

# THE WETLAND REMEDIATION SITE AT THE FORMER RAYTHEON FACILITY WAYLAND, MASSACHUSETTS 2005 WETLAND RESTORATION MONITORING REPORT

December 2005



**July 2005**



**August 2005**

**Prepared For:**

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|---|--|
| <b>Project Name:</b>                    | 2005 Wetland Restoration Monitoring Report<br>Former Raytheon Facility |
| <b>Project Location:</b>                | Wayland, Massachusetts   |
| <b>Mitigation Site Location:</b>        | Sudbury River Floodplain   |
| <b>ACOE Permit #:</b>                   | 200300294, September 19, 2003  |
| <b>MADEP Water Quality Cert. #:</b>     | 322-533, September 15, 2003  |
| <b>Wayland OOC #:</b>                   | 322-533, September 26, 2003  |
| <b>EOEA Compliance:</b>                 | 12984 July 17, 2003  |
| <b>Date Restoration Completed:</b>      | February 2004  |
| <b>Field Monitoring Dates for 2005:</b> | June 27, July 20, and August 18  |
| <b>Monitoring Report:</b>               | Year 2 of 5  |
| <b>Prepared By:</b>                     | Woodlot Alternatives, Inc. (Woodlot)                                   |
| <b>Woodlot Project Number:</b>          | 99123.82   |

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## 1.0 BACKGROUND

The remediation project at the former Raytheon Facility in Wayland, Massachusetts (Exhibit 1) was permitted through several regulatory agencies under the auspices of the Massachusetts Contingency Plan. The project received an Individual Permit from the Army Corps of Engineers (ACOE), Toxic Substances Control Act approval through the U.S. Environmental Protection Agency, an Environmental Impact Report through the Massachusetts Executive Office of Environmental Affairs (EOEA), Water Quality Certification from the Massachusetts Department of Environmental Protection (MADEP), and an Order of Conditions (OOC) from the Wayland Conservation Commission.

The remediation project involved excavation of contaminated floodplain soils from approximately 2.0 acres of floodplain wetlands and transportation of those contaminated soils to the proper disposal facilities under the appropriate manifests. Post- construction figures were provided in the first annual monitoring report prepared by Woodlot (Woodlot, 2004). The contaminated soils were replaced with manufactured soils and graded to pre-remediation project elevations. A new meandering swale was constructed to replace the existing swale. The remediation project area was planted with selected wetland herbaceous species and seeded with a wet meadow seeding mix. Small upland areas that were disturbed during the remediation project were reclaimed, and planted with upland trees and shrubs and seeded with an erosion control mixture.



**View looking north from the overlook.  
June 2005.**

## 2.0 RESTORATION GOALS, OBJECTIVES, AND STANDARDS FOR SUCCESS

The following goals, objectives, and Standards for Success are from the approved wetland restoration plan (Plan) for the remediation project (Woodlot and ERM, 2003).

### 2.1 GOALS

The goal of the Plan is to restore wetland functions that were impacted during the remediation project. The primary functions targeted for restoration include flood protection, fish and wildlife habitat, sediment and toxic retention, nutrient production/removal/transformation, food chain qualities, uniqueness and heritage, aesthetics, and education/scientific values. Secondary functions targeted for restoration include sediment stabilization, erosion control, and endangered species habitat.

### 2.2 OBJECTIVES

To achieve the Plan goals, the following objectives need to be met: establish emergent wetland vegetation in the restored area; establish forested buffers within disturbed upland areas; re-grade the restored floodplain; and establish initial control of invasive species such as purple loosestrife (*Lythrum salicaria*, FACW+) and common reed (*Phragmites australis*, FACW).



**Bur-reed (*Sparganium angustifolium*, OBL) and soft-stemmed bulrush (*Schoenoplectus tabernaemontanii*, OBL). July 2005.**

### 2.3 STANDARDS FOR SUCCESS

#### 2.3.1 Hydrology and Soils

To meet the Standard for Success criteria for hydrology, final grading of the remediation project area must be consistent with the original contours. The hydrology of the remediation project area was not altered during the remediation project. Pre-remediation project hydrology is retained by restoring pre-existing topographic elevations. Pre- and post-remediation project topographic elevations were surveyed and found to be consistent with the original contours (Woodlot 2004).

The soils used for restoration were a mixture of sand, loam, silt, clay, and 12 percent organic matter, which is consistent with the variable composition of floodplain soils. Soils are considered hydric if they are frequently ponded or flooded for a long or very long duration during the growing season. In these cases, underlying soil morphologic criteria may not occur and are not necessary for a designation as a hydric soil (New England Hydric Soils Technical Committee 2004).

#### 2.3.2 Vegetation

##### *Species Composition and Percent Areal Cover*

To meet the Standard for Success criteria for wetland vegetation, the remediation project area must be comprised of 75 percent areal coverage of wetland plants by the second growing season. The remediation project area must then achieve a 90 percent areal coverage of wetland vegetation for three consecutive growing seasons.



