FINAL RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT:

CHARLES GEORGE LAND RECLAMATION TRUST LANDFILL SUPERFUND SITE

Prepared by

The Charles George Natural Resources Trustee Council

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1.0 Introduction to the Restoration Plan and Environmental Assessment

This Final Restoration Plan and Environmental Assessment (RP/EA) was prepared by the Charles George Natural Resources Trustee Council (Trustee Council). The Trustee Council is comprised of three trustees for natural resources: the Commonwealth of Massachusetts Office of Environmental Affairs (EOEA), the U.S. Department of the Interior (DOI), and the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). This document describes the injuries that occurred to natural resources as a result of contamination at the Charles George Landfill Superfund Site, and identifies alternatives for restoration of injured resources and the services these resources provide. In addition, this document constitutes the environmental assessment for the proposed restoration of natural resources as defined under the National Environmental Policy Act (NEPA)(40 CFR Part 1502.10) and the Massachusetts Environmental Policy Act (MEPA) (M.G.L. c.30, §§ 61-62H, and 301 CMR 11.00), and addresses the potential impact of proposed restoration actions on the quality of the physical, biological, and cultural environment. This Final RP/EA is intended to inform the public of the proposed restoration actions.

Chapter 1.0 summarizes the history of the Charles George Landfill (Section 1.1); describes the Natural Resources Damage Assessment process including Trustee responsibilities and the legal settlements for the Charles George Landfill (Section 1.2); describes the natural resources restoration planning process (Section 1.3); lists the purpose and need for the RP/EA (Section 1.4); and summarizes the public notification and review provisions (Section 1.5).

1.1 History of the Charles George Landfill

The Landfill

The Charles George Reclamation Trust Landfill is an inactive landfill located in the Towns of Tyngsborough and Dunstable, Massachusetts, which are located approximately 35 miles northwest of Boston. The landfill was used for municipal wastes from 1955 to 1973. In 1973, the landfill was permitted to accept hazardous wastes. In 1982, volatile organic compounds (VOCs) and heavy metals were detected in the drinking water supply wells of the Cannongate condominium complex located approximately 800 feet southwest of the site. Polycyclic aromatic hydrocarbons (PAHs) and heavy metals were also detected in soils and sediments around the site. The site was closed, and the U.S. Environmental Protection Agency (EPA) began remedial activities.

Surrounding Environment

The landfill site is approximately 60 acres in size, and is surrounded by forest, wetlands, light industry, pasture land, and residences. It is located approximately one mile southwest of the town center of Tyngsborough, Massachusetts (Fig.1). The general area is presently receiving intense development pressure. To the east, U.S. Route 3 separates the landfill from the 16-acre Flint Pond Marsh and 61-acre Flint Pond. Dunstable Brook and several of its small tributaries are located to the west of the landfill and join Bridge Meadow Brook southwest of the site. Bridge Meadow Brook flows northeast, looping around the landfill and emptying into Flint Pond. Two

dams control the water levels of Flint Pond. A short distance below the second dam, the outlet stream of Flint Pond flows into the Merrimack River.

The two pathways by which contaminants from the landfill have reached the surrounding environment have been surface water runoff and groundwater migration. Surface water runoff (from rainfall) flows off of the landfill into a culvert that drains under Route 3 into Flint Pond Marsh. Groundwater lies in three different zones under the landfill: the overburden, shallow bedrock, and deep bedrock aquifers. There is a divide in groundwater flow for all three aquifers. The groundwater flows to the south in the western portion of the landfill and flows due east under the eastern portion. The deep bedrock aquifer in the western portion of the landfill is not believed to be within the contaminant pathway.

Remedial Activities

The remedial activities are summarized from EPA 1988 and EPA 1999. To address contamination of drinking water wells, the City of Lowell's existing water supply system was extended to serve the Cannongate area, the Academy of Notre Dame, and the Flint Road neighborhood after landfill contaminants were detected in a monitoring well on Notre Dame's property and in a residential well on Flint Road. The extensions were completed in 1998. Remediation includes long-term groundwater monitoring to protect nearby residential drinking water.

To control the source of contamination, the landfill was capped with a synthetic membrane with surface water diversion, off-gas collection and venting, and leachate seep collection (completed in 1990). On-site overburden extraction wells were installed at the southwest (1993) and east areas (1994) of the site where the two identified contaminant plumes exist. Between 1992 and 1997, the combined groundwater and leachate were pumped to a 3.5 million gallon storage lagoon and then treated when the lagoon reached capacity. The water was treated on-site in a temporary treatment facility and discharged to the eastern sedimentation pond which then discharged to Bridge Meadow Brook. Ambient Water Quality Criteria were strictly met. There were ten rounds of treatment with a total of approximately 35 million gallons treated. In 1997, EPA extended the municipal sewer to the site. In early 1998, the Lowell Regional Wastewater Utility issued the site an industrial discharge permit and the collected groundwater and leachate began discharging to the Publicly Owned Treatment Works via the extended sewer.

Landfill gas has been collected and treated since 1994. The gas is collected by a series of vents tying into a surficial (beneath the cap) gravel trench. The gas is then vacuum-transported to an enclosed flame where it is burned.

Part of the original plans for remediation included the removal of sediments from the upper portion of Dunstable Brook which were affected by carcinogenic polycyclic aromatic hydrocarbons (cPAHs). The plan originally called for the sediments to be solidified on-site and placed under the landfill cap. However, in 1998, EPA resampled the affected area and analyzed

for cPAHs. The results showed decreased concentration levels of cPAHs. EPA recalculated the risk associated with the cPAH levels using revised relative potency factors (the revision was based on recent toxicity data). The recalculation indicated that the sediments no longer posed an unacceptable human health risk. Therefore, removal of the sediments was determined to be unnecessary.

Chemical Hazards

High levels of inorganic contaminants have been found in groundwater and landfill leachate, and include: arsenic, cadmium, chromium, copper, cyanide, lead, mercury, nickel, silver, and zinc. High levels of chromium and zinc were detected in surface waters of the brooks and wetlands adjacent to the landfill, and Flint Pond. Elevated levels of arsenic, cadmium, copper, lead, mercury, and zinc were measured in the sediments of Dunstable Brook and associated wetlands, and drainage streams (Ebasco 1987, 1988). Organic contaminants, particularly polycyclic aromatic hydrocarbons (PAHs), were also detected at elevated levels in the sediments of the Dunstable Brook system (Ebasco 1987, 1988). Figure 2 shows the locations of Flint Pond Marsh, the wetlands adjacent to the landfill, and the upper portion of Dunstable Brook.

1.2 Natural Resource Damage Assessment

Trustee Responsibilities Under CERCLA

Executive Order 12580 designated federal and state trustees for natural resources, which designations are set forth in greater detail in Subpart G of the National Contingency Plan, 40 C.F.R. Section 300.600. The Secretary of the Department of the Interior is a designated federal trustee for natural resources including migratory birds, some marine mammals, anadromous and catadromous fish, endangered species and their respective habitats, and federal lands managed by the Department. The Northeast Regional Director of the U.S. Fish and Wildlife Service has been designated as Authorized Official to act on behalf of the Secretary as trustee for this Superfund Site. The Secretary of Commerce has delegated to the National Oceanic and Atmospheric Administration trusteeship for natural resources that include marine fishery resources, anadromous and catadromous fish, certain endangered species and their habitats. The states are designated trustees for all natural resources within their jurisdiction. The Governor of the Commonwealth of Massachusetts has designated the Secretary of the Executive Office of Environmental Affairs as trustee for all natural resources in the Commonwealth. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, natural resource trustees are authorized to assess and recover compensation for injury to or loss of natural resources resulting from a release of a hazardous substance.

Massachusetts General Laws (Chapter 21 E, s.5) states that persons responsible for hazardous materials will be liable to the Commonwealth for all damages for injury to and for destruction or loss of natural resources.

The Settlements

In 1992 the State and Federal Trustees settled natural resource damage claims with the Potentially Responsible Parties (PRPs). The total recovery of damages and future oversight expenses for all the Trustees was $1,353,440. The primary issue raised by DOI concerned the effects of heavy metals (*i.e.*, arsenic, cadmium, chromium, copper, cyanide, lead, mercury, nickel, silver, and zinc) and PAHs on migratory birds utilizing the contaminated Flint Pond Marsh. DOI determined that migratory birds had been injured in the past, and would continue to be injured, regardless of the success of the remedial action. Approximately 14.5 acres of Flint Pond Marsh (mostly emergent and deep water habitat) was calculated to have been adversely affected as migratory bird habitat, and it was estimated that 44 acres of wetland enhancement would be required to compensate for the injuries. DOI recovered $299,916 to provide for enhancement of 44 acres of wetlands to replace lost wetland resources, habitat, and productivity at the site, and to provide for long-term performance monitoring of the sites to assure success. This amount covers claims for past, interim, and residual damages for injury to the wetland migratory bird habitat.

The primary issue raised by NOAA regarded the potential migration of contaminants through Flint Pond to the Merrimack River. The Merrimack River supports runs of anadromous fish (spawns in freshwater but matures in saltwater), including runs of Atlantic salmon (*Salmo salar*), American shad (*Alosa sapidissima*), alewife herring (*Alosa pseudoharengus*), and blueback herring (*Alosa aestivalis*). It also supports runs of the catadromous (spawns in saltwater but matures in freshwater) American eel (*Anguilla rostrata*). Potential discharges of contaminants through Flint Pond and into the Merrimack River could impact spawning habitat for American shad, alewife, and blueback herring in the Merrimack River, and adult habitat of American eel in Flint Pond and Bridge Meadow Brook. It was decided that the selected remedy would protect fishery resources in the Merrimack River as long as the Flint Pond dams are maintained. Flint Pond Marsh appears to act as an effective depositional area for pre-remedial contaminants transported from the landfill, and the dams at Flint Pond appear to limit the movement of sediments from Flint Pond Marsh. Therefore, the structural integrity of the dams is critical. NOAA's portion of the settlement was based on the need to do ecological profiling involving collection and chemical analysis of sediments upstream and downstream of the dams, and collection of fish in the Merrimack River near the dams for tissue analysis. The settlement also included the need to conduct long-term monitoring to assure that the remedial action was effective. Since the structural integrity of the dams is critical to contaminant source control, the settlement also included monies for the Federal natural resource trustees to monitor and possibly initiate needed structural surveys. NOAA recovered $134,624 for damages and future oversight expenses. The federal settlements together included $25,000 for past assessment costs and $50,000 for future oversight expenses.

The Commonwealth of Massachusetts made a claim on behalf of injuries to groundwater and wetlands. Groundwater damage calculations were based on the costs of replacing the services lost due to site contamination. The groundwater contamination had made the aquifer unsuitable as a source of water for residential and non-residential users. As a result, present and future water users would be forced to develop alternate water supply systems. The Commonwealth's

claim for injuries to wetlands was based on the loss of 9.25 acres of wetlands due to contamination and physical alteration during the capping and remediation of the landfill. The wetlands cited in the claim were specifically: 3.25 acres of wetlands along Dunstable Brook and approximately 110 feet of the tributary channel to Dunstable Brook; 2.0 acres of wetland in Flint Pond Marsh along the Route 3 drainage system; 2.0 acres of altered wetlands adjacent to the landfill; and 1.5 acres of wetlands adjacent to the landfill that were destroyed in the process of remediation (Holcomb 1990). The Commonwealth recovered $918,900 for damages to state natural resources.

1.3 Natural Resource Restoration Planning

The Memorandum of Agreement

In 1996, the three Trustees for natural resources signed a Memorandum of Agreement (MOA) in recognition of the common interests to restore, replace and/or acquire the equivalent natural resources which were injured, destroyed, or lost by the releases of hazardous substances from or at the Charles George Landfill Superfund Site. The MOA outlines a framework for the development of a Trustee Council that is providing for the cooperative development and implementation of a single plan to restore injured natural resources (Restoration Plan). In addition to the three Trustee representatives, the MOA also provides for the inclusion of *ex-officio,* or non-voting members on the Trustee Council. In the case of the Charles George Natural Resources Trustee Council, the *ex-officio* members include technical and legal advisors from the state and federal agencies, a citizen from the Town of Tyngsborough, a representative from the Town of Tyngsborough Conservation Commission, and a representative from the Merrimack River Watershed Council.

Restoration Planning, NEPA, and MEPA

Prior to using funds for restoration, CERCLA requires that (1) a plan for use of such funds be developed and adopted by the Trustees, and (2) adequate public notice and opportunity for hearing and consideration of all public comments be granted. In addition, the DOI Natural Resource Damage Assessment Regulations (43 CFR, Part 11) provide for: (1) the development of a "Restoration and Compensation Determination Plan that lists a reasonable number of possible alternatives for restoration, rehabilitation, replacement, and/or acquisition of equivalent resources and the related services lost to the public associated with each" \s. 11.81]; and (2) upon determination of the award of a Natural Resource Damage claim the Trustees shall prepare a Restoration Plan to describe how the monies will be used. Such Restoration Plan shall be made available for public review for a period of at least 30 days \s. 11.93].

Under NEPA and MEPA the Trustees must also assess the potential environmental impacts associated with each of the proposed restoration actions. This Draft RP/EA integrates NEPA and MEPA requirements by summarizing the affected environment, describing the purpose and need for action, identifying alternative actions and assessing their applicability and environmental consequences, and summarizing opportunities for public participation in the

decision process.

The Trustees believe the Final RP/EA indicates that the proposed actions will not have significant impacts on the quality of the human environment.

