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## Conceptual Restoration Plans

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### 3.1 Selection of Sites for Field Review

Following the results of the Wetland Restoration Assessment Model, the consultant team worked with NHDES, NHFG and the rest of the Technical Advisory Group to select a set of sites to review in the field. The objective of this phase of the work was to develop existing condition and conceptual restoration plans for up to 30 sites in the Merrimack River Watershed. These sites were intended to jump start potential restoration of these systems and to provide examples of restoration projects to watershed stakeholders so as to spur interest in wetland restoration.

The selection of the field study set was initiated during a TAG Meeting in mid-August and finalized the following week in consultation with the NHDES Project Manager. An initial sub-set of 50 sites were reviewed during the selection process. VHB prepared simple maps of each potential site from GIS, depicting an aerial base with resources overlaid, to allow for a desktop review of field conditions by the TAG.

Candidate Sites were excluded from the field study set if significant impairments were not readily discernable based on review of the aerial mapping data. For those sites that were excluded, this was often the case when the only impairment was the presence of an impounded wetland system. An effort was made to ensure that sites were distributed throughout the watershed, and to include a diversity of restoration types.

It is very important to understand that, due to the limitations of GIS, *the model cannot identify or assess all potential restoration opportunities*. While the results suggest that there are numerous opportunities throughout the watershed, and that the model does a good job of identifying those opportunities, it is also clear that local Conservation Commissions and other local and regional organizations may know of other viable wetland restoration sites that are not included in this study and which do not appear on these maps. The exclusion of these sites should not be taken as evidence that such a site would not qualify for an ARM grant or other funding sources.

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## 3.2 Field Review Procedures

The objective of the field review was to gather the field information needed to develop a conceptual restoration plan, including:

- Existing use/disturbance of site;
- Soils – planting medium;
- Compatibility with surrounding land use;
- Landscape position;
- Adjacency to undisturbed riparian wetland systems;
- Exemplary natural communities or individual RTE occurrences; and
- Surface water runoff/hydrological input.

Specific information collected during the field work included refined wetland and restoration site boundaries, which were based on field checking of aerial photography. The level of impairment and type of disturbance/degradation (e.g., drained, filled, cropped, urban encroachment) was also noted.

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## 3.3 Conceptual Restoration Plan Elements

Based on data gathered during the field portion of the project, VHB developed a set of simple plans of each site that shows the existing conditions and the potential restoration measures that could be implemented. The intent of the existing conditions map is to represent the existing conditions and identify impairments. The conceptual restoration plan depicts potential restoration measures, including target cover types and habitat features.

Restoration techniques considered in this phase are as follows:

- Creation of grass buffer zones or vegetative filter strips;
- Riparian plantings with trees and other vegetation;
- Restoring historic hydrological conditions by filling or blocking drainage ditches or tile drainage or breaching dikes;
- Creation of small levees and water control devices;
- Livestock exclusion;
- Removal of historic fill or grading to reestablish historic topography;
- Removal of nonnative invasive plants;
- Removal of fish passage barriers such as hanging culverts, dams or other unnatural barriers; and
- In-stream aquatic habitat restoration including creation of riffles, pools, meanders, and woody debris.

In preparing each site-specific restoration plan, the following criteria were considered where information existed to allow evaluation:

- Extent of ecological degradation
- Potential for recovery without intervention
- Potential to meet objectives with restoration measures
- Ecological impacts of construction
- Complexity of construction and access

A preliminary cost estimate was prepared for each of the 30 example restoration sites. Because no engineering design (beyond a very preliminary concept) was completed during this study, cost estimates will be “order of magnitude” or assigned to three or four range categories.

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## 3.4 Description of Conceptual Restoration Sites

A set of plans for the 30 example restoration sites is contained in **Appendix B** and can be accessed on the internet at: [www.restoreNHwetlands.com](http://www.restoreNHwetlands.com). Conceptual cost estimates for each of these site is provided in **Appendix E**. Below, we provide a brief description of each of the example sites.

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### 3.4.1 Site 5 – Beaver Brook Tributary, Pelham

#### Description

At more than 100 acres of contiguous wetland area, this site is the largest in the set of 951 Candidate Sites and has a diversity of restoration opportunities. It occupies a low valley created by Marsh Hill and Burns Hill to the south and east, and an unnamed hillside to the north and east. The wetland drains from the east to the west.

Emergent shallow marsh is the dominant cover type, with some deep marsh also present in the eastern portion of the site. The fringes of the marsh, particularly where disturbed by adjacent land uses, tend to be dominated by wet meadow species. Soils are organic throughout.

Dominant plants in the marsh include cattail (*Typha latifolia*) and wool-grass (*Scirpus cyperinus*). Tussock forming species, like tussock sedge (*Carex stricta*) and Canada bluejoint (*Calamagrostis canadensis* var. *canadensis*), also cover broad areas and form a hummock-hollow topography. Phragmites stands were dominant in several areas of the marsh. The deep marsh typically has a mixture of bur-reeds (*Sparganium* spp.), sedges (*Carex* spp.), and rice cut-grass (*Leersia oryzoides*). Duckweed (*Lemna* spp.) was abundant in the excavated ponds. The wet meadows components of the wetland were typically dominated by reed canary grass (*Phalaris arundinacea*) alongside

unidentified sedges (*Carex* spp.). Purple loosestrife was found throughout the marsh as well, either as a dominant or subdominant species.

### **Impairments**

- Several drainage channels have been excavated throughout the system, resulting in lower ground water elevations in substantial portions of the system.
- Suburban land uses are encroaching on the wetland system, principally from the north and east, although some residential development is located to the south.
- Two large ponds have been excavated from emergent marsh in the south central portion of Site 5.
- A buried natural gas pipeline (Tennessee Gas) bisects the wetland from north to south.
- A large crushed stone operation is located on the southwest side of the wetland, although there has been relatively minor impact considering the magnitude of this land use.

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### **3.4.2 Site 6 – Lower Beaver Brook Tributary**

#### **Description**

This site is located about 1,500 ft downstream of Site 5, on the same unnamed perennial tributary to Beaver Brook. It is part of the broad, flat floodplain wetland system that is contiguous with Beaver Brook and is one of the most significant wetland systems in southern New Hampshire. The tributary flows into the mainstem of Beaver Brook about 2,000 ft downstream.