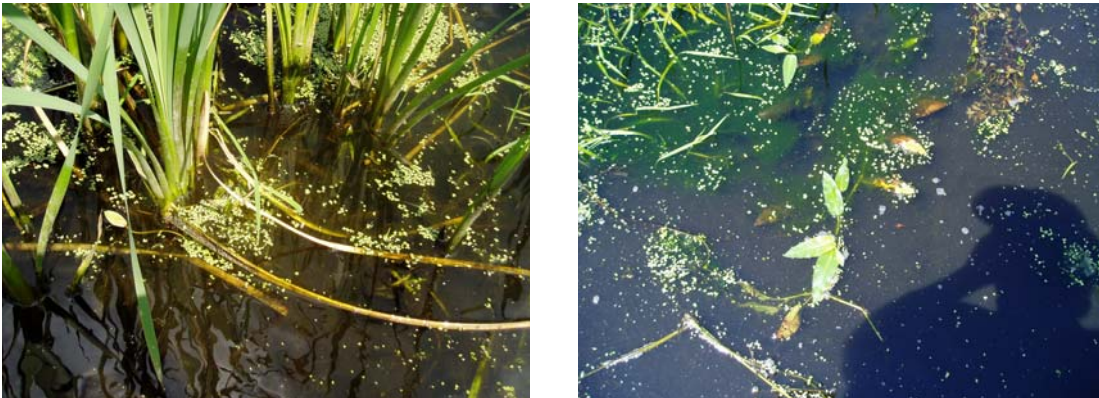
**A mixture of bur-reed and soft-stemmed bulrush (left) and rice cut-grass (*Leersia oryzoides*, OBL), bur-reed, and soft-stemmed bulrush (right). July 2005.**

#### *Planted Stock Survivorship and Woody Volunteers*

To meet the Standard for Success criteria for planted stock survivorship and woody volunteers, at least 90 percent of the planted buttonbush (*Cephalanthus occidentalis*, OBL) must survive for three consecutive years following the initial planting.

#### *Invasive Species Control*

To meet the Standard for Success criteria for invasive species control, common reed and purple loosestrife populations must be controlled with reasonable measures. It should be noted that the OOC does not allow the use of herbicides, therefore manual removal of invasive species is required.



**Duckweed (*Lemna minor*) (left) and Potamogeton (*Potamogeton diversifolius*) (right). July 2005.**

### 2.3.3 Wildlife Use

To meet the Standard for Success for wildlife use, wetland and aquatic-dependant species must occur at the remediation project area. It is anticipated that numerous wildlife species will be observed foraging and breeding in the wetland system. Wetland-dependent species would include marsh birds, herons and egrets, wetland-dependent songbirds, and species that use wetlands and uplands, such as a variety of hawks, whitetail deer (*Odocoileus virginianus*), and other songbirds. Aquatic species would include turtles, fish, aquatic insects, and frogs.



**View of the swale at a downstream location (left) and view of the swale near the discharge culvert with soft-stemmed bulrush, bur-reed, pickerelweed (*Pontederia cordata*, OBL), and rice cut-grass (right). August 2005.**

## 3.0 MONITORING METHODS

Monitoring of the remediation project area included assessment hydrology and soils, vegetation composition and coverage, and documentation of planted buttonbush survivorship, invasive plants, erosion control, and wildlife use. Monitoring was completed in accordance with the methods outlined in the approved Plan for the project (Woodlot and ERM, 2003). Monitoring site visits took place on June 27, July 17, and August 18, 2005.

### 3.1 HYDROLOGY AND SOILS

Specific monitoring of hydrologic and hydric soil criteria was not proposed or required through the issued permits. However, observations of the extent and depth of inundation and soil saturation conditions were made. These wetland characteristics have been established based on the continuation of the historic hydrologic regime.



**One of several establishing willow seedlings. August 2005.**

## 3.2 VEGETATION

### 3.2.1 Species Composition and Percent Areal Cover

Vegetation was sampled on August 18, 2005, using 25 one-meter<sup>2</sup> plots randomly spaced throughout the remediation project area (Exhibit 2). Data collected in each plot included a list of species present, estimated percent areal cover by species, and percent areal cover of bare ground and water for each plot. The data was tabulated and averaged across plots. Areal cover data can exceed 100 percent, due to overlapping layers of vegetation. For example, tall species will overhang middle and smaller sized plants, creating a multi-layered effect. A meander survey was used to identify plants present in the area but not contained in the sample vegetation plots. Plant taxonomy and nomenclature follows *The Vascular Plants of Massachusetts: A County Checklist* (Sorrie and Somers, 1999).

### 3.2.2 Planted Stock Survivorship and Woody Volunteers

Observations were made of the planted buttonbush while locating sampling plots and while conducting meander surveys along the swale. These areas were reviewed during all three monitoring visits. Observations were also made regarding volunteer buttonbush shrubs while conducting the meander surveys and locating the sampling plots. Meander surveys were used to identify and assess shrub survival and volunteers.

### 3.2.3 Invasive Species

Sampling plots and meander surveys were used to identify and assess the extent of invasive plant species, including purple loosestrife, hybrid cat-tail (*Typha x glauca*, OBL), which is a cross between *T. latifolia* and *T. angustifolium*, barnyard grass (*Echinochloa crus-galli*, FACU), and common reed. The sampling plots were used to provide a quantitative assessment of any invasive species that were located in the plots. Observations were made during the meander surveys to provide additional detail regarding the presence and location of invasive species.

## 3.3 EROSION CONTROL

The remediation project area was visually evaluated for evidence of erosion during regular site visits.

## 3.4 WILDLIFE USE

Incidental wildlife observations were recorded during each site visit.

## 4.0 2005 MONITORING RESULTS

### 4.1 HYDROLOGY AND SOILS

Based on field observations, hydrologic conditions ranged from shallow inundation to seasonally saturated depending on the season and location in the remediation project area. According to observations made by Environmental Resource Management staff., the restoration area was inundated through June 2005. The area was partially inundated with 12-18 inches of water, especially in the northern portion of the remediation area during late June and July 2005, and was saturated to the surface in the balance of the area. While water levels had dropped by the August site visit, the entire site had saturated soils but no inundation, which was expected.



