Powow River, Amesbury, MA

Executive Office of Environmental Affairs

MERRIMACK RIVER

A Comprehensive Watershed Assessment Report

2001

EXECUTIVE OFFICE of ENVIRONMENTAL AFFAIRS

Communities Connected by Water

MASSACHUSETTS Watershed INITIATIVE

The Commonwealth of Massachusetts

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June 2002

Dear Friends of the Merrimack River Watershed:

I am pleased to present the Year 3 Assessment Report for the Merrimack River Watershed. This report outlines the main environmental issues that face the watershed and provides the most current status of the Merrimack River. This report will help formulate the 5-year watershed action plan that will guide state and local environmental actions within the Merrimack River Watershed. The plan will implement the goals of the Massachusetts Watershed Initiative including: improving water quality; restoring natural flows to rivers; protecting and restoring biodiversity and habitats; improving public access and balanced resource use; improving local capacity; and promoting a shared responsibility for watershed protection and management.

The EOEA Merrimack River Watershed Team Leader has developed this Assessment Report after extensive research and input was provided from state and federal agencies, Regional Planning Agencies, watershed groups and organizations, and team members. The Watershed Initiative is unique because it focuses on the problems and challenges that are identified with stakeholders and local community partners in each watershed, rather than deciding these priorities solely at the state level. The priority issues identified in the Report include:

- Water Quality
- Water Quantity and Supply
- Open Space
- Habitat

I commend all of those involved with the Merrimack River Assessment effort. Thank you for your dedication, perseverance, and commitment to help develop the Assessment Report. The watershed team approach is the best way for government and community partners to make significant progress in addressing the environmental challenges of the 21st century. If you are not currently involved, I strongly encourage you to contact William Dunn, the Merrimack River Watershed Team Leader, at (508) 792-7716 ext.151, and become active in the Merrimack River Watershed restoration and protection efforts.

Very truly yours,

Bob Durand

Bob Durand

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WATERSHED PROFILE

Merrimack River Watershed

The Merrimack River Watershed encompasses 5010 square miles within the states of New Hampshire and Massachusetts (Figure 1). It is the fourth largest watershed in New England. The Merrimack River is formed by the confluence of two major rivers, the Pemigewasset and Winnipesaukee, in Franklin, NH. From here, it flows for 115 miles to the Atlantic Ocean. The watershed includes all or parts of approximately 200 communities with a total population of two million people. The state of Massachusetts defines the Merrimack River Watershed somewhat differently. It does not include the Nashua, SuAsCo, and Shawsheen River Watersheds or any of the NH watersheds and, with an area of 275 square miles, is much smaller (refer to map). It includes 50 miles of the Merrimack River from the NH border at Tyngsborough to the Atlantic Ocean at Newburyport and Salisbury and encompasses all or parts of 25 communities in Essex and Middlesex counties. Lowell, Lawrence, and Haverhill are the three major urban cities and most densely developed and populated. Elevations in the watershed range from sea level at the coast to about 300 feet at some of the inland hills. In Massachusetts, the Merrimack River is designated a Class B (inland) water from the NH border to Haverhill at Creek Brook, while the 22-mile tidal section from Haverhill to the ocean is designated a Class SB (coastal and marine) water. The river must meet minimum water quality criteria for primary (swimming) and secondary (fishing and boating) contact recreation as established by the Clean Water Act. Within the Merrimack River Watershed (MA definition), there are several smaller subwatersheds, including the Powow River, Little River, Spicket River, Beaver Brook, Stony Brook, and Salmon Brook. Several smaller tributaries also drain directly to the Merrimack River. The major subwatersheds are described more fully below.

Powow River Subwatershed

The Powow River subwatershed lies at the eastern end of the Merrimack River watershed (Figure 2). It is 58 square miles and encompasses 12 municipalities in two states, New Hampshire and Massachusetts. Towns in Massachusetts include Merrimac, Amesbury, and a very small portion of Salisbury. Towns in New Hampshire include Sandown, Hampstead, Danville, Kingston, Newton, East Kingston, South Hampton, Kensington, and Seabrook. The watershed is primarily rural and suburban with more intense development downstream in Amesbury. The river begins in Danville at Long Pond and flows for several miles before joining the Merrimack River at Amesbury. While there are still many large tracts of open land bordering the river, development has intensified in the region threatening the integrity of the river and its watershed. The watershed is water supply source for all of the communities. Amesbury withdraws directly from the Powow River, while many of the other communities rely on groundwater wells located throughout the watershed. The river is dammed at three locations in New Hampshire and three more in Massachusetts. As a result of this, the river has become a series of ponds and lakes linked by shorter river corridors. The river is tidal in the lower segment, for almost one and a half miles upstream from the Merrimack River. It is a Class A water (designated public water supply) from the Tuxbury Pond outlet to the Lake Gardner inlet. It is a Class B water from the Lake Gardner outlet to the tidal portion (mile 1.3) and Class SB in the tidal portion (mile 1.3 to 0.0). It must meet standards for primary (swimming) and secondary

(fishing and boating) contact recreation as established by the Clean Water Act. Other waterbodies and waterways associated with the Powow River in Massachusetts include the Back River (2), Lake Attitash, Meadowbrook Pond, Tuxbury Pond, Lake Gardner, and Clarks Pond.

Little River Subwatershed

The Little River subwatershed is a 30 square mile area encompassing two states and six municipalities (Figure 3). The towns in New Hampshire are Atkinson, Plaistow, Hampstead, Newton, and Kingston. In Massachusetts, only one city, Haverhill, is part of this subwatershed. The Little River flows for approximately 11 miles, beginning at Bayberry Pond in Plaistow and ending at the Merrimack River in Haverhill. The river corridor and its watershed are relatively undeveloped upstream, but become very urbanized in Haverhill. The Cash Energy/Beede Waste Oil Superfund site is located in Plaistow and is a potential water quality threat to the Little River. At its terminus, the river flows through a culverted section underneath the city and out to the Merrimack River. In this segment, there are water quality impacts from CSO discharges. Development pressures are increasing throughout the watershed, especially in the New Hampshire communities. There is one dam on the river in downtown Haverhill. It is a Class B water and must meet standards for primary (swimming) and secondary (fishing and boating) contact recreation as established by the Clean Water Act. Other waterbodies associated with the Little River in Massachusetts include Snow Brook, Fishin Brook, Camp Brook, and Foote Brook.

Spicket River Subwatershed

The Spicket River subwatershed is a 74.5 square mile area encompassing two states and nine municipalities (Figure 4). Six communities are located in New Hampshire and include Derry, Hampstead, Atkinson, Salem, Windham, and Pelham. The remaining three communities are located in Massachusetts and include Haverhill, Methuen, and Lawrence. The river itself originates at Big Island Pond, spanning the towns of Derry and Hampstead, and flows for approximately 15 miles to its confluence with the Merrimack River in Lawrence. Much of the lower watershed is urbanized and densely developed and has led to substantial flooding problems in Salem, NH and Methuen and Lawrence, MA. To add to the problem, development pressures are rapidly increasing in the upstream communities. There are four dams on the river, two in New Hampshire and two in Massachusetts. It is a Class B water and must meet standards for primary (swimming) and secondary (fishing and boating) contact recreation as established by the Clean Water Act. Other waterbodies associated with the Spicket River in Massachusetts are Harris Brook and Forest Lake.

Beaver Brook Subwatershed

The Beaver Brook subwatershed is a 96 square mile area encompassing two states and eleven municipalities (Figure 5). The majority of this subwatershed is located in New Hampshire and consists of all or part of eight communities including Auburn, Chester, Derry, Londonderry, Windham, Hudson, Salem, and Pelham. The remaining three communities are located in Massachusetts and include Dracut, Tyngsborough, and Lowell. The brook itself originates in Auburn from a series of small lakes and tributaries and flows for several miles to its confluence with the Merrimack River in Lowell. Much of the watershed is rural or suburban but becomes very urbanized and developed in Lowell. Development has increased dramatically in most of the

communities threatening the integrity of the brook and watershed. In Massachusetts, there are a total of three dams on the brook. It is a Class B water and must meet standards for primary (swimming) and secondary (fishing and boating) contact recreation as established by the Clean Water Act. Other waterbodies associated with Beaver Brook in Massachusetts include Long Pond, Peppermint Brook, and Double Brook.

Stony Brook Subwatershed

The Stony Brook Watershed is a 45 square mile area located in the southwest corner of the Merrimack River watershed (Figure 6). It is located entirely within the state of Massachusetts and encompasses all or parts of eight towns including Boxborough, Harvard, Littleton, Ayer, Groton, Westford, Tyngsborough, and Chelmsford. The brook originates at Wolf Swamp in Boxborough and flows for 22 miles to its confluence with the Merrimack River in Chelmsford. The stream is known as Beaver Brook from Wolf Swamp to Forge Pond in Westford. Upon exiting Forge Pond, it becomes Stony Brook and remains so to its terminus at the Merrimack River. Communities in this watershed are primarily rural to suburban but are growing rapidly given their proximity to Routes 3 and 495. Residential and commercial development threatens the sensitive and highly productive aquifers in the region. Stony Brook and Beaver Brook are Class B waters and must meet standards for primary (swimming) and secondary (fishing and boating) contact recreation as established by the Clean Water Act. Other waterbodies associated with Stony Brook in Massachusetts include Bennetts Brook, Gilson Brook, Black Pond, Spectacle Pond, Mill Pond, Forge Pond, Boutwell Brook, Snake Meadow Brook, Keyes Pond, Keyes Brook, Burgess Pond, Long Sought for Pond, Flushing Pond, Blue Brook, Nabnassett Pond, Tadmuck Brook, Crooked Springs Brook, Cold Spring Brook, and Newfield Pond (Freeman Lake).

Salmon Brook Subwatershed

The Salmon Brook Subwatershed is a 31 square mile area located on the western edge of the Merrimack watershed (Figure 7). It encompasses four municipalities in two states. Three communities are located in Massachusetts and include Groton, Dunstable, and Tyngsborough. The fourth community, Nashua, is located in New Hampshire. The brook originates at Martin's Pond in Groton, passes through a series of lakes and ponds in both Groton and Dunstable, and, after flowing 17 miles, meets the Merrimack River in Nashua, NH. With the exception of the city of Nashua, much of the watershed can be characterized as rural with many tracts of undeveloped land bordering the brook and its ponds. However, all of the communities are facing increasing development pressures as suburban sprawl moves up the Route 3 and 495 corridors. The brook is a Class B water and must meet standards for primary (swimming) and secondary (fishing and boating) contact recreation as established by the Clean Water Act. Other waterbodies associated with Salmon Brook in Massachusetts include Martin's Pond, Martin's Pond Brook, Lost Lake/Knopps Pond, Duck Pond, Whitney Pond, Baddacook Pond/Brook, Cow Pond Brook, Massapoag Pond, Black Brook, Hauk Brook, and Joint Grass Brook.

The remaining portions of the Merrimack watershed (MA definition) are drained by several smaller tributaries that flow directly to the Merrimack River. Typically, these tributaries lie within only one or two municipalities. They include Town Creek, Shad Creek, Black Rocks Creek, Plumbush Creek, Artichoke River, Indian River, Cobbler's Brook, East Meadow River, Johnson's Creek, Creek Brook, Baremeadow Brook, Fish Brook, Trull Brook, Bartlett

Brook, Trout/Richardson Brook, Black Brook, Lawrence Brook, Deep Brook, and Limit Brook (see **Attachment 1f** for a complete list of rivers and streams in the watershed).

Interstate coordination:
It is apparent that coordination with the state of New Hampshire is crucial in order to protect many of the major subwatersheds of the Merrimack River watershed (MA definition), and ultimately the Merrimack River, since a greater part of these subwatersheds lie in New Hampshire.

Figure 1

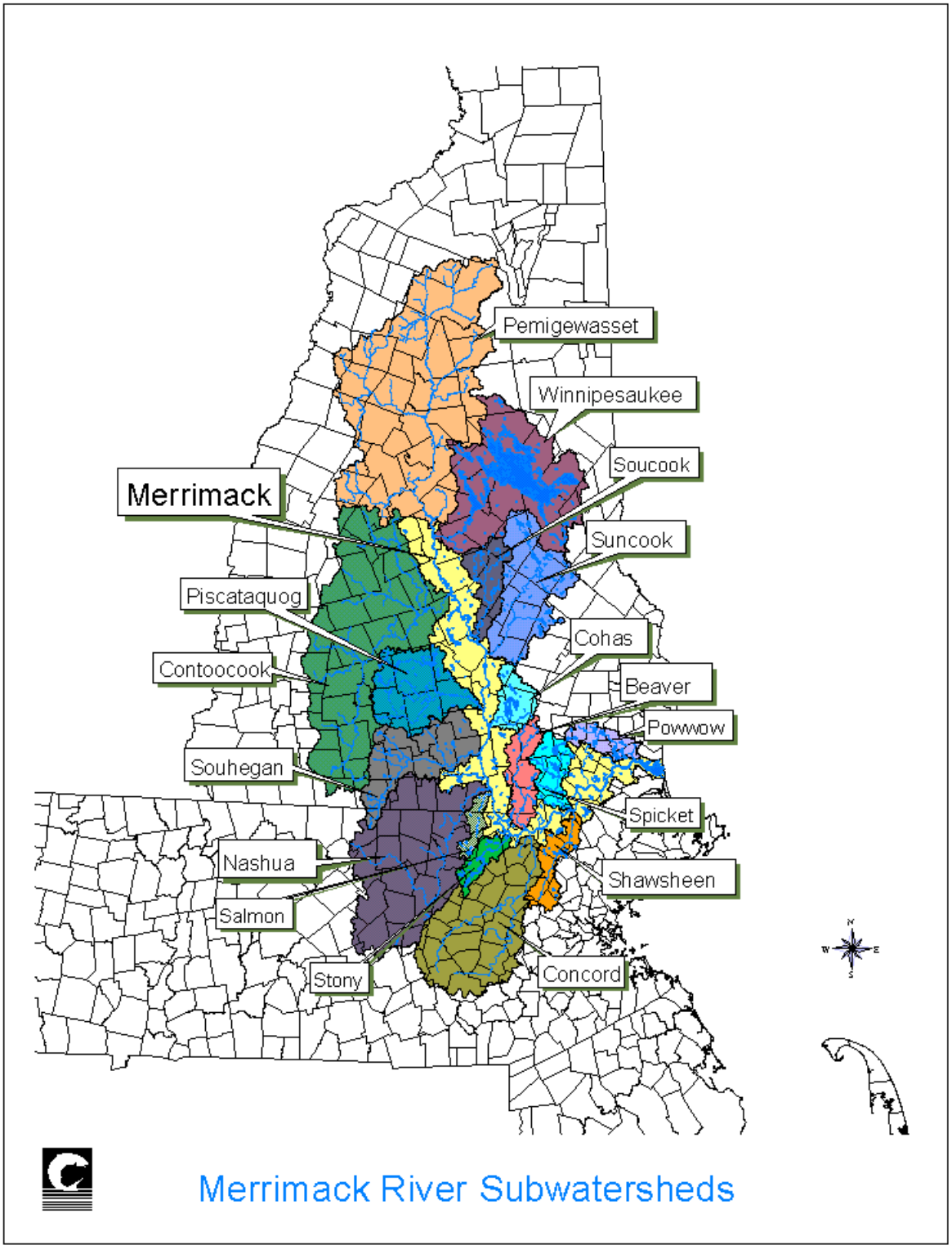

Pemigewasset
Winnipesaukee
Soucook
Merrimack
Suncook
Piscataquog
Cohas
Contoocook
Beaver
Powwow
Souhegan
Spicket
Nashua
Shawsheen
Salmon
Stony
Concord
Merrimack River Subwatersheds

Figure 2

Powow River Subwatershed

Figure 3

Little River Subwatershed

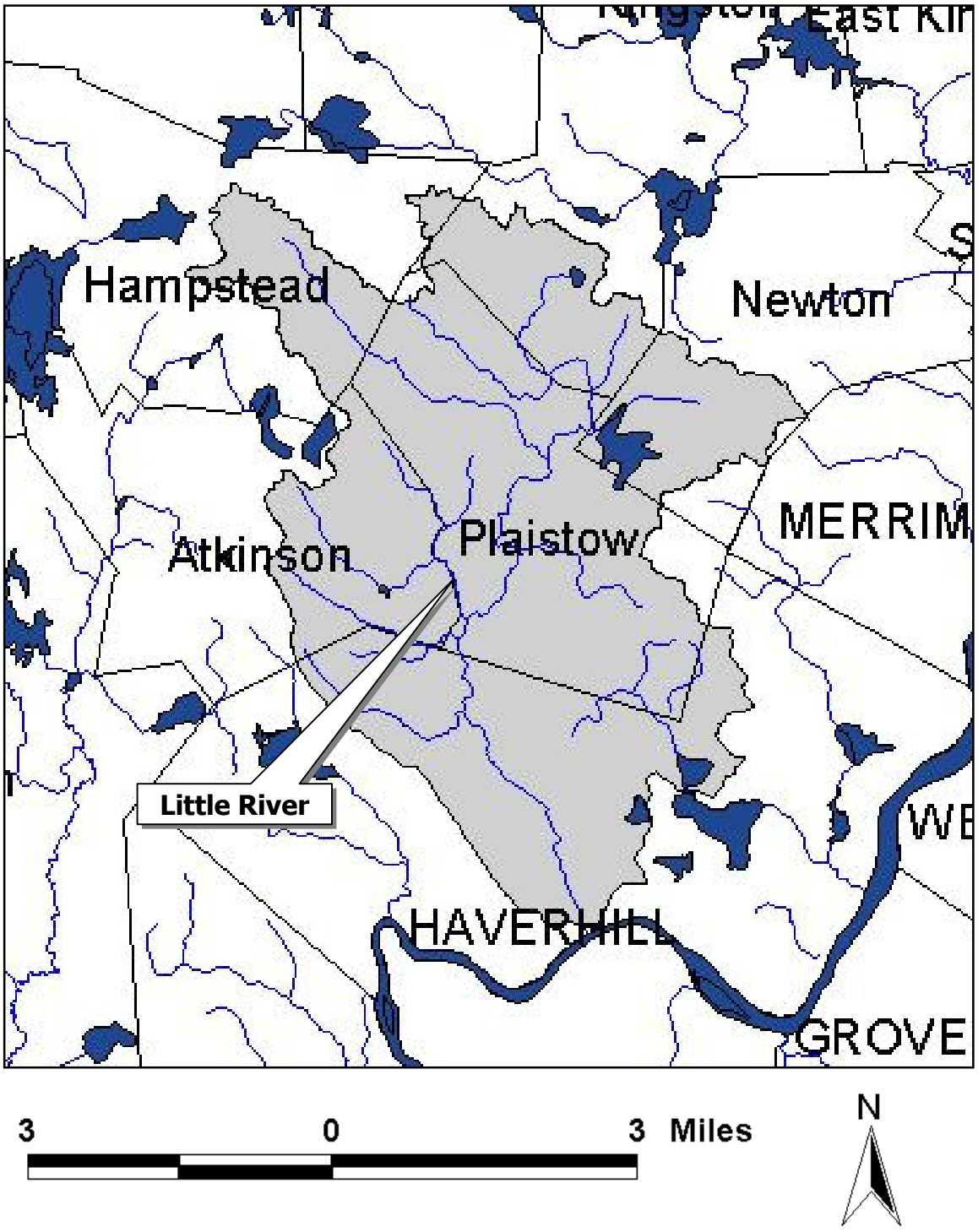


Figure 4

Spicket River Subwatershed

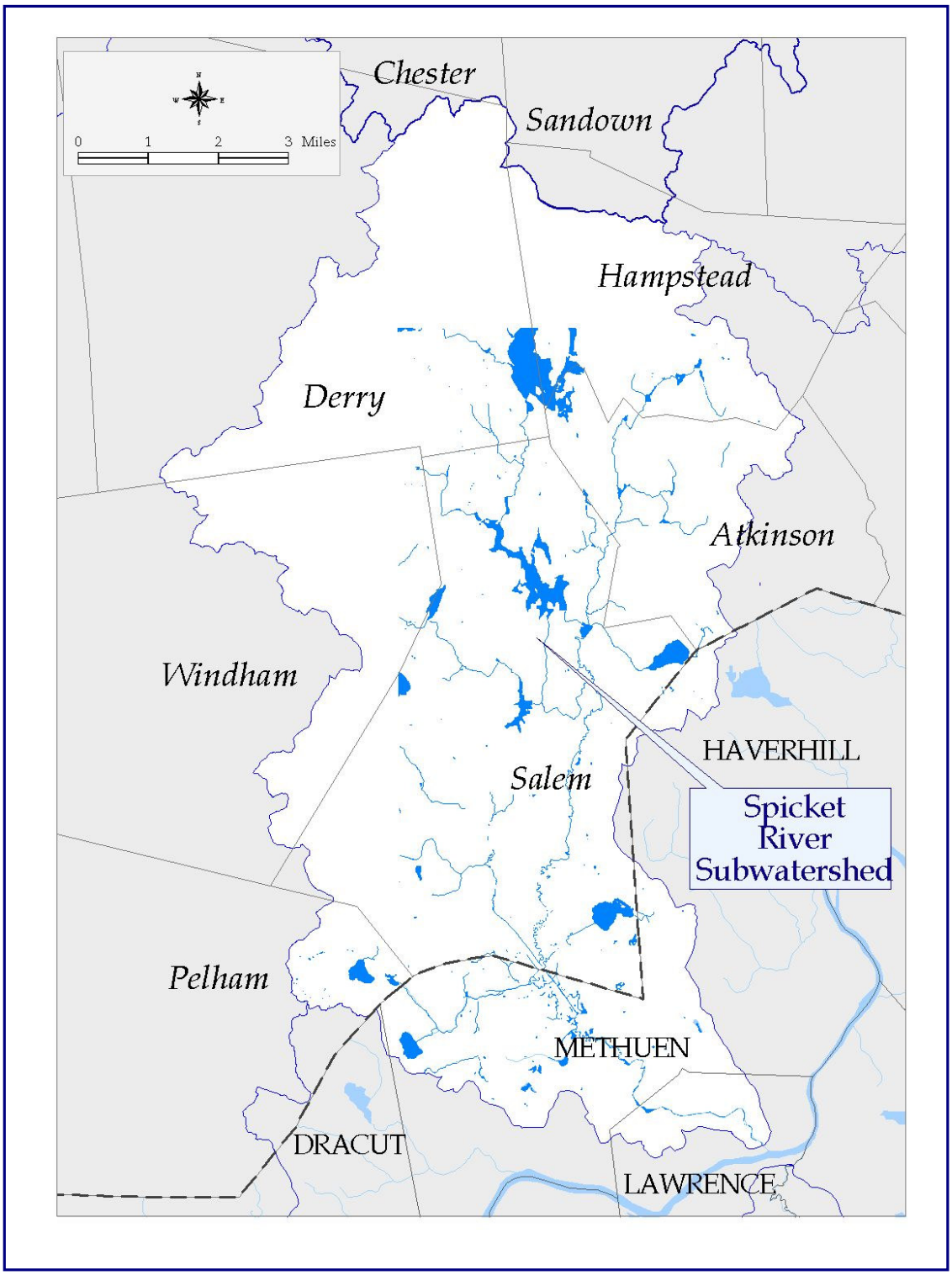


Figure 5

Beaver Brook Subwatershed

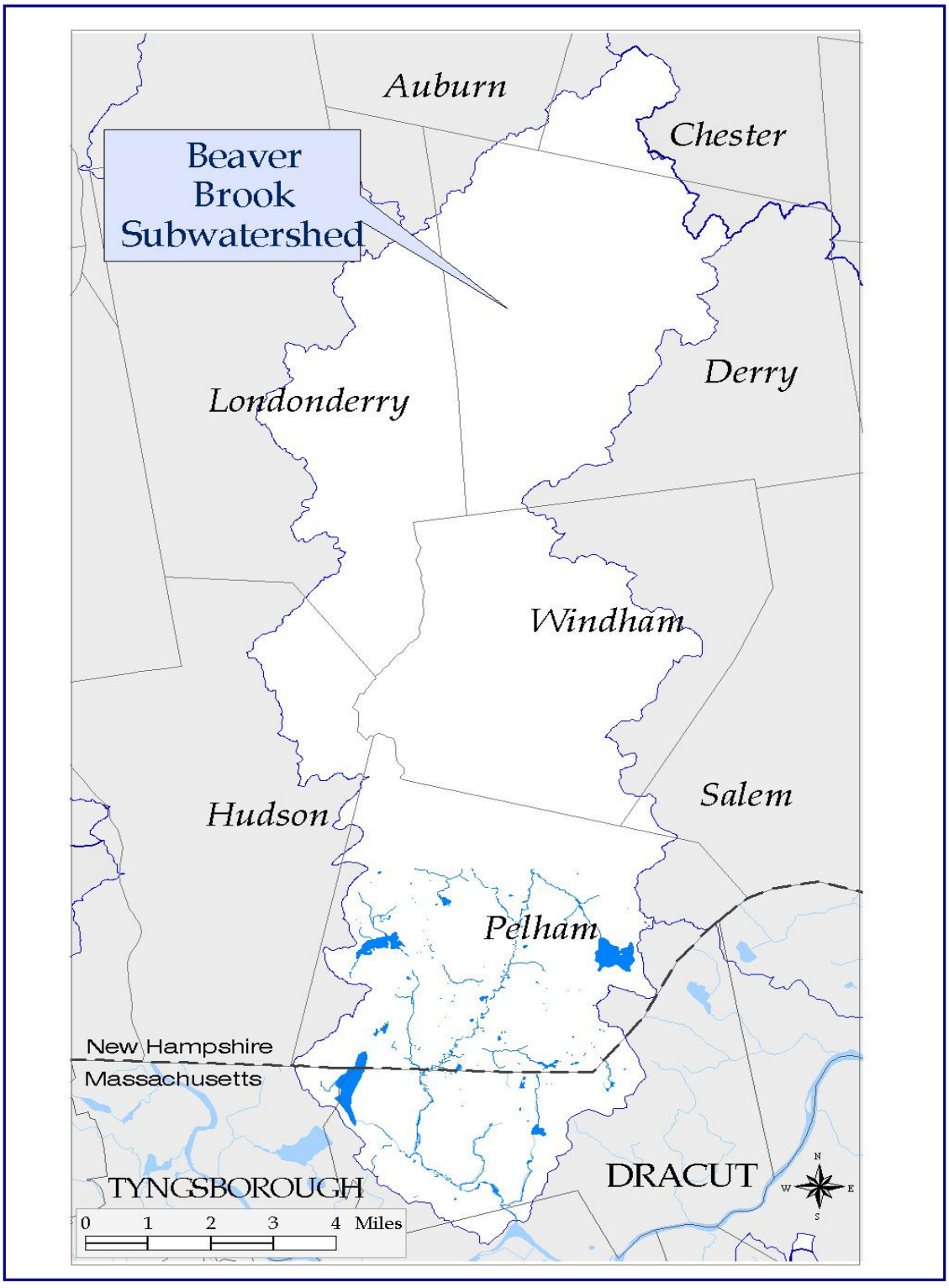


Figure 6

Stony Brook Subwatershed

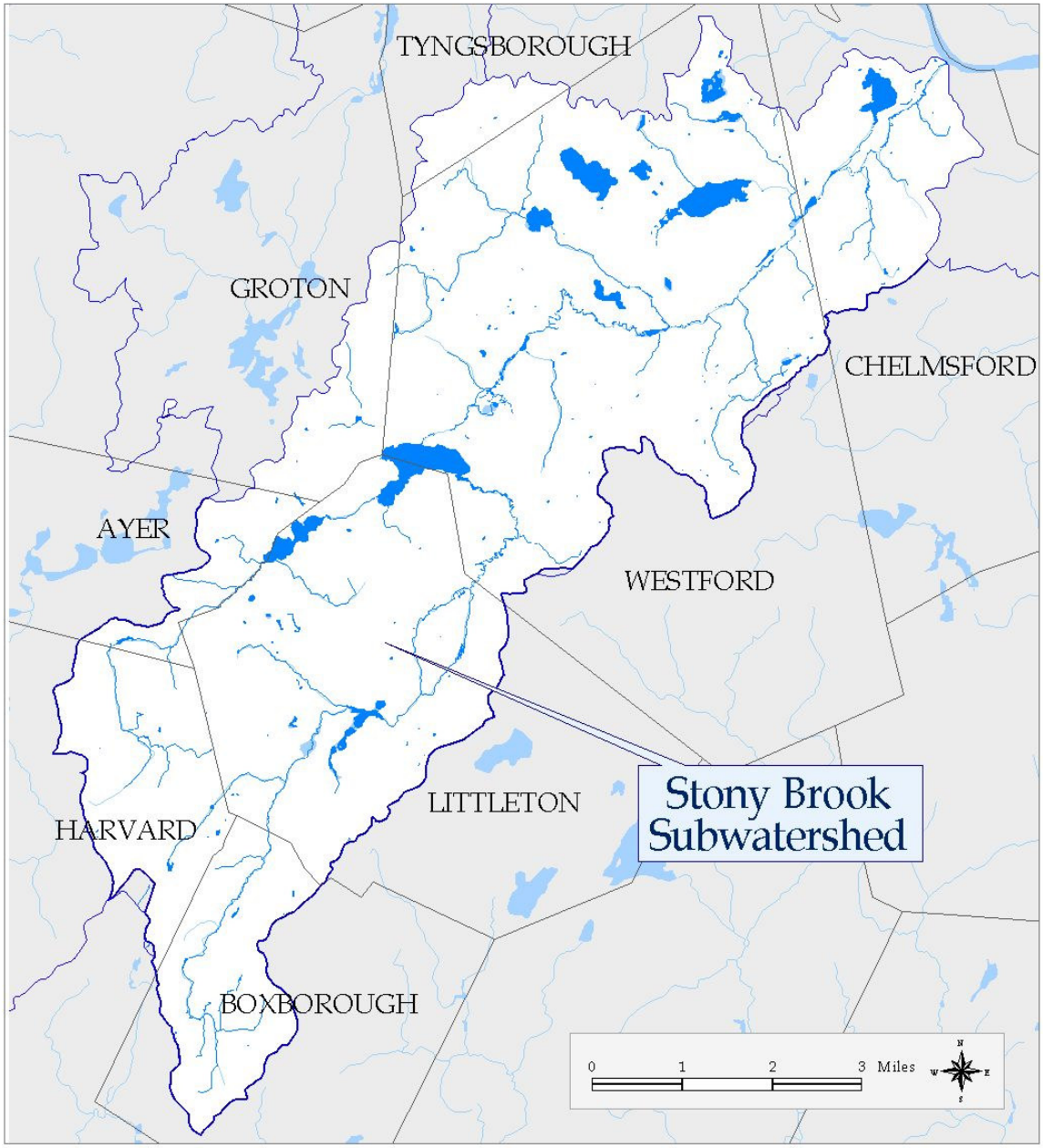
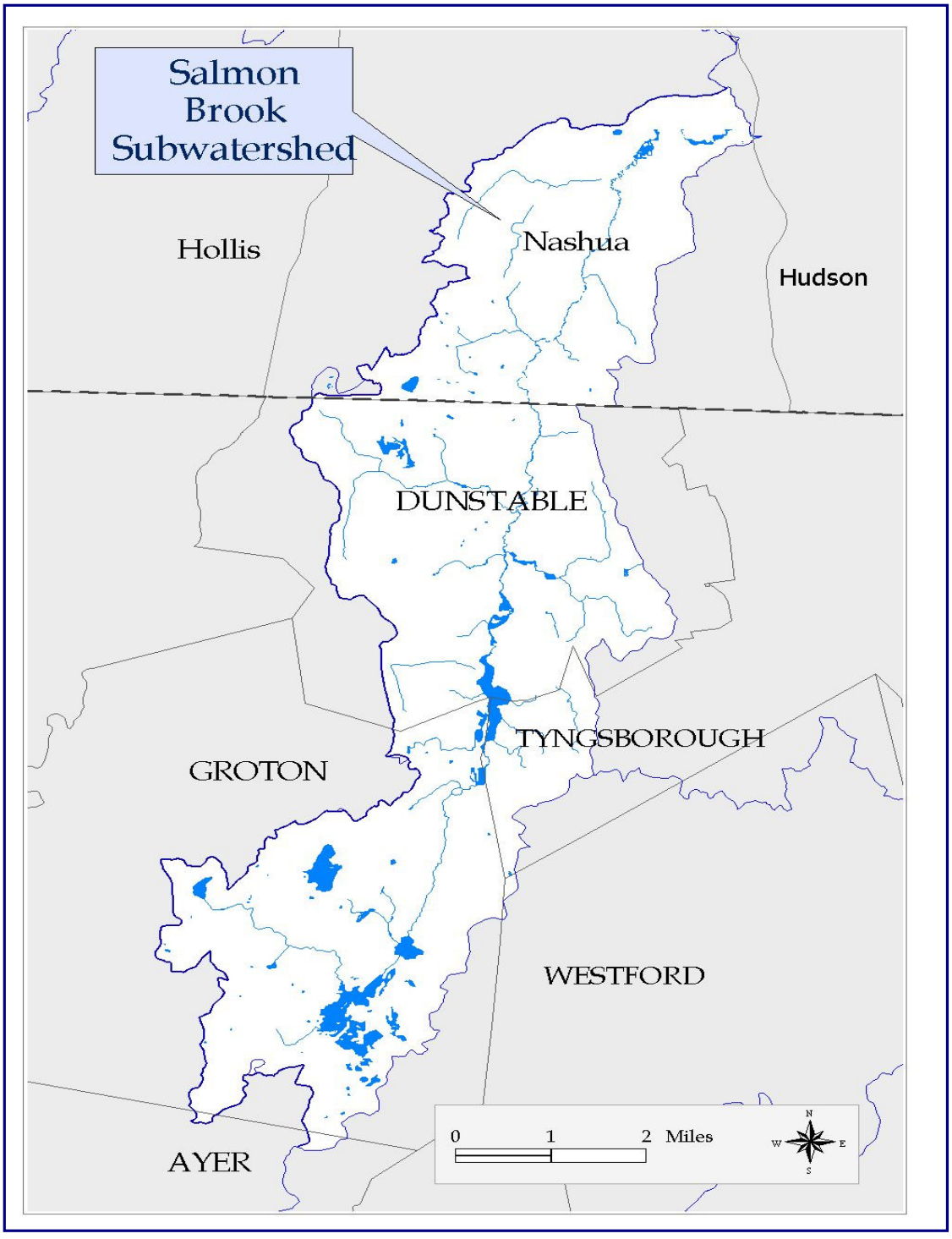


Figure 7

Salmon Brook Subwatershed



Water Quality

Historical Water Quality Monitoring

Monitoring of the Merrimack River during the 1970s and 1980s focused on determining the effects of municipal and industrial wastewater discharges on the river and any improvements made after the construction of wastewater treatment facilities. As water quality problems due to point sources diminished, focus shifted in the 1980s to looking at the effects of chronic discharges of toxic pollutants on water quality of the river as well as nutrient problems, particularly associated with lakes. Beginning in the early 1990s, more wet weather sampling was conducted to assess the effects of nonpoint source pollution in the river, an ever increasing and pervasive problem as the watershed urbanized and as point sources of pollution were eliminated. Other new and innovative water quality sampling methods such as benthic macroinvertebrate and sediment sampling also increased to assess the chronic and less obvious effects of historical pollution in the river. DEP monitoring data from 1974 to 1994 (**DEP unpublished data**) indicate an overall improvement in many conventional pollutants. Suspended solids, ammonia nitrogen, and BOD loads decreased. There is also a decreasing trend for fecal coliform, nitrate nitrogen, and total phosphorous, although they are still relatively high. For a comprehensive list of water quality studies conducted through the mid-1990s, see water quality references. Refer to **314 CMR 4.0 MA Surface Water Quality Standards** for the current classification of waterbodies in the Merrimack watershed and associated criteria.

Current Water Quality Monitoring (1995-2000)

There is little current information on the water quality status of the Merrimack River mainstem, particularly during wet weather events. Recent water quality information for the Merrimack River watershed (EOEA definition) comes from DMF monitoring in the Merrimack River estuary, USGS monitoring at the NAWQA station in Lowell, Souhegan Watershed Association monitoring in Tyngsborough, DEP Fish Toxics Study (final report not released), DWM lake and benthic environmental monitoring (reports not yet available), DEP NPDES Permit Inventory including some monitoring, CSO Planning studies, and CZM's Gulf Watch.

As of the **1998 305(b) Report**, all 50 miles of the Merrimack River from Tyngsborough to the river mouth are listed as non-supporting for Class B waters. Pathogens have been pinpointed as the major cause of water quality problems for the river, coming primarily from the combined effects of CSOs (Lowell, Lawrence, and Haverhill) and urban runoff. Nutrients and ammonia are also listed as stressors along sections of the river, particularly near the major urban centers. Violations of the standards for dissolved oxygen (DO) levels and biochemical oxygen demand (BOD) occur less frequently than they had been historically. A report from the 1960s for the Department of Public Health **(CDM 1963)** indicate that DO levels consistently fell below the 5.0 mg/L standard, often to zero levels. Generally speaking, since the mid- to late-1970s when many of the wastewater treatment plants came on line, DO violations have dropped dramatically. Some violations still occur in periods of drought (**1999 NAWQA Data**) and/or low flow.

The **1994 305(b) Report** also listed pH and metals as causes of non-support for certain stretches

of the Merrimack River. This report was based on 1990 data and, as of the **1998 305(b) Report**, these stressors had been removed from the list. However, it is important to note that, in 1995, when sampling was conducted under the Merrimack River Initiative, there were still dry and wet weather violations of some metals including lead, copper, and zinc along segments of the river from Tyngsborough to Haverhill. Water quality data from the Lowell WWT Facility (**DEP NPDES Inventory 1999**) also show violations of the standards for cadmium, copper, lead, silver, and zinc. Furthermore, a **1996 study by the Environmental Working Group** on toxic discharges indicates that approximately 16,000 pounds of toxic chemicals, including metals, were released to the Merrimack River from 1990-1994. This number does not include toxic chemicals discharged through sewage treatment facilities or the chemicals and/or industries exempt from reporting requirements. The **Gulf of Maine Point Source Inventory (1991)** also documents pollutant discharges into the Merrimack River from various industrial and wastewater sources. Finally, tissue analyses of mussels taken from a monitoring station at the mouth of Merrimack River as part of the **Gulfwatch Program** indicate high levels of metals, in particular cadmium and mercury, coming from local and upstream point source discharges.

Pollution from toxic contaminants, such as metals or organics, is probably more widespread than conventional water quality tests indicate. More sediment and/or fish sampling, where metals and other contaminants accumulate more readily, is needed to determine the true threat posed by historical and current discharges and deposition of pollutants. To date, little sediment sampling has been conducted on the Merrimack River (**DEQE and MVPC 1981**; **MDC 1985**). More recently, fish sampling has occurred in lakes and along river segments as concerns for mercury contamination have increased. These studies confirm the presence of concentrated levels of mercury in fish and point to atmospheric deposition from incinerators and power plants as the major source (**Maietta 1999**). As a result, the Department of Public Health (**DPH 1999**) has issued fish consumption advisories for several local lakes as well as the Merrimack River segment from Tyngsborough to Methuen. A microbiological study was initiated in 1999 by DEP's Wall Experiment Station to document the presence and extent of pathogens and viruses in the Merrimack River mainstem, particularly near water treatment plant intakes. Final results are not yet published and available.

There are several potential non-point sources of pollution in the Merrimack River Watershed that could impact either surface or ground water quality including Superfund sites, hazardous waste sites, landfills both active and closed, incinerators, junkyards, municipal and industrial wastewater dischargers, failing septic systems, CSOs, and USTs. See Attachments 1a-d for the major NPS sources in the watershed and the maps provided at the end of this report for locational information. In 1991, the EPA, through its NPS Program, conducted a Risk Assessment for Merrimack Watershed communities in order to identify those with the greatest risk to water resources from stormwater (NPS) pollution for further evaluation of BMPs that would reduce or mitigate those risks. Newburyport had the greatest risk with a rating of 190, while Dunstable had the lowest risk with a rating of 24 (see Attachment 1e for further details). Unfortunately, the complete report and data are no longer available. EPA has also developed an IWI (Index of Watershed Indicators) score for the Merrimack watershed based on indicators of current condition and future vulnerability and provides back-up data sources for this score (see www.epa.gov/iwi/hucs/01070002/indicators/indindex.html).

Merrimack Mainstem (8450125)

Merrimack River at Tyngsborough (MA84A-01)
The Merrimack River in this section is on the 303(d) list for pathogens. For at least the past three years, the **Souhegan Watershed Association** has monitored the Merrimack River just upstream of the Tyngsborough Bridge. They have consistently monitored *E. coli* bacteria levels, dissolved oxygen, and temperature. Overall, the Merrimack River in Tyngsborough exhibits good to excellent water quality. Temperature and dissolved oxygen generally met the standards. *E. coli* bacteria standards for both NH and EPA were violated occasionally and typically after rainfall events. These violations were attributed to CSOs and stormwater runoff and levels returned to normal by the next monitoring round in the absence of any additional storms.

Merrimack River at Lowell (MA84A-02, MA84A-03)
The Merrimack River in this section is on the 303(d) list for pathogens and nutrients. The source of the most recent water quality information for this segment of the river is the USGS-sponsored **NAWQA station (01100000)**. As part of their assessment of the New England Coastal Basins, several water quality and flow monitoring stations have been established throughout coastal New England including one at Lowell on the Merrimack River just below the Concord River. This station had formerly been monitored for water quality from 1966-1974. Water quality data is available for Water Year 1999, extending from October 1998 to September 1999, on a monthly basis. Another USGS station on the Merrimack River above Lowell (01096550) has water quality records for the period 1969 to 1995. Water sampling is also conducted regularly by the Lowell Water Treatment Plant and Lowell Wastewater Treatment Plant. Some of this data has been made available through DEP's **NPDES Permit Inventory (1997)** and as part of **CSO Planning (1998)**. Full access to this data would help the Merrimack Watershed Team to better assess current conditions and trends along this stretch of the Merrimack River. Lowell Heritage State Park **(1998/1999)** does some additional bacteria monitoring as it relates their local swimming beach.

These groups monitor conventional parameters such as bacteria, dissolved oxygen, BOD, and temperature as well as many other pollutants including metals, nutrients, alkalinity, and pH. Water quality data from Station 01096550 indicate an overall improvement of fecal bacteria levels and dissolved oxygen by the early 1990s. The single record from 1995 shows acceptable readings for bacteria, dissolved oxygen, pH, and turbidity. Water quality data from NAWQA Station 01100000 for Water Year 1999 includes conductivity, pH, temperature, dissolved oxygen, various metals and ions, and nutrients. Bacteria data is not available for these records. Dissolved oxygen dropped below the standard during two sampling weeks of August. At the same time, water temperatures and sodium levels increased above normal. These violations can most likely be attributed to the drought that occurred during the summer of 1999. Manganese, a secondary contaminant, also exceeded the standard intermittently throughout the sampling year.