Soils are largely organic. Two relatively large glacial kame features rise above the adjacent wetland on the north and south sides of Site 6, but no corresponding kettle morphology was observed to occur in the vicinity.

Similar to Site 5, shallow marsh dominates this wetland. Dominant plants in the marsh include cattail and wool-grass, tussock sedge and Canada bluejoint. Phragmites stands were dominant in several areas of the marsh, as were other invasive species such as reed canary grass and purple loosestrife.

#### **Impairments**

- Similar to Site 5, several channels have been excavated in this wetland, again lowering groundwater contours in the immediate vicinity.
- There is some urban encroachment on the east side of the wetland with two cemeteries, a roadway and an industrial site all located to the east.
- Fortunately, there is relatively little encroachment on the north, south and western sides of this wetland.
- A stormwater basin empties into the perennial tributary just upstream of Site 6.

- Several invasive species such as Phragmites, purple loosestrife and reed canary grass were dominant in portions of the wetland.

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### 3.4.3 Site 52 – Musquash Brook, Hudson

#### Description

Site 52 is contained within the larger Musquash Brook system. This portion of the wetland is located south of Bush Hill Road, just west of the boundary between the Town of Hudson and the Town of Pelham. A utility right-of-way runs parallel to the western edge of the wetland. This wetland drains to the south, supporting downstream reaches of Musquash Brook and its associated riparian wetlands.

The northeastern portion of the wetland consists of a mixed graminoid emergent community in the vicinity of the stream inlet. Vegetation includes jewelweed (*Impatiens capensis*), sensitive fern (*Onoclea sensibilis*), reed canary grass, sedges, broadleaf cattail and giant goldenrod (*Solidago gigantea*) extending up to the tree line. Speckled alder (*Alnus incana*) occurs in a narrow fringe along the upland tree line, dominated by mixed red maple (*Acer rubrum*), white pine (*Pinus strobus*) and red oak (*Quercus rubra*) in the overstory. The mixed graminoid community at the stream inlet is a small portion of the areal cover of the entire wetland.

The northern portion of the wetland includes a red maple swamp community, extending south along the eastern boundary in a band approximately 200 feet wide. This community is composed of red maples in the overstory with white pines in the uplands and dead snags along the transition to emergent shallow marsh near the central portion of the system. Understory vegetation consists of silky dogwood (*Cornus amomum*), arrowwood (*Viburnum dentatum*), royal fern (*Osmunda regalis*), sensitive fern, cinnamon fern (*Osmunda cinamomea*), tussock sedge and jewelweed.

The majority of the wetland, encompassing the western edge and central portion, is composed of a dense, broadleaf cattail-dominated shallow to deep marsh cover type. Sedges, soft rush (*Juncus effusus*) and joe-pye weed (*Eupatorium maculatum*) are subdominant. Moving further south, the vegetated community becomes less dense with spotty areas of standing water, containing water lilies and other aquatic bed vegetation. Highbush blueberry (*Vaccinium corymbosum*) and tussock sedge occur along the fringe with red and white pine, red oak and red maple in the adjacent uplands.

A single residence is closely adjacent to the eastern wetland edge. An excavated pool, which functions as a vernal pool, is located at the forested edge of a mowed back yard with fill material to the edge of the water.

## Impairments

- Several channels have been excavated within the wetland, lowering groundwater contours in the wetland.
- Surrounding land use is mainly undeveloped and forested. Minimal residential development occurs adjacent to the northeastern edge.
- A maintained utility right-of-way runs parallel to the western boundary of the wetland.

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### 3.4.4 Site 67 – Second Brook Swamp, Hudson

#### Description

Site 67 is located at the confluence of the north and south branches of Second Brook, draining across Bush Hill Road and Wason Road, respectively. At almost 108 acres, this is one of the largest sites in the list of Candidate Sites. The area is known locally as “Miles Swamp.” The restoration site, which is bordered on the east by the Pasture Drive neighborhood and on the west and south by Glen Drive, is part of a larger system which extends to the north. The restoration site drains north and west to a deep marsh/shallow pond, which outlets to the main stem of Second Brook.

The site contains high interspersions of wetland classes, vegetated communities and water features. Upland islands are also found distributed throughout the wetland system, particularly in the southeastern portion. The patchwork nature of this wetland system makes it a valuable habitat to a wide variety of wildlife.

The dominant cover type within Site 67 is emergent shallow marsh dominated by cattail, which may occur at or near monoculture in most areas, but also is co-dominant with reed canary grass, wool-grass, Phragmites, loosestrife. Emergent cover types generally compose the main body of the wetland but may also be adjacent to peripheral scrub-shrub cover types. A typical mixed community consists of jewelweed, broadleaf cattails, bluejoint grass (*Arctagrostis latifolia*), false hellebore (*Veratrum viride*), sensitive fern, royal fern, sedges, purple loosestrife and giant goldenrod. Some areas toward the center of the system are dominated by reed canary grass with sedges, purple loosestrife, and cattails mixed in. Areas near the periphery may have a higher concentration of jewelweed, while other marginal strips or central patches may nearly be a monoculture of broadleaf cattail.

The southern and eastern portions of the site consist of mixed forest and shrub vegetation. A typical forest community includes red maple dominant in the overstory, bordered by white pine and red oak in the adjacent uplands. Understory vegetation in the wetland includes highbush blueberry, arrowwood, glossy buckthorn, red maple saplings, sedges, royal fern, marsh fern, sensitive fern, cinnamon fern and false hellebore.

Scrub-shrub wetlands are interspersed, often within the forest setting, as dense alder shrub thickets. Sedges and sensitive fern are also common. The riparian area in the

eastern portion of the wetland system consists of a shrub wetland, as well, with dominance by arrowwood, speckled alder, and red maple saplings. Associated ground cover includes false hellebore, jewelweed, sensitive fern and sedges.