## 4.2 VEGETATION

### 4.2.1 Species Composition and Percent Areal Cover

The results of the 2005 vegetation plot sampling (Appendix A) and plant meander survey (Appendix B) indicate that the remediation project area has attained 75 percent areal cover of wetland species with a range of 5-92 percent over the project area. The total areal cover ranges from 21-123 percent<sup>1</sup> within the remediation project area. The overall areal coverage of vegetation increased from 92.4 percent to 110.9 percent from 2004-2005. Furthermore the coverage of noninvasive wetland species increased from 61.6 percent to 75.0 percent from 2004-2005.

Major plant communities in the remediation project area include an emergent marsh and a developing shrub swamp. The emergent marsh community was dominated by native hydrophytes and barnyard grass. The most commonly occurring native hydrophytes in the sample vegetation plots were nodding bur-marigold (*Bidens cernua*, OBL), rice cut-grass, giant bur-reed (*Sparganium eurycarpum* OBL), and soft-stemmed bulrush. *The Aquatic and Wetland Plants of Northeastern North America* (Crow and Hellquist, 2000) describes the barnyard grass habitat as moist to wet ground, marshes, shores, ditches, and cultivated fields. It can be very common and vigorous in wetland areas, and does not appear to be an



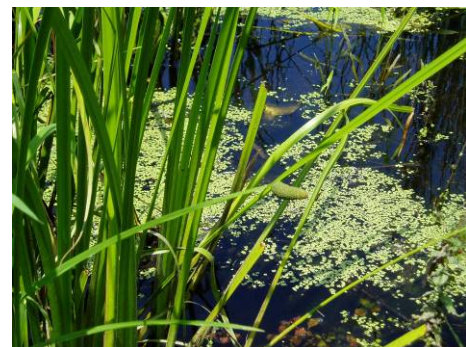
**View looking southwest (left) and view looking northwest (right) taken in August 2005.**

indicator of upland conditions at the remediation project site. Barnyard grass does provide an abundant seed source for wildlife, but because it is an introduced grass, it is not desirable as a dominant species.

As per the Plan, standing water was present in the swale during each monitoring visit, including in August when conditions were the driest of the three site visits. Soft-stemmed bulrush, bur-reed, and nodding bur-marigold were also observed in the swale.

### 4.2.2 Planted Stock Survivorship and Woody Volunteers

The 25 planted buttonbush were located, but a summary count assessed only 22 plants (Appendix C). While no dead stock was found, three likely did not survive. Volunteer buttonbush shrubs were observed along the outer edge of the remediation area, and it is anticipated that buttonbush will quickly colonize areas of the remediation project site.



**Fruiting sweet flag (*Acorus americanus*, OBL). July 2005.**

<sup>1</sup> Areal cover can exceed 100 percent due to overlapping layers of vegetation.

Woody volunteers observed in the remediation project area include buttonbush, black willow (*Salix nigra*, FACW+), red maple (*Acer rubrum*, FAC), silver maple (*Acer saccharinum*, FACW), and eastern cottonwood (*Populus deltoids*, FAC) seedlings.

#### 4.2.3 Invasive Species

Purple loosestrife and barnyard grass were observed in the remediation project area and are being controlled by cutting the flowering and seed heads (i.e., “deadheading”). Purple loosestrife represented 1.6 percent of the areal cover in the mitigation area, while it represented 1.4 percent during 2004. Barnyard grass represented 31 percent areal cover, while during 2004 it represented 30 percent. The lack of increase suggests that control is working well to keep these species from spreading, but is not reducing their presence. Barnyard grass is an annual plant, and as such only reproduces from seeds. Carefully removing the flowering and seed heads as they emerge can reduce the infestation the following year. Because the OOC does not allow the use of herbicide to control invasive plant populations, the cutting and off-site disposal of seed heads is being used to slow the spread of these species in the remediation project area. However, if monitoring identifies a problem where an invasive plant is becoming dominant, is crowding out the native species, and is reducing the overall species diversity, a species-specific management plan will be developed.

A small stand of common reed was observed along the edge of the remediation project area. Flowering heads were removed during the July site visit, and the plants were removed in August. The area where they were growing was covered in black plastic to prevent sprouting. The plastic should remain in place until the late growing season of 2006.

Hybrid cat-tail was also observed during the monitoring visits. It has the capacity to form dense, monotypic colonies. Flowering heads were also removed, bagged, and disposed of to an off-site location, and its spread is being monitored



**Flowering pickerelweed (left) and an outfall area (right). July 2004.**

#### 4.3 EROSION CONTROL AND UPLAND PLANTINGS

The upland areas disturbed during the remediation project have been reclaimed and planted with upland trees and shrubs, and seeded with an erosion control seeding mixture to control erosion and provide wildlife habitat. Survival of upland trees and shrubs was approximately 94 percent, including on-site

access areas and along the edge of the embankment (Appendix C). A small number of dead trees were observed in the access areas. No erosion related problems were observed in the remediation project area.

#### 4.4 WILDLIFE USE

A complete list of wildlife observations in the remediation project area is presented in Appendix D. Wetland-dependent species observed during 2005 monitoring work include mallard (*Anas platyrhynchos*), green frog (*Rana clamitans*), long-billed marsh wren (*Cistothorus palustris*), red-winged blackbird (*Agelaius phoeniceus*), common whitetail (*Libellula lydia*), and ruby meadowhawk (*Sympetrum internum*).

