

Section 3 – Martins Pond

Martins Pond (segment MA92038-2004) is a Great Pond in the Commonwealth of Massachusetts and covers some 92 acres. It is a Class B water body meaning that is not designated for water supplies, but it is designated for supporting aquatic life and recreational uses. Martins Pond is listed under the Year 2004 Integrated List of Waters (303d list) as an impaired water body due to turbidity, noxious aquatic plants, exotic species and metals. Turbidity levels are such that the pond does not meet minimum clarity for swimming, and a local beach that offered swimming at one time, was closed in 1988. Martins Pond is classified as a *Category 5 Water*, which means it requires a TMDL or ‘Total Maximum Daily Load’ - essentially the maximum amount of pollution that a water body can assimilate without violating state water quality standards.

The area surrounding Martins Pond is highly congested with homes, with a few Town owned parcels in a matrix of small, private landholdings. The area was historically a summer camp vacation spot that evolved into year round residences during the Depression. As the area has experienced increased pressure from development, many homes around Martins Pond have unstable shores, either due to the age of the retaining walls, clear cutting, or poor or non-existent shoreline stabilization efforts. In addition, old stormwater conveyance systems that end in outfalls at several locations around the pond are poorly equipped to reduce sediment by the time water reaches Martins Pond. Some of the basic limnological characteristics of Martins Pond are noted below in Table 10. The estimated hydraulic residence time (10.1 days) is based on the pond volume divided by the mean outflow rate.

Table 10. Basic Limnological Characteristics of Martins Pond

Pond surface area	37.2 ha	(91.9 ac)
Maximum depth	2.47 m	(8.1 ft)
Mean depth	1.25 m	(4.1 ft)
Volume	638,764 m ³	(517.85 ac-ft)
Length of shoreline ¹	3002 m	(9847 ft)
Osgood Ratio ²	2.03	
Shoreline Development Index ³	1.38	
Watershed area	1994 ha	(4927 acres)
Watershed area/Lake area ratio	~54:1	
Hydraulic residence time	10.1 days	

¹ Based on a pond elevation of 74.5 feet based on Burroughs Road Gauge

² Osgood ratio = mean depth / sqrt of surface area (Osgood 1988)

³ Shoreline Development Index (SDI) = length of shoreline / 2(sqrt[πA])

Figure 12 is a revised bathymetric map of the water depth in Martins Pond. The pond is obviously shallow with a mean depth of 4.1 ft and a maximum depth of 8.1 ft. Based on this 2005 re-mapping of the bathymetry of the pond, the volume was estimated to be approximately 638,764 m³ (518 acre-feet or some 168.744 million gallons). This was determined by calculating the volume of water of a frustrum of a circular cone based on the surface area of the top and bottom of 1-ft section of pond depth. The volume of the pond was previously reported to be between 414 acre-feet (Anderson-Nichols and Lycott 1985) and 500 acre-feet (Eco-Control 1972). That corresponds to between some 135 and 163 million gallons of surface water. The newer estimate is much closer to the Eco-Control estimate. Of course, the elevation of the pond will change its volume (Table 11 – based on FEMA Flood Study: USACE 2004).

Table 11. Relationship between surface elevation of Martins Pond and extent of surface area. Interconnected surface areas refers to flooding of wetland complexes around the Pond.

Water Surface Elevation ft	Martins Pond Surface Area acres	Total Interconnected Surface Area acres
72	98	129
74	101	213
76	110	310
78	121	390
80	135	470

The information in Table 11 shows that the water surface elevation in Martins Pond and in the watershed makes a substantial difference in the amount of available water storage, especially as it relates to help, delay or reduce the impact to flooding in the Martins Pond area.

