarily forested with a small opening abutting Lowell Road (the former location of a demolished residence). A constructed drainage channel (approximately 8 feet wide by 2 feet deep) from Cole's Trailer Park to the northwest bisects the site and drains toward the highway median via a 24 inch culvert. As the property was acquired for reconstruction of the I-93 bridge over Lowell Road, the opportunity for wetland and floodplain creation has been pursued. The main goal when developing a conceptual plan for this site was the replacement of flood storage which has been identified by the USACOE, NHDES, and town officials, including the Conservation Commission, as a high priority in providing wetland compensation for the project in the Salem area. Flood storage and the related floodflow alteration function are the principle functions impacted by project-related fills in wetlands along the highway. A second goal was to provide additional acreage of wetland creation to the project's mitigation package.

Since detailed groundwater monitoring is currently unavailable, the grading design is based on the elevation of existing pockets of forested wetland within the site, underlying surfacial geology and field observations. Three wetland communities were configured to create edge diversity. Wetland hydrology will be primarily supported by intercepting groundwater contained within the extensive underlying surfacial deposits. Wetland hydrology will be supplemented by redirecting and naturalizing a drainage channel which will be impacted by the new roadway embankment. The relatively minor anticipated flow rates within the channel will ultimately be directed toward the existing culvert (to be extended) which conveys excess surface waters under the alignment toward the median.

The Highway Median Site (Site #24) is located between the northbound and southbound lanes, south of NH 111A in the vicinity of Canobie Lake and Cobbetts Pond. This site is approximately 24 acres in size and will become available due to the shift of the northbound barrel away from Canobie Lake with the so-called "tight shift" option (see Figures 3 and 4). The site lies adjacent to the Windham-Salem Project Mitigation Site and is within the Wellhead Protection District of the Pennichuck Water Supply.

[1] The Pelham Road Site #31 in Salem was constructed in 2001. The South Road Site #14/15 in Londonderry has already been designed. The Salem Wastewater Treatment Plant site is in the final design stage.

The removal of previous wetland fill will allow for the relocation of approximately 3 acres of wetland. Three wetland classes were proposed: emergent or shallow marsh, scrub-shrub wetland, and forested wetland. The basic assumption was that hydrological support for the created wetlands can be provided through a combination of surface and groundwater inputs. This is a reasonable assumption considering the fact that the site appears to consist of fill within former wetlands which existed prior to the construction of I-93.

In developing a planting plan for the wetland mitigation, species have been selected that are not only appropriate for the particular wetland class but are also locally common native species. They have also been chosen to enhance the opportunity for wildlife food on the site. The ultimate goal of the design is to provide a plant species mix that mimics the communities found within the surrounding wetlands bordering the restoration site. Slightly deeper zones of marsh/aquatic bed zones are proposed to provide limited areas which initially would not support purple loosestrife (*Lythrum salicaria)*, which is common within the adjacent wetlands. Neither site raises any concern over the creation of wetland habitat in close proximity to airport runways.

As indicated above, the Baggett and Median sites are two of five wetland creation sites identified in the EIS for the I-93 Project. In January 2002, the Army Corps participated in a field review of the site. In addition, when the Draft EIS was circulated in September 2004, the Corps had the opportunity to comment on whether these sites should remain a part of the mitigation package. NHDOT did not receive any written objection to its inclusion and hence continues to propose these sits as viable mitigation opportunities. Commitments made to the Town of Salem also require that NHDOT follow through with its plans to create wetlands within the Baggett property. The destructive flooding that occurred in Salem during the May 2006 storms only served to reinforce the Town's desire that NHDOT persist with its plans, which will add much-needed compensatory flood storage within the municipality.

2.0 Project Impacts

2.1 Direct Impacts

Both the FEIS (April 2004, Sections 3.6.3 and 4.6.2-4.6.3) and the Application for Department of Army Permit/NH Wetlands Bureau Permit, Salem – Manchester I-93 Widening (September 2002, Revised July 2004) provide extensive discussion and details of the direct and indirect impacts of the I-93 project on wetlands.

Maps showing the location of all impacted wetlands along the 19.8 mile highway corridor were included in the permit application. Impacts by highway segment and wetland class, using the Cowardin et al. (1979) classification system, were presented in the FEIS and graphically represented in the project's Wetland Mitigation Report (VHB, July 2004). A detailed database listing all of the impacts by location, wetland class, and wetland system was also provided in these two documents.

A summary of the direct wetland impacts by wetland class for the project is provided in Table 2-1. The largest percentage of impacts will occur to forested wetlands (58 percent) with the second highest to emergent marshes (32 percent).

The total impact of the project was estimated to be 76+ acres. However, this number is subject to revision up or down during final design, which is currently underway. All of the impacted wetlands lie within the Merrimack River watershed, Hydrologic Unit Code 01070002. A number of local, state and regional watershed councils and alliances have established long-term goals for this watershed - primarily water quality, recreation, and flood protection. The Merrimack River Watershed Council (Lawrence, MA) provided comments on the I-93 project impacts and recommendations for mitigation.[2] Their input and others' were used in the development of the mitigation package for the I-93 Project.

2.2 Functions and Values

Functions and values for the impacted wetlands were determined through field investigations conducted in 2002. VHB followed The Highway Methodology Workbook Supplement: Wetland Functions and Values – A Descriptive Approach (USACOE 1999) for this assessment. The assessment forms, photographs, graphical summaries, and a detailed description of the methodology are provided in the Wetland Functions and Values Assessment Report, Interstate 93 Improvements, Salem – Manchester (VHB, October 2002).

Key functions and values for wetlands along the I-93 corridor are listed in Table 2-2. The approximate size and watershed of each of the evaluated wetlands are also shown. In general, wetlands located along the southern one-third of the project corridor are more disturbed, altered, and fragmented than those in the northern two-thirds. Proximity to existing roads and commercial and residential development have degraded portions of most wetlands along the I-93 corridor from the Massachusetts border in Salem to the weigh stations in Windham.

[2] See Comment and Response P-2 in FEIS, Volume 3 (April 2004)

Table 2-1: Summary of Project Impacts on Wetlands

Cowardin et al. Classification	Impacted Areas	Percentage
Palustrine Forested (PFO)	43.7	58%
Palustrine Emergent (PEM)	24.6	32%
Palustrine Scrub Shrub (PSS)	5.6	7%
Open Water (POW & Riverine)	1.8	2%
Total	75.7	99%

Source: Appendix A Table 1 in Wetland Mitigation Report, VHB, July 2004.

North of this area, wetlands have been adversely affected to a lesser degree by adjacent land development, but continue to be affected by stormwater runoff from I-93 where they lie adjacent to it. The project's final design will attempt to address the runoff issue by providing a state-of-the-art approach to stormwater treatment.

The principal functions of most of the affected wetlands along the corridor are floodflow alteration (flood storage), sediment/toxicant retention, nutrient removal, and wildlife habitat. Fish and shellfish habitat and production export are principal functions but to a lesser degree in some wetlands. Other important wetland functions and values (e.g., recreation, education, uniqueness/heritage, and threatened & endangered species) occur in very few of the wetlands.

Table 2-2 Summary of Functions and Values For Representative Wetlands Along the I-93 Corridor (VHB, October 2002)

Wetland Number	Wetland Name	Watershed	Total Wetland Area (acres)	Cover Type(s)	Ground water Recharge/ Discharge	Floodflow Alteration	Fish and Shellfish Habitat	Sediment/Toxicant Retention	Nutrient Removal	Production Export	Sediment/ Shoreline Stabilization	Wildlife Habitat	Recreation	Educational/ Scientific Value	Uniqueness/ Heritage	Visual Quality/ Aesthetics
1	Policy Brook/Spicket River	Spicket River	3.7	PFO, PEM, POW	X	0	0	0	X	0	X	0	X		0	X
2	Spicket River Tributary	Spicket River	22.3	PFO, PEM		0	X	0	X		X	0				
3	Porcupine Brook Tributary	Spicket River	40.2	PFO, PEM, POW, PSS	X	0		0	X	X	X	0				X
4	Porcupine Brook	Spicket River	21.5	PFO, PEM, PSS	X	0	0	0	X	X	X	0				X
5	Exit 2	Spicket River	13.1	PFO, PEM, PSS	X	0	X	0	0	X	X	0				X
6	Policy Brook	Spicket River	13.1	PFO, PEM	X	0	0	0	0	X	X	0				X
7	Porcupine Brook Tributary	Spicket River	1	PFO, PEM	X	0		0	X		X	0				X
8	Canobie Lake South Tributary	Spicket River	2.3	PFO, PSS	X	0		0	X		X	0				X
9	North Tributary to Policy Brook	Spicket River	2	PFO	0	X		0	X		X	0				X
10	Canobie Lake West Tributary	Spicket River	8.3	PFO, PEM, PSS	X	0	X	0	0	0	X	0			X	X
11	Route 111A	Spicket River	28.6	PFO, PEM, POW	X	0	X	0	0	0	X	0			X	X
12	Exit 3	Golden Brook	19.8	PFO, PEM, PSS,POW	X	0	0	0	0	0	X	0			X	X
13	Route 111	Golden Brook	17.1	PFO	X	0	X	0	0	0	X	0	X	0	0	X
14	Weigh Stations South	Golden Brook	5.4	PFO, PEM	X	0	X	0	0	X	X	X				X
15	Weigh Stations North	Golden Brook	11.6	PFO, PEM	X	0		0	0	X	X	0				X
16	Bridge Street Pond	Spicket River	7.1	PFO, PSS	X	0		0	0	X	X	0	X			
17	Windham North	Spicket River	14.9	PFO, PSS		0		0	X	X	X	X	X			
18	Derry South	Spicket River	11.8	PFO, PSS, PEM	X	0		0	0	X	0	0				X
19	Derry Central	North Beaver Brook	16.9	PFO, PEM, POW	0	0	0	0	0	X	X	0				X
20	Beaver Brook	Beaver Brook	23.5	PFO, PEM, PSS	X	0	0	0	0	X	X	0				X
21	Wheeler Pond and Tributary	Beaver Brook	15.4	PFO, PEM, PSS	X	0	0	0	0	X	X	0	X	X	X	0
22	Pillsbury Road to PSNH Easement	Beaver Brook	28.5	PFO, PEM, PSS, POW	X	0	X	0	0	X	X	0	X		X	X
23	Stonehenge Road	Beaver Brook	13.5	PFO, PEM, POW	X	0		0	0	X		0				
24	Londonderry Central	Little Cohas Brook	10.9	PFO, PEM, PSS	X	0		0	0	X	X	0			0	X
25	Exit 5	Little Cohas Brook	46.7	PFO, PEM, PSS	X	0	0	0	0	0	X	0	X	X	X	0
26	Cohas Brook	Cohas Brook	31.7	PFO, PEM, PSS	0	0	0	0	0	X	X	0				X
27	I-93/I-293 Interchange	Cohas Brook	45	PFO, PEM, PSS	X	0	0	0	0	0	X	0			0	0