### 5.0 SUMMARY AND RECOMMENDATIONS

#### 5.1 SUMMARY

The remediation project is meeting the Standards for Success. The site exhibits desired wetland hydrology, and is densely vegetated and dominated by hydrophytes. Numerous wetland-dependent species were observed using the area for foraging and breeding. Survival of trees and shrubs exceeds requirements.

Purple loosestrife, common reed, barnyard grass, and hybrid cat-tail occur on-site. However, the cutting and off-site disposal of seed heads is being utilized to slow the spread of purple loosestrife and reduce the amount of barnyard grass. The spread of each species is being monitored, and species-specific controls will be recommended as needed. The presence of common reed should be monitored and controlled using cutting and plant removal methods.



**View looking north dominated by open water, greater duckweed (*Spirodela polyrhiza*), and bur-reed as observed during July 2005.**

#### 5.2 RECOMMENDATIONS

- 1) Continue to remove seed heads from purple loosestrife, hybrid cat-tail, and barnyard grass;
- 2) Remove seed heads and rhizomes of common reed; and
- 3) Continue to monitor the remediation project area as outlined in the Plan.

## 6.0 LITERATURE CITATIONS

- Crow, G .E. and C. B. Hellquist. 2000. Aquatic and Wetland Plants of Northeastern North America. University of Wisconsin Press, 2527 Daniels Street, Madison , WI 53718.
- New England Hydric Soils Technical Committee. 2004. Field Indicators for Identifying Hydric Soils in New England. Version 3.
- Sorrie, B. A. and P. Somers. 1999. The Vascular Plants of Massachusetts: A County Checklist. Massachusetts Division of Fisheries and Wildlife, Natural Heritage & Endangered Species Program, Westborough, Massachusetts 01581.
- USFWS 1996. 1996 National List of Vascular Plants That Occur in Wetlands. U.S. Fish and Wildlife Service. 1996.
- Woodlot Alternatives, Inc. and Environmental Resources Management, Inc. 2003. Regulatory Permit Application for Wetland Impacts Resulting from Remediation of Oils and Hazardous Materials in Sudbury River Floodplain Wetlands, Wayland, Massachusetts.
- Woodlot Alternatives, Inc. 2004. The Wetland Remediation Site at the Former Raytheon Facility Wayland, Massachusetts, 2004 Wetland Restoration Monitoring Report.

## **Exhibit 1**

### **Site Location Map**



PREPARED BY:  
  
**WOODLOT**  
 ALTERNATIVES, INC.  
 ENVIRONMENTAL CONSULTANTS

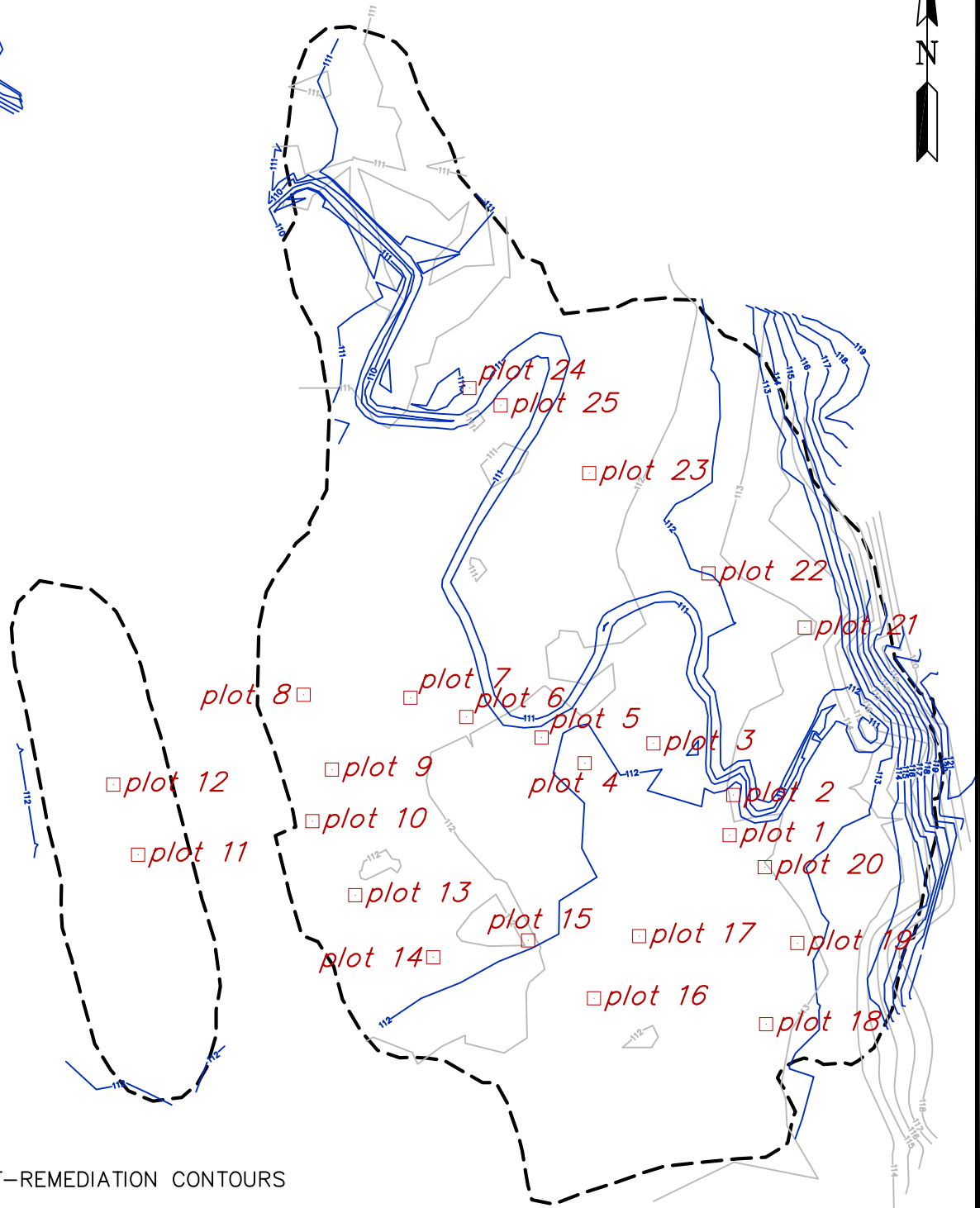
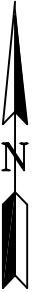
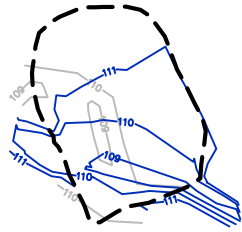
DATE: December 2004  
 SCALE: 1" = 1000'  
 JOB NO. 99123  
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*Exhibit 1*  
 Site Location Map  
 Boston Post Road  
 Wayland, Massachusetts