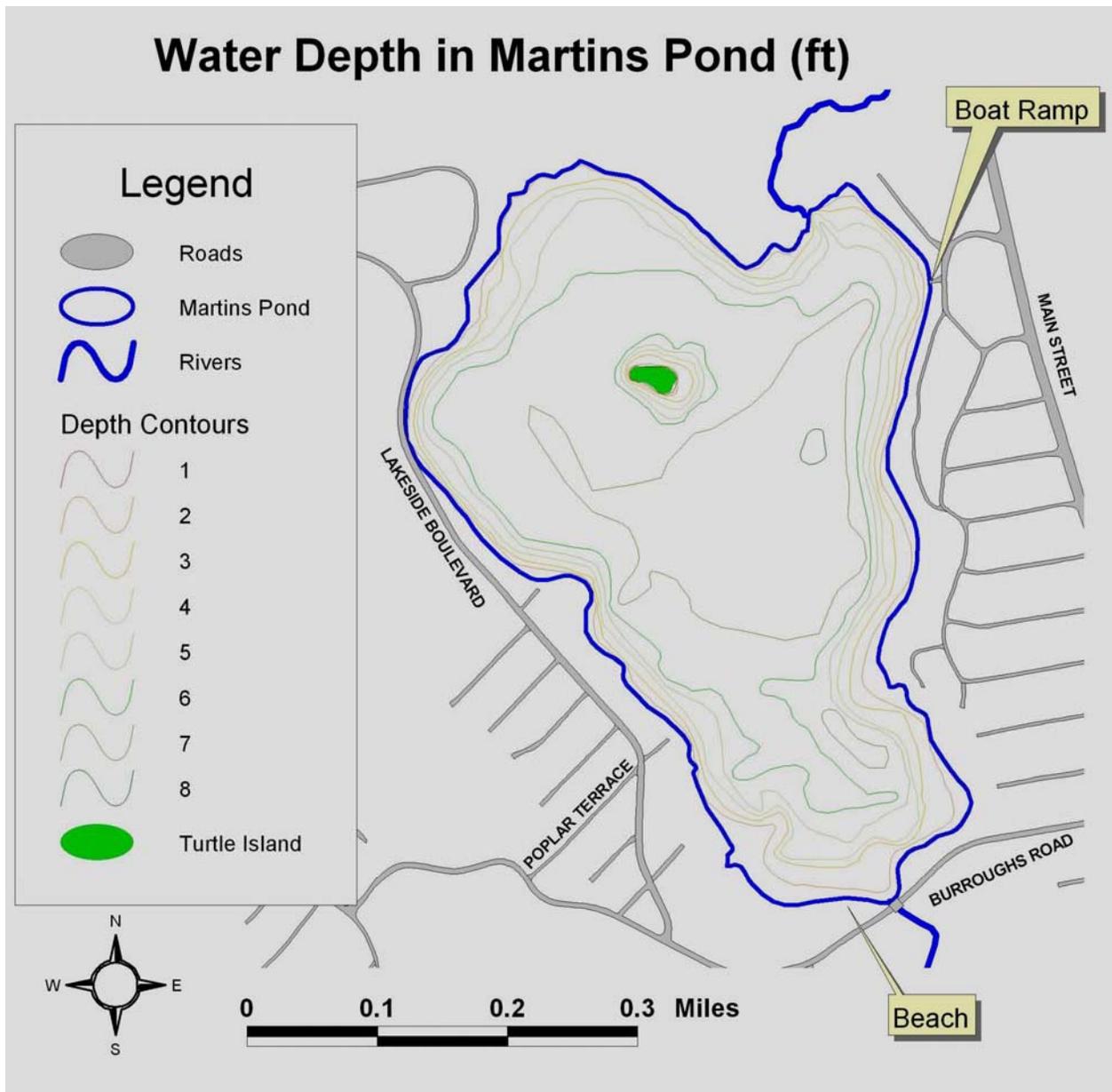


Figure 12. Water depth or bathymetric map of Martins Pond created in 2005. The map was created using Spatial Analyst® in ArcGIS and based on 250 depth points entered via a Trimble GeoXT GPS unit. The extent of the 7 ft depth contour is more extensive than previous depth class approximations in 1985. The inlet of the Pond is the Skug River and the outlet of the Pond is Martins Brook.

Based on the Federal Register (Volume 68, No. 230, 1 December 2003) published under Part 67 (administrative practice and procedure, flood insurance, report and recordkeeping requirements), the flooding information regarding Martins Pond (FEMA Docket No. D7576) is presented in Table 12. Also shown are water surface elevations and flow results based on the USACE (2004) Martins Brook Flood Reduction Study.

