MILLERS RIVER WATERSHED

2000 WATER QUALITY ASSESSMENT REPORT

Millers River at Blossom Street, Royalston

COMMONWEALTH OF MASSACHUSETTS
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2000 WATER QUALITY ASSESSMENT REPORT

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Department of Environmental Protection
Division of Watershed Management

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Division of Watershed Management
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State

- Massachusetts Executive Office of Environmental Affairs (EOEA), Millers River Watershed Team
- Massachusetts Department of Environmental Protection (MA DEP):
  - Bureau of Resource Protection
  - Bureau of Strategic Policy and Technology's Wall Experiment Station
  - Bureau of Waste Prevention
  - Bureau of Waste Site Cleanup
- Massachusetts Department of Public Health (MA DPH)
- Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement (MA DFWELE) (now the Department of Fish and Game)
  - Division of Fisheries and Wildlife (MassWildlife)
  - Riverways Program
- Massachusetts Department of Environmental Management (MA DEM) (now the Department of Conservation and Recreation)

Federal

- United States Environmental Protection Agency (EPA)
- United States Army Corps of Engineers (ACOE)
- United States Geological Survey (USGS)
  - Water Resources Division

Other Non-profit Groups and Agencies

- Millers River Environmental Center
- Montachusett Regional Planning Commission
- Franklin Regional Council of Governments
- Otter River Stream Team
- Tully River Stream Team

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Cover photo credit: Alice Rojko, MA DEP Division of Watershed Management

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7Q10	seven day, ten year low flow
ACEC	Area of Critical Environmental Concern
ACO	Administrative Consent Order
ACOE	Army Corps of Engineers (United States)
ADB	assessment database
BMP	best management practice
BOD	biochemical oxygen demand
BPJ	best professional judgment
BRP	Bureau of Resource Protection
BWSC	Bureau of Waste Site Cleanup
CERO	MA DEP Central Regional Office
CMR	Code of Massachusetts Regulations
CNOEC	chronic no observed effect concentration
CSO	combined sewer overflow
CWA	Clean Water Act
DDT	dichlorodiphenyltrichloroethane
DMF	Division of Marine Fisheries
DMR	discharge monitoring report
DO	dissolved oxygen
DWM	Division of Watershed Management
DWP	Drinking Water Program
EOEA	Executive Office of Environmental Affairs
EPA	United States Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, caddisflies)
FERC	Federal Energy Regulatory Commission
FPOM	fine particulate organic matter
FRCOG	Franklin Regional Council of Government
LC_{50}	lethal concentration to 50% of the test organisms
L-EL	low effect level
MA DEM	Massachusetts Department of Environmental Management (now the Department of Conservation and Recreation)
MA DEP	Massachusetts Department of Environmental Protection
MA DFWELE	Department of Fisheries, Wildlife and Environmental Law Enforcement (now the Department of Fish and Game)
MA DPH	Massachusetts Department of Public Health
MassGIS	Massachusetts Geographic Information System
MREC	Millers River Environmental Center
MRPC	Montachusett Regional Planning Commission
NAS/NAE	National Academy of Sciences/National Academy of Engineers
NAWQA	National Water-Quality Assessment
NERL	New England Regional Laboratory
NH DES	New Hampshire Department of Environmental Services
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source pollution
ORS	Office of Research and Standards
ORW	Outstanding Resource Water
PALIS	Pond and Lake Information System
PCB	polychlorinated biphenyls
POTW	publicly owned treatment works
RBP	rapid bioassessment protocol
SARIS	Stream and River Inventory System
S-EL	severe effect level
SMART	Strategic Monitoring and Assessment for River Basin Teams
SWPPP	Stormwater pollution prevention plan
SWQS	Surface Water Quality Standards
TIE/TRE	Toxicity Identification Evaluation/Toxicity Reduction Evaluation
TMDL	total maximum daily load
TOXTD	MA DEP DWM Toxicity Testing Database
TOC	total ogranic carbon
TRC	total residual chlorine
USFWS	United State Fish and Wildlife Service
USGS	United States Geological Survey
WBID	waterbody identification code
WBS	waterbody system database
WMA	Water Management Act
WPCF	water pollution control facility
WTF	water treatment facility
WWTF	wastewater treatment facility
WWTP	wastewater treatment plant

LIST OF UNITS

cfs	cubic feet per second
cfu	colony forming unit
gpcd	gallons per capita per day
MGD	million gallons per day
µg/kg	microgram per kilogram
µS/cm	Microsiemens per centimeter
mg/Kg	milligram per kilogram
mg/L	milligram per liter
MPN	most probable number
ng	nanograms
NTU	nephelometric turbidity units
ppb	parts per billion
ppm	parts per million
SU	standard units
TEQ/kg	toxic equivalents per kilogram

EXECUTIVE SUMMARY
MILLERS RIVER WATERSHED 2000 WATER QUALITY ASSESSMENT REPORT

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which surface waters in the Commonwealth shall be protected. This assessment report resents a summary of current water quality data and information used to assess the status of the designated uses as defined in the SWQS in the Millers River Watershed. The designated uses where applicable, include: *Aquatic Life, Fish Consumption, Drinking Water, Primary* and *Secondary Contact Recreation* and *Aesthetics*. The assessment of current water quality conditions provides a determination of whether or not each designated use of a particular water body is ***supported*** or ***impaired***, or when too little current data/information exists or no quality assured data are available, the use is ***not assessed***. However, if there is some indication of water quality impairment, which is not "naturally occurring", the use is identified with an "Alert Status". It is important to note that not all waters are assessed. Many small and/or unnamed rivers and ponds are currently ***unassessed***; the status of their designated uses has never been reported to the EPA in the Commonwealth's Summary of Water Quality Report (305(b) Report) nor is information on these waters maintained by the Massachusetts Department of Environmental Protection in the Waterbody System (WBS) or Assessment Database (ADB). This report provides basic information that can be used to focus resource protection and remediation activities later in the watershed management planning process.

There are a total of 14 rivers, streams, or brooks (the term "rivers" will hereafter be used to include all) in the Millers River Watershed included in this report. These are the Millers, North Branch Millers, Otter, East Branch Tully, West Branch Tully and Tully rivers, Beaver, Boyce, Keyup, Lawrence, Lyons, Mormon Hollow, Priest and Whetstone brooks. While these rivers represent only a small number (15%) of the 91 named streams, they account for approximately 48% (117.4 of 242.2 miles) of the named river miles in the watershed. The remaining rivers are small and they are currently unassessed. This report also includes information on 64 of the 100 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) that have been assigned a pond and lake identification system (PALIS) number in the Millers River Watershed. The 64 lakes included in this report represent 93% of the total lake acreage (3,833 of 4,120 acres) in the Millers River Watershed.

AQUATIC LIFE USE

The *Aquatic Life Use* is supported when suitable habitat (including water quality) is available for sustaining a native, naturally diverse, community of aquatic flora and fauna. Impairment of the *Aquatic Life Use* (impaired) may result from anthropogenic stressors that include point and/or nonpoint source(s) of pollution and hydrologic modification.

Aquatic Life Use Summary - Rivers:

As illustrated in Figure 1, of the 117.4 river miles in the Millers River Watershed included in this report, a total of 74.2 river miles (approximately 63%), representing 10 tributaries (53.1 miles) and the lower 21.1 miles of the mainstem Millers River are assessed as supporting the *Aquatic Life Use*. The *Aquatic Life Use* is assessed as impaired in the Otter River (the lower 9.9 miles) and the Millers River (a total of 19 miles) representing 25% (28.9 miles) of the total river miles in the watershed. The primary cause of impairment is PCB contamination in sediment and whole fish. The current source of PCB in river water is contaminated sediments. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP. It probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River. Flow fluctuations resulting from hydromodification, habitat quality degradation, slightly elevated levels of total phosphorus, and toxicity (whole effluent and/or ambient) were also identified as being of concern. The upper reaches of the Millers and Otter rivers as well as the North Branch Millers River and the Tully River (12% of the river miles in the watershed) are currently not assessed for this use.

Aquatic Life Use

Rivers
Total length assessed in report – 117.4 miles
- **Support – 74.2 miles (63%)**
- **Impaired – 28.9 miles (25%)**
- **Not Assessed – 14 miles (12%)**

Lakes
Total acreage assessed in report 3,833 acres
- **Impaired – 736 acres (19%)**
- **Not Assessed – 3,097 acres (81%)**

***Aquatic Life Use Summary - Lakes*:**
Few lakes in the Millers River Watershed have recently been surveyed for variables used to assess the status of the *Aquatic Life Use* (i.e., DO, pH, nutrients, macrophytes and plankton/chlorophyll *a*). Because of the lack of these types of data, none of the lakes in the Millers River Watershed are assessed as support for the *Aquatic Life Use*. The *Aquatic Life Use* is assessed as impaired for eight lakes (Ellis, Parker, South Athol, and White ponds and Lake Monomonac and Lake Rohunta [north, middle, and south basins]) because they are infested with one or more of the following non-native species: *Cabomba caroliniana*, *Myriophyllum heterophyllum, and M. spicatum* (Figure 1). These non-native aquatic plant species are particularly invasive because they grow and spread rapidly through vegetative reproduction. The majority of the lake acreage in the Millers River Watershed (81%) is currently not assessed for the *Aquatic Life Use*.

FISH CONSUMPTION USE
The *Fish Consumption Use* is supported when there are no pollutants present that result in unacceptable concentrations in edible portions (as opposed to whole fish - see *Aquatic Life Use*) of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption. The assessment of the *Fish Consumption Use* is made using the most recent list of Fish Consumption Advisories issued by the Massachusetts Executive Office of Health and Human Services, MA DPH, Bureau of Environmental Health Assessment (MA DPH 2002a). The MA DPH list identifies waterbodies where elevated levels of a specified contaminant in edible portions of freshwater species poses a health risk for human consumption; hence the *Fish Consumption Use* is assessed as non-support in these waters. In July 2001, MA DPH issued new statewide consumer advisories on fish consumption and mercury contamination (MA DPH 2001). Because of these statewide advisories, no waters can be assessed as support for the *Fish Consumption Use*; these waters default to "not assessed". The statewide advisories read as follows:

> The MA DPH "is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age to refrain from eating the following marine fish; shark, swordfish, king mackerel, tuna steak and tilefish. In addition, MA DPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination, to now include women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age (MA DPH 2001)." Additionally, MA DPH "is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about 2 meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to 2 cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury (MA DPH 2001)." MA DPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially.

Fish Consumption Use Summary - Rivers and Lakes:
Because of elevated levels of PCB and mercury in edible portions of fish, MA DPH has issued fish consumption advisories for the mainstem Millers River and all of its tributaries (MA DPH 2002a). Because of the wording of their advisory, the *Fish Consumption Use* for all rivers in the Millers River Watershed is assessed as impaired. The MA DPH is currently in the process of reevaluating the advisory. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River. The source of mercury is unknown although atmospheric deposition is suspected. MA DPH has also issued fish consumption advisories for eight lakes in the Millers River Watershed including Gales and Whitney ponds, Lake Denison, Lake Rohunta (all basins), Upper Naukeag Lake, and Upper Reservoir because of health concerns related to elevated levels of mercury (Figure 2). The majority of the lakes in the Millers River Watershed default to Not Assessed for the *Fish Consumption Use* because of the statewide advisory. Sources of mercury in this area are currently unknown, although atmospheric deposition is suspected.

Fish Consumption Use

Rivers
Total length assessed in report – 117.4 miles
- **Impaired – 117.4 miles (100%)**

Lakes
Total area assessed in report 3,833 acres
- **Impaired – 824 acres (21%)**
- **Not Assessed – 3,009 acres (79%)**

DRINKING WATER USE

The term *Drinking Water Use* has been used to indicate sources of public drinking water. While this use is not assessed in this report, the state provides general guidance on drinking water source protection of both surface water and groundwater sources (available at http://www.mass.gov/dep/brp/dws/dwshome.htm). These waters are subject to stringent regulation in accordance with the Massachusetts Drinking Water Regulations. MA DEP's Drinking Water Program (DWP) has primacy for implementing the provisions of the federal Safe Drinking Water Act. DWP has also initiated work on its Source Water Assessment Program (SWAP), which requires that the Commonwealth delineate protection areas for all public ground and surface water sources, inventory land uses in those areas that may present potential threats to drinking water quality, determine the susceptibility of water supplies to contamination from these potential sources, and publicize the results.

Public water suppliers monitor their finished water (tap water) for major categories of both naturally occurring and man-made contaminants such as: microbiological, inorganic, organic, pesticides, herbicides and radioactive contaminants. Specific information on community drinking water sources, including SWAP activities and drinking water quality information, is updated and distributed annually by the public water system to its customers in a "Consumer Confidence Report". These reports are available from the public water system.

PRIMARY AND SECONDARY CONTACT RECREATIONAL AND AESTHETICS USES

The *Primary Contact Recreational Use* is supported when conditions are suitable (fecal coliform bacteria densities, turbidity and aesthetics meet the SWQS) for any recreational or other water related activity during which there is prolonged and intimate contact with the water and there exists a significant risk of ingestion. Activities include, but are not limited to, wading, swimming, diving, surfing and water skiing. The *Secondary Contact Recreational Use* is supported when conditions are suitable for any recreational or other water use during which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact related to shoreline activities. For lakes, macrophyte cover and/or transparency (Secchi disk depth) data are assessed to evaluate the status of the recreational uses. The *Aesthetics Use* is supported when surface waters are free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

***Primary and Secondary Contact Recreational and Aesthetics Use Summary - Rivers*:**

The majority of the river miles (92%) are currently not assessed for the *Primary* and *Secondary Contact Recreational Uses* because of the lack of current bacteria data (Figure 3). The lower 9.9 miles of the Otter River are assessed as impaired for the *Primary and Secondary Contact Recreational and Aesthetics Uses* because of turbidity. Suspected sources of impairment include sand and gravel operations in this subwatershed and runoff from highway, road, and bridges associated with construction activities. The *Aesthetics Use* is assessed as support for 73% of the river miles (Figure 4).

***Primary and Secondary Contact Recreational and Aesthetics Use Summary - Lakes*:**

Due to a lack of fecal coliform bacteria data 93% of the lake acreage was not assessed for the *Primary* and *Secondary Contact Recreational and Aesthetics Uses* (Figures 3 and 4). A total of five lakes (7% of the total lake acreage) are assessed as supporting these uses. These include: Dunn and Ruggles ponds, Lake Denison, Lake Mattawa, and Laurel Lake. None of the lakes in the Millers River Watershed are assessed as impaired for the *Primary* and *Secondary Contact Recreational and Aesthetics* uses.

Primary and Secondary Contact Recreational Uses

Rivers

Total length assessed in report – 117.4 miles

- **Impaired – 9.9 (8%)**
- **Not Assessed – 107.5 miles (92%)**

Lakes

Total lake area assessed in report – 3,833 acres

- **Support – 272 acres (7%)**
- **Not Assessed – 3,561 acres (93%)**

Aesthetics Use

Rivers

Total length assessed in report – 117.4 miles

- **Support – 85.7 miles (73%)**
- **Impaired – 9.9 (8%)**
- **Not Assessed – 21.8 miles (19%)**

Lakes

Total lake area assessed in report – 3,833 acres

- **Support – 272 acres (7%)**
- **Not Assessed – 3,561 acres (93%)**

MILLERS RIVER WATERSHED

Aquatic Life Use Assessment Summary – Rivers and Lakes

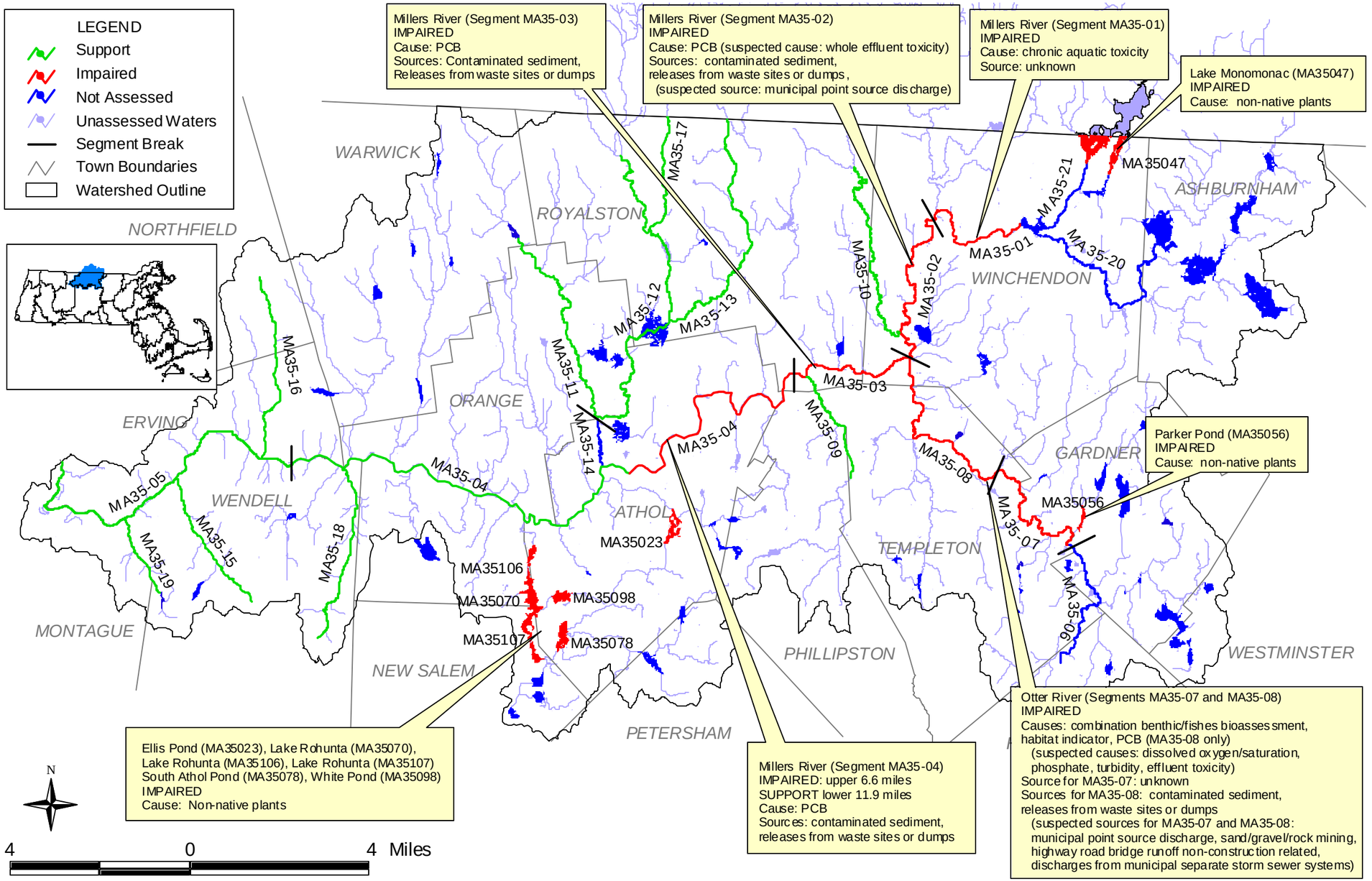

Figure 1. Millers River Watershed *Aquatic Life Use* Assessment Summary – Rivers and Lakes

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MILLERS RIVER WATERSHED

Fish Consumption Use Assessment Summary – Rivers and Lakes

The current MA DPH site-specific fish consumption advisory for rivers (MA DPH 2002):
Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:
1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody **and its tributaries**"
2. "The general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River."
3. "The general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Otter River, within ½ mile of the Millers River (Templeton and Winchendon) because of PCBs:
1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish taken from this waterbody."
2. "The general public should not consume any white sucker or brown bullhead taken from this waterbody."

Site-specific advisories for lakes in the watershed were based on results of fish contaminant monitoring.

The current MA DPH statewide advisory (MA DPH 2001):
The MA DPH "is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age to refrain from eating the following marine fish; shark, swordfish, king mackerel, tuna steak and tilefish. In addition, MA DPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination, to now include women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age (MA DPH 2001)." Additionally, MA DPH "is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about 2 meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to 2 cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury (MA DPH 2001)." MA DPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially.

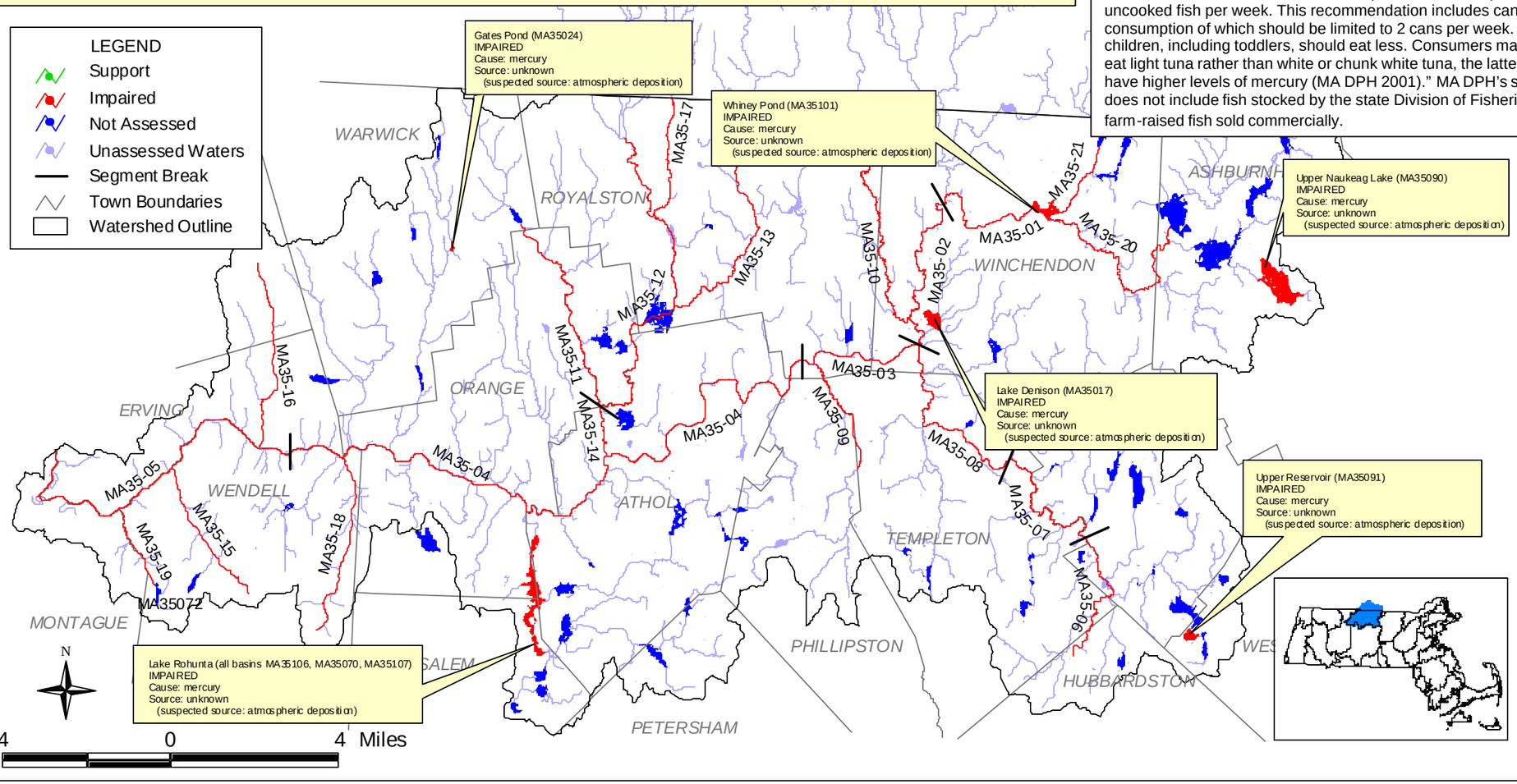

Figure 2. Millers River Watershed *Fish Consumption Use* Assessment Summary – Rivers and Lakes

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MILLERS RIVER WATERSHED

Primary and Secondary Contact Recreational Uses Assessment Summary – Rivers and Lakes

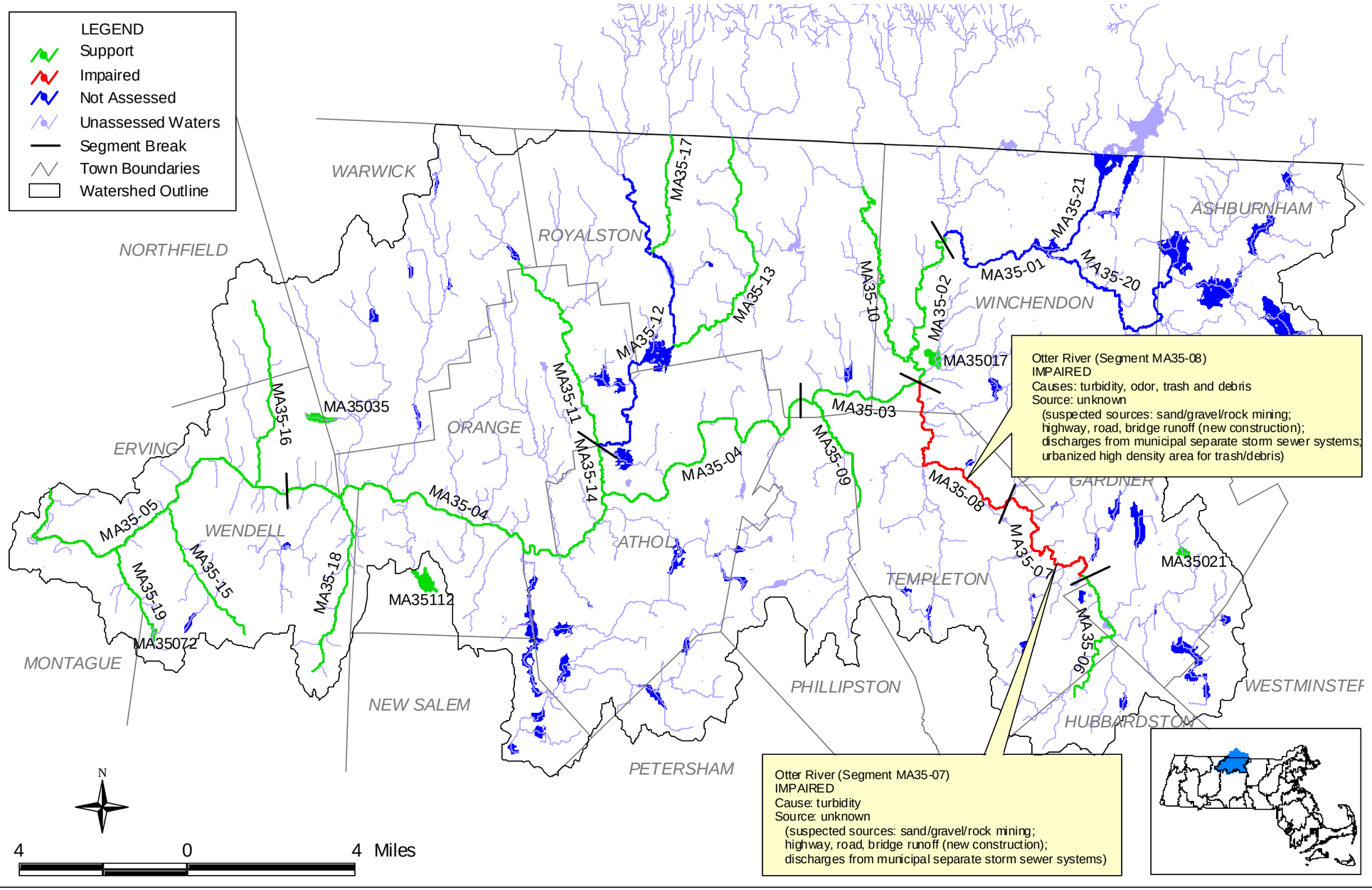

Figure 3. Millers River Watershed *Primary and Secondary Contact Recreational Uses* Assessment Summary – Rivers and Lakes

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MILLERS RIVER WATERSHED

Aesthetics Use Assessment Summary – Rivers and Lakes

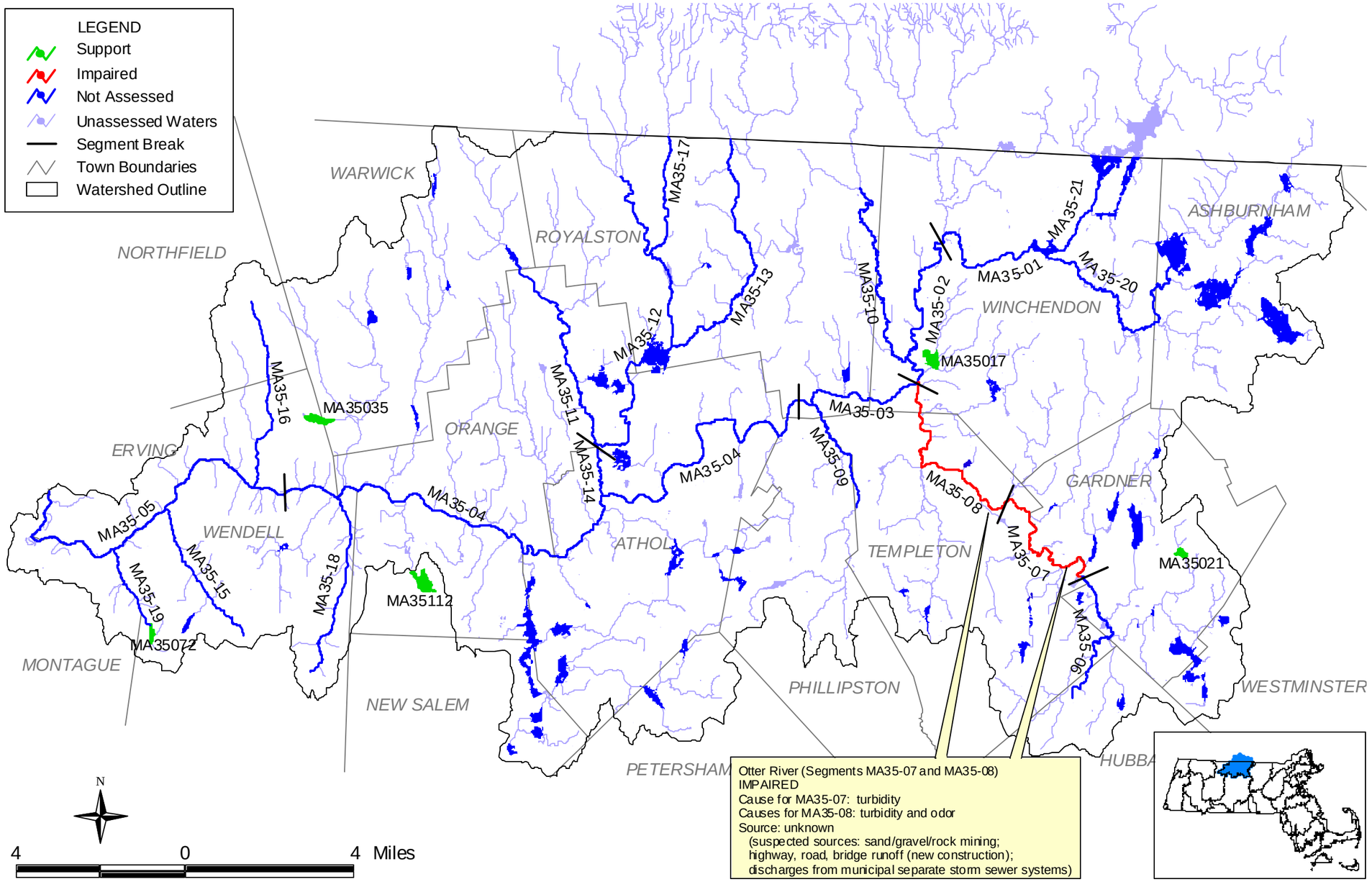

Figure 4. Millers River Watershed *Aesthetics Use* Assessment Summary – Rivers and Lakes

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SUMMARY OF WATER QUALITY INDICATORS - RIVERS

Table 1 presents indicator types used to assess the status of the designated uses for the rivers in the Millers River Watershed. It illustrates where criteria or guidance were met (green shading), where they were not met (red shading) and also where issues of concern were identified (yellow shading). The grey shading indicates that no or insufficient data were available. The cross hatching indicates that very limted data were available. This table can be used as a planning tool to identify where additional monitoring or information gathering is warranted. It is also valuable in identifying areas where mitigative actions can be taken to improve water quality. Based on this summary, the following conclusions are presented:

- Although a fish advisory is in effect for the Millers River and its tributaries, elevated levels of PCBs and/or mercury were detected in the tissue of fish collected from certain segments of the Millers River and the Otter River whereas no testing of fish from other tributaries has been conducted.
- Sediments in the Otter River and the Millers River downstream from the confluence with the Otter River are contaminated with PCBs.
- The alteration of the natural flow regime, and ultimately its effects on instream habitat and biological integrity, in the Millers River and several tributaries is of concern. There are numerous activities that affect the timing, magnitude, frequency, and rate of change of natural flows including, but not limited to, the operation of flood control projects, hydropower operation(s) and outlet control practices at dams.
- More data were available for the Millers River and the Otter River than on the other tributaries to the Millers River.
- The Otter River stands out as having multiple water quality problems.
- There is a lack of bacteria data throughout the watershed limiting the assessment of recreational uses.