REV.

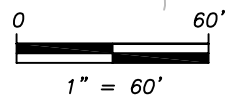
## **Exhibit 2**

### **Summer 2005 Vegetation Plots**



**LEGEND**

- POST-REMEDICATION CONTOURS
- EXTENT OF EXCAVATION AREA
- plot 10* VEGETATION SAMPLE PLOT LOCATION



PREPARED BY:



DATE: December 2005

SCALE: 1" = 60'

JOB NO. 99123

FILE: 99123-E02-VegPlots.dwg

*Exhibit 2*  
**Summer 2005 Vegetation Plots**  
**Boston Post Road**  
**Wayland, Massachusetts**

REV.



## **Appendix A**

### **Table of Sampling Plot Data**

2005 WETLAND RESTORATION MONITORING - FORMER RAYTHEON FACILITY, WAYLAND, MASSACHUSETTS

Table of Sampling Plot Data. Data collected 8/18/2005.

| Plant Species  | Common Name               | NWI Status | 1    | 2     | 3    | 4     | 5     | 6    | 7     | 8    | 9    | 10    | 11   | 12    | 13    | 14   | 15   | 16    | 17   | 18   | 19    | 20   | 21    | 22   | 23   | 24   | 25   | Species Occurrence in Plots | Total % Cover in Plots | Average Cover Per Plot |
|--|---------------------------|------------|------|-------|------|-------|-------|------|-------|------|------|-------|------|-------|-------|------|------|-------|------|------|-------|------|-------|------|------|------|------|-----------------------------|------------------------|------------------------|
| <i>Acer rubrum</i>   | red maple                 | FAC        | 1    |       |      |       |       |      |       |      |      |       |      |       |       |      |      |       |      |      |       |      |       |      |      |      |      | 1                           | 1                      | 0.04                   |
| <i>Acorus americanus</i>                                       | sweet flag                | OBL        |      |       |      |       |       |      |       |      |      |       |      |       |       |      | 30   |       |      |      | 35    |      |       |      |      |      |      | 2                           | 65                     | 2.6                    |
| <i>Alisma plantago-aquatica</i> var. <i>parviflorum</i>        | lesser water-plantain     | OBL        |      |       |      |       |       |      |       |      |      |       | 1    |       |       |      | 2    |       | 1    |      |       |      |       |      |      |      |      | 3                           | 4                      | 0.16                   |
| <i>Bidens cernua</i>   | nodding bur-marigold      | OBL        |      |       | 3    |       | 5     | 1    | 3     | 20   | 35   | 5     | 3    | 1     | 5     | 40   | 3    |       | 10   |      |       |      |       | 25   | 15   | 2    | 16   | 176                         | 7.04                   |                        |
| <i>Bidens frondosa</i>   | begger-ticks              | FACW       |      |       |      |       |       |      |       |      |      |       |      |       |       |      |      |       |      |      |       |      |       | 1    |      |      | 1    | 1                           | 0.04                   |                        |
| <i>Carex lupulina</i>  | hop-sedge                 | OBL        |      |       |      |       |       |      |       |      |      |       |      |       |       |      |      |       | 1    | 20   |       | 25   |       |      |      |      | 3    | 46                          | 1.84                   |                        |
| <i>Carex/Scirpus, sp (vegetative wetland spp)</i> <sup>2</sup> | sedge                     | FACW       | 7    |       |      |       |       |      |       |      | 3    |       |      |       |       |      | 2    |       |      | 3    |       |      | 15    |      |      | 5    | 6    | 35                          | 1.4                    |                        |
| <i>Echinochloa crus-galli</i> *                                | barnyard- grass           | FACU       | 65   |       | 25   |       | 2     | 40   | 5     | 55   | 60   |       | 80   | 5     | 2     | 30   | 25   |       | 20   | 65   |       | 40   |       | 30   | 80   | 80   | 60   | 19                          | 769                    | 30.76                  |
| <i>Iris versicolor</i>   | northern blue flag        | OBL        |      |       |      |       |       |      |       |      |      |       |      |       |       |      |      |       |      | 25   |       |      |       |      |      |      | 1    | 25                          | 1                      |                        |
| <i>Leersia oryzoides</i>                                       | rice cut- grass           | OBL        | 20   | 50    |      | 85    | 25    | 25   | 5     | 25   |      | 75    |      | 25    | 50    |      |      | 115   |      | 5    | 85    |      | 25    | 5    |      | 40   | 16   | 660                         | 26.4                   |                        |
| <i>Ludwigia palustris</i>                                      | water purslane            | OBL        |      |       |      |       | 1     |      | 2     | 3    |      | 8     | 1    | 2     |       |      |      |       |      |      |       |      |       |      |      |      | 6    | 17                          | 0.68                   |                        |
| <i>Lythrum salicaria</i> *                                     | purple loosestrife        | FACW       |      | 10    | 7    |       | 1     |      | 1     |      |      |       |      |       | 1     |      | 7    |       |      | 1    | 5     | 7    |       | 1    |      |      | 10   | 41                          | 1.64                   |                        |
| <i>Penthorum sedoides</i>                                      | ditch stonecrop           | OBL        | 1    |       |      |       |       |      | 10    |      |      |       |      |       |       |      |      |       |      |      |       | 5    |       | 1    |      |      | 4    | 17                          | 0.68                   |                        |
| <i>Polygonum persicaria</i> *                                  | lady's thumb              | FACW       |      |       |      |       |       |      |       |      |      |       |      |       |       |      |      |       |      |      |       |      | 1     | 1    | 1    |      | 3    | 3                           | 0.12                   |                        |