Data based on VHB Field Evaluation conducted April – May 2002

X = Function/Value Present

0 = Principal Function

Note: No known populations of wetland-dependent threatened or endangered species are present in the study area.

3.0 Description of Existing Conditions

3.1 Surrounding Land Use

The first area, the Baggett Property is located immediately adjacent to the expanded southbound barrel of I-93- in the southwest quadrant of the Lowell Road (NH Route 38) underpass of I-93. The latitude and longitude of the Baggett site is 42.96331 North and -71.23851 West. The site is bounded by these two roadways, as well as a mobile home park (Coles Trailer Park). The western property line abuts a substantial tract of forested upland and wetlands. Approximately 95% of the parcel is a mix of upland and wetland forest composed of both softwoods (primarily white pine, *Pinus strobus*) and hardwoods (primarily red maple, *Acer rubrum*, and oaks, *Quercus* spp.). The remaining 5% contains open lands which was the former location of a residence purchased by NHDOT and subsequently demolished. The existing channelized drainage through the site flows into the median of the highway and ultimately to Policy Brook.

The second area, the Highway Median site will encompass the majority of the area that is left after shifting the northbound lanes of I-93 to the west. The latitude and longitude of the Highway Median Site is 42.79717 North and -71.27007 West The focus of the current design report is the area of former wetlands filled by the construction of I-93 in the early 1960's. Additional upland and/or wetland restoration opportunities may exist within other segments of the highway which will be removed and other disturbed lands within the median further southbound from the primary restoration site. These opportunities will be examined further when locations of proposed stormwater management facilities are located within the current median.

The primary area for restoration within the Highway Median site is bounded to the north by Route 111A, to the south by the adjacent upland hillside and by the limits of the highway fill slope to the east and west. The site is also contiguous with the Windham-Salem Mitigation Site, immediately to the east which abuts West Shore Drive. The site is also contained within the within the Well Head Protection Area (WHPA) of a community well system consisting of three bedrock well located off West Shore Road adjacent to Canobie Lake. The wells are owned and operated by Pennichuck Water Works, Inc. and supply drinking water to nearby homes and businesses in Windham. Development along Route 111A is primarily commercial, while development off West Shore Road is primarily residential. There has been some limited recent development in the median to the west and south of the restoration area. This work included construction of a utilities road through the wetland, as well as a commercial septic system and well. With the exception of lands previously disturbed by NHDOT maintenance activities, the remainder of the undeveloped median contains of mature upland and wetland deciduous forest.

3.2 Wildlife & Fisheries

The majority of the Baggett site supports a mixture of upland and wetland forest composed of both softwoods and hardwoods. Many of the white pines are mature trees in excess of 30 inches d.b.h. This forested area in combination with a much larger forested tract to the west provides a relatively large block of contiguous forested habitat and may support breeding habitat for some forest interior species. This function would be minimal in the vicinity of the proposed earth work due to the proximity of disturbances from the highway and adjacent mobile home park. The open lands adjacent to Lowell Road also suffer from disturbances from surrounding development.

Several of the small depressional wetlands (especially toward the western end of the site) may provide habitat for vernal pool species during some years. The small forested wetlands within or adjacent to the proposed work zone appear to be too shallow to provide important vernal pool species habitat. There is no fish habitat associated with this site. Photographs of the Baggett site are included at the end of this report.

The restoration component of the Highway Median site currently provides a relatively broad zone of open field habitat, as well as a narrow band of upland shrubland habitat along the base of the roadway embankment (see site photos). The adjacent wetland fragmented by construction of I-93 is a mix of emergent marsh, scrub-shrub and forested wetland. It appears some of the forested wetland found at the base of the roadway embankment occupies deposits of unsuitable organic soils side-casted during highway construction. There is one upland forested area on the west side of the highway embankment dominated by oaks and white pine. Leatherleaf (*Chamaedaphne calyculata*) is relatively common within central portions of the existing wetland, and there are also aquatic bed small pockets of open water. Beaver activity has resulted in a fluctuating surface water table within the wetland. The relatively large size and diversity of wetland types add to the wildlife habitat value within the existing wetland system. The habitat value is negatively impacted by the presence of invasive species and the severe fragmentation caused by the highway. Photographs of the Highway Median site are included at the end of this report.

During site visits conducted in the spring of 2006, a number of relatively common wetland-dependant wildlife were observed including, red-winged blackbird (*Agelaius phoeniceus*), yellowthroat (*Geothlypis trichas*), great blue heron (*Ardea herodias*), mallard (*Anas platyrhynchos*), green frog (*Rana clamitans*), and painted turtle (*Chrysemys picta picta)* were observed. Sign of beaver (*Castor canadensis*) activity were common at culvert locations and along the upland perimeter.

It is unlikely that the wetlands adjacent to the restoration site provide important spawning or nursery habitat to the warmwater fishery found in Canobie Lake, however the large drainage area flowing through the site likely provides important food chain support in the form of production export.

3.3 Soils

The Soil Survey of Rockingham County, New Hampshire[3] maps the soils on the Baggett site as 313A Deerfield fine sandy loam. The wetlands adjacent to the Median restoration site are mapped as 295-Greenwood muck peat.

Table 16 of the Soil Survey indicates the following depths to the high water table for the mapped soils:

Soil Type	Depth to High Water Table (ft)	Months
295	+1-0.5	Jan-Dec
313A	1.5-3.0	Dec-April

[3] Soil Conservation Service. 1994. Soil Survey of Rockingham County, New Hampshire, Parts 1 and 2. U.S. Department of Agriculture.

The Soil Survey describes the Deerfield series as a very deep, moderately well drained soil formed in glacial outwash. Based on field observations and aquifer mapping, the soil type and predicted depth to the water table appear greatly accurate. This information will be verified with planned observation wells and test pits. The Survey describes the Greenwood Series as a very deep, very poorly drained soil formed in organic materials associated with bogs, kettles and upland till basins. The presence of a deep organic layer was confirmed during recent field investigations. Well log information suggests all the organic deposits over till or bedrock were removed under the road bed during roadway construction.

3.4 Wetlands

Baggett Property

Wetland boundaries within the Baggett Property were recently field verified. There is a relatively large forested wetland which contains a drainage channel extending from the adjacent mobile home park. This wetland is a mix of white pine and red maple with fairly pronounced mound-and-pool microtopography. These cover type would be classified as PFO4/1En[4]. Smaller depressional wetlands to the east are primarily red maple swamps (PFO1En[4]) with a few scattered white pines. There are no pronounced drainage patterns within these smaller wetland pockets. Standing water depths within the depression appear to be too shallow to support vernal pool species. The base elevation of these wetlands is approximately 128 feet. Based on the Geomorphic ID Classification[5] system, the wetlands would be considered depressional with an ephemeral outlet.

Highway Median Site

The wetland edge bordering the roadway embankment was originally delineated in support of the EIS several years ago. VHB is in the process of verifying wetland boundaries along the corridor. This boundary is not anticipated to substantially change as the upland/wetland edge is typically well defined by abrupt topography.