### **Impairments**

- Generally, the ecological integrity of the site is relatively good. Human activity within the surrounding uplands and within the wetland itself is minimal.
- However, invasives such as Phragmites, purple loosestrife and reed canary grass are dominant or sub-dominant in the majority of the site.
- Some excavated channels are present within the forested portions of the wetland on the east side of the site.

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## **3.4.5 Site 71 – Salmon Brook Marsh, Nashua**

### **Description**

At more than 116 acres, the Salmon Brook Marsh is among the largest wetlands in Nashua. It occupies the floodplain created by the confluence of Hassells Brook with Salmon Brook. Salmon Brook then runs east until it flows into the Merrimack River, about 1,300 lin ft downstream of Site 71. Two structures impound water in the marsh: 1) bike/pedestrian crossing at Chesnut Street contains three culverts appears to impound Salmon Brook, at least during higher flow events, and 2) a dam structure located at the outlet of Site 71 adjacent to the Daniel Webster Highway clearly impounds several feet of water within the marsh.

The site is mapped as a designated Prime Wetland under RSA 482-A by the City of Nashua, and the southeastern portion of the wetland is contained within a conservation easement. These two mechanisms provide additional protection to the site beyond typical state and federal wetland regulations.

Despite the several observed impairments (see below), the Salmon Brook wetland is a relatively diverse system with 13 different NWI cover types configured with a relatively high degree of interspersion. This creates important structural and ecological diversity within the wetland, and is a key factor in making this area one of the most significant remaining natural habitats in Nashua.

The site is dominated by emergent shallow and deep marsh, with vegetative communities similar to other such marshes in southern NH. Soils are largely organic Chocurua Mucky Peat, where they are not flooded by the two impounding structures within the marsh.

### **Impairments**

- The site is surrounded on all sides by urban development.

- Invasive species such as Phragmites, reed canary grass and purple loosestrife are dominant to sub-dominant throughout.
- Several stormwater discharges were noted in the wetland. Based on preliminary review of the adjacent land uses, it is highly unlikely that these discharges are detained and/or treated prior to discharge.
- There are several excavated channels within the wetland, although their effect on the water table may not be significant.
- The wetland is flooded by a dam at the outlet of the system at the Daniel Webster Highway/Main Street.
- A significant portion (almost 1,000 lin ft) of Salmon Brook downstream of Site 71 was buried by previous land development activity. This represents a significant barrier to the upstream and downstream passage of anadromous fish and other aquatic species.

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### 3.4.6 Site 76 – Harris Brook Tributary, Salem

#### Description

This site consists of a red maple swamp along the floodplain of a perennial tributary to Harris Brook. The tributary drains southerly, crossing under Cross Street, then flowing south along Interstate 93 until it reaches its confluence with the mainstem of Harris Brook about  $\frac{3}{4}$  mile downstream.

The site is mapped as a designated Prime Wetland under RSA 482-A by the Town of Salem (Prime Wetland 26), and a portion of the wetland is contained within a conservation easement. These two mechanisms provide additional protection to the site beyond typical state and federal wetland regulations.

Red maple is dominant in the overstory, and often provides more than 90% of the canopy cover. A variable mixture of tree species co-occurs with red maple, including yellow birch (*Betula alleghaniensis*), white ash, white pine, American elm (*Ulmus americana*). The shrub layer is dense and well-developed. Common shrubs are highbush blueberry and common winterberry (*Ilex verticillata*), which are often dominant, and spicebush (*Lindera benzoin*). The herbaceous layer is variable, but ferns are abundant. Cinnamon fern is common; other ferns include sensitive fern, royal fern, marsh fern (*Thelypteris palustris*), and spinulose wood fern (*Dryopteris carthusiana*). Graminoids are common, mixed with a variety of herbaceous species. Some of the most common herbaceous species are skunk cabbage (*Symplocarpus foetidus*), false hellebore, jewelweed, swamp dewberry (*Rubus hispidus*), marsh marigold (*Caltha palustris*), and the bugleweeds (*Lycopus* spp.).

#### Impairments

- Residential development encroaches on the southwest and southeast boundaries of the site.

- A series of drainage ditches have been excavated from the swamp in the southern portion, effectively lowering the groundwater contours in a portion of the swamp.

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### 3.4.7 Site 81 - Porcupine Brook, Salem

#### Description

This site consists of the forested, emergent and scrub-shrub wetlands bordering a branch of Porcupine Brook in the southwestern portion of Salem. The wetland forms the headwaters of the perennial stream, which flows west about 0.9 mile, through the I-93 Exit 1 area, until it flows into the mainstem of Porcupine Brook just southeast of the Rockingham Mall. The wetland is dominated by a forested riparian swamp with red maple the dominant overstory species. Substantial encroachment from an industrial use and a recreational use have substantially affected this wetland. Obviously, restoration of this site, like all others in the study, is contingent upon the willing participation of the property owners.

The site is mapped as a designated Prime Wetland under RSA 482-A by the Town of Salem (Prime Wetland 16), and the central portion of the wetland is contained within a conservation easement – the “Turner Homestead” site. These two mechanisms provide additional protection to the site beyond typical state and federal wetland regulations.

#### Impairments

- A substantial portion of the wetland appears to have been filled on the north side of the site by the adjacent waste management facility. This filling apparently occurred without a permit from NHDES, but a previous enforcement case was resolved (Mary Ann Tilton, NHDES Wetlands Bureau, personal communication).
- Porcupine Brook has been straightened and deepened along much of its length in Site 81.
- Land use associated with a golf course along the southern boundary of the wetland system has had an impact on the wetland. Impacts include previous fill and disturbance to vegetation associated with periodic mowing.
- Several ponds have been excavated from the wetland, which now serve as water features and irrigation sources for the golf course. Ponds are eutrophic.
- A small number of excavated ditches are present within the wetland, particularly the western half of the site.

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### 3.4.8 Site 134 – Farmed Wetland, Litchfield

#### Description

The broad, flat Merrimack River floodplain that dominates the western part of Litchfield is one of the last remaining important farming areas in southern New Hampshire. This area is home to several large farms that produce important local food supplies for the region. Much of this area was once floodplain wetland, which has since been converted to agricultural production.