Data from the Lowell Water and Wastewater Treatment Facility collected during 1997 and submitted as part of **DEP's NPDES Inventory** show violations for some metals at several of the Merrimack River sampling stations. Overall, the data shows that fecal coliform and dissolved oxygen levels were acceptable along the Lowell stretch of the Merrimack River during 1997 with

a maximum reading of 467 colonies/ml measured at the Rt. 93 bridge. Bacteria levels averaged below 100 colonies/ml at all sampling sites for the year. There were some high readings for pH (above 8) at several sampling locations. Data from the Lowell Wastewater Treatment Facility collected during 1998 indicates that bacteria violations were few and levels never exceeded 500 colonies/ml. There were no DO violations, pH was within acceptable limits, and turbidity levels were generally below 6 NTUs with the exception of one high reading on 3/11/98 where levels reached 20 NTUs. Data from 1999 shows few problems with bacteria, DO, turbidity, and pH. It is important to point out that this year was a severe drought year. The data from all years shows violations of several metal standards including cadmium, copper, zinc, lead, and silver. Mercury levels were not monitored as part of these studies. Data collected in 2000 by the Lowell Wastewater Treatment Facility shows similar trends with some improvements in metals violations.

Water quality data from Lowell Heritage State Park for 1998 and 1999 shows consistent recurring problems with bacteria. Levels were often in the thousands in the summer of 1998. These bacteria levels are much higher than those measured by Lowell WWT at their nearby monitoring site below Aiken St. Bridge.

Merrimack River at Lawrence (MA84A-04)

The Merrimack River in this segment is on the 303(d) list for pathogens and nutrients. Some recent water quality data is available from the Greater Lawrence Sanitary District from 1997-1998 as part of **DEP's NPDES Inventory**. This sampling was conducted during both dry and wet weather at two sites on the Merrimack River to assess the effects of CSOs on water quality in the river. GLSD also regularly conducts water sampling of influent and effluent as part of its water and wastewater treatment operations. Complete access to this data would help the Team to better assess current trends and conditions in this segment of the Merrimack River. The data show violations of bacteria on every wet weather sampling run, ranging from a low of 367 colonies/ml to a high of 36,000 colonies/ml. Dry weather sampling showed bacteria levels at less than 100 colonies/ml, well within acceptable limits. Dissolved oxygen levels never fell below the standards. There were also several violations of metal standards during both dry and wet weather sampling, but the total number of violations did decrease during dry weather sampling. The total phosphorous was high during both dry and wet weather sampling.

Merrimack Estuary at Newburyport and Salisbury (MA84A-06)

The Merrimack River in this segment is on the 303(d) list for pathogens. The MA Division of Marine Fisheries has monitored the Merrimack River estuary for several years to assess the health of shellfish areas and recommend and monitor closures. The only parameter that DMF monitors is fecal coliform bacteria in both the water column and shellfish. In 1999, stations sampled by DMF exhibited acceptable bacteria levels on most days (**MA DMF Merrimack River Data**). There were violations on a few occasions with the highest reading of 2500 colonies/ml. Compared to DMF data from 1980 when bacteria levels were more frequently in the thousands, there has been an overall improvement in the Merrimack River estuary. However, the data must be interpreted with some caution as sampling took place only two months of the year during the late winter with an average of 4-6 collection days. Furthermore, on the sampling days when shellfish tissue was also evaluated for bacteria, levels were always higher in shellfish than in water. So, while the estuary meets standards for primary and secondary contact

recreation, current bacteria levels still adversely affect the shellfish population.

Merrimack Tributaries

There is inadequate up-to-date information on the water quality of many tributaries of the Merrimack River. Many of these tributaries are on the 1998 Massachusetts Section 303(d) List of Impaired Waters, but follow-up monitoring to confirm cause and sources of impairment is lacking.

Lawrence Brook, Tyngsborough (8451550, MA84A-20)

Lawrence Brook, from its headwaters to the confluence with the Merrimack River in Tyngsborough, is on the 303(d) List for an unknown toxicity. There is no current water quality data for this waterbody. Qualitative information regarding its general health exists from a **1999 Shoreline Survey** conducted by the Lawrence Brook Stream Team under the direction of the Merrimack River Watershed Council. Survey findings were generally favorable. A good vegetative buffer was found throughout all segments. Some trash and dumping of grass clippings was noted. Other NPS issues, i.e. failing septic systems and road runoff, may be a problem. Prior to this survey, the brook was assessed in 1990 as part of **DEP's RBP Study**. The brook was found to be moderately impaired based on rapid biological monitoring techniques. While the habitat rated excellent, its biological condition did not reflect this and indicated possible water quality problems. However, water quality parameters evaluated on that sampling day showed nothing out of the ordinary. DO was low but still within warm water standards.

Martin's Pond Brook, Groton (8451825, MA84A-19)

Martin's Pond Brook, from the outlet of Martin's Pond to the inlet of Lost Lake in Groton, is on the 303(d) List for siltation, organic enrichment/low DO, and turbidity. There is no current water quality data for this waterbody. A 1999 Shoreline Survey Report for the Salmon Brook watershed included Martin's Pond Brook. Surveyors reported no obvious problems within this segment. A **1990 DEP study** used both conventional water quality monitoring and RBP methods to assess the health of the brook. RBP indicated that the brook was moderately impaired due to both habitat and water quality. Chemical analysis revealed low DO levels.

Salmon Brook, Groton and Dunstable

Salmon Brook is not on the 303(d) List. However, some qualitative information exists for this waterbody as a result of a **1999 RWAT** conducted by the Merrimack River Watershed Council. Findings from visual surveys were positive overall with minor NPS problems noted. A benthic macroinvertebrate survey was also conducted at 3 sites along the brook, but only one site was in Massachusetts. Results are tentative because of the lack of a suitable reference site, but indicate an impaired condition.

Unnamed Tributary (to Beaver Brook), Boxborough and Littleton (8451480, MA84B-01)

This tributary, from the outlet of Wolf Swamp to the inlet of Mill Pond in Littleton, is on the 303(d) List for nutrients, pH, organic enrichment/low DO, pathogens, and suspended solids. Limited water quality data is available from a **MRWC 2000 RWAT study** (currently unpublished). Two sampling rounds show high bacteria and low DO levels. Prior to this, in 1995, the former Stony Brook Watershed Association, assisted by DEP, conducted a watershed-

wide study (**SBWA 1995**).

Beaver Brook, Boxborough and Littleton (8451475, MA84A-02)

Beaver Brook, from the outlet of Mill Pond to the inlet of Forge Pond in Westford, is on the 303(d) List for nutrients, pH, organic enrichment/low DO, pathogens, and suspended solids. Limited water quality data is available from a **MRWC 2000 RWAT study** (currently unpublished). Two sampling rounds show high bacteria and low DO levels. Prior to this, in 1995, the former Stony Brook Watershed Association, assisted by DEP, conducted a watershed-wide study (**SBWA 1995**).

Stony Brook, Westford and Chelmsford (8451200, MA 84B-03)

Stony Brook, from Concord Rd. to Chamberlin Rd. in Westford, is on the 303(d) List for pH, organic enrichment/low DO, pathogens, and turbidity. Limited water quality data is available from a **MRWC 2000 RWAT study** (currently unpublished). Two sampling rounds suggest that this Stony Brook segment continues to have a problem with elevated bacteria and low DO levels. Prior to this, in 1995, the former Stony Brook Watershed Association, assisted by MA DEP, conducted a watershed-wide study (**SBWA 1995**).

Stony Brook, Westford and Chelmsford (8451200, MA84B-04)

Stony Brook, from Chamberlin Rd. in Westford to the confluence with the Merrimack River, is on the 303(d) List for nutrients, pH, and pathogens. Limited water quality data is available from a **MRWC 2000 RWAT study** (currently unpublished). Two sampling rounds show acceptable DO levels, but elevated bacteria levels. A 1999 biological assessment conducted by DEP (**Fiorentino 2001**) at a site in Stony Brook indicates that habitat conditions within the brook are good but the benthic community is slightly impacted, most likely due to organic enrichment. Prior to this, in 1995, the former Stony Brook Watershed Association, assisted by DEP, conducted a watershed-wide study (**SBWA 1995**).

Beaver Brook, Dracut and Lowell (8451075, MA 84A-11)

Beaver Brook, from the NH state line to the confluence with the Merrimack River in Lowell, is on the 303(d) List for pathogens. One recent source of water quality data for Beaver Brook is the Lowell Regional Wastewater Utility. They monitor a site on the brook in Lowell on an ongoing basis because it receives CSO discharges. Data is available for the years 1997 to 1999 (**Merrimack River Water Quality Report 1998 and 1999; DEP NPDES Inventory 1999**). 1997 data indicates that there were bacteria violations during wet weather events, yet these were not extreme. There were also violations of metal standards for cadmium, copper, lead, silver, and zinc. Monthly sampling on Beaver Brook in 1998 shows instances of high turbidity and alkalinity. There were violations of the standards for bacteria, cadmium, copper, lead, and zinc. Data from 1999 shows similar violations of bacteria and metals. The DO standard was violated on one sampling date in August, presumably because of the severe drought and low flow. A 1999 biological assessment conducted by DEP (**Fiorentino 2001**) at a Beaver Brook site in Dracut indicates that habitat degradation within the brook impacts the benthic community as well as organic enrichment from upstream impoundments.

Richardson/Trout Brook, Dracut (8451025, MA84A-12)

Richardson Brook, from its headwaters to the confluence with the Merrimack River, is on the

303(d) List for noxious aquatic plants and other habitat alterations. The most recent data that exists for Richardson Brook and its tributary, Trout Brook, is from a **1990 DEP survey**. Conventional water quality monitoring at both Richardson and Trout Brook showed nothing out of the ordinary, however one sampling event is probably not representative of ongoing episodic problems in the brook. Furthermore, no samples were taken for fecal bacteria levels. Rapid biological monitoring (RBP) was also conducted on both brooks. This monitoring indicated that Richardson Brook was moderately impaired, while Trout Brook was non-impaired. There was a permitted discharge on Trout Brook (NPDES Permit #MA0022225) from the Exxon Company Dracut Storage Facility, so sampling for petroleum hydrocarbons was conducted. None were detected in the sample. According to a recent **DEP NPDES Inventory (1999)**, this permitted discharge no longer exists.

Black Brook, Chelmsford and Lowell (8451175, MA84A-17)

Black Brook, from its headwaters to its confluence with the Merrimack River, is on the 303(d) List for unknown toxicity, siltation, pathogens, and turbidity. Recent data for the brook comes from monitoring by the Lowell Wastewater Treatment Facility. Data is available for the years 1997 to 1999 (**Merrimack River Water Quality Report 1998 and 1999; DEP NPDES Inventory 1999**). 1997 data shows that there were bacteria violations during wet weather events. There were also violations of metal standards for copper and zinc, while alkalinity and iron levels were very high compared to other sites monitored. Monthly sampling on Black Brook in 1998 shows instances of high BOD, turbidity, and alkalinity. There are violations of the standards for bacteria, DO, cadmium, copper, lead, and zinc. Data from 1999, a severe drought year, shows a similar pattern. A **1990 DEP study** examined the health of Black Brook using RBP and conventional water quality monitoring. The water quality data shows slightly elevated bacteria levels and low DO levels. Concentrations of ammonia, phosphorous, chloride, and some metals were also elevated. Rapid biological monitoring indicated that the two sites on Black Brook were moderately impaired. The major cause of impairment for the first (Westford St. bridge, Lowell) of the two sites was runoff from a nearby landfill. That landfill is now closed and has been capped and lined. The second site (Mt. Pleasant Golf Course, 2nd Tee, Lowell) had better habitat but was still impaired. The cause of impairment was not determined at the time, although one suggested possibility was the adjacent golf course.

Deep Brook, Dunstable and Chelmsford (8451550, MA84A-21)

Deep Brook, from its headwaters to the confluence with the Merrimack River in Chelmsford, is on the 303(d) List for unknown toxicity, siltation, organic enrichment/low DO, and pathogens. There is no current water quality data for this waterbody. A **1990 DEP study** used both conventional water quality monitoring and RBP methods to assess the health of the brook. RBP determined that the brook was moderately impaired partly due to habitat, but also probably due to water quality. The DO level was below the standard, bacteria levels were slightly elevated, and chloride was higher than expected. Wet weather monitoring was recommended, but has never been done.

Trull Brook, Tewksbury (8451000, MA84A-14)

Trull Brook, from its headwaters to the confluence with the Merrimack River in Tewksbury, is on the 303(d) List for an unknown toxicity. There is no current water quality data for this waterbody. A **1990 DEP study** used RBP methods to assess the health of the brook.

Conventional water quality monitoring was not conducted. The RBP assessment determined that the two sites on Trull Brook were moderately impaired and probably related to water quality since habitat was rated good to excellent. There were no water quality measures to support or contradict RBP findings. Trull Brook flows through the Trull Brook Golf Course.

Spicket River, Methuen and Lawrence (8450800, MA84A-10)

The Spicket River, from NH line to confluence with the Merrimack River, is on the 303(d) List for pathogens, metals, and nutrients. There are four recent data sources with water quality information for the Spicket River. Benthic invertebrate surveys of the Spicket River in Lawrence, Massachusetts were conducted by GenCorp, Inc. to assess any potential detrimental effects of a raceway on the lower river segment (**Aquatic Resources Center 1996, 1997, 1998a, 1998b**). Five sites were sampled on the Spicket River, one in Methuen and four near the confluence with the Merrimack River. Based on habitat assessments, the report concluded that most of the sites should support a healthy benthic community. Benthic assessments indicated that most sites were moderately to severely affected. The upstream site in Methuen was slightly to moderately affected. A 1999 biological assessment conducted by DEP (**Fiorentino 2001**) at a Spicket River site in Lawrence indicates that, while habitat constraints exist within the river, the benthic community is not impacted.

Some water quality data exists from dry weather monitoring by GLSD at two sites on the Spicket River as part of their CSO Monitoring Program (**DEP NPDES Inventory 1999**). Both sites showed violations of fecal bacteria standards on the date they were sampled. DO, pH, and BOD fell within acceptable limits. The upstream Spicket River site violated the water quality standard for zinc. The Merrimack River Watershed Council conducted water quality sampling on the river in 1995 as part of a volunteer monitoring program (unpublished data) and in 1997 and 1998 as part of Section 319 and 104(b)3 funded projects (**MRWC 1999a and b**). Data from both 1995 and 1997 indicated problems with high bacteria levels along much of the river in Methuen and Lawrence. Monitoring was also done in 1997 and 1998 to assess the effectiveness of filters for "cleaning" stormwater at select catch basins. The data collected indicates that, at these catch basins, copper, lead, and suspended solids are at high levels in stormwater.

Bare Meadow Brook, Methuen (8450750, MA84A-18)

Bare Meadow Brook, from its headwaters to the confluence with the Merrimack River, is on the 303(d) List for siltation, organic enrichment/low dissolved oxygen, pathogens, and turbidity. Current water quality data comes from monitoring by the Bare Meadow Brook Stream Team in 1999 and 2000 under the direction of MRWC. Six sampling rounds from June to November 2000 at 3 sites confirm problems with high bacteria levels and low dissolved oxygen. Turbidity is consistently high at one site. A **1990 DEP study** used both conventional water quality monitoring and RBP methods to assess the health of the brook. RBP found one site to be moderately impaired. The other site, because of habitat constraints, could not be evaluated with RBP. Chemical analysis indicated problems with high turbidity and solids, elevated nutrient levels, and low dissolved oxygen.

Johnson Creek, Groveland (8450550, MA84A-15)

Johnson Creek, from its headwaters to the confluence with the Merrimack River, is on the 303(d) List for siltation. There is no current water quality information for this waterbody. A **1990 DEP**

study used both conventional water quality monitoring and RBP methods to assess the health of the creek. RBP found both sites monitored to be unimpaired. Water quality analysis also showed no impairment. In fact, the study recommends that the creek be used as a reference site for the area. The Groveland Wells Superfund site is within the watershed of Johnson Creek.

Little River, Haverhill (8450575, MA84A-09)

The Little River, from NH line to confluence with the Merrimack River, is on the 303(d) List for pathogens. The most recent data comes from a study by the Merrimack River Watershed Council **(1997 Little River Report)** and indicates that bacteria counts as well as dissolved oxygen levels are acceptable along the river segment in Haverhill. However, the study does point out that there was very little rainfall during the 1997 summer season limiting the assessment of runoff and other non-point source pollution impacts on the river.

Cobbler's Brook, Merrimac (8450500, MA84A-22)

Cobbler's Brook, from its headwaters to the confluence with the Merrimack River, is on the 303(d) List for an unknown toxicity. It had also been listed as threatened for pathogens and turbidity, which were recently removed. Current water quality data comes from monitoring by MA DEP in 1999 and by the Cobbler's Brook Stream Team in 1999 and 2000 under the direction of MRWC. Six sampling rounds from June to November 2000 at 4 sites indicate problems with high bacteria levels, typically higher after storm events. DO and turbidity levels are generally acceptable. However, two sites exhibited high turbidity on one sampling date. A 1999 biological assessment conducted by DEP (**Fiorentino 2001**) at a site in Cobbler's Brook indicates that, while habitat conditions are better than the established reference site, the benthic community is slightly impacted, possibly due to organic enrichment. A previous **1990 DEP study** used both conventional water quality monitoring and RBP methods to assess the health of the brook. RBP indicated that the brook was moderately impaired. Chemical analysis showed no problems, however the DO sample was lost and could not be evaluated.

Powow River, Amesbury (8450300, MA84A-07/08)

The Powow River, from the inlet of Lake Gardner to the tidal portion, is on the 303(d) List for pathogens. From the tidal portion to its confluence with the Merrimack River, it is listed for pathogens, suspended solids, noxious aquatic plants, and turbidity. Current water quality information exists from monitoring by the Powow River Watershed Association during 1999 and 2000 (**PRWA Data 2000**). The group monitors DO, turbidity, pH, and nutrient levels. The Powow River was last assessed in 1986 by DEP. The Amesbury Water Treatment Plant monitors water quality on the Powow River at a site upstream from its water supply intake. Parameters include turbidity, pH and fecal coliform.

Back River, Amesbury (8450325, MA 84A-16)

The Back River, from the NH Line to the confluence with the Powow River, is on the 303(d) List for siltation, pathogens, and turbidity. Some water quality monitoring has been conducted by **PRWA**. It was assessed in 1990 by DEP. RBP determined that the river was moderately impaired and was most likely due to water quality. Water quality sampling showed high bacteria levels and moderate levels of nutrients, solids, and turbidity. The study concluded that more sampling was needed.

There are several other rivers and streams in the Merrimack watershed that have not been

monitored to any extent by an organized group or state agency. See Attachment 1f for a complete list of rivers and streams in the watershed. See Attachment 1g for a list of impaired waterbodies on the 303(d) List in the watershed and accompanying map for the locations of these waterbodies.

Lakes/Ponds

Artichoke Reservoir, W. Newbury and Newburyport

This is a water supply reservoir for the city of Newburyport. Any recent water quality data for this waterbody comes from sampling by the local water department and yearly Drinking Water Quality Reports.

Mill Pond, W. Newbury (MA84039)

Mill Pond is on the 303(d) List for nutrients, siltation, and noxious aquatic plants. There is no current water quality data. However, a restoration project is underway to mitigate the above problems through dredging and the manual removal of weeds. The Mill Pond Committee of West Newbury is overseeing this project.

Lake Attitash, Amesbury and Merrimac (MA84002)

Lake Attitash is on the 303(d) List for noxious aquatic plants. Recent water quality information exists from the 1999 Lake Attitash Watershed Management Plan conducted by CDM for the Town of Amesbury as part of a DEM Lake and Pond Grant. The Lake Attitash Association also has water quality data for the lake from their ongoing monitoring from 1994 to the present. Water quality data collected and reviewed by CDM indicate that there are high levels of chlorophyll a and phosphorous as well as episodic problems with elevated bacteria levels at most sampling sites. While only one of the sites met the Class A (drinking water) water quality standard for fecal coliform in 1998, most met the Class B (fishing and swimming) water quality standard. Dissolved oxygen profiles show anoxic conditions at the bottom of the lake in 1998. Comparison to a 1977/1978 Lake Attitash Water Quality Study by MA DEQE (now DEP) indicates that water quality of the lake has declined over time. Furthermore, as of 1999, the lake is on the Fish Consumption Advisory List (DPH 1999) for elevated mercury levels in all fish species.

Tuxbury and Meadowbrook Ponds, Amesbury

Water quality information is available for these waterbodies from the Powow River Watershed Association for the years 1999 and 2000. Nutrient levels (nitrogen and phosphorous) are monitored in both ponds. Dissolved oxygen levels, turbidity, and pH are also measured at this site and are generally within acceptable levels.

Bailey Pond, Amesbury

Bailey Pond is listed as a Tier 1B hazardous waste site by DEP. Elevated levels of mercury are present from historical industrial processes. Site remediation is in progress.

Johnson's Pond, Groveland

There is no current water quality data for this waterbody. It is on the Fish Consumption Advisory List (DPH 1999) for elevated mercury levels in all fish species.

Frye Pond, Haverhill
No recent water quality data is available.

Millvale Reservoir, Haverhill
The reservoir is a water supply source for the city of Haverhill. Recent water quality data comes from sampling from the local water department and yearly Drinking Water Quality Reports. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in all fish species.

Kenoza Lake, Haverhill
The lake is a water supply source for the city of Haverhill. Recent water quality data comes from sampling by the local water department and yearly Drinking Water Quality Reports. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in all fish species.

Lake Saltonstall, Haverhill
There is no current water quality data for this waterbody. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in largemouth bass.

Lake Pentucket, Haverhill
The lake is a water supply source for the city of Haverhill. Recent water quality data comes from sampling by the local water department and yearly Drinking Water Quality Reports. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in all fish species.

Crystal Lake, Haverhill
The lake is a water supply source for the city of Haverhill. Recent water quality data comes from sampling by the local water department and yearly Drinking Water Quality Reports. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in all fish species.

Chadwick Pond, Haverhill and Boxford
There is no current water quality data for this waterbody. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in all fish species.

Lake Cochichewick, N. Andover
The lake is a water supply source for the town of North Andover. Recent water quality data comes from sampling by the local water department and yearly Drinking Water Quality Reports. In 1992, the lake experienced problems with blue-green algal blooms that had the potential to produce toxins dangerous to humans. It was determined that external sources of phosphorous were getting into the lake and causing the blooms. The town has made efforts to curtail these problems with the development of a Watershed Protection District and implementation of a land acquisition program. The lake is also on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in all fish species.

Haggett's Pond, Andover
The pond is a water supply source for the town of Andover. Recent water quality data comes from sampling by the local water department and yearly Drinking Water Quality Reports. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in all fish species.

Forest Lake, Methuen (MA84014)
Forest Lake is on the 303(d) List for noxious aquatic plants. There is no current water quality information for this waterbody. It is on the Fish Consumption Advisory List (**DPH 1999**) for elevated mercury levels in largemouth bass.

Spectacle Pond, Littleton
Spectacle Pond was recently removed from the 303(d) List as it is impaired solely by the presence of non-native aquatic plant species. DEP determined that this is not a pollutant for which a TMDL can be calculated. There is no current water quality data available.

Mill Pond, Littleton (MA84038)
Mill Pond is on the 303(d) List for noxious aquatic plants. There is no current water quality data for this waterbody. However, a restoration project is underway to address the weed problem.

Forge Pond, Westford/Littleton
Forge Pond was removed from the 303(d) List as it is impaired solely by non-native aquatic plants and, according to DEP, it is not a pollutant for which a TMDL can be developed. There is no current water quality data for this waterbody. The town recently received funding from MA Clean Lakes Program to develop a management plan for the lake and to implement a drawdown to remove oxygen deficient water from the lake bottom.

Newfield Pond (Freeman Lake), Chelmsford (MA84046)
Newfield Pond is on the 303(d) List for organic enrichment/low DO. There is no current water quality data for this waterbody. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in largemouth bass.

Lost Lake/Knopps Pond, Groton (MA84084)
These ponds are on the 303(d) List for noxious aquatic plants. Some water quality data exists from a drawdown study by the town as the result of an ACOE from DEP. It is suspected that septic failures are producing the weed growth. The Groton Lakes Association hopes to establish a monitoring program by 2001 (Robert Watson, pers. communication).

Massapoag Pond, Groton, Dunstable and Tyngsborough (MA84087)
Current water quality data exists from monitoring by Massapoag Pond Rod & Gun Club. The group has collected information on phosphorous levels, pH, and dissolved oxygen levels since 1991 (Nancy Todd, pers. communication). Dissolved oxygen levels were low on the one date sampled in each year.

Flint Pond, Tyngsborough (MA84012)
Flint Pond is on the 303(d) List for metals and noxious aquatic plants. There is no current water

quality data for this waterbody. The pond and associated wetlands are located within close proximity of a Superfund site, the Charles George landfill. It is on the Fish Consumption Advisory List (**DPH 1999**) for elevated mercury levels in all fish species.

Locust Pond, Tyngsborough

There is no current water quality data available for this waterbody.

Long Pond, Tyngsborough and Dracut (MA84032)

Long Pond is on the 303(d) List for noxious aquatic plants. There is no current water quality data for this waterbody. In 1995, the town received a Lake & Pond Grant for chemical weed control on the pond. It is on the Fish Consumption Advisory List **(DPH 1999)** for elevated mercury levels in all fish species.

Recommendations

Based on the preceding information and data, remaining water quality needs for the watershed include:

- Up-to-date water quality data for the 303(d) listed waterbodies
- Assessment of current condition and water quality status for waterbodies not on the 303(d) list
- Sediment sampling to determine extent of contamination in river, stream, lake sediments
- Chronic microtoxicity testing to evaluate actual extent and impacts of contaminants from major NPDES dischargers
- Increased biomonitoring in the watershed
- Assessment of bioaccumulation of contaminants in aquatic species relative to the biological health of the system
- Relative effects of CSOs vs. stormwater on water quality in the mainstem
- More stormwater sampling on mainstem and tributaries
- TMDLs for impaired waterbodies, i.e. assessment of maximum amount of pollution a waterbody can accommodate before water quality standards are violated
- Standardization with New Hampshire sampling protocols, i.e. the use of *E. coli* as an indicator
- Additional fixed water quality monitoring stations on the mainstem
- Stricter enforcement of NPDES discharges to reduce pollution inputs, particularly metals and organic chemicals
- DEP acceptance of volunteer monitoring data through a formal MOU
- Development of a QAPP template for streamlined use by volunteer monitoring groups

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  -Bacteria data for Merrimack River at Tyngsborough
Gulf Watch (CZM)
  -Mussel monitoring
Merrimack College Applied Health Program
  -1997/1998 Wet Weather Bacteria Study
Annual Drinking Water Quality Reports
Monitoring data from MRWC Stream Teams: Cobbler's Brook, Bare Meadow Brook, Stony Brook
Monitoring data from other monitoring groups: PRWA, Massapoag Rod & Gun Club

Attachment 1a-NPDES Permits

Current[1] NPDES Permits in the Merrimack River Watershed								
Name	Town	Address	Type	Size	Permit No.	Issue Date	Discharge	Receiving Water
Amesbury WWTF	Amesbury	19 Merrimac St.	Municipal	major	MA0101745	3/28/85	wastewater, industry	Merrimack & Back Rivers
Amesbury WTP	Amesbury	Newton Rd.	Municipal	minor	MA0102822		filtered backwash	Powwow River
Valley Manuf. Products	Groveland	64 Washington St.	Industrial	minor	MA0102661		remediated groundwater	Johnson Creek
Haverhill WWTF	Haverhill	40 S. Porter St.	Municipal	major	MA0101621	9/26/90	wastewater, industry	Merrimack & Little Rivers
Haverhill Paperboard	Haverhill	S. Kimball Rd.	Industrial	minor	MAG250961		non-contact cooling	Merrimack River
Ogden Martin Systems	Haverhill	Route 125	Industrial	minor	MA0031950		stormwater	Merrimack River
GLSD	Lawrence	Charles St.	Municipal	major	MA0100447	8/2/83	wastewater, industry	Merrimack River
Newark Atlantic Paperboard (forme	Lawrence	9 S. Canal St.	Industrial	minor	MAG250813	10/24/97	non-contact cooling	Merrimack River
Gencorp (Diversitech General)	Lawrence	70 General St.	Industrial	minor	MA0003824	7/23/92	stormwater, groundwater infiltratio	Spicket River
Lawrence Hydro	Lawrence	9 S. Broadway	Industrial	minor	MAG250948		non-contact cooling	Merrimack River
Lawrence Water Dept.	Lawrence	Water St.	Municipal	minor	MA0001066		filtered backwash	Merrimack River
Ferrous Technology	Lawrence	Island St.	Industrial	minor	MA0020095		non-contact cooling	Merrimack River
Lowell WTF	Lowell	Pawtucket St.	Industrial	minor	MA0005452		filtered backwash	Merrimack River
Lowell WWTF	Lowell	First St. Blvd, Route 1	Municipal	major	MA0100633	8/14/97	wastewater, industry	Merrimack River
Boott Hydro Power	Lowell	John St.	Industrial	minor	MAG250950		non-contact cooling	Merrimack River
		Eldred Field	Industrial	minor	MAG250163		non-contact cooling	Merrimack River
		Hamilton	Industrial	minor	MAG949		non-contact cooling	Merrimack River
Lowell National Park	Lowell	169 Merrimack St.	Industrial	minor	MAG250732		non-contact cooling	Merrimack River
Majilite MFG, Inc.	Lowell	Whipple St.	Industrial	minor	MA0032506		general permit	Merrimack River
UAE Lowell Power	Lowell		Industrial	minor	MA0033201		stormwater	River Meadow Brook
Merrimac WWTF	Merrimac	Federal Way	Municipal	major	MA0101150	2/5/86	wastewater, industry	Merrimack River
Merrimac WTP	Merrimac	W. Main St.	Municipal	minor	MA0103179		filtered backwash	Merrimack River
Lucent Tech.	N. Andover	1600 Osgood St.	Industrial	major	MA0001261	7/29/96	wastewater, non-contact cooling	Merrimack River
N. Andover Emer. Overflow	N. Andover	384 Osgood St.	Industrial	minor	MA0103217		remediated groundwater	Lake Cochichewick
Gould Electronics	Newburyport	374 Merrimac St.	Industrial	major	MA0000281	9/18/97	process wastewater, non-contact	Merrimack River
Newburyport WWTF	Newburyport	157 Water St.	Municipal	major	MA0101427	9/17/91	wastewater, industry	Merrimack River
Newburyport WTP	Newburyport	Water St.	Municipal	minor	MA0023094		filtered backwash, stormwater	Merrimack River
Salisbury WWTF	Salisbury	187 Elm St.	Municipal	major	MA0102873	10/2/97	wastewater, industry	Tidal Creek to Merr. River
Salisbury WTP	Salisbury	Hampton, NH	Municipal	minor	MA0025038		filtered backwash	Black Rock Creek
Tewksbury WTP	Tewksbury	408 River Rd.	Municipal	minor	MA0102954		filtered backwash	Merrimack River

[1] DEP data 3/01 (changes often)

Attachment 1b-Tier 1 Sites

Tier 1[1] Sites in the Merrimack Watershed[2]						
Town	Address	Site Name	Site ID	Type	Status	Pollution
Amesbury	Haverhill Rd. (Route 110)	Microfab, Inc.	3-0000201	Tier 1A	Phase 2	VOCs
Amesbury	77 Merrimac St.	Bailey Pond Parcel	3-0000204	Tier 1B	Phase 4	mercury
Amesbury	37 Friend St.	Property	3-0002855	Def Tier 1B	Phase 1	petroleum/VOCs
Amesbury	Merrimac St.	Merrimac Hat (FMR)	3-0001615	Def Tier 1B	Phase 1	mercury
Amesbury	Merrimac St.	Hat Factory Sediments	3-0003173	Def Tier 1B	Phase 1	
Chelmsford	188 Princeton St.	Shell Service Station	3-0002098	Tier 1C	Phase 3	gasoline
Chelmsford	11 School St.	Nyes Japenamelac	3-0000049	Def Tier 1B	Phase 5	petroleum/chlorinated solvents
Dracut	Broadway Rd.	Property	3-0001069	Def Tier 1B	Phase 1	VOCs
Dracut	2060 Bridge St.	Vehicle Repair Garage	3-0004651	Def Tier 1B	Phase 1	oil
Dracut	290 Salem Rd.	unknown	3-0017436	Def Tier 1B	Phase 1	oil
Groton	37 Gilson Rd.	Groton Screw Machine	2-0000223	Tier 1A	Phase 2	VOCs
Groveland	Johnson Creek Watershed	Groveland Wells Site*	3-0000321	Tier 1A	Phase 3	VOCs
Haverhill	81 Hale St.	Haverhill Salvage	3-0000325	Tier 1B	Phase 1	PCBs
Haverhill	Old Groveland Road	Haverhill Landfill*	3-0000324	Tier 1A	Phase 2	organics/metals
Haverhill	Broadway and Hilldale Ave.	Lafayette St.	3-0011347	Def Tier 1B	Phase 1	oil
Haverhill	104 Essex St.	Accelerated Circuits	3-0000328	Def Tier 1B	Phase 1	
Haverhill	57 Granite St.	Quality Tire	3-0011439	Def Tier 1B	Phase 1	oil
Haverhill	57 Granite St.	Quality Tire	3-0000642	Def Tier 1B	Phase 1	oil
Haverhill	504 Groveland St/Orchard St.	Dry cleaning (FMR)	3-0001259	Def Tier 1B	Phase 1	petroleum
Haverhill	106 Hale St.	Collins Oil	3-0003003	Def Tier 1B	Phase 1	oil
Haverhill	13-17 Locust St.	Winchell Bldg.	3-0012494	Def Tier 1B	Phase 1	oil
Haverhill	near 285 South River View St.	Avco Rd. Ind. Park	3-0011424	Def Tier 1B	Phase 1	haz
Haverhill	205 Water St.	Cleary Cleaners	3-0002324	Def Tier 1B	Phase 1	haz
Lawrence	70 General St.	GenCorp	3-0000340	Tier 1B	Phase 2	PCBs, metals
Lawrence	Hudson, Oregon, & Lawrence A	Tower Hill	3-0000342	Tier 1A	Phase 2	petroleum
Lawrence	46 Stafford St.	Malden Mills Industries	3-0000728	Tier 1C	Phase 2	petroleum, VOCs
Lawrence	55 Marston St.	Lawrence Gas Mfg.	3-0000341	Tier 1B	Phase 4	
Lawrence	Canal St.	Canal St. Area	3-0000339	Def Tier 1B	Phase 1	organics/napthalene
Lawrence	21 Canal St.	Paper Mill (FMR)	3-0002691	Def Tier 1B	Phase 1	oil
Lawrence	665 Haverhill St.	Larry's Service	3-0013008	Def Tier 1B	Phase 1	oil/haz
Lawrence	246 Lawrence St.	No location aid	3-0010319	Def Tier 1B	Phase 1	oil
Lawrence	Market St.	Bolton-Emerson	3-0000055	Def Tier 1B	Phase 4	organics

Tier 1[1] Sites in the Merrimack Watershed[2]						
Town	Address	Site Name	Site ID	Type	Status	Pollution
Lawrence	Market St./Parker St.	No location aid	3-0012312	Def Tier 1B	Phase 1	oil
Lawrence	111 May St.	Dalrymple Oil Co.	3-0002499	Def Tier 1B	Phase 1	#2 fuel oil
Lawrence	566 Broadway	Bldg 25	3-0011604	Tier 1C	Phase 4	haz
Lawrence	39 South Canal St.	FMR Polycraft Bldg	3-0014863	Tier 1C	Phase 1	haz
Lawrence	101 Union St.	Hilton Oil	3-0014888	Tier 1C	Phase 1	haz/oil
Lowell	261 & 295 Broadway	Lowell DPW Facility	3-0013249	Tier 1C	Phase 2	haz/oil
Lowell	Broadway & Dummer St.	Holy Trinity Comm. Ctr.	3-0000355	Def Tier 1B	Phase 4	petroleum/organics
Lowell	125 Church St.	Zayre Store	3-0002798	Def Tier 1B	Phase 1	petroleum/virgin oil
Lowell	774 Dutton St.	Property	3-0002629	Def Tier 1B	Phase 1	haz/oil
Lowell	Flemming St.	Daley School	3-0000092	Def Tier 1B	Phase 1	oil
Lowell	70 French & Armory Sts.	Gasoline Station (FMR)	3-0001975	Def Tier 1B	Phase 1	oil
Lowell	1317 Middlesex	Basbanes Linen	3-0003633	Def Tier 1B	No phase	oil
Lowell	246.1 Market St.	Boott Mills Steam Plant	3-0004561	Def Tier 1B	Phase 2	oil
Lowell	43 Lakeview Ave.	Starr Realty Property	3-0000852	Def Tier 1B	Phase 1	oil
Lowell	1465 Middlesex St.	Gasoline Station	3-0002044	Def Tier 1B	Phase 1	oil
Lowell	Varnum Ave.	Bedford Estates	3-0001056	Def Tier 1B	Phase 1	
Lowell	224 Walker St.	Property	3-0002756	Def Tier 1B	Phase 2	gasoline
Lowell	Westford St.	Intersection of Technology	3-0011528	Def Tier 1B	Phase 1	haz/oil
Lowell	1264 Westford St.	Parcels D & X	3-0014240	Def Tier 1B	No phase	haz
Lowell	Pevey St. @ Arlene St.	No location aid	3-0014250	Def Tier 1B	No phase	oil
Lowell	290 Westford St.	No location aid	3-0017559	Def Tier 1B	No phase	oil
Lowell	68 Arch St.	No location aid	3-0017756	Def Tier 1B	No phase	oil
Lowell	479 Broadway	No location aid	3-0017804	Def Tier 1B	No phase	oil
Lowell	50 Arcand Dr.	No location aid	3-0018004	Def Tier 1B	No phase	oil
Lowell	530 Stevens St.	Lowell Catholic HS	3-0018665	Def Tier 1B	No phase	oil
Methuen	38 Kirk St.	Automotive Shop	3-0000111	Def Tier 1B	Phase 2	petroleum/VOCs
Methuen	7 Lowell St.	Appleyard Trucking	3-0010894	Def Tier 1B	Phase 1	oil
Methuen	7 Lowell St.	Appleyard Trucking	3-0003382	Def Tier 1B	Phase 1	petroleum/gasoline
Methuen	54 Osgood St.	Bullseye/FMR Precise Circ	3-0010447	Def Tier 1B	Phase 1	haz/oil
Methuen	27 Center St.	D & D Transmission	3-0004130	Def Tier 1B	No phase	haz/oil
Methuen	45 Haverhill St.	Commercial Property	3-0004215	Def Tier 1B	No phase	oil
Methuen	Behind 39 Oakland Ave.	Perfection Auto Radiator	3-0004482	Def Tier 1B	No phase	oil
Methuen	Rt. 93	Pelham St. Exit Ramp	3-0015420	Def Tier 1B	No phase	haz
Methuen	75 Swan St.	No location aid	3-0015512	Def Tier 1B	No phase	oil
Methuen	551 Broadway	Mobil NH/MA State line	3-0016876	Def Tier 1B	No phase	oil

Tier 1[1] Sites in the Merrimack Watershed[2]						
Town	Address	Site Name	Site ID	Type	Status	Pollution
Methuen	75 Swan St.	Jackson St.	3-0016966	Def Tier 1B	No phase	oil
Methuen	Lindberg Ave.	No location aid	3-0018785	Def Tier 1B	No phase	oil
North Andover	Holt Rd.	No location aid	3-0017092	Def Tier 1B	No phase	oil
North Andover	1615 Osgood St.	Townline Auto Repair	3-0001062	Def Tier 1B	Phase 1	haz
North Andover	547 Osgood St.	Edgewood Farms, Lot 7	3-0003403	Def Tier 1B	Phase 2	gasoline
North Andover	Sutton St.	Lawrence Municipal Airpor	3-0011244	Def Tier 1B	Phase 1	oil
North Andover	1430 Great Pond Rd.	Property	3-0015859	Tier 1C	No phase	oil
Salisbury	241 Bridge St.	Gallagher's Furniture	3-0012916	Def Tier 1B	Phase 1	oil
Salisbury	84 Elm St.	Property	3-0003359	Def Tier 1B	Phase 1	petroleum/VOCs
Salisbury	188-189 Elm St.	Property	3-0001279	Def Tier 1B	Phase 1	oil/chlorinated solvents
Salisbury	Rabbit Rd. & Old Elm St.	Downeast Dispatch	3-0001925	Def Tier 1B	Phase 1	
Tewksbury	Main St. and Clark Rd.	No location aid	3-0012734	Def Tier 1B	Phase 1	oil
Tewksbury	Main St.	Clark Rd.	3-0012895	Def Tier 1B	No phase	oil
Tyngsborough	475-530 Dunstable Rd.	Charles George Landfill*	2-0000136	Tier 1A	Phase 4	organics/metals
Tyngsborough	257 Middlesex Rd.	Tyngsborough Tire & Gas	2-0000137	Tier 1A	Phase 2	gasoline
Tyngsborough	138-142 Frost Rd.	DeSousa Family Trust	2-0010348	Tier 1C	Phase 2	chlorinated solvents
Tyngsborough	292 Middlesex Rd.	Property	2-0000392	Def Tier 1B	Phase 1	haz/oil
Tyngsborough	West Tech Dr.	West Tech Ind. Park	2-0000428	Def Tier 1B	Phase 2	haz/oil
Tyngsborough	95-97 Westford Rd.	Property	2-0011257	Tier 1C	Phase 2	haz/oil
Tyngsborough	54 Pawtucket Blvd.	Stateline Auto Recovery	2-0012727	Tier 1C	Phase 2	oil
Tyngsborough	397 Middlesex Rd.	Texaco Station	2-0012737	Tier 1C	Phase 2	haz
Westford	Beacon St.	DPW Garage	2-0000819	Tier 1C	Phase 4	gasoline
Westford	10 N. Main St.	Rustlick Inc.	2-0000232	Def Tier 1B	Phase 1	haz/oil
Westford	Groton Rd.	Gaudette Construction	2-0000161	Def Tier 1B	Phase 2	haz/oil