1.4 Purpose and Need

The underlying purpose of the proposed action is to restore, replace, or acquire the equivalent of natural resources injured or destroyed as a result of contamination from the Site, pursuant to applicable state and federal laws and regulations. The underlying need for the action is to ensure the recovery of natural resources injured as a result of contamination from the landfill. The primary injuries resulting from contamination at the Site involve the impairment of groundwater and wetland resources, and the potential effect that a continuing migration of contaminants into the Merrimack River could have on migratory fish. The settlement for DOI regarding wetlands referred specifically to the resulting loss of habitat services to wetland-dependent migratory birds.

1.5 Public Notification and Review

Under CERCLA, NEPA, and MEPA, the Trustees must notify the public and any federal, state, or local agencies with special interests or expertise relating to the RP/EA. To satisfy this requirement, the Trustees published the notice of the availability of the Draft RP/EA in the Federal Register, the Environmental Monitor, the Lowell Sun, the Billerica Minuteman, and the Boston Globe. The document was also available for review at the Tyngsborough Public Library, the Dunstable Public Library, and the Billerica Public Library, and copies of the Draft RP/EA were available from the U.S. Fish and Wildlife Service. The document could also be read or down loaded from the Web at the following address:
http://greatmeadows.fws.gov/charlesgeorge.html.

In addition, the the Trustee Council conducted a public meeting on November 29, 2001 in Tyngsborough. A summary of questions and comments received and the Trustee Council's responses is provided in Section 5.0. Written comments from the public are reproduced in Appendix D.

A copy of the Final RP/EA will be available for review at the Tyngsborough Public Library:
Tyngsborough Public Library
25 Bryants Lane
Tyngsborough, Massachusetts 01879
(978) 649-7361

Hours:	Monday and Wednesday	9:00 am - 9:00 pm
	Tuesday, Thursday, and Friday	9:00 am - 5:00 pm
	Saturday	10:00 am - 3:00 pm

Copies of the Final RP/EA will be obtainable at the web site:
http://greatmeadows.fws.gov/charles george.html, or from the following address:

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2.0 Restoration Actions and Alternatives

In developing the RP/EA, the Trustees were required to consider a reasonable number of possible restoration alternatives (43 CFR, Section 11.81, DOI Natural Resource Damage Assessment Regulations). Chapter 2.0 explains the criteria for identifying alternatives (Section 2.1), describes Alternative A - No Action (Section 2.2), and Alternatives B through F- Other Action Alternatives (Sections 2.3 through 2.7). The proposed restoration actions are identified in Section 2.8.

2.1 Criteria for Identifying the Proposed Restoration Actions and Alternatives

The Trustees' objective is to compensate for impacts to groundwater, wetlands, migratory birds that use wetland habitat, and migratory fish in the Merrimack River. The Trustees will ensure that restoration funds are used to provide the maximum benefit for Trust Resources (maximum benefit is stipulated since the damage settlement was insufficient to provide complete restoration), and ensure that the project provides benefits to Trust Resources in perpetuity. The criteria used to evaluate the alternatives are listed in Table 1. These criteria were developed by the Trustee Council and were based on the DOI Natural Resource Damage Assessment Regulations for factors to consider when selecting alternatives \s. 11.81].

2.2 Alternative A: No Action

Under Alternative A, no action would be taken to restore resources injured due to contamination from the Site.

Specific Projects

No projects would be conducted under this alternative.

Table 1. [1]Criteria for selecting restoration sites to compensate for environmental injury caused by the Charles George Landfill.

A. Extent to which the alternative restores, replaces, or enhances the natural resources that were injured.

* Priority will be given to projects which most closely restore or replace the values of the natural resources injured. For example, if emergent marsh was injured, then a project which restores or replaces the values of emergent marsh would be given priority. Second consideration would be given to improving existing emergent marsh, and lastly to acquisition or protection of emergent marsh.

B. Proximity to injured resources.

* Priority will be given to projects which are closest to the location of injury. Specifically, priority will be given to projects within the immediately impacted area in Tyngsborough and Dunstable, and secondly to the rest of Tyngsborough and Dunstable. Projects beyond this area may be considered if the restoration cannot be accomplished within the Towns of Tyngsborough or Dunstable, or if there are projects that will provide a greater environmental benefit relative to the injured resources outside of Tyngsborough or Dunstable. Projects outside the Commonwealth and outside the Merrimack River watershed will not be considered.

C. Cost effectiveness of the alternative.

* Priority will be given to projects which provide the greatest environmental benefit for the least cost in comparison to other proposed projects.

D. Extent to which the alternative will enhance the public's ability to use, enjoy, or benefit from the natural resources.

E. Extent of ecological benefit to the public.

F. Extent that the alternative provides an opportunity for community involvement to continue after the Trustee Council's involvement has ended.

G. Extent to which the project is expected to be successful.

H. Compliance with applicable federal, state, and local laws.

[1] Criteria are not listed in order of priority.

2.3 Alternative B: On-Site Wetland Restoration

On-site wetland restoration projects include capping contaminated portions of wetlands, dredging contaminated areas of wetlands, converting upland areas to wetland, removing erosion deposits from wetlands, and enhancing existing wetland values by eradicating common reed (*Phragmities australis*) and/or purple loosestrife (*Lythrum salicaria*).

Specific Projects

Sediment Capping:
Surface water and sediments in approximately 14.5 acres of Flint Pond Marsh were contaminated with PAHs and metals (primarily arsenic) above biological effect levels (USFWS 1992). Approximately 3.0 acres of the Dunstable Brook system were contaminated with PAHs and metals above biological effect levels (Holcomb 1990). Contaminated sediments could be capped with clean material.

Contaminated Sediment Removal:
Flint Pond Marsh and Dunstable Brook could be restored by removing contaminated sediments. Excavated sediments could be remediated by various treatment techniques and returned to the site or deposited in an appropriate landfill. Removal of contaminated sediments is often an expensive alternative; removal and disposal of 2.75 acres of highly contaminated sediments in Dunstable Brook and Flint Pond Marsh was estimated to cost $3,656,803 (Holcomb 1990).

Wetland Creation:
On-site uplands could be converted to wetlands. Upland adjacent to Flint Pond Marsh or adjacent to the landfill could potentially be available for wetland creation. Typical costs for creating wetlands vary between $25,300/acre and $77,900 per acre, depending on the type of wetland being constructed (King and Bohlen 1994).

Erosion Sediments Removal:
Sediments could be removed from 2.0 acres of wetlands adjacent to the landfill and from 3.0 acres along Dunstable Brook that were impacted by erosion from the capping of the landfill. Since 1990, when these sites were assessed (Holcomb 1990), the disturbed sites have revegetated. Although the sites are altered from their original condition, excavating the eroded material after this relatively extended period of time would only serve to redisturb the sites, including the upland areas adjacent to the wetlands due to the entry of heavy equipment.

Management of Invasive Vegetation (Common Reed and Purple Loosestrife):
Partial restoration of lost natural resource values could be accomplished by managing stands of common reed and purple loosestrife. Purple loosestrife is present in dense stands in Flint Pond Marsh and the wetlands adjacent to the landfill, which has degraded the habitat for some migratory birds. Common reed is present in discrete patches, but these patches could expand. Potential measures to control common reed and purple loosestrife include manipulating water levels, applying chemicals, cutting, mowing,

mulching, and biological control (release of insects that feed exclusively on the nuisance plant) (Malecki *et al.* 1993; Tiner 1998).

Redirection of Route 3 Runoff:
Water quality enhancement of Flint Pond may be improved by redirecting highway runoff from Route 3 into detention ponds before it is discharged into Flint Pond Marsh. Detention basins can serve to remove nutrients such as phosphorus, as well as oils, heavy metals, and suspended solids (Chan *et al.* 1982). Presently there are five cross culverts

that collect water from Route 3 and then empty into Flint Pond; two empty directly into Flint Pond and three discharge into unnamed streams that flow into Flint Pond (C. Mizioch, Massachusetts Department of Highways, pers. comm.). This runoff contributes salts, petroleum, and phosphorus to Flint Pond Marsh and Flint Pond. The Massachusetts Department of Highways (MassHighways) is presently planning the expansion of Route 3 through Tyngsborough, which provides the opportunity to revisit the issue of stormwater drainage to Flint Pond. The Commonwealth of Massachusetts requires that stormwater receive treatment, such as through a detention basin, before being discharged into a natural waterbody (David Buckley, Massachusetts Department of Environmental Protecton, pers. comm. citing the Stormwater Management Handbook by Massachusetts Department of Environmental Protection and the Massachusetts Office of Coastal Zone Management, March 1995). Communications with the MassHighways have indicated that the present plans are to construct two detention basins and direct stormwater into the detention basins or roadside ditches, with the exception of one cross-culvert from the Charles George Landfill, which is expected to remain a direct discharge. The Trustee Council does not have the authority to alter the drainage or to require MassHighways to alter the drainage, however, the U.S. Fish and Wildlife Service serves as an advisor to the U.S. Army Corps of Engineers on wetland dredge and fill permits and will continue to work with the U.S. Army Corps of Engineers and MassHighways to address this issue.

2.4 Alternative C: Off-Site Wetland Restoration

An extensive search was made within the Town of Tyngsborough for suitable off-site wetland restoration sites using National Wetlands Inventory Maps and aerial photography, as well as through solicitation of suggestions from citizens and the Town of Tyngsborough Conservation Commission. Wetland restoration is defined here as wetland creation (excavating upland to create wetland), or wetland enhancement (improving a wetland that has been degraded in some way such as by fill, poor water quality, or invasion by non-native vegetation). An upland site that is a candidate for wetland creation must have access to water and already be disturbed such that quality upland habitat is not sacrificed to create wetland.

Specific Projects

Sandpit on Groton Road adjacent to Massapoag Pond: This site is an inactive sandpit with a small, shallow pond (less than one acre in size). The presence of the pond suggests that the water table is not far from the surface, however, the actual availability of water would require further study. The total site is 38.77 acres in size. The area that might be available for conversion to wetland because of topography is about five acres. To avoid having wetland surrounded by denuded upland, a large area of upland would also need to be restored for the site to provide quality wildlife habitat. We have been unable to contact the owners of this site, therefore, the availability of the land for purchase is not known. The site is zoned residential. The location of this site is shown in Figure 4.

Sandpit on Red Gate Road/Dunstable Road/Brook View Circle: This site is approximately 7.5 acres in size and is surrounded by residences except for the west side which abuts Dunstable Brook. The site is owned by eight different landowners whose lots incorporate a portion of the sandpit. About two-thirds of the site is already wetland that developed after the site was excavated to the water table. The wetland area has varying degrees of vegetative

development but the site is dominated by exotic invasive plants such as purple loosestrife, common reed, autumn olive (*Elaeagnus umbellata*), and honey locust (*Gleditsia triacanthos*). The other one-third of the site is upland with relatively little vegetative development. However, investigation of the water table indicated that even in the upland area the water table is relatively shallow (within two feet of the surface). A soil berm exists between Dunstable Brook and the site. Wetland restoration on the site could include some combination of the following: increasing the amount of wetland on the site by excavating upland, creating vegetated upland buffer zones around the site, increasing the depth of surface water in some portions of the site, breaching the berm adjacent to Dunstable Brook to increase flooding of the wetlands, controlling nuisance non-native vegetation, establishing cavity trees, and improving nesting opportunities for wood turtles. Since the original investigation into this site, some of the landowners decided that they did not want to participate in the restoration, making the project unviable. The location of this site is shown in Figure 5.

Brox Industries Pond behind Town Highway Department on Kendall Road: The site is an inactive sandpit with a small pond (about five acres in size). The presence of the pond, and hence, water on the site, indicates that it could be possible to develop wetlands adjacent to the pond. However, further study would be required to determine the actual availability of water and the amount of upland that could be converted to wetland. The pond also has a dense growth of common reed which could be managed as part of the restoration. The total site is 63 acres in size and is zoned industrial. A large area of upland restoration would be needed to make the site valuable wildlife habitat. The Trustee Council contacted a representative for the landowner who indicated that this site was not available for purchase. The location of this site is shown in Figure 5.

Middle School Site on Westford Road: The site is an inactive sandpit with Bridge Meadow Brook flowing through it. Some areas of the site that were excavated to the water table have revegetated over time and are not suitable for restoration. However, two small areas still remain in an early successional state (*i.e.,* limited vegetative development), and could be enhanced through excavation to increase depth and aerial coverage of surface water, and to encourage the development of a diversity of vegetation. The early successional area on the north side of the brook is about one acre in size and and the area on the south side of the brook is about one and one-half acre in size. The site is owned by the Town of Tyngsborough. The availability of the areas for restoration will not be clear until the plans for the school are completed. The location of this site is shown in Figure 6.

2.5 Alternative D: Acquisition of Equivalent Resources

Acquisition of equivalent resources entails the purchase and protection in perpetuity of wetland and/or upland habitats.