The wetland (having been fragmented by road construction) is generally similar on either side of the highway. The most common wetland cover type is scrub-shrub wetlands (PSSEg[4]) dominated by red maple saplings, although leatherleaf is abundant in some locations. Red-maple-dominated forested wetland (PFO1Eg[4]) is found primarily along the toe of the highway embankment. Cattail-dominated emergent marsh (PEMFg[4]) is interspersed within larger zones of scrub-shrub wetlands. Based on the Geomorphic ID Classification[5] system, the entire wetland complex would be considered depressional with an ephemeral outlet. There are several minor ephemeral drainage ways which enter the wetland to the west of the restoration site. Flow is conveyed under the northbound lanes via a 30 inch RCP culvert near Route 111A. Flow from the wetland east of the restoration areas is conveyed to Canobie Lake via a 30 inch RCP culvert under West Shore Road, near the intersection with Woodvue Road.

Vegetation succession from emergent marsh to scrub shrub wetland appears to be aided by large mounds of tussock sedge which are supporting red maple saplings. Microtopography within the existing forested wetlands is not pronounced. This community appears to be growing on discarded organic soil spoils excavated from below the highway footprint.

[4] Cowardin , L.M., V. Carter., F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Fish and Wildlife Service, U.S. Department of Interior. 131 pp.

[5] Brinson, M.M. 1993. A Hydrogeomorphic Classification for Wetlands. U.S. Army Corps of Engineers, Waterways Experiment Station. 79 pp. plus appendices.

A list of plant species observed during field investigations conducted in April 2006 is shown in Table 3-1 and 2.

Table 3-1 Plant Species List – Baggett Property Wetlands and Transition

Common Name	Scientific Name	NWI Region 1 Indicator Status
Red maple	*Acer rubrum*	FAC
Eastern white pine	*Pinus strobus*	FACU
White oak	*Quercus albai*	FACU
Red oak	*Quercus rubrai*	FACU-
Highbush blueberry	*Vaccinium corymbosum*	FACW-
Cinnamon fern	*Osmunda cinnamomea*	FACW
Glossy buckthorn	*Frangula alnus*	FAC+
Sensitive fern	*Onoclea sensibilis*	FACW
Evergreen woodfern	*Dryopteris intermedia*	FAC
Cat briar	*Simax rotundifolia*	FAC
Canada mayflower	*Maianthemum canadense*	FAC-
Round-leaf wintergreen	*Pyrola rotundifolia*	FAC
American starflower	*Trientalis borealis*	FAC
Common goldthread	*Coptis trifolia*	FACW
Bristly blackberry	*Rubus hispidus*	FACW
Bracken fern	*Pteridium aquilinum*	FAC-
Bunchberry	*Cornus canadensis*	FAC
Wild sarsaparilla	*Aralia nudicaulis*	FAC
Spotted touch-me-not	*Impatiens capensis*	FACW

Table 3-2 Plant Species List – Highway Median

Common Name	Scientific Name	NWI Region 1 Indicator Status
Red maple	*Acer rubrum*	FAC
Eastern white pine	*Pinus strobus*	FACU
Sweet pepperbush	*Clethra alnifolia*	FAC
Glossy buckthorn	*Frangula alnus*	FAC+
Winterberry holly	*Ilex verticillata*	OBL
Highbush blueberry	*Vaccinium corymbosum*	FACW-
White ash	*Fraxinus americana*	FACU
American elm	*Ulmus americana*	FACW
Leatherleaf	*Chamaedaphne calyculata*	OBL
Tussock sedge	*Carex stricta*	OBL
Cattail	*Typha latifolia*	OBL
Cinnamon fern	*Osmunda cinnamomea*	FACW
Sensitive fern	*Onoclea sensibilis*	FACW
Canada mayflower	*Maianthemum canadense*	FAC-
Round-leaf wintergreen	*Pyrola rotundifolia*	FAC
American starflower	*Trientalis borealis*	FAC
Common goldthread	*Coptis trifolia*	FACW
Bristly blackberry	*Rubus hispidus*	FACW
Spotted touch-me-not	*Impatiens capensis*	FACW
Marsh fern	*Thelypteris thelypteroides*	OBL
Red oak	*Quercus rubra*	FACU-
Black cherry	*Prunus serotina*	FACU
Gray birch	*Betula populifolia*	FAC
Purple loosestrife	*Lythrum salicaria*	FACW+
Grape	*Vitis* sp.	
Canada mayflower	*Maianthemum canadense*	FAC-
Round-leaf wintergreen	*Pyrola rotundifolia*	FAC

The U.S. Fish and Wildlife Service (USFWS) has reviewed the FEIS for the I-93 Project, has attended natural resource agency coordination meetings in which the details of the mitigation package were presented, and has expressed their approval. In addition, the State Historic Preservation Office (SHPO) has provided the required approvals for the project and has determined there were no cultural resource concerns.

4.0 Wetland Design & Construction

4.1 Design Elements Related to Principal Wetland Functions

The proposed mitigation designs are intended to provide replacement for the principal wetland functions and values impacted by the project: floodflow alteration, sediment/toxicant retention, nutrient removal, and wildlife habitat (or more generally, biological productivity). See Section 2.0.

4.1.1 Floodflow Alteration (Flood Storage)

One of the most important functions performed by the majority of wetlands impacted by the highway widening project is floodflow alteration or flood storage. Concerns were expressed by the U.S. Army Corps of Engineers (USACOE), the U.S. Environmental Protection Agency (EPA) and the New Hampshire Department of Environmental Services (NHDES) that the project should not contribute to the additional loss of flood storage.

One of the design goals in the FEIS for all five sites proposed for wetland mitigation is the replacement of flood storage. This compensatory flood storage will be augmented by up to 14 flood storage basins to be constructed adjacent to flood susceptible brooks and rivers along the I-93 corridor, and at locations upgradient or higher in the watershed from the flood prone areas along the Spicket River (i.e., in both the towns of Salem and Windham). Approximately 50 extended-detention basins are also being proposed for both water quality treatment and stormwater storage at a number of locations along the widened highway. These basins are typically designed to store up to a 50-year storm event before discharging to a nearby watercourse.

Flooding in Salem has historically been a serious problem and early coordination between the Town and NHDOT indicated that the creation of additional flood storage along the Spicket River was of the highest priority. The Spicket River watershed Association, with representatives from both Massachusetts and New Hampshire, reinforced this. Although the amount of proposed grading to create additional wetlands within the Baggett site is relatively minor, the amount of additional flood storage is estimated to be one acre foot.

The Highway Median site lies slightly upgradient from Canobie Lake. The site is not included within the mapped floodplain associated with the Lake, however no elevation data is listed in the Flood Insurance Study for Windham or the FIRM panel. The proposed wetland restoration within the median site is estimated to be 2.5 acre feet.

The ability of a wetland to function in floodflow alteration is dependent upon its storage capacity and position in the watershed. Effective desynchronization of downstream peak flows is a function of a wetland's outlet size and elevation. Design elements which typically promote floodflow alteration and storage include[6]:

- A basin-like morphology to increase available floodwater storage.
- Plant establishment with wetland species which are well adapted to the specific planting location (for high productivity and density).

[6] Marble, A.D. 1990. A Guide to Wetland Functional Design. U.S. Department of Transportation, Federal Highway Administration. Report No. FHWA-IP-90-010. 230 pp.

- Establishment of persistent vegetation which provides increased frictional resistance to flowing water.
- A minimal amount of open water in relation to the total wetland area.
- A maximum amount of area where water depth does not exceed 50 percent of plant height.
- Absence of an outlet which limits the rate of discharge from the site.

Both the Baggett and Highway Median sites include the items listed above however both have an ephemeral connection to downstream resources. The intent of the design is to prolong surface waters passing through the sites. The planned excavation will provide storage volume for flood waters which is currently unavailable.

4.1.2 Water Quality Treatment

Both sediment/toxicant retention and nutrient removal are key components of a wetland's water quality treatment function. The design elements for both are similar as discussed below.

The ability of a wetland to provide treatment and attenuation of water-borne pollutants in surface runoff is a function of its size in relation to the watershed, the period of surface water detention or retention, and the density and type of vegetation within the wetland. The proposed wetlands will be supported by both groundwater and surface water, where surface water input will occur during storm events generating surface water flows.

The present designs provide for treatment of surface water through removal of suspended solids (sediments) and nutrients. As the flow velocity of surface water is reduced in the wetland through contact with vegetation and the presence of a large still water body, suspended solids will settle out of the water column during its detention and be deposited in the wetland. Any pollutants that are attached to the sediments will also be removed from the water column. Prolonged contact of water borne pollutants with the vegetation/soil interface as occurs in low gradient and ponded wetlands also encourages nutrient uptake by the plants and chemical breakdown of some pollutants through microbial activity. Specific design elements intended to address these processes include[7]:

- Plant establishment with multi-stemmed wetland species that are well adapted to the specific planting zone enabling dense and productive vegetative establishment.
- Promotion of dense emergent development at the edge of open water areas.
- Basin development with a constricted outlet to maximize retention time.
- Flat slopes that minimize the velocity of surface runoff into the wetland.
- Vegetated zones lined with highly organic soil amendments to increase toxicant retention efficiency.

4.1.3 Biological Productivity (including Wildlife Habitat)

The productivity of the Highway Median site will be greatly enhanced by the restoration of former wetlands under the roadway to be abandoned.