[1] Highest Pollution Risk, includes A, B, C levels

[2] DEP data 10/00

*Superfund site

Attachment 1c-CSOs

CSOs in the Merrimack Watershed							
CSO/NPDES Outfall #	Town	Location	Receiving Water	Average Volume (MG)[1]	Approx. Acres Drained	Res	Bus
002-SDS#1	Lowell	Walker Street	Merrimack River[2]	n/a	75	75	0
007-SDS#2	Lowell	Beaver Brook	Beaver Brook[2]	54	550	75	25
008-SDS#3	Lowell	West Street	Merrimack River[2]	35	575	80	20
011-SDS#4	Lowell	Read Street	Merrimack River[2]	n/a	200	80	20
012-SDS#5	Lowell	First Street	Merrimack River[2]	n/a	75	100	0
027-SDS#7	Lowell	Tilden Street	Merrimack River[2]	n/a	350	30	35
020-SDS#6	Lowell	Warren Street	Concord River[2]	256	3,000	60	30
030(1)-SDS#8	Lowell	Barasford Street	Merrimack River[2]	16	575	80	10
030(2)-SDS#8	Lowell	Merrimack Street	Merrimack River[2]	35	300	90	10
002-SDS	Lawrence	Merrimack Street	Merrimack River	111 (combined)	nd	nd	nd
003-SDS	Lawrence	Merrimack Street	Merrimack River	111 (combined)	nd	nd	nd
004-SDS	Lawrence	Island Street	Merrimack River	111 (combined)	nd	nd	nd
005-SDS	Lawrence	Canal Street	Merrimack River	111 (combined)	nd	nd	nd
006-SDS	Lawrence	Garden Street	Spicket River	111 (combined)	nd	nd	nd
001-SDS	Haverhill	Bates Bridge	Merrimack River	0.003	nd	nd	nd
010-SDS	Haverhill	Boardman Street	Merrimack River	0	nd	nd	nd
013-SDS	Haverhill	Lower Siphon	Merrimack River	17.1	nd	nd	nd
016-SDS	Haverhill	Fire Station	Merrimack River	0	nd	nd	nd
019-SDS	Haverhill	Main Street - North	Merrimack River	0	nd	nd	nd
021A-SDS	Haverhill	Middle Siphon	Merrimack River	18.9	nd	nd	nd
021B-SDS	Haverhill	Emerson St.	Little River	na	nd	nd	nd
021C-SDS	Haverhill	Essex St.	Little River	0	nd	nd	nd
021D-SDS	Haverhill	Locke St. - North	Little River	3.3	nd	nd	nd
021E-SDS	Haverhill	Locke St. - South	Little River	1.3	nd	nd	nd
022-SDS	Haverhill	RR Bridge	Merrimack River	0	nd	nd	nd
023-SDS	Haverhill	266 River St.	Merrimack River	0	nd	nd	nd
024-SDS	Haverhill	Upper Siphon	Merrimack River	17.6	nd	nd	nd
025-SDS	Haverhill	Beach Street	Merrimack River	0	nd	nd	nd
031-SDS	Haverhill	Front Street	Merrimack River	1.2	nd	nd	nd
032-SDS	Haverhill	Bradford Avenue	Merrimack River	6	nd	nd	nd
033-SDS	Haverhill	S. Prospect St.	Merrimack River	0.04	nd	nd	nd
034-SDS	Haverhill	Middlesex Street	Merrimack River	0.15	nd	nd	nd
035-SDS	Haverhill	S. Main St.	Merrimack River	1.4	nd	nd	nd
036-SDS	Haverhill	Ferry Street	Merrimack River	1.6	nd	nd	nd

[1] 1997 Lowell WWTF Data; Haverhill LTCP DEIR 2000
[2] Average Annual volume (1993-1997)

Attachment 1d-Landfill Sites

Active and Inactive Landfills, Ash Landfills, Transfer Stations, Incinerators in the Merrimack Watershed												
Town	Name	Address	ID No.	Acres[1]	Status	Yr. Open	Yr. Close	Type	Liner?	Cap?	TPD	Owner
Amesbury	St. Joseph's Landfill	Route 150	DL0007.004	5,5	inactive	1977	1985	demolition	no	partial	?	Archdiocese of Boston
Amesbury	SCA Landfill	26 Hunt Rd.	SL0007.001	0,60	closed	1962	1984	MSW	yes	yes	?	Waste Mgmt. of NA
Amesbury	Titcomb Pit Landfill	Hunt Rd./Route 150	SL0007.002	0,0	closed	1975	1978	MSW	no	yes	200	Waste Mgmt. of NA
Andover	Andover Landfill	Chandler/Ledges Rd.	SL0009.002	20,20	inactive	1946	1983	MSW	no	partial	?	Town of Andover
Ayer	Routhier Tire Recycling	Willow Rd.	TR0019.006	n/a	active	1991	n/a	TS	n/a	n/a		JP Routhier & Sons
Dunstable	Dunstable Landfill	Depot St.	SL0081.001	6,8	inactive	1960	1992	MSW	yes	partial	49	Town of Dunstable
Dunstable	Dunstable Transfer Stati	Depot St.	TR0081.002	n/a	active	1992	n/a	TS	n/a	n/a		Town of Dunstable
Groton	Groton Landfill	600 Cow Pond Brook F	SL0115.001	0,11	inactive	1976	1991	MSW	no	no	32	Town of Groton
Groton	Groton Transfer Station	600 Cow Pond Brook F	TR0115.005	n/a	active	1991	n/a	TS	n/a	n/a		Town of Groton
Groveland	Groveland Landfill	Yemma Property	SL0116.001	0,0	inactive	?	?	MSW	no	?	?	private
Haverhill	Ward Hill Neck Landfill	100 Recovery Way	SL0128.003	43,83	inactive	1981	1989	MSW	yes	partial	?	Ogden Martin Systems
Haverhill	Haverhill Landfill	Old Groveland Rd.	SL0128.005	0,46	inactive	1938	1996	MSW	no	no	200	City of Haverhill
Haverhill	Ash Landfill	100 Recovery Way	AL0128.010		active	?	2009	Ash	yes	no	550	Ogden Martin Systems
Haverhill	Incinerator	100 Recovery Way	RR0128.008		active	1989		RRI			1650	Ogden Martin Systems
Haverhill	Biosystems Medical Was	159-181 Ferry Rd.	TR0128.014	n/a	active	1991	n/a	TS	n/a	n/a		Medical Waste Systems
Haverhill	Med-Tech Env Inc.	139-141 Ferry Rd.	TR0128.011	n/a	active	1991	n/a	TS	n/a	n/a		Med-Tech Env. Inc.
Lawrence	Lawrence Landfill	Marston St./Incinerator	SL0149.001	9,9	inactive	?	1974	MSW	no	no	?	City of Lawrence
Littleton	Littleton Transfer Station	Spectacle Pond Rd.	TR0158.002	n/a	active	1989	n/a	TS	n/a	n/a		Town of Littleton
Lowell	Corey Construction Dum	Middlesex St.	DL0160.002	0,0	inactive	?	1974	demolition	no	no	?	Corey Construction
Lowell	Lowell Landfill (Brady's D	Westford/Stedman Sts	SL0160.001	0,60	closed	1948	1992	MSW	yes	yes	200	City of Lowell
Lowell	Lowell Landfill	Nesmith St.	SL0160.003	0,0	inactive	?	?	MSW	no	?	?	City of Lowell
Lowell	Lowell Landfill	Methuen St.	SL0160.005	0,0	inactive	?	?	MSW	no	?	?	City of Lowell
Merrimac	Cobbler's Stump Landfill	82 Bearhill Rd.	SD0180.004	0,0	inactive	?	1979	stump	no	?	?	Sargent Farm
Merrimac	Merrimac Landfill	Highland Rd.	SL0180.002	0,0	inactive	?	?	MSW	no	?	?	?
Merrimac	Merrimac Landfill	Battis Rd.	SL0180.003	10,15	closed	? (ca. 1969)	1998	MSW	no	yes	99	Town of Merrimac
Merrimac	Broad St. Landfill	Broad St./North St.	SL0180.005	0,0	inactive	?	1969	MSW	no	no	?	Town of Merrimac
Methuen	Methuen Landfill	Huntington Ave.	SL0181.001	28,28	inactive	1955	1989	MSW	no	no	?	Town of Methuen
Methuen	Methuen Transfer Statior	Huntington Ave.	TR0181.004	n/a	active	1990	n/a	TS	n/a	n/a		Town of Methuen
North Andover	North Andover Landfill	Holt Rd./Clark St.	SL0210.005	18,18	inactive	1955	1985	MSW	no	no	?	MA DEP
North Andover	Incinerator	Holt Road	RR0210.001		active	1985		RRI			1500	Refusetech
Salisbury	Salisbury Landfill	Old County Road	SL0259.001	15,15	inactive	?	1997	MSW	no	partial	99	Town of Salisbury
Tyngsborough	Charles George Landfill	475-530 Dunstable Rd	SL0301.001	0,70	inactive	?	1984	MSW	no	?	?	private

[1]# DEP approved acres/site acreage assigned by BOH

Attachment 1e-News & Notes

News & Notes, Issue #15

September 1991

EPA'S REGION I PAIRS GIS WITH RISK ASSESSMENT

"Making decisions using Geographic Information System (GIS) with a risk assessment matrix is a very effective andaccurate way to identify high priority areas into which to direct our efforts," reported EPA Region I NPS Coordinator Nancy Sullivan. "Once we set it up, having GIS do it was really a snap."

The project involved selection of Merrimack River Basin communities for evaluation of existing stormwater best management practices (BMPs). Sullivan's aim was to "identify those communities with the greatest diversity of water resources which were at the greatest risk from storm-induced pollution."
To prioritize communities based on risks, Sullivan developed a decision matrix which was compatible with data in the region's GIS database.

Specifically, for each community, the surface area of each of the six pollution sources (agriculture, new construction, urban residential, urban commercial/industrial, landfills and highways) was compared to the surface areas of each resource (surface water supplies, groundwater supplies and a category called Clean Water Act Goals, which represented things like recreation and aquatic habitat). "For example," said Sullivan "We asked GIS how much of a wellhead protection area is in agricultural production? We did that for every resource area for every source." Only that surface area that fell within the river drainage area was used.

The comparison yielded percentages which were added together to give a final numerical rating for each community. Ratings over the twenty-one communities ranged from 24 for Dunstable to 190 for Newburyport. The numbers indicated that Newburyport had more nonpoint source risk to its water resources. Sullivan called GIS "a very accurate tool" but said its use did force her to utilize broader categories than she would have liked. For instance, where the project would have benefitted from discrete categories for water recreation; and fish, shellfish and wildlife resources, GIS forced the use of a single category: Clean Water Act Goals. "We couldn't consider areas of significant importance or risk potential, such as habitat or wetlands," Sullivan noted.

Despite that drawback, Sullivan said she was impressed with GIS and, in fact, intends to use it in the third phase of the project. After reviewing stormwater BMPs within the four selected communities, the project will make stormwater management recommendations to the communities.

For Newburyport, the highest priority community, data from the National Wetlands Inventory map, National Heritage Program and current land use have been digitized into GIS. "What we'll be asking is: Is GIS an effective tool for developing recommendations for stormwater management? So far, I think it will be. Preliminary review of the GIS maps indicates that current land use information is a critical data layer," Sullivan said.

[For more information, contact Nancy Sullivan, NPS Coordinator, U.S. EPA Region I, JFK Building, Boston, MA 02203. Phone: (617) 565-3546.]

Attachment 1f- Merrimack Rivers and Streams

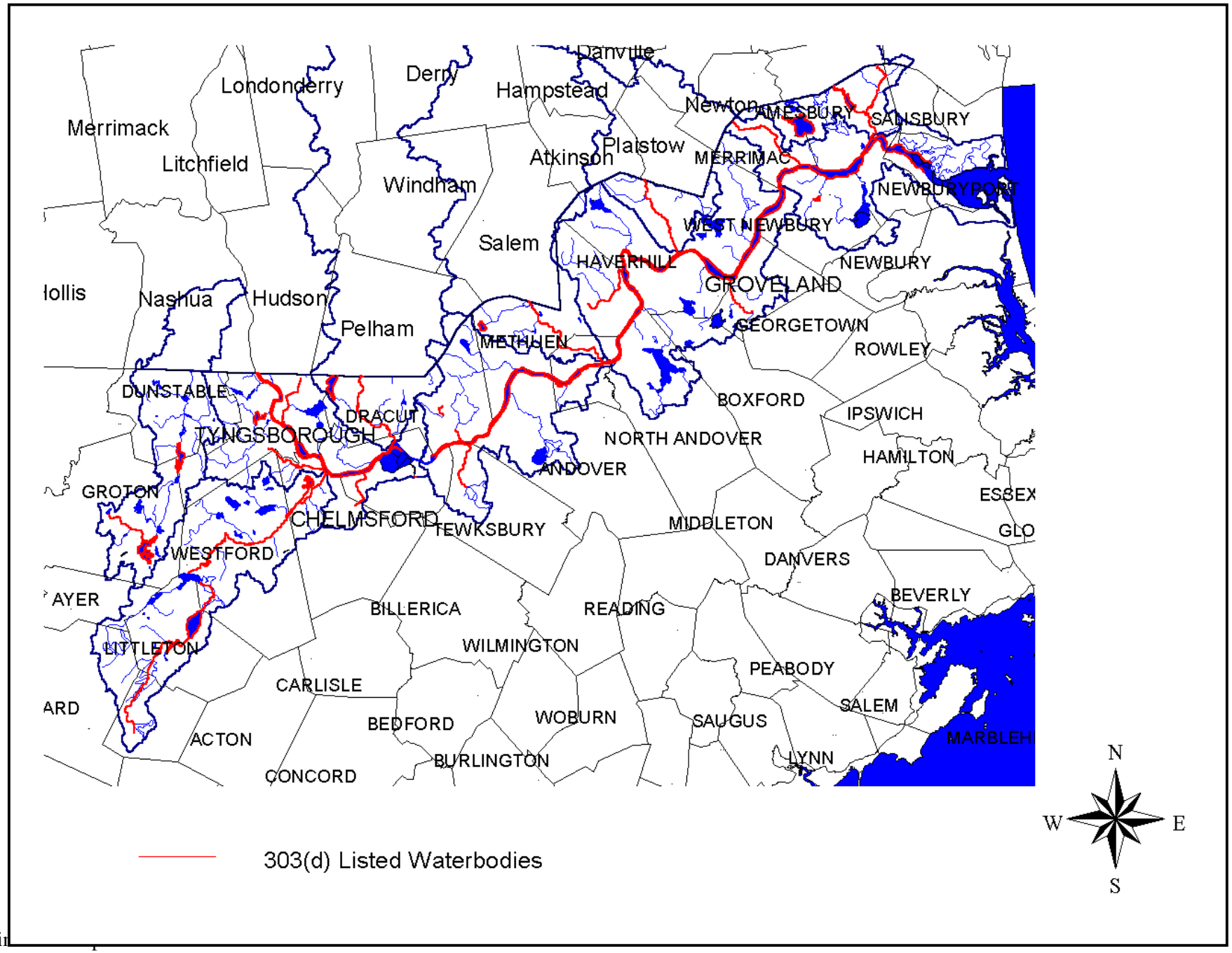
Allen Creek	Johnson Creek
Artichoke River	Joint Grass Brook
Back River (2)	Keyes Brook
Baddacook Brook	Lawrence Brook
Bare Meadow Brook	Limit Brook
Bartlett Brook	Little Pine
Beaver Brook (2)	Little River
Bennetts Brook	Lucy Brook
Black Brook	Martins Pond Brook
Black Rock Creek	Merrimack River
Blue Brook	Morrill Creek
Boutwell Brook	Nickel Mine Brook
Bridge Meadow Brook	Peppermint Brook
Camp Brook	Pine Island Creek
Claypit Brook	Plum Island River
Cobbler's Brook	Plumbush Creek
Cold Springs Brook	Powwow River
Cow Pond Brook	Reed Brook
Creek Brook	Richardson Brook
Crooked Springs Brook	Salmon Brook
Deep Brook	Sawmill Brook
Double Brook	Sawyer Brook
East Meadow River	Scarlet Brook
Fish Brook	Shad Creek
Fishin Brook	Snake Meadow Brook
Foote Brook	Snows Brook
Gilson Brook	Souhegan River
Gilson Brook	Spicket River
Goodwin Creek	Stony Brook
Griffin Brook	Tadmuck Brook
Harris Brook	Town Creek
Hauk Brook	Trout Brook
Hawkes Brook	Trull Brook
Indian River	West Meadow Brook
Jericho Creek	World End Brook

Attachment 1g-Status of Rivers/Streams

Status of Merrimack Watershed Rivers/Streams						
Name	Town(s)	Segment	303(d) List?	Stressor(s)	ID No.	Category
Black Rock Creek	Salisbury		unk status		na	None
Allen Creek	Salisbury		unk status		na	None
Shad Creek	Salisbury		unk status		na	None
Middle Creek	Salisbury		unk status		na	None
Morrill Creek	Salisbury		unk status		na	None
Town Creek	Salisbury		unk status		na	None
Plum Island River	Newburyport	Chaces Island to mouth	y	pathogens	MA84A-23	Not assessed
Plum Island Sound	Nbport/Salisbury		y	pathogens	MA84A-24	Evaluated
Plumbush Creek	Newburyport		unk status		na	None
Powow River	Amesbury	Inlet Lake Gardner to tidal Miles 6.4-1.3	y	pathogens	MA84A-07	Not assessed
Powow River	Amesbury	Miles 1.3-0.0	y	pathogens	MA84A-08	Evaluated
Back River	Amesbury	NH State line to conf w/Powow Miles 3.3-0.0	y	siltation, pathogens, turbidity	MA84A-16	Evaluated
Goodwin Creek	Amesbury		unk status		na	None
Pressy's Creek	Amesbury/Merrimac		unk status		na	None
Artichoke River	W. Newbury/Nbport		unk status		na	None
Indian River	W. Newbury		unk status		na	None
Cobbler's Brook	Merrimac	Headwaters to confluence Miles 4.5-0.0	y	unknown toxicity	MA84A-22	Evaluated
Johnson Creek	Groveland	Headwaters to confluence Miles 3.3-0.0	y	siltation	MA84A-15	Evaluated
E. Meadow River	Haverhill		unk status		na	None
Little River	Haverhill	NH State line to confluence Miles 4.3-0.0	y	pathogens	MA84A-09	Not assessed
Snows Brook	Haverhill		unk status		na	None
Creek Brook (Bradley)	Haverhill		unk status		na	None
W. Meadow Brook	Haverhill		unk status		na	None
Bare Meadow Brook	Methuen	Headwaters to confluence Miles 3.2-0.0	y	siltation, organic enrichment, low DO, pathogens, turbidity	MA84A-18	Evaluated
Hawkes Brook	Methuen		unk status		na	None
Fish Brook	Andover		unk status		na	None

Status of Merrimack Watershed Rivers/Streams						
Name	Town(s)	Segment	303(d) List?	Stressor(s)	ID No.	Category
Spicket River	Methuen/Lawrence	NH State line to confluence Miles 6.4-0.0	y	metals, nutrients, pathogens	MA84A-10	Monitored
Harris Brook	Methuen		unk status		na	None
Bartlett Brook	Methuen/Dracut		unk status		na	None
Griffin Brook	Methuen		unk status		na	None
Nickel Mine Brook	Dracut		unk status		na	None
Richardson Brook	Dracut	Headwaters to confluence Miles 3.4-0.0	y	habitat alterations, noxious aquatic plants	MA84A-12	Evaluated
Trout Brook	Dracut	Headwaters to conf w/ Richardson Miles 4.0-0.0	y		MA84A-13	Evaluated
Peppermint Brook	Dracut		unk status		na	None
Beaver Brook	Dracut/Lowell	NH State line to confluence Miles 4.2-0.0	y	pathogens	MA84A-11	Monitored
Trull Brook	Tewksbury	Headwaters to confluence Miles 3.25-0.0	y	unknown toxicity	MA84A-14	Evaluated
Black Brook	Lowell/Chelmsford		y	unknown toxicity, siltation, pathogens, turbidity	MA84A-17	Evaluated
Claypit Brook	Lowell		unk status		na	None
Deep Brook	Chelmsford/Dunstable	Headwaters to confluence Miles 3.05-0.0	y	unknown toxicity, siltation, organic enrichment, low DO, pathogens	MA84A-21	Evaluated
Gilson Brook	Chelmsford		unk status		na	None
Cold Spring Brook	Chelmsford		unk status		na	None
Crooked Spring Brook	Chelmsford		unk status		na	None
Stony Brook	Westford/Chelmsford	Route 225 to Chamberlin Rd.	y	pH, organic enrichment, low DO, pathogens, turbidity	MA84B-03	Not assessed
Stony Brook	Westford/Chelmsford	Chamberlin Rd. to confluence	y	nutrients, pH, pathogens	MA84B-04	Not assessed
Beaver Brook	Westford/Littleton	Outlet Mill Pond to inlet Forge Pond Miles 4.8-0.0	y	nutrients, pH, organic enrichment, low DO, pathogens, suspended solids	MA84B-02	Not assessed
Tadmuck Brook	Westford		unk status		na	None
Keyes Brook	Westford		unk status		na	None

Status of Merrimack Watershed Rivers/Streams						
Name	Town(s)	Segment	303(d) List?	Stressor(s)	ID No.	Category
Snake Meadow Brook	Westford		unk status		na	None
Bennetts Brook	Westford		unk status		na	None
Boutwell Brook	Westford		unk status		na	None
Unnamed Tributary (headwaters Wolf Swamp)	Boxborough/Littleton	Outlet Wolf Swamp to inlet Mill Pond Miles 1.9-0.0	y	nutrients, pH, organic enrichment, low DO, pathogens, suspended solids	MA84B-01	Evaluated
Bridge Meadow Brook	Tyngsboro		unk status		na	None
Limit Brook	Tyngsboro		unk status		na	None
Lawrence Brook	Tyngsboro	Headwaters to confluence Miles 2.35-0.0	y	unknown toxicity	MA84A-20	Evaluated
Scarlet Brook	Tyngsboro		unk status		na	None
Salmon Brook	Groton/Dunstable		unk status		na	None
Joint Grass Brook	Dunstable		unk status		na	None
Hauk Brook	Dunstable		unk status		na	None
Black Brook	Dunstable		unk status		na	None
Martin's Pond Brook	Groton	Outlet Martin's Pond to inlet Lost Lake Miles 2.4-0.0	y	siltation, organic enrichment, low DO, turbidity	MA84A-19	Evaluated
Merrimack River	NH to Pawtucket Dam, Lowell	Miles 49.8-40.6	y	pathogens	MA84A-01	Monitored
Merrimack River	PD to Duck Isl., Lowell	Miles 40.6-37.8	y	nutrients, pathogens	MA84A-02	Evaluated
Merrimack River	Duck Isl. to Essex Dam, Lawrence	Miles 37.8-29.0	y	nutrients, pathogens	MA84A-03	Monitored
Merrimack River	Essex Dam to Creek Brook, Haverhill	Miles 29.0-21.9	y	nutrients, pathogens	MA84A-04	Evaluated
Merrimack River	Creek Brook to Indian River, W. Newbury	Miles 21.9-9.0	y	unionized ammonia, pathogens	MA84A-05	Monitored
Merrimack River	Indian River to Atlantic Ocean	Miles 9.0-0.0	y	pathogens	MA84A-06	Evaluated



Executive Office of Environmental Affairs
2001

Water Quantity/Supply in the Merrimack Watershed

General Hydrologic Characteristics

The Merrimack River Watershed is part of the New England Province, a physiographic region of Massachusetts characterized by hills and valleys running in a north-south direction. In Massachusetts, almost all surface and ground water has originated from precipitation. In the Merrimack watershed, the average annual precipitation ranges from 40-42 inches and average annual runoff is 20 inches. Much of the region's geohydrology has been shaped by glaciation. Deposits left behind by the glaciers are the primary source of groundwater supply in the watershed. The unconfined stratified-drift aquifers are the most important groundwater sources. These deposits have an upper layer formed by the water table and a lower layer of less permeable clay, glacial till, or bedrock and typically form along valleys separated by higher ridges. Significant stratified drift deposits are found in some of the smaller subwatersheds of the Merrimack watershed, namely along the Powwow River, Stony Brook, and Salmon Brook, as well as the Merrimack River itself. Refer to **USGS 1980** and **1985**, as well as the attached Water Supply maps, for exact locations of the major aquifers in this watershed. Igneous and metamorphic bedrock aquifers found throughout the watershed are less productive, but are sufficient for residential water supplies.

Surface water in the watershed, that is streams, lakes and ponds, also formed from glacier activity and many are now important primary or supplemental public water supplies. Within the 279 square mile area of the watershed, there are 76 lakes and ponds. Forty-two are over 10 acres in size and are considered "Great Ponds." The largest lake in the watershed is Lake Cochichewick at 564 acres, which is a public water supply for North Andover. The Merrimack River forms the backbone of the watershed with several smaller tributaries draining to it. Over its 50-mile course from the NH State line to the Atlantic Ocean, it drops about 90 feet in elevation. In Massachusetts, the greatest drops in river elevation occur at Pawtucket Dam in Lowell and at Essex Dam in Lawrence. The average discharge measured by the USGS gauge (01100000) on the Merrimack River at Lowell is 7,562 ft^3/s with an extreme high of 173,000 ft^3/s in 1936 and an extreme low of 199 ft^3/s in 1923 (data from **USGS Water Resources of Massachusetts 1999**).

Hydroelectric power production at both dams can cause fluctuations in river flows, particularly during the summer months. The river's flow is also affected by reservoirs, some outside of the watershed, used for flood control and water supply. See Attachment 2f for a list of dams, including their storage capacity, in the Merrimack watershed. At various times, USGS has operated 42 gauges (continuous, low-flow partial record, or peak flow) to measure stream flows in the watershed (**USGS Water Resources Report 84-4284**). Currently, one real-time flow gauge (01100000) is operating in the watershed on the Merrimack River at Lowell just below the Concord River. Data from this flow gauge and historic flow gauges can be obtained from the **USGS website** (ma.water.usgs.gov) or from the yearly **USGS Water Resources Data Reports** for Massachusetts and Rhode Island. StreamStats, a web application developed by USGS, also provides statistics on historical and current stream flows in the watershed. Additionally, there is

one observation well in Haverhill that monitors groundwater levels (see ma.water.usgs.gov/ground_water or **Water Resources Data Reports**). Other wells have been drilled and monitored as part of past and current USGS studies (**MA Hydrologic Data Report No. 24** and **NAWQA**). These studies help to track trends in water flows and levels over the years. The information is also used by regulators to establish withdrawal limits for aquifers, lakes or rivers. The limits help to ensure that these waterbodies, as well as associated wetlands, will not run dry from excessive pumping by public water suppliers and other water users.

Currently, four communities withdraw water from the Merrimack River for drinking water use: Lowell, Tewksbury, Lawrence, and Methuen. However, the town of Chelmsford has recently received approval to begin withdrawing water from the river and other communities may follow as their groundwater sources become overstressed or contaminated. Because of the tidal influence and brackish condition, drawing water from the Merrimack River for drinking water use is not feasible for communities downstream of Haverhill. Other surface waters used for drinking water supply are Artichoke and Indian Hill reservoirs in Newburyport and West Newbury; Powwow River and Lake Attitash in Amesbury; Kenoza Lake, Round Pond, Crystal Lake, and Millvale Reservoir in Haverhill; Johnson's Pond in Groveland (historic back-up supply for Haverhill) and Fish Brook and Haggetts Pond in Andover. Several of these surface water supplies are also Outstanding Resource Waters (ORWs) including Artichoke Reservoir, Lake Attitash and associated tributaries, Kenoza Lake, Crystal Lake, Millvale Reservoir, Haggetts Pond, and Lake Cochichewick.

Water supply conditions in the Watershed

The available data from EPA's **SDWIS** database and Annual Drinking Water Quality Reports indicate that drinking water quality throughout the watershed is good to excellent. However, problems with high levels of coliform appear to be increasing among some water suppliers. The town of Westford will be building two water treatment plants to address their bacterial contamination problems. The town of Merrimac had coliform violations almost every year from 1994 to 1999. Other communities with coliform violations include Lowell, Methuen, Haverhill, Groveland, and West Newbury. See Attachment 2e for drinking water quality violations.

Many communities are facing shortages in water supply as growing water demands outpace supply. In the last five years, several communities have applied for and/or received permits to increase surface or ground water withdrawals including Ayer, Dracut, Groton, Littleton, Merrimac, North Andover, Westford, and West Newbury. See Attachment 2a for the list of registered and/or permitted water withdrawals in the watershed. Water use data taken from DEP Annual Statistical Reports indicates that other communities will also have to apply for increased withdrawal permits (see Attachment 2b). During the summer months, daily water withdrawal rates in several watershed communities often exceed the registered or permitted withdrawal volumes and approach maximum safe yields (Merrimack Water Demand Analysis data). However, because DEP regulates withdrawals on annual rather than daily basis and these communities do not exceed registered or permitted annual withdrawal volumes, they are allowed to maintain their daily withdrawal rates. Does this extreme pumping on a daily basis cause environmental harm? If so, should DEP revise and strengthen its WMA regulations to track daily usage instead of annual usage? To address and answer questions regarding water supply

and use in the watershed and its sustainability over the long-term, the Merrimack Watershed Team has funded a water use study currently in progress (**Data and Literature on the Water Use in the Merrimack River Watershed 2001**).

Aggressive water conservation programs are lacking in most watershed communities. Many annual consumer reports fail to adequately address water conservation and some not at all (**1998/1999 CCRs**). The communities of Westford and North Andover present two examples of more proactive efforts to promote water conservation. The Westford Water Department has implemented a 4-step water rate system to decrease water use in town and has mandatory outside water restrictions from May to October. North Andover has developed a Water Conservation Program that includes a draft water use restriction by-law and a draft automatic lawn irrigation system by-law (not yet implemented as of this writing). The town also has a Drought Management Plan. In other watershed communities, it is more difficult to regulate water use and guarantee safe drinking water quality since the majority of the population is on private wells. Only 5% of Dunstable's population and 10% of Tyngsborough's population is on public water supply. In Boxborough and Harvard, 100% of the population is on private wells or other non-public system. Private well users are responsible for their own water conservation and water quality monitoring. Regulation by state or local government is minimal. Unfortunately, private well owners often mistakenly assume their supply of water is both clean and inexhaustible. For this reason, contamination or over pumping of private wells is a real possibility. See **Weintraub 1988** for an assessment of private well contamination in Massachusetts.

The development of a water supply management plan is left to the discretion of each individual community and is not required or regulated by the Department of Environmental Protection. As a result, not all communities in the Merrimack watershed have a comprehensive water supply management plan. Communities that have a management or master plan include Groveland, Haverhill, Littleton (Aquifer Watershed Management Plan), Methuen, Newburyport, North Andover (Watershed Management Plan/Surface Water Supply Protection Plan), Westford (Water Supply Management Plan), and West Newbury (Water Supply Master Plan). Many watershed communities have been diligent in protecting their well recharge or surface watershed areas with watershed or groundwater protection districts as well as IWPA/Zone II designations (see Attachments 2c & d). Watershed or groundwater protection district by-laws have been instituted in Amesbury, Andover, Haverhill, Littleton, Merrimac, North Andover, and Westford. But, overall, it appears that several of the watershed communities do not have all the mechanisms in place to ensure a self-sustaining, plentiful and healthy supply of water for the future.

Flooding problems in the watershed are more localized than widespread. Major dams and impoundments on the Merrimack River have decreased the frequency and severity of floods along the mainstem. Flooding can still occur on the river and its tributaries during major storm events and most often occurs in the spring when both rainfall and snow melt overwhelm local waterways. Of all the tributaries in the watershed, the Spicket River experiences chronic flooding. The Spicket River Flood Mitigation Task Force organized in 1998 and has been meeting ever since to come up with workable solutions for the river's flooding problems. The US Army Corps of Engineers and USGS are also engaged in this process. Localized flooding is on the rise as the beaver population grows and they build more dams on rivers and streams throughout the watershed. In Stony Brook watershed communities especially, flooding has increased due to beaver activity. ESRI in cooperation with FEMA

(www.esri.com/hazards/makemap.html) publishes hazard maps on-line delineating the limits of the 100-yr flood plain for the communities in the watershed. The federal floodplain maps are old and have not been updated since the 1980s. Some residents and local officials question the accuracy of these maps in portraying the true extent of the flood limits and suggest that an update may be needed.

Recommendations

Based on the preceding summary, existing needs for water quantity information include:

- Water use of small (< 100,000 gallons/day) community systems (i.e. condos, shopping plazas, restaurants, campgrounds, etc.) and their locations within the watershed
- Documentation of private well use in the watershed, including contamination problems (update from 1988 report) and conservation practices, and recommendations for better oversight (i.e. regulation) of private well use
- Identification of the prime recharge areas and aquifers in the watershed as well as their level of protection and threats to their integrity (i.e. when can we say that a particular area is crucial for recharge and should be permanently protected?)
- Identification/location of remaining potential groundwater sources (if any)
- Water use/demand projections for the watershed and by community (in progress)
- Identification of the minimum in-stream flows required in both the mainstem and tributaries to support aquatic habitat needs
- Assessment of flow conditions on the mainstem and possibly major tributaries, like the Spicket and Powow, with the installation of additional flow gauges
- Extent of flooding and base flow problems in the watershed and recommendations for mitigation
- Revision and updating of federal flood maps to reflect current conditions
- Review of water conservation policies and programs used by both public water suppliers and other small water users in the watershed and recommendations for improvement to protect future water supply
- Evaluate the impacts of overpumping groundwater sources on a *daily* basis as permitted by DEP
- Review of current WMA regulations and identification of policy changes and improvements that could be made to better protect surface and ground water supplies

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FEMA Flood Insurance Studies: Andover, Dracut, Lowell, Methuen, Tewksbury
EPA's SDWIS database
StreamStats (ma.water.usgs.gov/streamstats)

Attachment 2a -Water Withdrawals

Regulated Water Withdrawals in the Merrimack River Watershed*											
						Permit Vol. (mgd)					
Town	Water User	Reg #	Permit #	PWSID#	Reg. Vol. (mgd)	5 yr (up to 1999)	10 yr (1999-2004)	15 yr (2004 2009)	20 yr (2009 2014)	Source	# Wells/ sources
Amesbury	Amesbury WTF	31300701		3007000	1.23	0.00	**0.00**	0.00	0.00	G/S	3
Andover	Andover Water Dept.	31300901	9P31300901	3009000	4.56	1.95	**2.71**	3.32	3.95	S	2
Ayer	Ayer DPW/Water Dept.	21301901		2019000	0.66	0.00	**0.00**	0.00	0.00	G	2
Boxborough	Equamarc/Towermarc (Cisco)		9P221303701		na	0.14	**0.14**	0.14	0.14	G	6
Boxford	Stanwood Morss	31303801			0.11	0.00	**0.00**	0.00	0.00	G/S	4
Chelmsford	Chelmsford Water Dist.	31305603		3056000	1.73	0.00	**0.00**	0.00	0.00	G	7
Chelmsford	Aggregate Materials Corp.	21315802			1.58	0.00	**0.00**	0.00	0.00	G/S	7
Dracut	Dracut Water Dist.	31307902		3079000	0.79	0.00	**0.00**	0.00	0.00	G	7
Dracut	PJ Keating Co.	31307901			0.58	0.00	**0.00**	0.00	0.00	S	1
Groton	Groton Water Dept.	21311501	9P21311501	2115000	0.22	0.23	**0.28**	0.30	0.33	G	3
Groveland	Groveland Water Dept.	31311601		3116000	0.41	0.00	**0.00**	0.00	0.00	G	1
Haverhill	Haverhill Water Dept.	31312802		3128000	6.06	0.00	**0.00**	0.00	0.00	S	3
Haverhill	Haverhill Paperboard Co.	31312803			2.23	0.00	**0.00**	0.00	0.00	S	1
Haverhill	Bradford Country Club	31312804			0.06	0.00	**0.00**	0.00	0.00	G/S	2
Haverhill	Spring Hill Farm Dairy Inc.	31312805			0.06	0.00	**0.00**	0.00	0.00	S	1
Haverhill	Ogden Martin Systems	31314904			10.25	0.00	**0.00**	0.00	0.00	S	1
Lawrence	Lawrence Water Works	31314902		3149000	9.46	0.00	**0.00**	0.00	0.00	S	1
Lawrence	Malden Mills Industries		9P31314901		na	2.77	**2.77**	2.77	2.77	S	1
Lawrence	Newark Atlantic Paperboard	31314901			0.56	0.00	**0.00**	0.00	0.00	S	1
Lawrence	Merrimac Paper Co.	31314903			0.55	0.00	**0.00**	0.00	0.00	S	2
Littleton	Veryfine Products	21315801	9P21315801		0.22	0.22	**0.22**	0.22	0.22	G	2
Littleton	Littleton Water Dept.	21315803	9P21315802	2158000	0.84	0.42	**0.50**	0.59	0.63	G	4
Lowell	Lowell WTF	31316001	9P231316003	3160000	13.84	3.49	**4.32**	4.79	5.18	S	1
Lowell	Western Ave. Dyers		9P31316001		na	1.93	**1.93**	1.93	1.93	S	1
Merrimac	Merrimac Water Dept.	31318001		3180000	0.36	0.00	**0.00**	0.00	0.00	G	2
Methuen	Methuen Water Dept.	31318101		3181000	4.59	0.00	**0.00**	0.00	0.00	S	1
Methuen	Hickory Hill Golf Course	31318102			0.07	0.00	**0.00**	0.00	0.00	G/S	2
N. Andover	N. Andover Water Dept.	31321001		3210000	2.66	0.00	**0.00**	0.00	0.00	S	1
N. Andover	Lucent Technologies	31321002			0.38	0.26	**0.00**	0.00	0.00	G	5
N. Chelmsford	N. Chelmsford Water Dist.	31305602		3056002	0.94	0.00	**0.00**	0.00	0.00	G	4
N. Chelmsford	Laughton Garden Center	31305601			0.07	0.00	**0.00**	0.00	0.00	G	3
Newburyport	Newburyport Water Dept.	31320601	9P31320601	3206000	2.20	0.18	**0.22**	0.27	0.29	G/S	4
Newburyport	Arrowhead Farm	31320602			0.11	0.00	**0.00**	0.00	0.00	G/S	4
Salisbury	Salisbury Water Supl. Co.	31325901		3259000	0.25	0.00	**0.00**	0.00	0.00	G	1
Tewksbury	Tewksbury Water Dept.		9P31329501	3295000	1.74	2.72	**2.96**	3.08	3.17	S	1
Tyngsborough	Vesper Country Club	21330101			0.23	0.00	**0.00**	0.00	0.00	G/S	4
W. Newbury	W. Newbury Water Dept.		9P231332401	3324000	na	0.16	**0.16**	0.16	0.16	G	1
Westford	Westford Water Dept.	21333001	9P21333001	2330000	1.18	0.66	**0.98**	1.18	1.26	G	8

*Data taken from DEP database/files

Attachment 2b-Water Use Statistics

Water Use Statistics since 1994 for major water withdrawers[1]								
			Total Annual Water Use (MG)					
Town	Water User	MGY Allowable	1999	1998	1997	1996	1995	1994
Amesbury[3,4]	Amesbury Water Dept.	448.95	640.27	590.62	579.61	563.41	595.99	568.9
Andover[4]	Andover Water Dept.	2653.50	1753.83	1911.93	1859.51	1803.31	1960.22	1749.64
Ayer	Ayer Water Dept.	240.90	223.00	313.40	171.8*	303.00	na	241.40
Boxboro	Towermarc/Cisco[2]	51.10			currently not in use			
Chelmsford[4]	Chelmsford Water District	631.45	663.70	609.44	538.51	532.59	599.57	527.92
Chelmsford	Aggregate Materials	576.70	na	na	na	na	na	na
Dracut[3,4]	Dracut Water District	288.35	na	259.83	57.70	na	na	na
Dracut	PJ Keating Co.	211.70	52.00	108.00	171.10	166.40	na	178.40
Dunstable	Dunstable Water Dept.	na	0.036	0.022	0.014	na	na	na
Groton	Groton Water Dept.	182.50	183.20	149.20	135.71	129.93	130.08	117.13
Groveland	Groveland Water Dept.	149.65	170.53	156.56	166.20	142.22	144.93	144.97
Haverhill	Haverhill Water Dept.	2211.90	2434.25	2313.17	2303.46	2246.94	2297.02	2164.40
Haverhill	Haverhill Paperboard Co.	813.95	849.67	862.09	783.99	853.76	854.26	779.39
Haverhill	Bradford Country Club	21.90	20.20	18.19	8.54	9.95	16.90	6.72
Haverhill	Spring Hill Farm Dairy	21.90	na	5.45	5.81	5.62	5.46	4.27
Haverhill	Ogden Martin Systems	3741.25	0.23	40.03	144.99	151.09	184.71	62.42
Lawrence	Lawrence Water Dept.	3452.90	2596.60	2346.69	2368.25	2622.35	2558.02	2692.23
Lawrence	Malden Mills Industries	1011.05	271.99	287.35	272.50	12.40	657.44	na
Lawrence	Merrimac Paper	200.75	252.22	267.10	na	245.61	na	223.33
Lawrence	Newark Atlantic	204.40	116.84	173.43	184.59	187.09	240.26	211.60
Littleton	Littleton Water Dept.	489.10	415.40	369.20	na	na	na	na
Littleton	Very Fine Products	160.60	66.80	49.10	50.70	44.40	53.70	na
Lowell	Lowell WTF	6628.40	5125.60	4876.97	5329.10	5261.20	4930.11	5512.00
Lowell[4]	Dyers Western Ave.	704.45	133.81	130.21	146.15	120.26	114.88	na
Merrimac[4]	Merrimac Water Dept.	131.40	173.26	170.83	154.46	154.32	148.17	177.01
Methuen[4]	Methuen Water Dept.	1675.35	1831.53	1765.18	na	1799.92	1745.81	1504.87
Methuen	Hickory Hill Golf Course	25.55	23.60	na	9.85	na	na	na
N. Andover	N. Andover Water Dept.	970.90	1237.15	1122.37	1165.26	1078.66	1148.84	1091.52
N. Andover	Lucent Technologies	233.60	61.26	126.34	82.93	95.96	na	139.68