RECOMMENDATIONS

In addition to specific actions identified for each individual segment, this assessment report has revealed the need for the following actions to be taken in the Millers River Watershed to protect, restore and/or improve water quality conditions:

<u>Water Quality Classification</u>

- The CSO designation for the upper reach of the Millers River should be removed in the next revision of the Massachusetts Surface Water Quality Standards since overflows from the Winchendon collection system were eliminated in December 2003 (Peirent 2003).
- Incorporate/designate Cold Water Fishery resources that were recommended by MA DFWELE in the Millers River Watershed in the next revision of the Massachusetts Surface Water Quality Standards.

<u>Water Quality Monitoring</u>

- Continue to periodically conduct biological and habitat quality sampling in the Millers River Watershed to assess the status of the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Develop an instream monitoring strategy to evaluate the effectiveness of point and nonpoint source nutrient reduction efforts. Such monitoring efforts should include evalutation of primary productivity (e.g., periphyton, phytoplankton, macrophyte) as well as direct chemical measurements.
- Further investigation is needed to determine the source of toxicity (naturally related to low alkalinity, pH and hardness waters vs. anthropogenic influences) in the upper reaches of the Millers River. An in-depth instream toxicity evaluation that addresses variability of water quality conditions should be conducted.
- MA DEP's Division of Waste Site Cleanup should work with other agencies and potential principle responsible parties to continue the investigation of PCB contamination and remediation efforts.
- Evaluate the need for additional PCB sampling of sediment and whole fish in the Millers River downstream from Birch Hill Dam, Royalston to better assess the status of the *Aquatic Life Use*.

- Recommendations for long-term restoration/preservation that are contained in lake diagnostic/feasibility studies and watershed management plans should be reviewed and steps taken to effect their implementation. Likewise, recommendations from the nutrient total maximum daily loads (TMDL) analysis that was conducted by MA DEP should be reviewed and implemented.
- Continue to conduct long-term fixed site monitoring including chemical, physical, bacteriological, and biological characteristics at the five Strategic Monitoring and Assessment for River Basin Teams (SMART) monitoring sites in the Millers River Watershed to determine long-term water quality trends.
- Continue to monitor and analyze data (e.g., habitat quality, benthic macroinvertebrate and fish community) to support the development of biocriteria for Massachusetts wadeable rivers and streams. Prior to development of biocriteria, however, and to the extent possible given time constraints and different sample collection methods, an RBP III analysis of the benthos data should be conducted for use by DWM to assess the *Aquatic Life Use* in the streams where these data have been collected.
- MA DFWELE should continue to stock the Bear's Den section of the Millers River with salmon fry to restore this fishery to the river. The cooperative efforts of MA DFWELE, U.S. Fish & Wildlife (USFWS), Trout Unlimited (TU) and Guilford Rail in stocking this remote section of the river should continue.

Point Sources of Pollution

- Continue to evaluate results of the whole effluent toxicity testing required by NPDES permits for all facilities in the Millers River Watershed. Determine if toxicity identification and reduction evaluations (TIE/TRE) are warranted (discharge exhibits severe and/or persistent toxicity problems).
- Conduct upstream/downstream biological evaluations (e.g., benthic macroinvertebrate study) of NPDES discharges to evaluate whether or not there are any instream impacts from the discharge.
- Carefully monitor the effectiveness of facilities with phosphorus loading, evaluation, and reduction programs as well as their compliance with a seasonal total phosphorus limit, which have been required in their recently reissued NPDES permits.
- Evaluate the quality of storm water pollution prevention plans (SWPPP) required of facilities in the watershed, extent of compliance, and the effectiveness of the plans in minimizing impacts of stormwater runoff.
- Evaluate the effectiveness of the Gardner and Templeton stormwater management programs in reducing the discharge of pollutants from the storm sewer system to protect water quality.

Nonpoint Sources of Pollution

- The Montachusett Regional Planning Commission (MRPC) and the Franklin Regional Council of Governments (FRCOG) completed an Assessment of Potential Nonpoint Sources of Pollution for the Millers River Watershed. This project was undertaken to comprehensively assess both existing and potential water quality problems in the Millers River Watershed. Communities and other interested parties in the watershed should review and implement these recommendations, as appropriate. The report indicated that an important factor in determining the impacts of land use on water quality is the knowledge base of each community regarding the types of control that are available. It was recommended that education be provided to local governments on issues of specific concern. The EOEA Millers River Watershed Team recommended modifying the Nonpoint Source Education for Municipal Officials (NEMO) program to address concerns in the watershed.
- Investigate and confirm the presence of the numerous sand and gravel operations identified in MRPC and FRCOG 2002 study. Evaluate these sites to ensure that they are being operated and maintained properly and that water quality is being protected. Best management practices (BMPs) should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive

identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for town boards to provide town officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604(b) Water Quality Assessment).

- There are numerous landfills at various stages of operation and closure throughout the Millers River Watershed. These sites are listed in the Solid Waste Facility Municipal Atlas prepared by MA DEP. The Atlas also lists unconfirmed sites that need more investigation to determine their status. In addition to these sites, there may be previously unidentified historic landfills and many other undocumented disposal areas that exist. The recently completed Assessment of Potential Nonpoint Sources of Pollution for the Millers River Watershed (MRPC and FRCOG 2002) indicated that illegal dumping occurs throughout the watershed. An identification and evaluation of all recent and historic landfill and disposal sites should be undertaken so that communities can manage these areas in a manner that is protective of water quality and sensitive environmental resources.
- Many communities rely on septic systems for wastewater disposal. Efforts should be made, therefore, to ensure that on-site systems are properly sited, maintained and inspected.
- There are numerous underground storage tanks sited throughout the watershed. An inventory of these tanks should be maintained by communities to identify areas of risk. The inventory should include the location, age, material and condition of the tank. Priority should be given to areas near drinking water supplies, lakes, ponds, and wetlands and areas where stormwater runoff conditions are intensified by extensive impervious surfaces. Communities that do not have them should consider town bylaws that regulate the construction, installation, operation and maintenance of underground storage tanks.
- The MRPC and FRCOG 2002 report indicates that there are at least 654 potential vernal pools in the Millers River Watershed. These areas should be prioritized for nonpoint source protection measures and to pursue a course of certification to obtain further protection under the Wetlands Protection Act.
- The communities of Gardner and Templeton are Phase II Stormwater communities. Each community was issued a stormwater general permit from EPA and MA DEP in 2003, and is authorized to discharge stormwater from their municipal drainage systems (MAR041190 and MAR041225, respectively). Over the five-year permit term, the communities will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

Hydrology

- Instream flow regimes in the Millers River (as affected by operation of the Federal Energy Regulatory Commission [FERC]-exempt and FERC nonjurisdictional hydropower projects and the Army Corps of Engineers [ACOE] Flood Control Projects) should be documented and attempts should be made to mimic natural flow regimes to the extent possible. Efforts should be made to reduce aberrant streamflow fluctuations (pulsing once to twice per day) in the Millers River observed at the USGS gages located at the Otter River and at the Millers River near Winchendon, Athol and Erving.
- Investigate the operating conditions of the FERC-exempt projects during periods of low flow. Determine if these projects release their required minimum flows. Evaluate and monitor these operations for compliance with run-of-river requirements. To ensure run-of-river operations, all dam operators should install, calibrate and maintain a continuous streamflow monitoring gage or determine some other method to ensure compliance with run-of-river operations.
- Stream gaging data for the Millers River (USGS gage 01164000 at South Royalston MA) and the East Branch Tully River (USGS gage 01165000 near Athol MA) should be analyzed and published in the annual USGS Water Resources Data reports. ACOE gage data should also be analyzed and published.
- Recommendations that were made in the *Hydrologic Assessment of the Millers River* report, prepared by Gomez and Sullivan (2003) should be reviewed and implemented, as appropriate. In particular, consideration should be given to the following:

- investigate the pulsing flows that were observed in the 2000 hourly hydrographs in the Otter River and in the Millers River near Winchendon, Athol, and Erving,
- encourage all public water suppliers and industrial water users to develop up-to-date water conservation plans,
- evaluate subbasin stress levels in greater depth,
- encourage municipalities to initiate the planning process to identify solutions to meet future water demands,
- enforce the operation of the FERC-exempt hydropower projects on the Millers River as run-of-river facilities, and
- the ACOE and USFWS should continue with discussions concerning flow related issues on the Tully Lake and Birch Hill Dam Flood Control facilities.

- The Franklin County Regional Water Supply Study (FRCOG 2003) was undertaken to assess the short- and long-term capacity of water supplies to support growth in the region. Detailed information on each community water supply system was presented and evaluated. Recommendations that were made in the report should be reviewed and implemented, as appropriate. In particular, consideration should be given to recommendations that deal with the following:
  - encouraging community water suppliers and municipalities to work together to determine and implement the most cost effective approaches to sustaining the quality and quantity of drinking water supplies,
  - protecting high yield aquifers for future water supply purposes, and
  - developing safe yield measurements for high yield aquifers.

Fish Consumption

- MA DPH is currently reevaluating their Fish Consumption Advisory for the Millers River Watershed. Additional fish toxics monitoring should be conducted to better define the extent of the Fish Consumption Advisory (MA DPH 2002a).
- A determination of natural or man-made barriers to migration in tributaries of the Millers River should be made. This will aid in the identification of stream reaches where the potential for PCB contamination in fishes is greatest.

Land Protection

- Most of the watershed contains less than 10% impervious surfaces, classifying the watershed as sensitive (Stoltzfus 2001). In order to preserve the watershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth) to desired zones, preserve sensitive areas, and maintain or reduce the impervious cover. Communities should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999), Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented.
- The North Quabbin Regional Landscape Partnership (NQRLP) should continue to coordinate and collaborate land protection efforts in the watershed.
- Communities within the Millers River Watershed should work with the NQRLP in an ongoing manner to participate in the conservation of regional landscape-scale natural resources such as large blocks of forest, ridgelines, Biomap core habitat areas and riparian corridors.
- Organizations such as the Mount Grace Land Conservation Trust, New England Forestry Foundation, and Trustees of Reservations should continue with their land protection efforts.
- MREC should participate in land protection efforts in the watershed by serving as a clearing house of information through its developing library of resources and by providing physical meeting and conference space with multimedia capabilities.
- It is recommended that communities participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project communities can

work cooperatively with each other to determine regional open space priorities and environmental goals including the protection of water quality.

- Through the efforts of the Mass. Watershed Initiative all communities in the watershed either have individual Open Space Plans or are in the process of completing/updating them. Open space committees that are formed should continue to work together to implement recommendations from the plan.
- Communities should work to ensure that consistency exists between their Master Plan and their zoning regulations/bylaws regarding natural resource use and protection.
- The North Quabbin Bioreserve is a collection of more than 64,000 acres of private and public land that has been protected through conservation restrictions and purchases by the state and environmental organizations. With this substantial amount of land, there is an increased need for monitoring of these conservation restrictions. This type of monitoring will ensure that water quality is protected. The state agencies that are responsible for this monitoring (the Massachusetts Department of Environmental Management and the Metropolitan District Commision [both agencies now within the Department of Conservation and Recreation] and the Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement [now the Department of Fish and Game], Division of Fisheries and Wildlife) should be given adequate resources to ensure that this function is carried out. These agencies should also consider training forestry and other natural resource professionals so that they may cooperatively monitor conservation restrictions.
- Communities in the watershed should use the Fiscal Impact Tool developed by EOEA's Community Preservation Program to analyze the financial implications of development projects. This tool can be used to compare the revenue generated and expenses incurred as a result of varied development alternatives in order to make informed decisions about future growth.
- The Ecotourism Task Force/North Quabbin Woods group that was established through the New England Forestry Foundation should continue with its efforts to promote the watershed and its water resources in a sustainable low-impact manner.
- The MRPC and FRCOG 2002 nonpoint source assessment study recommends the following actions be taken to assist local communities in watershed protection zoning efforts:
    - Conduct a comprehensive comparison of zoning practices to evaluate the effectiveness of the zoning language each community has adopted (regarding surface and groundwater resource areas, parking dimension regulations, lot size dimension regulations, open space residential design, use regulations) and identify specific areas for improvement. Include impacts anticipated by the EOEA buildout analysis.
    - Map zoning districts for the entire watershed to highlight water resources, nutrient loads (determined through modeling), and identified water quality problems to target specific zoning district improvements.
    - Develop a continuing watershed protection zoning education program aimed at improving voter awareness of zoning impacts on water quality. Conduct surveys of participants as a measure of effectiveness. Include impacts anticipated by the EOEA buildout analysis.
    - Recommend changes to local general and zoning bylaws and subdivision regulations for each affected community for voters to take action at Town meetings. Update the procedure annually.

<u>Public Outreach/Education</u>

- In view of the illegal dumping that occurs throughout the watershed, consideration should also be given to offering educational programs to inform residents of the negative effects of illegal solid waste dumping on the environment. The Millers River Environmental Center (MREC) should work with residents as well as town and regional authorities to develop a program addressing improper disposal of household solid waste.
- Efforts that were begun by the EOEA Millers River Watershed Team to establish signs that name the various watercourses/waterbodies that are crossed by roadways should continue. The naming of these various watercourses/waterbodies will serve as an educational outreach tool by increasing public awareness of these valuable resources and will serve to create a sense of stewardship for the Millers River Watershed.

- MREC, the Tully River Stream Team and the Otter River Stream Team/Stony Bridge Foundation should continue to conduct stream cleanups particularly in the areas identified in the MRPC and FRCOG 2002 report.
- MREC, the Tully River Stream Team and the Otter River Stream Team/Stony Bridge Foundation should continue to raise community awareness, build an advocacy network and improve water quality. These groups should also continue to work with the MA DFWELE Riverways Program (now the Department of Fish and Game) to build capacity and conduct projects such as the ongoing photo documentation and midstream bioinventory projects.
- MREC should continue to participate in and coordinate the EOEA sponsored Biodiversity Days for the Millers River Watershed.
- Area schools should consider participating in the School Group Monitoring Network that was established through an EOEA Massachusetts Watershed Initiative project. In this network middle and high school groups participate in water quality, macroinvertebrate and other environmental monitoring activities and share their information with watershed managers and other school groups.
- MREC should continue to organize activities that focus attention on the environment (such as an open house at MREC highlighting the work of watershed agencies and groups) during events such as the annual Millers River Rat Race.
- MREC should work with schools within the Millers River Watershed and North Quabbin Bioreserve to build a stewardship ethic in the local community through student field trips led by local experts and professional development programs that inform and engage teachers.
- The newly formed Millers River Chapter of Trout Unlimited (TU) should continue to conduct the numerous educational, outreach and restoration efforts it has begun in the watershed. TU should also continue to coordinate and work with other environmental watershed groups, such as the Millers River Environmental Center, on various projects.
- MREC should continue to work with local schools in the Atlantic Salmon Egg Rearing Project in which salmon fry are raised by students for release to the natural environment.
- MREC should continue to work with local schools on restoration projects for increasing biodiversity of native fish, such as the American Eel Project in which an eel pass will be constructed for upstream passage of a native anadromous species.

Table 1. Summary of Water Quality Indicators - Rivers

Water Body (Segment)	Aquatic Life							Recreation & Aesthetics		Fish Tissue*	
		Water Quality									
	Biology	Chemistry	Nutrients	Toxicity	Sediments	Flow	Habitat	Bacteria	Aesthetics	Hg	PCB
MILLERS RIVER - MAINSTEM											
Sunset Lake to Whitney Pond (MA35-20)											
Whitney Pond to Winchendon WWTF (MA35-01)											
Winchendon WWTF to confluence with Otter River (MA35-02)											
Confluence of Otter River to South Royalston USGS Gage (MA35-03)											
South Royalston USGS Gage to Upper Cresticon Dam (MA35-04)											
Upper Cresticon Dam to Erving Center WWTF (MA35-04)											
Erving Center WWTF to confluence with Connecticut River (MA35-05)											
OTTER RIVER SUBWATERSHED											
Source in Hubbardston to Gardner WWTP (MA35-06)											
Gardner WWTP to Seaman Paper Dam (MA35-07)											
Seaman Paper Dam to Confluence with Millers River (MA35-08)											
TULLY RIVER SUBWATERSHED											
East Branch Tully River (MA35-12)											
Boyce Brook (MA35-17)											
Lawrence Brook (MA35-13)											
West Branch Tully River (MA 35-11)											
Tully River (MA 35-14)											

Table 1. Summary of Water Quality Indicators – Rivers - *Continued*

Water Body (Segment)	Aquatic Life							Recreation & Aesthetics		Fish Tissue	
		Water Quality									
	Biology	Chemistry	Nutrients	Toxicity	Sediments	Flow	Habitat	Bacteria	Aesthetics	Hg	PCB
OTHER TRIBUTARIES											
North Branch Millers River (MA35-21)											
Priest Brook (MA35-10)											
Beaver Brook (MA35-09)											
Whetstone Brook (MA35-18)											
Keyup Brook (MA 35-16)											
Mormon Hollow Brook (MA35-15)											
Lyons Brook (MA35-19)											
Tarbell Brook											
West Brook											
Lake Rohunta											
Moss Brook											

Criteria/guidance met
Concerns identified
Criteria/guidance not met
No/Insufficient data available
Very limited data available.

*Results presented are based on actual Fish Tissue Data that were collected and not the MA DPH Fish Consumption Advisory

INTRODUCTION

The Massachusetts watershed approach is a collaborative effort between state and federal environmental agencies, municipal agencies, citizens, non-profit groups, businesses and industries in the watershed. The mission is to improve water quality conditions and to provide a framework under which the restoration and/or protection of the watershed's natural resources can be achieved. Figure 5 illustrates the management structure to carry out the mission. This report presents the current assessment of water quality conditions in the Millers River Watershed. The assessment is based on information that has been researched and developed by the Massachusetts Department of Environmental Protection (MA DEP) through the first three years (information gathering, monitoring, and assessment) of the five-year cycle in partial fulfillment of MA DEP's federal mandate to report on the status of the Commonwealth's waters under the Federal Water Pollution Control Act (commonly known as the Clean Water Act [CWA]).

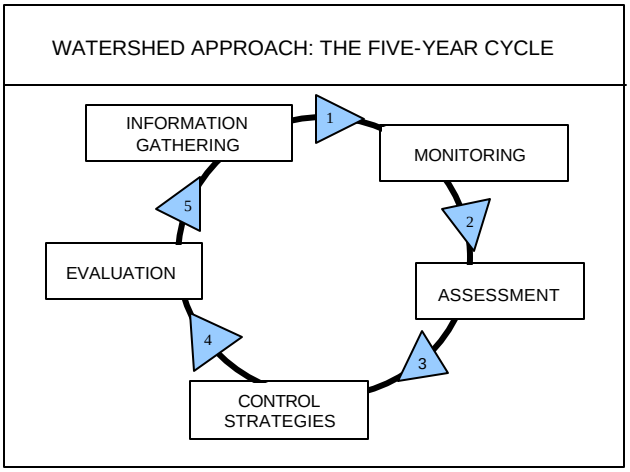


Figure 5: Five-year cycle of the Watershed Approach.

The goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). To meet this objective, the CWA requires states to develop information on the quality of the Nation's water resources and report this information to the United States Environmental Protection Agency (EPA), the United States Congress, and the public. Together, these agencies are responsible for implementation of the CWA mandates. Under Section 305(b) of the Federal Clean Water Act, every two years MA DEP was required to submit a statewide report (to the EPA) that described the status of water quality in the Commonwealth. The most recent 305(b) Report is the *Commonwealth of Massachusetts Summary of Water Quality 2000* (MA DEP 2000). States were also required to submit, under Section 303(d) of the CWA, a List Of Waters requiring a total maximum daily load (TMDL) calculation. The most recent 303(d) List is the *Final Massachusetts Section 303(d) List of Waters 1998* (MA DEP 1999). In 2002, however, EPA required the states to combine elements of the statewide 305(b) report and the Section 303(d) List Of Waters into one "Integrated List of Waters". This statewide list is based on the compilation of information for the Commonwealth's 27 watersheds. Massachusetts has opted to write individual watershed water quality assessment reports and use them as the supporting documentation for the Integrated List. The assessment reports utilize data compiled from a variety of sources and provide an evaluation of water quality, progress made towards maintaining and restoring water quality, and the extent to which problems remain within each watershed. Instream biological, habitat, physical/chemical, toxicity data and other information are evaluated to assess the status of water quality conditions. This analysis follows a standardized process described below (Assessment Methodology).

ASSESSMENT METHODOLOGY

WATER QUALITY CLASSIFICATION

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected; prescribe minimum water quality criteria required to sustain the designated uses; and include provisions for the prohibition of discharges (MA DEP 1996). These regulations should undergo public review every three years. The surface waters are segmented and each segment is assigned to one of the six classes described below. Each class is identified by the most sensitive and, therefore, governing water uses to be achieved and protected. Surface waters may be suitable for other beneficial uses, but shall be regulated by the Department of Environmental Protection to protect and enhance the designated uses.

Inland Water Classes

1. ***Class A*** *– These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life* and *wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORWs) under 314 Code of Massachusetts Regulations (CMR) 4.04(3).*
2. ***Class B*** *– These waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
3. ***Class C*** *– These waters are designated as a habitat for fish, other aquatic life and wildlife, and for secondary contact recreation. These waters shall be suitable for the irrigation of crops used for consumption after cooking and for compatible industrial cooling and process uses. These waters shall have good aesthetic value.*

Coastal and Marine Classes

4. ***Class SA*** *– These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfishing Areas). These waters shall have excellent aesthetic value.*
5. ***Class SB*** *– These waters are designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas they shall be suitable for shellfish harvesting with depuration (Restricted Shellfishing Areas). These waters shall have consistently good aesthetic value.*
6. ***Class SC*** *– These waters are designated as a habitat for fish, other aquatic life, and wildlife and for secondary contact recreation. They shall also be suitable for certain industrial cooling and process uses. These waters shall have good aesthetic value.*

The CWA Section 305(b) water quality reporting process is an essential aspect of the Nation's water pollution control effort. It is the principal means by which EPA, Congress, and the public evaluate existing water quality, assess progress made in maintaining and restoring water quality, and determine the extent of remaining problems. In so doing, the states report on waterbodies within the context of meeting their designated uses (described above in each class). These uses include: *Aquatic Life, Fish Consumption, Drinking Water, Primary Contact Recreation, Secondary Contact Recreation, Shellfish Harvesting* and *Aesthetics*. Two subclasses of Aquatic Life are also designated in the standards: Cold Water Fishery (capable of sustaining a year-round population of cold water aquatic life, such as trout), and Warm Water Fishery (waters that are not capable of sustaining a year-round population of cold water aquatic life).

The SWQS, summarized in Table 2, prescribes minimum water quality criteria to sustain the designated uses. Furthermore, these standards describe the hydrological conditions at which water quality criteria must be applied (MA DEP 1996). In rivers, the lowest flow conditions at and above which aquatic life criteria must be applied are the lowest mean flow for seven consecutive days to be expected once in ten years (7Q10). In artificially regulated waters, the lowest flow conditions at which aquatic life criteria must be applied are the flow equal to or exceeded 99% of the time on a yearly basis or another equivalent flow

that has been agreed upon. In coastal and marine waters and for lakes the most severe hydrological condition for which the aquatic life criteria must be applied shall be determined by MA DEP on a case-by-case basis.

The availability of appropriate and reliable scientific data and technical information is fundamental to the 305(b) reporting process. It is EPA policy (EPA Order 5360.1 CHG 1) that any organization performing work for or on behalf of EPA establishes a quality system to support the development, review, approval, implementation, and assessment of data collection operations. To this end, MA DEP describes its Quality System in an EPA-approved Quality Management Plan to ensure that environmental data collected or compiled by the MA DEP are of known and documented quality and are suitable for their intended use. For external sources of information MA DEP requires the following: 1). an appropriate *Quality Assurance Project Plan* including a laboratory Quality Assurance /Quality Control (QA/QC) plan, 2). use of a state certified lab (or as otherwise approved by MA DEP for particular analyses), and 3). sample data, QA/QC and other pertinent sample and data handling information are documented in a citable report.

EPA provides guidelines to the states for making their use support determinations (EPA 1997 and 2002, Grubbs and Wayland III 2000 and Wayland III 2001). The determination of whether or not a waterbody supports each of its designated uses is a function of the type(s), quality and quantity of available current information. Although data/information older than five years are usually considered "historical" and used for descriptive purposes, they can be utilized in the use support determination provided they are known to reflect the current conditions. While the water quality standards (Table 2) prescribe minimum water quality criteria to sustain the designated uses, numerical criteria are not available for every indicator of pollution. Best available guidance in the literature may be applied in lieu of actual numerical criteria (e.g., freshwater sediment data may be compared to *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* 1993 by D. Persaud, R. Jaagumagi and A. Hayton). Excursions from criteria due solely to "naturally occurring" conditions (e.g., low pH in some areas) do not constitute violations of the standards.

Each designated use within a given segment is individually assessed as ***support*** or ***impaired***. When too little current data/information exists or no reliable data are available, the use is ***not assessed***. In this report, however, if there is some indication that water quality impairment may exist, which is not "naturally occurring", the use is identified with an "Alert Status". Detailed guidance for assessing the status of each use follows in the Designated Uses Section of this report. It is important to note that not all waters are assessed. Many small and/or unnamed ponds, rivers, and estuaries are currently ***unassessed***; the status of their designated uses has never been reported to EPA in the Commonwealth's 305(b) Report or the Integrated List of Waters nor is information on these waters maintained in the waterbody system database (WBS) or the new assessment database (ADB).

Table 2. Summary of Massachusetts Surface Water Quality Standards (MA DEP 1996 and MA DPH 2002b).

Dissolved Oxygen	Class A, Class B Cold Water Fishery (BCWF), and Class SA: ≥6.0 mg/L and ≥75% saturation unless background conditions are lower Class B Warm Water Fishery (BWWF) and Class SB: ≥5.0 mg/L and ≥60% saturation unless background conditions are lower Class C: Not ≤5.0 mg/L for more than 16 of any 24-hour period and not ≤3.0 mg/L anytime unless background conditions are lower; levels cannot be lowered below 50% saturation due to a discharge Class SC: Not ≤5.0 mg/L for more than 16 of any 24-hour period and not ≤4.0 mg/L anytime unless background conditions are lower; and 50% saturation; levels cannot be lowered below 50% saturation due to a discharge
Temperature	Class A: ≤68°F (20°C) and Δ1.5°F (0.8°C) for Cold Water and ≤83°F (28.3°C) and Δ1.5°F (0.8°C) for Warm Water. Class BCWF: ≤68°F (20°C) and Δ3°F (1.7°C) due to a discharge Class BWWF: ≤83°F (28.3°C) and Δ3°F (1.7°C) in lakes, Δ5°F (2.8°C) in rivers Class C and Class SC: ≤85°F (29.4°C) nor Δ5°F (2.8°C) due to a discharge Class SA: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ1.5°F (0.8°C) Class SB: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ1.5°F (0.8°C) between July through September and Δ4.0°F (2.2°C) between October through June
pH	Class A, Class BCWF and Class BWWF: 6.5 - 8.3 SU and Δ0.5 outside the background range. Class C: 6.5 - 9.0SU and Δ1.0 outside the naturally occurring range. Class SA and Class SB: 6.5 - 8.5SU and Δ0.2 outside the normally occurring range. Class SC: 6.5 - 9.0SU and Δ0.5 outside the naturally occurring range.
Solids	All Classes: *These waters shall be free from floating, suspended, and settleable solids in concentrations or combinations that would impair any use assigned to each class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.*
Color and Turbidity	All Classes: *These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use.*
Oil and Grease	Class A and Class SA: *Waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.* Class SA: *Waters shall be free from oil and grease and petrochemicals.* Class B, Class C, Class SB and Class SC: *Waters shall be free from oil* and *grease, petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course or are deleterious or become toxic to aquatic life.*
Taste and Odor	Class A and Class SA: *None other than of natural origin.* Class B, Class C, Class SB and Class SC: *None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to each class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.*
Aesthetics	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.*
Toxic Pollutants	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife… The Division shall use the recommended limit published by EPA pursuant to 33 USC 1251, 304(a) as the allowable receiving water concentrations for the affected waters unless a site-specific limit is established*.
Nutrients	*Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.*

Note: *Italics are direct quotations.*
Δ criterion (referring to a change from natural background conditions) is applied to the effects of a permitted discharge.