Table 12. A summary of flooding elevation information for Martins Pond.

Martins Brook	
At Park Street	74 ft (elevation in feet NGVD)
At outlet of Martins Pond	80 ft
Skug River	
At confluence with Martins Pond	80 ft
Approximately 150 feet upstream of the corporate limits	84 ft

From information published in The Federal Register Volume 68, No. 230, 1 December 2003

Water Surface Elevations and Flow Results for Flood Events

Recurrence Interval	Feet above NGVD at Martins Pond	Flow into Martins Pond (cfs)	Flow out of Martins Pond (cfs)
10-year	77.8	640	240
25-year	78.6	905	335
50-year	79.2	1145	465
100-year	79.7	1330	750
500-year	81.4	1725	875

From information provided in the USACE (2004) Martins Brook Flood Reduction Study

The shallow nature of the pond means that the water column is generally always mixed and partial stratification is a rare event that only occurs on relatively long calm periods during the summer months; wave action combined with the fetch and a shallow basin keep the water column mixed. In addition, the shallow conditions and fetch mean that the organic rich sediments are also easily resuspended in the water column and there is extensive sediment-water contact. These conditions are typical of shallow, eutrophic pond and lake systems (Scheffer 1998).

3.1 - Pond Sediments

The sediment layer at the bottom of the Pond takes up some 70-75% of the potential volume of the pond. The IEP Study in 1977 reported a sediment depths ranging from 14 to 20+ ft. The 1985 D/F Study (Anderson-Nichols and Lycott 1985) reported a mean sediment depth of some 8 ft and depths ranging from 0 ft at sandy shorelines to 15+ ft in the northern half of the pond. Regardless of the exact percentage of the basin that is currently occupied by organic rich sediments, Martins Pond is clearly ‘filling in’ as is typical of shallow, eutrophic pond systems. The depth to bedrock beneath the pond was estimated to be some 40 ft (Anderson-Nichols and Lycott 1985).

Sediment Organic Content - The Eco-Control Study (1972) reported that 2-ft surface sediment cores had between 32-49% organic matter (mean = 40.5%). In the current study, 128 sediments samples were collected at sites chosen all around the Pond and the mean organic matter content was 40.6% (SE = 1.7). The 2003 Lakes and Ponds report indicated organic matter contents of surface sediments ranging from 1.3 to 39.6% (mean = 25.4%) (Merrimack College and Malcolm Pirnie 2003). Although there are differences between the results of the three studies, the 2003 study included more extensive coverage in the pond, including sandy shoreline areas, and this likely accounts for the disparity in organic matter content.

Figure 13 shows an estimation of the organic content of sediments in Martins Pond based on samples collected in 2005 (darker colors represent higher organic content sediments). There are clearly more organic rich sediments in the north-central portion of the pond with lower organic content generally on the eastern and southern sections of the pond.