Specific Projects

Brox Industries Property on Flint Pond, Kendall Road, Tyngsborough: The site is an inactive sandpit that is about 38 acres in size. Much of the site is upland, mostly unvegetated sandpit. The water table in the disturbed upland area is likely too deep for wetland creation to be

feasible. Habitat enhancement of the upland is possible and would require spreading substantial amounts of topsoil and replanting. The enhancement would help support the habitat value of adjacent Flint Pond and wetlands. To the south of the upland sandpit, wetland was created by excavation of sand below the water table. With time, the wetland area has revegetated into a diverse complex of habitats. Enhancement opportunities within the wetland are limited. Acquisition of this property would serve to protect a buffer zone along Flint Pond from any potential development threats and could provide public access. Wildlife use of the site should include a variety of mammal species and the emergent and scrub-shrub habitats would be expected to be used by waterfowl and wading birds. Forest adjacent to wetland can provide nesting habitat for wetland bird species such as black duck, wood duck, and belted kingfisher as well as birds specific to riparian environments such as northern waterthrush and yellow warbler. A variety of frogs species would be expected to use the wetlands of the site as well as Flint Pond. The sandpit area likely provides nesting habitat for painted turtle and snapping turtle. Based on two conversations with a representative for the landowner, we understand that the owner is not seeking to sell this property. The location of this site is shown in Figure 3.

Elkareh Property on Kendall Road, Tyngsborough: This property is 27 acres in size and has substantial frontage on Flint Pond. The frontage on Kendall Road is located across from Bryant Lane. This property is entirely wooded with one small pocket of scrub-shrub wetland fed by an intermittent drainage that then flows to the pond. Based on the foot trails running throughout the site it appears that the site already receives some public use. The Elkareh's have plans to subdivide the property if it is not purchased by the Trustee Council. This property provides habitat primarily for migratory songbirds of upland forest and of forest/wetland edge, as well as mammals of upland and riparian habitats. The property also serves as a substantial buffer for Flint Pond. The location of this property is shown in Figure 8.

Regonini Properties on Red Gate Road, Tyngsborough: These properties consist of two abutting parcels. One parcel consists of approximately 25 acres of forested upland and the other parcel consists of approximately 11 acres of emergent wetland associated with Dunstable Brook. This site abuts the *Red Gate Road/Dunstable Brook/Brook View Circle* site referred to in section 2.5. The upland forest on the site would be expected to be used by a variety of mammals and migratory songbirds. The emergent wetland along Dunstable Brook, although heavily vegetated by purple loosestrife, provides habitat for beaver, and potentially for black duck and wood duck, as well as many songbird species. The forested edge provides potential nesting habitat for black duck, wood duck, and belted kingfisher, as well as mammals of riparian habitats such as otter and mink. A section of Dunstable Brook, adjacent to the sandpit, was apparently excavated at one time, which created a couple of deep ponds. These areas appear to be serving as hibernaculum for wood turtles, of which a number have been sighted on the property. The wood turtle has been designated as a Species-of-Special Concern by the Commonwealth of Massachusetts. Since the Draft RP/EA, Ms Regonini has decided not to participate. The location of the properties is shown in Figure 7.

Larter Property on Dunstable Road, Tyngsborough and Dunstable: This property is approximately 113 acres in size; 8.5 acres along Dunstable Road are located in the Town of Tyngsborough and the remainder of the property is located in the Town of Dunstable. The property is located across the road from the Charles George Landfill, and is north and adjacent to the *Regonini Properties on Red Gate Road*. Most of the property is active cow pasture that is divided by stone walls and hedgerows. Dunstable Brook runs through the property creating

some emergent marsh and wet meadow habitat. Because of the patchiness of the habitat on this property, it is expected to provide habitat for an exceptional diversity of songbirds. It also provides habitat for upland game birds like ruffed grouse and American woodcock. A portion of the property could probably be managed for grassland birds such as meadowlark, bobolink, Savannah sparrow, and grasshopper sparrow. No bluebirds have been observed on the site so the site could potentially benefit from bluebird boxes. The property also likely provides habitat for white-tailed deer (particularly for grazing), eastern cottontail, numerous small mammals, and hunting areas for fox and coyote. Since the property abuts the Regonini Properties it likely also is utilized by wood turtles. A portion of Dunstable Brook running through the property was impacted by the landfill. The location of this property is shown in Figure 9.

Elkareh Property on Dunstable Road, Tyngsborough and Dunstable: This property is 27.5 acres in size; 2.5 acres along Dunstable Road are located in the Town of Tyngsborough and the remainder of the property is located in the Town of Dunstable. The property is located across the road from the Charles George Landfill and north and adjacent to the *Larter Property on Dunstable Road*. Dunstable Brook originates on this property and was impacted by leachate from the landfill. The property is entirely wooded with a steep hillside that offers a view from the top. The hillside facing Dunstable Road was recently logged and thus provides patches of early successional woodland. This tends to increase the diversity of songbirds utilizing the site and provides foraging habitat for white-tailed deer. The more mature portions of the forest provide a block of habitat for species that prefer mature forest such as ovenbird, red-eyed vireo, eastern wood-pewee, wood thrush, and scarlet tanager. The large, mature oak trees on the property produce acorns which serve as excellent food for species like white-tailed deer and turkey. A small brook flows down the hillside, converging with Dunstable Brook. This brook system could provide habitat for the northern dusky salamander and the two-lined salamander. The location of this property is shown in Figure 10.

Larter Property on Main Street, Dunstable: This property is approximately 91 acres in size. The frontage of the property, about a quarter of the land, is primarily old field with scattered cedar, juniper, and hawthorn. Many songbird species would be expected use this habitat including song sparrow, chipping sparrow, cardinal, gray catbird, rufous-sided towhee, and bluebird. This area could be kept open through active management such as mowing or pasturing. The rest of the property is mixed forest with one large depression and some small drainages throughout. The forested area provides habitat for migratory songbirds that use forest interior habitats and many of the mammal species that inhabit the region. The location of this property is shown on Figure 11.

Japp Property on Lowell Street, Dunstable: This property is approximately 30 acres in size and abuts the *Elkareh Property on Dunstable Road* at its southeast corner. The parcel is completely wooded and has a small drainage flowing through it. This property likely provides habitat for migratory songbirds of forested habitats including forest interior species such as the the ovenbird, wood thrush, veery, eastern wood-pewee, and scarlet tanager. It also likely provides habitat for most of the mammal species inhabiting the region. The location of this property is shown in Figure 12.

Greene Property on Scribner Road, Tyngsborough: This property is approximately 75 acres in size, and is mostly forested. This property is located on the Dunstable Town line. To the west and north, in the Town of Dunstable, the Greene property is abutted by conservation land

owned by the Town of Dunstable and the Massachusetts Division of Fish and Wildlife (MDF&W). With the purchase of the Greene Property a contiguous block of approximately 180 acres would be protected. The Town of Tyngsborough had the First Right of Refusal in purchasing this property and only a 120-day window to make the decision. The purchase price was 1.4 million dollars. The Town voted on March 28, 2001 to purchase the land. However, this purchase was a stress on the Town and they will be looking for various methods of financial assistance. The approximate location of this site, as well as the adjacent protected land is shown in Figure 13.

Bell Property on Locust Avenue, Tyngsborough: This property is approximately 62 acres in size and includes Locust Pond, which is an impounded area of stream. The site is bordered by Locust Avenue and light residential development to the northwest, and Route 3 to the southwest. The other half of the perimeter is bordered by dense development. The pond is mostly open water with no emergent marsh development. The upland is all forested. The habitat quality of this site is limited by the development surrounding it, however, it should provide at least transient habitat for aquatic mammals such as beaver, otter, and mink, and many of the upland mammals and migratory songbirds of forested habitats. The location of this property is shown in Figure 14.

Woodward Property on Danforth Road, Tyngsborough: This property is 22 acres in size and borders Halfmoon Meadow which is a large emergent marsh. This property is bordered to the east by about 69 acres of property owned by a land trust, the Trustees of Reservations. Adjacent to the Trustees of Reservations land is 41 acres owned by the Town of Tyngsborough, the New England Power Company, and the Tyngsborough Association. The Woodward Property is completely forested. The property to the north is being cleared for development. Wildlife noted in Halfmoon Meadow includes muskrat, great blue heron, and beaver. Other species expected include songbirds of emergent marsh such as red-winged blackbird, swamp sparrow, American bittern, and Virginia rail. Other species of birds associated with wetlands include yellow warbler, northern waterthrush, and American redstart. Aquatic mammals such as otter and mink would be expected to utilize the marsh and adjacent forest. The forest will support the common mammals of the region and migratory songbirds of upland forest, including species of the forest interior. Although this property is relatively small, its value is increased by the
adjacent conservation land. The landowner has not indicated an interest in selling the property. The location of this property is shown in Figure 14.

O'Coin Property on Danforth Road, Tyngsborough: This is a 97 acre parcel adjacent to the Woodward Property described above. A portion of the property includes a part of the Halfmoon Meadow Marsh, and also a pond and stream that flow into Halfmoon Meadow Marsh. The rest of the property is forested. The species of wildlife utilizing this property are similar to that of the Woodward Property, however, the value of this property is greater because it is much larger and it has more riparian habitat along Halfmoon Meadow Marsh. The landowners have indicated that they are not interested in selling. The location of this property is shown in Figure 14.

2.6 Alternative E: On-Site Migratory Fish Restoration

Specific Projects

Fish Passage on Flint Pond: Flint Pond was created by damming Bridge Meadow Brook in two locations. The lower dam is about 700 feet upstream of the confluence with the Merrimack River. The upper dam is another 700 feet upstream. It is likely that American eel and possibly Atlantic salmon once entered Bridge Meadow Brook before it was dammed. River herring, however, typically spawn in deeper, slower water, and, therefore, probably did not spawn in Bridge Meadow Brook. However, Flint Pond could potentially provide spawning opportunities for blueback and alewife herring if a seed-stock is established in the pond and fish passage is provided. However, the following factors may limit the feasibility of this project:

· Flint Pond is relatively small, only 61 acres in size, so a substantial run of herring could not be expected. It is also shallow, only six feet at its deepest, therefore, there is a question as to whether the water temperature gets too warm in the summer to support juvenile herring. Bridge Meadow Brook would likely still be suitable for American eel if passage was provided.

· The cost of constructing fish passage facilities for herring would be substantial because the lower dam is 16 feet high and sits in a deep, narrow section of the river. Fitting an adequate fish passage facility into the narrow confines offers some engineering challenges. Also, two fish passage facilities would have to be constructed. A rough estimate of costs for constructing the two fish ladders is $200,000 (Richard Quinn, USFWS hydraulic engineer, pers. comm.).

The other question that remains is whether it is prudent to reintroduce migratory fish into Flint Pond if the sediments are contaminated. To evaluate this, we compared 1987 contaminants levels in Flint Pond and Flint Pond Marsh to levels found during the Five-Year Reviews[1] conducted in 1994 and 1999.

Screening criteria for sediments have been developed for both marine and freshwater, against which sediment contaminant concentrations can be compared and a prediction can be made as to the likelihood of toxicity. Only one contaminant, arsenic, was found to exceed sediment quality criteria. When the highest concentrations of arsenic found in sediments collected in 1987 were compared to the highest concentrations of arsenic in sediments collected in 1999, it appeared that the concentrations had decreased by more than half since 1987 (EBASCO 1988; EPA 1999 unpublished data). The highest concentration of arsenic in Flint Pond from the 1987 sampling was 110 ppm; the highest concentration of arsenic from the sampling in 1994 was 69.7 ppm (Metcalf and Eddy 1995); and the highest concentration of arsenic from1999 was 48.6 ppm. The 1999 sampling indicated that three samples in the pond and two samples in the marsh exceeded the Effects Range-Low or ERL (the lower 10^{th} percentile of the data effects distribution)[2] for arsenic (13.0 ppm). None of the samples exceeded the Effects Range-Median or ERM[3] for arsenic (50.0 ppm), as defined by Ingersoll (1996) as the 50^{th} percentile of the data effects distribution. Long *et al.* (1998) reported that the probability of toxic responses in test organisms in marine sediments when one or more ERLs are exceeded and no ERMs is 16 to 18 percent (no probabilities have been developed for freshwater sediments). Given the trend of decreasing chemical concentrations in Flint Pond and the low probability of effects, we believe that sediment contamination would not be an impediment to successful herring introduction.

Restoration of the Upper Flint Pond Dam: This dam creates Flint Pond and belongs to the MDF&W. The dam is in relatively poor condition and the MDF&W has not had the funding for repairs. NOAA's settlement referred to the importance of maintaining the structural integrity

of the dams to prevent migration of contaminated sediments. The settlement included monies for monitoring the dams and initiating structural surveys, but not monies to actually restore the dams. The Massachusetts Department of Environmental Management, Dam Safety Office contracted with GEI Consultants to inspect and evaluate the Upper Flint Pond Dam in 1998. GEI estimated that it would cost $103,000 for minimal repairs on the dam. However, MDF&W does not support minimal repairs on the dam; they would prefer a more lasting solution. Therefore, arrangements are being made for a thorough evaluation of the dam and an estimation of costs for a number of remedial scenarios. Because this will take some time, the Trustee Council did not want to postpone the Final RP/EA until this information was collected. Since it was NOAA's settlement that raised conserns about the integrity of the dams and they recovered $134,000 for damages, it seems that this is a reasonable cap for expenditure. However, acknowledging that this is not likely to be sufficient, the Trustee Council has agreed to raise the cap to $200,000 for expenditure out of settlement funds.

Stabilization of Bank Erosion in the Merrimack River through Tyngsborough: There are numerous locations of bank erosion along the Merrimack River through Tyngsborough and locations just south. Some of the erosion is likely due to natural processes and some due to human-alterations. Bioengineering, or stabilizing with vegetation, is not always successful in large rivers of the north such as the Merrimack River because of ice scour (David Killoy, U.S. Army Corps of Engineers, pers. comm.), therefore, stabilization generally requires at least some riprap. Although an excessive rate of erosion is not desirable in a river system, riprap has deleterious effects as well, such as increasing water velocities and aggravating erosion both upstream and downstream. Riprap is also costly; approximately $40 per linear foot. Riprap of one mile of the Trout River in Vermont has been estimated to cost $211,000 in 1999 (Martha Abair, U.S. Army Corps of Engineers, pers. comm.).