Table 2. Summary of Massachusetts Surface Water Quality Standards (MA DEP 1996 and MA DPH 2002b) - *Continued*.

Bacteria (MA DEP 1996 and MDPH 2002b) Class A criteria apply to the *Drinking Water Use*. Class B and SB criteria apply to *Primary Contact Recreation Use* while Class C and SC criteria apply to *Secondary Contact Recreation Use*.	Class A: • Fecal coliform bacteria: An arithmetic mean of <20 cfu/100mL in any representative set of samples and <10% of the samples >100 cfu/100mL. Class B: • At public bathing beaches, as defined by MA DPH, where *E. coli* is the chosen indicator: No single *E. Coli* sample shall exceed 235 *E. coli* /100 mL and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 *E. coli* per 100 ml. • At public bathing beaches, as defined by MA DPH, where *Enterococci* are the chosen indicator: No single *Enterococci* sample shall exceed 61 *Enterococci* /100mL and the geometric mean of the most recent five samples within same bathing season shall not exceed 33 *Enterococci* /100mL. • Current standards for other waters (not designated as bathing beaches), where Fecal coliform bacteria are the chosen indicator: Waters shall not exceed a geometric mean of 200 cfu/100mL in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100mL. (This criterion may be applied on a seasonal basis at the discretion of the MA DEP.) Class C: • Fecal coliform bacteria: Shall not exceed a geometric mean of 1000 cfu/100ml, nor shall 10% of the samples exceed 2000 cfu/100 mL. Class SA: • Fecal coliform bacteria: Waters approved for open shellfishing shall not exceed a geometric mean (most probable number (MPN) method) of 14 MPN/100 mL, nor shall more than 10% of the samples exceed 43 MPN/100mL. • At public bathing beaches, as defined by MA DPH, where *Enterococci* are the chosen indicator: No single Enterococci sample shall exceed 104 *Enterococci* /100mL and the geometric mean of the most recent five Enterococci levels within the same bathing season shall not exceed 35 *Enterococci* /100mL. • Current standards for other waters (not designated as shellfishing areas or public bathing beaches), where Fecal coliform bacteria are the chosen indicator: Waters shall not exceed a geometric mean of 200 cfu/100mL in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100mL. (This criterion may be applied on a seasonal basis at the discretion of the MA DEP.) Class SB: • Fecal coliform bacteria: Waters approved for restricted shellfish: a fecal coliform median or geometric mean (MPN method) of <88 MPN/100mL and <10% of the samples >260 MPN/100mL (MPN method). • At public bathing beaches, as defined by MA DPH, where *Enterococci* are the chosen indicator: No single Enterococci sample shall exceed 104 *Enterococci* /100mL and the geometric mean of the most recent five Enterococci levels within the same bathing season shall not exceed 35 *Enterococci* /100mL. • Current standards for other waters (not designated as shellfishing areas or public bathing beaches), where Fecal coliform bacteria are the chosen indicator: Waters shall not exceed a geometric mean of 200 cfu/100mL in any representative set of samples, nor shall more than 10% of the samples exceed 400 cfu/100mL. (This criterion may be applied on a seasonal basis at the discretion of the MA DEP.) Class SC: • Fecal coliform bacteria: Shall not exceed a geometric mean of 1000 cfu/100mL, nor shall 10% of the samples exceed 2000 cfu/100mL.

DESIGNATED USES

The Massachusetts Surface Water Quality Standards designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected. Each of these uses is briefly described below (MA DEP 1996):

- *AQUATIC LIFE* - suitable habitat for sustaining a native, naturally diverse, community of aquatic flora and fauna. Two subclasses of aquatic life are also designated in the standards for freshwater bodies: *Cold Water Fishery* - capable of sustaining a year-round population of cold water aquatic life, such as trout; *Warm Water Fishery* - waters that are not capable of sustaining a year-round population of cold water aquatic life.
- *FISH CONSUMPTION* - pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption.
- *DRINKING WATER* - used to denote those waters used as a source of public drinking water. They may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). These waters are designated for protection as Outstanding Resource Waters under 314 CMR 4.04(3).
- *SHELLFISH HARVESTING* (in SA and SB segments) – Class SA waters in approved areas (Open Shellfish Areas) shellfish harvested without depuration shall be suitable for consumption; Class SB waters in approved areas (Restricted Shellfish Areas) shellfish harvested with depuration shall be suitable for consumption.
- *PRIMARY CONTACT RECREATION* - suitable for any recreation or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water. These include, but are not limited to, wading, swimming, diving, surfing and water skiing.
- *SECONDARY CONTACT RECREATION* - suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities.
- *AESTHETICS* - all surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *AGRICULTURAL AND INDUSTRIAL* - suitable for irrigation or other agricultural process water and for compatible industrial cooling and process water.

The guidance used to assess the *Aquatic Life, Fish Consumption, Drinking Water, Shellfish Harvesting, Primary Contact Recreation, Secondary Contact Recreation* and *Aesthetics uses* follows. The status of the *Agricultural and Industrial Use* is not reported to EPA.

AQUATIC LIFE USE

This use is suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. The results of biological (and habitat), toxicological, and chemical data are integrated to assess this use. The nature, frequency, and precision of the MA DEP's data collection techniques dictate that a weight of evidence be used to make the assessment, with biosurvey results used as the final arbiter of borderline cases. The following chart provides an overview of the guidance used to assess the status (support or impaired) of the *Aquatic Life Use*:

Variable	***Support*** – Data available clearly indicates support or minor modification of the biological community. Excursions from chemical criteria (Table 2) not frequent or prolonged and may be tolerated if the biosurvey results demonstrate sup port.	***Impaired*** – There are frequent or severe violations of chemical criteria, presence of acute toxicity, or a moderate or severe modification of the biological community.
BIOLOGY		
Rapid Bioassessment Protocol (RBP) III*	Non/Slightly Impacted	Moderately or Severely Impacted
Fish Community	Best Professional Judgment (BPJ)	BPJ
Habitat and Flow	BPJ	Dewatered streambed due to artificial regulation or channel alteration, BPJ
Eelgrass Bed Habitat (Howes et al. 2002)	No/minimal loss, BPJ	Moderate/severe loss, BPJ
Macrophytes	BPJ	Exotic species present, BPJ
Plankton/ Periphyton	No/infrequent algal blooms	Frequent and/or prolonged algal blooms
TOXICITY TESTS**		
Water Column/Ambient	≥75% survival either 48 hr or 7-day exposure	<75% survival either 48 hr or 7-day exposure
Sediment	≥75% survival	<75% survival
CHEMISTRY-WATER**		
Dissolved oxygen (DO)/percent saturation (MA DEP 1996, EPA 1997)	Infrequent excursion from criteria (Table 2), BPJ (minimum of three samples representing critical period)	Frequent and/or prolonged excursion from criteria [river and shallow lakes: exceedances >10% of measurements; deep lakes (with hypolimnion): exceedances in the hypolimnetic area >10% of the surface area].
pH (MA DEP 1996, EPA 19 November 1999)	Infrequent excursion from criteria (Table 2)	Criteria exceeded >10% of measurements.
Temperature (MA DEP 1996,EPA 1997)	Infrequent excursion from criteria (Table 2)[1]	Criteria exceeded >10% of measurements.
Toxic Pollutants (MA DEP 1996, EPA 19 November 1999) Ammonia-N (MA DEP 1996, EPA 1999a) Chlorine (MA DEP 1996, EPA 19 November 1999)	Infrequent excursion from criteria (Table 2) 1.32 mg/L NH_3-N [2] 0.011 mg/L total residual chlorine (TRC)[3]	Frequent and/or prolonged excursion from criteria (exceeded >10% of measurements).
CHEMISTRY-SEDIMENT**		
Toxic Pollutants (Persaud et al. 1993)	Concentrations ≤ Low Effect Level (L-EL), BPJ	Concentrations ≥ Severe Effect Level (S-EL)[4], BPJ
CHEMISTRY-TISSUE		
PCB – whole fish (Coles 1998)	≤500 µg/kg wet weight	BPJ
DDT (Environment Canada 04 November 1999)	≤14.0 µg/kg wet weight	BPJ
PCB in aquatic tissue (Environment Canada 04 November 1999)	≤0.79 ng TEQ/kg wet weight	BPJ

*RBP II analysis may be considered for assessment decision on a case-by-case basis, **For identification of impairment one or more of the following variables may be used to identify possible causes/sources of impairment: NPDES facility compliance with whole effluent toxicity test and other limits, turbidity and suspended solids data, nutrient (nitrogen and phosphorus) data for water column/sediments. [1]maximum daily mean T in a month (minimum six measurements evenly distributed over 24-hours) less than criterion, [2] [NH_3-N] at pH = 7.7 SU and 30°C, actual "criterion" varies with pH and temperature and is evaluated case-by-case. [3] The minimum quantification level for TRC is 0.05 mg/L. [4]For the purpose of this report, the S-EL for total polychlorinated biphenyl compounds (PCB) in sediment (which varies with Total Organic Carbon (TOC) content) with 1% TOC is 5.3 ppm, while a sediment sample with 10% TOC is 53 ppm.

Note: National Academy of Sciences/National Academy of Engineering (NAS/NAE) guideline for maximum organochlorine concentrations (i.e., total PCB) in fish tissue for the protection of fish-eating wildlife is 500µg/kg wet weight (ppb, not lipid-normalized). PCB data (tissue) in this report are presented in µg/kg wet weight (ppb) and are not lipid-normalized to allow for direct comparison to the NAS/NAE guideline.

FISH CONSUMPTION USE

Pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption. The assessment of this use is made using the most recent list of Fish Consumption Advisories issued by the Massachusetts Executive Office of Health and Human Services, Department of Public Health (MA DPH), Bureau of Environmental Health Assessment (MA DPH 2002). The MA DPH list identifies waterbodies where elevated levels of a specified contaminant in edible portions of freshwater species pose a health risk for human consumption. Hence, the Fish Consumption Use is assessed as non-support in these waters.

In July 2001, MA DPH issued new consumer advisories on fish consumption and mercury contamination (MA DPH 2001).

1. The MA DPH "…is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age to refrain from eating the following marine fish; shark, swordfish, king mackerel, tuna steak and tilefish. In addition, MA DPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination, to now include women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age (MA DPH 2001)."
2. Additionally, MA DPH "…is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about 2 meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to 2 cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury (MA DPH 2001)."

Other statewide advisories that MA DPH has previously issued and are still in effect are as follows (MA DPH 2001):

1. "Due to concerns about chemical contamination, primarily from polychlorinated biphenyl compounds (PCBs) and other contaminants, no individual should consume lobster tomalley from any source. Lobster tomalley is the soft green substance found in the tail and body section of the lobster.
2. Pregnant and breastfeeding women and those who are considering becoming pregnant should not eat bluefish due to concerns about PCB contamination in this species."

The following is an overview of EPA's guidance used to assess the status (support or impaired) of the *Fish Consumption Use*. Because of the statewide advisory no waters can be assessed as support for the *Fish Consumption Use*. Therefore, if no site-specific advisory is in place, the *Fish Consumption Use* is not assessed.

Variable	***Support*** No restrictions or bans in effect	***Impaired*** There is a "no consumption" advisory or ban in effect for the general population or a sub-population for one or more fish species or there is a commercial fishing ban in effect
MA DPH Fish Consumption Advisory List (MA DPH 2002, MA DPH 2001)	Not applicable, precluded by statewide advisory (Hg)	Waterbody on MA DPH Fish Consumption Advisory List

Note: MA DPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially.

DRINKING WATER USE

The term *Drinking Water Use* denotes those waters used as a source of public drinking water. These waters may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). They are designated for protection as Outstanding Resource Waters in 314 CMR 4.04(3). MA DEP's Drinking Water Program (DWP) has primacy for implementing the provisions of the federal Safe Drinking Water Act (SDWA). Except for suppliers with surface water sources for which a waiver from filtration has been granted (these systems also monitor surface water quality) all public drinking water supplies are monitored as finished water (tap water). Monitoring includes the major categories of contaminants established in the SDWA: bacteria, volatile and synthetic organic compounds, inorganic compounds and radionuclides. The DWP maintains current drinking supply monitoring data. The status of the supplies is currently reported to MA DEP and EPA by the suppliers on an annual basis in the form of a consumer confidence report (http://yosemite.epa.gov/ogwdw/ccr.nsf/Massachusetts). Below is EPA's guidance to assess the status (support or impaired) of the drinking water use.

Variable	***Support*** No closures or advisories (no contaminants with confirmed exceedances of maximum contaminant levels, conventional treatment is adequate to maintain the supply).	***Impaired*** Has one or more advisories or more than conventional treatment is required or has a contamination-based closure of the water supply.
Drinking Water Program (DWP) Evaluation	See note below	See note below

Note: While this use is not assessed in this report, information on drinking water source protection and finish water quality is available at and from the Millers River Watershed public water suppliers.

SHELLFISH HARVESTING USE

This use is assessed using information from the Department of Fisheries, Wildlife and Environmental Law Enforcement's Division of Marine Fisheries (DMF). A designated shellfish growing area is an area of potential shellfish habitat. Growing areas are managed with respect to shellfish harvest for direct human consumption, and comprise at least one or more classification areas. The classification areas are the management units and they range from being approved to prohibited (described below) with respect to shellfish harvest. Shellfish areas under management closures are *not assessed.* Not enough testing has been done in these areas to determine whether or not they are fit for shellfish harvest, therefore, they are closed for the harvest of shellfish.

Variable	***Support*** SA Waters: Approved[1] SB Waters: Approved[1], Conditionally Approved[2] or Restricted[3]	***Impaired*** SA Waters: Conditionally Approved[2], Restricted[3], Conditionally Restricted[4], or Prohibited[5] SB Waters: Conditionally Restricted[4] or Prohibited[5]
DMF Shellfish Project Classification Area Information (MA DFWELE 2000)	Reported by DMF	Reported by DMF

NOTE: Designated shellfish growing areas may be viewed using the MassGIS datalayer available from MassGIS at http://www.state.ma.us/mgis/dsga.htm. This coverage currently reflects classification areas as of July 1, 2000.

[1] **Approved** - "...open for harvest of shellfish for direct human consumption subject to local rules and regulations..." An approved area is open all the time and closes only due to hurricanes or other major coastwide events.

[2] **Conditionally Approved** - "...subject to intermittent microbiological pollution..." During the time the area is open, it is "...for harvest of shellfish for direct human consumption subject to local rules and regulations…" A conditionally approved area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, shellfish harvested are treated as from an approved area.

[3] **Restricted** - area contains a "limited degree of pollution." It is open for "harvest of shellfish with depuration subject to local rules and state regulations" or for the relay of shellfish. A restricted area is used by DMF for the relay of shellfish to a less contaminated area.

[4] **Conditionally Restricted** - "...subject to intermittent microbiological pollution..." During the time area is restricted, it is only open for "the harvest of shellfish with depuration subject to local rules and state regulations." A conditionally restricted area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, only soft-shell clams may be harvested by specially licensed diggers (Master/Subordinate Diggers) and transported to the DMF Shellfish Purification Plant for depuration (purification).

[5] **Prohibited -** Closed for harvest of shellfish.

PRIMARY CONTACT RECREATION USE

This use is suitable for any recreational or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water during the primary contact recreation season (1 April to 15 October). These include, but are not limited to, wading, swimming, diving, surfing and water skiing. The chart below provides an overview of the guidance used to assess the status (support or impaired) of the *Primary Contact Recreation Use*. Excursions from criteria due to natural conditions are not considered impairment of use.

Variable	***Support*** Criteria are met, no aesthetic conditions that preclude the use	***Impaired*** Frequent or prolonged violations of criteria and/or formal bathing area closures, or severe aesthetic conditions that preclude the use
Bacteria (MA DPH 2002b) Minimum Standards for Bathing Beaches State Sanitary Code and MA DEP 1996	At "public bathing beach" areas: Formal beach postings/advisories neither frequent nor prolonged during the swimming season (the number of days posted or closed cannot exceed 10% during the locally operated swimming season). Other waters: Samples* collected during the primary contact season must meet criteria (Table 2). Shellfish Growing Area classified as "Approved" by DMF.	At "public bathing beach" areas: Formal beach closures/postings >10% of time during swimming season (the number of days posted or closed exceeds 10% during the locally operated swimming season). Other waters: Samples* collected during the primary contact season do not meet the criteria (Table 2).
Aesthetics (MA DEP 1996) - *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance* [growth or amount] *species of aquatic life*		
Odor, oil and grease, color and turbidity, floating matter	Narrative "free from" criteria met or excursions neither frequent nor prolonged, BPJ.	Narrative "free from" criteria not met - objectionable conditions either frequent and/or prolonged, BPJ.
Transparency (MDPH 1969)	Public bathing beach and lakes – Secchi disk depth ≥1.2 meters (≥ 4') (minimum of three samples representing critical period*).	Public bathing beach and lakes - Secchi disk depth <1.2 meters (< 4') (minimum of three samples representing critical period*).
Nuisance organisms	No overabundant growths (i.e., blooms) that render the water aesthetically objectionable or unusable, BPJ.	Overabundant growths (i.e., blooms and/or non-native macrophyte growth dominating the biovolume) rendering the water aesthetically objectionable and/or unusable, BPJ.

*Data sets to be evaluated for assessment purposes must be representative of a sampling location (minimum of five samples per station recommended) over the course of the primary contact season. Samples collected on one date from multiple stations on a river are not considered adequate to assess this designated use. An impairment decision will not be based on a single sample (i.e., the geometric mean of five samples is <200 cfu/100mL but one of the five samples exceeds 400 cfu/100mL). The method detection limit (MDL) will be used in the calculation of the geometric mean when data are reported as less than the MDL (e.g., use 20 cfu/100mL if the result is reported as <20 cfu/100mL). Those data reported as too numerous to count (TNTC) will not be used in the geometric mean calculation; however frequency of TNTC sample results should be presented.

SECONDARY CONTACT RECREATIONAL USE

This use is suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities. Following is an overview of the guidance used to assess the status (support or impaired) of the *Secondary Contact Use*. Excursions from criteria due to natural conditions are not considered impairment of use.

Variable	***Support*** Criteria are met, no aesthetic conditions that preclude the use	***Impaired*** Frequent or prolonged violations of criteria, or severe aesthetic conditions that preclude the use
Fecal Coliform Bacteria (MA DEP 1996)	Other waters: Samples* collected must meet the Class C or SC criteria (see Table 2).	Other waters: Samples* collected do not meet the Class C or SC criteria (see Table 2).
Aesthetics (MA DEP 1996) - *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance* [growth or amount] *species of aquatic life*		
Odor, oil and grease, color and turbidity, floating matter	Narrative "free from" criteria met or excursions neither frequent nor prolonged*, BPJ.	Narrative "free from" criteria not met - objectionable conditions either frequent and/or prolonged*, BPJ.
Nuisance organisms	No overabundant growths (i.e., blooms) that render the water aesthetically objectionable or unusable, BPJ.	Overabundant growths (i.e., blooms and/or non-native macrophyte growth dominating the biovolume) rendering the water aesthetically objectionable and/or unusable, BPJ.

*Data sets to be evaluated for assessment purposes must be representative of a sampling location (minimum of five samples per station recommended) over time. Samples collected on one date from multiple stations on a river are not considered adequate to assess this designated use.

AESTHETICS USE

All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life. The aesthetic use is closely tied to the public health aspects of the recreational uses (swimming and boating). Below is an overview of the guidance used to assess the status (support or impaired) of the *Aesthetics Use*.

Variable	***Support*** Narrative "free from" criteria met	***Impaired*** Objectionable conditions frequent and/or prolonged
Odor, oil and grease, color and turbidity, floating matter	Narrative "free from" criteria met or excursions neither frequent nor prolonged*, BPJ.	Narrative "free from" criteria not met - objectionable conditions either frequent and/or prolonged*, BPJ.
Nuisance organisms	No overabundant growths (i.e., blooms) that render the water aesthetically objectionable or unusable, BPJ.	Overabundant growths (i.e., blooms and/or non-native macrophyte growth dominating the biovolume) rendering the water aesthetically objectionable and/or unusable, BPJ.

MILLERS RIVER WATERSHED DESCRIPTION AND CLASSIFICATION

MILLERS RIVER WATERSHED DESCRIPTION

The Millers River Watershed (Figure 6) is located in north-central Massachusetts and southwestern New Hampshire where it is bordered on the east by the Nashua, the south by the Chicopee, and on the west by the Connecticut River basins. From its origins in New Hampshire the Millers River flows south and then gradually turns west to its confluence with the Connecticut River. The watershed is hilly with uplands ranging from 200 to 1,500 feet in altitude. The geology is glacially influenced; comprised of rubble, till, and sand and gravel deposits. The lack of buffering capacity associated with these types of soils leaves the river and its aquatic community vulnerable to damage from acid deposition.

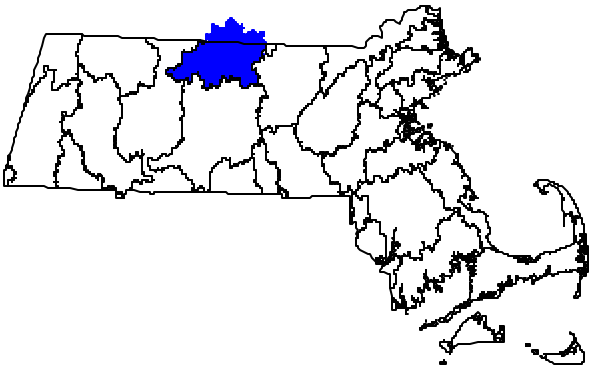


Figure 6. Location of Millers River Watershed.

The Millers River Watershed has a drainage area of 389 square miles (mi^2), approximately 310 mi^2 of which are in Massachusetts. Large parts of this area constitute the major tributaries of the Millers, specifically the Otter River (60.4 mi^2), and the Tully River (74.0 mi^2). The total river length of the mainstem Millers River is 51 miles, 46.5 of which are in Massachusetts. There are 4,121 acres of lakes, ponds and reservoirs in the Massachusetts' portion of the watershed. Eight dams on the mainstem Millers River and one dam on the East Branch Tully River are used for either hydropower or flood control projects. In addition, there are numerous other dams along the Otter River, and the smaller tributaries within the Millers River Watershed.

The Millers River Watershed contains large quantities of unconsolidated sand, gravel, silt and clay, which are capable of storing and transmitting large quantities of water (Collings *et al*. 1969). These surface deposits may form aquifers over the bedrock or "ledge". In fact, sufficient groundwater for domestic use is available nearly everywhere in the basin. High yield aquifers, however, are much more restricted (Collings *et al*. 1969). An average of 43 inches of rain falls annually on the watershed.

Seventeen Massachusetts municipalities are located in the Millers River Watershed, which is populated by approximately 87,000 people. These largely rural communities have some areas of moderate development. The highest population concentration is in Gardner. The major industries in the watershed are paper companies. Tool manufacturing and furniture-making were prominent in the past, but many of these factories have closed and the industries now play a much smaller role in the area economy.

The Millers River begins at the outlet of Sunset Lake in Ashburnham, Massachusetts. The headwaters of the North Branch Millers River lie in Rindge and New Ipswich, New Hampshire. The North Branch and mainstem join at Whitney Pond in Winchendon Center, MA. From the outlet of Whitney Pond the Millers River flows west through a short stretch of rapids to another small impoundment near the intersection of Routes 12 and 202. After leaving this impoundment the river continues west through more rapids passing under Route 202 to a small dam on Hill Street. After this point the flow becomes more laminar, the depth increases somewhat and the direction turns northerly until it reaches the Winchendon Water Pollution Control Facility (WPCF). The Millers river then turns south and flows somewhat sluggishly as it passes through a massive flatwater area that is part of the Birch Hill Flood Control Project. Before leaving this area the river turns west and is joined by one of its largest tributaries - the Otter River. This sluggish portion of the Millers River ends at Birch Hill Dam, one of two flood control dams in the basin built by The United States Army Corps of Engineers (ACOE).

After passing Birch Hill Dam the flow of the Millers River becomes swifter just upstream from Route 68 in South Royalston. The river begins a southwest course fluctuating between rapids and semi-uniform flow. For the next five miles the Millers River flows through a largely undeveloped area dropping over 225 feet. This stretch is often referred to as "The Chute." Downstream from "The Chute", the flow is impounded again by a dam at the old Union Twist Drill Company in Athol. After passing a short section of rapids the river is again impounded at the L. S. Starrett Company Dam. The Millers River flows west to its confluence with the

Tully River, then southwest under Route 2A to the Athol-Orange town line where it continues in a northwest direction to an impoundment in Orange Center.

After leaving the Orange Center impoundment the next 10.5 miles of the Millers River flows swiftly passing Erving Paper Company, the Erving Center Wastewater Treatment Plant (WWTP), and the Erving POTW # 3 before turning into rapids and entering a small impoundment behind Millers Falls Paper Company. The dam formerly located here has been breached. The river flows through the Village of Millers Falls where it receives the effluent from the Erving POTW # 1 and then flows past an old dam at Route 63 and a short distance farther before entering a backwater of the Connecticut River in Gill, MA.

The Millers River fluctuates between sluggish and rapid flow with an average drop of 22 feet per mile from Winchendon to its confluence with the Connecticut River. The United States Geological Survey (USGS) operates three gaging stations on the mainstem Millers River. The first is located on Winchendon Road, Winchendon. The drainage area at this station is 83 mi^2 with an average discharge of 139 cubic feet per second (cfs). The second, located near Route 68 in South Royalston, measures flow from 187 mi^2 and has an average discharge of 403 cfs. The third, located off Farley Road in Erving, has a drainage area of 375 mi^2 and has an average discharge of 620 cfs (Socolow et al. 2002).

The headwaters of the Otter River originate in the wetland areas of Hubbardston, Templeton, and Gardner. The river slowly meanders through the marshy areas of Gardner passing under Routes 2 and 2A, where it receives the effluent from the Gardner WWTP. The Otter River then flows under Route 101 and meanders past sand and gravel operations before entering the impoundment at Seaman Paper Company in Gardner. The paper company's treatment plant discharges a short distance below the dam. The river enters a short rapid section before entering another impounded area formed by the partially breached dam at the old Baldwinville Products Mill. Just downstream from this old dam the Templeton WWTP discharges to the Otter River. The velocity of the river picks up as the river flows through Baldwinville passing under Route 68. The river then enters wetlands in the Otter River State Forest and continues for three miles before emptying into the Millers River. The USGS operates one gage on the Otter River at the Turner Street Bridge in Templeton. The drainage area at this gage is 34.2 mi^2 with an average discharge of 53 cfs. The river here is sluggish, having an average fall of about 9 feet per mile.

The East Branch Tully River begins in Richmond, New Hampshire, entering Massachusetts at Royalston. The river flows south through wetlands to the Tully Reservoir, which was created by the Tully Dam. This impoundment is part of the second flood control project built and operated by the ACOE in the Millers River Watershed. After leaving the reservoir the velocity increases as the river flows south to Athol where it joins the West Branch Tully River. The West Branch Tully River originates in Warwick, Massachusetts as a mountain stream. It flows south to Sheomet Lake. Leaving the lake it flows swiftly southeast through the corner of Orange and into Athol, where it meets the East Branch Tully River. The Tully River then flows slowly through wetlands and empties into the Millers River just north of Routes 2A and 202 in Athol.

Lake Mattawa can drain in two possible directions (either south into the middle branch of the Swift River via the dam and spillway or northwest into North Pond Brook via a small valve structure near the intersection of Holtshire and Chestnut Hill roads). When the Watershed Protection Act (the "Cohen Bill") was passed, a decision had to be made about which way the lake drained and, thus, whether or not it was part of the Quabbin Reservoir Watershed. There is local disagreement about the relative merits of being in the Quabbin River Watershed (and, thus, subject to the Watershed Protection Act regulations, which put added constraints on development). When the Town of Orange tried to restrict the flow from the lake to the Millers River direction, periodic spillway overflows, possible leakage under the dam, and local residents' manipulation of the gates and valves still resulted in some flow into the Middle Branch of the Swift River. MA DEP includes Lake Mattawa in the Chicopee River Watershed with a Class A designation since there was no assurance that flows from the lake could be limited to the Miller's. However, since most of the flow from the lake in a typical year drains to the Millers River it is included in this report.

Many rivers and lakes in the Millers River Watershed are heavily used for recreation, including swimming, boating, fishing, and sightseeing. Designated public access points are located at: Lake Rohunta in Orange, the Millers River in Orange, Lake Denison in Winchendon, and Laurel Lake in Erving (MA DFWELE 2002).

There are 91 named streams in the Millers River Watershed that have been assigned Stream and River Inventory System (SARIS) code numbers (Halliwell *et al*. 1982). These streams and rivers are approximately 242.2 miles in length. A total of 100 lakes, ponds and impoundments (the term "lakes" will hereafter be used to include all) have been identified and assigned Pond and Lake Information System (PALIS) code numbers in the Millers River Watershed (Ackerman 1989 and MA DEP 2004). The total surface area of the Millers River Watershed lakes is 4,121 acres. [Note: A variety of sources have been used to determine the river length and lake area including the WBS database, diagnostic/feasibility studies, and 1:25,000 Massachusetts Geographic Information System (MassGIS) datalayers. Future plans are to base all size determinations on the most accurate MassGIS datalayer available.]

MILLERS RIVER WATERSHED: CLASSIFICATION

Consistent with the National Goal Uses of "fishable and swimmable waters" the classification of waters in Millers River Watershed according to the SWQS include the following categories (MA DEP 1996).

"Class A – These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life and wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORW) under 314 CMR 4.04(3)".

Class A Public Water Supplies in the Millers River Watershed

- Upper Naukeag Lake, source to outlet in Ashburnham and those tributaries thereto
- Newton Reservoir, source to outlet in Athol and those tributaries thereto
- Phillipston Reservoir, source to outlet in Phillipston and those tributaries thereto
- Crystal Lake, source to outlet in Gardner and those tributaries thereto
- Cowee Pond, source to outlet in Gardner and those tributaries thereto
- Perley Brook Reservoir, source to outlet in Gardner and those tributaries thereto
- Reservoirs #1 and #2, source to outlet in Athol and those tributaries thereto
- Lake Mattawa (North Pond Brook Reservoir), source to outlet in Orange and those tributaries thereto
- Lake Ellis (Ellis Pond), source to outlet in Athol and those tributaries thereto

"Class B – These waters are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value."