Water Use Statistics since 1994 for major water withdrawers[1]								
			Total Annual Water Use (MG)					
Town	Water User	MGY Allowable	1999	1998	1997	1996	1995	1994
N. Chelmsford	N. Chelmsford Water District	343.10	282.05	291.99	286.48	254.03	257.01	258.93
Newburyport[4]	Newburyport Water Dept.	883.30	801.57	734.82	790.89	751.17	855.77	835.52
Salisbury[3,5]	Salisbury Water Supply Co.	91.25	324.02	296.14	311.10	327.45	337.27	334.96
Tewksbury	Tewksbury Water Dept.	1715.50	928.00	915.84	870.99	851.13	893.34	935.01
Tyngsborough[3]	Tyngsborough Water District	(see Dracut & Lowell)	81.50	66.30	55.90	na	na	na
		Lowell water	72.40	59.00	47.20	na	na	na
		Dracut Water Distict	9.10	7.30	8.60	na	na	na
Tyngsborough	Vesper Country Club	83.95	36.20	28.60	16.20	25.10	38.90	na
W. Newbury[3]	W. Newbury Water Dept.	58.40	35.90	44.86	41.66	48.99	31.99	8.34
Westford	Westford Water Dept.	787.20	644.00	559.00	530.60	510.60	509.50	na

*Grove Pond well (Nashua Basin) went on-line

[1] Source: DEP Annual Statistical Reports

[2] will begin use in Spring 2001

[3]Purchase water from other community

[4]Sell water to other community

[5]Includes wells outside basin

Attachment 2c – Water Sources

Designated IWPAs and Zone IIs*						
Town	Water User	Address	Well	Zone I/IWPA	Zone II	Approval Date
Ayer	Ayer Water Dept.		Spectacle Pond Well #1		y	11/15/99
Ayer	Ayer Water Dept.		Spectacle Pond Well #2		y	11/15/99
Ayer	Littleton Lyne Apts.		Well #1	y		
Boxford	Ingaldsby Farm	14 Washington St.	Well #1	y		
Chelmsford	Chelmsford Water Dist.	Smith St.	Smith St. Well #1		y	9/1/95
Chelmsford	Chelmsford Water Dist.	Smith St.	Smith St. Well #2		y	9/1/95
Chelmsford	Chelmsford Water Dist.	Jordan Rd.	Jordan Rd. Well		y	9/1/95
Chelmsford	Chelmsford Water Dist.	Crooked Springs Rd.	Crooked Springs Well #1		y	9/1/95
Chelmsford	Chelmsford Water Dist.	Crooked Springs Rd.	Crooked Springs Well #2		y	9/1/95
Chelmsford	Chelmsford Water Dist.	Meadowbrook Rd.	Meadowbrook Well #1		y	9/1/95
Chelmsford	Chelmsford Water Dist.	Meadowbrook Rd.	Meadowbrook Well #2		y	9/1/95
Dunstable	Dunstable Water Dept.	Main/Depot St.	Salmon Brook Well		y	5/1/00
Dunstable	YMCA/Camp Massapoag	Massapoag Way	Well #1	y		
Groton	Groton Water Dept.		Shattuck Well		y	
Groton	Groton Water Dept.		Baddacook Well		y	
Groton	Groton Water Dept.		Whitney Pond Well		y	5/13/98
Groveland	Groveland Water Dept.		Well #1		y	4/16/97
Groveland	Groveland Water Dept.		Well #3		y	7/14/97
Groveland	Groveland Water Dept.		Well #4		y	7/14/97
Lawrence	J.H. Horne & Sons Co.		Well #1	y		
Lawrence	May Street Well	69 Parker St.	May Street Well	y		
Littleton	Littleton Water Dept.		Tub. Wellfield		y	3/18/99
Littleton	Littleton Water Dept.	Whitcomb Ave	Whitcomb Ave GP Well #1		y	3/18/99
Littleton	Littleton Water Dept.	Whitcomb Ave	Whitcomb Ave Well #1		y	3/18/99
Littleton	Littleton Water Dept.	Whitcomb Ave	Whitcomb Ave Well #3/4		y	3/18/99
Lowell	Heritage Farms Ice Cream	163 Pawtucket Blvd	Heritage Farms Well	y		
Merrimac	Merrimac Water Dept.	E. Main St.	E. Main St. GP Well		y	10/28/98
Merrimac	Merrimac Water Dept.	E. Main St.	E. Main St. Wellfield		y	10/28/99
Merrimac	Merrimac Water Dept.		Tub. Wellfield (4 wells)		y	10/28/99

Designated IWPAs and Zone IIs*						
Town	Water User	Address	Well	Zone I/IWPA	Zone II	Approval Date
Methuen	Hickory Hill Golf Course	200 N. Lowell St.	Hickory Hill Well	y		
Methuen	Jimmys II Restaurant	PO Box 205	Jimmy II Wells	y		
Plum Island	Beachcomber Rest.	23 Plum Island Blvd	Beachcomber Well	y		
Plum Island	Parker River NWR	Northern Blvd	Visitors Center Well	y		
Plum Island	Atty May's	2 Northern Blvd	Atty May's Well	y		
Newbury	Mad Martha's Café	26 Union St.	Café Well	y		
Newbury	Plum Island Grille	2 Plum Island Blvd	Island Steamers Well	y		
Newbury	Dick's Variety Store	29 Plum Island Blvd	Dick's Plum Island Variety	y		
Newbury	PJ Variety	134 Northern Blvd	PJ Variety Well	y		
Newburyport	Newburyport Comfort Station	Captain Perry Way	Comfort Station Well	y		
Tyngsborough	River Crossing Condo	942 Beacon St.	Tub. Wellfield	y		
Tyngsborough	Skate 3	Middlesex Road	Well #1	y		
Tyngsborough	Crossley's Restaurant	278 Middlesex Rd.	Well #1	y		
Tyngsborough	Dream Diner	384 Middlesex Rd.	Well #1	y		
Tyngsborough	Benchmark Condos	na	Well #1A	y		
Tyngsborough	Benchmark Condos	na	Well #1B	y		
Tyngsborough	Benchmark Condos	na	Well #1C	y		
Tyngsborough	Jacoppis Colonel Tyng Manor	273 Middlesex Rd.	Well #1	y		
Tyngsborough	American Legion #247	80 Pawtucket Blvd	Well #1	y		
Tyngsborough	The Pines Restaurant	194 Frost Rd.	Well #1	y		
Tyngsborough	Vesper Country Club	Pawtucket Blvd	Well #1	y		
Tyngsborough	Hussey Plastic	65 Middlesex Rd.	Well #1	y		
Tyngsborough	Piconics	26 Cummings Rd.	Well #1	y		
Tyngsborough	Colony Heights Condo	na	Rock Well #1	y		
Tyngsborough	Colony Heights Condo	na	Rock Well #2	y		
Tyngsborough	Colony Heights Condo	na	Rock Well #3	y		
Tyngsborough	MIT, Haystack Observatory	39 Ayer Rd.	Well #1	y		
Tyngsborough	Tyngsboro Country Club	Coburn Rd.	Well #1	y		
Tyngsborough	Pine Knoll Apts.	9 Dudley Rd.	Rock Well #1	y		
Tyngsborough	Pine Knoll Apts.	9 Dudley Rd.	Rock Well #2	y		
Tyngsborough	Camp Kiwanis	Alard Rd.	Well #1	y		
Tyngsborough	Bridgecrest Condo	14 Centercrest Dr.	Rock Well #1	y		

Designated IWPAs and Zone IIs*						
Town	Water User	Address	Well	Zone I/IWPA	Zone II	Approval Date
Tyngsborough	Bridgecrest Condo	14 Centercrest Dr.	Rock Well #2	y		
Tyngsborough	MIT Millstone	Off Millstone Hill Rd.	Well #1	y		
Tyngsborough	MIT Millstone	Off Millstone Hill Rd.	Well #2	y		
Tyngsborough	Curtis Hill Condo	na	Rock Well	y		
Tyngsborough	Curtis Hill Condo	na	GP Well	y		
Tyngsborough	Tyngsboro Campground	23 Appletree Lane	Rock Well #1	y		
Tyngsborough	TJ Maxx Plaza	44 Stark Lane	TJ Well #2	y		
Tyngsborough	TJ Maxx Plaza	44 Stark Lane	TJ Well #3	y		
Tyngsborough	Tyngsboro Business Park Lot	15 Broad St.	Well #1A	y		
Tyngsborough	Matthews	350 Middlesex Rd.	Well #1	y		
Tyngsborough	Pondview II	61 Endicott St.	Well #1	y		
W. Newbury	W. Newbury Water Dept.	off Route 113	Lower Artichoke Wellfield		y	
Westford	Westford Water Dept.		Farmers Well Site		y	
Westford	Westford Water Dept.	Nutting Rd.	Nutting Road Well		y	6/25/92
Westford	Westford Water Dept.	Depot Rd.	Depot Road Well		y	6/25/92
Westford	Westford Water Dept.		Site 11		y	6/20/96
Westford	Westford Water Dept.	Forge Village Rd.	Forge Village Wellfield		y	11/19/99
Westford	Westford Water Dept.	Forge Village Rd.	Forge Village GP Well		y	11/19/99
Westford	Westford Water Dept.	Country Rd.	Country Road Well		y	11/19/99
Westford	Wyman's Beach	Wyman Beach Road	Well #4	y		
Westford	Wyman's Beach	Wyman Beach Road	Well #5	y		
Westford	Wyman's Beach	Wyman Beach Road	Well #6	y		
Westford	Rancho De Amigos	211 Groton Rd.	Well #1	y		
Westford	YMCA Camp Weetamo	206 Rogers St.	Well #1			

Source: DEP PWS Reports 2001

*See Attachment 2e for definitions of water supply protection areas

Attachment 2d – Water Supply Areas

Water Supply Protection Area Definitions

Public Water Supply Protection Areas are defined in the Drinking Water Regulations at 310 CMR 22.02. The regulatory wording is also provided below.

Groundwater Protection Areas:

Interim Wellhead Protection Area (IWPA) -

For public water systems using wells or wellfields that lack a Department approved Zone II, the Department will apply an interim wellhead protection area. This interim wellhead protection area shall be a one-half mile radius measured from the well or wellfield for sources whose approved pumping rate is 100,000 gpd or greater. For wells or wellfields that pump less than 100,000 gpd, the IWPA radius is proportional to the approved pumping rate which may be calculated according to the following equation: IWPA radius in feet = (32 x pumping rate in gallons per minute) + 400. A default IWPA radius or an IWPA radius otherwise computed and determined by the Department shall be applied to transient non-community (TNC) and non-transient non-community (NTNC) wells when there is no metered rate of withdrawal or no approved pumping rate. The default IWPA radius shall be 500 feet for TNC wells and 750 feet for NTNC wells.

Zone I -

The protective radius required around a public water supply well or wellfield. For public water system wells with approved yields of 100,000 gpd or greater, the protective radius is 400 feet. Tubular wellfields require a 250-foot protective radius. Protective radii for all other public water system wells are determined by the following equation: Zone I radius in feet = (150 x log of pumping rate in gpd) - 350. This equation is equivalent to the chart in the Division's Water Supply Guidelines. A default Zone I radius or a Zone I radius otherwise computed and determined by the Department shall be applied to transient non-community (TNC) and non-transient non-community (NTNC) wells when there is no metered rate of withdrawal or no approved pumping rate. The default Zone I radius shall be 100 feet for TNC wells and 250 feet for NTNC wells.

Zone II -

That area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at approved yield, with no recharge from precipitation). It is bounded by the groundwater divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes may act as recharge boundaries. In all cases, Zone II shall extend upgradient to its point of intersection with prevailing hydrogeologic boundaries (a groundwater flow divide, a contact with till or bedrock, or a

recharge boundary).

Zone III -

The land area beyond the area of Zone II from which surface water and groundwater drain into Zone II. The surface drainage area as determined by topography is commonly coincident with the groundwater drainage area and will be used to delineate Zone III. In some locations, where surface and groundwater drainage are not coincident, Zone III shall consist of both the surface drainage and the groundwater drainage areas.

Surface Water Protection Areas:

Zone A -

(a) the land area between the surface water source and the upper boundary of the bank; (b) the land area within a 400 foot lateral distance from the upper boundary of the bank of a Class A surface water source, as defined in 314 CMR 4.05(3)(a); and (c) the land area within a 200 foot lateral distance from the upper boundary of the bank of a tributary or associated surface water body.

Zone B -

The land area within one-half mile of the upper boundary of the bank of a Class A surface water source, as defined in 314 CMR 4.05(3)(a), or edge of watershed, whichever is less. However, Zone B shall always include the land area within a 400 foot lateral distance from the upper boundary of the bank of the Class A surface water source.

Zone C -

The land area not designated as Zone A or B within the watershed of a Class A surface water source as defined at 314 CMR 4.05(3)(a).

Attachment 2e – Drinking Water Quality Violations

Drinking Water Quality Violations*			
Town	Type[1,2]	Year	Contaminants
Ayer	Monitoring	1998	inorganic
	Monitoring	1996	inorganic
Littleton	**None**		
Westford	Health	1999	coliform
	Monitoring	1999	inorganic
	Monitoring	1996	coliform
	Monitoring	1994	coliform
	Monitoring	1993	inorganic
Dunstable	Monitoring	1994	inorganic
Groton	**None**		
Tyngsborough	Monitoring	1996	inorganic
Dracut	Monitoring	1994	inorganic
	Monitoring	1996	inorganic
Chelmsford	Monitoring	1994	minor
Lowell	Health	1999	coliform
	Monitoring	1999	coliform
	Health	1999	lead
	Monitoring	1997	nitrate
	Monitoring	1995	coliform
	Monitoring	1994	nitrate
Tewksbury	**None**		
Andover	**None**		
Methuen	Health	1996	coliform
Lawrence	Health	1993	turbidity
	Monitoring	1998	inorganic
North Andover	**None**		
Haverhill	Health	1997	coliform
	Monitoring	1995	coliform
Groveland	Health	1995	coliform
	Health	2000	coliform
Merrimac	Health	1999(2x)	coliform
	Health	1997	coliform, lead & copper rule
	Health	1996	coliform
	Health	1995	coliform
	Health	1994	coliform, lead & copper rule
West Newbury	Health	1999	coliform
Amesbury	**None**		
Newburyport	Monitoring	1999	TTHM
Salisbury	**None**		

[1] Health based violations - amount of contaminant exceeded a safety standard (MCL) or water was not treated properly

[2] Monitoring violations - system failed to complete all samples or sample in a timely manner

* Data taken from SDWIS, available from 1993 to present

Attachment 2f - Dams

Dams within the Merrimack Watershed*			
Name	**Impoundment**	**Town**	**Storage (acre feet)**
Swains Pond Dam	Swains Pond	Chelmsford	45
Mill Pond Dam	Mill Pond	Littleton	50
Johnson Creek Dam	Lower Pond	Groveland	55
Cow Pond Brook Dam	Cow Pond Brook	Groton	66
Commodore Foods Co. Dam	Stony Brook	Westford	70
Kenoza Ave. Lake Dam	Kenoza Lake	Haverhill	78
Pleasant St. Dam	Beaver Brook	Dracut	80
North Canal Outlet Dam	North Canal	Lawrence	85
Stony Brook Dam	Stony Brook	Westford	95
Stephens Dam	Little River	Haverhill	96
Lower Artichoke Reservoir Dam	Lower Artichoke Reservoir	W. Newbury	130
Lawrence Reservoir Dam	Lawrence Reservoir	Lawrence	135
Long Pond Dam	Long Pond	Dracut	150
Upper Long Pond Dam	Upper Long Pond	Tyngsborough	180
Peters Pond Dam	Peters Pond	Dracut	190
Lake Salstonstall Dam	Lake Salstonstall	Haverhill	195
Spicket River Dam @ Lowell St.	Spicket River	Methuen	210
Upper Flint Pond Dam	Flint Pond	Tyngsborough	240
Stony Brook Dam	Stony Brook	Westford	253
Tuxbury Pond Outlet Dam	Tuxbury Pond	Amesbury	260
Westford Depot Dam	Stony Brook	Westford	280
Millvale Reservoir Dam	Millvale Reservoir	Haverhill	343
Massapoag Pond Dam	Massapoag Pond	Dunstable	366
Newfield Pond Dam	Newfield Pond	Chelmsford	600
Artichoke River Dam	Artichoke River	W. Newbury/New	700
Long Sought-for Pond Dam	Long Sought-For Pond	Westford	850
Murray Printing Co. Dam	Forge Pond	Westford	900
Nabnasset Pond Dam	Nabnasset Pond	Westford	1000
Haggetts Pond Dam	Haggetts Pond	Andover	1080
Lake Gardner Dam	Lake Gardner	Amesbury	1155
Lake Cochichewick Dam	Lake Cochichewick	N. Andover	1307
Lost Lake Dam	Lost Lake	Groton	1350
Crystal Lake Dam	Crystal Lake	Haverhill	1900
Northern Canal Head Gates Dam	Merrimack River	Lowell	3200
Upper Pawtucket Canal Dam	Upper Pawtucket Canal	Lowell	4500
Essex Dam	Merrimack River	Lawrence	18000

*Source: EPA Envirofacts

Open Space in the Merrimack Watershed

The Merrimack River watershed covers about 279 sq. mi., or 178,560 acres, in Massachusetts. Of this total, about 42,282 acres, or 24%, is protected open space (**MassGIS 1999**). The level of open space protection is quite variable among the Merrimack watershed communities. Protected/semi-protected open space ranges from a low of 7% in Lawrence to a high of 41% in Dunstable and Groveland (see Attachment 3a). The land is held by various owners, including federal, state, municipal, non-profit, and private entities. Land registered under the Chapter 61 program as agriculture, recreation or forest land is classified as open space. However, the land is not permanently protected and, if development pressure is high enough, may be taken out of the program and subsequently developed. Much of the information for this section has been taken from municipal Open Space & Recreation Plans. The necessary level of open space protection to protect watershed functions and wildlife habitat and provide recreational opportunities will vary for each town. With this in mind, communities with lower percentages (<20%) of land in open space should evaluate if their current situation is adequate and whether or not they need to protect more land.

Dominant themes in all community Open Space & Recreation plans were the desire for regional coordination on open space and recreation needs; the need to link existing protected parcels of land using greenways or trails thereby improving recreational access and providing critical wildlife corridors; and the desire to improve public access and recreation along the Merrimack River. Those communities not directly on the river sought improved access to its tributaries (see Attachment 3a). Since water quality of the Merrimack River has improved in the last 20 years, more communities are recognizing its importance as a recreational asset and, for the old mill cities in particular, as a catalyst for economic revitalization. Unfortunately, for the same reasons, real estate values along the river have soared making it difficult for cash-strapped communities to acquire land in these areas. Slowly but surely, the public's views and access to the river will disappear. Communities must act fast if they want to prevent this from happening. At the same time, it is important to protect the health and integrity of the river and its watershed as recreational use intensifies, particularly in sensitive habitats (**Craig 1977; Manning 1979; Settergren 1977**). There is no existing comprehensive study investigating the negative impacts that could occur as recreation in the watershed increases or how to prevent or mitigate these potential impacts. The Merrimack River would benefit from the development of a regional recreation management plan. Finally, every open space plan cited the need to protect watershed functions or assets such as wetlands, riparian corridors, or water supply lands. However, none of the communities suggested the development of watershed-based open space plans, which would be the best way to achieve this goal.

Public access for recreation along the Merrimack River is adequate but could be improved. In some towns, access exists but is restricted or known to residents only. As the watershed communities continue to grow and recreate on the river, more riverfront open space may be needed. Larger public riverfront parks, recreational facilities, or reserves include Lowell Heritage State Park (118 ac), Lowell National Historic Park (141 ac), Deer Jump Reservation in Andover (160 ac), Merrimack Riverfront State Park in Lawrence (47 ac), Riverside Park in

Haverhill (35 ac), Riverbend Recreation Area in West Newbury (68 ac), Maudsley State Park in Newburyport (480 ac), Plum Island Point in Newburyport (47 ac), Carr Island WMA in Salisbury (70 ac), and Salisbury Beach State Reservation (520 ac). Public boating access, either motorized or car-top, is found at various points along the river from Tyngsborough to the ocean. Major boat ramps are found in Lowell, Chelmsford, Lawrence, N. Andover (in progress), Haverhill, W. Newbury, Amesbury (residents only), Newburyport (2), and Salisbury (2). A boat ramp has been proposed for Tyngsborough on newly acquired riverfront property. Canoe/kayak access is possible at many of the above locations as well as many other informal and unimproved sites. Haverhill has a formally designated *car-top only* launch at one of its riverside parks. See Attachment 3b for a complete list of open space and recreational facilities along the river. Public access to riverfront open space is limited in Tyngsborough, Dracut, Tewksbury, Methuen, North Andover, Groveland, Merrimac, West Newbury, and Amesbury. In some cases, this is due to the siting of major roads along the river as well as the steep slope of the riverfront land leaving little room for open space or recreation use. Several communities including Tyngsborough, Dracut, Lowell, Tewksbury, Methuen, Andover, Lawrence, North Andover, and Haverhill are working to develop and/or expand greenways and trails along the river and improve regional coordination on the *Merrimack River Trail*, a concept that was begun in 1995 by MRWC. Better public access exists for lakes and ponds in the watershed due to the efforts of DFWELE's Public Access Board (see Attachment 3c for a list of sites). Some towns and citizen groups cite concerns regarding abuse from recreational users (i.e. Knopps Pond/Lost Lake, Lake Attitash).

The Essex County Greenbelt Association is the primary regional land trust in the watershed. There is no county-wide land trust for the Middlesex County portion of the watershed. As a result, many more of the Middlesex towns have their own local land trust. There are other regional organizations that acquire and hold land but they have less of a presence in the watershed. See Attachment 3d for a list of land trusts in the watershed. One priority of the Merrimack Watershed Team is to direct more attention to land acquisition efforts in the watershed by both governmental and non-profit organizations. The group has proposed that a Merrimack Watershed Refuge be developed similar to the Conte National Fish & Wildlife Refuge in the Connecticut River watershed. The recent designation of the Great Marsh as a *Focus Area* for land protection by EOEA may help to boost this effort. Currently, the Great Marsh Land Protection Team is working to protect areas of the Great Marsh but, thus far, they have focused on land in the coastal communities of Rowley, Ipswich, and Essex. Significant portions of the Merrimack watershed from Newburyport and Salisbury upriver to the city of Haverhill are also part of the Great Marsh. The Merrimack Watershed Team and affiliated member groups should advocate for the inclusion of these areas in the Great Marsh protection efforts. As part of their biodiversity initiative, the MA NHESP (**Barbour et al. 1998**) has identified the freshwater and brackish tidal marshes of the Merrimack River as a conservation target, because they are important to the protection of unique and rare natural communities. Therefore, they should become a priority for land protection efforts in the watershed as well.

Most open space in the Merrimack watershed is owned by municipal governments, non-profit groups or private owners (see Attachment 3e). There are a few large parcels held by the state agencies, DEM and MAFW, and even fewer held by the federal agencies (see Attachment 3f). Lowell National Historic Park, managed by the National Park Service, and a very small portion of the Parker River NWR, managed by the USFWS, are federally-owned lands in the watershed.

By promoting a Merrimack Watershed Refuge, the Team hopes to encourage more land protection and acquisition efforts by state and federal agencies.

Recommendations

Based on the preceding information and data, remaining needs for open space and recreation in the watershed include:

- Regional Open Space Plan on a watershed or subwatershed level
- Evaluation of the current extent of open space lands in each community and their adequacy in protecting watershed functions and wildlife habitat
- Recreational Management Plan for the Merrimack River to address problems associated with increasing recreational use
- Assessment of existing and potential recreational impacts on the river, particularly as it relates to streambank conditions and erosion problems
- Re-assessment of the feasibility for a Merrimack River Trail extending from Tyngsborough to the ocean and identification of lands appropriate for acquisition or easements
- Assessment of connectivity of existing open space lands and identification of links that can be made through trails or other land purchases
- Prioritization of prime agricultural lands (i.e. soils) for permanent protection from development
- Determine the ability of existing open space and recreation lands to meet recreational needs of the watershed population as established by national recreation standards
- Increased federal and state financial support for land acquisition in the watershed
- Acquisition of lands to provide improved visual and physical access to the river

Open Space References

1996 Amesbury Open Space and Recreation Plan

1997 Andover Open Space and Recreation Plan

1998 Chelmsford Open Space and Recreation Plan

1996 Dracut Open Space and Recreation Plan

1998 Dunstable Open Space and Recreation Plan

1998 Groton Open Space and Recreation Plan

1997 Groveland Open Space and Recreation Plan

2000 Haverhill Open Space and Recreation Plan

1997 Lawrence Open Space and Recreation Plan

1996 Littleton Open Space and Recreation Plan

1994 Lowell Open Space and Recreation Plan

Draft Merrimac Open Space and Recreation Plan

1995 Methuen Open Space and Recreation Plan

1995 North Andover Open Space and Recreation Plan

1996 Salisbury Land Protection Plan

1997 Tewksbury Open Space and Recreation Plan

1996 Tyngsborough Open Space and Recreation Plan

1997 West Newbury Open Space and Recreation Plan

1994 Westford Open Space and Recreation Plan

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Attachment 3a – Open Space/Recreation Lands

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Amesbury	Y	1996	7942	14	1125	Powow Riverwalk - in progress Walk and bike path along Powow Hill and Battis Farm Acquire/develop Camp Kent for env.ed. facility Protect more water supply lands Develop more multi-purpose playfields Enhance Woodsom Farm for recreation Improve Town Boat launch Improve public access to lakes and rivers Link 700 acres of Open Space with trail system Improve and maintain scenic areas Work w/neighbor towns on bike route along Merr River	Merrimack River Lake Attittash Powow River Back River
Andover	Y	1997	20563	28	5826	Shawsheen River Greenway Merrimack River Access/Trail Acquire St. Francis Seminary land Greenway trail along Skug River from Gray Rd. to Ward Hill Res.	Shawsheen River Greenway Merrimack River Trail/Bay Circuit Trail Den Rock Park Harold Parker State Forest

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Andover (cont.)						Acquire more land in Haggett's Pond watershed Acquire land in Fish Brook lowlands Improvements at Den Rock Park Develop the Bay Circuit Trail along Merrimack River Canoe launching sites on both rivers Town Beach on Shawsheen River or ponds	Existing bike routes in Andover Ward Reservation
Chelmsford	Y	1998	14835	15	2268	Community garden site Linkages among existing parcels Boat launch site Soccer and softball fields	Great Brook Farm State Park Freeman Memorial Bike Trail Cranberry Bog Russell Mill Pond & Forest Merrimack River corridor Concord River corridor Middlesex Canal Stony Brook Watershed Warren Wildlife Sanctuary

Open Space and Recreation Lands in the Merrimack River Watershed by Community

Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Dracut	Y	1996	13376	25	3361	Redevelop Intervale Park Develop Lachut/Rifle Range Property for recreation Acquire more land at Mascuppic Beach Acquire land along Beaver Brook Acquire land along Merrimack River to connect to Lowell Riverwalk and Lawrence/Methuen Riverwalks Preserve farmland in E. Dracut (*Marsh Hill Area) Pursue trails along powe/pipeline easements Develop campground outside State Forest	Merrimack River Beaver Brook Lowell/Dracut/Tyngs State Forest Long Pond Mascuppic Lake Peters Pond to Methuen Town Forest
Dunstable	Y	1998	10704	41	4417	Swimming/fishing access on Massapoag Pond Town-wide trail system Greenway corridor along Salmon Brook Athletic fields Black Brook system All hills (viewpoints) in town linkage to Gage Town Forest	Nashua River trail system Salmon Brook Rail Trail - Nashua to Groton Bike Path - Nashua Valley Rail Trail

Open Space and Recreation Lands in the Merrimack River Watershed by Community

Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Dunstable (cont.)						Access on Nashua River	
Groton	Y	1998	20979	30	6277	Protect water quality at Lost Lake (recreation value) Improve access to Nashua River Access and open space along Squannacook River Get ACEC designation for Nashua/Squannacook Rivers Maintain Groton C. C. as open space and rec. facility Public access for Long Pond Work to develop Ayer to Dunstable Rail Trail system Develop town greenway system More soccer & baseball field space Neighborhood recreational facilities	Nashua River Squannacook River Salmon Brook watershed Ayer to Dunstable Rail Trail Long Pond and Massapoag Pond Hunting Hills/Squannacook River WMAs Ayer State Game Farm Groton Town Forest Harry Rich Tree Farm State Forest Wharton Plantation, NEFF
Groveland	Y	1997	5721	41	2332.3	Swimming area on New Mill Pond Acquire greenway corridors along Brindle/Argilla Brooks Esty property b/t Johnson Creek and Merrimack River Johnson's Creek corridor to Georgetown/Boxford border	Merrimack River Johnson Creek/Pond watershed Crane Wildlife Mgmt. Area

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Groveland (cont.)						Develop corridor from Merrimack River to Town Forest near Pentucket School property More athletic fields, especially soccer	
Haverhill	Y	2000	21331	11	2422	Merrimack River access Plug Pond expansion More neighborhood playgrounds/tot lots Skateboard Park Acquire more watershed/water supply lands Improve Meadow Brook Conservation Area	Haverhill Country Club Merrimack River Little River Chadwick Pond E. Meadow River Watershed Crystal Lake Crystal Springs Golf Course B&M RR right of way
Lawrence	Y	1997	4210	7	281	Spicker River Greenway Shawsheen River Greenway Improvements to Den Rock Park/Veterans Stadium Revitalization of Oxford Paper Site Expansion of Pemberton Park	Merrimack Greenway Shawsheen Greenway Spicket Greenway Den Rock Park

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Littleton	Y	1996	10760	33	3577	Acuire/protect Hartwell Property Acquire/protect Westgate Property Acquire/Protect Black Pond Acquire/Protect Snow Village Acquire Town Forest landlocked property Acquire/protect Porter Road Esker Acquire/protect Whitcomb Property Acquire additional well site Soccer/baseball playfields	Forge, Spectacle, Nagog Pond Beaver Brook/Stony Brook Oak Hill Conservation Area Nagog Hill Conservation Area
Lowell	Y	1994	8819	10	887	To preserve 100 acres of open space and parks Merrimack River Trail Concord River Bikeway/Walkway More parkland for passive use i.e. walking, jogging, biking Increase park development through property acqusition Community gardens in several neighborhoods	Lowell/Dracut/Tyngs State Forest Merrimack River corridor/River Trail Concord River corridor Bruce Freeman Memorial Bike Trail

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Lowell (cont.)						Transfer city land to DEM for new boat ramp through PAB Establish acquisition program for land on river greenways Promote Canalway plan new soccer fields	
Merrimac	draft	1999	5651	33	1880	More soccer and play fields Canoe/kayak launch on river Greenway system that connects all major O/S parcels Ensure long-term protection of 61A farmlands Protect Town Forest buffer and add adjacent lands Rehabilitate and improve Town Beach area Improved access on Merrimack River	Merrimack River Lake Attittash E. Meadow River Watershed McLaren Trail Sargent Farm Spiegel/Perkins Conservation land
Methuen	Y	1995	14777	11	1624	Land/easements for Spicket Riverwalk Land/easements for Merrimack River Trail Expansion of Town Forest lands	Merrimack River Trail Town Forest Hickory Hill Golf Course

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Methuen (cont.)						Expansion of Schruender Park along Merrimack Reclaim ski tow area to add to Town Forest	
Newburyport	in progress	2001	6771	27	1855*	unknown	Merrimack River Maudsley State Park Newburyport Rail Trail Plum Island beachfront Artichoke River/Reservoir Colby Farm
North Andover	Y	1995	17824	19	3453.5	Acquire more land in Lake Cochichewick watershed Bikeways along roads Merrimack River access/develop boat ramp Determine feasibility of former landfill for recreation New rec. facilities (i.e. outdoor skating rink) Access to Lake Cochichewick for boating/fishing Protect and provide access to major hilltops	Harold Parker State Forest Boxford State Forest Merrimack River Mazarenka Farm & Rea's Pond Consv. Area Ward Reservation Shawsheen River MA Electric Power line easement

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
North Andover (cont.)						Essex Rail Trail	Essex Rail Trail
Salisbury	Y	1996	11417	15	1736*	Salisbury Rail Trail Multi-purpose recreation area Improve access and scenic qualities of Salisbury Beach Increase protection of salt marsh parcels Expand trail system in town (Old Ferry Road Trail, Dock Lane) Protect and preserve access to water corridors i.e. Town Creek and Black Rock Creek Establish a "Salisbury Marshes Ecotourism Center" Ensure protection of existing agricultural farms Protect/acquire land b/t RR and Town Creek	Merrimack River Salisbury Rail Trail Blackwater River coastal beachfront
Tewksbury	Y	1997-2002	12515	14	1800	Public access to town's rivers and ponds (town beach) Develop aban RR bed (Old Boston Rd.) for trail Protect town's well supply/wellfields Shawsheen River Greenway	Bay Circuit Trail - Merrimack River Bay Circuit Trail- Middlesex Canal Shawsheen River

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
Tewksbury (cont.)						Protect Natural areas (i.e. Great Swamp, Ames Hill) Town-wide bike and walk trail Pursue consv. restrictions on golf course, airport, rod & gun club	
Tyngsborough	Y	1996	10784	14	1530	Scribner Hill area Potash Hill area Mascuppic Lake area Hunter property on Merrimack River Girl Scouts Camp Kiwanee on Long Pond More land on river for access Trail system on private lands in town Develop ski area at Bear Hill	Lowell/Dracut/Tyngs State Forest Charles George Landfill Merrimack River Massapoag Pond MIT Haystack Observatory
West Newbury	Y	1997	8652	41	3601	River access for fishing/boating Town-wide trail system linking parcels Protect farmland Protect historic bridges	Merrimack River Artichoke River/Reservoir Riverbend Conservation Area Crane Wildlife Mgmt. Area

Open Space and Recreation Lands in the Merrimack River Watershed by Community							
Town	Open Space Plan?	Year	Total land area (acres)	% Open Space[1]	Open space acres[1,2]	Open space and recreation priorities:	Existing or potential regional linkages:
West Newbury (cont.)						Maintain existing trails through easements New rec. facilities especially baseball and soccer Recreation development of Pipestave Hill	Society of St. John Evangelist
Westford	Y	1994 (updating)	19590	24	4786	500 acres of land along Stony Brook including 3 future well sites Pursue E. Boston Camps land Pursue MIT property Drew Farm land Boat ramps at River Street and Farmer land Expansion/connection of town-wide trail system	Stony Brook watershed Forge Pond Westford Rail Trail Westford Bay Circuit Trail

Total 51447.8

[1] Includes Ch. 61 lands, school lands, recreation lands, and other muncipal lands not in conservation

[2] These figures include all open space in the town which may be found in other watersheds besides the Merrimack

*Numbers based on MA GIS 1992 data

Attachment 3b – Recreational Facilities

Recreational Facilities and Access along the Merrimack River					
City/Town	**State**	**Name of Facility**	**Type**	**Recreation Opportunity Offered**	**Total Acreage**
Amesbury	MA	Davy Jones Marina	P	BL	**1.1**
Amesbury	MA	Deer Island	M	CL, F, H, P, O	**4.8**
Amesbury	MA	Larry's Marina	P	BL	**1.5**
Amesbury	MA	MacKenzie's Landing Marina	P	BL	
Amesbury	MA	Merrimac St. Boat Landing	M	BL, CL	**0.38**
Amesbury	MA	Alliance Park	P	F,P,O	**1**
Amesbury	MA	Lowell's Boat Shop	P	BL,O	**<.25**
Andover	MA	AVIS Deer Jump Reservation	P	H,W/J,X-C,P,O	**127**
Andover	MA	Conservation Land	M	F,H,W/J,P,O	**95**
Chelmsford	MA	Southwell Field	M,U	BL,CL,F,P,SF	**26**
Groveland	MA	Elm Park	M	P,SF	**0.5**
Groveland	MA	Shanahan Field	M	SF	**8**
Groveland	MA	The Pines	M	BL,CL,P,SF	**28**
Groveland	MA	Riverview Cemetary	M	W/J,O	
Groveland	MA	Pentucket Middle School	M	F,W/J,SF	**19**
Haverhill	MA	Hannah Dustin Recreation & Rest Are	G	CL,F,H,P,O	
Haverhill	MA	Consentino Adopted Nature Trail	M	F,H,P,O	
Haverhill	MA	Downtown Riverfront Promenade	M	W/J,P	**2.3**
Haverhill	MA	Riverrest Park	M	BL,O	**~1**
Haverhill	MA	First Landing Park	M	P,O	**~1**
Haverhill	MA	Riverside Park	M	CL,F,W/J,P,SF	**56**
Haverhill	MA	Riveredge Park	M	F,P,SF	**~1**
Haverhill	MA	Abbott's Marine Service	P	BL	
Haverhill	MA	Lighthouse Landing Marina	P	BL	
Haverhill	MA	Kazmiera Marina	P	BL	**14**
Haverhill	MA	Crescent Yacht Club	P	BL	
Haverhill	MA	Kimball Farm APR	P	O	**198**
Haverhill	MA	Silsby's Farm (island @ WWTP)	P	O	**125**
Haverhill	MA	City Landing at Rock's Village (3)	M,U	CL,F	**<1**
Haverhill	MA	E. Meadow River landing	M,U	CL,F	**<1**
Lawrence	MA	Pemberton Park	M	F,W/J,P	**4.2**
Lawrence	MA	Lawrence Heritage State Park - Visito	G	P,O	**0.5**
Lawrence	MA	Merrimack Riverfront State Park	G	BL,CL,W/J,P,SF,O	**47**
Lawrence	MA	Gr. Lawrence Comm. Boating Prograr	P	CL,P,O	
Lowell	MA	St. Louis Field	M	SF	**9.3**
Lowell	MA	Sheehy Park	M	SF	**5**
Lowell	MA	Gr. Lowell Comm. Boating Program	M	BL,CL	**5**
Lowell	MA	Lowell Heritage State Park	G	BL,W/J,B,S,P,M,O	**118**

Recreational Facilities and Access along the Merrimack River

City/Town	State	Name of Facility	Type	Recreation Opportunity Offered	Total Acreage
Lowell	MA	Wannalancit Park	M	P,O	**16**
Lowell	MA	First St. Playground & Ferry Landing P	M	SF,O	**1.9**
Lowell	MA	North Bank Interceptor Bikeway	M	W/J,B	
Lowell	MA	Riverwalk	M	W/J,B	
Merrimac	MA	Locust St. Landing	M,U	CL,F,P	**1**
Merrimac	MA	Duck Landing	M,U	CL,F,P	**0.5**
Merrimacport	MA	Waterfront (Carey) Park	M	CL,F,P	**0.7**
Merrimacport	MA	Wallace Bros. Boat Co.	P	BL	**0.5**
Methuen	MA	Pine Island	P	CL,F,P	**8**
Methuen	MA	Schruender Park	M	F,W/J,P,O	**5.2**
Methuen	MA	Riverview Blvd Recreation Area	M	F,P,	**0.5**
Methuen	MA	Raymond Martin Riverside Park	M	W/J,PSF,O	**4.2**
Methuen	MA	Pirates Cove/Skyport	P	BL,CL,SF,O	
Newbury	MA	Plum Island Turnpike boat access	M	BL,CL,F	
Newburyport	MA	Maudsley State Park	G	F,H,W/J,B,X-C,P,O	**524**
Newburyport	MA	Moseley Pines	M	F,H,P,SF,O	**11**
Newburyport	MA	Cashman Park	M	BL,CL,F,P,SF,O	**12**
Newburyport	MA	Waterfront Boardwalk and Park	M	BL,W/J,P,O	**3**
Newburyport	MA	City Seawall/Boat Ramp	M	BL,CL,P,O	**1.2**
Newburyport	MA	Hale Park	M	P,O	**3**
Newburyport	MA	MAS Joppa Flats Educ. Center	P	P,O	**3.4**
Newburyport	MA	Plum Island Point	M	F.W/J,S,P,O	**55**
Newburyport	MA	Parker River NWR	G	F,H,W/J,B,S,P,O	**4650**
Newburyport	MA	American Yacht Club	P	BL	
Newburyport	MA	Boatworks at Newburyport	P	BL	
Newburyport	MA	Captain's Fishing Parties & Charter Se	P	F	
Newburyport	MA	Carr Island Marine	P	BL	
Newburyport	MA	Ferry Landing Marine	P	BL	
Newburyport	MA	Hilton's Fishing Dock	P	BL,F	
Newburyport	MA	MacKenzie's Channel Marker Marina	P	BL	
Newburyport	MA	Merri-Mar Yacht Basin Inc.	P	BL	
Newburyport	MA	North End Boat Club	P	BL	
Newburyport	MA	Preservation Shipyard	P	BL	
Newburyport	MA	The Boatworks at Newburyport	P	BL	
Newburyport	MA	Windward Yacht Club	P	BL	**~3**
North Andover	MA	Riverview St. Boat Ramp (in progress	M	BL,CL,F	**1**
North Andover	MA	Merrimack River Well	M,U	O	**8**

Recreational Facilities and Access along the Merrimack River

City/Town	State	Name of Facility	Type	Recreation Opportunity Offered	Total Acreage
Salisbury	MA	Salisbury Beach State Resv.	G	BL,CL,F,C,W/J,B,S,P,O	**520**
Salisbury	MA	Isaac Sprague WS Carr Island	G	F,H,P,O	**70**
Salisbury	MA	Ram Island WS	G	F,H,P,O	**26**
Salisbury	MA	Eagle Island	G	F,H,P,O	**4.8**
Salisbury	MA	Fish & Wildlife Land	G	F,H,P,O	**15 (multi)**
Salisbury	MA	Greenbelt Mendelson Marsh	P	H,P,O	**12**
Salisbury	MA	Salisbury Town Wharf	M	BL,CL	**0.4**
Tewksbury	MA	Trull Brook Golf Course	P	SF	**126**
Tyngsborough	MA	Vesper Country Club	P	SF	**160**
Tyngsborough	MA	Tyngsborough Country Club	M	SF	**87**
Tyngsborough	MA	Larson Ave. Boat Ramp	M	BL,CL,F	**15**
West Newbury	MA	Pentucket High School	M	F,H,SF	**19**
West Newbury	MA	Rock's Village Landing	G	BL,CL,F,P,O	**3.4**
West Newbury	MA	Long Hill Orchard	P	O	**187**
West Newbury	MA	Page School	M	F,H,P,SF,O	**130**
West Newbury	MA	Riverbend Recreation Area	M	F,H,P,O	**68**

~~Key to Type~~

G = state/federal govt.
M = municipal
P = private
E = easement
U = undeveloped

~~Key to Rec. Oppty.~~

BL = boat launch
CL = canoe launch
F = fishing
H = hiking
C = camping
W/J = walking/jogging
X-C = skiing
S = swimming
P = picnicking
SF = sports facilities
O = other