Site 134 is located within the floodplain of the Merrimack River and encompasses a large agricultural operation. Areas within this agricultural site are farmed wetlands, while other areas appear to be effectively filled and drained and no longer function as wetlands. The majority of the site is actively maintained cropland. Defining the wetland boundary in this type of landscape is very difficult without close inspection of soils characteristics, so the boundary shown in the existing conditions plan should not be interpreted as definitive, but rather as an estimate of the likely maximum extent of the wetland prior to agricultural conversion.

A small unnamed perennial stream emerges from a pond in the central portion of the site. The stream itself is channelized and highly entrenched. There is a narrow intact shrub/forested buffer along some of the stream consisting of alders and birches, although there are also significant portions of the stream that lack any kind of buffer. The stream flows south for a total length of about 1 mile, about  $\frac{3}{4}$  of which is located within Site 134.

Remnants of an alluvial red maple swamp (*sensu* Golet, et al. 1993) can be found along the western portion of the site, and provide a sense of the likely pre-settlement community located within Site 134. The overstory of this forested community is characterized by a mixture of red maple and silver maple (*Acer saccharinum*) with lesser amounts of green ash. Red oak (*Q. rubra*), white pine, and black cherry (*Prunus serotina*) occur in elevated sections. The swamp has a well-developed shrub layer composed of northern arrow-wood, silky dogwood, and the non-native plant European buckthorn (*Rhamnus frangula*).

#### Impairments

- Several areas of wetlands are actively drained or appear to have been filled.
- The perennial stream located in the central portion of the site is deeply entrenched, largely eliminating the connection between the stream and its adjacent floodplain. Erosion of this stream does not appear to be a significant issue however.
- Stream water quality is expected to be very poor given the agricultural use (nutrients) and lack of buffer (temperature).
- The invasive forage plant reed canary grass is dominant throughout many of the emergent portions of the disturbed remnant wetlands.

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### 3.4.9 Site 218 – Nesenkeag Brook, Londonderry

#### Description

Site 218 is an emergent marsh that, together with an adjacent undisturbed forested swamp, forms the headwaters of Nesenkeag Brook, an important perennial stream which flows east through Londonderry and Litchfield to empty into the Merrimack about five miles east of the site.

The emergent marsh that forms Site 218 is approximately 18 acres in size and is dominated by cattail, with purple loosestrife, Phragmites and wool grass also present. Cattail approaches 90 percent cover in some locations, while extensive Phragmites stands are interspersed.

#### Impairments

- Substantial evidence of OHRV within the wetland.
- Phragmites and purple loosestrife are dominant.
- Suburban encroachment on the north and south sides of the wetland, although substantial forested buffers exist to the east and west.

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### 3.4.10 Site 231 – Hartshorn Brook, Milford

#### Description

Site 231 is located in a small valley formed by the hills of Mont Vernon to the north and Christian Hill and Patch Hill in Amherst to the east. Joslin Road is located to the north of the site, Jennison Road to the west, and NH Route 13 to the west. Hartshorn Brook flows south and east through the site, then proceeds to flow southeast about ¼ mile to its confluence with the Souhegan River. Thus, the entire site can be considered tributary to Hartshorn Brook and the Souhegan.

The plant community is dominated by reed canary grass throughout much of the site. Cattail and tussock sedge dominate other, wetter emergent portions of the site. Most of the wetland is actively disturbed by on-going land use associated with the residences on the west side or the agricultural use on the north side. An excavated and impounded farm pond is located in the center of the site.

#### Impairments

- Reed canary grass dominates a wet meadow habitat is heavily impacted by adjacent land use and human use of the wetland.
- A portion of the farm pond appears to be filled.

- There has been some minor encroachment by a commercial use on the southern side of the site.
- Portions of the wetland may be tile drained. Outlets could not be confirmed, but at least one possibly riser was noted in the agricultural field.
- OHRV use appears to be on-going in the northeastern part of the wetland.

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### **3.4.11 Site 273 – Farmed Wetlands, Litchfield**

#### **Description**

The large wetland site is located in the floodplain of the Merrimack River in Litchfield. Like Site 134 described above, the most significant feature of the site is a large area of farmed wetland. NH Route 3A forms the western border of the site, and a relatively intact red maple swamp lies along the eastern boundary. A portion of the site lies within an easement apparently intended to preserve agricultural use of the area.

The northern portion of the site is currently used to grow corn, while the southern portion of the site is used as a hayfield. Aside from the red maple swamp on the west, the majority of the native wetland vegetation has been removed from the site due to the agricultural activity. The red maple community is similar to the community previously described above for Site 134.

#### **Impairments**

- Substantial area of farmed wetland in the northern portion of the site.
- An excavated ditch line drains the southern portion of the site, lowering groundwater contours.
- Some portions of the farmed wetland show evidence of fill.
- Minor residential encroachment on the western side of the wetland.
- Although it could not be confirmed, tile drain lines may be in place within the wetland.

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### **3.4.12 Site 295 – Hoodcroft Country Club, Derry**

#### **Description**

This site is a large emergent system that surrounds the Hoodcroft Golf Course in Derry. The wetland is supported by flow from Beaver Lake to the northeast via an unnamed perennial stream and from West Running Brook. These two perennial streams meet in the southern part of Site 295, where they proceed to flow south until they join Beaver Brook, about one mile downstream.

The site is mapped as a designated Prime Wetland under RSA 482-A by the Town of Derry (Prime Wetland 13F). This designation provides additional protection to the site beyond typical state and federal wetland regulations.

The majority of the wetland is a deep emergent marsh/shrub swamp, formed in the broad, flat areas bordering low-energy streams identified above. The soils (Scarboro muck, Greenwood and Ossipee soils, and Chocorua mucky peat) typically have a layer of well-decomposed organic muck at the surface overlying mineral soil. There is standing or running water during the growing season and throughout much of the year. Water depth averages between 6 inches and 3 feet.