Class B Cold Water Fisheries in the Millers River Watershed (other restrictions as noted)

- Millers River, source to Winchendon Water Pollution Control Facility (CSO)
- Beaver Brook, Fernald School (now Templeton Developmental Center) to confluence with the Millers River

Class B Warm Water Fisheries in the Millers River Watershed

- Millers River, Winchendon Water Pollution Control Facility to confluence with the Connecticut River
- Otter River, Gardner Wastewater Treatment Plant to confluence with Millers River

Class B Aquatic Life* in the Millers River Watershed

- Otter River, Source to Gardner Wastewater Treatment Plant
  (*This designation is made only where background conditions prevent the attainment of a "higher use" designation. In these waters Class C dissolved oxygen and temperature criteria apply.)

The designation of ORW is applied to those waters with exceptional socio-economic, recreational, ecological and/or aesthetic values. ORWs have more stringent requirements than other waters because the existing use is so exceptional or the perceived risk of harm is such that no lowering of water quality is permissible. ORWs include certified vernal pools (CVP), all designated Class A Public Water Supplies, and may include surface waters found in National Parks, State Forests and Parks, Areas of Critical Environmental Concern (ACEC) and those protected by special legislation (MA DEM 1993). Wetlands that border ORWs are designated as ORWs to the boundary of the defined area. Within the Millers River Watershed there are approximately 109 CVPs (Harding 2003). These are located in the towns of

Ashburnham, Athol, Gardner, Hubbardston, Montague, New Salem, Orange, Royalston, Wendell, Westminster and Winchendon.

Unlisted waters in the Millers River Watershed not otherwise designated in the SWQS are designated *Class B, High Quality Waters*. According to the SWQS, where fisheries designations are necessary they shall be made on a case-by-case basis.

SUMMARY OF HISTORICAL CONDITIONS AND PERCEIVED PROBLEMS

Numerous water quality surveys have been conducted over the years to identify water quality problems and document improvements. The most recent and intensive surveys in the Millers River Watershed were conducted in 1987 and 1995. Water quality data from the 1987 survey provided documentation that construction of wastewater treatment facilities has improved the water quality in the Millers River considerably. However, these facilities still contribute the largest loading of pollutants to the waters of the basin. Therefore, the water quality of the Millers River Watershed is largely dependent upon the quality of operation of the wastewater treatment plants.

Water quality data from the 1987 survey indicated that the Otter River had dissolved oxygen (DO) concentrations below the water quality standard of 5 mg/l. The Otter River's low assimilative capacity versus the total volume of wastewater discharged pointed to the need for an in-depth review of the discharge permits for the three NPDES permittees on the Otter River. The NPDES permit for the Gardner POTW was issued in 1992. They have been dechlorinating their effluent since 1987. Seaman Paper Company was issued an amended NPDES permit in 1994, but they have significantly improved their secondary treatment since 1987. The NPDES permit for the Templeton WWTP was issued in 1991. They now accept, for profit, industrial wastewater and septage on a regional basis. The MA DEP Central Regional Office (CERO) reported that a significant discharge of a volatile organic compound (VOC) occurred from this facility sometime in 1993 (MA DEP 1997).

Toxicity evaluations, which were conducted in 1987 on the WWTP effluents using fathead minnows and cladocerans, demonstrated acute toxicity from four WWTPs (Athol, Orange, South Royalston and Winchendon). In most of these cases, the source of the toxicity was thought to be chlorine. Microtox test results indicated acute toxicity in the Seaman Paper unchlorinated effluent. Chronic toxicity testing in 1987 using *Ceriodaphnia dubia* did not exhibit any toxic problems. However, these tests were designed to detect persistent, large-scale toxic effects. Local effects, especially those occurring in the evening or early morning hours, might have been overlooked using that design. In August 1995, two species chronic toxicity tests were conducted by EPA Region 1, Environmental Services Division Biology Section on samples collected from 12 sites in the Millers River Watershed – six stations bracketing the three discharges along the Otter River, one station on Priest Brook, and five stations on the mainstem Millers River (Barr 1995). Statistically significant mortality and/or growth/reproduction effects occurred at all but two of the river stations tested.

The Clean Water Act Section 303(d) requires states to identify those waterbodies that are not meeting standards and prioritize the development of total maximum daily loads (TMDLs) for these waterbodies. Table 3 identifies the waterbodies in the Millers River Watershed on the EPA approved 1998 Massachusetts Section 303(d) List Of Waters (MA DEP 1999).

Table 3. 1998 303(d) List of Waters in the Millers River Watershed (MA DEP 1999).

Name (WBID)	*Location*	*Size*	*Cause of Impairment*
Beaver Flowage Pond (MA35005)	Royalston	58 acres	-Noxious aquatic plants -Turbidity
Bents Pond (MA35007)	Gardner	9 acres	-Noxious aquatic plants -Turbidity
Bourn-Hadley Pond (MA35008)	Templeton	27 acres	-Noxious aquatic plants
Bowens Pond (MA35009)	Wendell	11 acres	-Turbidity
Brazell Pond (MA35010)	Templeton	16 acres	-Noxious aquatic plants
Cowee Pond (MA35013)	Gardner	20 acres	-Noxious aquatic plants
Davenport Pond (MA35015)	Petersham/Athol	32 acres	-Noxious aquatic plants
Lake Denison (MA35017)	Winchendon	82 acres	-Organic enrichment/Low DO
Depot Pond (MA35018)	Templeton	17 acres	-Noxious aquatic plants
Ellis Pond (MA35023)	Athol	67 acres	-Noxious aquatic plants
Gales Pond (MA35024)	Warwick	11 acres	-Turbidity
Greenwood Pond (MA35025)	Westminster	25 acres	-Noxious aquatic plants
Greenwood Pond (MA35026)	Templeton	25 acres	-Noxious aquatic plants
Hastings Pond (MA35028)	Warwick	20 acres	-Noxious aquatic plants
Hilchey Pond (MA35029)	Gardner	11 acres	-Turbidity
Kendall Pond (MA35034)	Gardner	23 acres	-Organic enrichment/Low DO -Noxious aquatic plants
Laurel Lake (MA35035)	Erving/Warwick	51 acres	-Organic enrichment/Low DO -Noxious aquatic plants
Lower Naukeag Lake (MA35041)	Ashburnham	260 acres	-Noxious aquatic plants
Minott Pond South (MA35045)	Westminster	30 acres	-Noxious aquatic plants
Minott Pond (MA35046)	Westminster	9 acres	-Noxious aquatic plants
Lake Monomonac (MA35047)	Winchendon/Rindge, NH	592 acres	-Noxious aquatic plants
Moores Pond (MA35048)	Warwick	31 acres	-Noxious aquatic plants
Parker Pond (MA35056)	Gardner	26 acres	-Flow alteration -Noxious aquatic plants
Ramsdall Pond (MA35062)	Gardner	20 acres	-Noxious aquatic plants
Reservoir No. 1 (MA35063)	Athol	9 acres	-Noxious aquatic plants
Reservoir No. 2 (MA35064)	Phillipston/Athol	54 acres	-Noxious aquatic plants
Riceville Pond (MA35065)	Athol/Petersham	68 acres	-Noxious aquatic plants
Richards Reservoir (MA35067)	Warwick	30 acres	-Noxious aquatic plants
Lake Rohunta (MA35070)	(Middle Basin) Athol/Orange/New Salem	250 acres	-Noxious aquatic plants
Lake Rohunta (MA35107)	(South Basin) New Salem	70 acres	-Noxious aquatic plants
Royalston Road Pond (MA35071)	Orange	10 acres	-Noxious aquatic plants
Ruggles Pond (MA35072)	Wendell	19 acres	-Noxious aquatic plants
South Athol Pond (MA35078)	Athol	76 acres	-Noxious aquatic plants
South Spectacle Pond (MA35081)	New Salem	37 acres	-Noxious aquatic plants
Sportsmans Pond (MA35082)	Athol	102 acres	-Noxious aquatic plants
Stoddard Pond (MA35083)	Winchendon	50 acres	-Noxious aquatic plants
Tully Pond (MA35089)	Orange	32 acres	-Noxious aquatic plants
Wallace Pond (MA35092)	Ashburnham	44 acres	-Noxious aquatic plants
Ward Pond (MA35093)	Athol	7 acres	-Noxious aquatic plants
Wheelers Pond (MA35097)	Warwick	22 acres	-Noxious aquatic plants
Whites Mill Pond (MA35099)	Winchendon	38 acres	-Noxious aquatic plants

Table 3 *continued*. 1998 303(d) List of Waters in the Millers River Watershed (MA DEP 1999).

Name (WBID)	*Location*	*Size*	*Cause of Impairment*
Whitney Pond (MA35101)	Winchendon	107 acres	-Metals -Noxious aquatic plants -Turbidity
Wrights Reservoir (MA35104)	Gardner/Westminster	128 acres	-Noxious aquatic plants
East Branch Tully River (MA35-12)	Confluence of Tully Brook and Falls Brook in Royalston State Forest, through Long Pond and Tully Lake to confluence with the West Branch Tully River forming headwaters Tully River, Orange/Athol.	10.5 miles	-Cause Unknown -Priority organics -Metals
Lawrence Brook (MA35-13)	New Hampshire state line, Royalston through Doane's Falls to confluence with East Branch Tully River, Royalston.	8.5 miles	-Cause Unknown -Priority organics -Metals
Millers River (MA35-01)	Outlet of Whitney Pond, Winchendon to Winchendon WWTP, Winchendon.	2 miles	-Priority organics -Metals -Nutrients -Pathogens
Millers River (MA35-02)	Winchendon WWTP, Winchendon to confluence with Otter River, Winchendon.	5.3 miles	-Unknown toxicity -Priority organics -Metals -Nutrients
Millers River (MA35-03)	Confluence with Otter River, Winchendon to South Royalston USGS Gage, South Royalston.	4.8 miles	-Priority organics -Metals -Nutrients -Salinity/TDS/chlorides -Suspended solids
Millers River (MA35-04)	South Royalston USGS Gage, South Royalston to Erving Paper Company, Erving.	17.5 miles	-Unknown toxicity -Priority organics -Metals -Nutrients -Pathogens
Millers River (MA35-05)	Erving Paper Company, Erving to confluence with Connecticut River, Erving.	8.1 miles	-Priority organics -Metals
Otter River (MA35-07)	Gardner WWTP to Seaman Paper Dam, Templeton.	4.3 miles	-Nutrients -Organic enrichment/Low DO -Other habitat alterations
Otter River (MA35-08)	Seaman Paper Dam, Templeton to confluence with Millers River, Winchendon.	5.6 miles	-Priority organics -Metals -Nutrients -Organic enrichment/Low DO -Salinity/TDS/chlorides -Other habitat alterations -Pathogens
Priest Brook (MA35-10)	Headwaters at the confluence of Towne and Scott Brooks, Royalston to the confluence with the Millers River, Winchendon. (According to SARIS includes lower portion of Scott Brook.)	7.4 miles	-Unknown toxicity -Priority organics -Metals
Tully River (MA35-14)	Confluence East and West Branches Tully River, Orange/Athol to confluence with Millers River, Athol.	1.5 miles	-Priority organics -Metals
West Branch Tully River (MA35-11)	Outlet Sheomet Lake, Warwick to confluence with East Branch Tully River forming headwaters Tully River, Orange/Athol.	6.2 miles	-Priority organics -Metals

Table 4. 1998 303(d) Segments Needing Confirmation in the Millers River Watershed (MA DEP 1999).

Name (WBID)	*Location*	*Size*	*Cause of Impairment*
Candlelight Pond * (MA35105)	Templeton		-Noxious aquatic plants
Beaver Brook (MA35-09)	Fernald School discharge, Templeton to confluence with Millers River, Royalston.	3.1 miles	-Priority organics -Metals -Pathogens

*Note: This pond was not surveyed by MA DEP DWM and was mistakenly listed on the 1998 303(d) list. (Data were actually collected from Bourn-Hadley Pond.)

All freshwaters in Massachusetts are technically (by default) listed in 1998 as Section 303(d) waters with mercury as the associated stressor/pollutant due to the 1994 MDPH Interim Freshwater Fish Consumption Advisory. This fish consumption advisory was aimed at pregnant women only; the general public was not considered to be at risk from fish consumption and encompassed all freshwaters in Massachusetts (MA DPH 1994).

Elevated concentrations of polychlorinated biphenyls (PCBs) were reported by the Massachusetts Department of Environmental Quality Engineering (MA DEQE), Division of Water Pollution Control (now the Massachusetts Department of Environmental Protection, Division of Watershed Management) for fish tissue samples collected from the Millers River downstream from the US Army Corps of Engineer (ACOE) Birch Hill Dam in 1985 (Maietta 1987). Subsequent investigations by MA DEP in 1987 and by the ACOE in the late 1980s/early 1990s confirmed the earlier findings that PCB contamination existed in the Millers River Basin. The sediments, aquatic invertebrates and fish were found to be contaminated at various points in the Otter River, through its' confluence with the Millers River, and downstream to the Connecticut River (Austin *et al.* 1990, Coleman 2001 and Maietta 1988). As a direct result of the 1987 investigations, the Massachusetts Department of Public Health issued a public health advisory regarding consumption of fish from the Millers River (Maietta 1989). Additional monitoring by MA DEP was conducted in 1989 to resample fish from Whitney Pond, where elevated levels of mercury were detected in 1987, as well as additional sites along the Otter River to evaluate PCB contamination problems. The source(s) of PCB contamination, however, was not identified in these studies (Austin *et al*. 1990 and Coleman 2001).

Within the last decade, the northeastern United States has been identified as receiving elevated rates of mercury deposition from the atmosphere and exhibiting high levels of mercury contamination in non-commercial freshwater fish (Tatsutani 1998). Mercury is a trace metal that exists in the earth's crust. It is a toxicant that, once mobilized in the environment, can be transformed into methylmercury -- a particularly toxic compound that can bioaccumulate. Most of the mercury contamination in the northeastern United States has been linked to air emissions (incinerators, fossil fuel combustion facilities) from both local and mid-western sources. A primary source of mercury exposure in humans is through the consumption of fish contaminated with methylmercury (EPA 1999b). As a result of this risk, the MA DPH, similar to other New England States, has issued a statewide fish consumption advisory (MA DPH 2001).

Results of fish tissue analyses revealed a potential health threat due to mercury contamination in the Whitney Pond (Winchendon) area and PCB contamination in the Otter River and Millers River downstream from their confluence. A total of six lakes in the Millers River Basin were sampled in either 1994 or 1995 as part of a research and development study on mercury contamination developed by the MA DEP Office of Research and Standards (ORS). The lakes included Upper Naukeag Lake (Ashburnham), Hilchey Pond (Gardner), Sheomet Lake (Warwick), Upper Reservoir (Westminster), Laurel Lake (Erving/Warwick), and Gales Pond (Warwick). The most recent MA DPH Fish Consumption List recommends the following for waterbodies in the Millers River Watershed (MA DPH 2001 and MA DPH 2002a):

Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries."
2. "The general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River."
3. "The general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Otter River, within ½ mile of the Millers River (Templeton and Winchendon) because of PCBs:

1. “Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish taken from this waterbody.”
2. “The general public should not consume any white sucker or brown bullhead taken from this waterbody.”

Lake Denison (Winchendon) because of mercury:

1. “Children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass from this waterbody.”
2. “The general public should limit consumption of largemouth bass from this waterbody to two meals per month.”

Lake Rohunta (Athol, New Salem, Orange) because of mercury:

1. “Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body.”
2. “The general public should limit consumption of all fish from this water body to two meals per month.”

Gales Pond (Warwick) because of mercury:

1. “Children younger than 12 years, pregnant women, and nursing mothers should not eat any yellow perch from this waterbody.”
2. “The general public should limit consumption of yellow perch from this waterbody to two meals per month.”

Upper Naukeag Lake (Ashburnham) because of mercury:

1. “Children younger than 12 years, pregnant women, and nursing mothers should not eat any smallmouth bass or yellow perch from this waterbody.”
2. “The general public should limit consumption of smallmouth bass or yellow perch from this waterbody to two meals per month.”

Upper Reservoir (Westminster) because of mercury:

1. “Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body.”
2. “The general public should limit consumption of all fish from this water body to two meals per month.”

SOURCES OF INFORMATION

Multiple local, private, state and federal agencies provided information used in the water quality assessment of the Millers River Watershed. Within MA DEP, information was obtained from three programmatic bureaus: Bureau of Resource Protection (BRP, see below), Bureau of Waste Prevention (industrial wastewater discharge information) and the Bureau of Waste Site Cleanup (hazardous waste site cleanup information). Specifically, water quality, habitat assessment, and biological and lake data were provided by MA DEP Division of Watershed Management's (DWM) Watershed Planning Program and the MA DEP Central Regional Office/Bureau of Resource Protection Strategic Monitoring and Assessment of River Basin Teams (SMART) program (Appendices A, B, C, F and G). Water withdrawal and wastewater discharge permit information were provided by members of the Millers River Watershed Team in the MA DEP Central and Western Regional Offices, as well as the DWM Watershed Permitting Program and can be found in Appendix D.

The Millers River and several of its tributaries receive discharges of treated municipal and industrial wastewater, contact and non-contact cooling water, etc. (Appendix D, Tables D1 and D2). The following types of National Pollutant Discharge Elimination System (NPDES) discharges occur in the Millers River Watershed (Hogan 2003).

Permitted Discharges

- *Municipal wastewater treatment plants (WWTPs):* These facilities treat wastewater from domestic and industrial sources within the WWTP service area. Six WWTPs discharge to the Millers River. From upstream to downstream the facilities service the towns of Winchendon, Royalston, Athol, Orange, Erving-Center and Erving-Millers Falls. Two WWTPs discharge to the Otter River (Gardner and Templeton) and one small WWTP discharges to a small unnamed tributary (Erving-#3). Because some of these facilities discharge upstream of riverine impoundments, nutrient controls (phosphorus) are now being required (Appendix D, Table D1) and limits/monitoring requirements will be incorporated into upcoming permit renewals. Additionally, EPA has decided there that there is a need to determine the loadings of nitrogen from sources in Massachusetts that may contribute to Long Island Sound. Therefore, quarterly monitoring for nitrogen by certain dischargers will be included in their permits (Appendix D, Table D1). Discharges range in size from the Erving-#3 facility, which discharges a monthly average permitted flow of 0.01 MGD and treats only municipal, sanitary wastewater, to the City of Gardner WWTP which has a treatment capacity of 5.0 MGD, and treats industrial and municipal wastewater from Gardner, as well as a portion of the Town of Ashburnham under an inter-municipal agreement. The Gardner, Winchendon, Athol, Orange, Erving-Center, and Erving- Millers Falls NPDES permits will be reissued in 2003. The others will be re-issued as they expire. In addition to the above facilities, the Ashburnham & Winchendon Joint Water Authority is authorized to discharge effluent from their Water Treatment Plant to Upper Naukeag Lake.

- *Industrial WWTPs and non-process discharges:* The majority of industrial process wastewaters are treated at the municipal WWTPs (particularly the Gardner and Erving-Center WWTPs) under conditions of their industrial pre-treatment programs (IPP). The IPP is controlled by the municipality and is a condition of the municipal WWTP NPDES permit. The only significant major industrial discharger in the watershed is Seaman Paper (Templeton), which discharges treated paper manufacturing wastewater to the Otter River. The L.S. Starrett Company of Athol discharges a small amount of treated process wastewater and non-contact cooling water. The Erving-Center WWTP, while classified as a municipal WWTP, receives the majority of its flow (95%) from the Erving Paper Company. The same situation existed at the Erving-Millers Falls facility until recently when the largest contributor of paper wastewater closed operations. There are some industrial general stormwater permits in the watershed as well as discharges covered under general permits for water treatment plants.

- *Institutional Discharges:* There is one institutional facility that discharges domestic wastewaters in the watershed. The Templeton Development Center, located in the Town of Templeton, discharges treated wastewater to Beaver Brook, a tributary to the Millers River. The permitted flow is 0.05 MGD.

- The NPDES Phase II General Permit program requires NPDES permit coverage for stormwater discharges from small municipal separate storm sewer systems (MS4s), and construction activity

disturbing one acre or more of land in a mapped "urbanized area" defined and delineated by the US Bureau of Census in 2000 http://www.epa.gov/npdes/pubs/fact2-2.pdf. Large and medium MS4s were permitted during Phase I of the NPDES stormwater program. Under EPA's Phase II program, the definition of "municipal" includes Massachusetts communities, U.S. military installations, state or federal owned facilities such as hospitals, prison complexes, state colleges or universities and state highways. An MS4 is a system that: discharges at one or more a point sources; is a separate storm sewer system (not designed to carry combined stormwater and sanitary waste water); is operated by a public body; discharges to the Waters of the United States or to another MS4; and, is located in an "Urbanized Area". The NPDES Phase II General Permit requires operators of regulated MS4s to develop and implement a stormwater management program that prevents harmful pollutants from being washed or dumped directly into the storm sewer system, which is subsequently discharged into local waterbodies. Certain Massachusetts communities were automatically designated (either in full or part) by the Phase II Rule based on the urbanized area delineations from the 2000 U.S. Census. Two of the 17 communities in the Millers River Watershed (Gardner and Templeton) require Phase II NPDES stormwater permits (MAR0412003 and MAR041225, respectively). Winchendon was issued a waiver from the program by EPA and MA DEP. These communities applied to EPA and DEP for coverage under the Phase II stormwater general permit, issued on 1 May 2003. Municipalities that are totally regulated must implement the requirements of the Phase II permit in the entire town, while communities that are partially regulated need to comply with the Phase II permit only in the mapped Urbanized Areas (see http://www.epa.gov/region01/npdes/stormwater/ma.html for detailed maps for each community). Stormwater general permits will be issued jointly by EPA and DEP after administrative review by EPA. A thorough review of the communities' stormwater management program will be completed by EPA, in coordination with DEP, during the five year permit term. Annual reports will be submitted to EPA and DEP by the permittees. Phase II stormwater general permits will expire on 1 May 2008 (Domizio 2004). This report does not have information on the other municipal (i.e., non-community) MS4s that may be in the Millers River Watershed and are regulated under the NPDES Stormwater Phase II permit program.

NPDES Toxicity Testing Discharge Monitoring Reports (DMR):

Eight of the municipal wastewater treatment plants in the Millers River Watershed, as well as some of the industrial and the institutional dischargers, submit toxicity testing reports to EPA and MA DEP as required by their NPDES permits. Data from these toxicity reports are maintained by DWM in a database entitled "Toxicity Testing Data - TOXTD". Information from the reports includes: survival of test organisms exposed to ambient river water (used as dilution water), physicochemical analysis (e.g., hardness, alkalinity, pH, total suspended solids) of the dilution water, and the whole effluent toxicity test results. Data from January 1996 to January 2003 were reviewed and summarized (ranges) for use in the assessment of current water quality conditions in the Millers River Watershed. These facilities include:

Municipal

- Athol (MA0100005)
- Erving Center (MA0101052)
- Gardner Water Pollution Control Facility (MA0100994)
- Erving POTW#1 (formerly known as Millers Falls Wastewater Treatment Plant) (MA0101516)
- Orange Wastewater Treatment Plant (MA0101257)
- Royalston Wastewater Treatment Facility (MA0100161)
- Templeton Wastewater Treatment Plant (MA0100340)
- Winchendon Wastewater Treatment Facility (MA0100862)

Other

- L.S. Starrett Facility, Athol (MA0001350)
- Seaman Paper Company, Templeton (MA0000469)
- Templeton Developmental Center (formerly Fernald School) Wastewater Treatment Plant (MA0102156)

Dams

There are no Federal Energy Regulatory Commission (FERC) licensed hydroelectric power plants in the Millers River Watershed in Massachusetts. There are, however, four FERC-exempt power-generating projects with a total of six developments in this basin. Exemptions are granted for small hydroelectric

projects that meet certain characteristics and have a generating capacity of less than 5 megawatts. While the exemptions are granted in perpetuity, under Article #2 of the exemption, the projects must comply with any terms and conditions that any Federal or state fish and wildlife agency has determined are appropriate to prevent the loss of, or damage to fish or wildlife resources or otherwise to carry out the purposes of the Fish and Wildlife Conservation Act. The six developments (upstream to downstream order) on the Millers River are briefly described below.

Project/Development Name (Project Number)	***Owner Name Issuance Date***	***River/Location***	***Kilowatts***
Hunts Pond (8012)	O'Connell Engineering & Financial 19 February 1985	Millers River/ Winchendon	120
Tannery Pond (8895)	O'Connell Engineering & Financial 20 April 1988	Millers River/ Winchendon	189
Cresticon Upper (10163A)	LP Athol Corp 12 February 1988	Millers River/Athol	250
Cresticon Lower (10163B)	LP Athol Corp 12 February 1988	Millers River/Athol	250
New Home North (6096A)	O'Connell Energy Group 28 December 1984	Millers River/Orange	187
New Home South (6096B)	O'Connell Energy Group 28 December 1984	Millers River/Orange	240

Additionally, there is one FERC non-jurisdictional (no regulations other than dam safety set forth) hydropower project on the Millers River at the Crescent Street Dam owned by the L.S. Starrett Company in Athol (just downstream from the Cresticon Lower Development). There are two developments (one on the north and one on the south side of the dam) with nameplate capacities of 250 and 112 KW, respectively for a total of 362 KW.

Water Withdrawals

A list of registered and permitted Water Management Act (WMA) withdrawals (both public water suppliers and other industrial users) is provided in Appendix D, Table D3 (LeVangie 2002).

Water Quality

Water quality, habitat assessment, and biological and lake data were provided by MA DEP Division of Watershed Management's (DWM) Watershed Planning Program and the MA DEP Central Regional Office/Bureau of Resource Protection Strategic Monitoring and Assessment of River Basin Teams (SMART) program (Appendices A, B, C, F and G). Projects funded through various MA DEP grant and loan programs provide valuable information that may be used in the water quality assessment report. A summary of these projects for the Millers River Watershed is provided in Appendix E.

Other state agencies contributing information to this report include: the MA DPH; the Department of Fisheries, Wildlife, and Environmental Law Enforcement (MA DFWELE; now the Department of Fish and Game), Division of Fisheries and Wildlife and Riverways Programs; and the Department of Environmental Management (MA DEM; now the Department of Conservation and Recreation). Contributing federal agencies include: EPA; United States Geological Survey (USGS); United States Federal Energy Regulatory Commission (FERC); United States Fish and Wildlife Service (USFWS); and the United States Army Corps of Engineers (ACOE).

During the first week of November 2000, personnel from the EPA, New England Regional Laboratory (NERL) collected surface water samples from eight stations in the Millers River Watershed (McDonald 2001). Samples were collected from four stations on the mainstem Millers River, three stations on the Otter River and one station on Priest Brook. Samples were collected on 1, 4 and 6 November and were tested at the laboratory using the daphnid (*Ceriodaphnia dubia*) and fathead minnow (*Pimephales promelas*) 7-day chronic toxicity test procedures.

The ACOE New England District owns and operates two flood control projects in the Millers River Basin - Tully Lake on the East Branch Tully River and the Birch Hill Dam flood control project on the Millers River, both of which are located in Royalston. These projects are described in more detail in this report within the segments in which they are located. The Tully Lake Project is considered to be a Class II project

(minor or suspected water quality problems) (Barker 2002). The Birch Hill Dam is operated as a dry-bed reservoir where a permanent pool behind the dam is not maintained. It operates run-of-river except during flooding events. The Birch Hill Dam Project is considered to be a Class III project (definite water quality problems) (Barker 1999). Both are considered to be Class B waters according to the Massachusetts Water Quality Standards.

The goals of the ACOE reservoir water quality control management program, established in 1982, are: to protect public health and safety, to meet State water quality standards, to maintain the water quality necessary to meet individual project goals, and to identify the impacts of the projects on water quality (Barker 1999). Activities conducted under the Reservoir Water Quality Operation and Maintenance Program during fiscal year 2000 (October 1, 1999 through September 30, 2000) include: potable water and bathing beach water quality monitoring, baseline monitoring of Class I and Class III projects with conservation pools, and continuation of the study of the relationship between rainfall and elevated bacteria counts at project beaches (among other projects). Beaches are monitored biweekly from May through Labor Day. The assessment of the data collected in these programs is presented in annual reports. The reports utilized in this assessment are for Fiscal Years 1998-2002 (Barker 2003, 2002, 2001, 2000, 1999).

In March 1999, in cooperation with the EOEA Millers River Watershed Team, MA DEP and the MA Department of Environmental Management (MA DEM; now the Department of Conservation and Recreation), USGS initiated a water–column investigation that utilized passive samplers to absorb the dissolved fraction of PCB in the water column to determine the source(s) of elevated PCB concentrations in fish and to establish the extent of fish exposure to PCB along the Millers and Otter rivers (Coleman 2001, Appendix E projects 99-05/MWI, 00-01/MWI and 01-13/MWI). The study concluded that a historical release point of PCBs in the Millers River Basin likely occurred on the Otter River at the upstream margin of Baldwinville in Templeton, MA and that in-place contaminated sediments continue to be a source from which PCBs are released to the water now that the original discharge has ceased or greatly decreased (Coleman 2001).

The USGS investigation was complemented by an ACOE site assessment and risk characterization of PCBs in water, fish, and sediment in the Birch Hill Dam area (ENSR 2000). Fish were collected from the Millers and Otter rivers, Lake Denison, and Beaver Flowage Pond in September and October 1999. The edible fillet from one side of each fish and the remaining “whole fish” (less the edible fillet removed) were analyzed individually for PCB Aroclors and the lipid concentration as part of the investigation. Other tissue samples (earthworms, adult green frogs, and benthic macroinvertebrate samples -usually crayfish) were also collected from the Millers and Otter rivers and analyzed for PCBs as part of the food web tissue sampling program (ENSR 2000).

Based primarily on these data, MA DEP had reason to believe that historic discharges of wastewater from Baldwinville Products contains PCBs and were a source of PCBs in river water, sediments and flood plain soils of the Otter and Millers rivers (DEP Waste Site #2-0664) (Benoit 2000). In October 2000 MA DEP issued four Notices of Responsibility to the Baldwinville Products Mill owners including: Baldwinville Products, Inc., Erving; Erving Industries, Inc., Erving; American Tissue Mills of Massachusetts, Inc., Baldwinville; and the Department of the Army, New England District, Army Corps of Engineers (Birch Hill Dam Project Area). Subsequently, the MA DEP accepted a downgradient property status (DPS) opinion submitted by the ACOE. Under the DPS requirements for comprehensive assessment and cleanup of releases by downgradient property owners are suspended (Ollila 2003).