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[1] EPA's Five-Year Review is undertaken to review remedial actions completed at the site to date, to ensure that the remedial actions remain protective of human health and the environment. This review is required by federal statute for any site remedy which results in hazardous substances remaining on site (CERCLA § 121(c) and 40 CFR §300.430(f)(4)(ii))(Metcalf and Eddy 1995).

[2] The Effects Range-Low is intended to represent chemical concentrations below which probability of toxicity and other effects are minimal (Long *et al.* 1998).

[3] The Effects Range-Median is intended to represent mid-range concentrations above which adverse effects are more likely, although not always expected (Long *et al.* 1998).

2.7 Alternative F: Off-Site Migratory Fish Restoration

Shawsheen River Fish Passage: The Shawsheen River is a tributary to the Merrimack River; its confluence with the Merrimack River is in Lawrence, Massachusetts. Historically, the Shawsheen River probably provided spawning habitat for migratory fish until dams were constructed that impeded migrations. In 1998 and 1999, river herring were once again sighted in the Shawsheen River just above its confluence with the Merrimack River (William Easte, MDF&W, pers. comm.) Presently, three dams impede upstream migration of fish. Fish passage at the second two could cost as much as $250,000 each for fish ladder construction or breaching. Little monitoring of the river has been conducted to determine the quality of upstream spawning habitat. This work should be conducted before investment in fish passage is considered. Also, a large culvert exists at the confluence of the Shawsheen River with the Merrimack River. An

investigation as to whether the culvert would inhibit movement of fish into the Shawsheen River would need to be conducted.

Concord River Fish Passage: The Concord River is a tributary to the Merrimack River; its confluence with the Merrimack River is in Lowell, Massachusetts. In 1999, shad were sighted just upstream of the mouth of the Concord River (Douglas Smithwood, USFWS, pers. comm.). Three dams in the lower reaches of the Concord River impede upstream fish migration. The locations of these dams are shown in Figure 14 and the dams are described below:

· The Middlesex Dam is located just upstream of the mouth of the confluence with the Merrimack River. This dam is partially breached, however, remnants of the dam, including the base of the dam that still extends across the width of the river and the abutments that remain along each shore, create water velocities that are difficult for shad and river herring to negotiate. Migration of shad and river herring are, therefore, only expected past this dam during very limited flow conditions, if at all (Richard Quinn, USFWS hydraulic engineer, pers. comm.).

· The second dam, Centennial Island, is located 1.4 miles upstream of the confluence of the Concord River with the Merrimack River. This dam is an active hydroelectric project that has an operational fish passage facility.

· The third dam, the Talbot Mills Dam, is located in Billerica, Massachusetts, approximately 4.6 miles upstream of the confluence with the Merrimack River. This dam is approximately seven feet high and 160 feet long and it creates a large impoundment. Removal of this dam is unlikely because loss of the impoundment would affect private properties and there is likely a substantial load of sediments behind the dam. Therefore, construction of a fishway would be necessary for fish passage to be provided past this dam.

The USFWS Central New England Fishery Resources Office in Nashua, New Hampshire obtained a grant to stabilize the breach at the Middlesex Dam to allow for fish migration. Therefore, passage past this dam is expected by 2002. However, fish passage at the Middlesex Dam will only allow fish movement to the Talbot Mills Dam. MDF&W does not support the construction of fishways unless fish have been observed in the river below the dam of interest (Mark Tisa, MDF&W, pers. comm.). Therefore, USFWS has begun to stock herring in the Concord River (750 herring were transported from the Charles River in 1999; 7,500 herring were transported from the Taunton/Nemasket River Watershed to the Concord River in the springs of 2000-2002, and they plan to monitor returns each year to provide the documentation needed for the Commonwealth to support construction of fish passage at the Talbot Mills Dam. Upstream of the Talbot Mills Dam there are no more obstructions until the Saxonville Dam on the Sudbury River in Saxonville, Massachusetts, and a small hydroelectric dam on the Assabet River in Acton (on the Maynard line), Massachusetts. Therefore, once fish get past the Talbot Mills Dam, more than 40 river miles of historical habitat become available.

An estimated cost of the construction of a denil fish ladder at the Talbot Mills Dam is $225,000 to $250,000 (Richard Quinn, USFWS hydraulic engineer, pers. comm.). This is more than NOAA's settlement of $134,000. Therefore, additional grants would be needed to fund the fish ladder construction. The following potential sources of additional funding were provided by Joseph McKeon, USFWS, Central New England Fishery Resources Office:

A. U.S. Fish and Wildlife Service - USFWS has typically provided funds on an annual basis to support fish and wildlife habitat restoration projects throughout the northeast. Funds have ranged from $10,000 to $238,000.

B. U.S. Environmental Protection Agency - Supplemental Environmental Projects (SEPs) are environmentally beneficial projects which a PRP agrees to undertake in the settlement of an environmental enforcement action, but which the PRP is not otherwise legally required to perform. In return, some percentage of the cost of the SEP is considered as a factor in establishing the final penalty paid by the PRP.

C. National Fish and Wildlife Foundation - NFWF is a private, nonprofit 501(c)(a) tax-exempt organization established by Congress in 1984. The NFWF fosters cooperative partnerships to conserve fish, wildlife, plants, and the habitats on which they depend. The NFWF works with its grantees and conservation partners to stimulate private, state, and local funding for conservation through challenge grants. Challenge grants are awarded to eligible recipients including federal, state, and local governments, educational institutions, and nonprofit organizations for conservation projects. Project proposals are received on a revolving basis with two decision cycles per year. The majority of support provided by the NFWF ranges from $25,000 to $75,000 with some small grants and some over $150,000.

D. Department of Defense - Innovative Readiness Training allows the Air Force, Army, Navy Reserves and other services within DoD to have training time available to assist in the completion of natural resources habitat restoration and enhancement projects.

E. National Marine Fisheries Service- Community Based Restoration Program provides funding for projects that benefit multiple species; achieves a variety of resource management objectives; encourages public involvement; and demonstrates a clear conservation need.
F. National Marine Fisheries Service - American Sportfishing Association, FishAmerica Foundation provides funding for projects that result directly in on-the-ground habitat restoration that clearly demonstrates significant benefits to marine, estuarine or anadromous fisheries resources, especially sportfish, and must involve community participation through an education or volunteer component tied to the restoration activities.

G. U.S. Army Corps of Engineers - Habitat Restoration Program (Section 1135 (206) of the 1996 Water Resources Development Act, as amended) offers Planning Assistance Programs and Environmental Assistance Programs which provide opportunities for the States to obtain assistance in addressing water resource issues. The Water Resources Development Act of 1996 offers opportunities for the COE to be involved in projects that include environmental restoration for aquatic habitat. The COE contribution for project costs is typically up to 65% to be matched with 35% non-federal funds.

H. Massachusetts Division of Marine Resources and Division of Fisheries and Wildlife - State resource agencies are often asked to contribute funds, technical support, or in-kind services to be used as financial matches for federal challenge grant projects.

I. Non-Governmental Organizations - Watershed associations; local Trout Unlimited chapters; angler groups; sportsman alliances, organizations, and clubs; commercial fisherman's

associations are examples of non-government organizations that typically offer financial assistance for environmental restoration projects.

A potential addition to this alternative could be the restoration of American eel. A fish ladder for American eel elvers could also be constructed at the Talbot Mills dam for approximately $50,000 (Douglas Smithwood, USFWS, pers. comm.).

Concord River Stocking and Monitoring: USFWS Central New England Fishery Resources Office in Nashua, New Hampshire also submitted a proposal for funds to the Trustee Council for stocking and monitoring of the Concord River for shad and river herring as part of the overall Merrimack River Anadromous Fish Restoration. The request for assistance with the costs of the stocking and monitoring was $30,000 for three years of work.

2.8 Preferred Alternatives

The Trustee Council is proposing to have two separate restoration actions: one to compensate for impacts to wetland resources and habitat, and one to compensate for the potential impacts to migratory fish.

Wetland Restoration

The Selection Criteria listed in Table 1 (page 12) indicate a hierarchy whereby a restoration involving creation or enhancement of habitat is preferred over simple protection of habitat. The Trustees were considering an alternative combining the *Sandpit on Red Gate Road/Dunstable Road/Brookview Circle,* which involved creation/enhancement of wetland, and protection of the *Regonini Properties* which abut the sandpit. However, the *Sandpit on Red Gate Road* alternative required the cooperation of eight different landowners, and not all of the landowners were interested in participating. Since no other active restoration alternatives appear to be viable, the Trustee Council has chosen land protection as the preferred alternative. Properties would be purchased by the Trustee Council and subsequently transferred to the another interested party, such as the Conservation Commissions of the Towns of Tyngsborough or Dunstable, or the MDF&W, with protective covenants incorporated into the deeds.

The criteria listed in Table 2 were used as a guide for evaluating the land protection alternatives. Table 3 provides a matrix whereby each alternative is rated - low, medium, or high- as to how well it meets each criterion in Table 2. The evaluation criteria serve as guides rather than as absolute decision-makers because all of the criteria are not weighted equally; for instance, “j” refers to the willingness of the seller, which is critical for the project to be viable. Therefore, the matrix provides a picture of how preliminary decisions were made, but cannot be used quantitatively, such as choosing the preferred alternative based on the number of “high” ratings that were assigned to it.

Some important information is still unknown. Specifically, the cost or appraised value of each alternative is still lacking because it was decided that land appraisal is too costly, potentially $5,000 per appraisal, to conduct for each of the land protection alternatives. The Trustees can only pay the fair market value for the properties based on an appraisal that uses federal and state standards (Public Law 91-646, the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended; and Massachusetts Executive Office of Environmental Affairs

Land Acquisition Policy, September 1, 1995). Therefore, discussions with the landowners have only determined whether they would consider having their land purchased by the Trustee Council, with an understanding that selling price would be discussed at a later date. The lack of appraisal also makes it difficult to evaluate the cost effectiveness of each alternative and to determine how many properties the Trustee Council can afford to purchase. Since the Trustee Council is presently lacking this critical information, the properties preferred for purchase and protection are listed in order of priority with the presumption that as much property will be purchased as money allows. Efforts will be made to attain grants to stretch the money as far as possible. If purchase agreements for preferred properties cannot be negotiated, the Trustee Council will pursue the next preferred property on the list. Maps of all the properties are provided in Appendix A.

The preferred alternatives, in order of priority, with a justification for each are provided below:

1. *Elkareh Property on Flint Pond*: The Elkareh Property is the only property on Flint Pond for which the Trustee Council could find a willing seller. The Elkareh Property only has a small pocket of wetland on it but it provides a significant buffer for Flint Pond. Based on the trails throughout the site, it already receives some public use. To the best of the Trustee Council's knowledge, the Elkareh's had plans to develop the property, which they postponed when the Trustee Council expressed its interest in potential purchase. Therefore, it is believed that the property is in imminent danger of being developed. There is not a lot of opportunity for habitat enhancement on this property. The Trustee Council believes that the Town of Tyngsborough is supportive of this acquisition.

2. *Larter Property on Dunstable Road*: This property is approximately 113 acres, and abuts the Regonini Properties. It is located across Dunstable Road from the Charles George Landfill. A portion of Dunstable Brook running through the property was impacted by the landfill. The property has very diverse wildlife habitat including cow pasture with hedgerows and patches of trees and shrubs, non-persistent emergent wetland associated with Dunstable Brook, wetland forest and upland forest. Therefore, it is expected to have a high diversity of wildlife species. Since wood turtles are known to utilize the Regonini Properties, it is likely that they use Dunstable Brook as a travel corridor and, therefore, also utilize the Larter Property. According

Table 2. [1]Criteria for selecting land protection alternatives to compensate for environmental injury caused by the Charles George Landfill.

a. Extent to which the alternative protects the types of natural resources that were injured; *ie,* groundwater, emergent wetlands, migratory bird habitat (particularly wetland-dependent species), and migratory fish.

b. Proximity to injured resources.
* Sites closer to the area of impact will be preferred.

c. Cost effectiveness of the alternative.

d. Extent to which the alternative will enhance the public's ability to use, enjoy, or benefit from the natural resources.

e. Size of the site

* Larger parcels or parcels adjacent to existing protected land would be preferable to small parcels or parcels surrounded by developed property or property vulnerable to development.

f. Vulnerability to development.

* Protection of property in danger of being developed would be considered of greater ecological benefit than protection of property not likely to be altered.

g. Restoration potential.

* Sites that could be enhanced in some way would be preferred over sites that do not have any enhancement potential.

h. Overall habitat value of the site.

* A high value site might have habitat for federal or state-listed threatened or endangered species, or for a high diversity of species.

i. Support of the town.

* Since the town Conservation Commissions are likely to be the holders of the properties it is important that the towns have an interest in the properties being considered.

j. Willingness of the seller.

[1]Criteria are not listed in order of priority.

Table 3. Evaluation of land protection alternatives using the criteria for selecting land protection alternatives to
compensate for ecological injury caused by the Charles George Landfill (see Table 2).