The dominant plants in this wetland are broad-leaved cat-tail, purple loosestrife and Phragmites, often in dense stands. Other characteristic plants include wool-grass, common threesquare (*Scirpus pungens*), Canada bluejoint, rice cut-grass, and tussock-sedge. Other observed herbaceous species include arrow-leaf tearthumb (*Polygonum sagittatum*), water-hemlock (*Cicuta bulbifera*), swamp-candles (*Lysimachia terrestris*), beggar-ticks (*Bidens* spp.), bedstraw (*Galium* spp.), common arrowhead (*Sagittaria latifolia* var. *latifolia*), slender-leaved goldenrod (*Euthamia tenuifolia*) and marsh-fern (*Thelypteris palustris* var. *pubescens*).

### Impairments

- Urban development surrounds the wetland site on its west, south and east boundaries.
- Small fill areas are evident in several places along the margin of the wetland.
- Portions of the wetland have been incorporated into the golf course, and are mowed and landscaped.
- Water quality in open water portions of the site display eutrophic conditions typical of high nutrient loading.
- Purple loosestrife is dominant in much of the wetland, as is Phragmites in parts of the site.

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### 3.4.13 Site 348 – Hog Hill Swamp, East Kingston

#### Description

This site occupies a broad, flat valley formed by Hog Hill, Bruce Hill and Martin Hill in the south and west and Morse Hill to the east. It is contiguous with the large forested Hog Hill Swamp on the south and west. The dominant cover type in this wetland, however, is emergent wet meadow dominated by reed canary grass. This community type is not likely native, but is probably due to the use of the wetland as an agricultural field. The hydrology of the area suggests that, if left undisturbed, a shrub or forested swamp would develop.

The most noticeable feature of this site are the numerous, precisely laid out ditch lines that are intended to drain this wetland, but which cannot completely do so. The vegetation appears to be mowed frequently.

Aside from reed canary grass, characteristic species include Canada rush (*Juncus canadensis*), spike sedge (*Eleocharis sp.*), various sedge (*Carex*) species and creeping bent grass (*Agrostis stolonifera*).

### **Impairments**

- Numerous ditches are present throughout the wetland, with a channel having been excavated from the central part of the site.
- Periodic mowing has affected the vegetative community and determines the cover type present in the wetland.
- Reed canary grass, generally considered an invasive species, is the dominant plant throughout much of the wetland area.

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### **3.4.14 Site 366 – Beaver Br Headwaters, Londonderry**

#### **Description**

This site contains a large emergent marsh which forms the headwaters of Beaver Brook, one of the most significant watercourses in southern NH. Emerging from this wetland, a perennial stream flows west about 1½ miles, across I-93 and NH Route 28, until it joins with Shields Brook near the Derry town line to form Beaver Brook. Beaver Brook then proceeds to flow south through Derry, Londonderry, Windham, Hudson and eventually Pelham, where it crosses the Massachusetts border into Dracut. Site 366 is one of several sites in this study which are tributary to Beaver Brook.

Despite its proximity to I-93, Site 366 has a relatively intact forested buffer dominated by white pine on all sides. The wetland itself is dominated by emergent marsh species such as cattail, wool-grass, Phragmites, and purple loosestrife. The site is located primarily on a parcel known locally as the Reed Clark parcel.

#### **Impairments**

- The site is partially drained by a network of excavated channels.
- Invasive species are dominant to subdominant.

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### **3.4.15 Site 371/376 – McQuade Brook, Bedford**

#### **Description**

McQuade Brook flows through Site 371/376 Flows into Baboosic Brook about ¼ mile downstream (to the south). The site consists of a deep marsh portion to the west of Jenkins Road, and a shallow marsh portion to the east. The western portion is dominated by a beaver impoundment that forms a large shallow pond. Emergent

vegetation includes tussock forming species such as tussock sedge and Canada bluejoint which form hummock-hollow topography. Other dominant plants in the marsh include cattail (*Typha latifolia*) and wool-grass (*Scirpus cyperinus*). Phragmites stands were dominant in several areas of the marsh. Bur-reeds (*Sparganium* spp.), sedges (*Carex* spp.), and rice cut-grass (*Leersia oryzoides*) were also present.

The shallow marsh on the east side of Jenkins Road is dominated by cattail and reed canary grass. To the north, a small perennial tributary meanders among the recent residential development. A small buffer remains in place, but this buffer is less than 25 feet in most places. The wetland along this stream, within the common land associated with the Cabot Preserves development, has been mowed and landscaped.

### Impairments

- McQuade Brook has been channelized throughout much of its length in the western segment of the site.
- A discontinued railroad grade runs the length of McQuade Brook and impacts the hydrology of the western segment.
- Residential development of recent filling has begun to encroach on the eastern portion of Site 371/376.
- Invasive species such as purple loosestrife and Phragmites are present.
- Significant portions of the eastern part of the site are mowed periodically.

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### 3.4.16 Site 378 - Riddle Brook Wetlands, Bedford & Merrimack

#### Description

This site consists of a relatively diverse emergent, scrub-shrub, and forested components at the confluence of lower Riddle Brook and Baboosic Brook. Portions of the system have retained good ecological integrity, while other areas have been impacted by adjacent land use, typically at the margins of the system. The portion of this site in Bedford is designated as Greenfield Farms Open Space.

Because the site spans the municipal boundary between Bedford and Merrimack, cooperation between these two communities would be required to conduct the full program depicted in the Conceptual Restoration Plan developed for this site.

The site is bordered on the north by the relatively new Greenfield Farms residential development. The roadway constructed to serve this development crosses Riddle Brook and its floodplain wetland by way of a large open bottom culvert as well as a series of five floodplain culverts. Dominant species in this portion of the site include those typical of deep marsh habitats including tussock sedge, cattail, and wool-grass. Button bush (*Cephalanthus occidentalis*) is a common shrub species, as are the dogwoods. Red maple and American elm are present in forested portions of the site.

## Impairments

- Despite the good efforts to minimize impacts to Riddle Brook resulting from the Greenfield Parkway crossing, there is still a substantial amount of fill in the floodplain, and multiple culverts typically create hydraulic conditions not normally found in floodplain flows. While probably not feasible, replacement of this crossing with a full span bridge structure would eliminate the majority of the impact to Riddle Brook in this location.
- Portions of the scrub marsh on the central portion of the site have been ditched, potentially impacting the groundwater contours in this area.
- Phragmites and purple loosestrife are among the dominant plant species in much of the wetland.
- Residential uses encroach from the north and east of the site.