American Tissue Mills and Erving Industries sampled groundwater and sediment on the Baldwinville Products property and collected additional sediment samples from the Otter River during 2001. Erving Industries will be collecting additional sediment samples in the Otter River during 2003 in an attempt to determine if there are additional significant upstream sources of PCBs (Ollila 2003).

The USGS, as part of their National Water-Quality Assessment (NAWQA) Program in the Connecticut, Housatonic, and Thames River Basins Study Unit, conducted streambed sediment and fish tissue sampling in the Millers River Watershed in 1993 and 1994. Under the NAWQA Program more than 50 of the largest river basins and aquifers in the U.S. (representing 50 percent of the land area of the nation) are being assessed.

In August 2001 the Massachusetts "Beach Bill" was enacted by the legislature and signed by the Governor (MGL. C111. S5S). This act created minimum standards for public bathing waters adjacent to any public or semi-public bathing beach in the Commonwealth. A "public bathing beach" is defined as a beach open to the general public whether or not any entry fee is charged that permits access to bathing waters. A "semi-public bathing beach" is defined as a bathing beach used in connection with a hotel, motel, trailer park, campground, apartment house, condominium, country club, youth club, school, camp, or similar establishment where the primary purpose of the establishment is not the operation of the bathing beach and where admission to the use of the bathing beach is included in the fee paid for use of the premises. A semi-public bathing beach shall also include a bathing beach operated and maintained solely for the use of members and guests of an organization that maintains such bathing beach. Under provisions in the Beach Bill the MA DPH is directed to establish minimum uniform water quality standards for coastal and inland beach waters and to determine the frequency and location of testing, reporting requirements, and requirements for notifying the public of threats to human health or safety. *105 CMR 445.000: Minimum Standards for Bathing Beaches, State Sanitary Code, Chapter VII* outlines MA DPH's guidelines for the Beach Bill and is available online at http://www.state.ma.us/dph/dcs/bb4_01.pdf (MA DPH 2002b). Additionally, under the Beach Bill and MA DPH guidelines local boards of health and state agencies are responsible for collecting samples from public beaches using testing procedures consistent with the American Public Health Association's *Standard Methods for Examination of Water and Waste Water* or methods approved by EPA. Operators of semi-public beaches are responsible for the costs of testing their beaches. Results of testing, monitoring, and analysis of public and semi-public beaches must be submitted in an annual report to MA DPH by 31 October of each year (MA DPH 2002b).

An assessment of potential non-point source pollution for the Millers River Watershed in Massachusetts (2000-03/604) was prepared by the Montachusett Regional Planning Commission and the Franklin Regional Council of Governments for the MA DEP and EPA (MRPC and FRCOG 2002). This report identifies potential nonpoint sources of pollution in the communities of the Millers River Basin including but not limited to land-use characteristics, underground storage tanks, landfills and illegal dumps, hazardous waste sites, winter road maintenance practices, vehicle maintenance and salvage yards, septic systems, sand and gravel operations, forestry cutting operations, and golf clubs/courses.

Research has indicated a strong correlation exists between percent impervious cover and water quality (Center for Watershed Protection 1998). Impervious cover influences streams by increasing surface runoff during storm events. In natural settings, very little annual rainfall is converted to runoff and about half is infiltrated into the ground and water table. This water is filtered by the soils and serves to supply aquifers and adjacent surface waters with clean water during dry periods. In urbanized areas less annual rainfall infiltrates and more volume is converted to runoff. The volume of runoff becomes greater and occurs more frequently and at higher magnitudes. As a result less water is available to streams during dry periods and more flow occurs during storms. Impervious cover can be a very useful indicator with which to measure the impacts of land development on aquatic systems. It can also serve as an indicator of potential problems in a watershed. The Rapid Watershed Planning Handbook (Center for Watershed Protection 1998) has defined the following three impact categories based on the percentage of impervious cover.

Water Quality	Impervious Cover	Description
Sensitive Stream	0-10%	❖ High habitat/water quality rating characterized by stable channels and good habitat structure with diverse communities of fish and aquatic insects. ❖ Hydrologic regime is consistent with natural conditions. ❖ Species sensitive to pollution are within normal abundance ranges.
Impacted Stream	11-25%	❖ Some decline in habitat and water quality is evident. ❖ Erosion and stream channel widening become evident. ❖ Sensitive fish and aquatic insects begin to drop in overall numbers. ❖ Water quality is classified as fair or good.
Nonsupporting Stream	Exceeds 25%	❖ Stream channels become highly unstable, severe widening occurs. Down-cutting and streambank erosion are chronic problems. ❖ Biological quality is relatively poor with only pollutant tolerant species existing within its reaches. ❖ Water quality is considered fair to poor. ❖ Not a candidate for stream restoration

The Millers River Watershed was divided into 90 sub-basins of 10 square miles or less. The impervious cover for these sub-basins was calculated and classified into one of three impact categories as defined above. Four sub-basins were identified as potentially problematic with residential or transportation sources of nonpoint pollution. Three streams were classified as impacted: the Otter River near Kendall Pond in Gardner, the Otter River near Snake Pond in Gardner/Athol and Shingle Swamp Brook in Orange/Athol. Pond Brook in Gardner was classified as non-support (Stoltzfus 2001).

Watershed Planning

To help communities consider and address the long-term impacts from growth and development, EOEA sponsored the creation of a set of buildout maps and analyses for all 351 cities and towns within the Commonwealth of Massachusetts. The maps and analyses depict currently developed and protected land within a community as well as what a community would look like if remaining undeveloped land were completely developed in accordance with local zoning. These buildout maps and analyses lay a foundation for decisions about future development and potential effects on the community including impacts on water quality and quantity (EOEA 2000 – 2001).

Launched by EOEA in the fall of 2002, the UrbanRiver Visions project focuses on revitalizing core downtown areas by using a river as a centerpiece for redevelopment efforts. The town of Athol and the Millers River was one of seven communities chosen for this project. The program incorporates principles of sustainable development by encouraging reuse and rehabilitation of existing infrastructure by supporting development that is compact, integrates uses, fosters a sense of place, and promotes development that respects and enhances the state's natural resources (Goody, Clancy & Associates 2002).

Through funding from EOEA's Massachusett Watershed Initiative, a Regional Open Space Plan is being developed for the Millers River Watershed. This project is designed to enhance open space preservation and planning efforts by bringing communities in the watershed together to work cooperatively toward prioritizing the watershed's goals. In this way it is possible to identify and protect valued environmental assets such as water quality, water supply and wildlife habitat.

TOTAL MAXIMUM DAILY LOADS (TMDLs)

As part of the Federal Clean Water Act states are required to develop TMDLs for lakes, rivers and coastal waters that do not meet SWQS as indicated by the states' 303(d) List of Waters (see Tables 3 and 4). A TMDL is the greatest amount of a pollutant that a waterbody can accept and still meet water quality standards. Further information on the 303(d) List and the TMDL Program are available on the MA DEP website at: http://www.mass.gov/dep/brp/wm/tmdls.htm.

RIVERS

MA DEP is required to produce TMDLs for various causes of impairment (e.g., nutrients, priority organics [PCB], pathogens) for the Millers River and its tributaries but this work is not specifically scheduled yet (Tables 3 and 4). Six of the municipal wastewater treatment plants permittees associated with these segments will be required to develop phosphorus loading evaluation and reduction programs as part of their NPDES permits. Additionally, the MA DEP BWSC is also engaged in an effort to assess and remediate PCB contamination in the Millers River Watershed.

LAKES

There were 39 lakes in the Millers River Watershed on the 1998 303(d) List for which the most common cause of impairment was noxious aquatic plants (MA DEP 1999). A single draft TMDL for total phosphorus was developed for 28 of these lakes (MA DEP 2002). It includes:

Beaver Flowage Pond (MA35005), Royalston
Bents Pond (MA35007), Gardner
Bourn-Hadley Pond (MA35008), Templeton
Brazell Pond (MA35010), Templeton
Cowee Pond (MA35013), Gardner
Davenport Pond (MA35015), Petersham/Athol
Lake Denison (MA35017), Winchendon
Depot Pond (MA35018), Templeton
Lake Ellis (MA35023), Athol
Greenwood Pond (MA35025), Westminster
Greenwood Pond (MA35026), Templeton
Hilchey Pond (35029), Gardner
Lower Naukeag Lake (35041), Ashburnham
Minott Pond South (35045), Westminster
Minott Pond (35046), Westminster
Lake Monomonac (MA35047), Winchendon/Rindge, NH
Parker Pond (MA35056), Gardner
Ramsdall Pond (MA35062), Gardner
Reservoir No.1 (MA35063), Athol
Reservoir No. 2 (MA35064), Phillipston/Athol
Riceville Pond (MA35065), Petersham/Athol
South Athol Pond (MA35078), Athol
Stoddard Pond (MA35083), Winchendon
Wallace Pond (MA35092), Ashburnham
Ward Pond (MA35093), Athol
Whites Mill Pond (MA35099), Winchendon
Whitney Pond (MA35101), Winchendon
Wrights Reservoir (MA35104), Gardner/Westminster

This draft TMDL was available for public comment in the fall of 2002 and the final revised version was submitted to EPA on 18 December 2002 but has not yet been approved (Mattson 2003). Although not utilized in this report, the Department has very recently received EPA's approval of the Massachusetts Year 2002 Integrated List of Waters including the new list of "Waters requiring a TMDL" (Murphy 2003 and MA DEP 2003).

OBJECTIVES

This report summarizes information generated in the Millers River Watershed through *Year 1* (information gathering in 1999) and *Year 2* (environmental monitoring in 2000) activities established in the "Five-Year Cycle" of the watershed approach. Data collected by the DWM and SMART programs in 2000 are provided in Appendices A, B, C, F and G of this report. Together with other sources of information (identified in each segment assessment) these data were used to assess the status of water quality conditions of lakes and rivers in the Millers River Watershed in accordance with EPA's and MA DEP's use assessment methods. Not all waters in the Millers River Watershed are included in the waterbody system database (WBS), the new assessment database (ADB), or this report.

The objectives of this water quality assessment report are to:

1. evaluate whether or not surface waters in the Millers River Watershed, defined as segments in the WBS/ADB databases, currently support their designated uses (i.e., meet SWQS),
2. identify water withdrawals (habitat quality/water quantity) and/or major point (wastewater discharges) and nonpoint (land-use practices, stormwater discharges, etc.) sources of pollution that may impair water quality conditions,
3. identify the presence or absence of any non-native macrophytes in lakes,
4. identify waters (or segments) of concern that require additional data to fully assess water quality conditions,
5. recommend additional monitoring needs and/or remediation actions in order to better determine the level of impairment or to improve/restore water quality, and
6. provide information for the development of a Millers River Watershed action plan.

REPORT FORMAT

RIVERS

The rivers assessed in the Millers River Watershed are presented in the River Segment Assessment section of this report. The order of river segments follows the Massachusetts Stream Classification Program (Halliwell *et al*. 1982) hierarchy. River segments are organized hydrologically (from most upstream to downstream) and tributary segments follow after the river segment into which they discharge. Each river segment assessment is formatted as follows:

SEGMENT IDENTIFICATION

Name, water body identification number (WBID), location, length, classification.

Sources of information: coding system (waterbody identification number e.g., MA35-01) used by MA DEP to reference the stream segment in databases such the WBS and the ADB, the Massachusetts SWQS (MA DEP 1996), and other descriptive information.

SEGMENT DESCRIPTION

Major land-use estimates (the top three uses for the subwatershed, excluding "open water", and other descriptive information.

Sources of information: descriptive information from USGS topographical maps, base geographic data from MassGIS, land use statistics from a GIS analysis using the MassGIS land use coverage developed at a scale of 1:25,000 and based on aerial photographs taken in 1997 except for four communities (Athol, Phillipston, Templeton and Wendell), which were taken in 1999 (Umass Amherst 1999).

SEGMENT LOCATOR MAP

Subwatershed map, major river location, segment origin and termination points, and segment drainage area (gray shaded).

Sources of information: MassGIS data layers (stream segments and quadrangle maps from MassGIS 2001).

WATER WITHDRAWALS AND WASTEWATER DISCHARGE PERMIT INFORMATION

Water withdrawal, NPDES wastewater discharge

Sources of information: WMA Database Printout (LeVangie 2002); open permit files located in the Central Regional MA DEP Office (MA DEP 2001, Ostrosky 2003).

USE ASSESSMENT

Aquatic Life, Fish Consumption, Drinking Water (where applicable – see note below), Primary Contact, Secondary Contact, and Aesthetics.

Sources of information include: MA DEP 1995 - 2000 survey data (Appendix A, B, C, F and G); MA DEP DWM Toxicity Testing Database "TOXTD". The MA DPH Freshwater Fish Consumption Advisory Lists (MA DPH 2001 and MA DPH 2002a) were used to assess the *Fish Consumption Use*. Where other sources of information were used to assess designated uses, citations were included.

[Note: Although the *Drinking Water Use* itself was not assessed in this water quality assessment report the Class A waters were identified.]

SUMMARY

Use summary table (uses, status, causes and sources of impairment).

RECOMMENDATIONS

Additional protection, monitoring and implementation needs.

LAKES

The assessed lakes, identified with their WBID code numbers, are listed alphabetically in the Lake Assessment section of this report (Table 5). The status of the individual uses is summarized for these lakes for each watershed. The location, acreage, trophic status, use assessments, and causes of impairment are then summarized for each individual lake (listed alphabetically).

MILLERS RIVER WATERSHED - RIVER SEGMENT ASSESSMENTS

There are a total of 14 rivers in the Millers River Watershed assessed in this report comprised of 21 segments (Figure 7). These include: the Millers, North Branch Millers, Otter, East Branch Tully, West Branch Tully and Tully rivers, Beaver, Boyce, Keyup, Lawrence, Lyons, Mormon Hollow, Priest and Whetstone brooks. While these rivers represent only a small number (15%) of the 91 named streams they account for approximately 48% of the named river miles in the basin. The remaining rivers are small and/or unnamed and are currently unassessed.

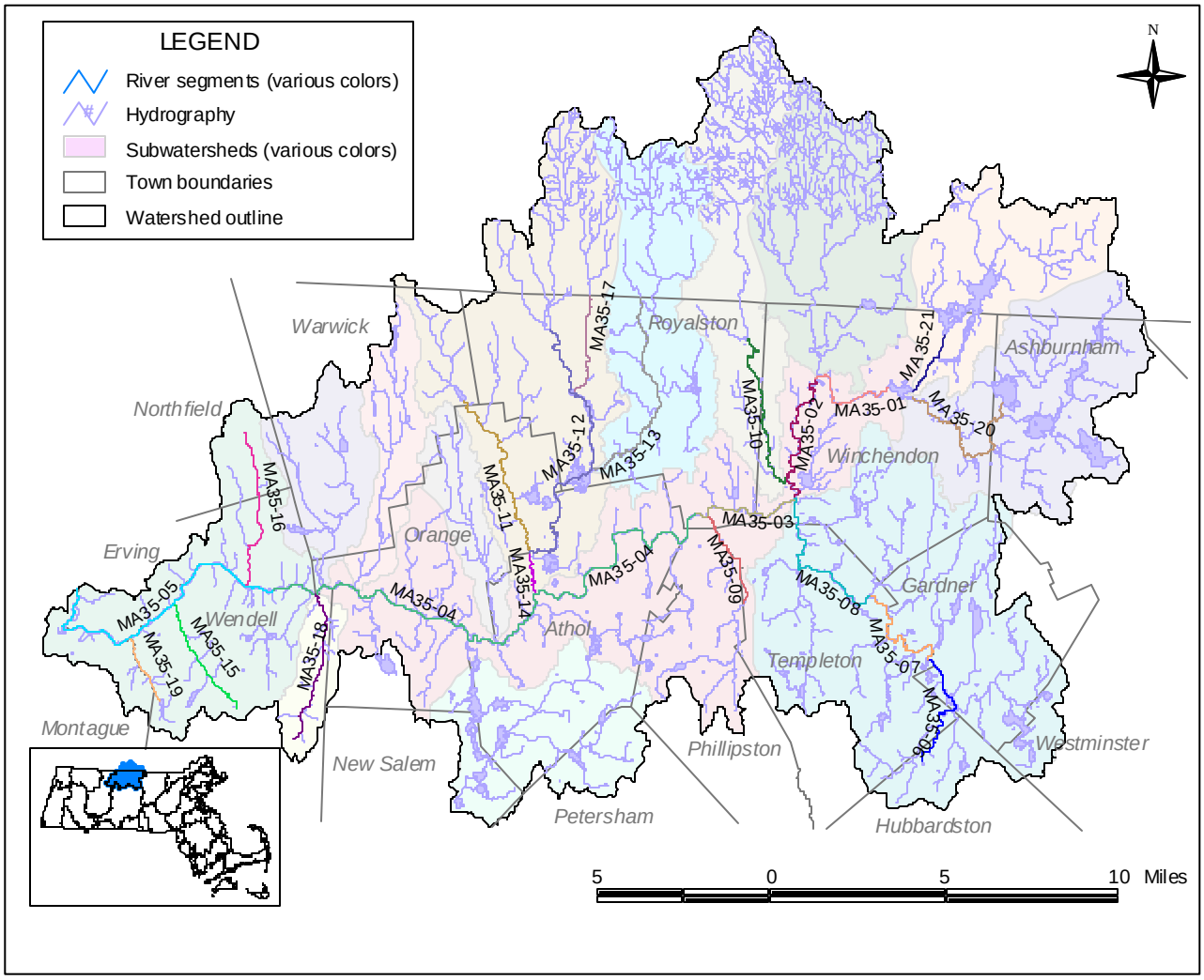


Figure 7. Millers River Watershed – river segment locations identified by segment number.

MAINSTEM MILLERS RIVER

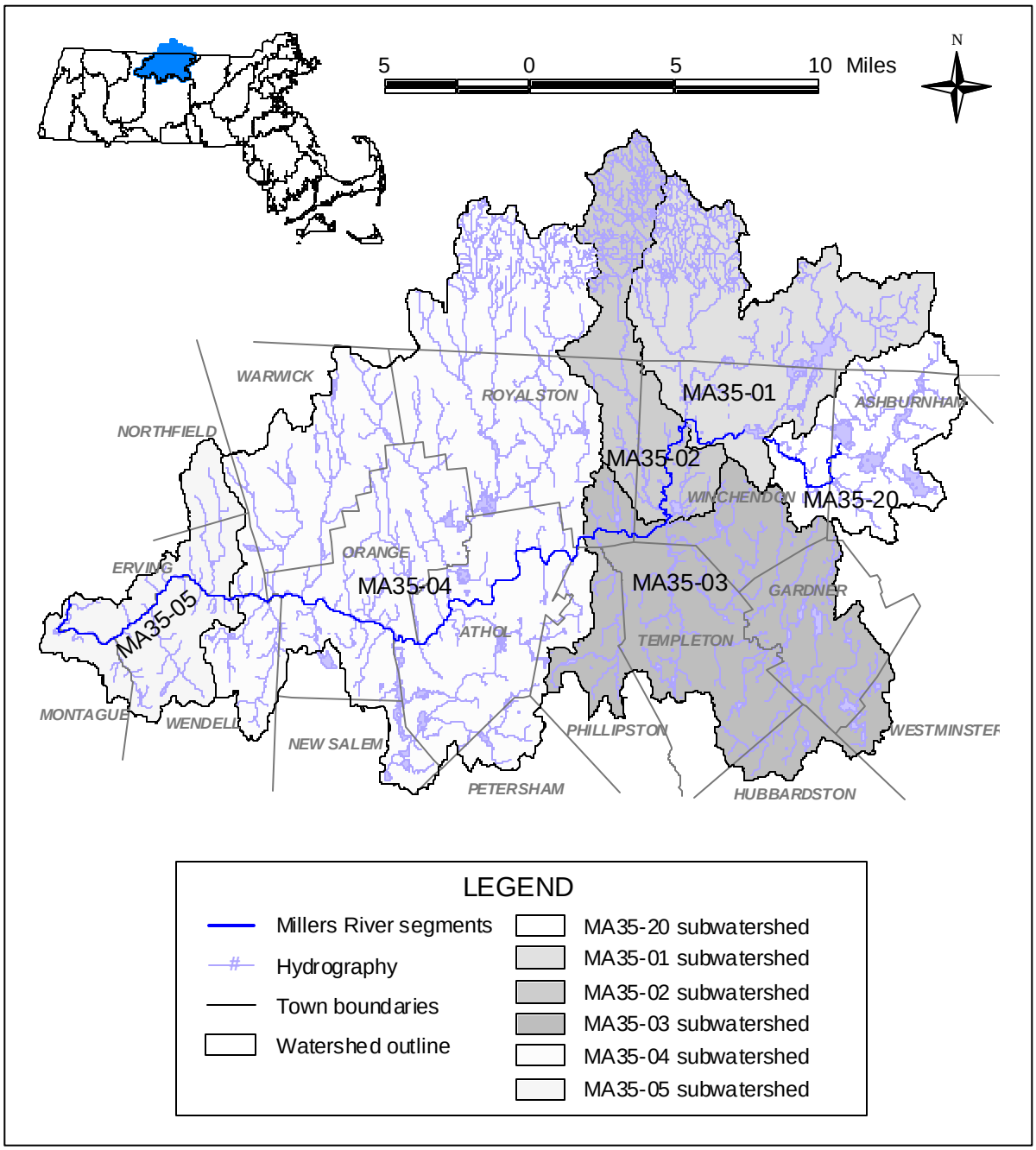
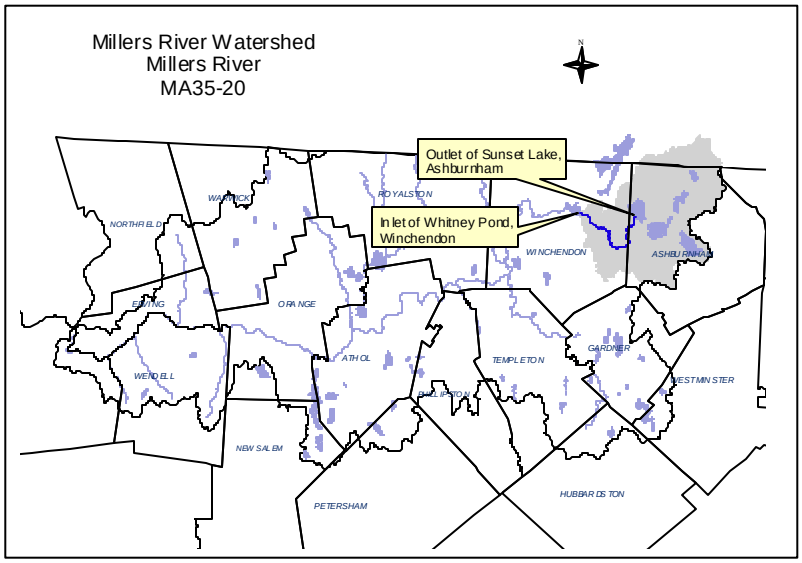


Figure 8. Mainstem Millers River segment locations

MILLERS RIVER (SEGMENT MA35-20)

Location: Outlet of Sunset Lake, Ashburnham to inlet of Whitney Pond, Winchendon.
Segment Length: 6.4 miles
Classification: Class B, Cold Water Fishery, CSO.



The drainage area of this segment is approximately 28.9 square miles (26 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	76%
Residential	7%
Wetlands	5%

The impervious cover area for the individual sub-basins located in this segment is all less than 10%, therefore, the Upper Millers River Subwatershed is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

This segment of the Millers River begins at the outlet of Sunset Lake in Ashburnham. The river flows in a generally west-southwesterly direction for approximately 2.8 miles before turning northwest and meandering towards Winchendon Center. The segment ends at the inlet to Whitney Pond in Winchendon.

The use assessments for Lower Naukeag Lake (MA35041), Sunset Lake (MA35086), Upper Naukeag Lake (MA35090), Wallace Pond (MA35092), and Lake Watatic (MA35095) are provided in the Lake Assessment section of this report.

MA DFWELE conducted fish population sampling on July 20, 2000 in two tributaries of this subwatershed, Binney Brook and Bear Meadow Brook. Binney Brook in Ashburnham was sampled north of Shore Drive. Using a backpack electroshocker, a total of 28 fish were collected with the most dominant fish species being yellow perch (*Perca flavescens*). Other species collected included pumpkinseed (*Lepomis gibbosus*), brown bullhead (*Ameiurus nebulosus*), and yellow bullhead (*Ameiurus natalis*). Bear Meadow Brook was sampled west of East Rindge Road in Ashburnham also using backpack shocking with the following species collected: banded sunfish (*Enneacanthus obesus*), chain pickerel (*Esox niger*), and brown bullhead (*Ameiurus nebulosus*).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3)

Facility WMA Permit # WMA Registration #	Source	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
			1998	1999	2000	2001	2002
Ashburnham Water Department no permit 20701101	Upper Naukeag Lake	0.18	0.22	0.25	0.21	0.25	0.29
Winchendon Water Department* no permit 20734301	Upper Naukeag Lake 343-01S	0.67	0.96	0.99	0.99	0.75	0.68

*Winchendon Water Dept. also has two wells 01 and 02G that are "inactive" (for emergency use only) which are not sources in their WMA registration. Winchendon and Ashburnham's reported actual use numbers for 1998, 1999, and 2000 are the result of inaccurate meters (Kickham 2003). Note: Both Ashburnham and Winchendon Water Departments have applied for a WMA permit because they have exceeded their registered volumes. MA DEM and MA DEP are currently in the process of developing interim permits for these suppliers. Approximately 40% of the water withdrawn by Ashburnham is utilized and will ultimately be treated as wastewater at the Gardner WWTP, which then discharges to the Otter River (MRPC and FRCOG 2002).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1)

The Ashburnham & Winchendon Joint Water Authority is authorized (MAG640045) to discharge effluent from their Water Treatment Plant to Upper Naukeag Lake.

Toytown Auto Salvage (800 Spring Street), Winchendon is permitted (MAR05B730) to discharge stormwater in this subwatershed area of the Millers River. As part of this permit the facility is required to develop a Stormwater Pollution Prevention Plan (SWPPP) and conduct quarterly visual monitoring of their stormwater discharge.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Septic Systems

Seventy-seven percent of the residents in the town of Ashburnham rely on individual on-site septic systems. There are numerous lakes in this community that are popular both seasonally and year-round. It has been reported that a number of old dwellings may be using outdated methods of sewage disposal, which includes outhouses at several camps. In the town of Winchendon 67% of the population relies on private individual septic systems.

Unpaved Roads

There are several unpaved roads in Ashburnham and Winchendon that are in close proximity to waterbodies and their tributaries. These include Lake Watatic, Sunset Lake and Lower Naukeag Pond.

Sand and Gravel Operations

There are numerous sand and gravel operations in the southern portion of this subwatershed near waterbodies, watercourses and wetland areas.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Upper Naukeag Pond Dam is owned and operated by the Town of Ashburnham and the pond is used as a water supply for the towns of Ashburnham and Winchendon. A stable lake level is typically maintained year round, but occasionally the lake may be drawn down six inches in the winter (Gomez and Sullivan 2003).

The Town of Ashburnham also owns and operates Lower Naukeag Pond Dam. A stable lake level is maintained during the summer and is lowered about five feet in the late fall for weed control. The lake is refilled in the late fall/early winter during which time flows below the dam are reduced (Gomez and Sullivan 2003).

The Far Hills Association, owners of Sunset Lake Dam, maintain a stable lake level during the summer. The spillway is equipped with 2 ft x 6 ft flashboards and a low-level gate. This gate serves to lower the lake in the fall. In early April the gate is closed further to allow the lake to refill (Gomez and Sullivan 2003).

Biology

MA DFWELE conducted fish population sampling in the Millers River west of Depot Road in Ashburnham on August 24, 2000. Using a barge electroshocker, 50 fish were collected. Fallfish (*Semotilus corporalis*) was the most dominant species followed by yellow perch (*Perca flavescens*). Other species present were chain pickerel (*Esox niger*), yellow bullhead (*Ameiurus natalis*), brown bullhead (*Ameiurus nebulosus*) and white sucker (*Catostomus commersoni*). Fallfish, a fluvial specialist, dominated the fish sample, but more than half of the species present were macrohabitat generalists. Two species, which represented 64% of the fish sample, were fluvial specialist or dependant species that require flowing water during all or part of their life cycle. All of the fish species present are tolerant/moderately tolerant of pollution.

Too limited data are available, and therefore, the *Aquatic Life Use* is not assessed for this segment of the Millers River. However, this use is identified with an Alert Status because of water withdrawals (both Ashburnham and Winchendon exceeded their WMA registrations, some water is transferred to the Nashua River Basin, the return flow from the Ashburnham sewers go to the Gardner WWTP and to the

Otter River Subbasin and the return flow from the Winchendon WWTP discharge is downstream from this segment), and dam operations that may affect instream habitat/flow. Additionally, no cold water fish species were collected during the August survey.

FISH CONSUMPTION

In August 1987 fish toxics monitoring was conducted by MA DEP at Whitney Pond in Winchendon. These data were published in the *Millers River Basin 1987 Water Quality Analysis* report (Austin *et al.* 1990). Mercury in fish collected from Whitney Pond exceeded the MA DPH action level of 0.5 mg/Kg. However, PCB levels in fish from Whitney Pond did not exceed the MA DPH action level of 1.0 mg/Kg. The MA DPH (2002a) recommends the following advisories for the Miller River (all towns from Erving to Winchendon) because of mercury and PCBs.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries."
2. "The general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River."
3. "The general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Because of the MA DPH fish consumption advisory, the *Fish Consumption Use* for the Millers River is assessed as impaired. However, PCB levels in fish from Whitney Pond did not exceed the MA DPH action level of 1.0 mg/Kg. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The *Fish Consumption Use* is assessed as impaired because of the existing site-specific advisory. However, the cause of impairment is limited to mercury.

Millers River (MA35-20) Use Summary Table

Designated Uses	Status
Aquatic Life 	NOT ASSESSED*
Fish Consumption 	IMPAIRED *Cause*: Mercury *Source*: Unknown (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	NOT ASSESSED

* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS MILLERS RIVER (MA35-20)

Water Quality Classification

- The CSO designation for this segment of the Millers River should be removed in the next revision of the Massachusetts Surface Water Quality Standards since overflows from the collection system in Winchedon (see details in segment MA35-01) were eliminated in December 2003 (Peirent 2003).
- The classification of this segment as a Cold Water Fishery needs to be further evaluated. Temperature and/or additional fisheries data should be generated in order to assess whether or not this segment is meeting its designated use or needs to be reclassified. Historical data review will be critical in this effort.