[7] Marble, A.D. 1990. A Guide to Wetland Functional Design. U.S. Department of Transportation, Federal Highway Administration. Report No. FHWA-IP-90-010. 230 pp.

The goal of the Baggett site is to enhance productively primarily within areas currently impacted by past development near Route 38 and providing additional habitat diversity.

The present designs will enhance the biological productivity function so as to promote long term biological health and diversity of the site. Basic site factors such as slope, basin configuration, water quality and quantity, water level variation, and substrate are important in terms of plant productivity, species composition, and system stability. Diversity in cover type and terrain, including vegetative layering, and open water-vegetation interspersion are all important factors influencing wildlife habitat value. Specific design elements which typically address biological productivity include:

- Variable shape and grading to increase "edge effect" between zones.
- Creation of limited areas of open water interspersed with several vegetated classes to increase habitat diversity and interspersion.
- Plantings of trees, shrubs, and emergents arranged in separate and distinct clusters rather than concentric zones.
- Locating species within and among groupings according to their specific environmental requirements.
- Preservation of coarse woody debris in all salvaged topsoil to provide refuges for amphibian larvae and adults (e.g., mole salamanders and wood frogs).
- Provision of logs, stumps and boulders as hiding, perching, or loafing sites for wildlife.
- Planting of native species typical of natural or undisturbed wetlands in the region and which have high wildlife food value.
- Provision of a highly organic substrate (i.e., use of salvaged wetland topsoil or a clean compost mix with a high organic content) to increase primary productivity.
- Establishment of side slopes of 10:1 or less whenever practicable.

4.2 Design Constraints

Aside from the potentially conflicting objectives of both flood storage and increasing biological productivity, there are no major site constraints affecting the design. The presence of the community well east of the Highway Median site is not anticipated to influence surface or shallow groundwater levels. The abutting residents to the Baggett site may have concerns over the creation of additional surface waters and perceptions for the potential of mosquito-borne illnesses which should be controlled by natural predictors. There are no known hazardous materials concerns. No airports are near the sites, so there are no constraints as to attract waterfowl or other birds that might pose a threat to aircraft.

4.3 Phased Construction

Phased development of the mitigation area so that it is concurrent with highway construction is necessary to facilitate the excavation and salvage of sufficient quantities of wetland humus and topsoil. A determination will also be made of the suitability of any excess borrow material from the mitigation site for use as fill for the new highway. It is anticipated that much of the existing topsoil within the Baggett site will be temporarily stock-piled and re-used on-site. Clearly,

restoration of former wetlands within the Median site will generate a substantial quality of suitable fill for roadway construction. However, this work cannot proceed until traffic has been shifted to the new northbound lanes which will delay the construction of this site. No soil contamination issues are anticipated.

Construction of the mitigation areas will require extensive grading. Care will need to be exercised in minimizing activities within the finish graded areas to prevent sedimentation and disturbance of substrate soil structure, e.g., compaction. Excavation can be performed at any time of year, however construction during the late summer will enable excavation to occur with minimal or no dewatering. Tree and shrub planting can be performed throughout the growing season if certain precautions relative to watering and pruning are followed. Bare-rooted or dormant woody stock will have to be planted in the spring. Herbaceous plants should also be planted in the spring. As the planting zones are excavated and finish grades established, erosion controls will need to be installed to prevent silt and sediment from accumulating in the specific zone. Sequencing and scheduling of excavation and planting will be up to the site contractor, however construction activities will incorporate the recommended planting windows as specified by NHDOT.

All wetland construction will be overseen by a certified wetland scientist who will work closely with NHDOT's site engineer to insure conformity with the design elements related to proposed wetland functions of the site. NHDOT will be the sole responsible party with full financial assurance of the state of New Hampshire for the construction of the mitigation sites.

4.4 Construction Timing/Sequencing

As described above, the wetland mitigation will need to be completed in phases. A pre-construction conference will be held with the contractor, the NHDOT's site engineer, their wetlands consultant, and an Army Corps representative to ensure a thorough understanding of the construction plan. An example of the proposed construction sequence follows but is ultimately the responsibility of the contractor performing the mitigation construction.

1. Contact nursery to order plant stock and schedule delivery window. Provide adequate time for site preparation prior to scheduled delivery of plant materials.

2. Install erosion control measures between areas to be disturbed and existing wetlands and/or waterbodies (as shown on final plans).

3. Establish sub-grade contours within mitigation sites. Construct temporary drainage/dewatering structures as required. Contact Army Corps for inspection.

4. Remove wetland topsoil from areas of large wetland impact and stockpile onsite. Inspect these areas for invasive plants before salvaging the wetland topsoil.

5. Spread and till topsoil mix within areas to be planted, seed and install erosion control measures as necessary.

6. Initiate planting schedule as seasonally appropriate.

7. Develop as-built plans if required and conduct onsite inspection with Army Corps for their sign-off.

8. Complete permanent seeding and landscaping. Install temporary irrigation system.

9. Initiate monitoring program.

10. Remove temporary erosion control measures after vegetation is established.

11. Remove temporary irrigation system after 2 years.

12. Take remedial actions annually as necessary.

5.0 Hydrology

5.1 Water Budget Analysis

Precipitation

Precipitation data for the area were obtained from the NOAA's Nashua, New Hampshire, station. The data are very similar to a longer record from Salem/Beverly that was analyzed in detail in Berger (2002)[8] (Table 5.1). Data from both stations indicate that the average monthly precipitation in the area is fairly uniform throughout the year. However, as expected, the monthly rates can vary from year to year as reflected by the minimum and maximum rainfall amounts.

Table 5.1: Precipitation at two gauging stations in the area

	Nashua, NH (1971-2002)[1]	Salem/Beverly, MA (1950 - 2002)[2]		
Month	Mean rainfall (inch)	Mean rainfall (inch)	Minimum rainfall (inch)	Maximum rainfall (inch)
Jan	3.86	3.68	0.37	11.07
Feb	3.09	3.36	0.36	7.30
Mar	4.07	3.93	0.67	12.27
Apr	3.92	3.78	0.49	13.17
May	3.66	3.39	0.63	9.73
Jun	3.91	3.12	0.00	11.70
Jul	3.70	3.17	0.31	7.53
Aug	3.78	3.29	0.78	10.63
Sep	3.63	3.36	0.40	9.15
Oct	3.93	3.85	0.30	14.11
Nov	4.17	4.39	0.46	10.08
Dec	3.71	3.93	0.86	9.30
Annual	45.43	43.20	26.47	58.16

[1]NOAA
[2]Salem Beverly Water Supply Board in Massachusetts

The total annual rainfall amount was 45 inches in Nashua, and 43 inches in Salem/Beverly. The data from Salem/Beverly are considered to be characteristic for the two wetland mitigation sites as well.

[8] Berger (Louis Berger Group, Inc.), 2002, *North Coastal Ipswich Basins Stormwater Sampling, Analysis, and Assessment Assistance*, §104(b)(3) Wetlands Ecological Assessment Project (Project No.: 97-01/104). Prepared for Executive Office for Environmental Affairs, Massachusetts Coastal Zone Management Office.

Baggett Property

Existing Conditions

Other than the constructed drainage channel along the highway embankment, there are no surface water streams within the drainage area of the Baggett site. The contributing watershed receives a total of 1.7 million cubic feet (cf) of direct precipitation per year.

The Baggett site is located immediately adjacent to an aquifer in the west. The aquifer consists of coarse-grained stratified drift deposits (medium sand to cobble) that were deposited by glacial meltwater[9]. It has a saturated thickness of over 40 feet and a transmissivity of 1,000 to 2,000 feet squared per day. Groundwater moves in an easterly direction, i.e., from the aquifer toward the Baggett site. Deposits of the Baggett site consist of fine-grained stratified drift deposits (clay to fine sand). The saturated thickness of these deposits is between 20 and 40 feet and the transmissivity of the groundwater is less than 1,000 feet squared per day.

The groundwater table of the Baggett site is close to the surface. Surface elevations of the site range from 128 to 130 feet. The elevations of the existing wetlands range from 128 to 129 feet. The groundwater table elevation in a monitoring well in the northern part of the Baggett site was observed at approximately 127 feet on May 31, 2006; this well was recently installed by NHDOT.

Proposed Conditions

The proposed plan is to excavate part of the upland area of the site to elevations as low as 125 feet (Figure 5). The widening of the southbound barrel will eliminate 0.38 acres of the 1.88 acres of existing wetlands. The newly created wetland will have an area of 1.2 acres, resulting in a total wetland area of 2.6 acres at the Baggett site.

Wetland boundaries within the Baggett Property were recently field verified. There is a relatively large forested wetland which contains a drainage channel extending from the adjacent mobile home park. This wetland is a mix of white pine and red maple with fairly pronounced mound-and-pool microtopography. These cover type would be classified as PFO4/1En[4]. Smaller depressional wetlands to the east are primarily red maple swamps (PFO1En[4]) with a few scattered white pines. There are no pronounced drainage patterns within these smaller wetland pockets. Standing water depths within the depression appear to be too shallow to support vernal pool species. The base elevation of these wetlands is approximately 128 feet. Based on the Geomorphic ID Classification[5] system, the wetlands would be considered depressional with an ephemeral outlet.