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### 3.4.17 Site 530 – Piscataquog R. Floodplain, Goffstown

#### Description

This site lies at the confluence of the mainstem of the Piscataquog River and the south Branch of the Piscataquog in Goffstown. This is a very active floodplain that experiences floodwaters reaching several feet or more quite frequently – in most years where spring flows are at or above the median. From this site, the Piscataquog River flows west through Goffstown and Manchester until it reaches the Merrimack River, about 9 ½ river miles downstream.

Like many other floodplain areas in the Merrimack Watershed, this area has been cleared and is active agricultural use. A blueberry orchard is located adjacent to the site, and the majority of the wetland is used to produce hay. Remnant floodplain channels are evident within the hayfield. The hayfield appears to be nearly completely dominated by reed canary grass. It is likely that the site would revert to floodplain forest similar to the adjacent undisturbed wetlands if the field mowing were discontinued.

The floodplain wetland to the south of site is mapped as a designated Prime Wetland under RSA 482-A by the Town of Goffstown (Prime Wetland 17) which provides protection to the wetland beyond typical state and federal wetland regulations.

Other vegetation observed in the adjacent wetlands includes purple loosestrife, sensitive fern, royal fern, deer tongue (*Dichanthelium clandestinum*), early meadow rue (*Thalictrum pubescens*), grape (*Vitis* sp.), poison ivy, Virginia creeper, joe-pye weed, barberry, bittersweet, broad-leaf cattail, spirea, speckled alder, musclewood, red maple, willow (*Salix* sp.), American elm, basswood (*Tilia americana*), hemlock, and eastern white pine.

## Impairments

- The periodic mowing of the floodplain wetland artificially maintains a wet meadow dominated by reed canary grass. This community type is limited in function and value compared to other wetland types.

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### 3.4.18 Site 578 – Kimball Pond Road Bog, Dunbarton

#### Description

Kimball Pond Road Bog is a kettle depression in sandy glacial outwash associated with the large Kimball Pond Wildlife Management Area in Dunbarton. This site is unique in that it was not directly identified by the Site ID Model, but is directly adjacent to two other wetland areas that were. Based on review of aerials and field investigation, it was decided to focus the restoration plan in this area on the bog habitat and the adjacent upland area.

The kettle hole bog occurs in an iceblock depression (commonly called kettle holes) in sandy glacial outwash. As with other true bog systems, it is relatively small, lacks any inlet or outlet, and lies directly adjacent to other glacial features (in this case a glacial esker). The adjacent esker has been mined for sand and gravel by the Town of Dunbarton. This activity has created a level of disturbance adjacent to this unique habitat, and therefore creates an opportunity to restore the site once mining activity is complete.

The vegetation within the bog is a ringed zonation pattern, which is typical of this wetland type. The bog mat has a mixture of tall and short shrubs that are predominantly ericaceous. Leatherleaf (*Chamaedaphne calyculata*) is dominant. Other typical ericaceous shrubs include rhodora, sheep laurel (*Kalmia angustifolia*), bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda polifolia* var. *glaucophylla*), Labrador tea (*Ledum groenlandicum*), and low-growing large and small cranberry (*Vaccinium macrocarpon* and *V. oxycoccus*). Scattered, stunted coniferous trees, primarily tamarack (*Larix laricina*) and black spruce (*Picea mariana*) occur throughout. A mixture of specialized bog plants grow on the hummocky sphagnum surface, including carnivorous pitcher plants (*Sarracenia purpurea*) and sundews (*Drosera rotundifolia* and *D. intermedia*).

#### Impairments

- The sole impairment to this site is the encroaching gravel mining operation directly to the east of the bog. The mining could create erosion into the bog, could impact the hydrology of the bog, and could create a site for the establishment of invasive species.

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### 3.4.19 Site 666 – Turkey River Floodplain, Concord

#### Description

This site is associated with the Turkey River floodplain, on the south side of Clinton Street in Concord. It is closely related to Sites 671 and 672, which are also associated with the Turkey River but which are located just north of this site. The Turkey River flows from the north to the south, bisecting the site, before it flows south to its confluence with the Merrimack River about two miles to the southeast.

The dominant characteristic of the site is its agricultural use. A band of floodplain forest is located along the Turkey River, which is dominated by red maple and other common floodplain forest species.

#### Impairments

- The majority of the site has been heavily impacted by agricultural use; hydrophytic vegetation has been replaced by cultivated species in most locations or by hydrophytic forage species (e.g., reed canary grass) in others.
- The hydrology of the northwest portion of the site has been modified by ditching and the practice of “plowing to the center,” which has had the effect of raising the elevation of the farmland above the adjacent wetland.
- The presence of drain tile could not be confirmed, but is suspected in portions of the site.

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### 3.4.20 Site 671 – Turkey River Floodplain, Concord

#### Description

This site is associated with the floodplain formed by the confluence of the Turkey River and a perennial tributary to the river, on the north side of Clinton Street in Concord. It is closely related to Sites 666 and 672, which are also associated with the Turkey River floodplain. The Turkey River itself flows from the north to the south, bisecting the site, before it flows south to its confluence with the Merrimack River about 2¼ miles to the southeast.

The dominant characteristic of the site is its agricultural use. A band of floodplain forest is located along the Turkey River, which is dominated by red maple and other common floodplain forest species, and a similar riparian forest is located along the perennial tributary located to the east of Site 671.

#### Impairments

- The majority of the site has been heavily impacted by agricultural use; hydrophytic vegetation has been replaced by cultivated species.

- The hydrology of the entire site has been modified by ditching and the practice of “plowing to the center,” which has had the effect of raising the elevation of the farmland above the adjacent wetland.
- The presence of drain tile could not be confirmed, but is suspected in portions of the site.

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### 3.4.21 Site 672 – White Farm, Concord

#### Description

This site, located on the state-owned “White Farm,” is an agricultural area which drains to a perennial tributary to the Turkey River. It is closely related to Sites 666 and 671, which are also associated with the Turkey River floodplain.