Water Quality Monitoring

- Baseline water quality data should be collected in this segment of the Millers River to assess the status of the designated uses.
- *In-situ* monitoring should be conducted which includes dissolved oxygen/saturation, pH and temperatures, to better evaluate the status of the *Aquatic Life Use*.
- Biological and habitat quality monitoring should be conducted in this segment of the Millers River to better evaluate the status of the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Point Sources of Pollution

- Review Toytown Auto Salvage's SWPPP (permit MAR05B730). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.

Nonpoint Sources of Pollution

- Since a majority of residents in the town of Ashburnham and Winchendon rely on individual on-site septic systems, these communities should implement and/or continue programs to ensure that on-site systems are properly sited, maintained and inspected (MRPC and FRCOG 2002).
- Investigate and confirm the presence of the numerous sand and gravel sites that were identified in this subwatershed. Evaluate these sites to ensure that they are being properly operated and maintained and that water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status, and history. Also proposed in this project was an education program for town boards to provide local officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. The Montachusett Regional Planning Commission should consider applying for funds (e.g., 604b Water Quality Assessment) to work with communities on this project.
- The unpaved roads indicated in this subwatershed should be field checked to confirm their location and an evaluation should be performed to determine if there are any impacts from these roads on adjacent waterbodies that may affect water quality. Best management practices, as described in Unpaved Roads BMP Manual (Berkshire Regional Planning Commission 2001), should then be implemented as appropriate.

Hydrology

- Instream flows along this segment of the Millers River (as affected by operation of Upper and Lower Naukeag and Sunset Lakes dams, and water withdrawals) should be documented and attempts made to mimic natural flow regimes to the extent possible.
    - The Town of Ashburnham should optimize their control practices at the Upper and Lower Naukeag and Sunset Lake dams to minimize impacts on the flow regime in the Millers River.
    - Instream habitat evaluations should be conducted to assess the effects of streamflow manipulation and to determine if there are any impacts.
    - As part of the WMA 5-year review process, MA DEP should continue to evaluate the Ashburnham and Winchendon Water Departments compliance with the WMA registration and interim permit limits.
    - Both the Ashburnham Water Department and the Winchendon Water Department should develop and/or maintain up-to-date water conservation plans to help reduce the need for increased water withdrawals. Residential water consumption should be maintained at 80 gpcd or less and unaccounted-for-water should be limited to 10% (Gomez and Sullivan 2003).
    - Since pulsing flows were observed in the 2000 hourly hydrographs in the Millers River near Winchendon, operations at Upper Naukeag Pond, Lower Naukeag Pond, and Sunset Lake dams should be evaluated. All dam operators should install, calibrate and maintain a continuous streamflow monitoring gage or determine some other method to ensure

compliance with mandated run-of-river operations and/or document stream flows (Gomez and Sullivan 2003).

- Hourly or daily discharges for the Ashburnham & Winchendon Joint Water Authority should be documented/evaluated (Gomez and Sullivan 2003).

Fish Consumption

- MPDH is currently reevaluating their Fish Consumption Advisory for the Millers River Watershed. Additional fish toxics monitoring should be considered for this segment of the Millers River and lakes in the Upper Millers River subwatershed (Sunset Lake, Lower Naukeag, Lake Watatic, and Wallace Pond).

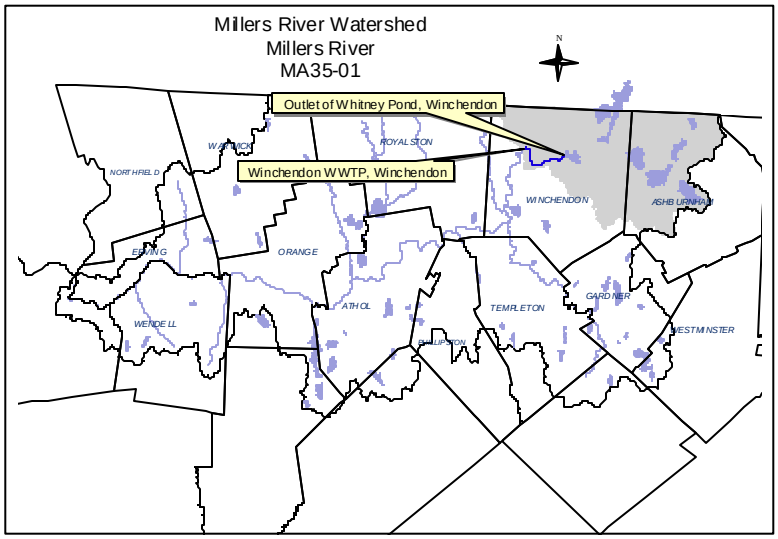
Land Protection

- The impervious cover area for the individual sub-basins located in this segment is all less than 10%, classifying it as sensitive, which predicts a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. Since this river segment serves as the headwaters of the Millers River, the use of various land protection tools (river buffer zones, purchase of conservation restrictions, etc.) should be given careful consideration in efforts to protect the river. Both Ashburnham and Winchendon should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at buildout according to its current zoning (EOEA 2000-2001). Additionally these communities should review the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports, which recommend actions to be taken. It is recommended that both Winchendon and Ashburnham continue to work with the Montachusett Regional Planning Commission on land use planning issues that preserve or restore water quality.
- Since this river segment is the headwaters of the Millers River it is imperative to protect the river from adverse development.
- It is recommended that Ashburnham and Winchendon participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project, Ashburnham and Winchendon can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.
- Continue to promote land protection efforts led by the Ashburnham Conservation Trust and the Department of Environmental Management on the East-West Property, which is a 445 acre parcel located in the north west corner of Ashburnham. Preservation of this area will serve to protect the water quality of Sunset Lake and the headwaters of the Millers River.

MILLERS RIVER (SEGMENT MA35-01)
Location: Outlet of Whitney Pond, Winchendon to Winchendon WWTP, Winchendon.
Segment Length: 3.3 miles.
Classification: Class B, Cold Water Fishery, CSO.

The total drainage area to this segment is approximately 82.3 square miles (41.7 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	75%
Residential	9%
Wetlands	4%



The impervious cover area for the individual sub-basins located in this segment is all less than 10%, therefore, the Middle Millers River Subwatershed is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

This segment of the Millers River begins at the outlet of Whitney Pond in Winchendon then flows in a generally west-southwesterly direction for a little over a mile before turning north for about a half mile. As the river turns almost 180° to the south, it is joined by Tarbell Brook. The segment ends at the Winchendon Water Pollution Control Facility discharge.

MA DFWELE conducted fish population sampling using backpack shocking at two sites in this subwatershed on July 20, 2000. The first site was located on Tarbell Brook, a tributary to the Millers River, south of Harris Street in Winchendon. The dominant fish species collected was fallfish (*Semotilus corporalis*). Other species present, in order of abundance, included: tesselated darter (*Etheostoma olmstedi*), brown bullhead (*Ameiurus nebulosus*), longnose dace (*Rhinicthys cataractae*), banded sunfish (*Enneacanthus obesus*), largemouth bass (*Micropterus salmoides*), and brown trout (*Salmo trutta*). Robbins Brook, a tributary to Tarbell Brook, was the other sampling site. A total of 19 fish were collected with creek chubsucker (*Erimyzon oblongus*) being the most prevalent species. Other fish species present, in order of abundance, included: golden shiner (*Notemigonus crysoleucas*), chain pickerel (*Esox niger*), and brown bullhead (*Ameiurus nebulosus*).

The Winchendon Sanitary Landfill, located near the downstream end of this segment of the Millers River/mouth of Tarbell Brook, has recently been capped (see projects 98-130/SRF, 00-03/604, and 2001 – *Winchendon Sewer System and Waste Water Treatment Facility (WWTF) Improvements* in Appendix E). Expansion plans for the landfill are currently under review by the MA DEP (Poirier 2002 and MRPC and FRCOG 2002).

This segment of the Millers River is on the 1998 303(d) List of Waters for priority organics, metals, nutrients, and pathogens (Table 3).

The use assessment for Whitney Pond (MA35101) is provided in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL SUMMARY
Based upon the available information there are no WMA registered or permitted withdrawals along this segment of the Millers River.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1)

There was a Sanitary Sewer Overflow to the Millers River located near River Street/Route 202. The Winchendon Water Pollution Control Facility (MA0100862) was not authorized to discharge from this outfall, however, until this outfall was eliminated through an upgrade, they were required to inspect and report on any discharges (estimates of duration and volume) as well as cumulative precipitation per discharge event on a monthly basis. Winchendon was under a Federal Consent Decree (dated 19 July 2000) that required the Town to upgrade their main intercepting sewer system and separate the common sanitary and stormwater manholes. The town's consultant reported to MA DEP that the overflow was eliminated on 29 December 2003 (Peirent 2003).

OTHER:

A FERC exempt hydropower project, The Hunts Pond Project Number 8012-MA, owned by O'Connell Engineering & Financial, is located at the dam that impounds Hunts Pond on the Millers River in a commercial/industrial area adjacent to Winchendon Center in Winchendon. The project generates 120 Kilowatts. The FERC license (exempt status) was issued February 1985 and operation began in 1986. There are no expiration dates for exempt licenses. The 184' long by 15' high concrete capped masonry gravity dam is built on ledge. The project includes one powerhouse on the northern dam abutment with two hydraulic turbines. Water is discharged through the turbine and directly back to the Millers River just downstream from the powerhouse. The project began operation in 1986 (Cataldo 2003). The project is supposed to operate as a run-of-river unit. The minimum flow is 25 cfs. Presently, there are no fish passage facilities located at this dam.

Another FERC exempt hydropower project, The Tannery Pond Project Number P-8895-MA, owned by O'Connell Engineering & Financial, is located at the dam that impounds Tannery Pond on the Millers River in Winchendon. The project generates 189 Kilowatts. The FERC license (exempt status) was issued April 1988 and operation began in early 2000. There are no expiration dates for exempt licenses. The 248 'long by 10' high concrete capped masonry gravity dam is founded on ledge. The project includes one powerhouse on the northern dam abutment with two hydraulic turbines. Water is discharged into a 25' wide by 425' long tailrace, which conveys the water back to the Millers River. The project is supposed to operate as a run-of-river unit. The project began operation in early 2000 (Cataldo 2003). The minimum flow is 26 cfs total with 6 cfs in the bypass reach (Cataldo 2003). Presently, there are no fish passage facilities located at this dam.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

In this segment of the Millers River here are several potential sources of nonpoint pollution, which were identified in the MRPC and FRCOG (2002) report. They are as follows.

Underground Storage Tanks (UST)

Numerous underground storage tanks are located in this portion of the watershed particularly near the center of Winchendon.

Sand & Gravel Operations

There are several sand and gravel operations in this subwatershed many of which are in the vicinity of the Millers River.

Golf Courses

The Winchendon Country Club located on Ash Street in Winchendon is comprised of 74.4 acres. It contains a golf course that is close to the Millers River and Whitney Pond.

Stormwater

Stormwater concerns were noted at Whitney Pond along High Street and stormwater quality may be impacted by old railroad ties along the riverbank.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The Town of Winchendon owns and operates Whitney Pond Dam. Whitney Pond is a defunct hydropower project that has not operated in over 60 years. The Town maintains the flashboards at the dam in the same position on a year-round basis (i.e., no manipulation) (Gomez and Sullivan 2003).

Hunts Pond Dam is a FERC exempt facility owned by the O'Connell Energy Group. The exemption for this project was issued by the USFWS and includes the following (Gomez and Sullivan 2003):

- The facility must be operated in a true run-of-river manner, whereby outflow equals inflow instantaneously. Turbine capacity ranges from 8.4 to 172cfs.
- The tailrace discharge is located at the base of the dam so there is a small bypass reach (≅ 0.01 mile) below the dam. The exemption requires an instantaneous minimum release of 25 cfs or inflow to the project, whichever is less, to conserve aquatic resources.
- The owner is required to provide fish passage facilities when prescribed by the USFWS and/or MA DFWELE.

The Tannery Pond Dam is a FERC exempt facility operated by Swift River Hydro Operations. The exemption for this project issued by the USFWS includes the following (Gomez and Sullivan 2003):

- The facility must be operated in a true run-of-river manner, whereby outflow equals inflow instantaneously. Turbine capacity ranges from 49.4 to 227 cfs.
- There is a small bypass reach (≅ 0.15 mile) below the dam at the hydropower project (water is conveyed from the impoundment to a powerhouse located downstream of the dam. Thus, a portion of the natural stream channel is bypassed by the hydropower facility)
- An instantaneous minimum flow of 26 cfs or inflow to the project, whichever is less, is required to protect downstream aquatic habitat.
- An instantaneous minimum flow of 6 cfs or inflow to the project, whichever is less, is required to conserve aquatic habitat in the bypassed reach.
- The owner is required to provide fish passage facilities when prescribed by the USFWS and/or MA DFWELE.

According to the USGS (remarks of their gaging station on the Millers River in Winchendon – 01162000), the flow in this segment of the Millers River is regulated by reservoir operations (Lake Monomonac and Whitney Pond) and powerplants (the two FERC exempt hydropower facilities - Hunts Pond Project #8012 and Tannery Pond Project #8895) (Socolow *et al*. 2001). The Hydrologic Assessment performed by Gomez & Sullivan (2003) indicated that pulsing flows (ranging from 6 to 7 cfs) were recorded in the hourly hydrographs in the Millers River near Winchendon during August and September 2000. The cause of this pulsing has not been determined.

Biology

The most recent benthic macroinvertebrate survey conducted along this reach of the Millers River (station MI12 at stone bridge along Route 202 in Winchendon) was in 1987 (Austin *et al.* 1990).

Toxicity

Ambient

Surface water samples of the Millers River were collected near the Route 202 crossing in Winchendon (station MI2021) on 1, 4 and 6 November 2000 by EPA NERL personnel. No instream toxicity to either *C. dubia* or *P. promelas* was detected during the 7-day chronic toxicity tests (McDonald 2001). Survival of both test species was ≥ 90% at the end of tests.

Water from the Millers River is collected upstream from the Winchendon WPCF discharge (approximately 1.3 miles upstream of the discharge off River Street near the intersection with Bruce Road, Winchendon) for use as dilution water in the facility's whole effluent toxicity tests. Between February 1996 and November 2002 survival of *C. dubia* exposed (7-day) to the river water ranged from 0 to 100% in the 26 tests conducted. Survival was less than 75% in four of these tests. Because of the presence of toxicity the river water (used as dilution water in the tests conducted prior to March 2000) has only been used as a receiving water test control in the whole effluent toxicity tests conducted since March 2000. Survival of *P. promelas* exposed (7-day) to the river water ranged from 17 to 98% in the 28 tests conducted. Survival was less than 75% in over half (15 of 28) of the tests.

Chemistry – water

Water from the Millers River was collected for use as dilution water or as a site control in the Winchendon WPCF whole effluent toxicity tests on 26 occasions between February 1996 and November 2002. Data from these reports (maintained in the TOXTD database) are summarized below.

pH and Alkalinity

Instream pH ranged between 5.9 and 7.6 SU with 8 of the 31 measurements (26%) <6.5 SU. The maximum alkalinity was 22 mg/l, but 23 measurements were reported as <10 mg/L.

Suspended Solids
The suspended solids concentrations were all reported as <10 mg/L.

Ammonia-Nitrogen
The highest reported ammonia-nitrogen concentration was 0.16 mg/L. (No comparison to water quality criteria was conducted because of the lack of instream temperature data—ammonia criterion varies with pH and temperature).

Total Residual Chlorine (TRC)
All of the 31 TRC measurements were below the minimum quantification level of 0.05 mg/L.

Hardness
Hardness measurements of the Millers River were all very low; ranging from 5.6 to 13 mg/L.

The *Aquatic Life Use* is assessed as impaired for this segment of the Millers River because of the frequently poor survival of test organisms exposed to river water (ambient bioassay - chronic aquatic toxicity). The source of toxicity is unknown at this time. Flow alteration resulting from hydromodification is also of concern (pulsing flows recorded at USGS gage) and merits further investigation.

FISH CONSUMPTION
In August 1987 fish toxics monitoring was conducted by the Department at Whitney Pond in Winchendon and from this segment of the Millers River along Route 202 in Winchendon. These data were published in the *Millers River Basin 1987 Water Quality Analysis* report (Austin *et al.* 1990). Mercury in fish collected from Whitney Pond ranged from 0.51 to 2.6 mg/Kg; exceeding the MA DPH action level of 0.5 mg/Kg. However, PCB levels in fish from Whitney Pond ranged from 0.119 to 0.47 mg/Kg and did not exceed the MA DPH action level of 1.0 mg/Kg. The MA DPH recommends the following (MA DPH 2002a).

Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:
1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries,"
2. "the general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River," and
3. "the general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Because of the MA DPH fish consumption advisory, the *Fish Consumption Use* for this segment of the Millers River is assessed as impaired. However, PCB levels in fish from Whitney Pond did not exceed the MA DPH action level of 1.0 mg/Kg. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The *Fish Consumption Use* is assessed as impaired because of the existing site-specific advisory. The cause of impairment is limited to mercury in the upper 0.8 mile reach of this segment and mercury and PCBs in the lower 2.4 mile reach. The source of mercury is unknown, although atmospheric deposition is suspected. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and may be related to historic discharges from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS
Although no current bacteria data are available to assess these uses, the Winchendon sanitary sewer overflow occasionally discharged to the Millers River near River Street/Route 202 particularly during rainstorms and spring runoff. Because of these discharges, the *Recreational* and *Aesthetic* uses are identified with an Alert Status for the lower 1.6 mile reach of this segment. The Town was under a consent order to remediate the overflow problems, and their consultant reported that the overflow was eliminated in December 2003.

Millers River (MA35-01) Use Summary Table

Designated Uses	Status
Aquatic Life 	IMPAIRED *Cause*: Ambient bioassay - chronic aquatic toxicity *Source*: Unknown
Fish Consumption 	IMPAIRED *Causes*: Mercury upper 0.8 mile reach, mercury and PCBs lower 2.4 mile reach *Sources*: Unknown for mercury, contaminated sediment, releases from waste s ites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED*
Secondary Contact 	NOT ASSESSED*
Aesthetics 	NOT ASSESSED*

* Alert Status issues identified, see details in the use assessment section

RECOMMENDATIONS MILLERS RIVER (MA35-01)

Water Quality Classification

- The CSO designation for this segment of the Millers River should be removed in the next revision of the Massachusetts Surface Water Quality Standards since overflows from the collection system were eliminated in December 2003 (Peirent 2003).

Water Quality Monitoring

- Continue to closely evaluate survival of test organisms exposed to Millers River water (data source Winchendon WPCF whole effluent toxicity testing reports). If toxicity continues to be problematic, further investigation is needed to determine the source of toxicity (natural related to low alkalinity, pH and hardness waters vs. anthropogenic influences) in this segment of the Millers River. An in-depth instream toxicity evaluation should be conducted that addresses variability of water quality conditions in this segment of the Millers River.
- Biological and habitat quality monitoring should be conducted in this segment of the Millers River to better evaluate the status of the *Aquatic Life Use.*
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Town of Winchendon's upgrade to their main intercepting sewer system and separation of the common sanitary and stormwater manholes and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Source Pollution

- Numerous underground storage tanks are located in this portion of the subwatershed particularly near the center of Winchendon (MRPC and FRCOG 2002). An inventory of all underground storage tanks, both registered and unregistered, should be maintained to identify areas of risk in the watershed. This inventory should include the location, age, material and condition of the tank. Priority should be given to areas near drinking water supplies, lakes, ponds, and wetlands and areas where stormwater runoff conditions are intensified by extensive impervious surfaces. The Town of Winchendon should consider adopting bylaws that regulate the construction, installation, operation and maintenance of underground storage tanks.
- Investigate and confirm the presence of the numerous sand and gravel operations indicated in the MRPC and FRCOG (2002) study. Evaluate these sites to ensure that they are being operated and maintained properly and that water quality is being protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for town boards to provide town officials with a good understanding

of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).

- Winchendon should investigate stormwater concerns at Whitney Pond along High Street and stormwater water quality concerns associated with old railroad ties (e.g., contamination from creosote) along the riverbank identified by the MRPC and FRCOG (2002) study.
- Vegetation management, irrigation of greenways, and the use of pesticides and fertilizers should be done in accordance with best management practices at the golf course at the Winchendon Country Club, which is in close proximity to the Millers River and Whitney Pond. Any chemicals utilized should be properly stored.

Hydrology

- Further investigation into the pulsing flows in the Millers River near Winchendon, which was noted in the Gomez and Sullivan (2003) report, is recommended to pinpoint their source and reduce artificial pulsing to match a natural cycle. The Hydrologic Assessment study performed by Gomez and Sullivan (2003) recommends that to ensure run-of-river operations, all dam operators install, calibrate and maintain a continuous streamflow monitoring gage or determine some other method to ensure compliance with run-of-river operations. This should be done at the Whitney Pond, Hunts Pond and Tannery Pond dams.

Fish Consumption

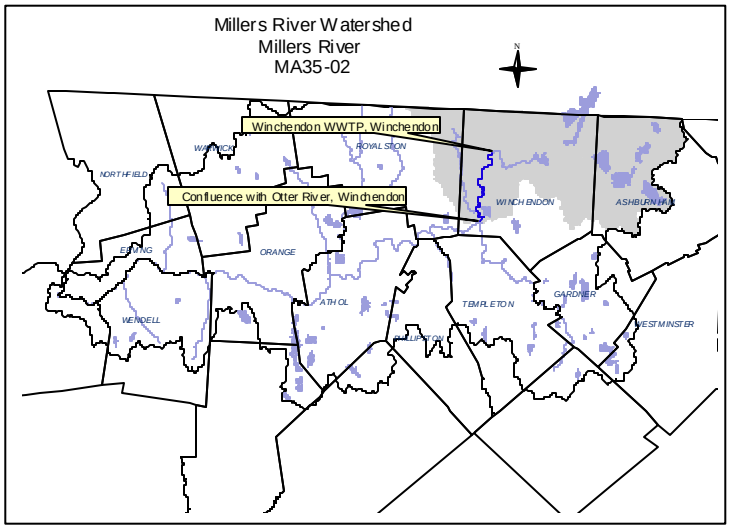
- MPDH is currently reevaluating their Fish Consumption Advisory for the Millers River Watershed. Additional fish toxics monitoring should be considered for this segment of the Millers River, if deemed necessary, to refine the extent of the advisory for PCBs (first barrier to migration on the mainstem Millers River from its confluence with the Otter River is Tannery Pond Dam).

Land Protection

- The impervious cover area for the individual sub-basins located in this segment is all less than 10%, therefore, the Middle Millers River Subwatershed is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Winchendon should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. Winchendon should continue to work with Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Town of Winchendon participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project the town can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.
- Support the efforts of the Mount Grace Land Conservation Trust to improve public use and access to the Millers River (i.e., the Whitney parcel).

MILLERS RIVER (SEGMENT MA35-02)

Location: Winchendon WPCF, Winchendon to confluence with Otter River, Winchendon.
Segment Length: 5.6 miles.
Classification: Class B, Warm Water Fishery.



The total drainage area to this segment is approximately 113 square miles (58.1 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	78%
Residential	8%
Wetlands	4%

The impervious cover area for the individual sub-basins in this segment is all less than 10%, therefore this segment of the Millers River is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

From its beginning at the Winchendon Water Pollution Control Facility this segment meanders essentially to the south, receiving the flow from Priest Brook, and ends at the confluence with the Otter River in Winchendon. The ACOE New England District maintains a dry-bed reservoir flood control project, Birch Hill Dam (Royalston), which can impound water throughout this segment of the Millers River. [Note: the project is described in more detail in the Millers River Segment MA35-03.]

This segment is on the 1998 303(d) List of Waters for unknown toxicity, priority organics, metals, and nutrients (Table 3).

The use assessment for Lake Denison (MA35017) is provided in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL SUMMARY

Based on the available information there are no WMA regulated water withdrawals in this subwatershed area.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1)

The Town of Winchendon is authorized to discharge from its Water Pollution Control Facility (WPCF) in Winchendon MA into the Millers River (NPDES permit #MA0100862 issued September 1998). The permittee is authorized to discharge 0.5 MGD of treated wastewater via outfall 001. The facility's whole effluent toxicity limits are the lethal concentration to 50% of the test organisms (LC_{50}) ≥ 100% and chronic no observed effect concentration (CNOEC) ≥ 10% with a monitoring frequency of 4X/year for both. Their maximum daily total residual chlorine (TRC) limit during seasonal chlorination (1 April through 30 September) is ≤ 0.19 mg/L. The facility implemented dechlorination with sodium bisulfite in November 1995. The maximum reported TRC concentration in the facility's whole effluent toxicity test reports was 0.1 mg/L. The facility has had problems meeting their total suspended solids, biochemical oxygen demand (BOD), settleable solids, fecal coliform and flow limits. These problems are heavily influenced by the facility operating at or above its design flow (Ostrosky 2003). A total plant failure also occurred in November 2001 due to a mechanical pump failure that flooded the mechanical room housing the facilities major pumping, /electrical and control systems. Treatment capabilities were degraded from this event for approximately one month (Ostrosky 2003). A final consent decree (dated 19 July 2000) requires the town to upgrade the WPCF with an average design flow capacity of 1.1 MGD. The upgraded facility should be on-line by January 2005 (2001 – *Winchendon Sewer System and Waste Water Treatment Facility (WWTF) Improvements,* Appendix E). EPA is scheduled to reissue this permit in 2004 (Hogan 2003).

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Underground Storage Tanks

Underground storage tanks are located in this portion of the subwatershed near the Millers River, Lake Denison and an unnamed tributary to Lake Denison.

Sand & Gravel Operations

Several sand and gravel operations in this subwatershed are close to the Millers River and an unnamed tributary to Lake Denison.

Stormwater

Stormwater concerns were noted at Lake Denison.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Stream gaging data for the Millers River are available from the USGS gage 01162000 located downstream from the River Street Bridge in Winchendon from 1916 to the present. The drainage area at this gage is 81.8 mi^2 and the average annual discharge over the period of record is 145 cfs (Socolow *et al.* 2001). According to USGS (remarks of their gaging station on the Millers River in Winchendon – 01162000) the flow in this segment of the Millers River is regulated by upstream reservoir operations (Lake Monomonac and Whitney Pond) as well as powerplants (the two FERC exempt hydropower facilities - Hunts Pond Project #8012 and Tannery Pond Project #8895) (Socolow *et al*. 2001). The Hydrologic Assessment performed by Gomez & Sullivan (2003) indicated that pulsing flows (ranging from 6 to 7 cfs) were recorded in the hourly hydrographs in the Millers River near Winchendon during August and September 2000. The cause of this pulsing has not been determined.

Biology

MA DFWELE conducted fish population sampling in the Millers River off McLaughlin Trail/Winchendon on September 8, 2000 using a barge electroshocker. The sample was dominated by white sucker (*Catostomus commersoni*), a tolerant fluvial dependant species. Other species present included: tesselated darter (*Etheostoma olmstedi*), fallfish (*Semotilus corporalis*), yellow perch (*Perca flavescens*), golden shiner, chain pickerel (*Esox niger*), brown trout (*Salmo trutta*), banded sunfish (*Enneacanthus obesus*), creek chubsucker (*Erimyzon oblongus*), redbreast sunfish, common shiner (*Luxilus cornutus*), and bluegill (*Lepomis macrochirus*). Although three fluvial specialists/dependant species dominated the fish sample, all are classified as tolerant or moderately tolerant of degraded water or habitat quality. A number of macrohabitat generalist species were also present but in very low numbers. The brown trout were likely stocked.

Toxicity

Ambient

Surface water samples from the Millers River were collected near the Sibley Road crossing in Winchendon (station MISIB2) on 1, 4 and 6 November 2000 by EPA NERL personnel as a follow-up to the detection of instream toxicity in the river near New Boston Road in Winchendon in August 1995 (Barr 1995). No instream toxicity to either *C. dubia* or *P. promelas* was detected during the 7-day chronic toxicity tests (McDonald 2001). Survival of both test species was $\geq$ 90% at the end of tests.

Effluent

A total of 26 and 28 modified acute and chronic whole effluent toxicity tests were conducted on the Winchendon WPCF effluent using *C. dubia* and *P. promelas,* respectively, between February 1996 and November 2002. The LC_{50} results were > 100% effluent for most tests. However, in three of 22 *C. dubia* tests the LC_{50}'s ranged between 52.6 and 100% effluent. Many of the chronic tests were invalid due to the poor dilution and/or laboratory control survival (did not meet the test acceptability criterion). Of the valid chronic tests, however, the CNOECs ranged from <6.25% to 100% effluent. The CNOEC results were less than 10% (permit limit) in three of the 20 valid *C. dubia* tests and one of the 16 valid *P. promelas* chronic tests. When both species were tested, *C. dubia* was the more sensitive of the two test organisms.

Chemistry – water

As part of the MA DEP SMART monitoring program, water quality sampling was conducted on five occasions between March and November of 2000 in the Millers River (station MI14) just upstream from the old Sibley Road bridge abutments in Winchendon (Appendix A).

DO

DO measurements ranged from a low of 6.8 mg/L in July to a high of 12.5 mg/L in March. Percent saturation ranged from 77% (July) to 94% (March). It should be noted that these data do not represent the worst-case (pre-dawn) conditions.

Temperature

The temperature ranged from a high of 22.8°C taken during the summer month of July to a low of 4.4° in March.

pH and Alkalinity

Instream pH had a narrow range between 5.8 and 6.0 SU. Alkalinity was quite low ranging from <2 to 4 mg/L.

Turbidity

Turbidity ranged from 0.70 to 2.4 nephelometic turbidity units (NTU) throughout the sampling period.

Suspended Solids

The maximum concentration of suspended solids was 4.3 mg/L.

Ammonia-Nitrogen

Ammonia-nitrogen concentrations ranged from <0.02 to a high of 0.12 mg/l (which do not exceed the chronic criterion for ammonia).

Nitrate-Nitrogen

Concentrations of nitrate-nitrogen ranged from 0.04 to 0.11 mg/l.

Total Kjeldahl Nitrogen

The range of total Kjeldahl nitrogen was from 0.22 to 0.49 mg/l.

Phosphorus

The concentration of total phosphorus that was measured ranged from 0.016 to 0.058 mg/l. Concentrations greater than 0.05 mg/l were measured during the July, August and November sampling events.

Hardness

Hardness data ranged from 7.5 to 11 mg/l.

Specific Conductance

Measurements of specific conductance at 25°C ranged from a low of 110 to a high of 166 µS/cm.

Chemistry – sediment

Total PCB concentrations in surficial sediment screening samples collected in July 1999 from six stations along the lower 2.0 miles of this segment of the Millers River were less than 2 ppm (ENSR 2000).