Due to the presence of several small forested wetlands within the Baggett site (discussed in Section 3.4), construction of the mitigation site will involve alternation to approximately 6,200 square feet of existing wetland habitat. Most of the impacts are associated with the required relocation of the existing channel which will be redirected through the mitigation area. In order to promote circulated of surface waters through the site, excavation within existing wetlands is necessary in several locations. These impacts are anticipated to be minor in nature and will be modified in the field as necessary to minimize any impacts. It is anticipated that most of the work

[9] Stekl, P.J. and S.F. Flanagan, 1992, Geohydrology and water quality of stratified-drift aquifers in the Lower Merrimack and Coastal River Basins, Southeastern New Hampshire. U.S. Geological Survey, Denver, CO.

within existing forested wetlands can be accomplished with leaving most of the overstory in tract. Work in uplands on the Baggett property will require excavation within both the disturbed portion of the property (location of the former residence) as well as forested uplands further to the south. Attempts will be made to maintain existing specimen trees during both final design and field modifications.

The drainage area of the site will decrease slightly from currently 10.2 to 9.7 acres due to the widening of I-93 (Figure 2). The drainage channel from the existing wetland will be redirected into the proposed wetland area. Runoff from the wetland will enter the 24 inch RCP underneath I-93 and continue from there to Policy Brook.

Success for the wetlands at the Baggett Property site is anticipated due to the existing relatively high groundwater table and the capacity of the underlying stratified drift deposits to store and release large volumes of groundwater. The additional wetland area is a small portion of the existing wetlands found both to the east and west of the southbound barrel of Route I-93. However, presently available groundwater monitoring data are still very limited. Two additional monitoring wells and test pit investigations are planned once conditions improve for better site access later this month. The hydrological analysis for this site will be refined once data from these wells and pits become available.

A year-round groundwater monitoring program of installed wells has been initiated. This monitoring involves monthly measurements and is expected to run for 1-2 years. At its completion, the design assumptions made will be re-examined to determine if any adjustments are warranted relative to the presumed elevations for each wetland class.

Existing Conditions

Within the Highway Median, the northbound barrel of the highway divides a formerly single wetland area at the site. The western wetland is located in the median strip of the highway, covering an area of approximately 9.5 acres. It has a drainage area of 78 acres (Figure 4). The eastern wetland is located to the east of the northbound barrel of I-93, covering an area of 7.8 acres, including a 1.6-acre area of recently restored wetland. The eastern wetland has a drainage area of 26 acres. The western and eastern wetlands of the Highway Median site are connected via a 30" RCP in the northern portion of the site. Occasionally, the water level in the western wetland is affected by beavers that partially block the outflow.

The eastern wetland is connected to Canobie Lake via a 30 inch culvert underneath West Shore Road. The elevation of Canobie Lake is shown as 219 feet on the USGS map. The baseline survey information from NHDOT recorded the lake at an elevation of 220.0 feet, i.e., 0.8 feet lower than the eastern wetland at the time of the survey. According to Mr. Bill Daly (Salem Water Department, pers. communication, June 2, 2006) the elevation of the lake typically ranges between 215 and 220 feet, depending on precipitation, water usage, and season. The spillway for the lake is at an elevation of approximately 220 feet, thereby limiting the likelihood of flooding of the wetlands of the Highway Median Site.

Direct Rainfall

With an average annual precipitation rate of 45 inches, the western wetland receives 1.55 million cubic feet (cf) of direct rainfall. The eastern wetland receives 1.27 million cf of direct rainfall per year.

Surface and Stormwater Inflow

Surface water inflow to the wetland consists of stormwater as point source runoff from I-93 and overland flow from the surrounding watershed. Ephemeral drainages enter the wetland from the surrounding hillsides. Runoff from each barrel of the highway enters an unlined swale. Runoff from the swale enters catch basins along the swale from which the runoff flows through a pipe into the wetland. Runoff from the southbound barrel enters the western wetland. Runoff from the northbound barrel is divided, entering both the western and eastern wetland. The total annual volume of water entering the wetlands (R_w) is estimated as follows:

$$R_w = A_{is} \times R_a \times LF_i$$

where

A_{is} is the impervious surface of the highway:

Western wetland:	northbound barrel: 0.53 acres
	southbound barrel: 1.51 acres
Eastern wetland:	northbound barrel: 1.77 acres
	southbound barrel: no inflow

R_a annual rainfall (i.e., 45 inches)

LF_i is the estimated loss factor as a result of infiltration into the ground along the swale. Rainfall of storms with low rainfall amounts will infiltrate the swale completely. We used a rough estimate of 30% for the annual rainfall entering the wetland.

Using these values, the estimated annual inflow of stormwater from I-93 is 0.10 million cubic feet (cf) to the western wetland and 0.09 Million cf to the eastern wetland. These volumes are small relative to the direct rainfall received by each wetland.

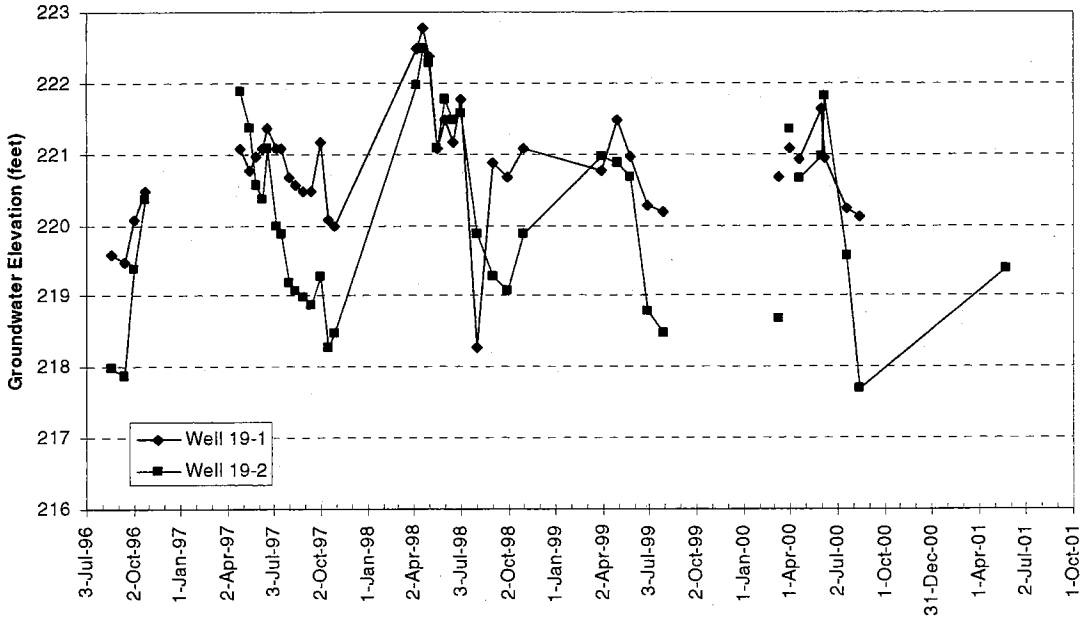
Runoff via surface water flow from the remaining sections of the watershed is considered small as the land is largely undeveloped. The drainage area consists of forested areas, a wetland in the south that drains into the western wetland of the Highway Median Site, a meadow, a few residences, and Range Road. It is expected that much of the rainfall infiltrates into the ground rather than result in surface water runoff.

Groundwater

In general, the subsurface of the center of the western wetland consists of deep peat (upper 3 feet), underlain by 13 feet of outwash deposits over bedrock (McFarland-Johnson, 2002). The depth to groundwater in the reconstructed eastern wetland was monitored at two wells by the NHDOT from 1996 to 2001(Exhibit 1). Well 19-1 was located approximately in the center of the eastern wetland; Well 19-2 was located further to the east, close to West Shore Road. Given the elevation of the eastern wetland of between 220.3 and 220.8 feet, the groundwater level is above or close to the wetland surface most of the time. The generally lower levels in Well 19-2 are a result of sloping of the groundwater between the wetland to the west and Canobie Lake to the east (McFarland-Johnson, 2002)[10]. Groundwater elevations for the western wetland are not available.

[10] McFarland-Johnson, 2002, Memorandum from Jed Merrow to the File, Windham-Salem Mitigation Site 19, Hydrology Determination. January 24, 2002.

Exhibit 1: Groundwater elevations at the Highway Median Site, eastern wetland (Source: NHDOT, 2006)



The groundwater flows into the wetlands of the Highway Median Site are not known. It is likely that the groundwater flows and the elevation of the groundwater table are partially controlled by the elevation of the water level in Canobie Lake.

Proposed Condition

The proposed plan is to reconnect the eastern and western wetlands by removing the fill underneath the northbound barrel of I-93 (Figure 7). The total area of the combined wetland will be 20.1 acres, thereby increasing the combined area of the existing eastern and western wetland by 16%. The total drainage area to the combined wetland will be 106 acres.