Attachment 3c – Lakes and Ponds Access

Lake and Pond Access in the Merrimack Watershed				
PAB Site	Location	Town	Acess Type	Mgm
Althea Lake	Althea Avenue	Tyngsborough	general	DEM
Lake Attitash	Attitash Street	Merrimac	general	DEM
Baddacook Pond	Pond Road	Groton	fisherman	MAFW
Flint Pond	Route 113	Tyngsborough	fisherman	MAFW
Forest Lake	Ridgewood Lane	Methuen	general	City
Forge Pond	Beaver Brook Road	Westford	general	Town
Knopps Pond	Lost Lake Drive	Groton	fisherman	MAFW
Long Pond	Meadowbrook Road	Littleton	fisherman	Town
Long Pond	Old Nashua Road	Dracut	fee	Town
Long Sought For Pond	Route 40	Westford	cartop	MAFW
Lake Mascuppic	Tyngsboro Road	Dracut	fisherman	MAFW
Lake Pentucket	Stanley Drive	Haverhill	cartop	City
Lake Saltonstall	Mill Street	Haverhill	fisherman	City
Nabnasset Pond	Moore Place	Westford	general	Town
Newfield Pond (Freeman	Spring St.	Chelmsford	general	Town

Attachment 3d – Land Trusts

Active Land Trusts in the Merrimack Watershed		
NAME	**REGION SERVED**	**TELEPHONE**
Boxford Trails Association	Boxford	978-887-2194
Essex County Greenbelt Assoc.	Essex County	978-768-7241
Essex County Trail Assoc.	Essex County	978-468-3310
MA Audubon Society	Massachusetts	781-259-9500
NE Forestry Foundation	New England	978-448-8380
The Nature Conservancy	Nationwide	617-227-7017
The Trustees of Reservations	Massachusetts	978-921-1944
Trust for Public Land	Nationwide	617-367-6200
Bay Circuit Alliance	Massachusetts	978-470-1982
Great Marsh Land Protection Team	Essex County	978-927-1122
Littleton Conservation Trust	Littleton	978-486-8292
Lowell Parks & Cons. Trust	Lowell	978-934-0030
Westford Conservation Trust	Westford	978-692-3907
AVIS	Andover	978-475-1209
Chelmsford Conservation Trust	Chelmsford	978-433-9003
Groton Conservation Trust	Groton	978-448-3131
Harvard Conservation Trust	Harvard	978-456-3552
Boxboro Conservation Trust	Boxboro	978-264-4519
Dunstable Rural Land Trust	Dunstable	na

Attachment 3e – Private Open Space

Non-Profit and Private Open Space in the Merrimack Watershed				
Name	Town	Owner/Mgr	Type	Size (acres
Pender's Farm APR	Amesbury	Private	Agriculture	10
Harold Rafton Reservation	Andover	AVIS	Conservation	23
Deer Jump Reservation	Andover	AVIS	Conservation	16
Bailey Reservation	Andover	AVIS	Conservation	6
Memorial Wetlands	Boxford	ECGA	Conservation	25.2
Dunlap Property APR	Dracut	Private	Agriculture	37.8
Ogonowski Property APR	Dracut	Private	Agriculture	12
Flat Rock Hill	Dunstable	Dunstable Rural LT	Conservation	8
Horse Hill Quarry	Dunstable	Dunstable Rural LT	Conservation	38
Mill Brook	Dunstable	Dunstable Rural LT	Conservation	7
Tully Wildlife Refuge	Dunstable	Dunstable Rural LT	Conservation	165
Salmon Brook Cons. Area	Dunstable	Dunstable Rural LT	Conservation	3
Lowell YMCA Camp	Dunstable	YMCA	Recreation	24
Kennedy APR	Dunstable	Private	Agriculture	83
Lost Lake Recreation Area	Groton	Groton CT	Conservation	87
Skinner Forest	Groton	Groton CT	Conservation	10
Duck Pond Conservation Area	Groton	Groton CT	Conservation	14
Genther Woods	Groton	Groton CT	Conservation	5
Massapoag Cons. Area	Groton	Groton CT	Conservation	16
Wharton Plantation	Groton	NEFF	Conservation	717
Tersolo Lots	Groveland/Haverhill	ECGA	Conservation	91.5
Kimball Farm APR	Haverhill	Private	Agriculture	198
Silsby Farm APR	Haverhill	Private	Agriculture	125
Davidowicz Property	Haverhill	Private	Agriculture	27
McPherson Woodlot	Haverhill/Atkinson, NH	ECGA	Conservation	52
Oak Hill Cons. Land	Littleton	Littleton CT	Conservation	1
Mill Pond Cons. Land	Littleton	Littleton CT	Conservation	2.25

Non-Profit and Private Open Space in the Merrimack Watershed				
Name	Town	Owner/Mgr	Type	Size
Conant Park Cons. Land	Littleton	Littleton CT	Conservation	
Taylor St. Cons. Land	Littleton	Littleton CT	Conservation	
Porter Rd. Cons. Land	Littleton	Littleton CT	Conservation	
Whitcomb Ave. Cons. Land	Littleton	Littleton CT	Conservation	
Sargent Farm APR	Merrimac	Private	Agriculture	
Homestead Farm APR	Merrimac	Private	Agriculture	
Pine Island	Methuen	MRWC	Conservation	
Borgesi APR	Methuen	Private	Agriculture	
Simone APR	Methuen	Private	Agriculture	
Farnsworth Reservation	N. Andover	ECGA	Conservation	
Bruin Hill	N. Andover	ECGA	Conservation	
Purgatory Swamp	N. Andover	ECGA	Conservation	
Xmas Tree Estate	N. Andover	ECGA	Conservation	
William/Henry Graf Reservation	Newbury	ECGA	Conservation	
Amelia Little Reservation	Newbury	ECGA	Conservation	
Plumbush Salt Marsh	Newbury	ECGA	Conservation	
Spencer Pierce Little Farm	Newbury	SPNEA	Historic/Consv	
Joppa Flats Education Center	Newburyport	MAS	Recreation/Consv	
Barnes Island	Salisbury	ECGA	Conservation	
Herbert True Mem. Marsh	Salisbury	ECGA	Conservation	
Mendleson Marsh	Salisbury	ECGA	Conservation	
Ferry Lots Woods	Salisbury	Essex Cnty Sportsmen	Hunting/Consv	
Half Moon Meadow	Tyngsborough	TTOR	Conservation	
Moulton Reservoir	W. Newbury	ECGA	Conservation	
Hilchey Woodland	W. Newbury	ECGA	Conservation	
Pike Bridge Road	W. Newbury	ECGA	Conservation	
Poore's Pond	W. Newbury	ECGA	Conservation	
Poore's Wetland	W. Newbury	ECGA	Conservation	

Non-Profit and Private Open Space in the Merrimack Watershed				
Name	Town	Owner/Mgr	Type	Size
Long Hill Orchard APR	West Newbury	Private	Agriculture	
Merrill Farm APR	West Newbury	Private	Agriculture	
Brown Farm APR	West Newbury	Private	Agriculture	
Acker Land	Westford	Westford Cons. Trust	Conservation	
Collins Land	Westford	Westford Cons. Trust	Conservation	
Foley Land	Westford	Westford Cons. Trust	Conservation	
MacQuarrie Land	Westford	Westford Cons. Trust	Conservation	
Gordon Land	Westford	Westford Cons. Trust	Conservation	
Lambert Land	Westford	Westford Cons. Trust	Conservation	
DeSilva Land	Westford	Westford Cons. Trust	Conservation	
Harman Land CR	Westford	Westford Cons. Trust	Conservation	
Chaplin Land CR	Westford	Westford Cons. Trust	Conservation	
Blanchard Farms	Westford	Westford Cons. Trust	Agriculture	
			Total	

Attachment 3f – Government Open Space

Federal and State-owned Open Space in Merrimack Watershed

Name	Town	Owner/Mgr	Type	Size (ac
Landfill Buffer	Tyngsborough	DEP	Env. Protection	
Elbow Meadow	Tyngsborough	DFWELE	Conservation	
Rock's Village Bridge boat landing	West Newbury	DFWELE PAB	Recreation	
FWS land	West Newbury	USFWS	Conservation	
Lake Mascuppic	Dracut	DFWELE PAB	Recreation	
Long Sought-For Pond	Westford	DFWELE PAB	Recreation	
Hauk Swamp	Dunstable	MAFW	Conservation	
Lahue Parcels	Dunstable	MAFW	Conservation	**Total** **33**
Elbow Meadow	Dunstable	DFWELE	Conservation	
Baddacook Pond	Groton	DFWELE PAB	Recreation	
Knopps Pond	Groton	DFWELE PAB	Recreation	
Crane Pond WMA	Groveland	MAFW	WMA	
Lawrence Heritage State Park	Lawrence	MA DEM	Recreation/Historic	
Lowell Heritage State Park	Lowell	MA DEM	Recreation/Historic	
Lowell National Historic Park	Lowell	NPS	Historic/Recreation	
Lowell/Dracut/Tyngs State Forest	Lowell/Dracut/Tyngs	MA DEM	Recreation	
UMass Lowell	Lowell	UML	Education	
Lake Attitash	Merrimac	DFWELE PAB	Recreation	
Tenney Estate	Methuen	DEM	Historic	
Martin Burns WMA	Newbury	MAFW	WMA	
Maudslay State Park	Newburyport	MA DEM	Recreation	
Parker River NWR	Newburyport/Newbury	USFWS	Refuge/Recreation	
Salisbury Beach State Reservation	Salisbury	MA DEM	Recreation	
Ram Island	Salisbury	MAFW	WMA	
Carr Island	Salisbury	MAFW	WMA	
Saltmarsh Conservation land	Salisbury	MAFW	Conservation	
Eagle Island	Salisbury	MAFW	WMA	
Flint Pond	Tyngsborough	DFWELE PAB	Recreation	

Habitat in the Merrimack Watershed

The Merrimack Watershed is part of an ecoregion, Southern NE Coastal Plains and Hills, that does not have many rare species (.1-.5 per sq. mi.) (**NHESP 1999**). There are a total of 66 documented rare and endangered species in the watershed communities. They are listed by community in Attachment 4a. Newburyport has the highest total with 17 species listed, while Lawrence has the lowest with 1 species listed. These numbers may reflect the lack of inventorying done in the communities rather than actual species present. Some rare species listed come from historical sightings and have not been seen for several years. It also reflects the development condition of the community: urban vs. rural. There are 34 native fish species in the watershed. Fourteen more species have been introduced over the years and are largely game species. See Attachment 4b for the list of fish species that occur in the Merrimack watershed. Much of the watershed no longer supports sustainable, year-round cold water fisheries. For this reason, trout species are stocked in many streams and ponds throughout the watershed (see Attachment 4c).

The river provides habitat for the endangered Atlantic salmon (*Salmo salar*), Shortnose sturgeon (*Acipenser brevirostrum*), and Atlantic sturgeon (*Acipenser oxyrinchus oxyrhincus*). NOAA has implemented a **Shortnose Sturgeon Recovery Plan (1998)**, while the **ASMFC (1990, 1998)** oversees a Fishery Management Plan (FMP) for Atlantic Sturgeon. Little is currently known about the habits and demographics of the two sturgeon species in the Merrimack River. A study by **Kieffer and Kynard (1993)** from UMass Amherst indicated that Atlantic sturgeon do not use the river for spawning but that it is probably an important nursery area. The same study found a small Shortnose sturgeon population with a wintering site at Merrimacport and a spawning site at Haverhill downstream of the incinerator facility in Ward Hill. Dam construction (i.e. Essex Dam) on the Merrimack accounted for a 59% loss of sturgeon habitat. Overfishing and pollution were also leading causes of mortality for both species. See Attachment 4d for information on both sturgeon species in the Merrimack watershed.

In 1990, the USFWS published the ***Atlantic Salmon Strategic Plan*** outlining how the agency would accomplish the restoration of the Atlantic Salmon to the Merrimack River and its major tributaries. Atlantic Salmon were extirpated from the Merrimack River in the late 19th century. Currently, restocking efforts are underway throughout the watershed. In 1997, the plan was revised to include other anadromous fish, specifically the river herrings and American shad, in the restoration program efforts. See Attachment 4e for documented anadromous fish returns from 1982 to 1999. The USFWS has a web site for the anadromous fish program (www.fws.gov/r5cneafp/index.html) in the Merrimack watershed, which provides much information on past and current restoration efforts.

Fish passage for river herring and salmon is available at both the Essex and Pawtucket Dams on the Merrimack River. Upstream passage is good at both facilities and all target species are passed. However, the efficiency of the fish lifts is unknown. Downstream passage is also in place at both facilities but is less effective. In particular, it is not adequate for passing salmon smolts. The adequacy and extent of fish passage in tributaries of the Merrimack River from

Newburyport to the New Hampshire state line is unknown. A study in 1969 by the MA Fish & Game Department indicated that most Merrimack tributaries in Massachusetts offered little in terms of nursery habitat for anadromous fish and, therefore, did not warrant fish passage. Currently, one of the goals of the Merrimack River Anadromous Fish Restoration Program is to evaluate and pursue opportunities for providing fish passage into currently blocked habitat within the watershed.

An inventory of algae and vascular plants in the Merrimack River estuary from Salisbury to Groveland (**Miller et al. 1971**) found that plant diversity was relatively low as compared to other nearby estuaries. There were 37 taxa of vascular plants with 14 species widely distributed and 31 taxa of algae. Lack of suitable substrate and pollution were cited as the contributing factors. The same study inventoried aquatic invertebrates and found 31 different species in the estuarine and freshwater portions of the river. Diversity of invertebrates was also low, presumably due to effects of pollution. It is important to point out that these lists are not representative of the entire Merrimack River or all of its associated tributaries. Furthermore, as water quality has improved, it is possible that species diversity and numbers have risen. There has been no repeat survey of the estuary, as was suggested by **Jerome et al. (1965)**, to evaluate results from river clean-up efforts. Other recommendations made by the authors have also never been fully pursued and include 1) evaluating the need for additional fishways and the effectiveness of existing fishways, 2) monitoring shellfish and finfish populations for pesticide residues, 3) researching the value and extent of clam worm and sand eel harvest, and 4) developing an estuarine plan for all affected communities.

Eelgrass beds throughout the region are also declining (**Fried 1998**), but not much information exists on the historic and current status of eelgrass in the Merrimack estuary. DMF personnel have documented at least one population in Town Creek, one of the estuary's tidal creeks (Dave Roach, pers. communication), but its true extent is not known. Eelgrass beds provide important nursery and feeding areas for finfish and shellfish and are therefore important for the long term survival of both fisheries. Eelgrass sites in Massachusetts have been mapped by the DEP's Wetland Conservancy Program and the data is available through MA GIS (see Habitat maps for their location).

Towns provide general wildlife and plant inventories in their Open Space & Recreation Plans, but detailed inventories have not been developed for the watershed or its member communities. The **USFWS (1988)** through the National Wetland Inventory provides a list of wetland plant species for Massachusetts. Native vascular plants found in Massachusetts are listed in NHESP's publication entitled *Vascular Plants of Massachusetts, A County Checklist* (**Sorrie and Somers 1994**). The publications, *Flora of Essex County* (**Harris 1975**) and *Flora of Middlesex County* (**Dame 1888**), better document plants found in the Merrimack watershed. Other inventories and studies have been done on the plant types found along the Merrimack River (see references). The MA Division of Fish & Wildlife publishes a list of the state's amphibians and reptiles (**Cardoza and Mirick 2000**) and mammals (**Cardoza et al. 1999**) including their current distribution. There is no existing publication that documents native plant and animal species found in the Merrimack River watershed.

Wetlands coverage ranges from 10-25% of the land area in the watershed (**DEP Water Quality**

Summary 2000). Of this, about 50% are classified as deciduous forested wetlands. It has been estimated that approximately 28% (**Dahl 1990**) of Massachusetts's wetlands have been lost since the 1600s (note: Defenders of Wildlife estimates that 42% of Massachusetts wetlands have been lost). This number does not include degraded or altered wetlands. State figures provide a reasonable estimate for wetlands loss in the Merrimack watershed. While historical wetland loss resulted from agricultural activities and ditching, the majority of wetland losses now occur from residential development and urban growth. There are no existing studies evaluating wetlands loss by town/watershed or the current condition of remaining wetlands, i.e. % degraded vs. % intact, in the watershed. There are a total of 107 certified vernal pools in the watershed with 1160 potential vernal pool sites (see Attachment 4f). The Salmon Brook and Stony Brook subwatersheds have the largest number of potential (i.e. uncertified and, therefore, unprotected) vernal pools, 253 and 325 respectively.

The Merrimack watershed is a moderately to intensely developed watershed in Massachusetts, because of the presence of three major urban centers: Lowell, Lawrence, and Haverhill. In spite of this, there are still areas of intact natural lands and riparian corridors in the watershed that provide important wildlife habitat and promote biodiversity (see Habitat maps). The Merrimack watershed lies within the transition zone from boreal forest to hardwood forest. Major associations include white pine/red pine, sugar maple/beech/birch, and elm/ash/red maple. Forest cover in the watershed is quite variable from town to town. Larger forested tracts are generally found at both the west (Salmon and Stony Brook subwatersheds) and east (Merrimack estuary, East Haverhill to Newburyport) ends of the watershed with increasing urbanization and less forest cover in the central portions. The same pattern holds true for contiguous natural lands. In particular, the regions of Lowell, Lawrence, and Haverhill have less forest area and more developed areas as shown by GAP analysis. The forest that does exist is largely classified as suburban forest. In general, the largest percentage of forest type in the watershed is suburban forest. In the lower end of the watershed, i.e. Haverhill to Newburyport, the oak/maple/birch association is also fairly widespread. The Salmon and Stony Brook subwatersheds and their associated communities contain the largest amount of forested wetlands compared to other regions of the watershed.

A 1995 study (**Vogelmann 1995**) used 1988 Landsat data to estimate % forest cover and forest continuity index values (measure of fragmentation) for several southern New Hampshire and northeastern Massachusetts communities. None of the communities in the Merrimack watershed had greater than 80% forest cover. Forest cover was estimated at 60-80% for the communities of Groton, Dunstable, Boxford, Groveland, and West Newbury; 40-60% for the communities of Littleton, Westford, Tyngsborough, Dracut, Andover, North Andover, Haverhill, and Merrimac; 20-40% for the communities of Chelmsford, Tewksbury, Methuen, Amesbury, Salisbury, and Newburyport; and 0-20% for the cities of Lowell and Lawrence. These forest cover estimates have likely decreased in the last ten years due to accelerated growth in the region. For some communities, like Newburyport, lower forest cover estimates may be related to the presence of saltmarsh or other extensive open wetland habitat rather than urban development.

NHESP (1999) and **TTOR (1999)** highlight the importance of protecting freshwater and brackish tidal marshes along the Merrimack River. These habitats contain unique species assemblages with some even considered rare in the region. For example, one unique plant

species found along the river is Wild rice (*Zizania aquatica*). It is typically found growing at river mouths in fresh to brackish waters. Freshwater tidal marshes are scarce in Massachusetts and the Merrimack River supports one of the largest freshwater and brackish systems. Furthermore, NHESP (**Natural Heritage News 1998**) states that "floodplain forests clearly are one of the most rare and threatened of our natural communities." Floodplain forest habitat is found along the Merrimack River drainage and is primarily a riverside forest community with a River birch association. Much of the existing floodplain forest habitat is degraded and/or threatened by clearing for campsites as well as residential developments and only small representative parcels remain. All of the Massachusetts river corridor is designated priority habitat for the Bald Eagle and provides important feeding and roosting areas for a species easily disturbed by humans and their activities. Increasing development along the river will likely have negative impacts on Bald Eagle habitat.

Prime and rare species habitat areas have been designated in the watershed by NHESP based upon verified observations of rare or endangered species (see Habitat map). A 1987 study by US EPA targeted the Salisbury Marshes (2400 acres) and Merrimack River Tidal Flats (~2500 acres) as priority wetlands for the preservation of Black Duck wintering habitat as recommended by the USFWS. In 1965, approximately 7-8,000 individuals were wintering in these areas. The study notes that illegal filling and development are possible threats to these habitats. US EPA also designated the Merrimack River from Franklin, NH to Lowell, MA a *Priority Waterbody/ Wetland* because of its importance for waterfowl, fisheries, anadromous fish, and flood storage. Currently, the USFWS Gulf of Maine (GOM) Program team in conjunction with the GOM Rivers Ecoteam is conducting as GOM Watershed Habitat Analysis to identify, map and rank fish and wildlife habitat for important species (see Attachment 4g). The study should yield important information for the Merrimack watershed since it is part of the larger GOM watershed.

According to **Jerome, Jr. et al. (1965)**, there are 861 acres of potential soft-shell clam habitat, amounting to approximately 100,000 bushels, along the Merrimack River in Salisbury, Newburyport, and Newbury combined (see Attachment 4i). A joint survey by DEQE and MVPC in 1981 yielded a slightly higher but similar estimate of 122,000 bushels. Soft-shell clams are the only commercially valuable shellfish species in the Merrimack estuary. Pollution does not appear to inhibit the survival of these mollusks. However, the pathogens and other contaminants that they assimilate can be transmitted to humans and limits their use as a commercial resource. Clam habitat in Salisbury is found in the Salisbury and Black Rock Creek flats. The 217 acres of flats are capable of producing 26,600 bushels of legal-sized clams under optimal conditions. In Newburyport, there are 530 acres of clam habitat. Joppa Flats at 300 acres constitutes a major proportion of that habitat. Altogether, the Newburyport flats are capable of producing 42,500 bushels of legal-sized clams. In Newbury, there are 114 acres of clam habitat most of which is found in an area of Plum Island called the Basin. The Newbury flats are capable of producing 8,400 bushels of legal-sized clams.

The price of soft-shell clams per bushel in any given season fluctuates widely from $55 to $100 depending on economic factors. The wholesale price of soft-shell clams as reported by the NY Fulton Fish Market on 3/12/01 (Source: **US Dept. of Commerce, NOAA, NMFS**) was $100/bushel. If the estimate given by **Jerome et al. 1965** is correct, there is a potential harvest of 100,000 bushels (this figure includes clams that were just under legal size), that amounts to

$10 million dollars in lost revenues for the communities of Salisbury, Newburyport, and Newbury. The shellfish beds in the estuary have not been open for digging since 1985 and are listed as "prohibited" under DMF's *Designated Shellfish Growing Area* program. In the 1960s, about 20% of the shellfish beds were open to digging but were "conditionally restricted" and required to go through a depuration process before they could be marketed.

Currently, DMF is the lead agency for monitoring and managing shellfish beds and their harvest. There is no official written management or restoration plan for the shellfish industry in the Merrimack estuary and few formal studies (**Jerome et al. 1965; MVPC 1981**). In particular, two factors limit the potential for re-opening beds in the Merrimack estuary: 1) the unpredictability of water quality on any given day and 2) the manageability of the resource, i.e. wastewater inputs affect the shellfish beds faster than DMF can react to regulate or close them (Dave Roach, DMF, personal communication). The re-opening of the shellfish beds is also limited by the capabilities of the depuration system. At present, toxic contaminants cannot be depurated using the available technologies and these contaminants (see Water Quality Executive Summary) are prevalent in the Merrimack River and its estuary. Currently, EOEA is spearheading the *Shellfish Clean Waters Initiative* and has outlined its goals and objectives for restoring shellfish beds throughout Massachusetts (see Attachment 4h). The **ORCA website** (seaserver.nos.noaa.gov) also documents classified shellfish growing areas through the National Shellfish Register of Classified Growing Waters.

Recommendations

Based on the preceding information, existing needs and priorities for habitat information and data include:

- Extent and condition of wetlands in the watershed
- Up-to-date inventory of aquatic plants and animals as recommended by **Jerome et al. 1965** to assess improvements in the water quality of the Merrimack River as clean-up efforts have moved forward
- Condition of aquatic habitat (i.e. eelgrass beds, saltmarsh extent) as well as the types, locations, and movements patterns of important fish species
- Inventory of aquatic plants and animals in major tributaries of the Merrimack River
- Inventory of all dams and their impacts on upstream or downstream fish passage and the feasibility of dam removal to restore aquatic habitat
- Condition of the forested areas and contiguous lands within the watershed and their suitability for wildlife habitat
- Complete and up-to-date survey of plant and animals species throughout the watershed and documentation of rare or unique natural communities
- Identification of prime wildlife habitat in the watershed, in particular migratory waterfowl habitat
- Inventory and assessment of non-native species, particularly plants, and their impacts on native species and natural communities
- Up-to-date assessment of shellfish restoration potential and development of a working recovery and management plan

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Attachment 4a – Endangered & Rare Species

Endangered and Rare Species in the Merrimack Watershed Communities

TOWN	SCIENTIFIC NAME	COMMON NAME	TAXONOMIC CLASS	STATE RANK	FEDERAL RANK
AMESBURY (5)	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	Fish	E	LE
	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	CLEMMYS INSCULPTA	WOOD TURTLE	Reptile	SC	
	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
	LIGUMIA NASUTA	EASTERN PONDMUSSEL	Mussel	SC	
ANDOVER (3)	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	TERRAPENE CAROLINA	EASTERN BOX TURTLE	Reptile	SC	
	CRANGONYX ABERRANS	MYSTIC VALLEY AMPHIPOD	Crustacean	SC	
AYER (7)	BARTRAMIA LONGICAUDA	UPLAND SANDPIPER	Bird	E	
	CLEMMYS INSCULPTA	WOOD TURTLE	Reptile	SC	
	TERRAPENE CAROLINA	EASTERN BOX TURTLE	Reptile	SC	
	CYPERUS HOUGHTONII	HOUGHTON'S FLATSEDGE	Vascular Plant	E	
	LIATRIS SCARIOSA VAR NOVAE-ANGLIAE	NEW ENGLAND BLAZING STAR	Vascular Plant	SC	
	LYGODIUM PALMATUM	CLIMBING FERN	Vascular Plant	SC	
	SENNA HEBECARPA	WILD SENNA	Vascular Plant	E	
BOXBOROUGH (3)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
BOXFORD (3)	ACCIPITER COOPERII	COOPER'S HAWK	Bird	SC	

TOWN	SCIENTIFIC NAME	COMMON NAME	TAXONOMIC CLASS	STATE RANK	FEDERAL RANK
BOXFORD (cont)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	AMBYSTOMA OPACUM	MARBLED SALAMANDER	Amphibian	T	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
	NOTROPIS BIFRENATUS	BRIDLE SHINER	Fish	SC	
	MYRIOPHYLLUM ALTERNIFLORUM	ALTERNATE-FLOWERED WATER-MILFOIL	Vascular Plant	T	
	SPARGANIUM NATANS	SMALL BUR-REED	Vascular Plant	E	
CHELMSFORD (3)	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	TERRAPENE CAROLINA	EASTERN BOX TURTLE	Reptile	SC	
	CRANGONYX ABERRANS	MYSTIC VALLEY AMPHIPOD	Crustacean	SC	
DRACUT (2)	TERRAPENE CAROLINA	EASTERN BOX TURTLE	Reptile	SC	
	MITOURA HESSELI	HESSEL'S HAIRSTREAK	Lepidoptera	SC	
DUNSTABLE (6)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	CLEMMYS INSCULPTA	WOOD TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
	NOTROPIS BIFRENATUS	BRIDLE SHINER	Fish	SC	
	SYNAPTOMYS COOPERI	SOUTHERN BOG LEMMING	Mammal	SC	
GROTON (10)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	

TOWN	SCIENTIFIC NAME	COMMON NAME	TAXONOMIC CLASS	STATE RANK	FEDERAL RANK
GROTON (cont)	AESHNA MUTATA	SPATTERDOCK DARNER	Odonate	E	
	CRANGONYX ABERRANS	MYSTIC VALLEY AMPHIPOD	Crustacean	SC	
	OPHIOGOMPHUS ASPERSUS	BROOK SNAKETAIL	Odonate	SC	
	STYLURUS SCUDDERI	ZEBRA CLUBTAIL	Odonate	E	
	CALYSTEGIA SPITHAMAEA	LOW BINDWEED	Vascular Plant	E	
	LYGODIUM PALMATUM	CLIMBING FERN	Vascular Plant	SC	
	SPARGANIUM NATANS	SMALL BUR-REED	Vascular Plant	E	
GROVELAND (10)	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	Fish	E	LE
	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	BOTAURUS LENTIGINOSUS	AMERICAN BITTERN	Bird	E	
	CLEMMYS INSCULPTA	WOOD TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
	IXOBRYCHUS EXILIS	LEAST BITTERN	Bird	E	
	NOTROPIS BIFRENATUS	BRIDLE SHINER	Fish	SC	
	VERMIVORA CHRYSOPTERA	GOLDEN-WINGED WARBLER	Bird	E	
	ELYMUS VILLOSUS	HAIRY WILD RYE	Vascular Plant	T	
HARVARD (14)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	AMMODRAMUS SAVANNARUM	GRASSHOPPER SPARROW	Bird	T	
	BOTAURUS LENTIGINOSUS	AMERICAN BITTERN	Bird	E	
	CLEMMYS INSCULPTA	WOOD TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	

TOWN	SCIENTIFIC NAME	COMMON NAME	TAXONOMIC CLASS	STATE RANK	FEDERAL RANK
HARVARD (cont)	PODILYMBUS PODICEPS	PIED-BILLED GREBE	Bird	E	
	TERRAPENE CAROLINA	EASTERN BOX TURTLE	Reptile	SC	
	ALASMIDONTA UNDULATA	TRIANGLE FLOATER	Mussel	SC	
	CRANGONYX ABERRANS	MYSTIC VALLEY AMPHIPOD	Crustacean	SC	
	DESMOCERUS PALLIATUS	ELDERBERRY LONG-HORNED BEETLE	Beetle	SC	
	ELEOCHARIS OBTUSA VAR OVATA	OVATE SPIKE-SEDGE	Vascular Plant	E	
	LYGODIUM PALMATUM	CLIMBING FERN	Vascular Plant	SC	
	SPARGANIUM NATANS	SMALL BUR-REED	Vascular Plant	E	
	VERONICASTRUM VIRGINICUM	CULVER'S-ROOT	Vascular Plant	SC	
HAVERHILL (9)	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	Fish	E	LE
	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	CLEMMYS INSCULPTA	WOOD TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
	IXOBRYCHUS EXILIS	LEAST BITTERN	Bird	E	
	LEPTODEA OCHRACEA	TIDEWATER MUCKET	Mussel	SC	
	LIGUMIA NASUTA	EASTERN PONDMUSSEL	Mussel	SC	
LAWRENCE (1)	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
LITTLETON (4)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	AMBYSTOMA OPACUM	MARBLED SALAMANDER	Amphibian	T	

TOWN	SCIENTIFIC NAME	COMMON NAME	TAXONOMIC CLASS	STATE RANK	FEDERAL RANK
LITTLETON (cont)	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	CRANGONYX ABERRANS	MYSTIC VALLEY AMPHIPOD	Crustacean	SC	
LOWELL (12)	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	GALLINULA CHLOROPUS	COMMON MOORHEN	Bird	SC	
	LOTA LOTA	BURBOT	Fish	SC	
	STYLURUS AMNICOLA	RIVERINE CLUBTAIL	Odonate	E	
	ARISAEMA DRACONTIUM	GREEN DRAGON	Vascular Plant	T	
	CAREX GRAYI	GRAY'S SEDGE	Vascular Plant	T	
	CLAYTONIA VIRGINICA	NARROW-LEAVED SPRING BEAUTY	Vascular Plant	T	
	ERAGROSTIS FRANKII	FRANK'S LOVEGRASS	Vascular Plant	SC	
	LUDWIGIA POLYCARPA	MANY-FRUITED FALSE-LOOSESTRIFE	Vascular Plant	T	
	MIMULUS ALATUS	WINGED MONKEY-FLOWER	Vascular Plant	E	
	PANICUM PHILADELPHICUM	PHILADELPHIA PANIC-GRASS	Vascular Plant	SC	
	RUMEX VERTICILLATUS	SWAMP DOCK	Vascular Plant	T	
MERRIMAC (4)	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	Fish	E	LE
	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
METHUEN (6)	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	Fish	E	LE
	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	

TOWN	SCIENTIFIC NAME	COMMON NAME	TAXONOMIC CLASS	STATE RANK	FEDERAL RANK
METHUEN (cont)	CLEMMYS INSCULPTA	WOOD TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
NEWBURYPORT (17)	ACCIPITER COOPERII	COOPER'S HAWK	Bird	SC	
	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	Fish	E	LE
	ACIPENSER OXYRHYNCHUS	ATLANTIC STURGEON	Fish	E	LTC
	AMMODRAMUS SAVANNARUM	GRASSHOPPER SPARROW	Bird	T	
	BARTRAMIA LONGICAUDA	UPLAND SANDPIPER	Bird	E	
	BOTAURUS LENTIGINOSUS	AMERICAN BITTERN	Bird	E	
	CHARADRIUS MELODUS	PIPING PLOVER	Bird	T	LELT
	CIRCUS CYANEUS	NORTHERN HARRIER	Bird	T	
	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
	RALLUS ELEGANS	KING RAIL	Bird	T	
	STERNA HIRUNDO	COMMON TERN	Bird	SC	
	ARISTIDA TUBERCULOSA	SEABEACH NEEDLEGRASS	Vascular Plant	SC	
	BIDENS EATONII	EATON'S BEGGAR-TICKS	Vascular Plant	T	
	CYPERUS ENGELMANNII	ENGELMANN'S UMBRELLA-SEDGE	Vascular Plant	SC	
	RUMEX PALLIDUS	SEABEACH DOCK	Vascular Plant	T	
	SCIRPUS FLUVIATILIS	RIVER BULRUSH	Vascular Plant	SC	
	SCIRPUS LONGII	LONG'S BULRUSH	Vascular Plant	E	
N. ANDOVER (6)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	

TOWN	SCIENTIFIC NAME	COMMON NAME	TAXONOMIC CLASS	STATE RANK	FEDERAL RANK
N. ANDOVER (cont)	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
	CRANGONYX ABERRANS	MYSTIC VALLEY AMPHIPOD	Crustacean	SC	
	MITOURA HESSELI	HESSEL'S HAIRSTREAK	Lepidoptera	SC	
SALISBURY (9)	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	Fish	E	LE
	ACIPENSER OXYRHYNCHUS	ATLANTIC STURGEON	Fish	E	LTC
	CHARADRIUS MELODUS	PIPING PLOVER	Bird	T	LELT
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
	STERNA HIRUNDO	COMMON TERN	Bird	SC	
	ARISTIDA TUBERCULOSA	SEABEACH NEEDLEGRASS	Vascular Plant	SC	
	CAREX RECTA	SALINE SEDGE	Vascular Plant	E	
	PARONYCHIA ARGYROCOMA	SILVERLING	Vascular Plant	E	
TEWSKBURY (5)	CISTOTHORUS PLATENSIS	SEDGE WREN	Bird	E	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	CLEMMYS INSCULPTA	WOOD TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
	PANICUM PHILADELPHICUM	PHILADELPHIA PANIC-GRASS	Vascular Plant	SC	
TYNGSBOROUGH (2)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	ERYNNIS PERSIUS PERSIUS	PERSIUS DUSKYWING	Lepidoptera	T	
W. NEWBURY (11)	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	Fish	E	LE
	AMMODRAMUS SAVANNARUM	GRASSHOPPER SPARROW	Bird	T	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	

TOWN	SCIENTIFIC NAME	COMMON NAME	TAXONOMIC CLASS	STATE RANK	FEDERAL RANK
W. NEWBURY (cont)	GALLINULA CHLOROPUS	COMMON MOORHEN	Bird	SC	
	HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	Bird	E	LTNL
	VERMIVORA CHRYSOPTERA	GOLDEN-WINGED WARBLER	Bird	E	
	CINCINNATIA WINKLEYI	NEW ENGLAND SILTSNAIL	Snail	SC	
	BIDENS EATONII	EATON'S BEGGAR-TICKS	Vascular Plant	T	
	CYPERUS ENGELMANNII	ENGELMANN'S UMBRELLA-SEDGE	Vascular Plant	SC	
	ERIOCAULON PARKERI	ESTUARY PIPEWORT	Vascular Plant	E	
	RUMEX PALLIDUS	SEABEACH DOCK	Vascular Plant	T	
WESTFORD (7)	AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	Amphibian	SC	
	BOTAURUS LENTIGINOSUS	AMERICAN BITTERN	Bird	E	
	CLEMMYS GUTTATA	SPOTTED TURTLE	Reptile	SC	
	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	Reptile	T	
	IXOBRYCHUS EXILIS	LEAST BITTERN	Bird	E	
	CRANGONYX ABERRANS	MYSTIC VALLEY AMPHIPOD	Crustacean	SC	
	ROTALA RAMOSIOR	TOOTHCUP	Vascular Plant	E	

~~State Rank~~
E = Endangered
T = Threatened
SC = Special Concern

Attachment 4b – Fish Species

Fish species in the Merrimack Watershed

Common Name	Scientific Name
3-spine stickleback	*Gasterosteus aculeatus*
4-spine stickleback	*Apeltes quardracus*
9-spine stickleback	*Pungitius pungitius*
Alewife	*Alosa pseudoharengus*
American shad	*Alosa sapidissima*
American smelt	*Osmerus mordax*
Atlantic salmon	*Salmo salar*
Atlantic silverside	*Menidia menidia*
Atlantic sturgeon	*Acipenser oxyryhnchus*
Banded killifish	*Fundulus diaphanus*
Banded Sunfish	*Enneacanthus obesus*
Black Crappie	*Pomoxis nigromaculatus*
Blacknose dace	*Rhinichthys atratulus*
Blueback herring	*Alosa astivalis*
Bluegill	*Lepomis macrochirus*
Bowfin	*Amia calva*
Bridle shiner	*Notropis bifrenatus*
Brown bullhead	*Ictalurus nebulosus*
Carp	*Cyprinus carpio*
Chain pickerel	*Esox niger*
Channel catfish	*Ictalurus punctatus*
Common shiner	*Luxilis cornutus*
Eel	*Anguilla rostrata*
Fallfish	*Semotilus corporalis*
Gizzard shad	*Dorosoma cepedianum*
Golden Shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Largemouth bass	*Micropterus salmoides*
Longnose dace	*Rhinichthys cataractae*
Margined madtom	*Noturus insignis*
Mummichog	*Fundulus heteroclitus*
Northern pike	*Esox lucius*
Northern pipefish	*Syngnathus fuscus*
Pumpkinseed	*Lepomis gibbosus*
Red breast sunfish	*Lepomis macrochirus*
Sand lance	*Ammodytes hexapterus*
Sea lamprey	*Petromyzon marinus*
Shortnose sturgeon	*Acipenser brevirostrum*
Smallmouth bass	*Micropterus dolomieu*
Spottail shiner	*Notropus hudsonius*
Striped bass	*Morone saxatilis*
Swamp Darter	*Etheostoma fusiforme*
Tessellated Darter	*Etheostoma olmstedi*
White catfish	*Ictalurus catus*
White perch	*Morone americana*
White Sucker	*Catostomus commersoni*
Yellow bullhead	*Ictalurus natalis*
Yellow Perch	*Perca flavescens*

Sources: Jerome et al. 1965; USACE 1971; Hartel et al. 199

Attachment 4c – Trout Stocked Waterbodies

Merrimack River Watershed
Trout stocked waterbodies

Waterbody	*Town*
Powow River	Amesbury
Little River	Haverhill
Plug Pond (Lake Saltonstall)	Haverhill
Lake Pentucket	Haverhill
E. Meadow Brook	Haverhill
Millvale Reservoir	Haverhill
Bartlett Brook	Methuen
Forest Lake	Methuen
Spicket River	Methuen
Bennetts Brook	Ayer
Deep Brook	Chelmsford
Stony Brook	Chelmsford
Crooked Springs Brook	Chelmsford
Richardson Brook	Dracut
Beaver Brook	Dracut
Salmon Brook	Dunstable
Massapoag Pond	Dunstable
Cow Pond Brook	Groton
Baddacook Pond	Groton
Knopps Pond/Lost Lake	Groton
Beaver Brook	Littleton
Bennetts Brook	Littleton
Bridge Meadow Brook	Tyngsborough
Long Sought-For Pond	Westford
Stony Brook	Westford

Source: DFWELE 2000

Attachment 4d – Atlantic Sturgeon

ATLANTIC STURGEON DISTRIBUTION–HISTORIC AND CURRENT STATUS–UNITED STATES

State	System	Historic Presence	Current Spawning Presence (sexually mature adults or < age 1)	Current Juvenile-subadult Presence (≥ age 2)	Source / Comments
ME	Androscoggin River	YES	Unknown	YES	Squiers (1998); spawning very likely
ME	Kennebec River	YES	YES	YES	Squiers (1998); adults & juveniles in 1997
ME	Penobscot River	YES	NO?	YES?	Squiers (1998); sampling but no captures
ME	Sheepscot River	YES?	Unknown	YES	Squiers (1998); subadults present, likely a nursery area
NH	Piscataqua River System	Unknown	NO?	YES	Squiers (1998); gravid female captured in 1990; 1981 subadult capture
NH/MA	Merrimack River	YES	NO?	YES	Squiers (1998); maybe a subadult nursery area only
MA	Taunton River	YES?	NO?	YES	Burkett and Kynard (1993); subadults captured 1991+1992
MA/CT	Connecticut River	YES	NO	YES	Savoy (1996 and pers. comm.); adult stock thought extinct
CT	Housatonic River	Unknown	NO	YES	Savoy (pers. comm.); subadults captured
CT	Thames River	NO	NO	YES	Savoy (pers. comm.); subadults only
NY	Hudson River	YES	YES	YES	Kahnle et al. (1998); all life stages occur
NJ/DE/PA	Delaware River	YES	YES	YES	Kahnle et al. (1998); declining but present
PA/MD	Susquehanna River	YES	Unknown	Unknown	Kahnle et al. (1998); dams block access in PA, no recent reports in MD
MD	Nanticoke River	YES	Unknown	NO	H. Speir (MD DNR, 1996), only fish present are from the 1996 stocking of Hudson River fish
MD	Potomac River	YES	Unknown	YES	Kahnle et al. (1998); no recent captures or reports
VA	James River	YES	YES	YES	Spells (1997); age 0 captured 1997
VA	York River	YES	Unknown	YES	Spells (1997); subadults captured 1997
VA	Rappahannock River	YES	Unknown	YES	Spells (1997); subadults captured 1997
NC	Roanoke River	YES	YES	Unknown	Moser (1998); age 0 present-Albemarle Sd.