	CRITERIA FOR SELECTION									
ALTERNATIVES							**a**	**b**	**c**	**d**
	e	**f**	**g**	**h**	**i**	**j**				
1. Brox Prop. on Flint Pond	H	N			H	H	?	H	M	H?	H	H

2. Regonini Properties	H	M	?	H	M	H	L	H	H	N	
3. Larter Prop/Dunstable Rd		H	H	?	H	H	M?	M	H	H	Y
4. Elkareh Prop/Dunstable Rd		H	H	?	H	M	L	L	M	M	Y
5. Elkareh Prop/Flint Pond		H	H	?	H	M	H	L	M	H	Y
6. Japp Property/Lowell Rd		L	M	?	H	M	H?	L	M	H	Y
7. Larter Prop/Main St.		L	L	?	H	H	H?	M	H	H	Y
8. Greene Property		L	M	?	H	H	H?	L	M	H	Y
9. Bell Property		M	L	?	H	M	M?	L	M	H	Y
10. Woodward Property		H	L	?	H	M	M?	L	M	H	N
11. O'Coin Property		H	L	?	H	H	L	L	H	H	N

to Tyning (1990), wood turtles stay close to their streams and rivers, and, therefore, have relatively linear home ranges that run up to a mile in length. The Trustee Council does not know what plans there may be for this property if it were not purchased by the Trustee Council; it is presently actively pastured. It is also not clear how the history of contamination in Dunstable Brook may affect the value of the property. The land could be actively managed in some ways, including erection of bluebird boxes, continuing active pasturing to keep the land open, and allowing some of the pasture to grow to tall grassland to provide for grassland bird species such as bobolink and meadowlark. The Town of Dunstable has indicated strong support for the purchase and protection of this property.

3. *Elkareh Property on Dunstable Road*: This property abuts the Larter Property to the north so its acquisition would contribute an additional 27.5 acres to the 113 acre Larter Property. This property is primarily forested, and although it is not especially diverse in itself, it contributes to the diversity of the Larter Property which is predominantly meadow. The forest/meadow edge is also utilized by American woodcock and whip-poor-will, although whip-poor-will populations have been declining in the Commonwealth (Veit and Petersen 1993). The meadow/forest mix, especially with a predominance of oak trees in the forest, also creates excellent habitat for white-tailed deer and turkey. Since most of the road frontage of the property is wet, we have reason to believe that the property is not especially vulnerable to development, however, part of the property has been logged and more harvestable trees appear to be present. The hillside on the property could contribute nicely to the walking experience if trails are constructed on the protected properties. The Elkareh's have indicated that they would be willing to sell this property to the Trustee Council. There are not a lot of opportunities to enhance the habitat of this property. Dunstable Brook running through the property was impacted by the landfill.

4. *Japp Property on Lowell Road*: A corner of this property abuts the Elkareh Property on Dunstable Road so this 30-acre parcel would contribute to the block of protected land if the block included the Elkareh Property. This property is mostly forested with a small brook running through it. The Dunstable Conservation Commission is supportive of this acquisition and the landowner is interested in selling to the Trustee Council. The Trustee Council does not know the intentions of the landowner if the property is not purchased by the Trustee Council, however, the property has a lot of frontage and a lot of upland forest, so it appears that it could be attractive for development.

5. *Larter Property on Main Street*: This property is of lower priority because it is the furthest away from the areas of injury, and it is disjunct from other protected properties or properties being considered for protection in this process. However, it is a good-sized parcel in itself, 91 acres. It consists of old field and forest, and, therefore, offers some habitat diversity. The Dunstable Conservation Commission is supportive of the acquisition. It is not clear what the landowner plans for the property if not purchased by the Trustee Council, but it does have upland frontage on a major roadway. The landowner is willing to sell to the Trustee Council.

7. *Greene Property*: This property is also relatively far from the areas of injury. It is, however, adjacent to other protected properties, and is, essentially, protected itself since the Town of Tyngsborough purchased it. The property would have been sold to a developer if not purchased by the town. However, the purchase was a burden on the town so if money remains available offering financial assistance to the town would make sense.

The following are potential sources of additional funding:

A. U.S. Fish and Wildlife Service - the North American Wetland Conservation Act (NAWCA) provides grants for long-term wetlands conservation projects including acquisition, restoration, and/or enhancement. There is a requirement of at least a 1:1 non-federal match.

B. National Fish and Wildlife Foundation - NFWF is a private, nonprofit 501(c)(a) tax-exempt organization established by Congress in 1984. The NFWF fosters cooperative partnerships to conserve fish, wildlife, plants, and the habitats on which they depend. The NFWF works with its grantees and conservation partners to stimulate private, state, and local funding for conservation through challenge grants. Challenge grants are awarded to eligible recipients including federal,

state, and local governments, educational institutions, and nonprofit organizations for conservation projects. Project proposals are received on a revolving basis with two decision cycles per year. The majority of support provided by the NFWF ranges from $25,000 to $75,000 with some small grants and some over $150,000. An NRDAR land acquisition project in Peterborough, New Hampshire recently received a NFWF grant (Molly Sperduto, USFWS, pers. comm., January, 2001).

C. Massachusetts Environmental Trust - established in 1988 by the Massachusetts Legislature to receive settlement proceeds from the Commonwealth of Massachusetts and the Metropolitan District Commission for violations of the Clean Water Act in Boston Harbor. Its purpose is to "fund and coordinate projects to restore, protect, and improve the quality of the waterways of the Commonwealth; to increase public understanding of Massachusetts waters, and the effects of human activities upon them; and to increase public understanding of Massachusetts water, and the effects of human activities upon them; and to encourage public involvement in activities that promote these waters as living resources and public treasures for present and future citizens of the Commonwealth of Massachusetts". This organization does provide grants to public agencies.

D. The Turner Foundation, Inc. - provides grants for the protection of rivers, lakes, wetlands, aquifiers, oceans, and other water systems from contamination, degradation, and other abuses. Priorities includes strengthening the advocacy, outreach, and technical capabilities of organizations addressing the protection of water systems; stopping further degradation of water-dependent habitats from new dams, diversions, and other large infrastructure projects; promoting allocation of water specifically for environmental purposes, including habitat restoration and fish and wildlife protection; supporting efforts to improve public policies affecting water protection, including initiatives to secure pollution prevention and habitat protection; reducing pesticide use; and strengthening the advocacy, outreach, and technical capabilities addressing the disproportionate use and location of toxic material in poor and rural areas.

F. Fields Pond Foundation - provides financial assistance to nature and land conservation organizations which are community-based, which address specific environmental challenges, and which serve to elevate environmental awareness by involving local inhabitants in conservation issues. Grants generally range from $500 to $25,000. Foundation support includes specific project grants for trailmaking and other enhancement of public access to conservation lands, rivers, coastlines and other natural resources; and for land acquisition for conservation. Recipients include governmental organizations.

G. Town of Dunstable - the Town of Dunstable Conservation Commission may have a small sum of money that could be used toward the purchase of land or as part of a non-federal match.

H. Non-Governmental Organizations - Watershed associations and land trusts are examples of non-governmental organizations that could serve as partners in securing grants for land acquisition and trail development.

<u>Migratory Fish Restoration</u>

The preferred alternative is a combination of two alternatives listed under Alternative G: Off-Site Migratory Fish Restoration. These are *Concord River Fish Passage* and *Concord River*

Stocking and Monitoring. For clarification, the Concord River Fish Passage would involve providing $100,000 towards constructing a fish ladder at the Talbot Mills Dam. Additional $150,000 would need to be obtained to complete the fish ladder. The monitoring would be funded for $30,000. The attributes of this project are compared to the Evaluation Criteria listed in table 1 below:

A. This project would enhance the population of shad and river herring in the Merrimack River Basin by: providing seed stock to historical habitat, monitoring the success of the stocking effort, and providing access to over 40 river miles of historical fish habitat.

B. This project is a substantial distance from the location of impact. However, the project addresses a resource of concern, the anadromous fisheries, by increasing the availability of spawning habitat. This project should ultimately enhance the populations of these fish throughout the watershed.

C. This project is cost-effective because, for approximately $130,000 of Charles George Restoration money, shad and river herring would have access to over 40 river miles of historical habitat. Ultimately, this project should make a major contribution to the overall populations of shad and river herring in the Merrimack River Watershed.

D. The public's ability to use, enjoy, or benefit from the natural resources should be enhanced by this project because the project is ultimately expected to significantly increase the populations of shad and river herring in the Merrimack River Basin and, thus, enhance the public's opportunities to enjoy these resources.

E. The ecological benefit to the public should be substantial since the populations of shad and herring in the Merrimack River Basin may be significantly increased.

F. The Town of Tyngsborough will probably not continue to be involved in this project after the Trustee Council's involvement has ended. However, the watershed associations in the Sudbury/Assabet/Concord River Watershed have indicated enthusiasm for fish restoration, and continued interest in enhancing habitat for migratory fish in the watershed is expected (SUASCO Watershed Association, letter dated January, 1998; Boston Chapter of Trout Unlimited, letter dated January, 1998; Hop Brook Protection Association, letter dated January, 1998; SuAsCo Watershed Coalition, letter dated January, 1998; Sudbury River Citizens Advisory Committee, letter dated January, 1998).

G. This project is expected to be successful. There is a high expectation that herring and shad will develop self-sustaining populations in the Concord/Sudbury/Assabet Rivers in response to stocking and provision of fish passage. The State of Maine has had success restoring alewives to many locations in Maine, most recently to the Kennebec and Royal Rivers (Thomas Squires, Maine Department of Marine Resources, pers. comm.). There is also a great deal of interest at this time at the state and federal level in stream restoration, dam removal, and fish passage, (*ie.*, Massachusetts River Restore Program, and USFWS Recreational Fisheries and Fish Passage Program), therefore, there is reason for optimism in finding supplemental funding for construction of a fishway at the Talbot Mills Dam once shad and herring have been documented to have returned to the river.

H. The project will comply with applicable federal, state, and local laws.

In addition, one alternative listed under Alternative E: On-Site Migratory Fish Restoration, the *Repair of Upper Flint Pond Dam* will be conducted if the evaluation of the dam determines that the work is cost effective. The primary purpose of the dam repair would be to assure the integrity of the dam so that contaminated sediments will not migrate to the Merrimack River where they could potentially impact migratory fish. The attributes of this project are compared to the evaluation criteria provided in Table 1 below:

A. This alternative does not restore, replace, or enhance natural resources but rather assures the perpetuation of existing conditions.

B. This project would occur essentially at the location of injury.

C. The cost effectiveness of this project remains unclear as an evaluation of the dam has not yet been conducted. Reconstruction of the dam could potentially be costly. Since NOAA's settlement only referenced conducting surveys to assure the integrity of the dam, but not monies to rebuild the dam, the Trustees have decided to limit the expenditure on this project to $200,000.

D. This project enhances the public's ability to use, enjoy, or benefit from the natural resources by assuring the pertuation of existing conditions.

E. The ecological benefit to the public is primarily in preventing sediments from migrating downstream. The current ponded condition of the site creates habitat for many species of wildlife, however, if the dams were removed the site would revert to a stream with riparian wetlands which would also provide high value habitat for wildlife.

F. This alternative would not provide increased opportunities in community involvement.

G. The project has a high likelihood of success, however, the cost required to make it successful still remains an unknown.

H. This project would be expected to be in compliance with applicable laws.

3.0 Environmental Consequences of Restoration Actions and Alternatives

CERCLA, NEPA, and MEPA require the Trustees to assess and disclose the potential effects of restoration alternatives. Chapter 3.0 discusses the potential benefits and consequences of each alternative, and evaluates each alternative according to the Criteria for Selection listed in table 1 (page 13) as a means of explaining why each alternative was not chosen as the preferred alternative. Table 4 shows how each of the alternatives was rated against the selection criteria of Table 1.

3.1 Effects of Alternative A: No Action

Under the no action alternative, injuries to groundwater, wetlands, migratory birds and migratory

fish and their habitats would be uncompensated. Given sufficient time, natural processes should enable natural resources and associated services to recover to pre-injury levels. However, the time frame for such natural recovery has been estimated to be in terms of decades. In addition, the increment of resources and associated services lost to the public in the past and during the recovery period would not be compensated. Further, no benefits would be realized from the settlement with Charles George Landfill Inc. *et al.*, and the obligations of the consent decree would not be met. This alternative was not rated against the selection criteria since under this alternative nothing would change.

3.2 Effects of Alternative B: On-Site Wetland Restoration

On-site restoration of wetlands would most proximally address the the services lost due to contamination. However, on-site opportunities are generally costly, and impractical or undesirable.

Sediment Capping

Capping of the sediments in Flint Pond Marsh, which would require one to two feet of fill, would alter the bottom contours of the wetland causing changes in wetland hydrology and associated plant communities. Considerable time and effort would be required to revegetate capped areas. Short-term irretrievable losses of wetland habitat would occur while remedial activities were being conducted. Long-term impacts may also result from the changes in hydrology that arise from partially filling the wetland. This alternative was rated LOW for most of the selection criteria. This alternative would change the wetland to upland, rather than restore or replace the resources that were impacted. It was rated HIGH for proximity since it would address the immediate location of impact. This would be a costly alternative that would destroy wetland, therefore, it was rated LOW for cost effectiveness. This alternative would not enhance the public's use of the resources, and therefore, was rated LOW for this criterion. It was rated MEDIUM for ecological benefit to the public because it would isolate the contaminated sediments but it would destroy the wetland. Further community involvement would not be expected. Since this alternative would be simple to perform it would be expected to have a HIGH likelyhood of success. The unnecessary capping of wetland would not comply with applicable state and federal wetland protection statutes, and is, therefore, rated LOW for meeting applicable laws.