The widening of I-93 will increase the impervious surface area (A_{is}) that discharges into the combined wetland to approximately 3.2 acres for the northbound barrel, and 3.7 acres for the southbound barrel. The runoff from I-93 will again enter swales and catch basins. However, swales will be lined with an impervious geomembrane. There will also be two or three detention basins along the highway. The forebay of the detention basins will be lined and have gated outlet control structures for spill containment. The main section of detection basin will be unlined. The basin will be designed to hold the runoff from a 50-year storm.

The estimated annual runoff from I-93 to be received by the combined wetland is 0.45 Million cf, assuming that 40% of the annual runoff from the highway is received by the wetland. This load represents an increase by a factor of 2.4 over present conditions, but is still small relative to the total direct rainfall of 3.3 Million cf that is received by the combined wetland.

In addition to runoff from I-93, the wetland will likely receive some point-source discharge from Range Road. Range Road will be realigned and part of the stormwater runoff will be collected

via a closed drainage system and discharged into the Highway Median wetland. Details of the drainage system for Range Road are still under design.

Based on the available information, the hydrology of the proposed project is not expected to adversely impact the combined wetland for a number of reasons:

- The combined wetland existed before fill placement during the construction of the northbound barrel divided the wetland into two parts. The wetland mitigation at the Highway Median site merely restores the former wetland.

- The wetland is expected to receive increased stormwater runoff from Route I-93 relative to present conditions because widening of the highway with result in a larger impervious surface area, and the lining of the swales will reduce infiltration of stormwater. However, the total volume of stormwater is small relative to input from direct rainfall.

- The elevation of the groundwater table for the eastern wetland is high. The elevation of the groundwater in the western wetland is expected to be generally similar. The groundwater elevation is not expected to change markedly by the wetland mitigation project, as the groundwater table is in all likelihood closely linked to the level of Canobie Lake.

5.2 Groundwater Monitoring

Three monitoring wells were recently installed within the Highway Median site to both characterize the nature of the fill material and confirm general consistency of water levels to the adjacent wetlands. A single reading of the recently installed wells during late May of 2006 indicated ground water levels were generally similar to surface water elevations within the adjacent wetland (between 221-222 feet).

A year-round groundwater monitoring program of installed wells has been initiated. This monitoring involves monthly measurements and is expected to run for 1-2 years. At its completion, the design assumptions made will be re-examined to determine if any adjustments are warranted relative to the presumed elevations for each wetland class.

6.0 Site Design – Overview

6.1 Grading Plan

The grading plans for the Baggett and Highway Median mitigation sites are shown on Sheet 6 of 16 of the Plan Set. Excavation of the wetland zones, will be one-foot lower than finish grades to accommodate the placement of wetland topsoil.

6.2 Soils Plan

The soils plans for the Baggett and Highway Median sites are shown on Sheet 7 of 16 of the Plan Set.

6.2.1 Requirements

The current Army Corps guidelines for wetland topsoil requiring a 4-12 percent minimum organic content (9-21 percent organic matter) will be followed. A minimum of 12 inches will be applied in all wetland areas.

6.2.2 Proposed Source

Soils salvaged from wetlands impacted by the project and free of invasive species will be used to provide topsoil for the constructed wetlands. Should there be insufficient available, a commercial supplier capable of manufacturing topsoil to particular specifications from clean leaf compost will be utilized. See also Section 6.7 below.

6.3 Planting Plan

The planting plans for the Baggett and Highway Median mitigation sites are shown on Sheets 8-16 of the Plan Set.

6.3.1 Description of Community Types

The following elevations, along with the resulting acreage of created wetlands, were assumed for the respective zones within the mitigation sites:

Baggett Site

Class	Elevation (feet)	Acres Created
Shallow Marsh	125-126	0.19
Scrub –Shrub (with mound & pool microtopography)	126-127	0.20
Forested Wetland (with mound & pool microtopography)	127-128	0.82
	Total	**1.21**

Highway Median Site

Class	Elevation (feet)	Acres Created
Shallow Marsh	219-221	1.13
Scrub –Shrub (with mound & pool microtopography)	221-222	0.31
Forested Wetland (with mound & pool microtopography)	222-223	1.63
	Total	**2.97**

6.3.2 Species Lists by Types

The planting plan will give preference to native plant species already found in wetlands onsite. See Table 3-2 for a list of species compiled in the spring of 2006.

Table 6-1 provides a more complete list of species suitable for the various proposed vegetation zones that can be used to supplement the local list. It is also desirable to salvage sod or root mats from wetlands that will be impacted by the highway construction (in addition to simply salvaging soils, see Section 6.2.2 above). The practicability of this will need to be explored further for NHDOT.

All planting and seeding will be monitored by a wetland scientist to insure compliance with design plans.

Table 6-1: Planting Schedule for the Various Zones within the Mitigation Site

Name	Indicator Category	Type/Size	Planting Density
Aquatic Bed (water depth >3')			
Arrowhead *(Sagittaria latifolia)*	OBL	root stock	2' o.c.
Arrow Arum (*Peltandra virginica*)	OBL	root stock	2' o.c.
Pickerelweed *(Pontederia cordata)*	OBL	root stock	2' o.c.
Pond Weed (*Potomageton pectinatus*)	OBL	root stock	2" o.c.
Water Smartweed *(Polygonum amphibium)*	OBL	root stock	2' o.c.
Wild Celery (*Vallisnaria Americana)*	OBL	root stock	2" o.c.
Yellow Water Lilly *(Nuphar lutem)*	OBL	root stock	2' o.c.
Emergent Marsh (water depth 6"-3')			
Arrowhead *(Sagittaria latifolia)*	OBL	root stock	2' o.c.
Arrow Arum (*Peltandra virginica*)	OBL	root stock	2' o.c.
Blue Flag *(Iris versicolor)*	OBL	root stock	2' o.c.
Burreed *(Sparganium eurycarpum)*	OBL	root stock	2' o.c.
Fringed Sedge (*Carex crininta*)	OBL	seed/plug	2' o.c.
Pickerelweed *(Pontederia cordata)*	OBL	root stock	2' o.c.
Soft Stem Bulrush (*Scirpus validus*)	OBL	plug	2" o.c.
Soft Rush *(Juncus effuses)*	FACW+	plug	2' o.c.
Tussock Sedge *(Carex stricta)*	OBL	plug	2' o.c.
Wool Grass *(Scirpus cyperinus)*	FACW+	seed/plug	2' o.c.
Wet Meadow (water depth 0-6")			
Fox Sedge (*Carex vulpinoidea*)	OBL	seed/plug	2' o.c.
Fringed Sedge (*Carex crininta*)	OBL	seed/plug	2' o.c.
Hop Sedge (*Carex lupulina*)	FACW+	seed/plug	2' o.c.
Lurid Sedge (*Carex lurida*)	OBL	seed/plug	2' o.c.
Mannagrass (*Glyceria septentrionalis*)	OBL	seed/plug	2' o.c.
Redtop Grass (*Agrostis alba*)	FAC	seed/plug	2' o.c.

Soft Rush (*Juncus effuses*)	FACW+	seed/plug	2' o.c.
Switchgrass (*Panicum virgatum*)	FAC	seed/plug	2' o.c.
Tussock Sedge (*Carex stricta*)	OBL	seed/plug	2' o.c.
Wool Grass *(Scirpus cyperinus)*	FACW+	seed/plug	2' o.c.
Shrub/Forested Swamp			
Arrowwood *(Viburnum dentatum)*	FAC	container/2'-3'	6' o.c.
Winterberry Holly *(Ilex verticillata)*	FACW+	container/2'-3'	6' o.c.
Pussy Willow *(Salix discolor)*	FACW	container/2'-3'	6' o.c.
Silky Dogwood *(Cornus amomum)*	FACW	container/2'-3'	6' o.c.
Highbush Blueberry *(Vaccinium corymbosum)*	FACW	container/2'-3'	6' o.c.
Speckled Alder *(Alnus rugosa)*	FACW+	container/2'-3'	6' o.c.
Red Maple *(Acer rubrum)*	FAC	container/4'	9'o.c.
Swamp White Oak *(Quercus bicolor)*	FACW+	container/4'	9'o.c.
Green Ash *(Fraxinus pennsylvanica)*	FACW	container/4'	9'o.c.
Gray Birch *(Betula populifolia)*	FAC	container/4'	9'o.c.
Northern Arrowwood (Viburnum *recognitum*)	FACW-	container/2'-3'	6' o.c.
Upland/Wetland Transition			
American Cranberry (*Viburnum trilobum*)[1]	FACW	container/2'-3'	6' o.c.
Eastern Hemlock *(Tsuga canadensis)*	FACU	ball & burlap/5'	9'o.c.
Red-osier Dogwood (*Cornus sericeaa*)	FACW+	container/2'-3'	6'o.c.
Broad-leaved Meadow Sweet *(Spirea latifolia)*	FAC	container/2'-3'	6' o.c.
Eastern White Pine *(Pinus strobus)*	FACU	ball & burlap/3'	6' o.c
Eastern White Pine *(Pinus strobus)*	FACU	3 gal container/3'	6' o.c
Nannyberry (*Viburnum lentago*)	FAC	container/2'-3'	6' o.c.
Witch Hazel *(Hamamelis virginiana)*	FAC-	container/2'-3'	6' o.c.
American Hazelnut *(Corylus americana)*[1]	FACU-	container/2'-3'	6' o.c.
Red Oak *(Quercus rubra)*	FACU-	bare root/ 2-1 trans.	9'o.c.
Chokecherry (*Prunus virginiana*)	FACU	container/2'-3'	6' o.c.
Grey Birch (*Betula populifolia*)	FAC	container/2'-3'	6' o.c.
River Bank Grape (*Vitis riparia*)	FACW	container/2'-3'	6' o.c.
Oblong-Leaf Service Berry (*Amelchancier canadensis*)	FAC	container/2'-3'	6' o.c.
Silky Dogwood (*Cornus amomum*)	FACW	container/2'-3'	6' o.c.
Black Chokeberry (*Aronia melanocarpa*)	FAC	container/2'-3'	6' o.c.
Upland Restoration/Enhancement			
Crab Apple (*Malus* cultivars- Indian Summer, Manchurian, Snowdrift, Profusion, or Golden Hornet[1]	UPL	ball & burlap/3'.	9'o.c.
White Oak (*Quercus alba*)	FACU-	ball & burlap/3'	9'o.c.
Eastern White Pine (*Pinus storbus*)	FACU	ball & burlap/3'	6' o.c.