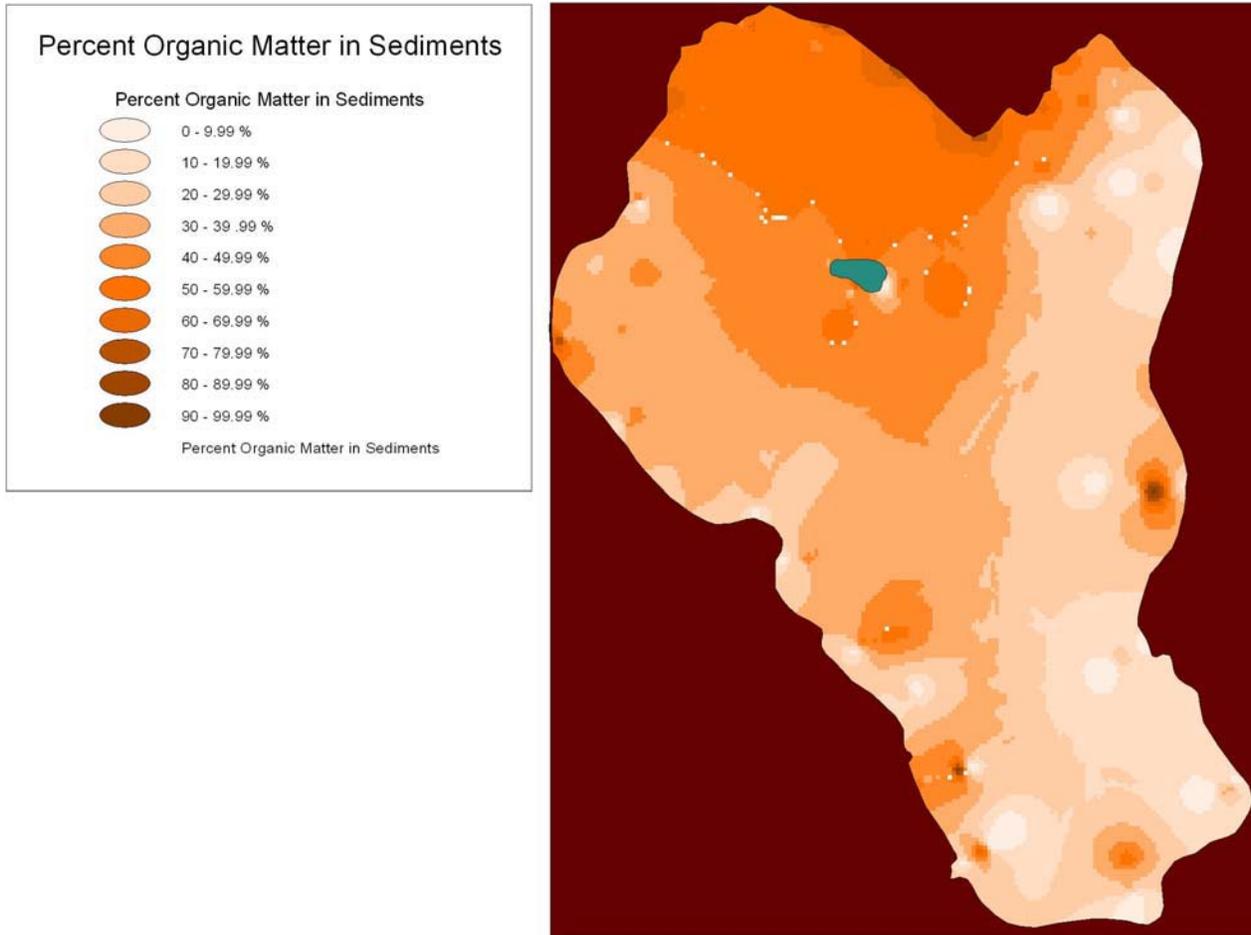


Figure 13. The spatial extent of organic sediments in Martins Pond. Darker orange colors reflect higher organic matter content.

Sediment Phosphorus Content - The Eco-Control (1972) study reported sediment Total P values ranging from 70 to 460 mg/kg of dry sediment. Anderson-Nichols and Lycott (1985) reported a total P value of 222 mg/kg dry sediment. Merrimack College and Malcolm Pirnie (2003) reported mean Mehlich extractable P levels of 5 mg/kg. While the latter clearly is only one component of total P, there is clearly a large reservoir of P in the sediments beneath Martins Pond and these sediments have had high P levels since at least the early 1970's. Therefore, P-release from sediments (internal loading) remains a potentially large source of P that can easily move to surface water through anoxic release and/or resuspension.

Section 3.2 – Biological Conditions in Martins Pond: Fish and Algae

A summary of fish survey results for Martins Pond is presented in Table 13. The fish fauna is typical of a shallow eutrophic pond in eastern Massachusetts.

Table 13. A summary of fish survey results conducted in Martins Pond.