Table 4. Evaluation of alternatives using the criteria for selecting restoration sites to compensate for ecological injury caused by the Charles George Landfill (see Table 1).

	CRITERIA FOR SELECTION							
ALTERNATIVES	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
A. No Action	x	x	x	x	x	x	x	x
B. On-Site Wetland Restor.								
1. Sediment capping	L	H	L	L	M	L	H	L
2. Sediment removal	M	H	L	L	M	L	L	L
3. Erosion removal	L	H	L	L	L	L	L	L
4. Wetland creation	H	H	L	M	M	L	L	M
5. Mgmt invasive plants	H	H	?	L	H	L	L	H

6. Rt 3 Runoff Control								
C. Off-Site Wetland Restor.								
1. Brox Prop. on Flint Pond	M	H	?	H	M	H	L	H
2. Sandpit on Groton Rd.	H	L	L	H	M	H	?	H
3. Sandpit on Red Gate Rd.	H	H	H	M	H	M	M	M
4. Brox Prop. by Town Highway Dept.	H	M	L	H	M	H	L	H
5. Middle School Site	H	M	M	H	M	H	L	M
D. Acquisition of Property								
1. Brox Prop on Flint Pond	M	H	?	H	M	H	L	H
2. Regonini Properties L	H	?	H	M	H	H	H	
3. Larter Property	L	H	?	H	M	H	H	H
4. Elkareh Prop/Dunstable Rd	L	H	?	H	M	H	H	H
5. Elkareh Prop/Flint Pond	L	H	?	H	M	H	H	H
6. Japp Property	L	M	?	H	M	H	H	H
7. Larter Prop/Main St.	L	M	?	H	M	H	H	H
8. Greene Property	L	L	?	L	M	H	H	H
9. Bell Property	L	L	?	H	M	H	H	H
10. Woodward Property	L	L	?	H	M	H	H	H
11. O'Coin Property	L	L	?	H	M	H	H	H
E. On-Site Migratory Fish Restoration								
1. Fish passage on Flint Pond H	H	L	H	L	M	L	H	H
2. Repair of Flint Pond Dam	M	H	?	M	M	L	H	H
3. Bank stabilization on Merrimack River	L	M	L	L	L	L	M	M
F. Off-Site Migratory Fish Restoration								
1. Fish passage on Shawsheen R	M	M	L	M	M	M	L?	H
2. Fish passage on Concord R.	H	M	H	H	H	M	H	H

Sediment Removal

Sediment removal, or dredging wetland areas affected by contamination, would likely result in increased injury to wetlands due to physical habitat disturbance, particularly due to the removal of well developed wetland soil and existing vegetation. Following sediment removal, new soil would need to be brought in and the site revegetated. Losses in habitat value would occur until the dredged areas recovered from remedial activities. Dredging activities associated with sediment removal would also resuspend contaminants and possibly increase contaminant loads in currently less contaminated portions of the wetland. Finally, lowering contaminant levels in the areas which exceeded sediment biological effect levels would require significantly more funds than are currently available. At an estimated cost of excavation and disposal of $1,040,245/acre (ERM 1994), restoration of the 2.75 acres of the most contaminated sediments would cost approximately $3,656,803 (HMM 1990).

This alternative was rated LOW for most of the selection criteria. It was rated MEDIUM for the extent that it restores, replaces or enhances the natural resources that were injured because, although the issue of contaminated sediments would be resolved, the same mature, well-

developed wetland could not in reality be replaced. It was rated HIGH for proximity to the injured resources since it would immediately address the location of impact. This alternative would cost more money than the Trustee Council has available for restoration, therefore, it was rated LOW for cost effectiveness. This alternative would not enhance the public's use or enjoyment of the resources, therefore, it was rated LOW for this criterion. It was rated MEDIUM for environmental benefit to the public since it would remove the contaminated sediments but it would also severely impact the integrity of the wetland. Community involvement would not be expected with this alternative. Technically the project has a high likelihood of success, however, it is not a viable project because the expected costs are greater than the funds available, therefore it was rated LOW for this criterion. The unnecessary dredging of wetlands would not comply with wetland protection statutes, therefore, this alternative was rated LOW for compliance with applicable laws.

It should be noted that EPA's Record of Decision determined that contamination of Dunstable Brook could warrant remediation. The sediments of Dunstable Brook were retested as part of the 1995 Five-Year Review. This round of testing indicated that environmental contaminants were present and available for uptake by biota used for the testing. EPA resampled the affected area in 1998 and found decreased concentrations of cPAHs. EPA recalculated the risk associated with the cPAH levels using revised relative potency factors and determined that the sediments no longer posed an unacceptable human health risk. Therefore, removal of sediments was determined to be unnecessary.

Erosion Sediment Removal

Removal of sediments that eroded into wetlands adjacent to the landfill due to the capping of the landfill would also likely result in increased injury to the wetlands due to physical disturbance, especially since the affected area has revegetated. With excavation carried out by heavy equipment it would be difficult to limit sediment removal to just the eroded sediments. Also, the affected areas have revegetated so the site would have to revegetate again after the eroded

sediments were removed. This alternative was rated LOW for all of the criteria except it is located at the area of impact so was rated HIGH for proximity to the area of impact.

Wetland Creation

Conversion of uplands to wetlands is not feasible at the landfill site. Roads and staging zones at the landfill are unavailable for wetland creation opportunities due to the need to maintain their current functions. Although there is upland adjacent to Flint Pond and Flint Pond Marsh, no sites were found that are available for acquisition and that could technically be converted to wetland (based on topography). Also, unless the upland habitat is degraded (such as is the case with a sandpit), the upland habitat is already serving important functions and there may not be a net gain in ecological value in converting high quality upland habitat to wetland. Upland buffers also serve adjacent wetland habitat by filtering contaminants before they reach the wetlands and by providing wildlife habitat. Some species of wildlife are specific to the upland/wetland edge. Conversion of uplands to wetlands would, therefore, result in irreversible losses of habitat services associated with those uplands.

This alternative was given a HIGH rating for the degree to which it could restore the injured resources since it would create additional wetland habitat, and HIGH for proximity to the injured

resources since it would take place adjacent to the sites of impact. It was rated LOW for cost effectiveness since wetland creation is typically very costly. It was rated MEDIUM for public use since it should create more habitat for wetland wildlife viewing or hunting. It was rated MEDIUM for ecological benefit because it would create wetland habitat but possibly at the loss of other valuable habitat. It was rated LOW for continued community involvement as there would be no need or mechanism for this. It was rated LOW for expected project success since no viable location was found, and creation sites need to be chosen carefully if success is to be expected.

Management of Invasive Plants (Common Reed (*Phragmites australis*) and Purple Loosestife (*Lythrum salicaria*))

Wetland restoration through management of common reed and/or purple loosestrife in Flint Pond Marsh or wetlands adjacent to the landfill is not preferred as the primary alternative as it requires intensive on-going management, and because efforts are not consistently successful. Control measures for common reed in flooded situations such as Flint Pond Marsh include hydroraking, cutting below the annual water line, and herbicide application (glyphosate). However, none of these control measures are considered a permanent cure, but rather are methods for managing the spread of the species that may require on-going maintenance (Tiner 1998). Glyphosate is a broad-spectrum herbicide, and if it is not applied carefully, surrounding vegetation can be affected.

Chemical and physical control measures for purple loosestrife include application of broad-spectrum herbicides, hand-pulling, and mowing. These measures are intensive and expensive and relatively ineffective, particularly for large stands of purple loosestrife. Biological control, with the use of leaf-feeding beetles (*Galerucella calmariensis* and *G. pusilla*) and a root-boring weevil (*Hylobius transversovittatus*) is the only long-term strategy which has been recommended to reduce the invasion of this exotic plant (Malecki *et. al.* 1993). Biological control of purple loosestrife is now permitted in the Commonwealth of Massachusetts, however, written documentation of long-term studies indicating the best sites and methods are lacking. Therefore, the effort would be somewhat experimental. It is known that beetles survive poorly in wetlands that are persistently flooded as the beetles overwinter in the duff (surface soil) in purple loosestrife stands (Janice Taylor, USFWS, pers.comm.). Therefore, sites such as Flint Pond Marsh and one of the wetlands adjacent to the Charles George Landfill would be poor candidates for biological control of purple loosestrife. The small wetland adjacent to the landfill and right next to Dunstable Road, is choked with purple loosestrife and is not persistently flooded, and could, therefore, be a possible candidate for biological control of purple loosestrife. However, this site is relatively small (less than one acre), so only a small area of habitat would be benefitted.

This alternative was rated HIGH for extent of restoration of injured resources because this alternative would signficantly improve the habitat in the areas that were injured. It was also rated HIGH for proximity to the injured resources. It was rated MEDIUM for cost effectiveness because of the cost of purchasing the equipment and because control of invasive plants can require intensive labor to be successful. It was rated HIGH for extent of ecological benefit to the public because it should increase the wildlife use of the wetlands. It was also rated HIGH for ecological benefit to the public for the same reason. It was rated LOW for community involvement, with the exception of whomever would be responsible for the long-term management. It was rated LOW for expected success since success would require long-term

intensive management. It was HIGH for compliance with applicable laws.

Control of Runoff from Route 3 into Flint Pond Marsh

Residents around Flint Pond raised the question as to whether storm runoff from Route 3, which is presently being directed to Flint Pond Marsh, could be directed elsewhere. The Trustee Council does not have any authority over Route 3, however, since planning for the Route 3 expansion is presently occurring, an opportunity exists for the drainage to be changed by the MassHighways. We are presently working with MassHighways to determine the present plans for the Route 3 section through Tyngsborough. However, we have been informed by the Massachusetts Department of Environmental Protection that the Commonwealth requires that stormwater discharges be treated, such as by a detention basin, before being discharged into a natural waterbody. Also, the U.S. Fish and Wildlife Service serves as an advisor to the U.S. Army Corps of Engineers on dredge and fill permits, which will provide another avenue for encouraging MassHighways to provide for discharging into detention basins before discharging into Flint Pond. Since this is not really a restoration to be undertaken by the Trustee Council it is not evaluated here in comparison to the other alternatives.

3.3 Effects of Alternative C: Off-Site Wetland Restoration

Off-site restoration of wetlands would compensate for many of the wetland services lost as a result of contamination from the Site. Wetland creation and/or enhancement near the sites impacted would provide additional wetland habitat to species of migratory birds that use wetlands. In addition, restoration efforts would also create or improve habitat for other wildlife species and provide other wetland functions. However, the Trustee Council was unable to find a

site with good restoration potential that was available for acquisition. The sites that were found are described and their evaluations discussed (see Tables 1 and 4 on pages 13 and 33, respectively).

Brox Property on Flint Pond

This site offers limited opportunity for wetland restoration. The site is disturbed by historical excavation but the areas that were dug to the water table seem to be developing into productive wetland areas on their own. The upland portion remains relatively denuded and could benefit from the spreading of topsoil and revegetation. However, the upland would remain upland as it is too far above the water table to allow for wetland creation. Restoration of upland habitat would help support adjacent wetland habitat and Flint Pond. Acquisition of this property would protect it from potential future development. However, based on two conversations with a representative for the landowner, it does not appear that the landowner is interested in selling this property to the Trustee Council.

This alternative was rated MEDIUM for the extent to which it would restore the injured resources because it would provide a buffer for Flint Pond and adjacent wetlands, however, no wetlands would be created, restored, or enhanced. It was given a HIGH rating for proximity to injured resources since it is located adjacent to Flint Pond. Cost effectiveness is difficult to evaluate without having an appraisal of the property. It was given a HIGH rating for the extent that it would enhance the public's ability to use and enjoy the public resource since it would likely be open for public use. It was given a MEDIUM rating for its environmental benefit to the public; it was not given a HIGH rating because of the lack of wetland restoration potential. It

was given a HIGH rating for community involvement because public access would be expected. It was given a low rating for expectation of success since the owner does not appear to be willing to sell. This alternative would be expected to be in compliance with applicable laws.

Sandpit on Groton Road

This site was considered a potential restoration site because the upland was degraded (sandpit) and because there was a small pond of water on the site suggesting that a portion of the site has a shallow water table. However, the amount of wetland that could be created on the site is unknown and would require an extensive and expensive investigation to determine. Also, a large area of upland would need to be restored to a more productive state to make the wetland restoration worthwhile. This site is relatively far from the area of impact. The landowner could not be reached.

This site was rated HIGH for the extent to which it could replace the injured resources because theoretically the types of wetlands injured could be re-created and, therefore, increase the amount of habitat available to the animals that use those wetland habitats. It was given a LOW rating for the proximity to the injured resources. Cost effectiveness is difficult to evaluate without an appraisal of the property but this alternative would be expected to be costly. It was given a HIGH rating for public use since it would be expected to be open to the public. It was given a MEDIUM rating for environmental benefit because it is a relatively long distance from the area of impact and possibly only a small area of wetland could be created. Community involvement would be expected to continue since the property would be open for public use. The potential for technical success can not be evaluated without further study, however, the fact that the landowner could not be contacted makes the project unviable. This project would be in compliance with applicable laws.