Chemistry – tissue

Two fish, a 5-year old white sucker and a 7-year old chain pickerel, were collected from this segment of the Millers River (just upstream of its confluence with the Otter River) in September 1999. The total PCB concentration in the white sucker “whole fish” sample was 959 ppb wet weight and the chain pickerel “whole fish” sample was 6,949 ppb wet weight (ENSR 2000). These levels of total PCB in whole fish both exceeded (by a factor of 1.9 and 13.9 times, respectively) the NAS/NAE guideline for total PCB (Coles 1998) of 500 ppb wet weight for the protection of fish-eating wildlife.

The *Aquatic Life Use* is assessed as impaired because of the elevated PCB in 'whole fish' that exceeded the NAS/NAE guidelines. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River. Whole effluent toxicity is occasionally a problem at the Winchendon WPCF and slightly elevated nutrient concentrations were detected instream. Flow alteration resulting from hydromodification is also of concern (pulsing flows recorded at USGS gage) and merits further investigation.

FISH CONSUMPTION

As a result of the 1987 fish toxics monitoring investigations, which confirmed earlier findings that PCB contamination existed in the Millers River Basin, MA DPH issued a public health advisory regarding consumption of fish from the Millers River (Maietta 1989). In September 1999 two fish, a 5-year old white sucker and a 7-year old chain pickerel, were collected from this segment of the Millers River (just upstream from its confluence with the Otter River) as part of the site assessment and risk characterization of PCBs at Birch Hill Reservoir (ENSR 2000). The concentration of total PCB in the white sucker fillet sample was 0.102 ppm wet weight and the chain pickerel fillet sample was 0.423 ppm wet weight. The MA DPH recommends the following (MA DPH 2002a):

Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries,"
2. "the general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River" and,
3. "the general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Because of the site-specific MA DPH fish consumption advisory the *Fish Consumption Use* for this segment of the Millers River is assessed as impaired due to mercury and PCB contamination. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The source of mercury is unknown, although atmospheric deposition is suspected. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

One fecal coliform bacteria sample was collected by MA DEP DWM from the Millers River downstream from New Boston Road, Winchendon (station M104) in May 1996. The bacteria count was 200 cfu/100 mLs (Appendix A, Table 11).

Observations of the Millers River (station MI14) just upstream from the old Sibley Road bridge abutments in Winchendon by MA DEP SMART sampling staff indicate that the river consistently exhibited a deep reddish color typical of tannic conditions, as well as patches of foam (appeared to be natural in origin). Dense beds of aquatic macrophytes were observed to extend across most of the streambed. The field sampling crew also noted limited areas of trash and debris.

Too little data are available to assess the status of the *Recreational Use*, however, the *Aesthetics Use* is assessed as support for this segment of the Millers River.

Millers River (MA35-02) Use Summary Table

Designated Uses	Status
Aquatic Life 	IMPAIRED *Cause*: PCBs (*Suspected Cause*: Whole effluent toxicity) *Sources*: Contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Municipal point source discharge)
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCBs *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

RECOMMENDATIONS MILLERS RIVER (SEGMENT MA35-02)

Water Quality Monitoring

- Continue to closely evaluate survival of test organisms exposed to Millers River water (data source Winchendon WPCF whole effluent toxicity testing reports). If instream toxicity continues to be problematic, further investigation is needed to determine the source of toxicity (natural related to low alkalinity, pH and hardness waters vs. anthropogenic influences) in this segment of the Millers River as well as the upstream segment (MA35-01). An in-depth instream toxicity evaluation should be conducted that addresses variability of water quality conditions in this segment of the Millers River.
- Biological and habitat quality monitoring should be conducted in this segment of the Millers River to better evaluate the status of the *Aquatic Life Use.*
- MA DEP's Bureau of Waste Site Cleanup should continue to work with other agencies and potential principle responsible parties to continue the investigation of PCB contamination and remediation efforts.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Town of Winchendon's upgrade to their main intercepting sewer system and separation of the common sanitary and stormwater manholes and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Continue to conduct long-term fixed site monitoring at the Millers River site on Sibley Road in Winchendon to determine long-term water quality trends.

Point Sources of Pollution

- The Winchendon WPCF NPDES permit should be renewed with appropriate limits and monitoring requirements. The toxicity testing requirements should be reduced to testing with *C. dubia* only since it has been the more sensitive test organism. The new permit should include a requirement for a phosphorus loading, evaluation and reduction program. A total phosphorus limit will likely be imposed (Appendix D, Table D1). If the facility continues to have problems meeting their whole effluent toxicity limit, a toxicity identification and reduction evaluation may be warranted.

Nonpoint Source Pollution

- Underground storage tanks are located in this portion of the subwatershed near the Millers River, Lake Denison and an unnamed tributary to Lake Denison. An inventory of all underground storage tanks, both registered and unregistered, should be maintained to identify areas of risk in the watershed. This inventory should include the location, age, material and condition of the tank. Priority should be given to areas near water bodies and water courses and where stormwater runoff conditions are intensified by extensive areas of impervious surfaces. Town bylaws to regulate the

construction, installation, operation and maintenance of underground storage tanks should be considered by the Town of Winchendon.

- Investigate and confirm the presence of the sand and gravel operations in this subwatershed that are indicated in the MRPC and FRCOG (2002) study, in particular, near the Millers River and near an unnamed tributary to Lake Denison. Evaluate these sites to ensure that they are being operated and maintained properly and that water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for town boards to provide town officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).

Hydrology

- In order to determine the cause of pulsing flows in the Millers River the Gomez and Sullivan (2003) report recommended that hourly or daily discharges for all NPDES facilities should be evaluated. These data should be collected at the Winchendon WPCF and used to determine what affect the discharge has on stream flow.

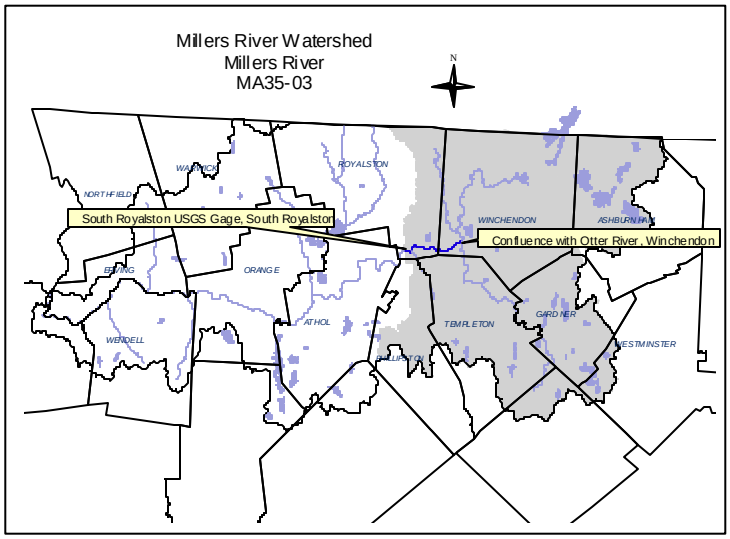
Land Protection

- The impervious cover area for the individual sub-basins in this segment is all less than 10%, therefore this segment of the Millers River is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Winchendon should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that Winchendon continue to work with Montachusett Regional Planning Commission on land use planning issues.

It is recommended that the Town of Winchendon participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project the Town can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

MILLERS RIVER (SEGMENT MA35-03)

Location: Confluence with Otter River, Winchendon to South Royalston USGS Gage, Royalston.
Segment Length: 3.5 miles.
Classification: Class B, Warm Water Fishery.



The total drainage area to this segment is approximately 189 square miles (134 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	73%
Residential	10%
Open Land	4%

The impervious cover area for the individual sub-basins in this segment only is less than 10%, therefore, it is classified as sensitive predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

From the confluence with the Otter River in Winchendon, this segment of the Millers River continues to meander westerly to the USGS gage station in South Royalston. The ACOE New England District maintains a dry-bed reservoir flood control project, Birch Hill Dam, in the town of Royalston within this segment of the Millers River. Birch Hill Dam is a Class III project (i.e., definite water quality problems), which is part of a system of two ACOE flood control dams in the Millers River Basin. The Birch Hill Dam is a 1,400' long, 56' high earthen structure with stone slope protection. This Class III project is operated as a run-of-river project except during flooding events. Peak storage capacity of the project is 16.26 billion gallons (ACOE 2001). Construction began in 1940 and was completed in 1942 providing flood storage for the towns of Athol, Orange and other communities along the Millers and Connecticut rivers. The 3,200-acre Army Corps owned property and associated lands total 4,637acres and encompass approximately 1.7 miles of this segment of the Millers River. The reservoir and associated land, which encompasses the Lake Denison Camping Area (leased by the Corps to MA DEM), offer recreational opportunities that include: camping, swimming, boating, picnicking, fishing, hunting, and trail activities (hiking, skiing, snowmobiling, etc.).

This segment is on the 1998 303(d) List of Waters for priority organics, metals, nutrients, salinity/total dissolved solids/chlorides, and suspended solids (Table 3).

The use assessment for Beaver Flowage Pond (MA35005) is provided in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

It should be noted that Templeton and Gardner are Phase II Stormwater communities. Each community was issued a stormwater general permit from EPA and MA DEP in 2003, and is authorized to discharge stormwater from their municipal drainage systems (MAR041225 and MAR041190, respectively). Over the five-year permit term, the communities will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

Septic Systems

The Town of Phillipston's 2001 Open Space and Recreation Plan (Phillipston Conservation Commission 2001) indicates that the town relies solely on septic systems for wastewater disposal. A majority of the residents in the town of Winchendon (67%) also rely on individual on-site septic systems.

Sand & Gravel Operations

The MRPC and FRCOG (2002) study indicated a couple of sand and gravel operations in the town of Phillipston.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The ACOE maintains a flood control project, Birch Hill Dam, on this segment of the Millers River. The project is operated as run-of-river with minimal/no flow manipulation, except during flood events, although special releases are provided for the River Rat Race and Farley Flats race (Gomez and Sullivan 2003). There is a minimum flow of 25 cfs except during periods of extremely low flow when discharges may be less than 25 cfs. Stream gaging data are available but no longer published [from the USGS gage 01164000 located 500' downstream from King Street Bridge in South Royalston (USGS 1 July 2002a). The drainage area at this gage is 189 mi^2 (Socolow *et al.* 2000).

Upstream from the Royalston WWTP discharge (station B0459) DWM biologists conducted a habitat quality evaluation on 12 September 2000. This section of the river was about 40 m wide with an open canopy. Riffle/run depths were generally between 30-50 cm, while some "pool" areas were $\geq$1 m. The substrates were dominated (70%) by large boulders. Aquatic vegetation included moss, burreed (*Sparganium* sp.), water cress, and water starwort, and a light surface coverage of duckweed (*Lemna* sp.). Algae of different forms—streaming filaments, mats of filaments, and thin film—were attached to rocks in about 75% of the reach. The total habitat score was 181 (Appendix C).

Biology

Benthic macroinvertebrate sampling in this segment of the Millers River was conducted by DWM in September 2000 upstream from the Royalston WWTP discharge in Royalston (station B0459). Compared to the Lawrence Brook reference station (station B0449) the RBP III analysis indicated the benthic community was non-impacted (Appendix C).

Toxicity

Ambient

Water from the Millers River was collected near the USGS gage in South Royalston for use as dilution water in the Royalston WWTF whole effluent toxicity tests in April 2000 and 2001. Survival of *C. dubia* exposed (48-hour) to the river water was 70% in April 2000 and 100% in April 2001(less than 75% in one of the two tests) (TOXTD database).

Chemistry – water

Water from the Millers River was collected near the USGS gage in South Royalston for use as dilution water in the Royalston WWTF whole effluent toxicity tests in April 2000 and 2001 (TOXTD database). Additionally, as part of the MA DEP SMART monitoring program, water quality sampling was conducted on five occasions between March and November of 2000 in this segment of the Millers River at Blossom Street approximately 150 meters downstream of King Street (station MI10A) at the USGS flow gauging station in Royalston (Appendix A).

DO

DO measurements ranged from 7.3 to 12.5 mg/L (station MI10A) while percent saturation ranged from 85 to 92%. It should be noted that these data do not represent the worse-case (pre-dawn) conditions.

Temperature

Temperature measurements ranged from a low of 4.1°C in March to a high of 23.8°C in August (station MI10A).

pH and Alkalinity
Instream pH measurements of dilution water were 6.7 and 7.2 SU (TOXTD database) and ranged from 5.6 to 6.3 SU at station MI10A. Alkalinity at station MI10A was low ranging from 3 to 5 mg/L.

Turbidity
Turbidity ranged from 0.90 to 4.7 NTU (station MI10A).

Suspended Solids/Total Dissolved Solids
Suspended solids concentrations did not exceed 10 mg/L (TOXTD database or station MI10A). Total dissolved solids ranged from 70.6 to 106 mg/L (station MI10A).

Ammonia-Nitrogen
Ammonia-nitrogen concentrations were below the detection limit (0.1 mg/L) (TOXTD database and station MI10A). .

Nitrate-Nitrogen
Concentrations of nitrate-nitrogen ranged from 0.11 to 0.74 mg/L (station MI10A).

Total Kjeldahl Nitrogen (TKN)
TKN ranged from 0.19 to 0.54 mg/L (station MI10A).

Phosphorus
The concentration of total phosphorus ranged from 0.018 to 0.097 mg/L (station MI10A). Four of the five measurements taken were were greater than 0.06 mg/L.

Total Residual Chlorine
TRC measurements were both below the minimum quantification level of 0.05 mg/L (TOXTD database).

Hardness
Hardness measurements of the Millers River were very low, 9.7 and 11 mg/L (TOXTD database) and ranged from 10 to 23 mg/L (station MI10A).

Specific Conductance
Measurements of specific conductance at 25°C ranged from 110 to 166 µS/cm (station MI10A).

Chemistry – sediment

Sediments in this segment of the Millers River including the ACOE Birch Hill Dam Project site are contaminated with PCBs (ACOE 1993, Barker 1999, Coleman 2001). The concentrations of total PCB in surficial sediment ranged from 4 to 49 ppm upstream of the Birch Hill Dam and were lower (<0.1 ppm to 0.5 ppm) in surficial sediment downstream from the Dam. The highest concentrations of PCB, however, were detected in deeper sediment samples (12 to 14 inches below the sediment/water interface) upstream of the Birch Hill Dam where the maximum concentration was 180 ppm (Coleman 2001).

The total PCB concentrations in surficial sediment screening samples collected in July 1999 and the focused surficial sediment screening samples collected in August 1999 from 21 stations along this segment of the Millers River ranged from <2 to 25 ppm (ENSR 2000).

Chemistry – tissue

A total of eight fish were collected from this segment of the Millers River in September and October 1999. Four fish, including a 5 and a 6-year old chain pickerel, a 2-year old brown bullhead and a 4-year old yellow perch were collected from this segment of the Millers River upstream from the Birch Hill Dam. Four fish, including two 3-year old chain pickerels, an 8-year old yellow perch and a 6-year old white sucker were collected from the river downstream from the Birch Hill Dam. The total PCB concentrations in the "whole fish" samples of fish collected from the Millers River upstream from the Birch Hill Dam ranged from 1707 to 18,371 ppb wet weight (ENSR 2000). These levels of total PCB in whole fish all exceeded (3.4 to 37 times) the NAS/NAE guideline for total PCB (Coles 1998) of 500

ppb wet weight for the protection of fish-eating wildlife. The total PCB concentrations in the "whole fish" samples of the fish collected from the river downstream from Birch Hill Dam ranged from 3,989 to 12,467 ppb wet weight (ENSR 2000), exceeding the NAS/NAE guideline by factors of 8.0 to 25 times.

Because of PCB contamination in sediment and whole fish the *Aquatic Life Use* is assessed as impaired. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River. Also of concern are elevated phosphorus levels.

FISH CONSUMPTION

As a result of the 1987 fish toxics monitoring investigations, which confirmed earlier findings that PCB contamination existed in the Millers River Basin, MA DPH issued a public health advisory regarding consumption of fish from the Millers River (Maietta 1989). In September 1999 an edible fillet sample from each of the eight fish (see description above in *Aquatic Life Use* chemistry-tissue) collected from this segment of the Millers River were analyzed for PCB as part of the site assessment and risk characterization of PCBs at Birch Hill Reservoir (ENSR 2000). The concentration of total PCB in the edible fillet samples in fish caught upstream from the Birch Hill Dam ranged from 0.705 to 1.456 ppm wet weight and from 0.573 to 2.23 ppm wet weight in fish caught downstream from the Birch Hill Dam. The MA DPH made the following recommendations (MA DPH 2002a).

Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries,"
2. "the general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River, " and
3. "the general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Because of the site-specific MA DPH fish consumption advisory, the *Fish Consumption Use* for this segment of the Millers River is assessed as impaired because of mercury and PCB contamination. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The source of mercury is unknown, although atmospheric deposition is suspected. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP. It probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

Observations of the Millers River near Blossom Street approximately 150 meters downstream of King Street at the USGS flow gauging station in Royalston (station MI10A) by MA DEP SMART sampling staff were that the river consistently exhibited a deep reddish color typical of tannic conditions, as well as patches of foam (appeared to be natural in origin). Relatively few aquatic macrophytes were present and no trash was observed.

Although too little data are available to assess the *Recreational* uses the *Aesthetics Use* is assessed as support.

Millers River (MA35-03) Use Summary Table

Designated Uses	Status
Aquatic Life 	IMPAIRED *Cause*: PCBs *Sources*: Contaminated sediment, releases from waste sites or dumps
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCBs *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

RECOMMENDATIONS MILLERS RIVER (SEGMENT MA35-03)

Water Quality Monitoring

- Continue to monitor biological (benthic macroinvertebrate and fish) and habitat quality in this segment of the Millers River to better evaluate the status of the *Aquatic Life Use.*
- Continue to conduct long-term fixed site monitoring at the Millers River Blossom Street site in Royalston to determine long-term water quality trends.
- MA DEP's Bureau of Waste Site Cleanup should continue to work with other agencies and potential principle responsible parties to continue the investigation of PCB contamination and remediation efforts.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Source Pollution

- Since the Town of Phillipston relies solely on septic systems for wastewater disposal, efforts should be made to ensure that on-site systems are properly sited, maintained and inspected. The same should be done in Winchendon where 67% of residents rely on individual onsite disposal systems.
- The MRPC and FRCOG (2002) study indicated the presence of sand and gravel operations in the town of Phillipston. These sites should be investigated to confirm their presence and evaluated to ensure that they are being properly operated and maintained and that water quality is being protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).

Hydrology

- The Birch Hill Dam Flood Control facility has a large impact on the timing, magnitude, duration and frequency of flows in the Millers River below South Royalston. The Gomez and Sullivan (2003) report recommends that discussions between the ACOE and the USFWS continue and that the following issues be discussed: a) seasonal minimum flows, b) flushing flows, c) special whitewater releases

and d) ramping flows. The objective would be to operate this facility to mimic the natural runoff cycle while preserving the purpose of the dam to reduce flood flows.

- Further investigation into the pulsing flows in the Millers River, which were noted in the Gomez and Sullivan (2003) report, is recommended to pinpoint their source and reduce artificial pulsing to match a natural cycle. The report recommended that to ensure run-of-river operations all dam operators install, calibrate and maintain a continuous streamflow monitoring gage or determine some other method to ensure compliance with run-of-river operations. Additionally, it was recommended that the following data be collected and evaluated.

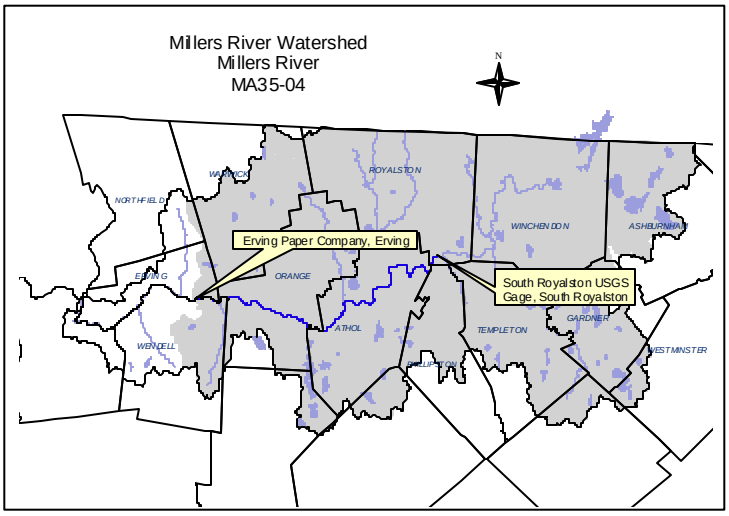
  - Hourly or daily water elevation records for the Birch Hill Dam to confirm that it is being operated in a run-of-river manner.
  - Hourly or daily discharge records for the Birch Hill Dam (broken down by turbine flow, gate flow, dam spillage, etc.). This would determine if this dam is pulsing discharges or if other upstream sources (Whitney Pond, Hunts Pond and Tannery Pond dams) contribute to aberrant streamflow conditions.

Land Protection

- The impervious cover area for the individual sub-basins in this segment only is less than 10%, therefore, it is classified as sensitive predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Royalston and Winchendon should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both Royalston and Winchendon continue to work with Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Towns of Royalston and Winchendon participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Royalston and Winchendon can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

MILLERS RIVER (SEGMENT MA35-04)

Location: South Royalston USGS Gage, Royalston to Erving Center WWTP (formerly known as Erving Paper Company), Erving.
Segment Length: 18.5 miles.
Classification: Class B, Warm Water Fishery.



The total drainage area to this segment is approximately 360 square miles (281 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	78%
Residential	8%
Agriculture	3%

The impervious cover area for most of the individual sub-basins in this segment of the Millers River is less than 10%, therefore it is classified as sensitive prediciting a low threat to water quality from impervious surface water runoff. The only exception is the Shingle Swamp Brook sub-basin that has an impervious area of 13.6%, which classifies it as impacted (Stoltzfus 2001).

From the USGS gage in South Royalston the Millers River flows west and west-southwest through Athol and then turns to flow west/northwest through Orange. The river then forms the border between Erving and Wendell. This segment ends at the Erving Center WWTP discharge (formerly the Erving Paper Company discharge).

This segment is on the 1998 303(d) List of Waters for unknown toxicity, priority organics, metals, nutrients, and pathogens (Table 3).

The use assessments for Bassett Pond (MA35002), Bowens Pond (MA35009), Davenport Pond (MA35015), Ellis Pond (MA35023), Gales Pond (MA35024), Hastings Pond (MA35028), Lake Mattawa (MA35112), Lake Rohunta-Middle Basin (MA35070), Lake Rohunta-North Basin (MA35106), Lake Rohunta-South Basin (MA35107), Laurel Lake (MA35035), Moores Pond (MA35048), North Spectacle Pond (MA35052), Phillipston Reservoir (MA35060), Reservoir #1, Athol (MA35063), Reservoir #2, Athol/Phillipston (MA35064), Riceville Pond (MA35065), Richards Reservoir (MA35067), South Athol Pond (MA35078), South Spectacle Pond (MA35081), Ward Pond (MA35093), Wheelers Pond (MA35097), and White Pond (MA35098) are provided in the Lake Assessment section of this report.

TMDLs for total phosphorus were calculated by MA DEP for Davenport Pond, Ellis Pond, Reservoir #1, Reservoir #2, Riceville Pond, South Athol Pond, and Ward Pond (MA DEP 2002).

MA DFWELE conducted fish population sampling in Moss Brook, West Brook, Mill Brook and Gulf Brook as follows.

Moss Brook was sampled using a backpack electroshocker on 30 August 2000. A total of 85 fish represented by eight species were collected. The most dominant species was blacknosed dace (*Rhinichthys atratulus*), which numbered 63. Other fish species present, in order of abundance, included: longnose dace (*Rhinicthys cataractae*), tesselated darter (*Etheostoma olmstedi*), white sucker (*Catostomus commersoni*), sea lamprey (*Petromyzon marinus*), brook trout (*Salvelinus fontinalis*), chain pickerel (*Esox niger*), and fallfish (*Semotilus corporalis*).

West Brook was sampled at two locations using backpack shocking on 6 July 2000. The first location was south of Ward Road extension in Orange. At that site a total of 169 fish represented by 11 species were collected. The dominant species was fallfish (*Semotilus corporalis*) followed by common shiner (*Luxilus cornutus*). Other fish species present, in order of abundance, included: brook trout (*Salvelinus fontinalis*), white sucker (*Catostomus commersoni*), longnose dace (*Rhinicthys cataractae*), yellow perch (*Perca flavescens*), yellow bullhead (*Ameiurus natalis*), brown trout (*Salmo trutta*), blacknosed

dace (*Rhinichthys atratulus*), chain pickerel (*Esox* niger) and brown bullhead (*Ameiurus nebulosus*). The other site sampled by MA DFWELE on the same date was south of Wheeler Avenue in Orange. A total of 265 fish representing eight species were collected with the dominant species being blacknosed dace (*Rhinichthys atratulus*). Other fish species present, in order of abundance, included: brook trout (*Salvelinus fontinalis*), common shiner (*Luxilus cornutus*), white sucker (*Catostomus commersoni*), tesselated darter (*Etheostoma olmstedi*), brown trout (*Salmo trutta*), American eel (*Anguilla rostrata*), and brown bullhead (*Ameiurus nebulosus*).

Mill Brook was sampled west of Canal Street, Athol on 6 July 2000. Using backpack shocking, 122 fish representing four species were collected. The population was dominated by blacknosed dace (*Rhinichthys atratulus*) and white sucker (*Catostomus commersoni*). Other fish species included fallfish (*Semotilus corporalis*) and one brook trout (*Salvelinus fontinalis*).

Gulf Brook at the confluence of the Millers River in Athol was sampled by backpack shocking on 18 September 2000. Brook trout (*Salvelinus fontinalis*) was the only species collected.

MA DFWELE has proposed that Gulf, Osgood, and West brooks, direct tributaries to this segment of the Millers River, and Ellinwood and Riceville brooks (in the Lake Rohunta subwatershed) be reclassified in the SWQS as cold water fisheries (MassWildlife 2001).

There is a public access site located on the Millers River near East River Street in Orange (MA DFWELE 2002).

Using guidelines developed by the Mass. Department of Environmental Management to identify a stressed river basin North Pond Brook has been classified at a medium stress level based on the magnitude of stream flow. The criterion established for the medium stress classification is net outflow equals or exceeds estimated natural 7Q10 flow (Gomez and Sullivan 2003). Two gravel packed wells withdraw water from the North Pond Brook aquifer, which may reduce the magnitude of flow in the brook. Any flow manipulation at Lake Mattawa may also affect flow in North Pond Brook.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3)

Facility WMA Permit # WMA Registration #	Source	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
			1998	1999	2000	2001	2002
Athol Water Department* 9P220701501 20701501	South Street Well (01G) Newton Reservoir (02S)	1.04 reg 0 per 1.04 total	0.95	0.97	0.84	0.91	1.05
Erving Paper Mills no permit 10709102	Millers River Intake Erving Paper Mills well 2 Erving Paper Mills well 1	2.66	2.14	2.25	2.02	1.9	1.85
Orange Water Department 9P10722301 10722301	MaGee's Meadow Well (02G) Daniel Shays Hwy Well/GP Well#3 Route 202 (04G) Minute Tapioca Well/GP Well#1 Crystal Spring (01G)	0.63 reg 0.33 per 0.96 total	0.63	0.66	0.66	0.62	0.56

* not all sources within this segment
Note: Athol's Newton Reservoir (02S) is now an emergency source (LeVangie 2002).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2)

The Town of Royalston is authorized to discharge from the Royalston Wastewater Treatment Facility (WWTF) into the Millers River (NPDES permit #MA0100161 issued September 1999). The permittee is authorized to discharge 0.039 MGD of treated sanitary wastewater via outfall 001. The facility's acute whole effluent toxicity limit is $LC_{50} \geq 50\%$ with a monitoring frequency of once a year. The maximum daily TRC limit is 1.0 mg/L. The facility's average daily flow is between 0.01 and 0.015 MGD. The facility regularly meets their permit limits (Ostrosky 2003). This permit, which will include a requirement for total nitrogen monitoring and reporting, is scheduled to be reissued by EPA in 2004 (Hogan 2003).

The L.S. Starrett Company of Athol, a manufacturer of precision instruments and hand measuring tools, was authorized to discharge 0.07 MGD of treated process wastewater via outfall #002 from their facility on Crescent Street into the Millers River (NPDES permit #MA0001350 issued September 1999). The

facility's acute whole effluent toxicity limit was $LC_{50} \geq 50\%$ with a monitoring frequency of twice per year. The facility was also authorized to discharge non-contact cooling water to the Millers River as follows:

- Outfall #004 - 0.0072 MGD maximum daily, 90°F,
- Outfall #005 - 0.02 MGD average monthly, 75°F, and
- Outfall #006 - 0.071 MGD maximum daily, 85°F.

[Note: The L.S. Starrett Company currently discharges their treated process wastewater during their hours of operation (9 hours/day). The current NPDES permit limits, however, were based on a 24-hour averaging period. The permit limits (including whole effluent toxicity and metals) should be based on the actual (9 hour) averaging period rather than the 24-hour averaging period. The available dilution is calculated as follows: using a 7Q10 of 14.2 MGD X 9/24 = 5.3 MGD of actual available dilution. If the instream waste concentration of the discharge is recalculated [(0.07 MGD) / (0.07 + 5.3 MGD) = 0.013 or 1.3%] the permit limits/monitoring requirements for whole effluent toxicity should be $LC_{50} \geq 100\%$ effluent and testing should be on a quarterly basis. However, if the facility were to discharge the same volume of wastewater over a 24-hour period, the current permit limits would be applicable.] The new permit was issued 10 February 2004. The company has a reuse system in place and so no longer discharges once-through NNCW. The NCCW outfalls are permitted for emergency use only with a monthly average temperature limit of 85°F in case of a discharge.

The L.S. Starrett Company also has a general permit (MAR05B615) to discharge stormwater to the Millers River. As part of this permit the facility is required to develop a SWPPP and conduct quarterly visual monitoring of their stormwater discharge.

The Town of Athol is authorized to discharge from the Athol Wastewater Treatment Plant (WWTP) into the Millers River (NPDES permit #MA0100005 issued September 1998). The permittee was authorized to discharge 1.75 MGD of treated sanitary wastewater via outfall 001. The facility's acute whole effluent toxicity limits are $LC_{50} \geq 100\%$ and CNOEC $\geq$ 10% with a monitoring frequency of four times per year. The maximum daily TRC limit is 0.19 mg/L. The facility was in the process of installing sodium bisulfite for dechlorination in May 2002. No exceedances of the TRC limits have been reported in the toxicity testing reports. As a result of inflow/infiltration problems, the facility occasionally exceeds the design flow capacity (wet weather) but has generally met other permit limits (i.e., copper, lead, TSS, and BOD) (Ostrosky 2003). In 2002 the facility had problems meeting pH and DO limits (pH between 6.0 and 6.5 SU). The new permit was issued 29 December 2003 and includes a requirement for total nitrogen monitoring and reporting as well as seasonal average monthly total phosphorus limit of 1.0 mg/L.