| <i>Polygonum punctatum</i>                                     | water or dotted smartweed | OBL        |      |       |      |       |       |      |       |      |      |       | 1    |       |       |      |      |       |      |      |       |      |       |      |      |      | 1    | 1                           | 0.04                   |                        |
| <i>Polygonum, sp (vegetative)</i>                              | knotweed                  | FACW       |      |       |      |       |       |      |       |      |      | 5     |      | 1     |       |      |      |       |      |      |       | 3    |       | 1    |      | 1    | 5    | 11                          | 0.44                   |                        |
| <i>Pontederia cordata</i>                                      | pickerel-weed             | OBL        |      |       |      | 1     | 65    |      |       |      |      |       |      |       |       |      |      |       |      |      |       |      |       |      |      |      | 2    | 66                          | 2.64                   |                        |
| <i>Populus deltoides (V)</i>                                   | cottonwood                | FAC        | 1    |       | 1    |       |       |      |       |      |      |       |      |       |       |      |      |       |      |      |       | 1    |       |      |      |      | 2    | 3                           | 0.12                   |                        |
| <i>Sagittaria latifolia</i>                                    | common arrowhead          | OBL        | 10   |       | 55   |       | 7     |      |       | 10   | 20   |       |      |       | 2     | 5    | 15   |       |      | 25   |       |      | 95    |      | 3    |      | 11   | 247                         | 9.88                   |                        |
| <i>Salix nigra (V)</i>   | black willow              | FACW+      |      |       |      |       |       |      |       |      |      |       |      |       | 2     |      |      |       |      | 2    |       | 1    |       |      |      |      | 3    | 5                           | 0.2                    |                        |
| <i>Scirpus tabernaemontanii</i>                                | soft-stemmed bullrush     | OBL        |      | 55    |      |       |       |      | 95    |      |      |       |      | 80    | 25    | 20   |      |       |      | 35   |       |      |       |      |      | 10   | 7    | 320                         | 12.8                   |                        |
| <i>Sium suave</i>  | water-parsnip             | OBL        |      | 10    |      |       |       |      |       |      |      |       |      |       |       |      |      |       |      |      | 5     |      |       |      |      |      | 2    | 15                          | 0.6                    |                        |
| <i>Sparganium eurycarpum</i>                                   | giant bur-weed            | OBL        |      | 5     |      |       | 5     | 45   |       |      | 10   | 40    | 20   | 15    |       |      |      |       |      |      |       |      |       |      |      | 15   | 8    | 155                         | 6.2                    |                        |
| <i>Typha xglauca</i>   | hybrid cat-tail           | OBL        |      |       |      | 15    |       |      |       | 2    |      |       |      |       | 10    | 5    | 15   |       |      |      |       | 1    |       |      |      | 40   | 7    | 88                          | 3.52                   |                        |
| Vegetative forb  |                           | N/A        | 1    |       |      |       |       |      |       |      |      |       |      |       |       |      |      |       |      |      | 1     |      |       |      |      |      | 2    | 2                           | 0.08                   |                        |
| Thatch/bare ground   |                           |            | 5    | 1     | 10   | 25    | 3     | 10   | 15    | 10   | 3    | 3     | 2    | 1     | 10    | 10   | 15   | 15    | 15   | 3    | 0     | 5    | 15    | 25   | 5    | 5    | 0    |                             |                        | 0                      |
| Saturated to surface   |                           |            | Yes  | Yes   | Yes  | Yes   | Yes   | Yes  | Yes   | Yes  | Yes  | Yes   | Yes  | Yes   | Yes   | Yes  | Yes  | Yes   | Yes  | Yes  | Yes   | Yes  | Yes   | Yes  | Yes  | Yes  | Yes  |                             |                        |                        |
| Standing Water   |                           |            | 0    | 0     | 0    | 0     | 0     | 0    | 0     | 0    | 0    | 0     | 0    | 0     | 0     | 0    | 0    | 0     | 0    | 0    | 0     | 0    | 0     | 0    | 0    | 0    | 0    |                             |                        |                        |
| Total % Vegetative Cover for Plot <sup>3</sup>                 |                           |            | 105  | 130   | 91   | 101   | 109   | 113  | 118   | 115  | 131  | 120   | 117  | 128   | 100   | 100  | 99   | 115   | 98   | 124  | 126   | 120  | 120   | 78   | 101  | 108  | 105  |                             | 2773.0                 | 110.9                  |
| Total % Hydrophytic Cover for Plot <sup>4</sup>                |                           |            | 41.0 | 120.0 | 59.0 | 86.0  | 107.0 | 72.0 | 113.0 | 57.0 | 71.0 | 120.0 | 37.0 | 123.0 | 87.0  | 65.0 | 52.0 | 115.0 | 77.0 | 58.0 | 121.0 | 33.0 | 120.0 | 47.0 | 21.0 | 28.0 | 45.0 |                             | 1875.0                 | 75.0                   |
| Relative % Hydrophytes: Corps Method                           |                           |            | 50.0 | 100.0 | 50.0 | 100.0 | 100.0 | 67.0 | 100.0 | 50.0 | 50.0 | 100.0 | 0.0  | 100.0 | 100.0 | 67.0 | 50.0 | 100.0 | 67.0 | 50.0 | 100.0 | 67.0 | 100.0 | 67.0 | 0.0  | 0.0  | 50.0 |                             | 1685.0                 | 75.0                   |