Sandpit on Red Gate Rd/ Dunstable Rd/ and Brookview Circle

This site is considered to have good restoration potential because it has access to water; the site was excavated to the water table in some locations and the site is adjacent to Dunstable Brook. The site is an old sandpit, so quality habitat would not be altered to create wetland. Although some of the site has developed into wetland already, the topography is flat and lacks diversity, and the ponded areas lack depth. A berm between the site and Dunstable Brook impedes water exchange. Much of the site is vegetated with invasive plants: purple loosestrife chokes part of the site; a discrete stand of Phragmites seems to be expanding; Japanese knotweed is growing on the berm; and sugar locust trees are distributed throughout the site. The southeast corner of the site remains upland sandpit with relatively little vegetative development. Therefore, there is ample opportunity to improve the site. The challenge for this restoration is that the site is broken up into at least eight different small parcels with different owners. All of the landowners would have to be interested in participating for the project to be viable. The Trustee Council was interested enough in this project to hire the Natural Resources Conservation Service (NRCS) to survey the microtopography of the site so that a draft map of what the restoration might look like could be developed. Once this draft restoration map was developed and shown to the landowners, some of them decided not to participate, deeming this restoration alternative inviable.

This project was rated HIGH for the extent it restores, replaces, or enhances the resources injured since it would create wetland habitat of a type similar to what was injured. It was rated

HIGH for proximity to the injured resources since Dunstable Brook was impacted a short distance upstream. It was rated HIGH for cost effectiveness since the site was already excavated, so the creation effort was essentially already started, and it could be partnered with a land protection alternative, the Regonini Properties. It was rated MEDIUM for the extent the alternative would enhance the public's ability to use, enjoy or benefit from the natural resources. This is because the site should attract more wildlife to the area which would be enjoyed by the immediate landowners. It would also create more habitat by increasing the quality of the habitat, and the additional wildlife produced would also move to adjacent habitats. But this site would essentially be closed to the general public because it is ringed by private residences. It was rated HIGH for environmental benefit to the public because it would partially replace resources that were lost. It was rated MEDIUM for community involvement because there was potential for long-term active management by the landholder and adjacent landowners but the site would not be open to the general public. The project was rated MEDIUM for compliance with applicable laws because some existing low quality wetland would be altered to create higher quality wetland, which could be controversial.

Brox Property on Kendall Road behind Highway Department

This property was considered as a restoration site because the upland is degraded sandpit and there is a small pond on the property which indicates possible access to groundwater. Theoretically, it would be possible to create wetland around the perimeter of the pond, but groundwater studies would be required to determine exactly where the groundwater table is around the pond. In addition to creating wetland, an extensive amount of upland would need to be restored around the wetland for the habitat to be of value. A representative for the landowner indicated through a phone conversation that the owner was unlikely to be interested in selling this property.

This alternative was rated HIGH for the extent to which it would restore, replace, or enhance the natural resources that were injured since habitat similar to what was injured would be created. It was rated MEDIUM for proximity to injured resources since it is separated from Flint Pond by Kendall Road. It was rated LOW for cost-effectiveness because the effort, including the preliminary testing, would be costly and potentially only a small area of wetland would be created. It was rated HIGH for the extent that it would enhance public use because once the property was acquired it would be open for public use. It was rated MEDIUM for environmental benefit to the public because it would create similar habitat to what was injured but possibly only a small area. It was rated HIGH for continued public involvement since the property would be open for public use. It was rated LOW for the extent to which the project would be successful because a lot more needs to be known about the water table, and the landowner appears to be unwilling to sell. Compliance with applicable laws would be expected to be high.

Middle School Site on Westford Road

This site was considered a potential restoration site because it includes an old sandpit adjacent to Bridge Meadow Brook. Some of the sandpit was excavated to the water table and wetland vegetation has developed. There are two small areas, each about an acre in size: one on the north side of the brook and one on the south side of the brook. The berms along the banks of the brook could be breached to provide water to enhance wetlands areas and to help absorb flood waters. Construction of a middle school is planned for the area, making the enhanced wetland areas potentially "living laboratories". However, recent development of housing around the wetlands,

in conjunction with the nearby construction of a school limits the amount of surrounding upland available as habitat to support the wetland areas. The Town of Tyngsborough has been hesitant to give approval to the enhancements because the entire property may be needed for the school.

This alternative was rated HIGH for the extent to which it restores, replaces, or enhances the natural resources that were injured. It was rated MEDIUM for proximity to injured resources because it is not on Flint Pond or Dunstable Brook. It was rated MEDIUM for cost effectiveness because it is a relatively small area that would be enhanced and the habitat around it is compromised by development. It was rated HIGH for the extent to which it would enhance public use. It was rated MEDIUM for environmental benefit to the public because it could serve as a "living laboratory" for students at the middle school and would help absorb flood waters, however, the enhanced areas would be relatively small. It was rated HIGH for the extent it provides an oportunity for community involvement to continue because it could be used as a "living lab" for the school. It was rated LOW for the extent to which the project would be expected to be successful because, although it is technically feasible, the Town has not given an approval to the project because the land may be needed for the school.

3.4 Effects of Alternative D: Acquisition of Equivalent Resources

Acquisition of equivalent resources is generally selected only after in-kind restoration projects have been evaluated because it results in preservation of existing resources rather than in replacement of lost resources. This is reflected in Criterion A of the evaluation of alternatives (Table 3 on page 25), which is "the extent to which the alternative restores, replaces, or enhances the natural resources that were injured". All of the acquisition alternatives were rated as LOW for this criterion except the Brox Property, which has good potential for active restoration. Since the acquisition alternatives were mostly rated the same for the criteria in Table 3, they are not discussed and compared in this section. Table 4 provides a new list of criteria for evaluating and comparing acquisition alternatives. This table is discussed in section 2.5.

3.5 Effects of Alternative E: On-Site Migratory Fish Restoration

Fish Passage for Flint Pond: Migratory fish restoration through construction of fish passage at the two Flint Pond dams would involve a relatively high cost for a relatively small gain. Fish passage facilities would allow alewife and blueback herring, and American eel to migrate into Flint Pond. Herring may not have historically entered this tributary to the Merrimack River because it may not have provided the relatively deep, quiet water environments, prior to impounding, needed for spawning. The present condition includes the impounded Flint Pond, which could provide an opportunity for herring spawning. However, habitat is limited. Although the pond provides potentially 61 acres of spawning habitat, there is no additional habitat upstream, and the shallow depths of Flint Pond may cause the water temperatures to be too warm for juvenile herring. Further, the pond appears to be silting in, as evidenced by an increase in floating-leaved aquatic plants (primarily lilypads). Given the relatively high price tag of constructing fish passage at this location, estimated to be approximately $200,000, this alternative may not be cost-effective.

This alternative was rated HIGH for the extent that it restores, replaces, or enhances the natural resources that were injured because it would enhance the fishery that may have been injured. It

was rated HIGH for proximity to injured resources since the work would take place at the site of injury. It was rated LOW for cost-effectiveness because of the high cost of the work and the relatively low likelyhood of success. It was rated MEDIUM for the extent to which the alternative will enhance the public's ability to use, enjoy, or benefit from the resource because the project would theoretically bring herring into Flint Pond, but success of reproduction may be limited by high water temperatures. It was rated LOW for ecological benefit to the public because the success of the project is expected to be LOW. It was rated MEDIUM for the extent that it provides for continued community involvement because the fish ladder would require some on-going maintenance. It was rated LOW for the extent to which the project is expected to be successful. It was rated HIGH for compliance with applicable laws.

Stabilization of Bank Erosion in the Merrimack River through Tyngsborough:
Abatement of bank erosion on the Merrimack River does not appear to be cost-effective. There are numerous locations on the Merrimack River in Tyngsborough and towns downstream with eroding, sloughing banks. The causes of the erosion range from natural processes to land development causing destabilization of the river banks. Excessive erosion results in degradation of aquatic habitat due to increased turbidity in the water column and siltation of the substrate. Placement of riprap is the most common method used to stabilize banks in rivers with significant ice scour, which is expected in a large river such as the Merrimack. Riprap is relatively costly, averaging $40 per linear foot. Riprap can also contribute to degradation of the river system by increasing water velocities which can aggravate erosion both upstream and downstream.

This alternative was rated LOW for the extent to which it restores, replaces, or enhances the natural resources that were injured. Although reducing erosion and, thus, turbidity would be beneficial to aquatic resources, it is unlikely that enough areas could be stabilized that turbidity could be reduced to a meaningful extent. Also, if riprap is used, it often degrades the aquatic habitat as much as it enhances it. It was rated MEDIUM for the proximity to injured resources because the areas of erosion extend up and down the Merrimack River. It was rated LOW for cost-effectiveness because bank stabilization in a large river is expensive and a lot of bank would need to be stabilized before turbidity would be reduced to a meaningful degree. It was rated LOW for the extent to which the alternative will enhance the public's ability to use, enjoy, or benefit from the natural resources that were injured because stabilizing a few banks will not likely increase the number of fish in the river. It was rated LOW for extent of environmental benefit to the public because a lot of bank would need to be stabilized before there was a meaningful reduction in turbidity, and the riprap can do damage to the river system. It was rated LOW for continued community involvement. It was rated MEDIUM for likelihood of success because technically the stabilization is possible in some locations, but the overall goal of improving habitat for migratory fish may not be met. It was rated MEDIUM for compliance with applicable laws because bank stabilization is frequently permitted when property is in danger but, otherwise, permitting can be difficult.

3.6 Effects of Alternative F: Off-Site Migratory Fish Restoration

Off-site restoration for migratory fish would compensate for injuries that possibly occurred due to the release of contamination from the Site into the Merrimack River. Since migratory fish move up and down through the watershed, an increase in reproduction in one portion of the watershed should ultimately contribute to a higher population throughout the watershed.

A proposal to survey the habitat of the Shawsheen River was received by the Trustee Council.

Herring have been observed in the lowermost parts of the Shawsheen, which suggests that the upstream portions of the river should be investigated for their potential to provide habitat for migratory fish. However, without further assessment of the suitability of the habitat in the river, it is difficult to judge whether money would be well spent restoring migratory fish to this river system. The Trustee Council received another proposal to provide fish passage, and stocking and monitoring of shad and herring in the Concord River. It is already known that quality habitat is present in the upstream reaches of the Concord/Sudbury/Assabet Rivers. Therefore, since it is known that quality habitat exists in the Concord River, and conversely, since little is known about the suitability of the habitat in the Shawsheen River for migratory fish, it appears that restoration of migratory fish in the Concord River would be more prudent.

Restoration of historical fish runs would be consistent with on-going federal and state activities. Organizations involved with these activities in Massachusetts include: the Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement, the Massachusetts Division of Marine Fisheries, the Massachusetts Riverways Program, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, as well as numerous non-profit organizations. Any dam work would be conducted during low-flow periods to minimize impacts on the river, however, the overall impact of constructing a fishway would be positive. No impacts on threatened and endangered species is expected. The construction of a fishway at the Talbot Mills Dam would be consistent with the Massachusetts Wetlands Protection Act (310 CMR 10.57 10.00), the Clean Water Act (Section 404), and the Rivers and Harbors Act (Section 10).

The Shawsheen River alternative was rated MEDIUM for the extent to which it restores, replaces, or enhances the natural resources that were injured because of the unknown probability of success. It was rated MEDIUM for proximity to the injured resources because, although it is located well outside of Tyngsborough, the same population of migratory fish would be addressed. It was rated LOW for cost-effectiveness because of the questions about the projects potential for success. It was rated MEDIUM for the extent the alternative would enhance the public's ability to use, enjoy, or benefit from the resource because if the project was successful a fishery would be restored to the river for the public to utilize. However, since the amount of habitat available is in question it is not clear how much of a run is possible. It was rated MEDIUM for environmental benefit to the public for the same reasons as the previous criterion. It was rated MEDIUM for the extent that community involvement can continue because volunteers are often used to assist in monitoring fish returns and maintaining fish ladders. It was rated LOW for the extent the project is expected to be successful because of the many unknowns. It was rated HIGH for compliance with applicable laws.

The Concord River alternative was rated HIGH for extent to which the alternative restores, replaces or enhances the natural resources that were injured because it would restore runs of migratory fish to a large area of historical habitat. It was rated MEDIUM for proximity to the injured resources because, although it is located well outside of Tyngsborough the same population of migratory fish would be addressed. It was rated HIGH for cost effectiveness because the project is expected to be successful, and if it is successful, a substantial run of migratory fish will be restored to a large area of historical habitat. It was rated HIGH for the extent to which it will enhance the public's use of the resource because a fishery will be restored to a substantial area of the Concord, Sudbury, and Assabet Rivers, which will benefit the entire watershed. It was rated HIGH for environmental benefit to the public for the same reason as the previous criterion. It was rated MEDIUM for the extent of continued community involvement because volunteers are often used to monitor fish returns and maintain fish ladders. It was rated

HIGH for the likelihood of success because similar projects in other watersheds have been successful, and because quality spawning and incubation habitat has been documented in the system. It was rated HIGH for compliance with applicable laws.

4.0 Monitoring Plan

4.1 Wetlands

Since the proposed preferred alternative involves land protection, an on-going monitoring plan to document the success of the project is not warranted. However, legal covenants assuring perpetual protection of the properties would be entered and enforced. In addition, efforts will be made to develop a species list and a management plan for each property.

4.2 Migratory Fish

Monitoring of migratory fish restoration would have three segments: 1) monitoring the success of the stocking efforts; 2) monitoring the returns of adults; and 3) monitoring the effectiveness of fish passage at the Talbot Mills Dam. The protocol for monitoring the success of the stocking effort is provided in Appendix B.