Like the two other candidate restoration sites in the vicinity, the dominant characteristic of the site is its agricultural use. A portion of the site is used to raise corn, while other areas appear to be hayed periodically. The site is bisected by the recently completed construction of the Langley Parkway connection to Pleasant Street.

The adjacent emergent wetlands are dominated by invasive species such as Phragmites and reed canary grass, while alder thickets are also important in adjacent scrub areas.

#### Impairments

- The majority of the site has been heavily impacted by agricultural use; hydrophytic vegetation has been replaced by cultivated species.
- The hydrology of the entire site has been modified by ditching.
- The presence of drain tile could not be confirmed, but is suspected in portions of the site.
- The construction of the Langley Parkway eliminated a portion of the wetland area within the site.

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### 3.4.20 Site 689 – Burnham Brook, Epsom

#### Description

Burnham Brook, an important perennial stream, flows about 3 ½ miles from its headwaters near Garvin Hill in Chichester to its confluence with the Suncook River at Site 689. The brook in this location flows through an active commercial farm which includes a livestock operation.

Riparian wetlands border the brook on both side, but are wider and more intact along the west side of the watercourse. The southern part of the site lies within the Suncook River floodplain, and includes a portion of floodplain forest.

### **Impairments**

- A portion of the site is farmed wetland; although certain areas are now used to grow crops, they appear to continue to meet criteria for wetland hydrology. Other areas may be drained wetlands.
- Burnham Brook appears to have been channelized, and there is relatively little vegetated buffer between the Brook and the adjacent agricultural operation.
- Farm runoff discharges to Burnham Brook; impacts to water quality are likely.

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### **3.4.23 Site 704 – Bowen Brook, Concord**

#### **Description**

Bowen Brook occupies a portion of the low, flat, broad Merrimack River floodplain that extends from Northfield and Franklin in the north, to Concord in the south. This reach of the river has similarities to the Litchfield portion of the river, described above for Sites 134 and 273. Like Litchfield, agricultural use of the floodplain remains an important use along this reach of the Upper Merrimack River.

The Bowen Brook site is located within a conservation easement managed by the NH Society for the Protection of NH Forests and other non-profit agencies. The dominant characteristic of the site is the farmed wetland that forms its central portion. Like other farmed wetlands, the native hydrophytic vegetation has been replaced by cultivated species. Despite the continual use for farming, evidence of hydric soils and wetland hydrology remain in place.

Bowen Brook itself lies on the eastern side of the site, and has been channelized and deepened such that the brook does not appear to have access to its floodplain. Based on interpretation of aerial photography, as well as information gathered during field work, it is likely that the brook was relocated from its original location in the center of the farm field many years ago.

#### **Impairments**

- Farmed wetland; normal conditions have been replaced by cultivated species, with periodic plowing and fertilization, eliminating normal wetland function and value.
- Bowen Brook has been channelized, compromising its value as a perennial stream, and a direct tributary to the Merrimack River.
- A decent buffer to the Merrimack is lacking in a portion of the site.

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### 3.4.24 Site 705 – State Prison Farm, Concord

#### Description

This potential restoration site is located directly east of the Bowen Brook site, on the Penacook side of the river. Like Site 704, its dominant characteristic is its use as an agricultural field. Some remnant emergent shallow marsh is located within the site. This area is dominated by cattail, reed canary grass and sedges (*Carex* spp.), but is substantially impacted by past and present land use.

#### Impairments

- Much of the site is farmed wetland; normal conditions have been replaced by cultivated species, with periodic plowing and fertilization, eliminating normal wetland function and value.
- The perennial stream that flows through the site has been channelized and deepened, compromising its value as a perennial stream, and eliminating a source of hydrology for adjacent wetlands.
- There is no effective buffer between the stream channel and the adjacent agricultural use.

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### 3.4.25 Site 733 – Gulf Brook Headwaters, Pittsfield

#### Description

This site is associated with an ephemeral stream that is the headwaters of Gulf Brook, an important stream that flows south to join the Little Suncook River in Epsom. The adjacent land use is rural low density residential and agricultural uses. The upland area directly adjacent to the site is maintained hayfield, and reed canary grass is dominant in some areas, with other grasses also present. While this site does not display the same level of substantial impairment of other sites included in the field study set, it is a useful example of a common situation, whereby a simple and inexpensive buffer creation strategy would have wildlife and water quality benefits.

#### Impairments

- There is no true buffer to the drainage; could be improved to protect downstream water quality and enhance wildlife usage.

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### 3.4.26 Site 769 – Hunting Swamp Headwaters, Loudon

#### Description

This site is associated with a large, regionally significant wetland known as “Hunting Swamp.” The site is located at the upper end of the system, and is bordered by an existing commercial nursery operation to the west which has expanded over the last decade. Undisturbed forested wetland adjacent to the potential restoration site is best characterized as a northern red maple swamp.

#### Impairments

- The western portion of the site, adjacent to the nursery operation, has been cleared of its forest cover.
- Stormwater runoff from the adjacent nursery apparently enters the wetland without treatment.
- While it could not be verified, portions of the site appear to have characteristics of drained wetland, and tile drains may be in place.

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### 3.4.27 Site 800/804 – Farmed Wetlands, Canterbury

#### Description

Site 800/804 is located in the floodplain of the Merrimack River in Canterbury and is dominated by the Gold Star Sod Farm, and active agricultural operation. The majority of the site has been modified to accommodate the agricultural use, which has been in place for many years.

A significant oxbow feature is also present within the site. This oxbow community is dominated by red maple, with a component of silver maple. An adjacent floodplain forest is also located on the western side of the site. The interspersions of these communities, together with the open pond located within the oxbow, creates wildlife habitat despite the intensive land use.

#### Impairments

- Portions of the site are farmed wetlands; normal wetland function has been impacted by cultivation, tilling and fertilization.
- The perennial outlet of the oxbow pond has been channelized, limiting its value as stream habitat.
- While it could not be verified, drain tile is likely in place over at least a portion of the site.