Notes:

- <sup>1</sup>FAC = facultative, 34 – 36% occurrence wetlands; FACU = facultative upland, 1 – 33% occurrence in wetlands.
- FACW = facultative wetland, 67 – 99% occurrence in wetlands; OBL = obligate wetland, greater than 99% occurrence in wetlands.
- UPL = obligate upland species >99% occurrence in non-wetlands in Northeast region.
- \* = introduced species N/A = Not applicable V = Volunteer species

<sup>2</sup>Plots 1, 9, 15, 18, 22, 25: two species of vegetative sedges

<sup>3</sup> Areal cover can exceed 100% due to overlapping layers of vegetation.

<sup>4</sup> Excludes barnyard grass, purple loosestrife, and cat-tail

## **Appendix B**

### **Plant Meander Survey**

### 2005 Plant Meander Survey of the Wetland Remediation Site

| Species                                       | Common Name             | NWI Rating | Introduced or Native |
|---|-------------------------|------------|----------------------|
| <i>Callitriche sp</i> (vegetative)            | water star-wort         | OBL        | Native               |
| <i>Eleocharis obtusa</i>                      | soft-stemmed spike-rush | OBL        | Native               |
| <i>Eleocharis palustris</i>                   | creeping spike-rush     | OBL        | Native               |
| <i>Eupatorium perfoliatum</i>                 | boneset                 | FACW+      | Native               |
| <i>Peltandra virginica</i>                    | arrow arum              | OBL        | Native               |
| <i>Polygonum amphibium</i>                    | erect smartweed         | OBL        | Native               |
| <i>Potamogeton diversifolius</i> <sup>1</sup> | pondweed                | OBL        | Native               |
| <i>Sium suave</i>                             | water parsnip           | OBL        | Native               |

<sup>1</sup>State listed endangered species

The following designations are based on the National List of Plant Species That Occur in Wetlands: Northeast (USFWS 1996):

- OBL (Obligate): Occurs almost always within wetlands (estimated probability >99%).
- FACW (Facultative Wetland): Usually occurs in wetlands (67-99%), but occasionally found in non-wetlands.
- FAC (Facultative): Equally likely to occur in wetlands or non-wetlands (34-66%).
- FACU (Facultative Upland): Usually occurs in non-wetlands, but occasionally found in wetlands (1-33%).
- NI (Not Rated) Listed on NWI but no rating given for the northeast

## **Appendix C**

### **Tree and Shrub Survival**

**SURVIVORSHIP OF UPLAND PLANTED TREES AND SHRUBS**

| Species                          | Common Name        | No. Planted | Found Alive | Found Dead |
|----------------------------------|--------------------|-------------|-------------|------------|
| <i>populus grandidentata</i>     | big-tooted aspen   | 55          | 25          | 0          |
| <i>Populus deltoides</i>         | cottonwood         | 0           | 4           | 0          |
| <i>Pinus strobus</i>             | eastern white pine | 5           | 16          | 0          |
| <i>Betula populifolia</i>        | gray birch         | 5           | 18          | 8          |
| <i>Betula paperifera</i>         | paper birch        | 5           | 0           | 0          |
| <i>Quercus rubra</i>             | red oak            | 5           | 8           | 4          |
| <i>Quercus bicolor</i>           | swamp white oak    | 0           | 1           | 0          |
| <i>Myrica pensylvanica</i>       | bayberry           | 6           | 3           | 0          |
| <i>Vaccinium spp</i>             | blueberry          | 6           | 9           | 0          |
| <i>Spiraea alba v. latifolia</i> | meadowsweet        | 7           | 4           | 0          |
| <i>Comptonia peregrina</i>       | sweet fern         | 6           | 6           | 0          |
|                                  | <b>Total</b>       | <b>100</b>  | <b>94</b>   | <b>12</b>  |
|                                  | <b>Survival %</b>  |             | <b>94</b>   |            |
|                                  |                    |             |             |            |
| <i>Cephalanthus occidentalis</i> | buttonbush         | 25          | 21          | 0          |
|                                  | <b>Survival %</b>  |             | <b>84</b>   |            |
|                                  |                    |             |             |            |