Eastern White Pine (Pinus strobus)	FACU	3 gal container/3'	6' o.c.
Shagbark Hickory (*Carya ovata*)[1]	FACU-	ball & burlap/3'	9'o.c.
Nannyberry *(Viburnum lentago)*	FAC	container/2'-3'	6' o.c.
Northern Bayberry (Myrica pensylvanica) [1]	FAC	container/2'-3'	6' o.c.
Cockspur Hawthorn (*Crataegus crus-galli*) [1]	FACU	container/2'-3'	6' o.c.
Sweet Fern *(Comptonia peregrina)*	UPL	1 gallon container	3' o.c.

[1] Wildlife habitat improvement species.

During construction, seeding will take place immediately after the application of topsoil to ensure rapid coverage for the site. The seed bank within the transplanted soils will also contribute to this initial flush of vegetation. Depending on the location (planting zone), one of the following seed mixes will be used (see details on Plan Sheet 9).

Table 6-2: Wetland Seed Mix

Botanical Name	Common Name	Lbs/Acre
Agrostis alba	Redtop Grass	6.0
Asclepias incarnata	Marsh Milkweed	0.5
Carex vulpinoidea	Fox Sedge	2.0
Festuca rubra	Creeping Red Fescue	10.0
Polygonum pensylvanicum	Knotweed	3.0
Verbena hastata	Blue Vervain	2.0
Total lbs/acre		23.5*

*Seeding Rate = 23.5 lbs. (Pure Live Seed)/Acre

Table 6-3: Upland Seed Mix

Botanical Name	Common Name	Lbs/Acre
Chrysanthemum leucanthemum	Ox Eye Daisy	3.50
Coreopsis lanceolata	Lanceleaf Coreopsis	4.25
Cichorium intybus	Chicory	1.50
Oenothera lamarckiana	Evening Primrose	1.50
Festuca rubra	Creeping Red Fescue	8.00
Giallardia puchella	Indian Blanket	3.75
Hesperis matronalis	Dames' Rocket	1.50
Polygonum pensylvanicum	Knotweed	1.50
Rudbeckia hirta	Black-eyed Susan	3.00
Total lbs/acre		28.50*

*Seeding Rate = 28.50 lbs (Pure Live Seed)/Acre

The above mixes contain only native species, are appropriate for erosion control, and also provide wildlife habitat value.

6.4 Irrigation and Special Requirements (Mulch)

Irrigation for no longer than two years will be required to ensure high survival of the planted material. The bases of all woody stock will also be surrounded by mulch to preserve moisture.

6.5 Coarse Woody Debris and Rocks

During the salvage of wetland soils from impacted wetlands, every attempt will be made to also retrieve coarse woody debris like stumps with roots attached, fallen trees, etc. The goal will be to have at least 4 percent of the ground at the mitigation site covered with this woody debris. Since boulders are not a characteristic feature of outwash deposits, a very limited number of boulders or large rocks will also be collected and placed within the Baggett Site. Boulders and large rocks will be placed more conspicuously within the Highway Median site due to its different geomorphic setting and the presence of shallow bedrock and ledge.

6.6 Erosion Control

NHDOT's standards for erosion and sedimentation control will be followed during all phases of the wetland construction.

6.7 Invasive and Noxious Species

All the proposed plant stocks, including the seed mixes, are native or indigenous species. None of the species is found on the Army Corps' list of invasive species. In addition, all locations along the highway corridor that are identified for possible salvaging of wetland soil will be inspected by a wetland scientist to determine if they are free of invasives. Should invasive species be present, the site will be rejected and alternative locations sought.

Should insufficient topsoil be available, a commercial source such as Agresource Inc. (Amesbury, MA) will be sought. Suitable topsoil of a specified organic content can be manufactured from leaf compost that is typically available from municipalities during the fall season. Leaf compost has the advantage in that it is relatively "clean" or free from weed seeds that might include invasive species.

After construction, the wetland will be inspected twice per year for five years (see Section 7.0). If invasives are found they will be removed at the appropriate time in the growing season to prevent further propagation. Recommended protocols for removal published by NHDES and similar agencies will be followed.

6.8 Limitations on Off-Road Vehicle Use

Both the Baggett and Highway Median site will be fenced (as necessary) and signed to indicate that motorized vehicles are not allowed. At the Baggett Site, fencing can be placed along the right-of-way of Lowell Street as well as the property limits of the existing mobile home park abutting the mitigation site. Details associated with the removal of the former highway roadbed are still under discussion with the Town of Windham and abutting private owners. Pending resolution of this issue, appropriate measures will be developed to limit off-road vehicle use.

6.9 Buffer Preservation

The mitigation design intentionally preserves and enhances available buffer habitat associated with both mitigation sites. The Median site is contiguous with the Windham-Salem Mitigation Site and its associated buffer. In addition, the former highway roadbed will be removed to enhance available habitat abutting both ends of the mitigation site. Both the Median and Baggett sites include extensive planting within the upland buffer to provide a visual screen from Route 111A and Lowell Road, respectively. The Baggett site also attempts to retain a vegetated buffer between the site and the adjacent mobile home park.

After construction of the wetlands, the entire mitigation site, including all unimpacted wetlands and upland, will be preserved in perpetuity. As required by the Corps Guidance document, the following language is included herein:

Within 30 days of the date of permit issuance, the permittee (NHDOT) shall execute and record the preservation document with the Registry of Deeds for the Town of Salem and/or Windham and the State of New Hampshire. A copy of the executed and recorded document must then be sent to the Corps of Engineers within 90 days of the date it was recorded.

The State of New Hampshire will execute a deed restriction that will place a conservation easement on both properties to be held by the respective municipalities to ensure that the both sites will remain protected. Both of the site designs, as well as the size of the existing NHDOT land holdings allow sufficient upland buffers to adjacent properties.

7.0 Monitoring

During the first full growing season after construction, and for four subsequent years, the mitigation site will be evaluated at least once in the late spring/early summer and again in late summer/early fall. The observations will be compared to the Success Standards listed in the *Guidance For Mitigation Plan Checklist* (USACOE June 15, 2004). A formal post-construction assessment will also be performed after the fifth growing season.

As required by the Corps *Guidance* document, the following text is included herein.

7.1 Monitoring Plan Guidance

If mitigation construction is initiated in, or continues throughout the year, but is not completed by December 31 of any given year, the permittee (NHDOT) will provide the Corps, Policy Analysis and Technical Support Branch, a letter providing the date mitigation work began and the work completed as of December 31. The letter should be sent no late than January 31 of the next year. The letter must include the Corps permit number.

For each of the first five full growing seasons following construction of the mitigation site, the site shall be monitored. Observations will occur at least two times during the growing season – in late spring/early summer and again in late summer/early fall. Each annual monitoring report shall be submitted to the Corps, Regulatory Division, Policy Analysis and Technical Support Branch, no later than December 15 of the year being monitored. Failure to perform the monitoring and submit monitoring reports constitutes permit non-compliance. Each report coversheet shall indicate the permit number and report number (Monitoring Report 1 of 5, for example). The reports shall answer the following success-standard questions and shall address in narrative format the items listed after the questions. The reports shall also include the monitoring report appendices listed below. The first year of monitoring shall be the first year that the site has been through a full growing season after completion of construction and planting. For these special conditions, a growing season starts no later than May 31. However, if there are problems that will need to be addressed and if the measures to correct them require prior approval from the Corps, the permittee shall contact the Corps by phone, email or letter as soon as the need for corrective action is discovered.

Remedial measures shall be implemented at least two years prior to the completion of the monitoring period- to attain the success standards described below within five growing seasons after completion of construction of the mitigation site. Should measures be required within two years of the end of the monitoring period, the monitoring period will be extended to ensure two years of monitoring after the remedial work is completed. Measures requiring earth movement or changes in hydrology shall not be implemented without written approval from the Corps.