Adult returns will be monitored by capturing fish in the denil ladder at the Centennial Island Dam. Fish will then be transported up river to stocking locations above the Talbot Mills Dam. A plan for monitoring the effectiveness of fish passage at the Talbot Mills Dam has not been developed yet, however, it is commonly done at hydrodam facilities. Methods depend on the fish species targeted and the design of the passage facility.

5.0 Public Comments on the Draft Restoration Plan and Responses from the Trustee Council

A public meeting was held at the Tyngsborough Junior-Senior High School on November 29, 2001. Nine members of the public, seven members of the Trustee Council, and one representative from the MDF&W were in attendance. The Trustee Council gave a brief overview of the proposed restorations and then opened the floor to comments and questions. One attendee also submitted a letter repeating the questions asked at the meeting. A copy of this letter is provided in Appendix D. The questions or issues raised at the meeting or in the letter are stated below with a response:

Issue 1. There was one general objection to spending money for restoration on the Concord River since it is not in Tyngsborough.

Response: The Trustee Council has always said that it might need to conduct migratory fish restoration outside of Tyngsborough if it could not find meaningful restoration within Tyngsborough. The Trustee Council believes that restoration of migratory fish on the Concord River is a good project in that it has a high likelihood of success and will open many miles of spawning habitat that should benefit the entire watershed. The Trustee Council committed to limiting money spent outside Tyngsborough to the amount of NOAA's settlement and we have continued to meet that commitment.

Issue 2. There was a concern that since Kathy Regonini decided not to participate in the land protection effort that the majority of properties protected would be in Dunstable rather than Tyngsborough and it was recommended that the Trustee Council consider the Bell Property on Locust Avenue in Tyngsborough.

Response: We contacted the landowner of the Bell Property and got permission to consider it and walk the land. However, as discussed in the text, we did not find it to offer the habitat qualities we were looking for, primarily in that it is not hydrologically connected to any of the areas that were injured, it is disjunct from other protected properties, and it is bordered by a lot of development, and it does not offer habitat for migratory birds that use wetlands. We did, however, notice a large wetland complex upstream of this site which turned out to have protected land along its north side. There were two properties, the Woodward Property and the O'Coin Property, that would contribute nicely to the habitat already protected around the wetland complex. We contacted both landowners and neither were interested in selling their land to the Trustee Council. We are unaware of any other properties available for purchase in the Town of Tyngsborough.

Issue 3. There was a concern that restoration money was not proposed to be spent to fix the Upper Flint Pond Dam.

Response: The Trustee Council has revisited this issue and the dam will be addressed if it can be done with what the Trustee Council has determined to be a reasonable proportion of the settlement funds; ie, approximately $200,000.

Issue 4: There was a suggestion that we use restoration money to address bank erosion on the Merrimack River.

Response: This issue was addressed in the text. There are many areas of erosion on the Merrimack River, some of which is natural and some of which is due to development on the banks. Armoring the banks with stone is expensive and armoring just a few areas is unlikely to improve the habitat of the river. Further, armoring a bank can actually exacerbate erosion downstream, so in the end it can do more harm than good.

Issue 5: The issue of weed control in Flint Pond was raised arguing that the lilypads in the pond have become so thick that they are an impediment to recreation. Further, it was argued that NRD settlement monies are encouraged to be used to restore public recreation opportunities.

Response: The Trustee Council is familiar with this issue and believes the dense lilypads are present because Flint Pond is filling in. Much of the pond is less than five feet deep which allows light to penetrate to the bottom promoting vegetative growth. Lilypads are a native plant common to shallow ponds. Such pond vegetation provides habitat for aquatic animals. The Trustee Council does not feel that lilypad control in Flint Pond is an appropriate use of NRDAR funds. Further, the Commonwealth of Massachusetts settlement did not mention impacts to public recreation. The Trustee Council believes that the restoration should be driven by the settlements.

Issue 6: It was requested that the Trustee Council reconsider purchase of the Brox Property on Flint Pond.

Response: The Trustee Council has contacted the landowner on two occasions and was told on both occasions that Brox Industries was not interested in selling the property. The Trustee Council feels that asking twice is sufficient.

Issue 7: Funds could be used to compensate the Town of Tyngsborough for the purchase of the Greene Property or the Sherburne Property. The Sherburne Property is expected to have an environmental education center. Monies could be used to assist with trail construction, signage, butterfly gardens, etc.

Response: The Trustee Council believes that the priority is to protect habitat as close to the area of impact as possible. The first priority for acquisition is the Elkareh Property on Flint Pond, which provides a buffer to Flint Pond. The second and third priorities are the Larter Property and Elkareh Property on Dunstable Road. Both of these properties are partially in Tyngsborough and both were directly impacted by leachate from the landfill. We believe it is unlikely that there will be enough money to purchase more than these three properties.

6.0 List of Preparers

The Final RP/EA was prepared by the Charles George Natural Resources Trustee Council. The primary author was Laura Eaton-Poole with the U.S. Fish and Wildlife Service and coordinator for the Council. Document review was provided by members of the Trustee Council. Ideas for restoration were provided by numerous interested persons. Members of the Trustee Council are listed below:

Dale Young, Trustee Representative for the Commonwealth of Massachusetts, Executive Office of Environmental Affairs
Kenneth Carr, Trustee Representative for the U.S. Department of Interior, Fish and Wildlife Service
Kenneth Finkelstein, Trustee Representative for the U.S. Department of Commerce, National Oceanic and Atmospheric Administration
Arthur Jackson, *ex-officio* member, Citizen of the Town of Tyngsborough
Mark Whitehead, *ex-officio* member, Town of Tyngsborough Director of Planning and Community Development
Ralph Goodno, *ex-officio* member, Merrimack River Watershed Council
David Buckley, technical advisor, Commonwealth of Massachusetts, Department of Environmental Protection
Andrew Cohen, legal advisor, Commonwealth of Massachusetts, Department of Environmental Protection
Thomas LaRosa, legal advisor, Commonwealth of Massachusetts, Executive Office of Environmental Affairs
Mark Barash, legal advisor, U.S. Department of the Interior
Anthony Giedt, legal advisor, U.S. Department of Commerce, National Oceanic and Atmospheric Administration

7.0 List of Agencies, Organizations, and Parties Consulted for Information

Martha Abair, U.S. Army Corps of Engineers
William Archambault, U.S. Fish and Wildlife Service

Charles Bell, Massachusetts Division of Fisheries and Wildlife
Dani Carville, Town of Dunstable Conservation Commission
William Dunn, Shawsheen River Watershed Team Leader
William Easte, Massachusetts Division of Fisheries and Wildlife
Michael Fleming, Sudbury/Assabet/Concord Watershed Team Leader
Carl Gustafson, Natural Resources Conservation Service
Charles Katuska, Massachusetts Wetland Restoration and Banking Program
David Killoy, U.S. Army Corps of Engineers
Joseph McKeon, U.S. Fish and Wildlife Service
Everett McLaughlin, U.S. Fish and Wildlife Service
Sarah MacLennan, Town of Tyngsborough Conservation Commission
Dennis McNamara, Massachusetts Division of Fisheries and Wildlife
William Minor, Massachusetts Division of Fisheries and Wildlife
Christine Mizioch, Massachusetts Department of Highways
Susan Oliveira, U.S. Fish and Wildlife Service
Richard Quinn, U.S. Fish and Wildlife Service
Christy Foote-Smith, Massachusetts Wetland Restoration and Banking Program
Douglas Smithwood, U.S. Fish and Wildlife Service
Elaine Stanley, U.S. Environmental Protection Agency
Thomas Squires, Maine Department of Marine Resources
Mark Tisa, Massachusetts Division of Fisheries and Wildlife
Town of Dunstable Conservation Commission
Town of Tyngsborough Conservation Commission

Literature Cited

Chan, E. T. Bursztynshky, N. Hantzche, and Y.T. Litwin. 1982. The use of wetlands for water pollution control. U.S. Env. Protection Agency, Municipal Env. Res. Lab., Cincinnati, OH. EPA-600/S2-82-086. 4 pp.

DeGraaf, R.M. and D.D. Rudis. 1983. New England wildlife: habitat, natural history, and distribution. Northeast. For. Exp. Sta., U.S. For. Serv. Gen. Tech. Rep. NE-108. 491 pp.

Ebasco Services. 1987. Draft Remedial Investigation, Charles George Landfill Reclamation Trust Site, Tyngsborough, Massachusetts. December, 1987.

Ebasco Services. 1988. Draft Final Remedial Investigation, Charles George Landfill Reclamation Trust Site, Tyngsborough, Massachusetts. December, 1988.

EPA, 1988. Charles George Landfill Reclamation Trust Site Record of Decision. Dated September 29, 1988.

EPA, 1999. Explanation of Significant Difference: Charles George Reclamation Trust Landfill Superfund Site, Tyngsborough, Massachusetts. Dated September 29, 1999.

ERM-New England, Inc. 1994. Draft Burgess Brothers Superfund Site Engineering Evaluation/Cost Analysis. Prepared on behalf of: Burgess Brothers Steering Committee. Dated September 26, 1994.

Holcomb, B.P. 1990. Wetland damages assessment: Charles George Landfill. Prepared for the Commonwealth of Massachusetts. 5039-3/ENV-4313.

Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, F.J. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius.* J. Great Lakes Res. 22(3): 602-623.

King, D. and C. Bohlen. 1994. Estimating the costs of restoration. National Wetlands Newsletter. May/June, 1994:3-8.

Long, E.R., L.J. Field, and D.D. MacDonald. 1998. Predicting toxicity in marine sediments with numerical sediment quality guidelines. Environ. Tox. and Chem. 17(4):
714-727.

Malecki, R.A., B. Blossey, S.D. Hight, D. Schroeder, L.T. Lok, and J.R. Coulson. 1993. Biological control of purple loosestrife. BioScience 43(10): 680-686.

Metcalf and Eddy. 1995. Final Report: Five Year Review for Charles George Reclamation Landfill, Tyngsborough, Massachusetts. Prepared for the Environmental Protection Agency.

Tiner, R. 1998. Managing common reed (*Phragmites australis*) in Massachusetts: An introduction to the species and control techniques. USFWS for the Massachusetts Wetlands Restoration and Banking Program. 49 pp.

Tyning, T. 1990. A guide to amphibians and reptiles. Little, Brown and Co., Boston, MA. 400 pp.

USFWS, 1992. Proposed covenant not to sue for Charles George Superfund Site in Tyngsboro, Massachusetts. Dated December 2, 1992.

Veit, R.R. and W.R. Petersen. 1993. Birds of Massachusetts. Massachusetts Audubon Society. 514 pp.

Appendix A:
Site Locations of Restoration Alternatives

Appendix B:
Property Maps of Land Protection Alternatives

Appendix C:
Protocol for Assessing Juvenile Salmon Production on the Concord River

Assessment of Juvenile Alewife Production on the Concord River September, 2000

Overview: In order to determine the success of the transfer operation of adult alewife from the Nemasket River to the Concord River in April of 2000 as semi quantitative assessment of juvenile production will be performed during the middle of September, 2000. During the time period of this study and under the flow conditions experienced this summer, it is likely that many/most juveniles have already successfully migrated from the Concord River watershed. However, mid September is a likely time to encounter school of congregating juveniles in the area above the Billerica Dam. It is thought that this section of the river potentially represents a staging area where juveniles will congregate prior to the higher flows and lower water temperature that will drive them to the ocean later in the month.

Scope: Within the limitations of time, juvenile alewife production will be assessed on the Concord River from the Billerica Dam upstream to the Rt. 4 Bridge.

Sampling Protocol: Sampling will occur using a electrofishing boat along the right (upstream) bank of the river with the right anode of the boat within 10 feet of the river bank. A sample will be defined as a 5 second pulse during which time the observation of 5 or more juveniles will be considered as a positive sample. Approximately, 100 samples will be taken per river mile and the number of positive and negative samples recorded. Overall, approximately 500 samples will be taken in the 4.7 river mile section between the Billerica Dam and the Rt 4. Bridge. Known landmarks, such as bridges, will be used to determine relative positions. X's and O's will be used to mark the approximate positions on an enlarged topographic map in which positive (X) and negative (O) samples were recorded. At least 10 nettings during the survey will occur for positive identification and to collect samples for future enumeration.

Concord River Juvenile Herring Assessment
Sample Reach Description and Proposed Sampling Criteria

Sampling Criteria

- **Boat Speed should be approximately 2.0 mph**
- **whatever the true boat speed, it should be held constant for each sample reach**
- **sampling should occur about ever 53 feet**
- **samples should be for a 5 sec duration**
- **a positive sample (x) is a sample in which 5 or more juveniles alewife are observed during the 5 minute pulse (a negative sample is when 4 or less juvenile alewife are observed)**

Description of Sampling Reach (running river miles from Billerica Dam)	**Distance** (River Miles)	**# of samples**	**Elapsed Time** (min:sec)
Billerica Dam to Colson St. Bridge (0.00-0.56)	0.56	56	16:48
Colson St. Bridge to Billerica Filtration Plant (0.56-1.18)	0.62	62	18:36
Billerica Filtration Plant to Rt. 3A Bridge (1.18-1.48)	0.30	30	09:00
Rt 3A Bridge to River St Bridge (1.48-2.73)	1.25	125	37:30
River Street Bridge to upstream end of Rt 3 Bridge (2.73-3.50)	0.77	77	23:06
Rt 3 Bridge to Rt 4 Bridge (3.50-4.66)	1.16	116	34.48
Totals	4.66	466	2:19:48

Appendix D:
Written Comments on the Draft Restoration Plan and Environmental Assessment