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ATLANTIC STURGEON HABITAT AVAILABILITY AND ACCESSIBILITY

State	River	Historically Accessible River Habitat	Location of Any Impediment Blocking Access to Historic Habita (Name & River km)
ME	Androscoggin	40 km	Brunswick Dam (rkm 40)
ME	Kennebec	98 km	Edwards Dam (rkm 71)
ME	Penobscot	71 km	Veazie Dam (rkm 56)
ME	Sheepscot	32 km (shoals)	Head Tide Dam (rkm 35)
ME/NH	Salmon Falls	30 km	Salmon Falls Dam (rkm 25)
NH	Lamprey	Packers Falls (km?)	McCallen Dam (rkm ?)
NH	Oyster	17.6 km	Place? (rkm 16)
NH/MA	Merrimack	113 km	Essex Dam (rkm 46)
MA/CT	Connecticut	140 km(South Hadley Falls)	Holyoke Dam (rkm 140)
CT	Housatonic	123 km	Derby Dam (23.5 rkm)
NY	Hudson	181 km	Federal Dam (246 rkm)
NJ/DE/PA	Delaware	220 km	none
PA/MD	Susquehanna	50 km	Conowingo Dam (rkm 16)
MD/VA	Potomac	Great Falls (km?)	Little Falls Dam (rkm ?)
VA	Rappahannock	160 km	none
VA	York	80 km	none
VA	James	130 km	none
NC	Roanoke	unknown	Roanoke Rapids Dam (rkm 220)
NC	Tar-Pamlico	unknown	Rocky Mt. Dam (rkm 136)
NC	Neuse	378 km (falls)	Milburnie Dam (rkm 353)
NC	Cape Fear	unknown	Locks and Dam #1 (rkm 90)
SC	Great Peedee	unknown	Dam#1

ATLANTIC STURGEON HABITAT AVAILABILITY AND ACCESSIBILITY (cont.)

State	River	Historically Accessible River Habitat	Location of Any Impediment Blocking Access to Historic Habita (Name & River km)
SC	Santee	unknown	Wilson Dam
SC	Ashepoo	unknown	none
SC	Combahee	unknown	none
SC	Edisto	unknown	none

CURRENT CONSERVATION EFFORTS

State	Year	River	Description	Investigator	Funding Sources	Project Number
ME	1976-81	Kennebec	Distribution and abundance of Atlantic sturgeon in the Kennebec River Estuary	Tom Squiers	Anadromous Fish Conservation Act	AFC-19/20
MA	1987,88	Merrimack	Survey of Atlantic sturgeon population in the Merrimack	Joseph DiCarlo	Anadromous Fish Conservation Act	AFC-15/21
	1991,92	Taunton River and Mount Hope Bay	Study annual movements feeding and spawning habitats and species interactions of sturgeon populations in the Taunton River and Mount Hope Bay		Anadromous Fish Conservation Act	AFC-24
CT	1991, 92, 94,95,96, 97	Connecticut and Thames	Monitor population levels, location, and movements of shortnose and Atlantic sturgeon	Tom Savoy	Anadromous Fish Conservation Act	AFC-20/21/22/23
DE	1992,93, 94,95	Delaware	Marking and recapture study to look at population status and migratory movements.		Anadromous Fish Conservation Act	AFC-6/7/8/12

CURRENT CONSERVATION EFFORTS (cont.)

Table 3. Shortnose Sturgeon Population Estimates*

Locality	Time	Type	Marked (m)	Captured (c)	Re-captured	Estimate Type	Population estimate	Precision 95% CI		Source
Saint John	1973-77	Adult	3,705	4,082	343	S-J	18,000	± 30%		Dadswell 1979
Kennebec	1977-81	Adult	703	272	56	SCH	7,222	5,046	10,765	Squiers et al. 1982
Merrimack	1989	Spawning males				CAP	5	5	20	Kynard unpublished data
	1988-90	Spawning males				CAP	12	10	28	Kynard unpublished data
	1989-90	Total				CAP	33	18	89	Kynard unpublished data
Upper Connecticut	1992	Spawning				CAP	47	33	80	Kynard unpublished data
	1993	Spawning				CAP	98	58	231	Kynard unpublished data
	1976-77	Total	51	162	16	PET	516	317	898	Taubert 1980
	1976-78	Total	51	56	4	PET	714	280	2,856	Taubert 1980
	1977-78	Total	119	56	18	PET	370	235	623	Taubert 1980
	1976-78	Total	170	56	24	PET	297	267	618	Taubert 1980
Lower Connecticut	1988-93	Adult				SHU	895	799	1,018	Savoy and Shake 1993
	1988-93	Adult				SCH	875			
	1988-93	Adult				CHA	856			
Hudson	1979	Spawning	548	899	38	PET	12,669			Dovel 1979
	1980	Spawning	811	698	40	PET	13,844			Dovel 1979
	1980	Total					30,311			Dovel 1979 (extrapolation)
	1995	Adult	1909	2201	29	CAP	38,024	26,427	55,072	Bain et al. 1995
Delaware	1981-84	Partial				PET	14,080	10,079	20,378	Hastings et al. 1987
	1981-84	Partial				SCH	12,796	10,288	16,267	Hastings et al. 1987
	1983	Partial				S-J	6,408			Hastings et al. 1987
Ogeechee	1993	Total	31	36	5	SCH	361	326	400	Rogers and Weber 1994
Altamaha	1988	Total	64	87	1	SCH	2,862	1,069	4,226	
	1990	Total	112	175	24	SCH	798	645	1,045	

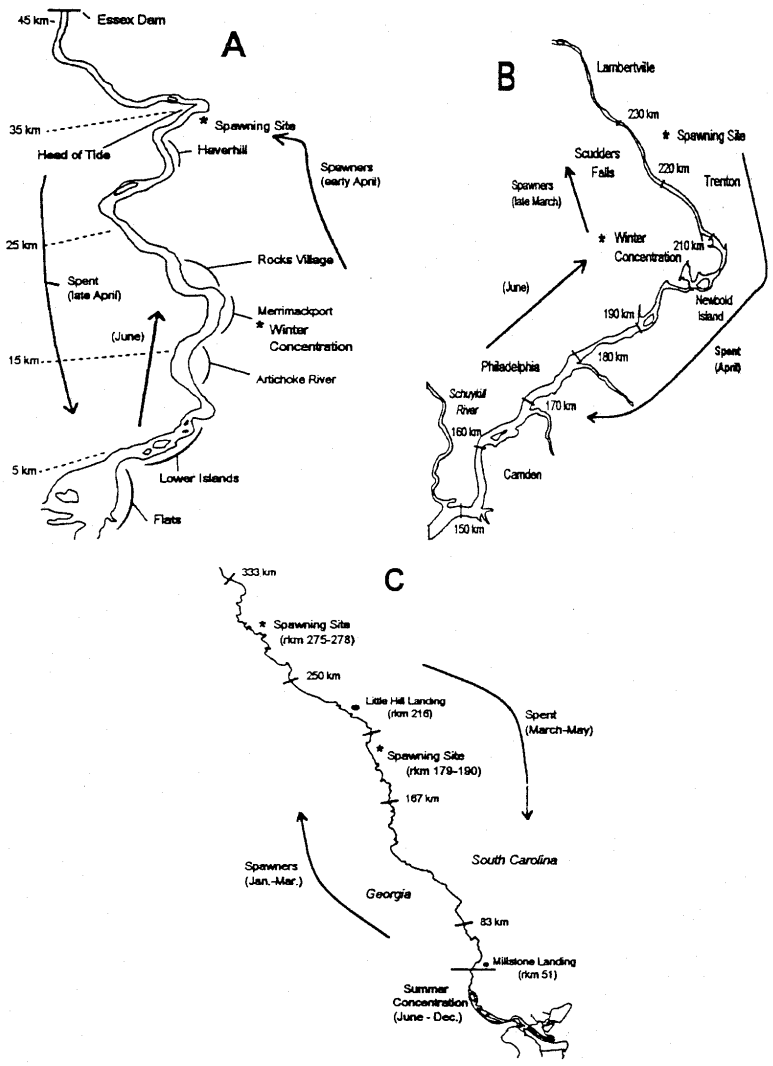


Figure 3. Recently documented migration patterns of shortnose sturgeon in the following rivers: A) Merrimack (Kieffer and Kynard 1993), B) Delaware (O'Herron et al. 1993), and C) Savannah (Hall et al. 1991).

Attachment 4e – Anadromous Fish Data

HISTORIC DATA
ANADROMOUS FISH RETURNS

Year	River Herring*	American Shad	Atlantic Salmon
1982			23
1983	4794	5629	114
1984	1769	5497	115
1985	23112	12793	213
1986	16265	18173	103
1987	77209	16909	139
1988	361012	12359	65
1989	387973	7875	84
1990	254242	6013	248
1991	379588	16098	332
1992	102166	20796	199
1993	14027	8599	61
1994	88913	4349	21
1995	33425	13857	34
1996	51	11322	76
1997	403	22586	71
1998	1362	27891	123
1999	7898	56465	192
2000	24576	85536	84
TOTAL	**1778785**	**352747**	**2297**

All counts were taken at the Essex Dam Fish Lift in Lawrence, Massachusetts
*River Herring refers collectively to two fish species: blueback herring and alewife

Attachment 4f – Vernal Pool Sites

Certified and Potential Vernal Pool sites* in the Merrimack River watershed by community

Town	# CVPs	# PVPs
Amesbury	3	25
Andover	0	33
Ayer	0	8
Boxborough	1	24
Boxford	0	22
Chelmsford	2	29
Dracut	1	73
Dunstable	5	105
Groton	0	139
Groveland	0	23
Harvard	0	35
Haverhill	9	128
Lawrence	0	3
Littleton	2	61
Lowell	0	11
Merrimac	2	26
Methuen	8	86
Newbury	0	11
Newburyport	0	8
North Andover	2	19
Tewksbury	0	20
Tyngsborough	4	153
West Newbury	1	34
Westford	67	84
Total	**107**	**1160**

*Source: NHESP 1999-2001 Massachusetts Certified and Potential Vernal Pools

Attachment 4g – Gulf of Maine

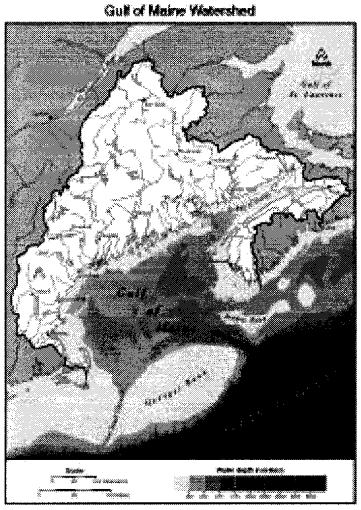
U.S. Fish and Wildlife Service Update

Identifying, mapping, protecting and restoring habitat in the Gulf of Maine watershed

Gulf of Maine
Coastal Program

The Gulf of Maine watershed, situated in the northeast corner of the United States and the southeast corner of Canada, includes more than 43,000 square miles of land in Maine, New Hampshire and Massachusetts. The watershed includes the biologically productive Gulf of Maine as well as coastal habitats (salt marshes, mudflats, sandy beaches, intertidal zone, and islands) and inland streams, rivers, lakes, ponds, bogs, deciduous and coniferous woodlands, grasslands and alpine tundra. The Gulf of Maine watershed provides productive nurseries for many marine fish, riverine pathways for historically abundant populations of anadromous fish, important habitat for breeding, migratory and wintering waterbirds and neotropical migrants, and vital habitat for nationally threatened and endangered species. Many who live in the Gulf of Maine watershed appreciate its biological wealth. However, habitat loss and degradation from sprawling development, wetland and associated upland loss, overharvesting, oil spills, pollution, and other cumulative effects of development threaten the integrity of the Gulf of Maine watershed.

Gulf of Maine Watershed



In order to protect fish and wildlife habitat for endangered, threatened or declining species in the region, the U.S. Fish and Wildlife Service's Gulf of Maine Program, in coordination with the Gulf of Maine Rivers Ecoteam, initiated a project to identify, map and rank important fish and wildlife habitat for priority species throughout the Gulf of Maine watershed. USFWS biologists selected 64 species that regularly inhabit the Gulf of Maine watershed that meet the following criteria:

- federally endangered, threatened and candidate species,
- migratory birds, anadromous and estuarine fish that are significantly declining nationwide,
- migratory birds, anadromous and estuarine fish that have been identified as threatened or endangered by two of the three states in the Gulf of Maine watershed.

Note: All species included in this analysis are listed on the reverse side.

Biologists are identifying, ranking and mapping habitat for all species -- from actual sightings, or by developing habitat suitability models reflecting the environmental requirements for each species. Once species-specific maps are created, composite maps ranking habitats for all species will be developed. All of this data will be available on a CD that can help conservationists focus habitat protection efforts in areas of greatest biological value. Results of this analysis may be used to help implement a variety of on-the-ground conservation initiatives, including:

- comprehensive planning and management activities on national wildlife refuges,
- permit and license review by state and federal agencies,
- contaminants and oil spill damage assessment and mitigation,
- identification of high value habitat to prioritize and support permanent protection through state and federal agencies, non-governmental conservation partners and willing landowners,
- habitat characterization to guide proposed restoration projects conducted by state and federal agencies and non-governmental conservation partners, and
- educational/outreach activities with conservation partners, teachers and the media.

For further information, please contact:

U.S. Fish and Wildlife Service
Gulf of Maine Coastal Program
4R Fundy Road
Falmouth, Maine 04105
(207) 781-8364
FAX (207) 781-8369
fw5es_gomp@fws.gov
http://gulfofmaine.fws.gov
Project Leader, Stewart Fefer

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Gulf of Maine watershed priority species list

Birds (48 species):
American bittern
American black duck
American woodcock
Arctic tern
Bald eagle
Bicknell's thrush
Black scoter
Black tern
Black-bellied plover
Blue-winged warbler
Canada warbler
Chestnut-sided warbler
Common loon
Common snipe
Common tern
Eastern meadowlark
Field sparrow
Grasshopper sparrow
Killdeer
Least sandpiper
Least tern
Northern flicker
Northern goshawk
Northern harrier
Olive-sided flycatcher
Osprey
Peregrine falcon
Pied-billed grebe
Piping plover
Purple sandpiper
Red knot
Red-shouldered hawk
Roseate tern
Saltmarsh sharp-tailed sparrow
Sanderling
Scaup (greater and lesser)
Sedge wren
Semipalmated sandpiper
Short-billed dowitcher
Short-eared owl
Surf scoter
Upland sandpiper
Veery
Whimbrel
White-winged scoter
Wood duck
Wood thrush

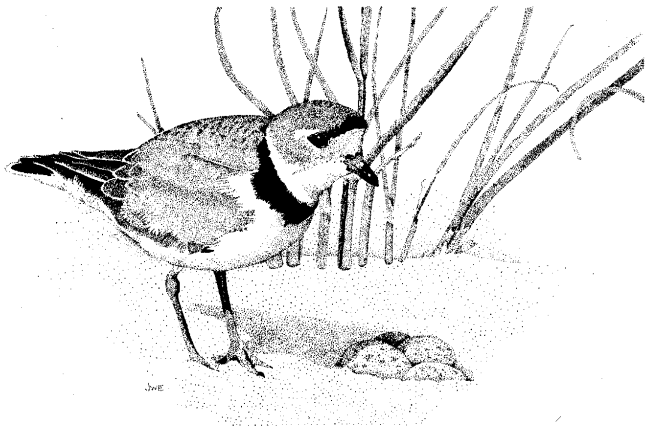
Plants (4 species):
Eastern prairie fringed orchid
Furbish's lousewort
Robbins' cinquefoil
Small whorled pogonia

Fish (9 species):
Alewife
American eel
American shad
Atlantic salmon
Atlantic sturgeon
Blueback herring
Bluefish
Shortnose sturgeon
Winter flounder

Mammal:
Canada lynx

Invertebrate:
Horseshoe crab

Herps:
Plymouth redbelly turtle



Attachment 4h – Shellfish Clean Waters Initiative

DRAFT DOCUMENT

THE SHELLFISH CLEAN WATERS INITIATIVE : A program to protect and restore coastal water quality in shellfish areas impacted by stormwater discharges and other pollution sources

Many of the Commonwealth's agencies and municipalities have complimentary goals and responsibilities regarding the protection and restoration of marine water quality, especially in those areas that do or could contain public and/or private shellfish resources. This program will promote cooperative efforts among these groups in an effort to identify and mitigate pollution sources that impact coastal marine water quality and associated coastal resources.

The ultimate goal of this program is to address the improvement of marine water quality on three fronts :
The improvement of marine water quality in areas presently closed or threatened to be closed to the taking of shellfish, maintaining water quality in areas presently approved for the taking of shellfish and lastly, the prevention of new sources of contamination to coastal resource areas. These goals will be achieved by assisting municipalities in the implementation of BMP's (best management practices) and through public education in the matter of coastal resource pollution.

Economic growth and cultural preservation can be achieved through environmental protection and restoration. Shellfish bed closures are an indicator of degraded water quality. Opening shellfish areas for commercial harvesting has economic benefits to a coastal community. Recreational shellfishing promotes a heightened awareness and appreciation of the coastal environment, resulting in a better quality of life. Improving coastal water quality will heighten a coastal community's connection to its marine resources and heritage.

This program will minimize duplicative efforts and maximize the Commonwealth's efficiency in addressing coastal pollution sources and the resultant poor water quality.
By organizing a multi-agency effort, a significant level of success in addressing the Commonwealth's coastal water quality problems will be achieved.

SCWI Priority Goals and Objectives

1) The identification of coastal water quality problems in shellfish growing areas via site assessment, water sampling and documentation.

2) The classification of areas requiring remediation , based on the complexity and magnitude of the areas problems, into categories according to the short or long term effort required or anticipated

3) The prioritization of sites according to a process developed by the Inter-Agency Working group

4) To provide technical assistance in planning the process for mitigating an areas pollution problems

5) To provide technical assistance in identifying, installing and maintaining BMP's

6) To provide assistance in identifying appropriate funding sources for mitigation projects AND assist in the preparation of application for remediation funding (when appropriate)

7) To ensure follow-up assessments in the form of Quality Assurance-Quality Control Monitoring Programs when necessary AND to report the results to agencies, technical staff and the public

8) To conduct public outreach and education with regard to coastal resource water quality/pollution problems in shellfish resource areas

Participating Agencies

MA Coastal Zone Management (CZM)

CZM will provide the services of the Initiative Coordinator as well as the assistance of technical staff in matters of site assessment, identification of BMP's, financial assistance, inter-agency communication, communication with municipalities and public education/outreach.

Mass Bays Program (MBP)

MBP and regional technical staff will act as liasons between the Initiative and the coastal communities in the Mass Bay region. Staff will contribute to resource identification and mitigation planning, and can assist with securing financial assistance for projects. Staff will also provide outreach and education efforts.

Buzzard's Bay Project (BBP)

The BBP will provide technical support to Buzzard's Bay municipalities in identifying stormwater remediation priorities, assist in the development of stormwater design, and assist towns in obtaining grant funding to address the problem.

MA Division of Marine Fisheries (DMF)

DMF will provide access to water quality data and historical background information, offer advice on pollution sources and potential mitigation practices, provide shellfish classification area maps, conduct supplemental bacterial water testing as necessary, participate in core working groups, and re-classify shellfish growing waters subsequent to pollution mitigation when deemed appropriate by the DMF Shellfish Sanitation and Management Program.

MA Department of Environmental Protection (DEP)

DEP will provide guidance and technical assistance to the Initiative through access to general and specific water quality data, water quality studies and the expertise of its staff.

Funding opportunities are available through competitive bidding programs like

Section 319 and the State Revolving Loan Program.

MA Department of Food and Agriculture (DFA)

DFA, through the Agricultural Environmental Enhancement Program, will lend advice and assistance to the Initiative in order to resolve non-point source pollution problems coming from agricultural operations.

United States Department of Agriculture/ Natural Resources Conservation Service (USDA/NRCS)

NRCS offers expertise in soils, engineering, plant sciences and natural resources planning; has data from soil surveys; will assist in the planning and evaluation of non-point source pollution issues; will provide on-site evaluation of soil characteristics and limited engineering assistance.

MA Association of Conservation Districts (MACD)

MACD will support the participation of NRCS in the Initiative.

United States Environmental Protection Agency (US EPA)

To the extent practicable, EPA supports and will participate in the inter-agency working group, and offers assistance in meeting the goals and objectives of the program.

In particular, EPA staff will be involved in grants management by providing guidance on the expenditure of federal funds. Also, EPA will support the identification, classification and prioritization of coastal water problems in shellfish areas, and provide technical assistance and support for public outreach and education.

MA Executive Office of Environmental Affairs/ Watershed Initiative (MWI)

The Watershed Initiative will provide the assistance of its basin team leaders in restoring shellfish habitat and water quality in their regions. This will include the identification of potential remediation projects and support for remediation efforts. WI personnel will assist in identifying and applying for potential remediation funding.
WI will support public outreach and education in matters of coastal resource water quality.

Academic Liason : Judy Pederson,Ph.D.

Judy works for the Massachusetts Institute of Technology (MIT) Sea Grant College Program. She will assist the committee with review of scientific documents, and advise the committee and Initiative Coordinator on subjects relative to the Initiative's projects, overall goals and objectives. Judy will assist with access to various academic institutions and scientists, facilities and students for involvement in mutually beneficial projects.

Program Management

The members of the Inter-Agency Working Group (IWG), working with the Initiative coordinator, will cooperatively manage this program on behalf of their respective agencies.

Program Funding

The program coordinator position will be funded by CZM out of existing agency funds. Signatory agencies and advisory agencies/personnel agree to contribute personnel resources on a cooperative basis. Project design and implementation funds will be sought from all available sources.

(AGENCY REP SIGNATURES TO FOLLOW)

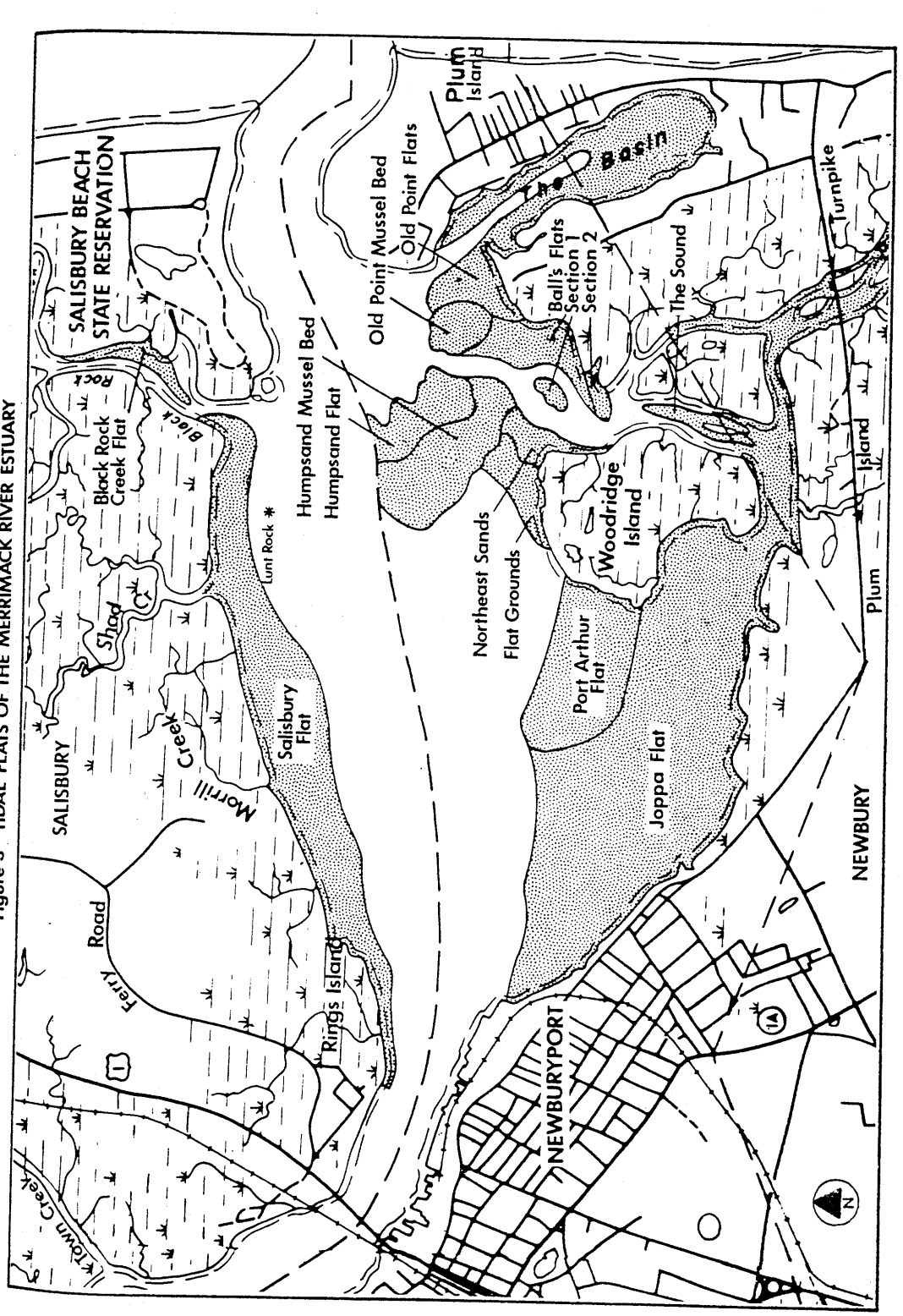
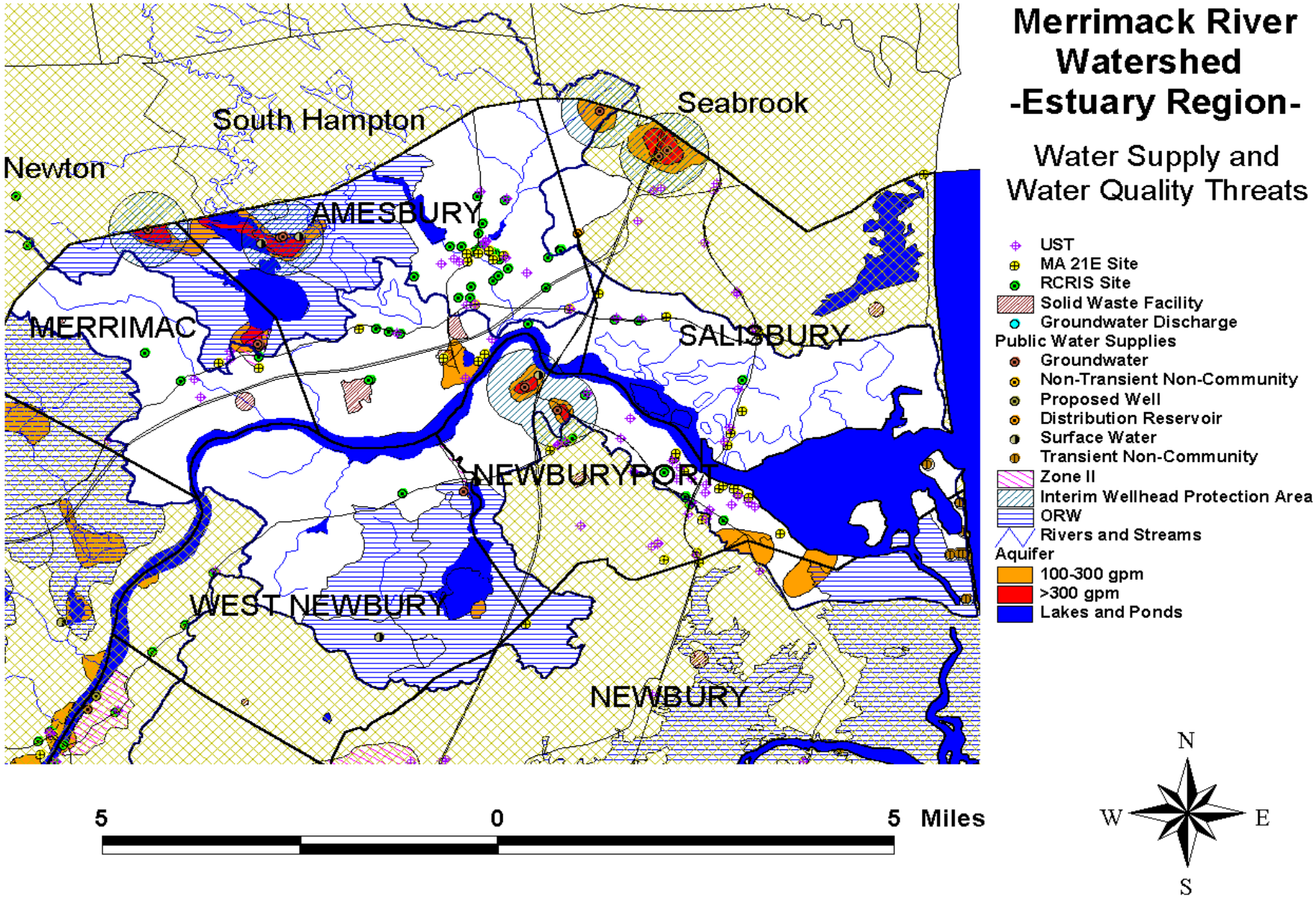


Figure 3 TIDAL FLATS OF THE MERRIMACK RIVER ESTUARY

Appendix A

Merrimack Watershed Maps showing Water Quality, Water Supply, Habitat, and Open Space Attributes

Produced by the Merrimack Watershed Team Using MassGIS Data


Merrimack River Watershed
-Estuary Region-
Water Supply and Water Quality Threats
South Hampton
Seabrook
Newton
AMESBURY
MERRIMAC
SALISBURY
NEWBURYPORT
WEST NEWBURY
NEWBURY
UST
MA 21E Site
RCRIS Site
Solid Waste Facility
Groundwater Discharge
Public Water Supplies
Groundwater
Non-Transient Non-Community
Proposed Well
Distribution Reservoir
Surface Water
Transient Non-Community
Zone II
Interim Wellhead Protection Area
ORW
Rivers and Streams
Aquifer
100-300 gpm
>300 gpm
Lakes and Ponds
5
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5 Miles
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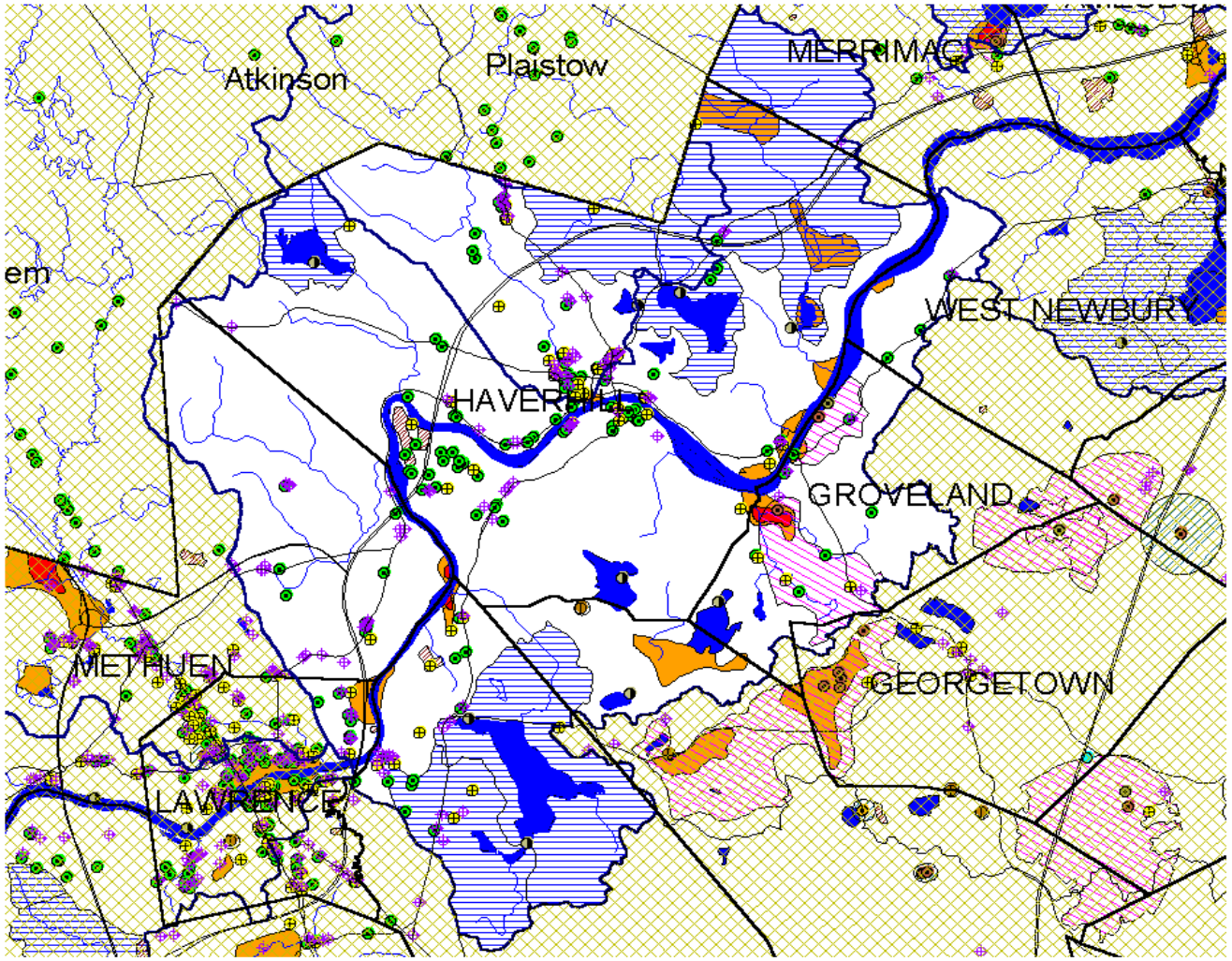
E
S



Merrimack River Watershed -Haverhill Region-

Water Supply and Water Quality Threats

- UST
- MA 21E Site
- RCRIS Site
- Solid Waste Facility
- Groundwater Discharge

Public Water Supplies

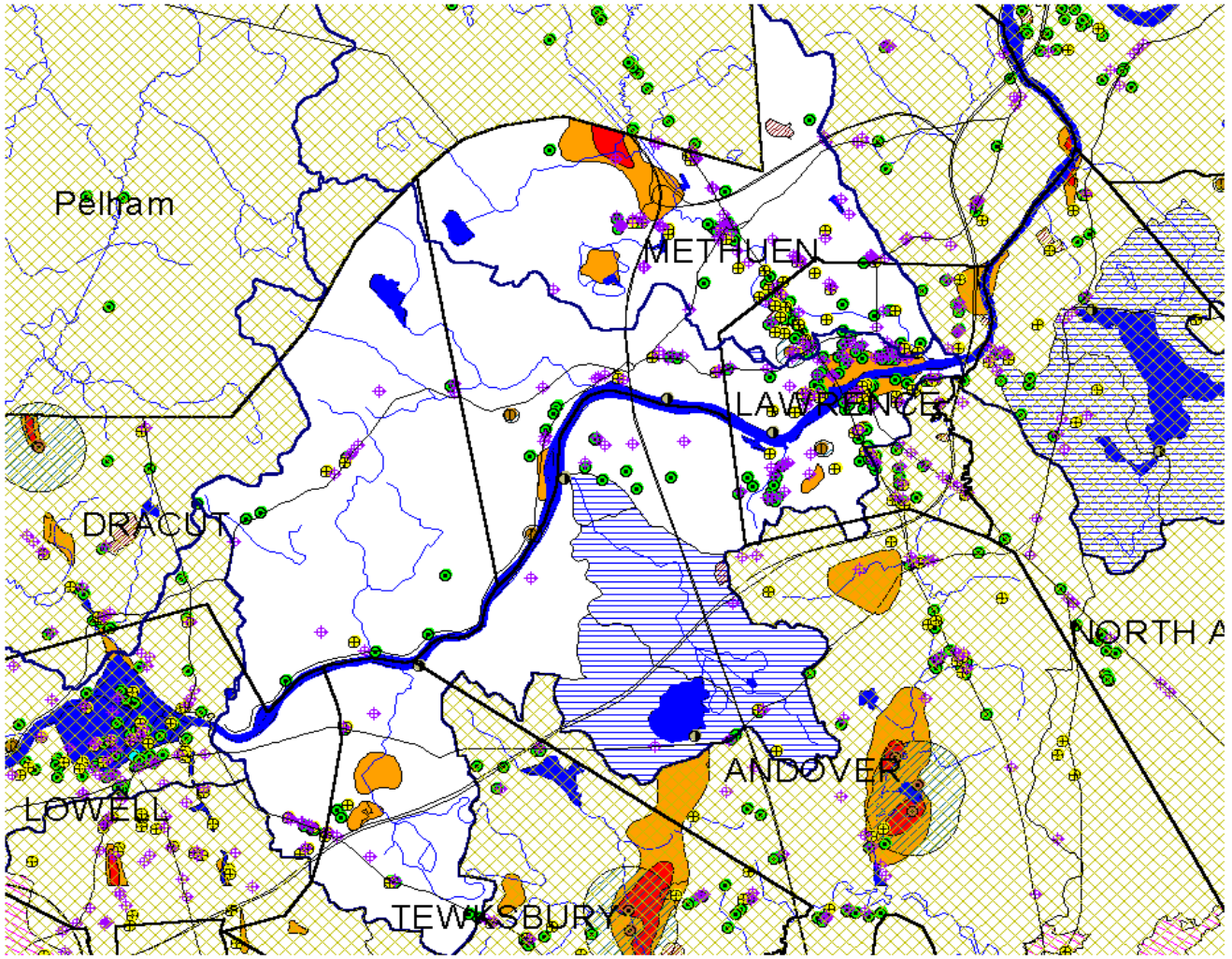
- Groundwater
- Non-Transient Non-Community
- Proposed Well
- Distribution Reservoir
- Surface Water
- Transient Non-Community
- Zone II
- Interim Wellhead Protection Area
- ORW
- Rivers and Streams

Aquifer

- 100-300 gpm
- >300 gpm
- Lakes and Ponds

6 0 6 Miles

N W E S



Merrimack River Watershed -Lawrence Region-

Water Supply and Water Quality Threats

- UST
- MA 21E Site
- RCRIS Site
- Solid Waste Facility
- Groundwater Discharge

Public Water Supplies

- Groundwater
- Non-Transient Non-Community
- Proposed Well
- Distribution Reservoir
- Surface Water
- Transient Non-Community

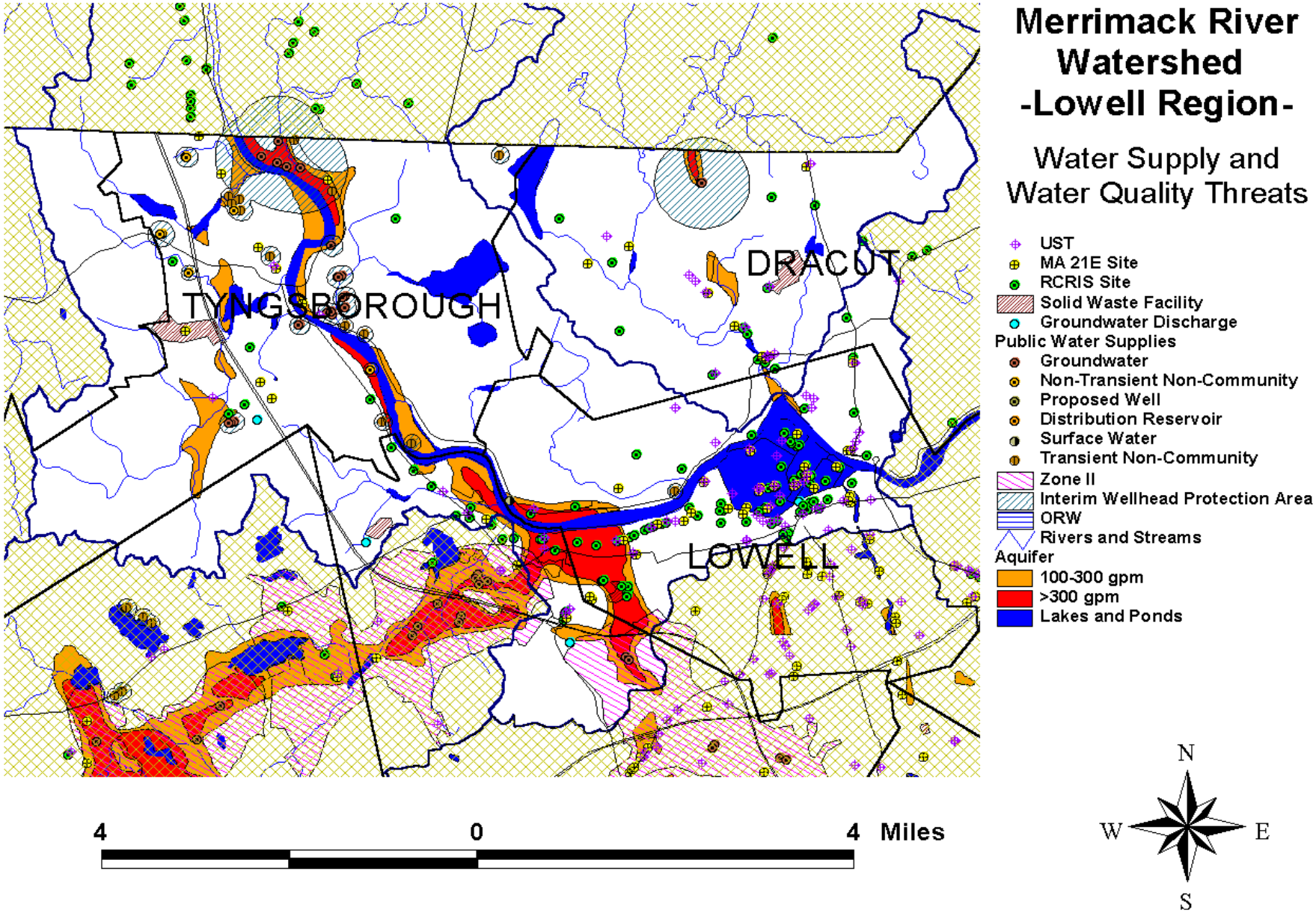
- Zone II
- Interim Wellhead Protection Area
- ORW
- Rivers and Streams