Common name	Scientific name	1976	1985	1995	2003
Yellow perch (YP)	<i>Perca flavescens</i>	X	X	X	X
Chain pickerel	<i>Esox americanus</i>	X	X	X	X
Brown bullhead	<i>Ictalurus nebulosa</i>	X	X	X	X
Largemouth bass (LMB)	<i>Micropterus salmoides</i>	X	X	X	X
Pumpkinseed	<i>Lepomis gibbosus</i>	X	X	X	X
Bluegill	<i>Lepomis macrochirus</i>	X	X	X	X
Golden shiners	<i>Notemignus crysoleucas</i>	X	X	X	X
Black crappie (BC)	<i>Pomoxis nigromaculatus</i>	X		X	X
Swamp darter	<i>Etheostoma fusiforme</i>				X

The Ipswich River Watershed Assessment Report (DEP 2004) also found the following species and their percent of the total sampling along the Skug River at Harold Parker Road (Site WW-3 in the current study): pumpkinseed 71.1%, bluegill 8.0%, banded sunfish 6.5%, redbfin pickerel 5.5%, brown bullhead 4.0%, yellow perch 2.5%, American eel 1%, yellow bullhead 1% and swamp darter 0.5%.

In September and October 1995, fish toxics monitoring was conducted by the Department of Watershed Management in Martins Pond. Mercury in the fish tissue ranged from 0.132 to 0.898 mg/kg wet weight (DEP 2004). The mercury data triggered a site-specific advisory against the consumption of fish from Martins Pond that read as follows:

Children under 12, pregnant women and nursing mothers should refrain from consuming largemouth bass, black crappie and yellow perch from Martins Pond in order to prevent exposure of developing fetuses and young children to mercury. The general public should limit consumption of largemouth bass, black crappie, and yellow perch from Martins Pond to two meals per month. (MDPH 1996)

Because of elevated mercury concentrations, The Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, in June 2002, added Martins Pond to the *Freshwater Fish Consumption Advisory List* (MDPH 2002). The following fish advisory advice has been given to persons who consume fish from Martins Pond.

- **P1** (LMB, BC, YP) - Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish (in parenthesis) from this water body.

- **P3** (LMB, BC, YP) - The general public should limit consumption of affected fish species (in parenthesis) to two meals per month.
- LMB = largemouth bass (*Micropterus salmoides*); BC = black crappie (*Pomoxis nigromaculatus*); and YP = yellow perch (*Perca flavescens*).

The presence of algae, diatoms and blue-green algae has also been analyzed in various reports on Martins Pond. A summary of those results is presented in Table 14. No assessment of algae, diatoms or blue green algae was made in the current study.

Table 14. A summary of diatom, blue-green algae and green algae identified in Martins Pond.

Taxa	1976 ¹	1984 ²	1987 ³	2000 ⁴	2005 ⁵
Bacillariophyceae (Diatoms)					
<i>Asterionella sp.</i>	X	X	X		X
<i>Cocconeis sp.</i>		X			X
<i>Cyclotella sp.</i>		X	X		X
<i>Fragilaria sp.</i>	X	X	X		
<i>Gonphonema sp.</i>		X	X		X
<i>Meridion sp.</i>		X			
<i>Navicula sp.</i>		X	X		X
<i>Tabellaria sp.</i>					X
Cyanophyceae (Blue-Green Algae)					
<i>Anabaena sp.</i>	X				
<i>Anacystis sp.</i>	X				X
<i>Chroococcus sp.</i>			X		
<i>Coelosphaerium sp.</i>			X	X	X
<i>Merismopedia sp.</i>			X		X
<i>Microcystis flos-aquae</i>				X	
Chlorophyceae (Green Algae)					
<i>Actinastrum sp.</i>	X				
<i>Ankistrodesmus sp.</i>	X		X		X
<i>Chlorococcum sp.</i>	X	X			X
<i>Coelastium sp.</i>			X		
<i>Pachycladon sp.</i>	X				X
<i>Pediastrum sp.</i>	X				
<i>Scenedesmus sp.</i>	X	X	X		X
<i>Spirogyra sp.</i>		X			
<i>Staurastrum sp.</i>	X	X			X
<i>Ulothrix sp.</i>		X	X		X

¹ data from IEP (1977)

² data from Anderson-Nichols and Lycott (1985)

³ data from Lycott (1987)

⁴ data from DEP (2004)

⁵ based on microscopic surveys at part of current study in 2005 and 2006 (not meant to represent a complete list)

Section 4 – Surface Water Quality Assessment

Figure 14 shows the ten (10) major subwatersheds delineated for the current study and the surface water quality sampling sites (♦) for this project. The bold-faced sites represent samples that are as close as possible to being the outlets for the entire subwatershed. It was impossible to exactly locate all sample sites at the exact outlet to do private property, logistical considerations and safety concerns.