**Appendix D**  
**Wildlife Observations**

**2005 Wildlife Observations at the Wetland Remediation Site**

| <b>Species</b>                        | <b>Common Name</b>                   | <b>Habitat Use On-site</b>   |
|---------------------------------------|--------------------------------------|--|
| <b>Amphibians and Reptiles</b>        |                                      |  |
| ( <i>Rana catesbeiana</i> )           | bullfrog                             | Inundated wetland: foraging and breeding.                                    |
| ( <i>Rana clamitans</i> )             | green frog                           | Inundated wetland: foraging and breeding.                                    |
| ( <i>Chrysemys picta</i> )            | painted turtle                       | Inundated wetland: foraging. Upland: breeding                                |
| <b>Birds</b>                          |                                      |  |
| ( <i>Dumetella carolinensis</i> )     | gray catbird                         | Upland: foraging and breeding. Wetland: foraging.                            |
| ( <i>Colaptes auratus</i> )           | northern flicker                     | Upland: foraging and breeding. Dry wetland: foraging.                        |
| ( <i>Charadrius vociferus</i> )       | killdeer (adult and young)           | Exposed mud and shallow pools: foraging. Dry wetland: foraging and breeding. |
| ( <i>Geothlypis trichas</i> )         | common yellowthroat                  | Wetland and upland: foraging and breeding.                                   |
| ( <i>Carduelis tristis</i> )          | American goldfinch                   | Upland: foraging and breeding. Wetland: foraging.                            |
| ( <i>Melospiza melodia</i> )          | song sparrow                         | Wetland and upland: foraging and breeding.                                   |
| ( <i>Cyanocitta cristata</i> )        | blue jay                             | Upland: foraging and breeding. Wetland: foraging.                            |
| ( <i>Agelaius phoeniceus</i> )        | red-winged blackbird                 | Wetland: foraging and breeding.  |
| ( <i>Turdus migratorius</i> )         | American robin                       | Dry wetland and upland: foraging and breeding.                               |
| ( <i>Empidonax traillii</i> )         | willow flycatcher                    | Wetland: foraging and breeding.  |
| ( <i>Cistothorus palustris</i> )      | long-billed marsh wren               | Wetland: foraging and breeding.  |
| ( <i>Zenaida macroura</i> )           | mourning dove                        | Dry wetland: foraging. Upland: foraging and breeding.                        |
| ( <i>Melospiza georgiana</i> )        | swamp sparrow                        | Wetland: Foraging and breeding.  |
| ( <i>Calidris minutilla</i> )         | least sandpiper                      | Exposed mud and shallow pools: foraging.                                     |
| ( <i>Actitis macularia</i> )          | spotted sandpiper                    | Exposed mud and shallow pools: foraging.                                     |
| ( <i>Anas rubripes</i> )              | black duck                           | Wetland: foraging.   |
| ( <i>Tachycineta bicolor</i> )        | tree swallow                         | Wetland and upland: foraging over.   |
| ( <i>Stelgidopteryx serripennis</i> ) | northern rough-winged swallow        | Wetland and upland: foraging over.   |
| ( <i>Dendroica petechia</i> )         | yellow warbler                       | Wetland and upland: foraging and breeding.                                   |
| ( <i>Quiscalus quiscula</i> )         | common grackle                       | Wetland: foraging. Upland: foraging and breeding.                            |
| ( <i>Molothrus ater</i> )             | brown-headed cowbird                 | Wetland: foraging. Upland: foraging and breeding.                            |
| ( <i>Ardea herodias</i> )             | great blue heron                     | Inundated wetland: foraging.   |
| ( <i>Cardinalis cardinalis</i> )      | northern cardinal                    | Dry wetland and upland: foraging and breeding.                               |
| ( <i>Buteo jamaicensis</i> )          | red-tailed hawk                      | Dry wetland: foraging. Upland: foraging and breeding.                        |
| ( <i>Anas platyrhynchos</i> )         | mallard                              | Wetland: foraging.   |
| ( <i>Rallus limicola</i> )            | Virginia rail                        | Wetland: foraging and breeding.  |
| <b>Mammals</b>                        |                                      |  |
| ( <i>Odocoileus virginianus</i> )     | white-tailed deer                    | Wetland and upland: foraging, bedding, and breeding.                         |
| ( <i>Procyon lotor</i> )              | raccoon                              | Wetland and upland: foraging and breeding.                                   |
| ( <i>Sylvilagus floridanus</i> )      | eastern cottontail (adult and young) | Dry wetland and upland: foraging and breeding.                               |
| ( <i>Sciurus carolinensis</i> )       | gray squirrel                        | Upland: foraging and breeding.   |
| <b>Insects</b>                        |                                      |  |
| ( <i>Anax junius</i> )                | common green darner                  | Wetlands and uplands: foraging and ovipositing.                              |
| ( <i>Libellula Lydia</i> )            | Common whitetail                     | Wetlands and uplands: foraging and ovipositing.                              |
| ( <i>Sympetrum internum</i> )         | ruby meadowhawk                      | Wetlands and uplands: foraging and ovipositing.                              |
| ( <i>Enallagma signatum</i> )         | orange bluet                         | Wetlands: foraging.  |
| ( <i>Vanessa cardui</i> )             | painted lady butterfly               | Wetlands and uplands: foraging and puddling.                                 |
| ( <i>Papilio glaucus</i> )            | eastern tiger swallowtail            | Wetlands and uplands: foraging and puddling.                                 |
| ( <i>Speyeria cybele</i> )            | great spangled fritillary            | Wetlands and uplands: foraging and puddling.                                 |
| ( <i>Enallagma signatum</i> )         | orange blue damselfly                | Wetlands and uplands: foraging and puddling.                                 |
| ( <i>Notonectidae</i> )               | back swimmer                         | Ponded water: foraging.  |
| ( <i>Gerridae</i> )                   | water striders                       | Ponded water: foraging.  |