Aquifer

- 100-300 gpm
- >300 gpm
- Lakes and Ponds

5 0 5 Miles

N W E S


Merrimack River Watershed
-Lowell Region-
Water Supply and Water Quality Threats
TYNGSBOROUGH
DRACUT
LOWELL
UST
MA 21E Site
RCRIS Site
Solid Waste Facility
Groundwater Discharge
Public Water Supplies
Groundwater
Non-Transient Non-Community
Proposed Well
Distribution Reservoir
Surface Water
Transient Non-Community
Zone II
Interim Wellhead Protection Area
ORW
Rivers and Streams
Aquifer
100-300 gpm
>300 gpm
Lakes and Ponds
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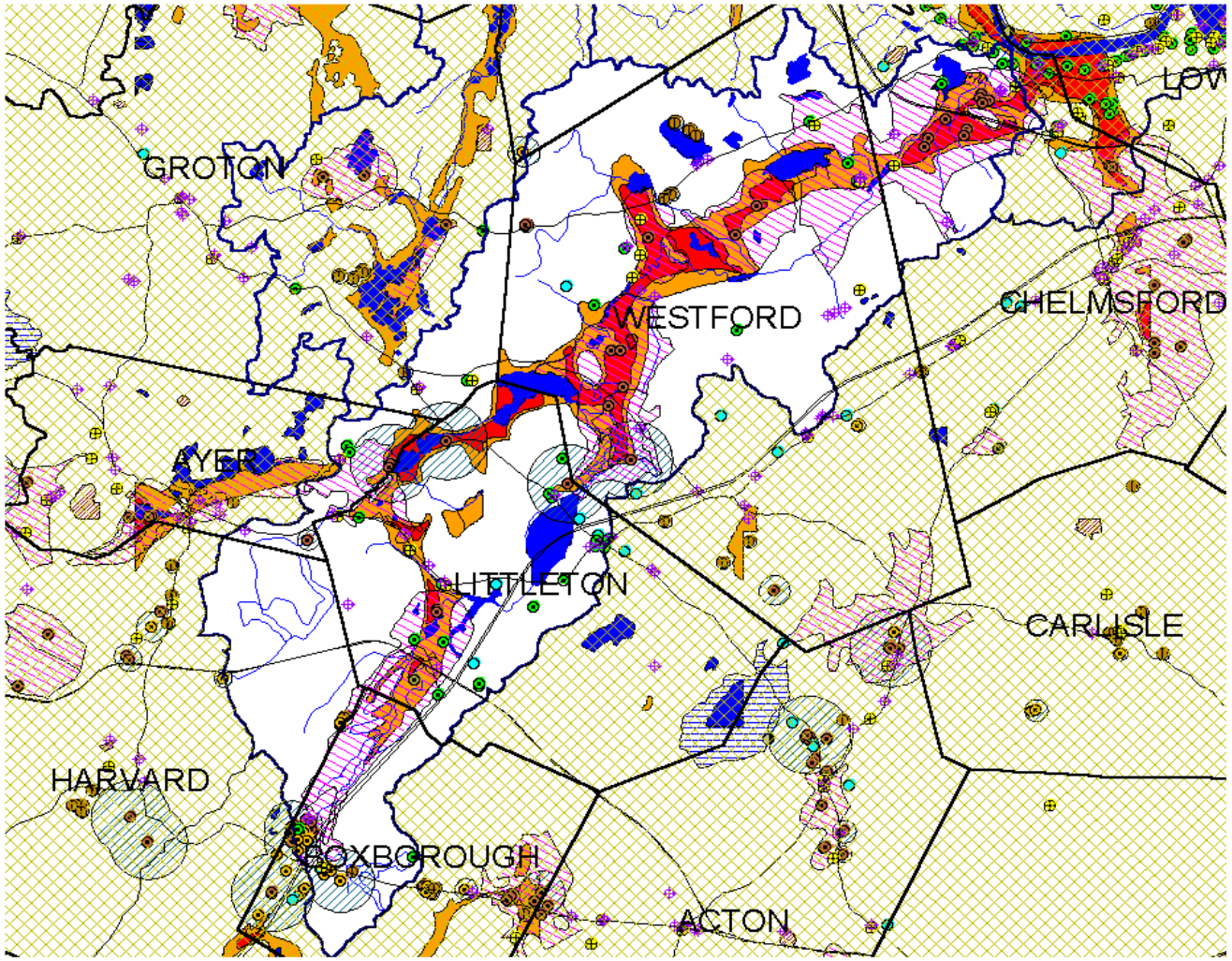


Merrimack River Watershed -Stony Brook-

Water Supply and Water Quality Threats

- UST
- MA 21E Site
- RCRIS Site
- Solid Waste Facility
- Groundwater Discharge

Public Water Supplies

- Groundwater
- Non-Transient Non-Community
- Proposed Well
- Distribution Reservoir
- Surface Water
- Transient Non-Community

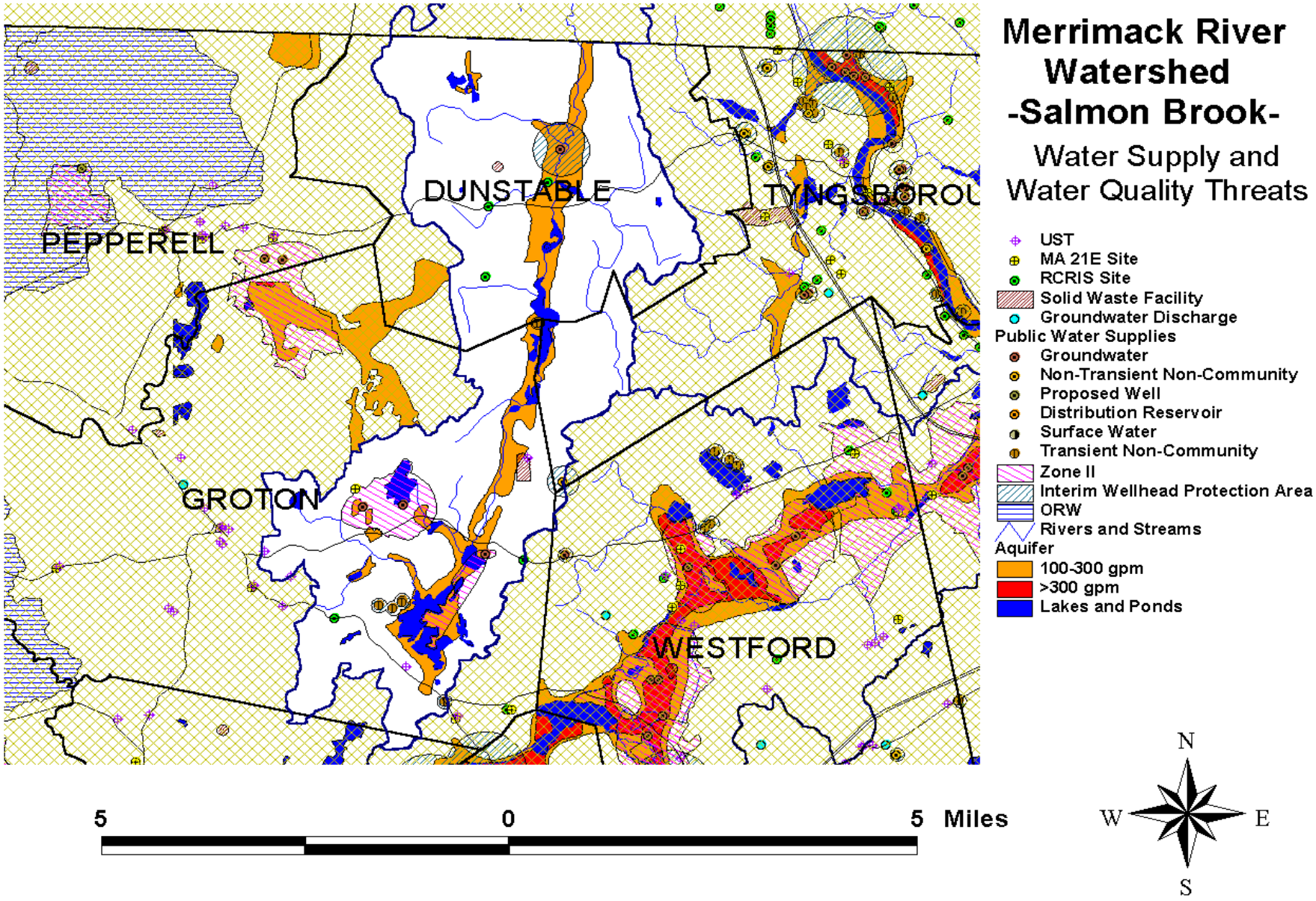
- Zone II
- Interim Wellhead Protection Area
- ORW
- Rivers and Streams

Aquifer

- 100-300 gpm
- >300 gpm
- Lakes and Ponds

6 0 6 Miles

N W E S


DUNSTABLE
TYNGSBOROU
PEPPERELL
GROTON
WESTFORD
Merrimack River Watershed
-Salmon Brook-
Water Supply and Water Quality Threats
UST
MA 21E Site
RCRIS Site
Solid Waste Facility
Groundwater Discharge
Public Water Supplies
Groundwater
Non-Transient Non-Community
Proposed Well
Distribution Reservoir
Surface Water
Transient Non-Community
Zone II
Interim Wellhead Protection Area
ORW
Rivers and Streams
Aquifer
100-300 gpm
>300 gpm
Lakes and Ponds
5 0 5 Miles
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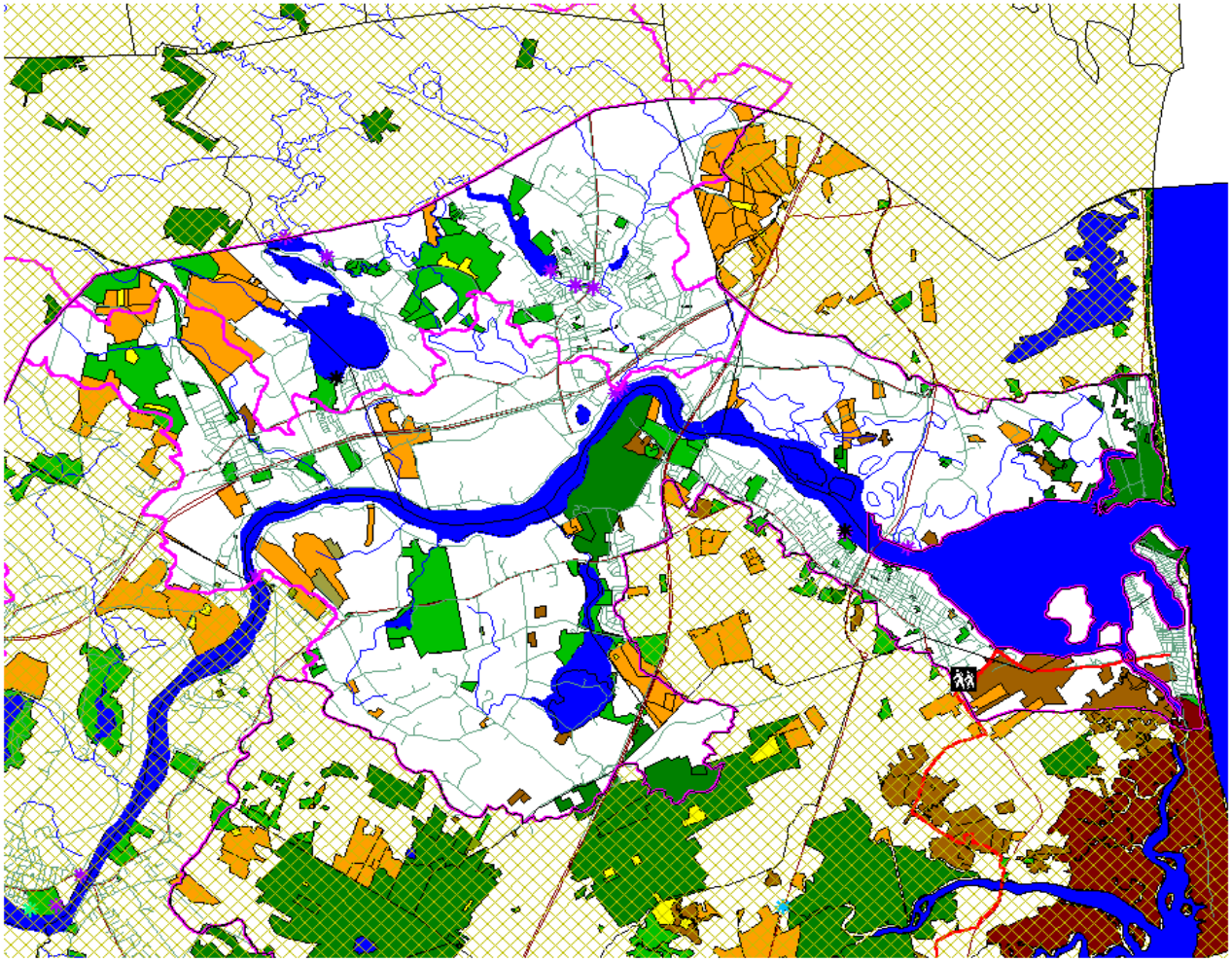


Merrimack River Watershed -Estuary Region-

Open Space and Recreation Lands

PAB Sites
- ASPHALT
- CARRY
- CONCRETE
- GRAVEL
- Canoe access

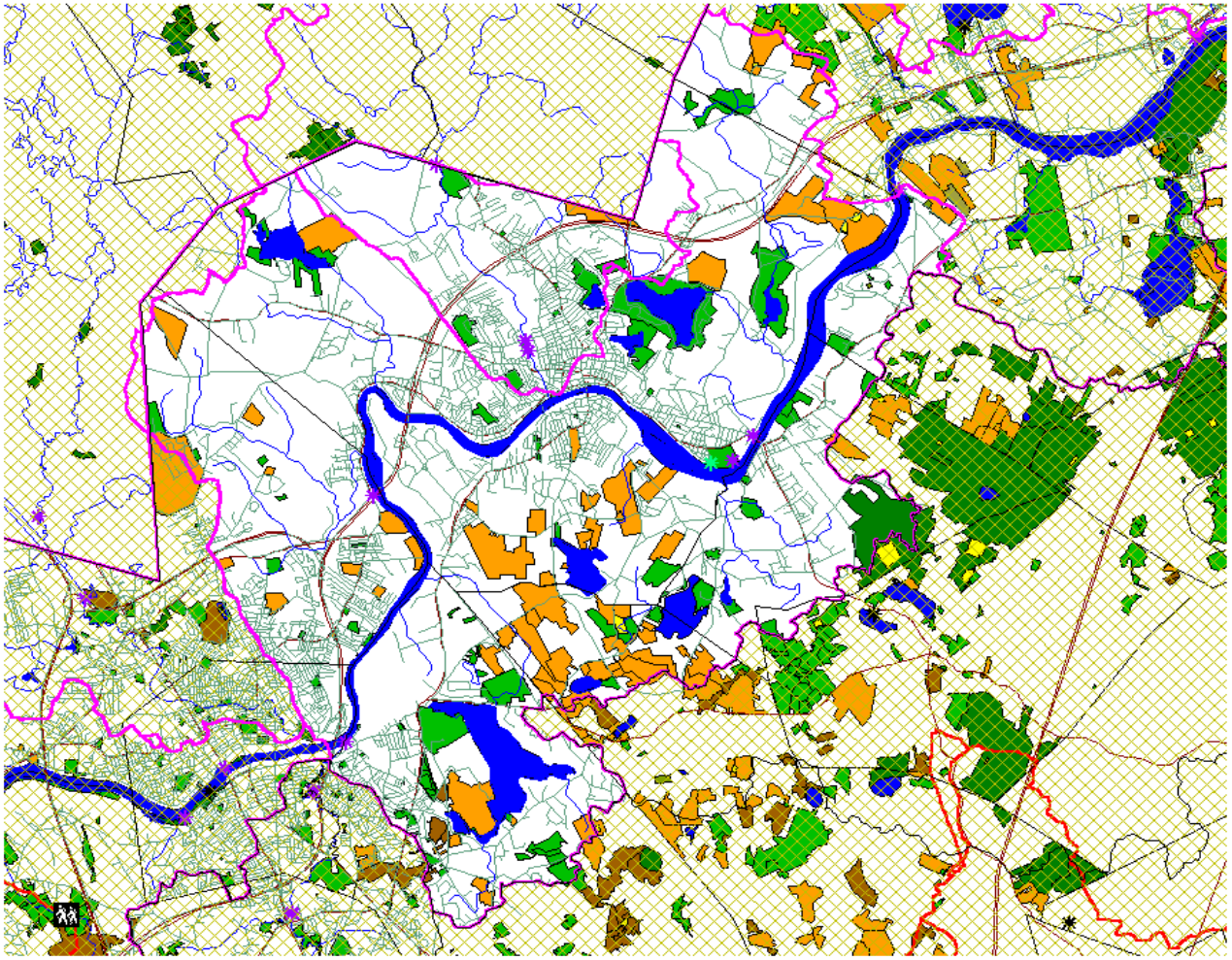
Long Distance Trails
Rivers and Streams
Roads

Protected Open Space
- Inholding
- Municipal
- Non-Profit
- Private (Ch. 61, APR)
- State
- Unknown
- Federal

Lakes and Ponds

4 0 4 8 Miles

N
W E
S



Merrimack River Watershed -Haverhill Region-

Open Space and Recreation Lands

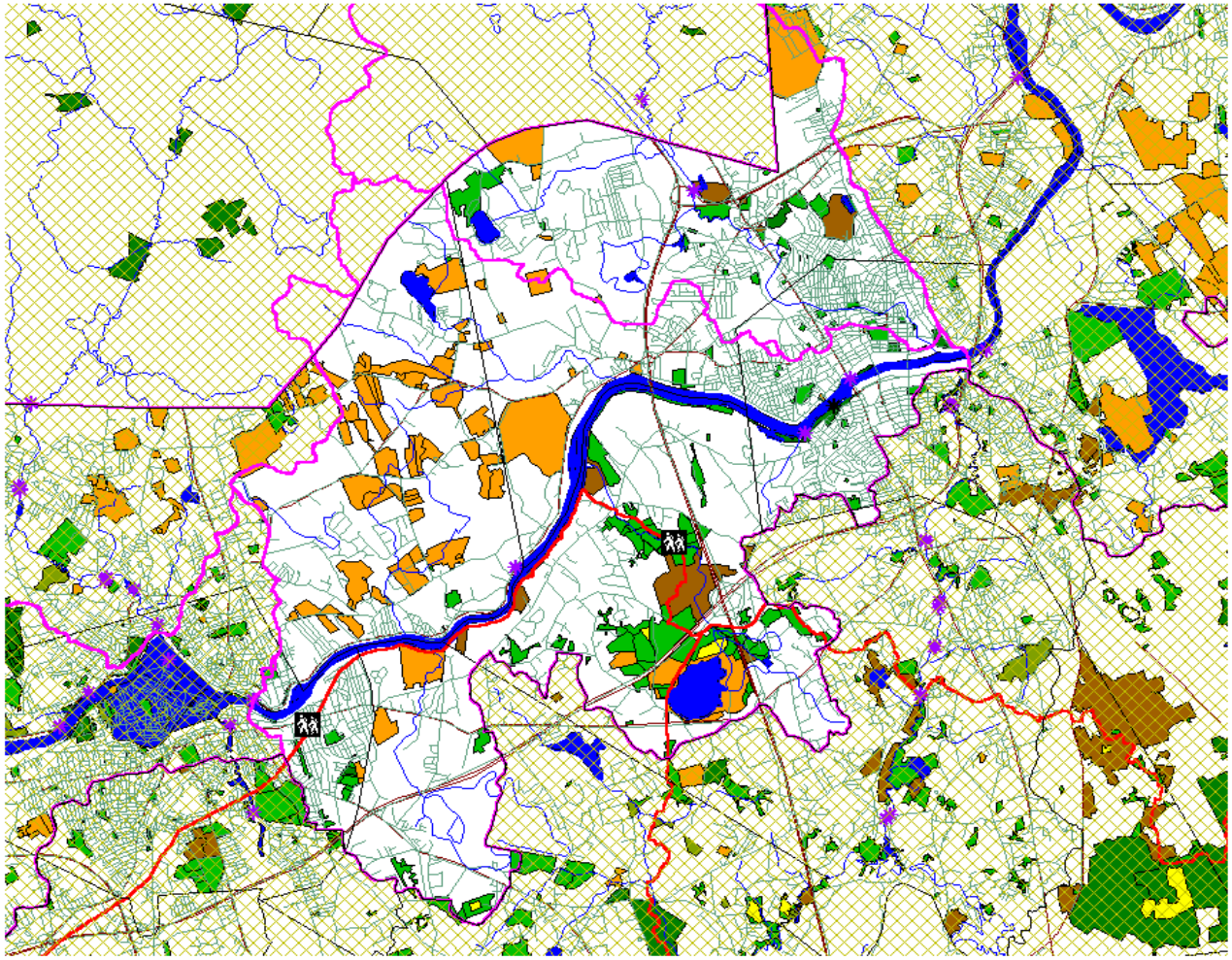
PAB Sites
- ASPHALT
- CARRY
- CONCRETE
- GRAVEL
- Canoe access

Long Distance Trails
Rivers and Streams
Roads

Protected Open Space
- Inholding
- Municipal
- Non-Profit
- Private (Ch. 61, APR)
- State
- Unknown
- Federal
- Lakes and Ponds

4 0 4 8 Miles

N
W E
S



Merrimack River Watershed -Lawrence Region-

Open Space and Recreation Lands

PAB Sites
- ASPHALT
- CARRY
- CONCRETE
- GRAVEL
- Canoe access

Long Distance Trails
Rivers and Streams
Roads
Lakes and Ponds

Protected Open Space
- Inholding
- Municipal
- Non-Profit
- Private (Ch. 61, APR)
- State
- Unknown
- Federal

4 0 4 8 Miles

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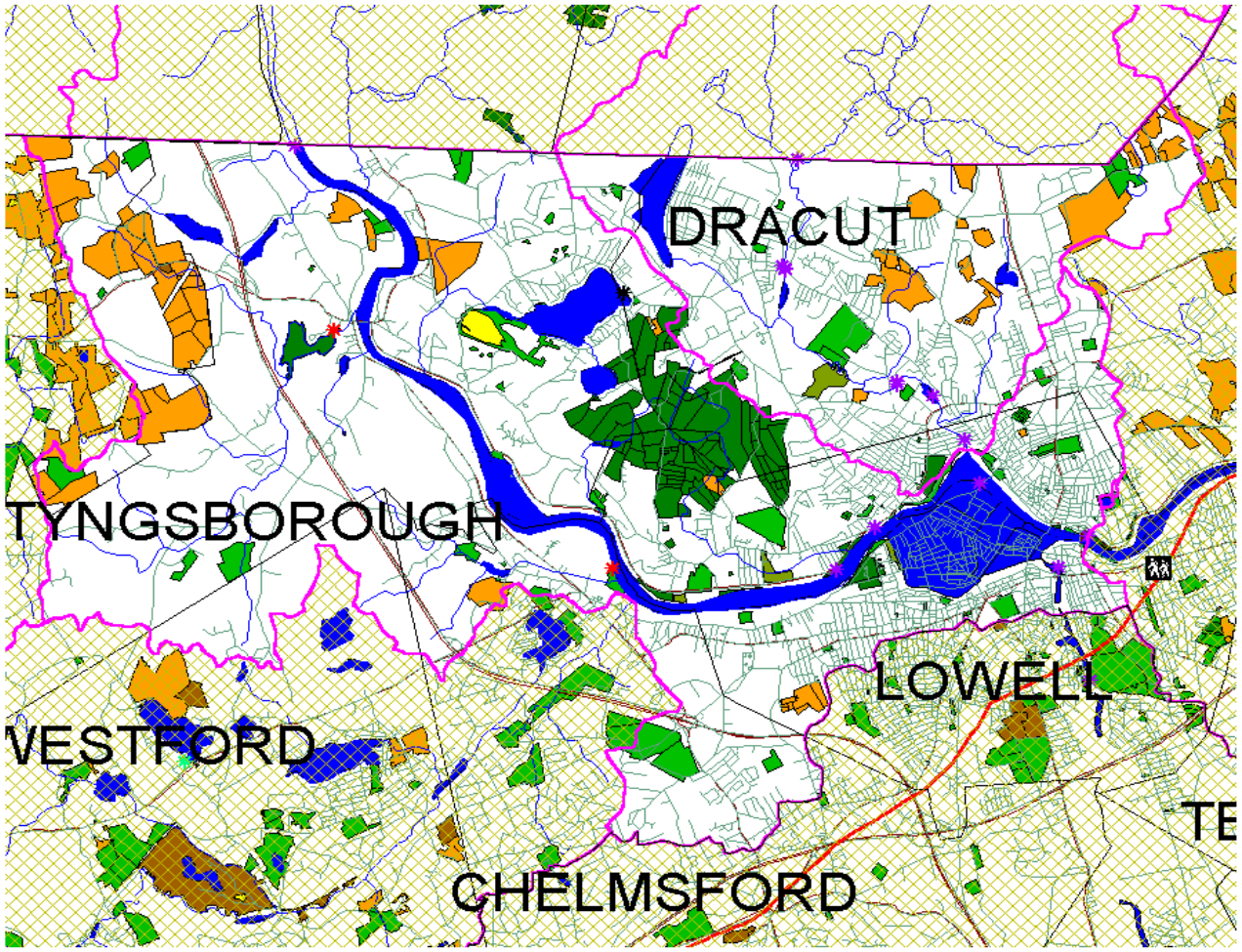


Merrimack River Watershed -Lowell Region-

Open Space and Recreation Lands

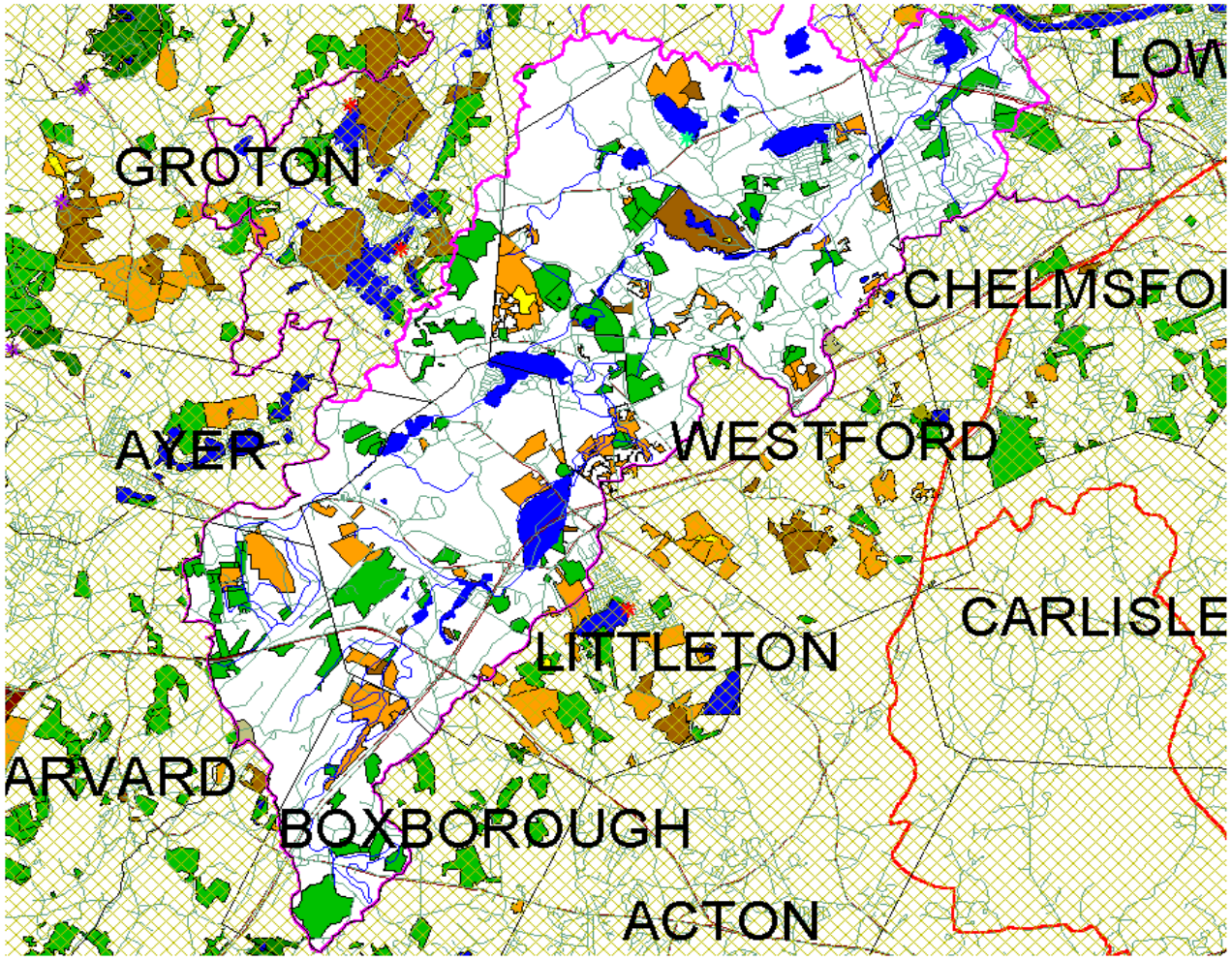
PAB Sites
- ASPHALT
- CARRY
- CONCRETE
- GRAVEL
- Canoe access

Long Distance Trails
Rivers and Streams
Roads
Lakes and Ponds

Protected Open Space
- Inholding
- Municipal
- Non-Profit
- Private (Ch. 61, APR)
- State
- Unknown
- Federal

4 0 4 8 Miles

N
W E
S



Merrimack River Watershed -Stony Brook-

Open Space and Recreation Lands

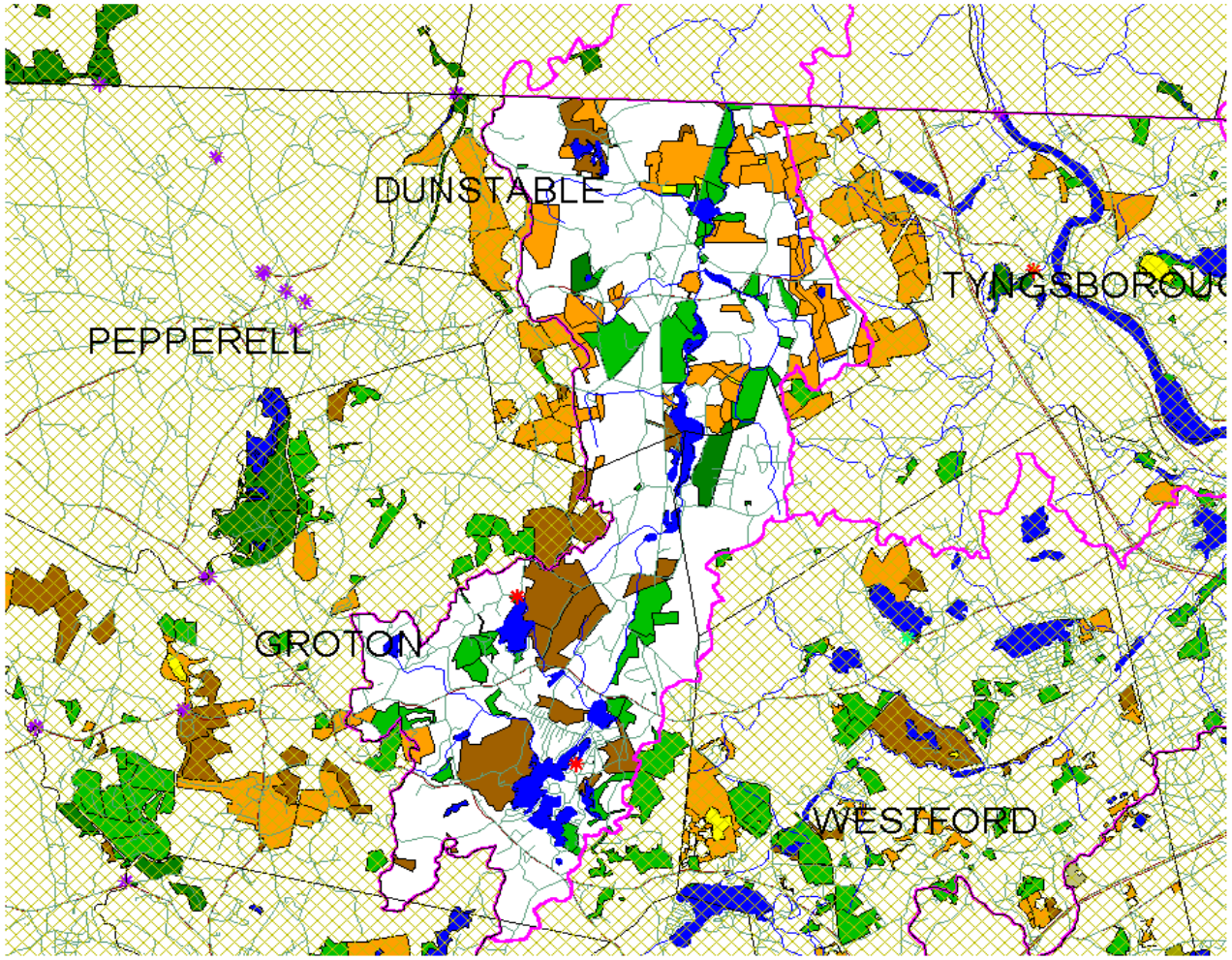
PAB Sites
- ASPHALT
- CARRY
- CONCRETE
- GRAVEL
- Canoe access

Long Distance Trails
Rivers and Streams
Roads
Lakes and Ponds

Protected Open Space
- Inholding
- Municipal
- Non-Profit
- Private (Ch. 61, APR)
- State
- Unknown
- Federal

4 0 4 8 Miles

N
W E
S



Merrimack River Watershed -Salmon Brook-

Open Space and Recreation Lands

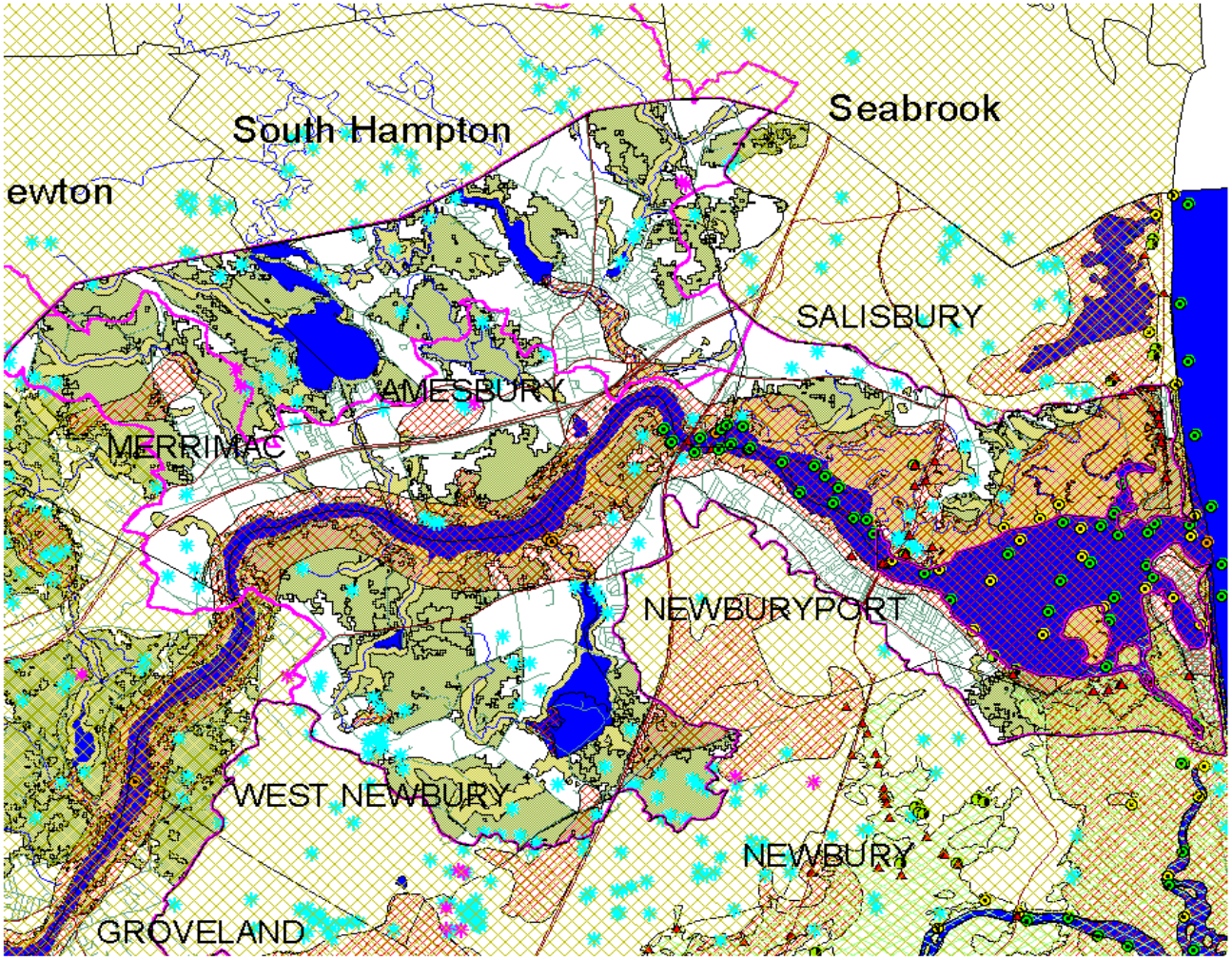
PAB Sites
- ASPHALT
- CARRY
- CONCRETE
- GRAVEL
- Canoe access

Long Distance Trails
Rivers and Streams
Roads
Lakes and Ponds

Protected Open Space
- Inholding
- Municipal
- Non-Profit
- Private (Ch. 61, APR)
- State
- Unknown
- Federal

4 0 4 8 Miles

N
W E
S



Merrimack River Watershed -Estuary Region-

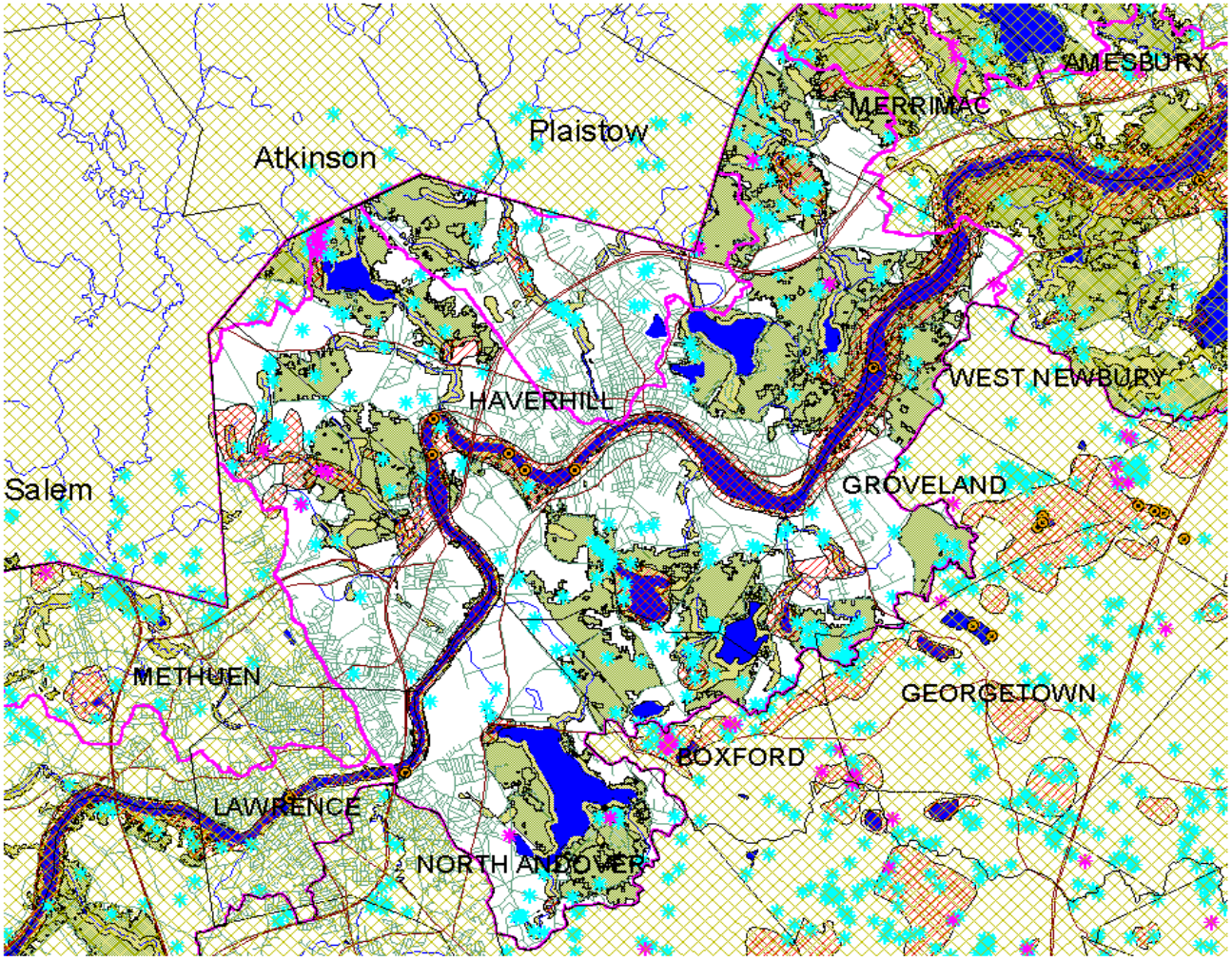
Habitat Conditions

- Eelgrass beds
- Tidal restrictions
- Shellfish sites
- Saltmarsh Restoration sites
- Certified vernal pools*
- Anadromous fish sites
- Potential vernal pools
- ACECs
- Priority Habitat sites*
- Est. Habitat of Rare Wildlife*
- Rivers and Streams
- Lakes and Ponds
- Natural riparian corridor
- Natural contiguous lands

2 0 2 4 Miles

N
W E
S

*NHESP 1999-2001 Massachusetts Certified Vernal Pools
*NHESP 1999-2001 Estimated Habitats of Rare Wildlife: Use with Wetlands Protection Act.
*NHESP 1999-2001 Priority Habitats of State-listed Rare Species: NOT Equivalent to 'Significant Habitat' as designated under the Massachusetts Endangered Species Act



Merrimack River Watershed -Haverhill Region

Habitat Conditions

- Eelgrass beds
- Tidal restrictions
- Shellfish sites
- Saltmarsh Restoration sites
- Certified vernal pools*
- Anadromous fish sites
- Potential vernal pools
- ACECs
- Priority Habitat sites*
- Est. Habitat of Rare Wildlife*
- Rivers and Streams
- Lakes and Ponds
- Natural riparian corridor
- Natural contiguous lands