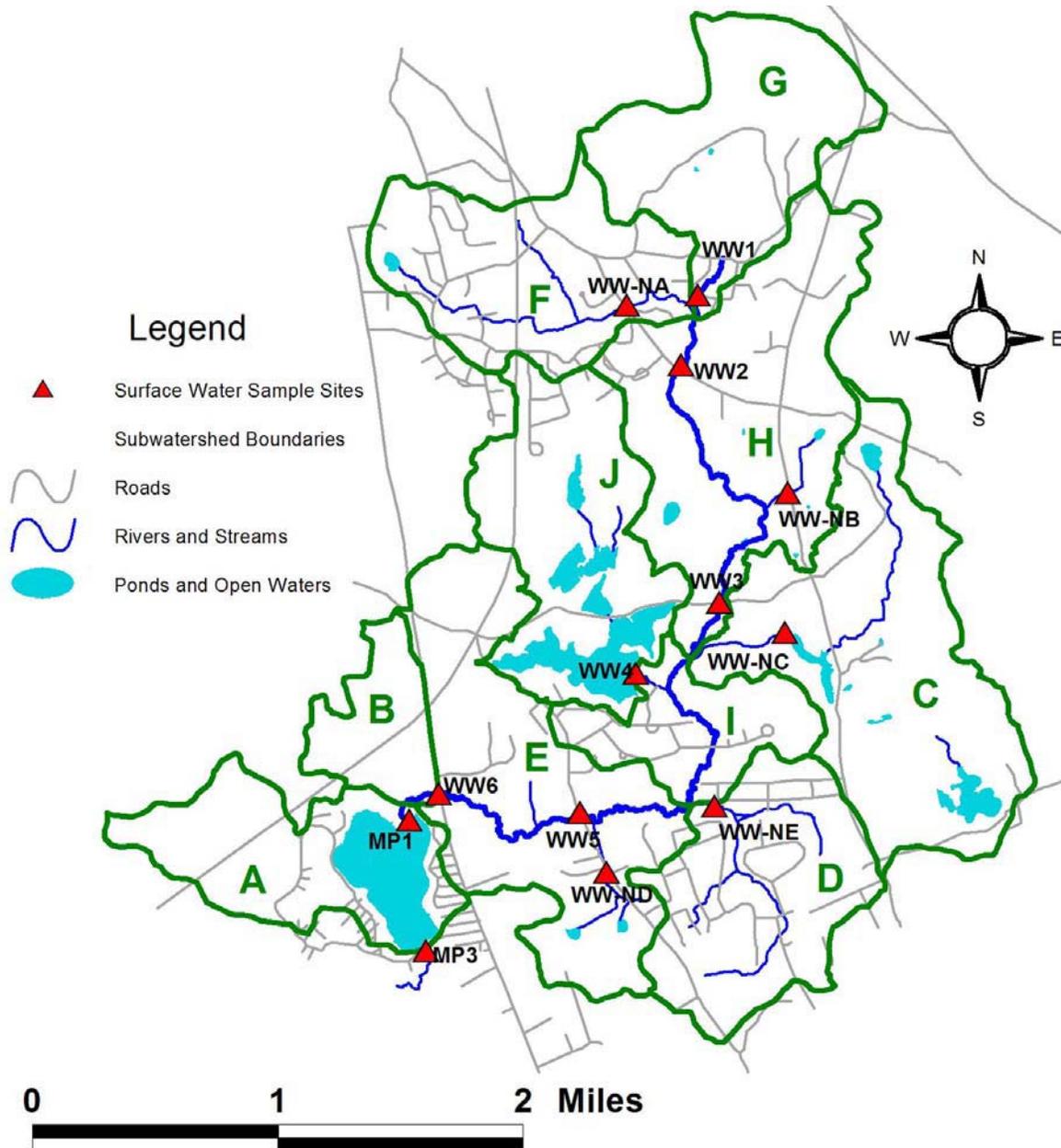


Figure 14. Martins Pond watershed map showing the locations of surface water quality monitoring/sampling sites relative to the 10 major subwatersheds delineated and assessed in this study.