At least one reference site adjacent to or near each mitigation site is described and shown on a locus map and the monitoring report.

7.2 Success Standards

The Success Standards as listed in the *Guidance* are described below and summarized in Table 7-1. These standards will be implemented by NHDOT for the Baggett and Median sites as appropriate.

1) Does the site have at least 500 trees and shrubs per acre, of which at least 350 per acre are trees for proposed forested cover types, that are healthy and vigorous and are at least 18" tall in 75% of each planned woody zone AND at least the following number of non-exotic species including planted and volunteer species? Volunteer species should support functions consistent with the design goals. To count a species, it should be well represented on the site (e.g., at least 50 individuals of that species per acre).

# species planted	minimum # species required (volunteer and planted)
2	2
3	3
4	3
5	4
6	4
7	5
8	5
9 or more	6

Vegetative zones consist of areas proposed for various types of wetlands (shrub swamp, forested swamp, etc.). The performance standards for density can be assessed using either total inventory or quadrat sampling methods, depending upon the size and complexity of the site.

2) Does each mitigation site have at least 80% areal cover, excluding planned open water or planned bare soil areas (such as turtle nesting), by noninvasive species? Do planned emergent areas on each mitigation site have at least 80% cover by noninvasive hydrophytes? Do planned scrub-shrub and forested cover types have at least 60% cover by noninvasive hydrophytes, of which at least 15% are woody species? For the purpose of this success standard, invasive species of hydrophytes are:

Cattails – *Typha latifolia, Typha angustifolia, Typha glauca*:
Common Reed – *Phragmites australis*;
Purple Loosestrife – *Lythrum salicaria*;
Reed canary Grass – *Phalaris arundinacea*; and
Buckthorn – *Rhamnus frangula*

3) Are Common reed *(Phragmites australis)*, Purple loosestrife (*Lythrum salicaria*), Russian and Autumn Olive (*Elaeagnus* spp.), Buckthorn (*Rhamnus* spp.), Japanese knotweed (*Polygonum cuspidatum*), and /or Multiflora rose (*Rosa multiflora*) plants at the mitigation site being controlled?

4) Are all slopes, soils, substrates, and constructed features within and adjacent to the mitigation site stabilized?

Table 7-1: Success Standards and Criteria for the Mitigation Site.

Success Standard	Criteria
1. 500 trees and shrubs per acre, and the minimum number of total species (planted and volunteer) as specified in the *Guidance* (2004)	At least 350 stems are species originally proposed for the forested zones, that are healthy and vigorous and ≥ 18 in. tall. Also, total number of species shall meet the requirements as listed in the *Guidance*.
2. 80% areal cover of the entire site by non-invasives (excluding open water or special bare soil areas, i.e., turtle nesting areas)	80% areal cover by non-invasives in emergent zones and 60% cover (of which 15% are woody species) in scrub-shrub and forested zones.
3. Common reed, purple loosestrife, Russian and autumn olive, and/or multiflora rose are controlled.	Absence of stems of these species on the site.
4. All slopes, soils, substrates and constructed features are stabilized	No evidence of sedimentation in runoff from the site during storms and all erosion control measures are in good condition.

7.3 Monitoring Report Narrative Requirements

Items for narrative discussion:

- Highlighted summary of problems that need immediate attention (e.g., problem with hydrology, severe invasives problem, serious erosion, major losses from herbivory, etc.). This should be at the beginning of the report.
- Dates work on each mitigation site began and ended.
- Describe the monitoring inspections that occurred since the last report.
- Soils data, commensurate with the requirements of the soils portion of the 1987 Corps Delineation manual (Technical Report Y-87-1) New England District data form, should be collected after construction and every alternate year through the monitoring period. If monitoring wells or gauges were installed as part of the project, this hydrology data should be submitted annually.
- Concisely describe remedial actions done during the monitoring year to meet the four success standards – actions such as removing debris, replanting controlling invasive plan species (with biological, herbicidal, or mechanical methods), regarding the site, applying

- Additional topsoil or soil amendments, adjusting site hydrology, etc. Also describe any other remedial actions done at each site.

- Report the status of all erosion control measures on the compensation site. Are they in place and functioning? If temporary measures are no longer needed, have they been removed?

- Give visual estimates of (1) percent vegetative cover for each mitigation site and (2) percent cover of the invasive species listed under Success Standard No. 2, above, in each mitigation site.

- What fish and wildlife use the site and what do they use it for (nesting, feeding, shelter, etc.)?

- By species planted, describe the general health and vigor of the surviving plants, the prognosis for their future survival and a diagnosis of the cause(s) of morbidity or mortality.

- What remedial measures are recommended to achieve or maintain achievement of the four success standards and otherwise improve the extent to which the mitigation site replace the functions and values lost because of project impacts?

Monitoring Report Appendices

- Appendix A – A copy of this permit's mitigation special conditions and summary of the mitigation goals.

- Appendix B – An as-built plan showing topography to 1-foot contours, any inlet/outlet structures and the location and extent of the designed plant community types (e.g., shrub swamp). Within each community type the plan shall show the species planted – but it is not necessary to illustrate the precise location of each individual plant. This is should be included in the fires monitoring report unless there are grading modifications or additional plantings of different species in subsequent years.

- Appendix C – A vegetative species list of volunteer species in each plant community type. The volunteer species list should, at a minimum, include those that cover at least 5% of their vegetative layer.

- Appendix D – Representative photos of each mitigation site taken from the same locations for each monitoring event.

7.4 Post-Construction Assessment

As required by the Corps *Guidance* document, the following commitment is included herein:

A post construction assessment of the condition of the mitigation site shall be performed following the fifth growing season after completion of the mitigation site construction. "Growing

season" in this context begins no later than May 31st. To ensure objectivity, the person(s) who prepared the annual monitoring reports shall not perform this assessment without written approval from the Corps. The assessment report shall be submitted to the Corps by December 15 of the year the assessment is conducted; this will coincide with the year of the final monitoring report, so it is acceptable to include both the final monitoring report and assessment in the same document.

The post-construction assessment shall include the four assessment appendices listed below and shall:

- Summarize the original or modified mitigation goals and discuss the level of attainment of these goals at each mitigation site (include vernal pool creation if that is a component of the mitigation).
- Describe significant problems and solutions during construction and maintenance (monitoring) of the mitigation sites(s).
- Identify agency procedures or policies that encumbered implementation of the mitigation plan. Specifically note procedures or policies that contributed to less success or less effectiveness than anticipated in the mitigation plan.
- Recommend measures to improve the efficiency, reduce cost, or improve the effectiveness of similar projects in the future.

Assessment Appendices

Appendix A – Summary of the results of a functions and values assessment of the mitigation site, using the same methodology used to determine the functions and values of the impacted wetlands.

Appendix B – Calculation of the area of wetlands in each mitigation site using the 1987 Corps Wetland Delineation Manual. Supporting documents shall include (1) a scaled drawing showing the wetland boundaries and representative transects and (2) data sheets for corresponding data points along each transect.

Appendix C – Comparison of the area and extent of delineated constructed wetlands (from Appendix B) with the area and extent of created wetlands proposed in the mitigation plan. This comparison shall be made on a scaled drawing or as an overly on the as-built plan. This plan shall also show the major vegetation community types.

Appendix D – Photos of each mitigation site taken from the same locations *as the* monitoring photos, including photos of vernal pools, if applicable.

7.5 Contingency Plans

Careful mitigation planning coupled with accurate implementation is the key to mitigation success. However, unforeseen problems can arise. In order to ensure mitigation success, problems will have to be addressed and rectified as they arise. A contingency plan involves developing a list of proposed remedial measures (adapted from NAI 1992).

Mitigation effectiveness can often be substantially improved through very simple measures. A list of potential problems can be developed based on the performance standards set forth in the previous section. In its simplest terms, as summarized in Table 7-2, remediation takes place if standards are not met. However, the decision to invoke a contingency plan must be carefully evaluated. For example, it may not be practical to rectify one minor problem, which could impair other functioning elements of the system. The performance standards may also prove to be unreasonable. Therefore decisions on remediation, if necessary, will be made on a case-by-case basis after consultation with the USACOE.

Table 7-2: Summary of Remedial Measures for Mitigation Deficiencies[1]

Deficiency	Remedial Measures
Final elevations not as planned	Regrade
Inadequate soil saturation/inundation after at least 1 full growing season	Regrade only if there is not a predominance of OBL, FACW , and FAC species
<50% hydrophytes	Supplement seeding/planting
Inadequate species composition	Supplement seeding/planting
Inadequate plant density	Fertilize, supplement seeding
Significant erosion	Install erosion control blankets or similar materials
<80% areal cover by non-invasives	Replant as necessary
Marginal tree/shrub vigor	Fertilize
Substantial human disturbance	Fencing, legal remedies
Significant wildlife depredation/damage	Trapping/relocation, netting
Presence of invasive plant species	Biocontrol, manual removal, systemic herbicide control (e.g., Rodeo)
Presence of archaeological resources	Notify SHPO and contract with an archaeological consultant to conduct investigation
Presence of hazardous waste	Notify NHDES and contract with a hazardous waste firm to determine extent of contamination