3 0 3 6 Miles

N
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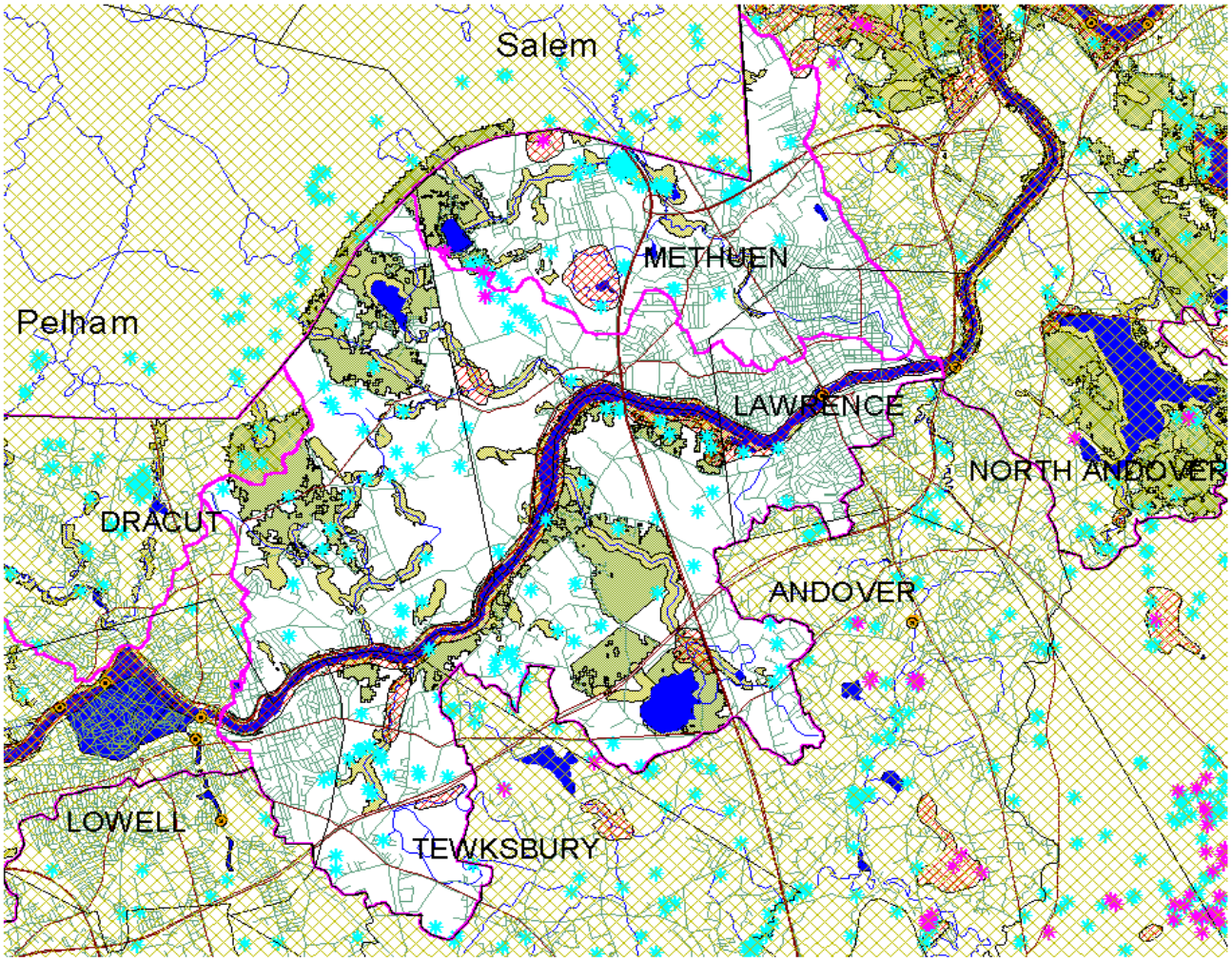
*NHESP 1999-2001 Massachusetts Certified Vernal Pools
*NHESP 1999-2001 Estimated Habitats of Rare Wildlife: Use with Wetlands Protection Act.
*NHESP 1999-2001 Priority Habitats of State-listed Rare Species: NOT Equivalent to 'Significant Habitat' as designated under the Massachusetts Endangered Species Act



Merrimack River Watershed -Lawrence Region-

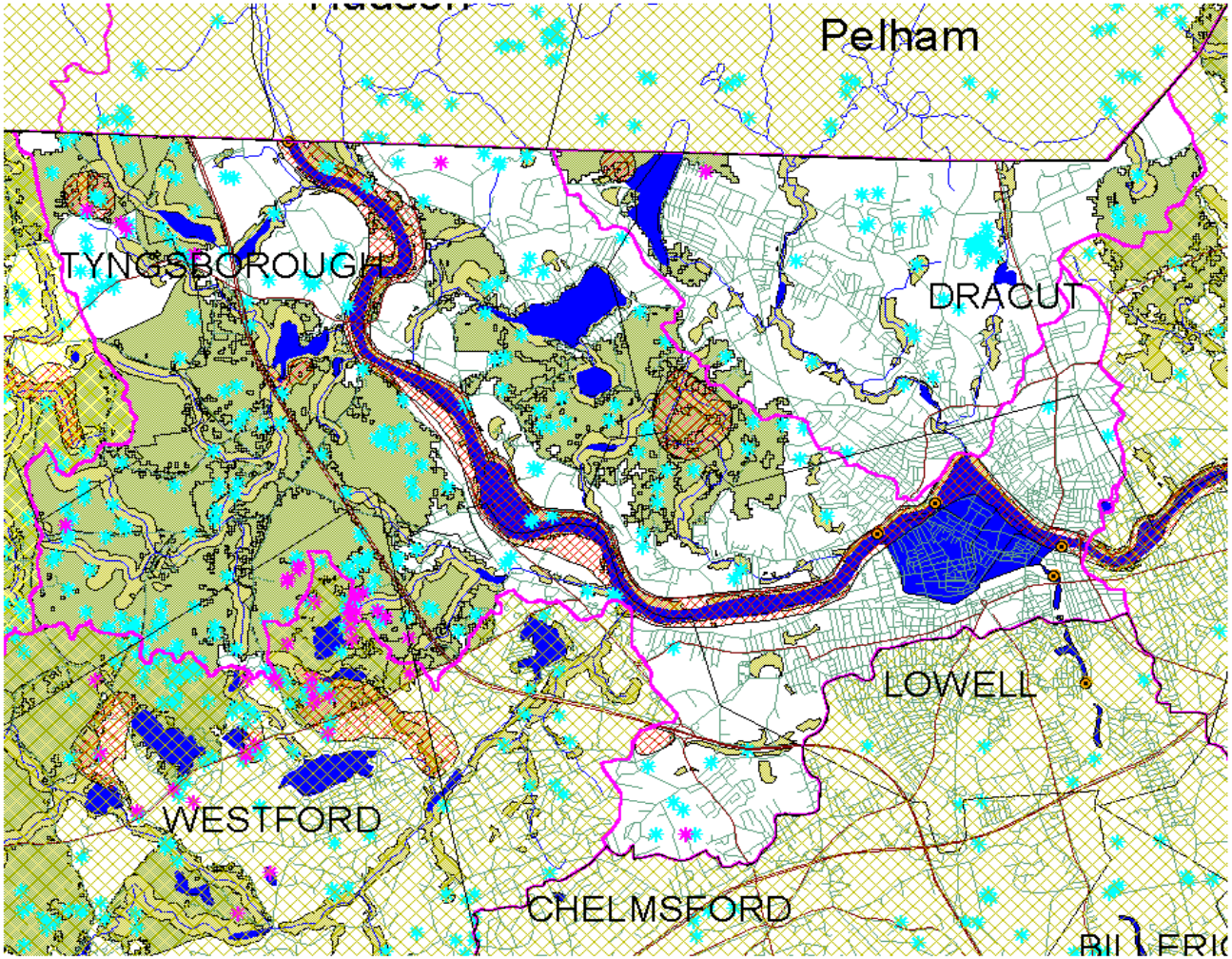
Habitat Conditions

- Eelgrass beds
- Tidal restrictions
- Shellfish sites
- Saltmarsh Restoration sites
- Certified vernal pools*
- Anadromous fish sites
- Potential vernal pools
- ACECs
- Priority Habitat sites*
- Est. Habitat of Rare Wildlife*
- Rivers and Streams
- Lakes and Ponds
- Natural riparian corridor
- Natural contiguous lands

3 0 3 6 Miles

N W E S

*NHESP 1999-2001 Massachusetts Certified Vernal Pools
*NHESP 1999-2001 Estimated Habitats of Rare Wildlife: Use with Wetlands Protection Act.
*NHESP 1999-2001 Priority Habitats of State-listed Rare Species: NOT Equivalent to 'Significant Habitat' as designated under the Massachusetts Endangered Species Act



Merrimack River Watershed -Lowell Region-

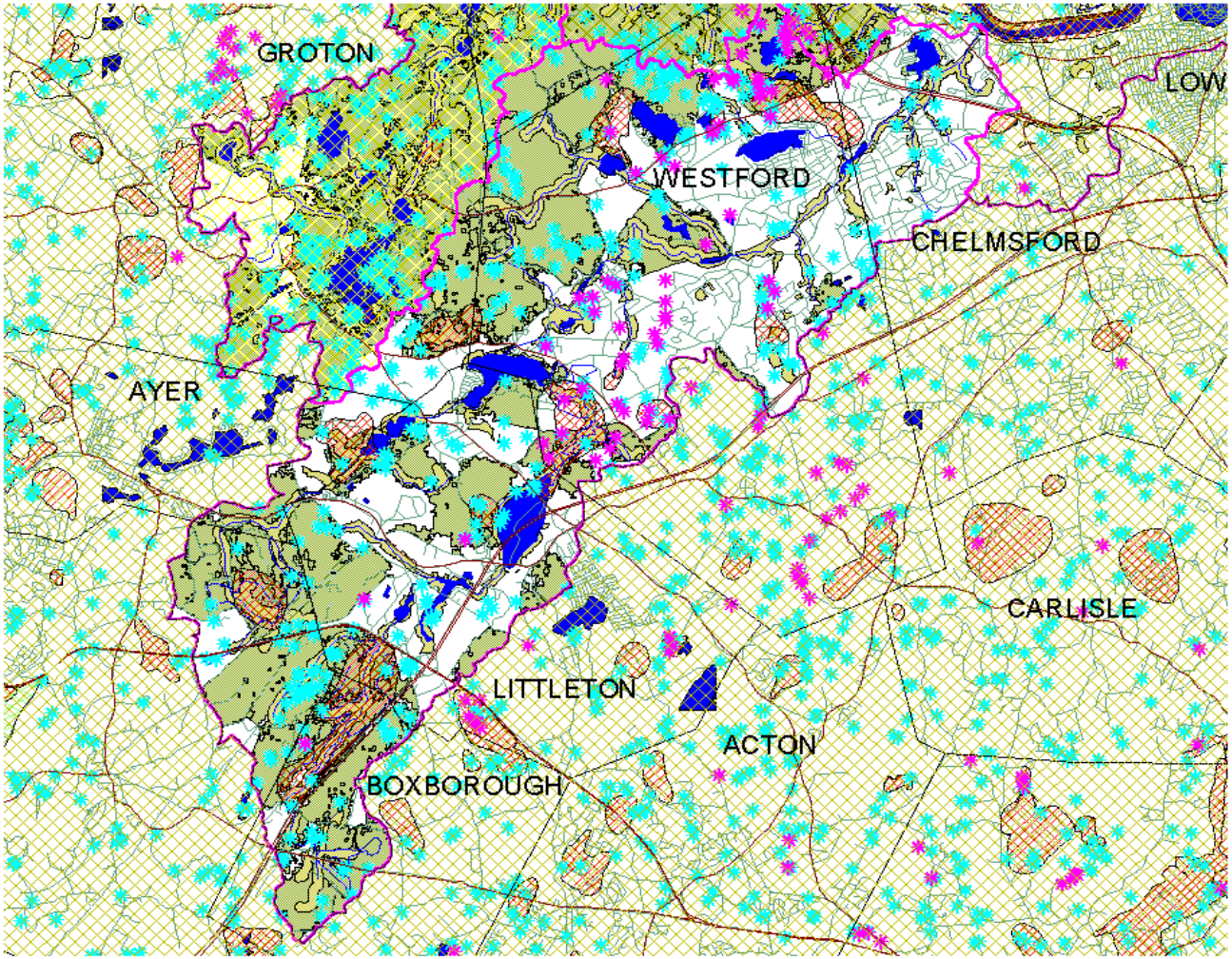
Habitat Conditions

- Eelgrass beds
- Tidal restrictions
- Shellfish sites
- Saltmarsh Restoration sites
- Certified vernal pools*
- Anadromous fish sites
- Potential vernal pools
- ACECs
- Priority Habitat sites*
- Est. Habitat of Rare Wildlife*
- Rivers and Streams
- Lakes and Ponds
- Natural riparian corridor
- Natural contiguous lands

2 0 2 4 Miles

N W E S

*NHESP 1999-2001 Massachusetts Certified Vernal Pools
*NHESP 1999-2001 Estimated Habitats of Rare Wildlife: Use with Wetlands Protection Act.
*NHESP 1999-2001 Priority Habitats of State-listed Rare Species: NOT Equivalent to 'Significant Habitat' as designated under the Massachusetts Endangered Species Act



Merrimack River Watershed -Stony Brook-

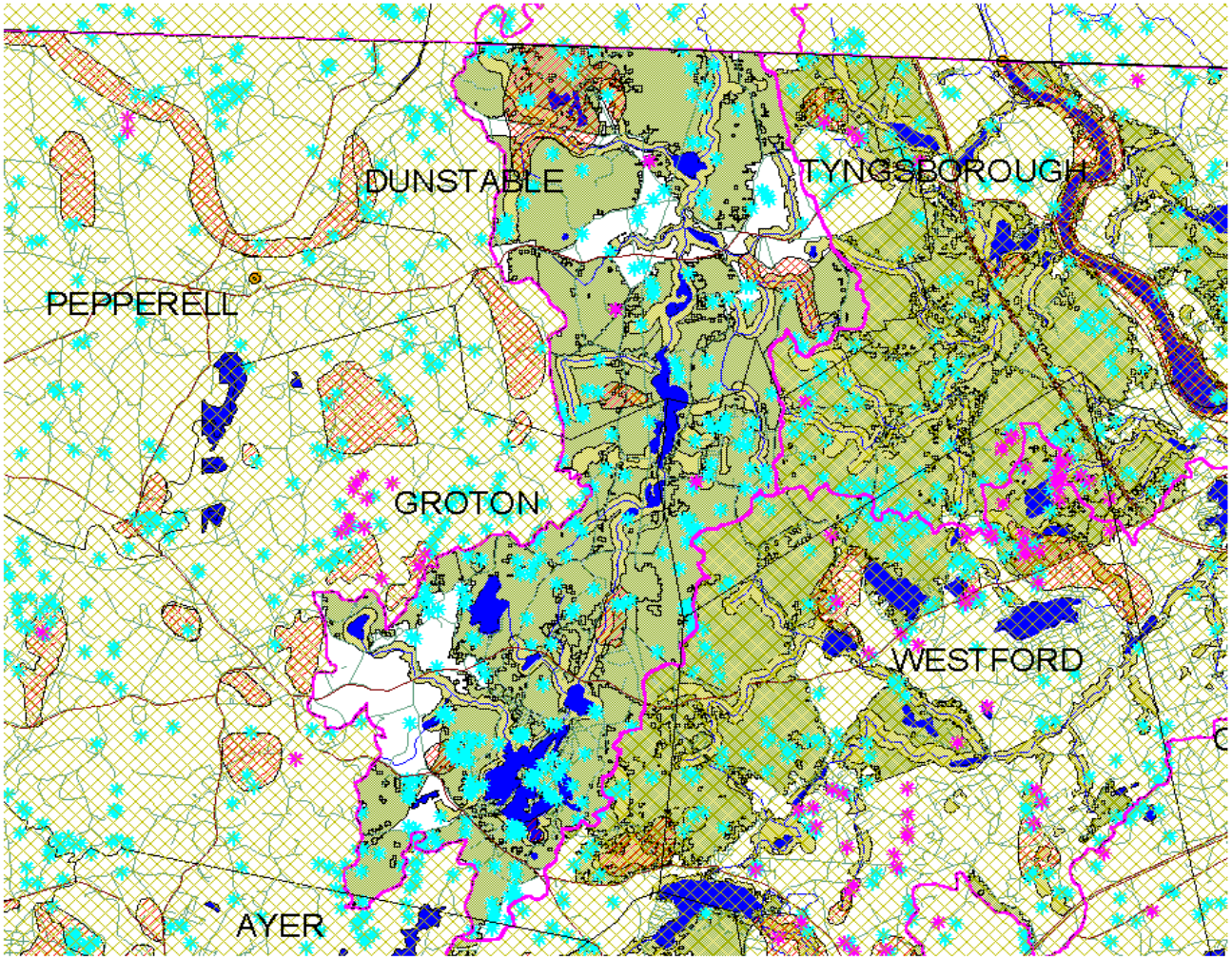
Habitat Conditions

- Eelgrass beds
- Tidal restrictions
- Shellfish sites
- Saltmarsh Restoration sites
- Certified vernal pools*
- Anadromous fish sites
- Potential vernal pools
- ACECs
- Priority Habitat sites*
- Est. Habitat of Rare Wildlife*
- Rivers and Streams
- Lakes and Ponds
- Natural riparian corridor
- Natural contiguous lands

3 0 3 6 Miles

N W E S

*NHESP 1999-2001 Massachusetts Certified Vernal Pools
*NHESP 1999-2001 Estimated Habitats of Rare Wildlife: Use with Wetlands Protection Act.
*NHESP 1999-2001 Priority Habitats of State-listed Rare Species: NOT Equivalent to 'Significant Habitat' as designated under the Massachusetts Endangered Species Act



Merrimack River Watershed -Salmon Brook-

Habitat Conditions

- Eelgrass beds
- Tidal restrictions
- Shellfish sites
- Saltmarsh Restoration sites
- Certified vernal pools*
- Anadromous fish sites
- Potential vernal pools
- ACECs
- Priority Habitat sites*
- Est. Habitat of Rare Wildlife*
- Rivers and Streams
- Lakes and Ponds
- Natural riparian corridor
- Natural contiguous lands

2 0 2 4 Miles

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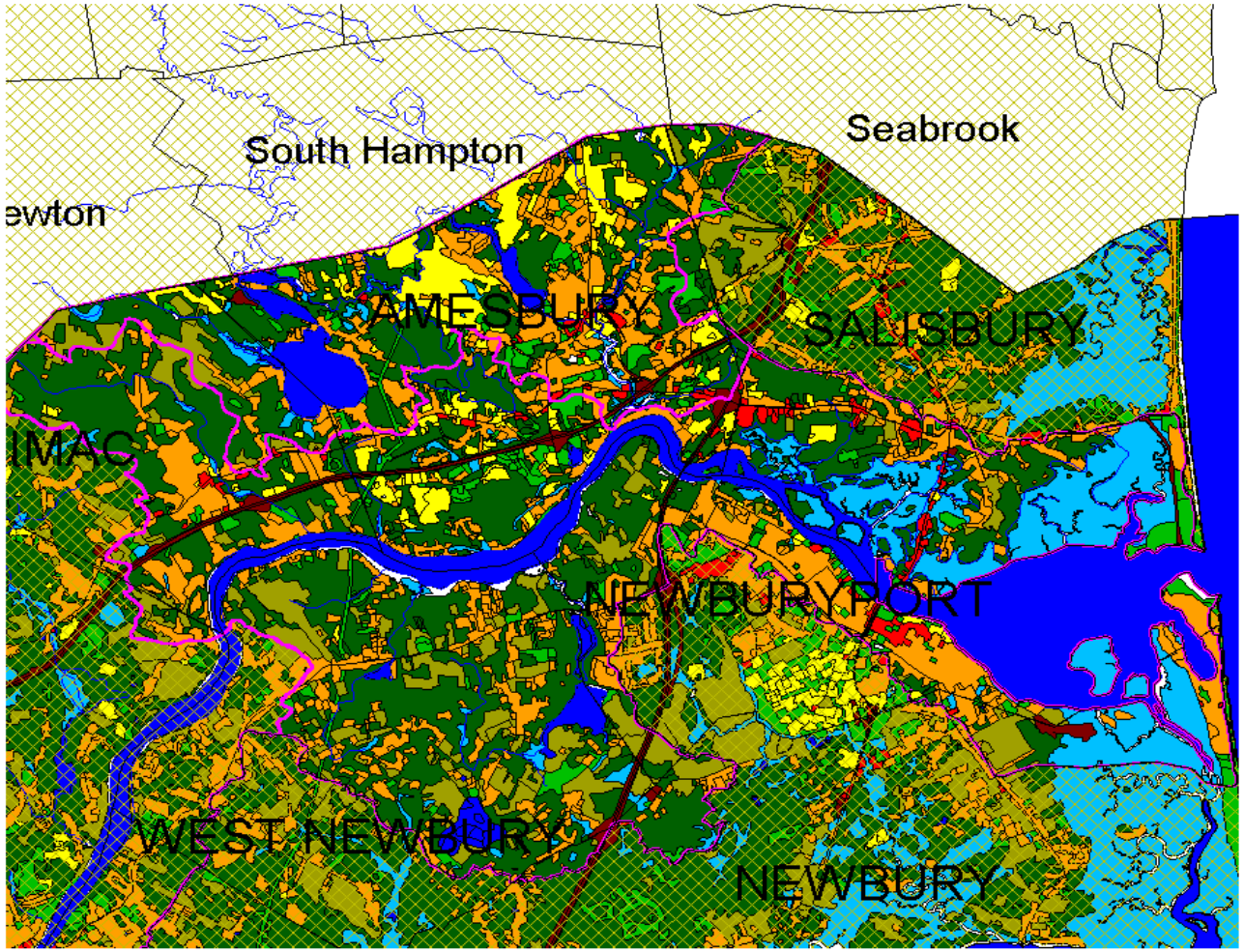
*NHESP 1999-2001 Massachusetts Certified Vernal Pools
*NHESP 1999-2001 Estimated Habitats of Rare Wildlife: Use with Wetlands Protection Act.
*NHESP 1999-2001 Priority Habitats of State-listed Rare Species: NOT Equivalent to 'Significant Habitat' as designated under the Massachusetts Endangered Species Act



Merrimack River Watershed -Estuary Region-

Land Use*

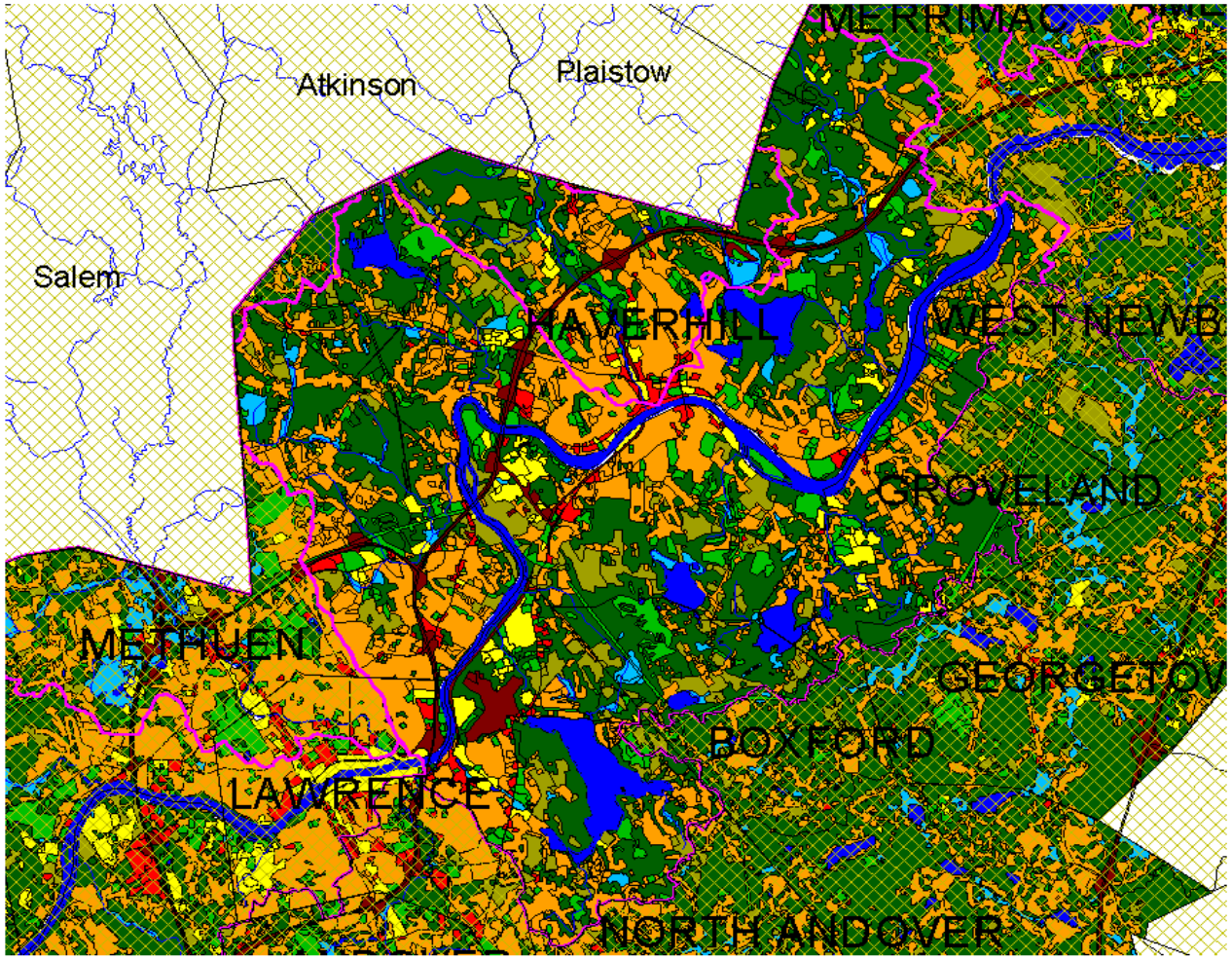
Key

- Agriculture
- Commercial
- Forest
- Industrial
- Residential
- Transportation
- Open Land
- Water
- Wetland

3 0 3 6 Miles

N W E S

*Based on interpretation of 1999 1:25,000 color infrared photography



Merrimack River Watershed -Haverhill Region-

Land Use*

Key

- Agriculture
- Commercial
- Forest
- Industrial
- Residential
- Transportation
- Open Land
- Water
- Wetland

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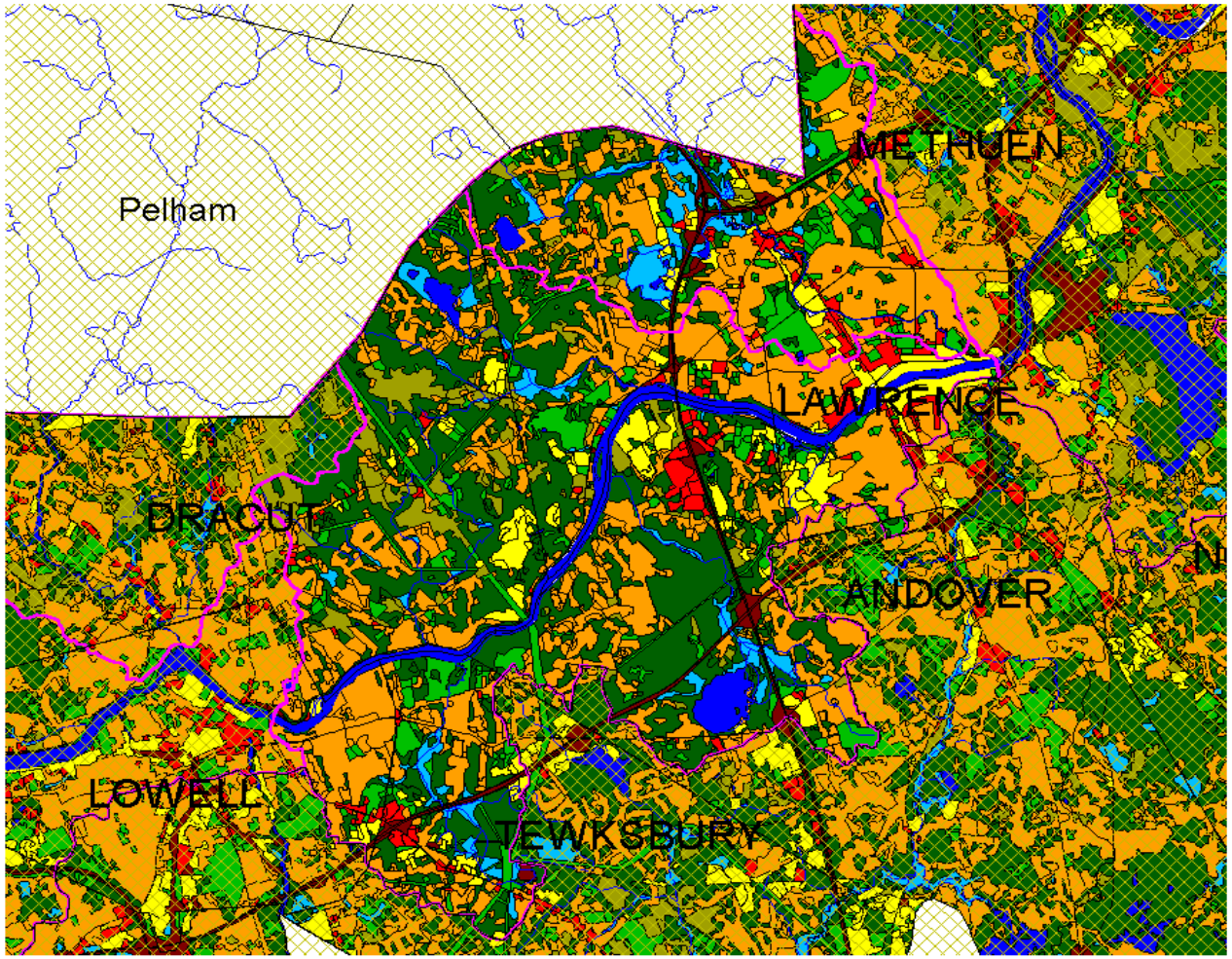
*Based on interpretation of 1999 1:25,000 color infrared photography



Merrimack River Watershed -Lawrence Region-

Land Use*

Key

- Agriculture
- Commercial
- Forest
- Industrial
- Residential
- Transportation
- Open Land
- Water
- Wetland

4 0 4 8 Miles

N
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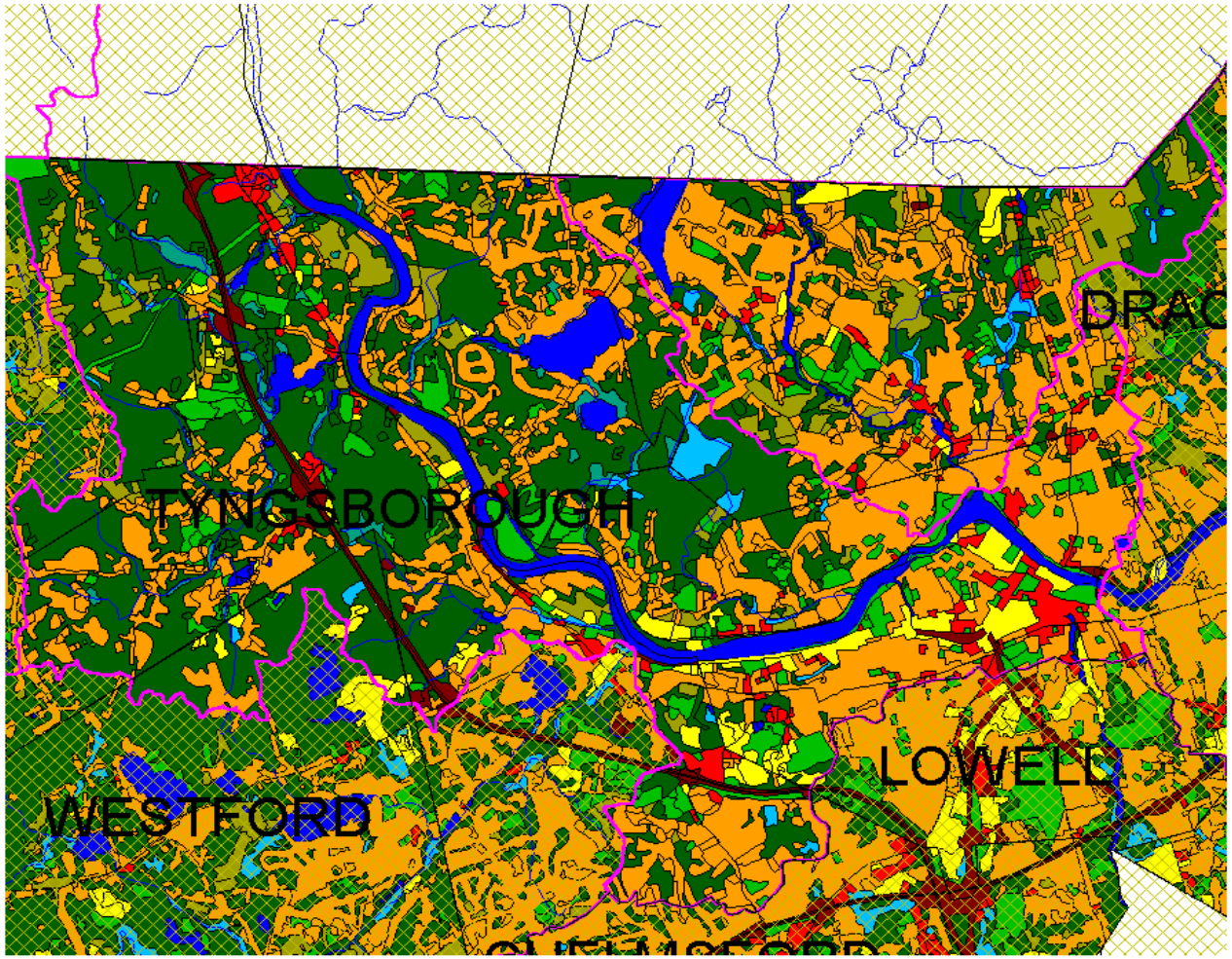
*Based on interpretation of 1999 1:25,000 color infrared photography



Merrimack River Watershed -Lowell Region-

Land Use*

Key

- Agriculture
- Commercial
- Forest
- Industrial
- Residential
- Transportation
- Open Land
- Water
- Wetland

N
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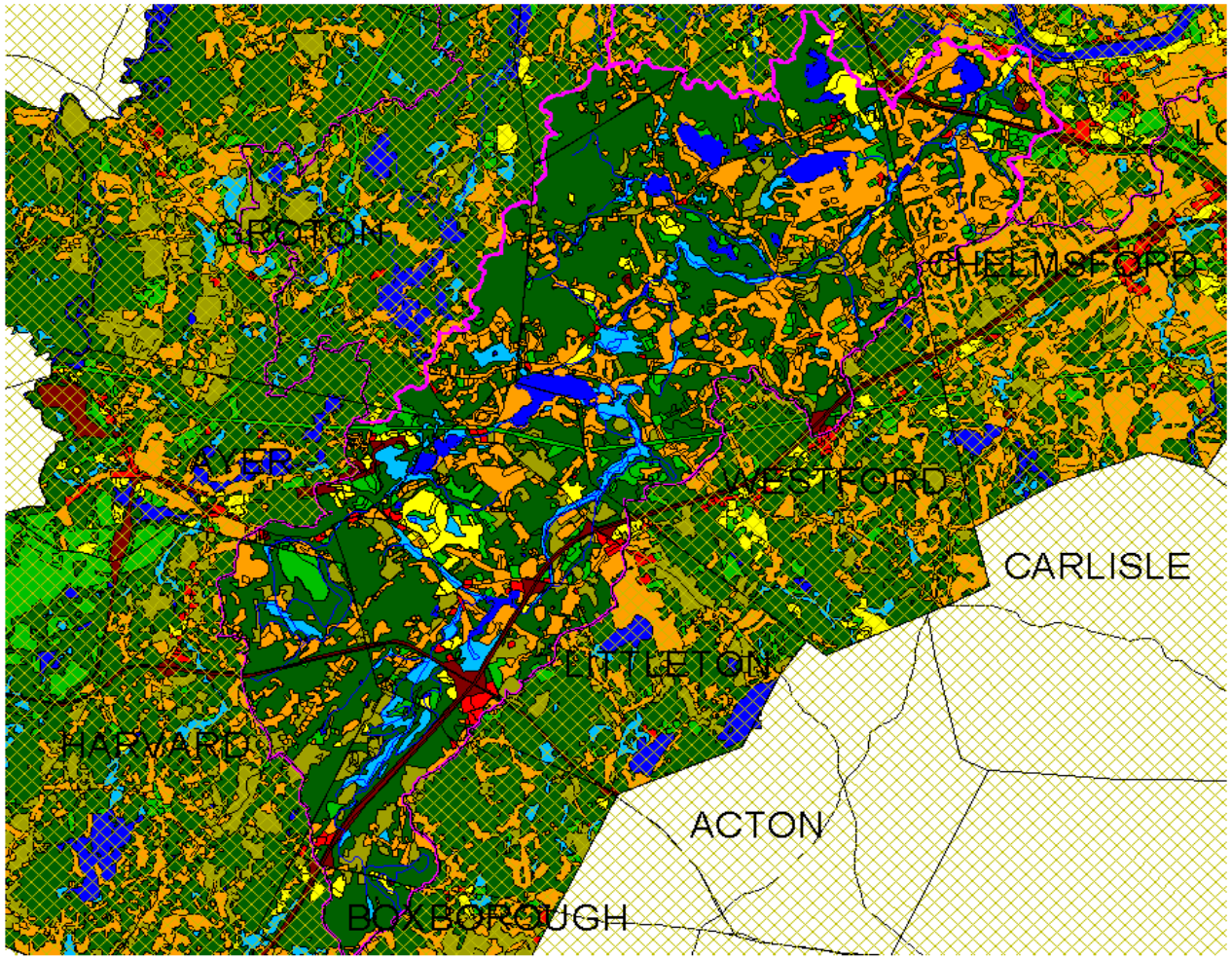
*Based on interpretation of 1999 1:25,000 color infrared photography



Merrimack River Watershed -Stony Brook-

Land Use*

Key

- Agriculture
- Commercial
- Forest
- Industrial
- Residential
- Transportation
- Open Land
- Water
- Wetland

4 0 4 8 Miles

N
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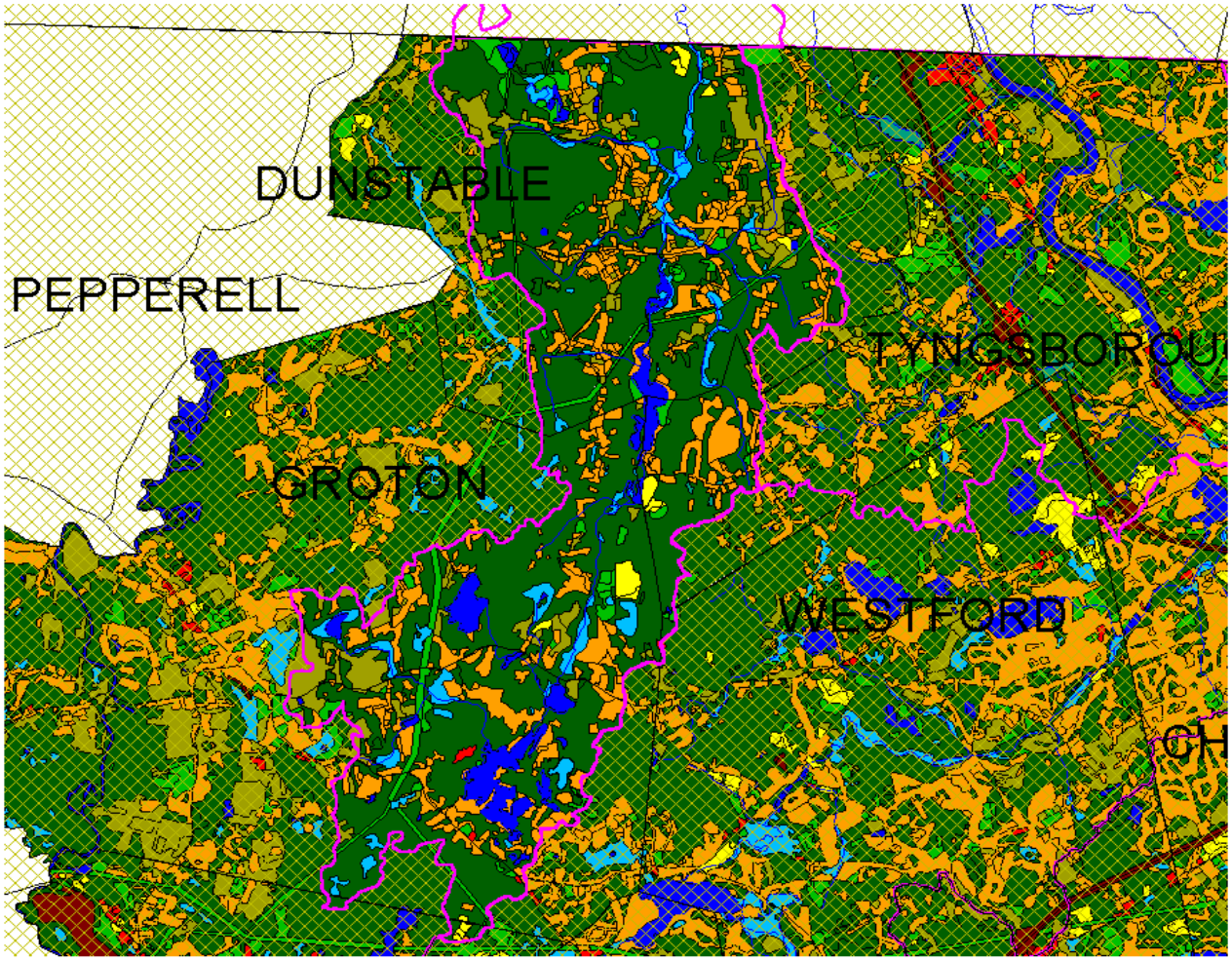
S

*Based on interpretation of 1999 1:25,000 color infrared photography



Merrimack River Watershed -Salmon Brook-

Land Use*

Key

- Agriculture
- Commercial
- Forest
- Industrial
- Residential
- Transportation
- Open Land
- Water
- Wetland

3 0 3 6 Miles

N
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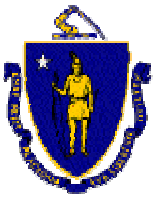
*Based on interpretation of 1999 1:25,000 color infrared photography



Jane Swift
Governor

Bob Durand
Secretary

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