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### 3.4.28 Site 806 – Tannery Brook, Boscawen

#### Description

Similar to other agricultural sites in the Merrimack River Floodplain, this site is characterized by former wetland which has been converted to cropland use. Much of the site has been protected through the use of an easement that allows continued agricultural use, but limits development. Tannery Brook flows through the site from its headwaters in northern Boscawen.

#### Impairments

- There is no effective buffer between the agricultural use and the adjacent Merrimack River.
- Tannery Brook has been impacted by the agricultural use, and is also lacking an effective buffer.
- A railroad grade bisects the site.
- The emergent portion of the wetland in the northern portion of the site shows evidence of degradation in the form of invasive species and a shift in community type from obligate hydrophytes to drier species.
- Portions of wetlands closest to NH Route 3 may have been filled in the past.

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### 3.4.29 Site 825 – Kelly Brook Tributary, Loudon

#### Description

Site 825 is in a rural area of Loudon on the Pittsfield border. The site is characterized by a red maple riparian wetland along a perennial tributary to Kelly Brook. A portion of the swamp and its adjacent upland has been cleared and converted to agricultural use. The existing community is dominated by scrub-shrub species such as silky dogwood and winterberry holly, with the herbaceous layer dominated by cattail, wool-grass and reed canary grass.

#### Impairments

- A substantial buffer to the wetland is lacking.
- Runoff from the adjacent agricultural use contributes nutrients to the watershed. A constructed wetland or buffer could capture excess nutrients prior to entering the wetland system.

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### 3.4.30 Site 1010 – Lower Shield Pond, Derry

#### Description

Site 1010, Lower Shield Pond in Derry, was identified for this study by the NH Natural Heritage Bureau, part of the NH Department of Resources and Economic Development that is responsible for tracking rare species and important natural communities in the state. The site contains a poor level fen/bog system with its classic fen sequence of floating mat, open peat, low heath, tall heath, dwarf spruce and larch, and shrub swamp.<sup>6</sup>

The lag varies from 20 to over 200 feet wide, although the low and high heath zones are not always well developed. The dominant plant in the low heath was leather leaf, the same species that dominated the Kimball Pond Bog in Dunbarton. Previous Heritage Bureau biologists found the threatened species *Gaylussacia dumosa* (dwarf huckleberry) within this community. Dwarf black spruce and larch are scattered throughout this zone. The shrub swamp further back from the pond is dominated by mountain holly, winterberry holly, and high bush blueberry.

Monitoring records provided by the Natural Heritage Bureau indicates a concern that beaver activity downstream may alter water levels within the site. Some precautions have already been taken by installing a beaver dam culvert downstream by the NH Route 28 bypass bridge. It is uncertain how flooding would ultimately affect plants in the peat lag, but it probably would kill present vegetation in favor of more aggressive, flood tolerant species.

#### Impairments

- A high-tension electrical line crosses the wetland, and a wide utility right-of-way runs parallel to the pond system to the north and east. Equipment and OHRV use of the corridor has impacted flow into the site.
- There has been some encroachment on the site by a landowner located on the northern boundary of the site.
- Residential development encroaches on the south and east. However, a reasonable buffer remains on the northwest side of the system.

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## 3.5 Cost Estimates

A conceptual restoration plan was developed for each of the 30 example sites discussed in Section 3.4 above, as presented in **Appendix B**. To provide additional information for each of the example sites, a conceptual cost estimate was developed. The cost estimates are based on two-dimensional plans, with no verified information



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<sup>6</sup> The description of this site was excerpted from information provided by the NH Natural Heritage Bureau.

on grading, planting, or engineering issues. Therefore, these estimates should not be interpreted to be final construction cost estimates, since the final restoration plans may differ from the concept plans in ways that would have a significant impact on construction costs. The estimates will allow comparison of the likely costs of each of the sites relative to one another and will help as a general planning tool.

A template estimating tool was developed to develop the cost estimates. This template lists each of the main activities needed to complete a restoration project including land costs, construction expenses associated with grading, planting, etc., as well as typical costs for planning, engineering and permitting. Cost information was taken from several sources:

- The NH Department of Transportation maintains a set of standard specifications for construction projects, and compiles a database of costs related to each item in the specification. NHDOT Item Numbers are from the publication, NHDOT Standard Specifications - 2006 Edition. NHDOT Item Costs are taken from NHDOT Weighted Average Unit Prices Years 2008 Qtrs 3,2,1 and 2007 Qtr 4, accessed via the internet.
- RS Means is a private company that maintains and publishes cost estimating tools for the construction industry. "Means" Item Numbers and Costs are taken from their publication, Site Work & Landscape Cost Data, 27th Annual Edition, 2008.
- For some items, particularly those for which no related item was found in either the NHDOT or RS Means databases, recent contractor bids from similar projects was used.

Each line in the cost estimate template cites one of these sources. Quantity estimates from each restoration plan were input into the template, which was then used to calculate costs. A spreadsheet for each of the sites is included in **Appendix E**.

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### 3.6 Functional Benefits

The overall goal of the ARM Fund is to replace wetland functions and values lost through legally permitted activities. Under the rules that guide the award of grants from the ARM Fund, the site selection committee shall select projects that *"provide the greatest potential to replace or protect specific wetland functions and values lost by the impacts in the HUC 8 watershed."* [NH Admin Rule Env-Wt 807.17(d)]

NHDES maintains a database of information on the functions and values lost through each project that has contributed to the fund. This database can be used to describe lost function and value in each of the watersheds.

It is possible to use the WRAM to estimate the functional benefit of restoration sites. As discussed in Chapter 2, a key part of the model is the concept of the "Net

Functional Benefit.” This portion of model uses a GIS-based approach to the *Method for Comparative Evaluation of Nontidal Wetlands in NH* to estimate the amount of function provided by the existing wetland as well as that same system if it were fully restored. This calculation is performed for each of five main functions:

- Ecological Integrity
- Significant Habitats
- Flood Control
- Groundwater
- Water Quality

By comparing the existing and restored values for each of these functions, it is possible to project the relative amount of wetland function that can be created by a restoration site. **Appendix F** provides these data for each of the 30 example sites discussed in this chapter.