The Town of Orange is authorized to discharge from the Orange Wastewater Treatment Plant (WWTP) into the Millers River (NPDES permit #MA0101257 issued September 1998). The permittee was authorized to discharge 1.1 MGD of treated sanitary wastewater via outfall 001. The facility's acute whole effluent toxicity limits are $LC_{50} \geq 100\%$ and CNOEC $\geq$ monitor only with a monitoring frequency of four times per year. The maximum daily TRC limit is 0.47 mg/L. No exceedances of the TRC limits have been reported in the toxicity testing reports. The new permit issued June 2003, includes a requirement for total nitrogen monitoring and reporting as well as a seasonal average monthly total phosphorus limit of 1.0 mg/L.

Bunzl Extrusion (764 South Street) Athol is permitted (MAR05B880 and MAR05B879) to discharge stormwater to the Millers River. As part of these permits the facility is required to develop a SWPPP and conduct quarterly visual monitoring of their stormwater discharge.

Duall Plastics Inc. (764 South Street) Athol is permitted (MAR05B626) to discharge stormwater to the Millers River. As part of this permit the facility is required to develop a SWPPP and conduct quarterly visual monitoring of their stormwater discharge.

Rodney Hunt Company (46 Mill Street) Orange is permitted (MAR05B630) to discharge stormwater to the Millers River. As part of this permit the facility is required to develop a SWPPP and conduct quarterly visual monitoring of their stormwater discharge.

OTHER:

FERC exempt hydropower project: The Cresticon Project Numbers P-10163A and B -MA, owned by L.P. Athol Corporation, consists of two developments that are located at the dams just upstream and

downstream of the Route 32 Bridge on the Millers River in Athol. Each project can generate 250 Kilowatts for a total of 500 Kilowatts (Purple 2003). The FERC license (exempt status) was issued February 1988. There are no expiration dates for exempt licenses. The upper concrete dam is 280‘ long by 12’ high with 2’ high flashboards that can impound an area of approximately 9 acres. This development has a 334-foot long power canal that conveys water to the upper powerhouse that holds one generating unit (capacity 250 kilowatt). The tailrace, which is approximately 223’ long, bypasses about 0.1 miles of the river. The lower development consists of a concrete dam that is 135’ long by 6’ high with 2’ high flashboards. It can impound approximately a 2-acre reservoir. The power canal is 670’ long and conveys water to the lower powerhouse that holds one generating unit (capacity 250 kilowatt). The tailrace bypasses approximately 0.15 river miles. The projects began operation in 1988 (Cataldo 2003). These projects are both required to operate as run-of-river units with a minimum flow of 25 cfs in the bypass reaches of the river and 95 cfs below the projects tailraces. Downstream fish passage at the Cresticon Upper Dam was in place as of summer 2002. Fish passage had previously been in place at Cresticon Lower Dam (Cataldo 2003).

FERC non-jurisdictional hydropower project (no regulations other than dam safety set forth): The Crescent Street Dam on the Millers River at the L.S. Starrett Company, Crescent Street in Athol is 127' long and approximately 17' high. The facility is operated as run-of-river unit. According to Joe Sumner (2003), Environmental Manager at L.S. Starrett, there are two powerhouses equipped with one single speed turbine each (2003). On the north side of the Millers River the 250 KW turbine has a hydraulic capacity of 300 cfs. Approximately 200' of the Millers River is bypassed on the north side. On the south side of the Millers River the 112 KW turbine has a hydraulic capacity of 180 cfs. Approximately 75 - 100' of the river is bypassed by this development. The total nameplate capacity of the turbines is 362 KW. The L.S. Starrett utilizes their hydropower projects to provide power for their operations - five days/week for approximately 9 hours/day. They don't operate if the flow in the river is too low or under ice conditions. During the annual shutdown (last week of July) the gates are opened to drain the holding pond approximately 4' on Friday afternoon so that any repairs can be made. The gates are then closed on the following Thursday to refill the pond, which reportedly takes approximately 6 hours (Grader 2003b).

FERC exempt hydropower project: The New Home Project P-6096-MA, owned by O’Connell Energy Group, is located at the dam on the Millers River just downstream from the Route 122 Bridge in Orange. The project generates a total of 427 Kilowatts. The FERC license (exempt status) was issued December 1984. There are no expiration dates for exempt licenses. The project consists of a 90‘ long by 9’ high concrete/masonry spillway. The project includes two powerhouses on either side (north and south) of the spillway. There is one generating unit at the north powerhouse, which went online in 1940, that can generate 187 KW. There are two generating units at the south powerhouse, which went on-line in 1992, that can generate 240 KW (Cataldo 2003). Water is discharged into the tailrace areas which convey water back to the Millers River at both the north and south side of the dam. The project is required to operate as a run of river unit (Berry 2002). A minimum flow of 10 cfs is required in the bypass reach (Cataldo 2003). A minimum flow of 152 cfs or inflow (whichever is lower) is required below the project (Taylor 2002). In January 1999 the US Fish & Wildlife Service informed the New Home Project owners of the need to provide a downstream fish passage at the site. The downstream fish passage facility at the north side powerhouse was installed and became operational May 2002. An economically feasible solution was not found for the Southside powerhouse. Because of the lack of ability to provide downstream passage the two generating units at the Southside powerhouse will not be operated during the fish migration season (LeGrand 2002).

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Septic Systems

The outlying rural areas in the town of Athol and portions of the town of Orange rely on private septic systems for wastewater disposal. Potential septic system problems were noted around White Pond in Athol.

Underground Storage Tanks (UST)

Numerous underground storage tanks are located in this portion of the subwatershed particularly near the centers of Athol and Orange.

Golf courses
The Ellinwood Country Club in Athol maintains a golf course that is in close proximity to Ellinwood Brook, Lake Ellis and surrounding wetland and floodplain areas.
Stormwater
Stormwater quality concerns were reported along Marble Street and Bridge Street in Athol and Haskins Road in Orange.
Illegal Junk Yard/Dumping Sites
Solid waste dumping was noted along Bridge Street and at the end of Greenwood Terrace both located in Athol.
Industrial Sites
There are two abandoned/underutilized industrial sites in Orange - one at West River Street and the other at East River Street.
Airports
The Orange Municipal Airport is located on East River Street in Orange and is adjacent to Shingle Swamp Brook.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Stream gaging data are available but no longer published from the USGS gage 01164000 located 500' downstream from the King Street Bridge in South Royalston (USGS 2002a). The drainage area at this gage is 189 mi^2 and the period of record for published data is 1939 to 1990 (Socolow *et al.* 2001). The ACOE maintains a flood control project, Birch Hill Dam, upstream from this segment of the Millers River that is operated as run-of-river with minimal/no flow manipulation, except during flood events.

Cresticon Upper is a FERC exempt facility owned by the L.P. Athol Corporation. The exemption for this project was issued by the USFWS and includes the following (Gomez and Sullivan 2003, Grader 2003a).

- The facility must be operated in a true run-of-river manner, whereby outflow equals inflow instantaneously. Turbine capacity ranges from 85 to 217cfs.
- There is a small bypass reach (≅ 0.1 mile) below the dam at the hydropower project (water is conveyed from the impoundment to a powerhouse located downstream from the dam and, thus, a portion of the natural stream channel is bypassed by the hydropower facility). The exemption requires an instantaneous minimum release of 25 cfs or inflow in the bypass reach and 95 cfs through the project, whichever is less, to conserve aquatic resources.
- The owner was required to provide downstream fish passage by the USFWS and/or MA DFWELE.

Cresticon Lower is a FERC exempt facility owned by the L.P. Athol Corporation. The exemption for this project was issued by the USFWS and includes the following (Gomez and Sullivan 2003, Grader 2003a):

- The facility must be operated in a true run-of-river manner, whereby outflow equals inflow instantaneously. Turbine capacity ranges from 100 to 407 cfs.
- There is a small bypass reach (≅ 0.15 mile) below the dam at the hydropower project (water is conveyed from the impoundment to a powerhouse located downstream from the dam and, thus, a portion of the natural stream channel is bypassed by the hydropower facility). The exemption requires an instantaneous minimum release of 25 cfs or inflow in the bypass reach and 95 cfs through the project, whichever is less, to conserve aquatic resources.
- The owner was required to provide downstream fish passage by the USFWS and/or MA DFWELE.

The Crescent Street Dam owned by the L.S. Starrett Company in Athol is a FERC non-jurisdictional (no regulations other than dam safety set forth) hydropower project on the Millers River just downstream from the Cresticon Lower Development. There are two developments, one on the north and one on the south side of the dam, with turbine capacities of 300 and 180 cfs, respectively (Gomez and Sullivan 2003 and Sumner 2003).

The Hydrologic Assessment performed by Gomez & Sullivan 2003 indicated that pulsing flows (ranging from 50 to 60 cfs each day) were recorded in the hourly hydrographs in the Millers River near Athol during August and September 2000. The cause of this pulsing has not been determined.

The New Home Dam is a FERC exempt facility with two projects (north and south) operated by O'Connell Energy Group. The exemption for this project issued by the USFWS includes the following (Gomez and Sullivan 2003).

- The facility must be operated in a true run-of-river manner, whereby outflow equals inflow instantaneously. Turbine capacity at the north project ranges from 160 to 250 cfs and at the south project from 87 to 308 cfs.
- There is a small bypass reach (≅ 0.05 mile) below the dam at the hydropower project (water is conveyed from the impoundment to the powerhouses located downstream from the dam and, thus, a portion of the natural stream channel is bypassed by the hydropower facility). The exemption requires an instantaneous minimum release of 10 cfs or inflow in the bypass reach and 152 cfs below the project, whichever is less, to conserve aquatic resources.
- The owner was required to provide downstream fish passage facilities by the USFWS and/or MA DFWELE. They provided downstream fish passage on the north side of the project but do not use the south project during the migration season since no downstream passage has been implemented at this time.

It should also be noted that the Millers River Environmental Center is coordinating with the U.S. Fish and Wildlife Service on an eelway project at the north side of the New Home Dam.

Biology

In August 2000 white suckers and one rainbow trout (most likely stocked) were captured in gillnets set by DWM in the Millers River just above the dam upstream from Route 32 (West Royalston Road) in Athol. The goal of this sampling was to collect white suckers for fish toxics monitoring.

MA DFWELE conducted the following fish population sampling at several sites on the mainstem Millers River.

Barge shocking on the mainstem Millers, near Fish Park in Athol, was conducted on 30 August 2000. A total of 91 fish were collected represented by 8 species and included the following, listed in order of abundance: white sucker (*Catostomus commersoni*), fallfish (*Semotilus corporalis*), smallmouth bass (*Micropterus dolomieu*), American eel (*Anguilla rostrata*), yellow bullhead (*Ameiurus natalis*), common shiner (*Luxilus cornutus*), rainbow trout (*Oncorhynchus mykiss*) and chain pickerel (*Esox niger*). The sample was dominated by fluvial specialist/dependant species (white sucker and fallfish). The presence of smallmouth bass and common shiner in the community is more consistent with that typically found in larger rivers.

The mainstem Millers River north of the rail crossing in Athol was sampled using a boat shocker on 12 September 2000. The most dominant species present were white sucker (*Catostomus commersoni*) and smallmouth bass (*Micropterus dolomieu*). Other species, in order of abundance, included: largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), redbreast sunfish (*Lepomis auritus*), American eel (*Anguilla rostrata*), chain pickerel (*Esox niger*), yellow bullhead (*Ameiurus natalis*), and tesselated darter (*Etheostoma olmstedi*). Although the sample was co-dominated by white sucker, a fluvial dependant species, most of the other fish were macrohabitat generalists. The presence of warm-water macrohabitat generalists is typical of slow-moving or impounded waters. All fish collected were either tolerant or moderately tolerant to pollution. It appears that the impoundments located both upstream and downstream may be influencing the fish community at this location.

Boat shocking for fish was conducted east of Route 202, Athol on the mainstem Millers River on 12 September 2000. The most dominant species was yellow perch (*Perca flavescens*). Other species present, in order of abundance, were: white sucker (*Catostomus commersoni*), largemouth bass (*Micropterus salmoides*), pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), chain pickerel (*Esox niger*), fallfish (*Semotilus corporalis*), smallmouth bass (*Micropterus dolomieu*), golden shiner (*Notemigonus crysoleucas*), and black crappie (*Promoxis nigromaculatus*). Although

the sample included white sucker and fallfish (fluvial dependant species) the sample was dominated by yellow perch and most of the other species collected were also macrohabitat generalists. The presence of warmwater macrohabitat generalists is typical of slow-moving or impounded waters. All fish collected were either tolerant or moderately tolerant to pollution. It appears that the impoundments located both upstream and downstream may be influencing the fish community at this location.

The mainstem Millers River south of the Route 202 bridge in Orange was sampled on 18 August 2000. A total of 32 fish were collected with the most dominant species being white sucker (*Catostomus commersoni*). Other species present included: yellow perch (*Perca flavescens*), smallmouth bass (*Micropterus dolomieu*), pumpkinseed (*Lepomis gibbosus*), chain pickerel (*Esox niger*), and golden shiner (*Notemigonus crysoleucas*). Although the sample was dominated by white sucker, a fluvial dependant species, the other fish were all macrohabitat generalists. All fish collected were either tolerant or moderately tolerant to pollution. It appears that the impoundments located both upstream and downstream may be influencing the fish community at this location.

Boat shocking was conducted on the mainstem Millers at the Lake Rohunta outlet stream in Orange on 18 August 2000. A total of 98 fish were collected with the most dominant species being white sucker (*Catostomus commersoni*). Other species present included: yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), golden shiner (*Notemigonus crysoleucas*), creek chubsucker (*Erimyzon oblongus*), chain pickerel (*Esox niger*) and pumpkinseed (*Lepomis gibbosus*). The presence of creek chubsucker at this location is noteworthy. This species is a fluvial specialist and is either moderately tolerant or intolerant to pollution.

Boat shocking was conducted on the mainstem Millers north of the boat ramp in Orange on 18 August 2000. A total of 88 fish were collected with the most dominant species being pumpkinseed (*Lepomis gibbosus*). Other species present, in order of abundance, included: chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), bluegill (*Lepomis macrochirus*), and white sucker (*Catostomus commersoni*). Sampling was also conducted at this location by DWM as part of the fish toxics monitoring survey in 2000. In addition to the species observed by MA DFWELE, DWM also noted the presence of black crappie (*Promoxis nigromaculatus)*, pumpkinseed (*Lepomis gibbosus*), and American eel (*Anguilla rostrata*). The dominance of warm-water macrohabitat generalist species is typical of impounded waters.

For the past several years the Mass. Division of Fisheries and Wildlife, with the aid of volunteers, has been stocking salmon fry in the Millers River from South Royalston to Athol.

On 25 September 2002 DWM and EPA sampled benthic macroalgae and periphyton in the Millers River at the following stations (Appendix G).

- Approximately 50 feet above the Orange WWTP discharge
- Approximately 50 feet below the Orange WWTP
- Approximately two miles downstream from the Orange WWTP and approximately 50 feet about Route 2 in Wendell Depot

The algal genera that dominated above and below the treatment plant were the green, macroalgae *Oedogonium* sp. and *Hydrodictyon* sp. None of the locations examined had algal cover described as nuisance aquatic growth at the time of sampling, although algae at lengths of 38-40 cm were visible from shore. The substantial biomass of *Oedogonium* sp. encountered upstream and downstream from the Orange WWTP is typical of enriched streams. Another green macroalgae found in the vicinity of the Orange WWTP was *Hydrodictyon* sp. This alga can form massively luxuriant growths, particularly in slow moving areas.

Toxicity

Ambient

Surface water samples of the Millers River were collected from two locations along this segment of the Millers River - near Route 32 bridge upstream of the L.S. Starrett Company (station MIU327) and at Shore Drive downstream from the L.S. Starrett Company (station MISH08) in Athol on 1, 4 and 6 November 2000 by EPA NERL personnel. No instream toxicity to either *C. dubia* or *P. promelas* was

detected during the 7-day chronic toxicity tests (McDonald 2001). Survival of both test species was ≥88% at the end of tests.

Water from the Millers River was collected approximately 50 feet upstream from the L.S. Starrett Company treated process wastewater discharge (Outfall #002) in Athol for use as dilution water in the company's whole effluent toxicity tests. Between June 1996 and December 2002, survival of *C. dubia* and *P. promelas* exposed (48-hour) to the river water was good (≥95 and 93%, respectively).

Water from the Millers River was collected approximately 250' upstream from the Athol WWTP discharge for use as dilution water in the Athol WWTP whole effluent toxicity tests. Between February 1996 and January 2003, survival of *C. dubia* exposed (7-day) to the river water ranged from 60 to 100%. Survival was less than 75% in only two of 24 tests when river water was used as dilution water.

Water from the Millers River was collected approximately 200' upstream from the Orange WWTP discharge for use as dilution water in the Orange WWTP whole effluent toxicity tests. Between February 1996 and January 2003, survival of *C. dubia* exposed (48-hour) to the river water was good (≥ 80%). (Survival of *P. promelas* exposed to river water in the 11 tests conducted between February 1996 and August 1998 was also good – 100%). No chronic data have been submitted although these data should have been reported by the permittee.

Water from the Millers River was collected approximately 60' upstream from the Erving Center WWTP discharge for use as dilution water in the facility's whole effluent toxicity tests. Between January 1998 and July 2002, survival of *C. dubia* and *P. promelas* exposed (7-day) to the river water was good (≥ 90 and 85%, respectively).

Effluent

Two definitive acute whole effluent toxicity tests were conducted on the Royalston WWTF effluent using *C. dubia* in April 2000 and 2001. The effluent was not acutely toxic (LC_{50} >100% effluent) during the April 2001 test (the April 2000 test was not valid because survival in the dilution water control was less than the minimum test acceptability criteria of 90%).

A total of 12 definitive acute whole effluent toxicity tests were conducted on the L. S. Starrett Company treated process wastewater (Outfall #002) discharge using *C. dubia* and *P. promelas* between June 1996 and December 2002. The effluent has exhibited acute toxicity to *C. dubia* ($LC_{50's}$ ranged from 27 to >100% effluent) although the LC_{50} did not meet the permit limit of 50% in only one of the 12 tests conducted(June 1997). The effluent was not acutely toxic to the fathead minnows. *C. dubia* was consistently the more sensitive of the two test organisms. The effluent toxicity has generally decreased since 1998 (was more toxic prior to 1998).

A total of 30 modified acute and chronic whole effluent toxicity tests were conducted on the Athol WWTP effluent using *C. dubia* between February 1996 and January 2003. The effluent exhibited acute toxicity in only one test event (July 1999 LC_{50} = 80.4% effluent) and was otherwise not acutely toxic (LC_{50} >100% effluent). Of the 24 valid chronic toxicity tests (six tests were not valid because survival in the dilution and/or control water was less than the minimum test acceptability criteria of 80% or the average number of young per female in the dilution and/or control water was less than 15) chronic toxicity was detected in the effluent with CNOECs ranging from 10 to 100%. The facility was in compliance with their CNOEC limit.

A total of 25 definitive acute whole effluent toxicity tests were conducted on the Orange WWTP effluent between February 1996 and January 2003 using *C. dubia* and 11 tests were conducted between February 1996 and August 1998 using *P. promelas*. No acute toxicity was detected during any of these tests (LC_{50}'s all >100% effluent). The facility did not submit any chronic toxicity test results required by their NPDES permit.

Chemistry – water

MA DEP DWM sampled the Millers River in July and August of 2000 at the three sites described below (Appendix A).

Station MI08 – approximately 30 feet upstream/north of Route 2A Bridge, Athol,
Station MI07 – at upstream/eastern side of Daniel Shays Highway Bridge, Athol (near the Athol/Orange border),
Station MI05A – at upstream/eastern side of Holtshire Road Bridge, Orange.

Water from the Millers River was also collected from four locations for use as dilution water for facilities conducting whole effluent toxicity tests as required by their NPDES permits. Data from these reports, which are maintained in the TOXTD database by DWM, were summarized for the period indicated in parentheses. These locations (upstream to downstream) are as follows:

- approximately 50' upstream of the L.S. Starrett Company treated process wastewater discharge (Outfall #002) in Athol (June 1996 to December 2002),
- approximately 250' upstream of the Athol WWTP discharge (February 1996 to January 2003,
- approximately 200' upstream of the Orange WWTP discharge (February 1996 to January 2003, and
- approximately 60' upstream of the Erving Center WWTP discharge (January 1998 to July 2002).

These data sets were summarized below.

DO
DO measurements in this segment of the Millers River (stations MI08, MI07 and MI05A) ranged from 7.5 to 9.4 mg/L and percent saturation ranged from 86 to 96% (Appendix A, Table 6). It should be noted, however, that these data do not represent the worse-case (pre-dawn) conditions.

Temperature
The maximum temperature measured in this segment of the Millers River was 22.9°C (station MI05A).

pH and Alkalinity
The instream pH in this segment of the Millers River (stations MI08, MI07 and MI05A) was very low ranging from 6.1 to 6.5 SU (Appendix A, Tables 6 and 7). The pH for this segment of the Millers River (recorded in the TOXTD database from the four locations described above between February 1996 and January 2003) ranged between 5.6 and 7.8 SU and 26% of the 80 measurements reported were less than 6.5 SU. Alkalinity at stations MI03, MI07 and MI05A was consistently 6 mg/L.

Specific Conductance
Measurements for specific conductance in this segment of the Millers River (stations MI08, MI07 and MI05A) ranged from 103 to 141 µS/cm (Appendix A, Table 6).

Suspended Solids
Suspended solids measurements in this segment of the Millers River (stations MI08, MI07 and MI05A) were very low, ranging between 1.4 to 2.2 mg/L (Appendix A, Table 7). The maximum reported suspended solids concentration for this segment of the Millers River (TOXTD database from the four locations described above between February 1996 and January 2003) was 30 mg/L. However, it should be noted that of the 82 measurements reported only one (1%) exceeded 25 mg/L.

Turbidity
Measurements for turbidity in this segment of the Millers River (stations MI08, MI07 and MI05A) ranged from 2.4 to 3.5 NTU (Appendix A, Table 7).

Ammonia-Nitrogen
The ammonia-nitrogen concentrations in this segment of the Millers River (stations MI08, MI07 and MI05A) were consistently <0.02 mg/L (Appendix A, Table 7). The maximum reported ammonia-nitrogen concentration for this segment of the Millers River (TOXTD database from the four locations described above between February 1996 and January 2003) was 1.2 mg/L (river water collected upstream from the Erving Center WWTP discharge). None of the measurements exceeded water quality criteria.

Nitrate-Nitrogen
Measurements for nitrate-nitrogen in this segment of the Millers River (stations MI08, MI07 and MI05A) ranged from 0.34 to 0.58 mg/L (Appendix A, Table 7).

Total Kjeldahl Nitrogen
Total Kjeldahl Nitrogen measurements in this segment of the Millers River (stations MI08, MI07 and MI05A) ranged from 0.35 to 0.50 mg/L (Appendix A, Table 7).

Phosphorus
Total phosphorus measurements in this segment of the Millers River (stations MI08, MI07 and MI05A) ranged from 0.040 to 0.087 mg/L (Appendix A, Table 7). Five out of the six measurements were above 0.05 mg/L.

Total Residual Chlorine
The maximum reported TRC measurement for this segment of the Millers River (recorded in the TOXTD database from the four locations described above between February 1996 and January 2003) was 0.1mg/L (river water collected upstream from the Orange WWTP discharge). It should be noted, however, that only three of 83 measurements (4%) were above the minimum quantification level of 0.05 mg/L.

Hardness
Hardness measured by DWM in this segment of the Millers River (stations MI08, MI07 and MI05A) was very low ranging from 15 to 20 mg/L (Appendix A, Table 7). Measurements recorded in the TOXTD database from the four locations described above between February 1996 and January 2003 were also low ranging from 6.6 to 34 mg/L.

Chloride
Chloride measurements in this segment of the Millers River (stations MI08, MI07 and MI05A) ranged from 21 to 35 mg/L (Appendix A, Table 7).

Dissolved metals
Although no instream toxicity was detected, the dissolved aluminum concentration reported by EPA NERL in the Millers River downstream from the L.S. Starrett company discharge and the dissolved lead concentration both upstream and downstream of the discharge both slightly exceeded (up to 1.4 times) the national water quality criteria at a hardness of 25 mg/L (McDonald 2001).

Chemistry – sediment

The total PCB concentrations in surficial sediment screening samples collected in July 1999 from seven stations along the upper 2.4 miles of this segment of the Millers River ranged from <2 to 25 ppm (ENSR 2000).

Aquatic Life Use is assessed as impaired in the upper 6.6 mile reach of this segment (from South Royalston USGS Gage downstream to the dam at the Cresticon Upper FERC Project) because of PCB contamination in sediment in the upper reach of this segment and best professional judgment. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP. It probably is related to historic discharges from the former Baldwinville Products Mill to the Otter River. This segment of the Millers River is impounded at several dams, and because of hydro facilities approximately 0.3 miles of the Millers River is bypassed. Aberrant flow fluctuations (pulsing once to twice per day) have been documented and are of concern. The fish community in this segment of the Millers River appears to be heavily influenced by dams and subsequent flow alteration. The community in most cases is dominated by macrohabitat generalists. The overall numbers of fishes are excellent, indicating that suitable water quality conditions exist for the propagation of fish. The L.S. Starrett Company discharge frequently exhibited acute toxicity, however the effluent has been less toxic since 1998. The *Aquatic Life Use* for the downstream 11.3 mile reach of this segment is assessed as support but is identified with an Alert Status because of flow fluctuations resulting from hydromodification, which appear to be influencing

the fish community and potential PCB contamination problems documented upstream. Slightly elevated levels of total phosphorus and the algal growth in this segment of the Millers River are also of concern.

FISH CONSUMPTION

As a result of the 1987 fish toxics monitoring, which confirmed earlier findings that PCB contamination existed in the Millers River Basin, MA DPH issued a public health advisory regarding consumption of fish from the Millers River (Maietta 1989). In August 2000 fish toxics monitoring was conducted by DWM in two reaches of this segment of the Millers River - just above the dam upstream of Route 32 (West Royalston Road) in Athol and upstream of the dam located at Route 122 (Main Street) in Orange (Maietta and Colonna-Romano 2001). Five individual white suckers were retained for analysis from each sampling station to support the ongoing PCB contamination evaluation in the Millers River Watershed. These data can be found in Appendix A, Table 15. Because of elevated mercury and PCB concentrations, the MA DPH recommends the following (MA DPH 2002a).

Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries,"
2. "the general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River," and
3. "the general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Because of the site-specific MA DPH fish consumption advisory the *Fish Consumption Use* for this segment of the Millers River is assessed as impaired because of mercury and PCB contamination. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The source of mercury is unknown, although atmospheric deposition is suspected. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharges from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

MA DEP DWM biologists noted that the water column of the Millers River upstream from the Royalston WWTP discharge was slightly turbid in September 2000 (Appendix C). They did not observe any other objectionable deposits, oils, trash or debris. Natural foam and tannic color were noted at the three stations sampled by MA DEP DWM monitoring staff from this reach of the Millers River. It should be noted, however, that bank sediment upstream from an area near the Route 2A Bridge in Athol (station MI08) was observed to release oil when compressed (Beaudoin 2003).

Although too limited data are available to assess the *Recreational* uses, the *Aesthetics Use* is assessed as support for this segment of the Millers River.

Millers River (MA35-04) Use Summary Table

Designated Uses	Status
Aquatic Life 	IMPAIRED upper 6.6 mile reach SUPPORT* lower 11.9 mile reach *Cause*: PCB *Sources*: Contaminated sediment, releases from waste sites or dumps
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS MILLERS RIVER (SEGMENT MA35-04)

Water Quality Monitoring

- Continue to monitor biological and habitat quality in this segment of the Millers River, bracketing point source discharges whenever feasible, to better evaluate the status of the *Aquatic Life Use.*
- Continue to monitor the fish community along this segment of the Millers River to evaluate any changes resulting from efforts to improve/mimic natural flow regimes.
- MA DEP's Bureau of Waste Site Cleanup should continue to work with other agencies and potential principle responsible parties to continue the investigation of PCB contamination and remediation efforts.
- Evaluate the need for additional PCB sampling of sediment and whole fish in this reach of the Millers River downstream from Birch Hill Dam.
- Develop an instream monitoring strategy to evaluate the effectiveness of point and nonpoint source nutrient reduction efforts. Such monitoring efforts should include evalutation of primary productivity (e.g., periphyton, phytoplankton, macrophyte) as well as direct chemical measurements.
- Downstream fish passage should be considered at the Crescent Street Dam (owned by L.S. Starrett Company) since this would facilitate the migration of salmon in keeping with the MA DFWELE salmon stocking program.
- The work being coordinated by the Millers River Environmental Center should continue for the design and construction of the eel pass at New Home Dam in Orange. Once completed, monitoring of the eel population and performance of the eel pass should be undertaken.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Point Sources of Pollution

- Continue to evaluate results of the whole effluent toxicity testing required by NPDES permits for all facilities in this segment of the Millers River. Determine if toxicity identification and reduction evaluations (TIE/TRE) are warranted (discharge exhibits severe and/or persistent toxicity problems).
- The Royalston Wastewater Treatment Facility permit (MA0100161) should be reissued with appropriate monitoring requirements and limits.
- The L.S. Starrett Company permit (MA0001350) was recently (February 2004) reissued with monitoring requirements and limits set upon a 24 hour averaging period. If deemed necessary, a permit modification could be issued to reflect the actual averaging period of the discharge (9 hours vs. 24 hours). The whole effluent toxicity testing requirements could be reduced to *C. dubia* only (the more sensitive test organism).
- Biomonitoring in the Millers River is recommended to bracket the discharge from the L.S. Starrett facility because of the frequency of acute whole effluent toxicity.

- Review L.S. Starrett Company's SWPPP (permit MAR05B615). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.
- Carefully monitor the effectiveness of the Athol WWTP (MA0100005) and the Orange WWTP (MA0101257) phosphorus loading, evaluation, and reduction programs as well as their compliance with a seasonal total phosphorus limit, which have been required in their recently reissued NPDES permits.
- Review Bunzl Extrusion's SWPPP (permits MAR05B880 and MAR05B879). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.
- Review Duall Plastics Inc.'s SWPPP (permit MAR05B626). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.
- Review Rodney Hunt Company's SWPPP (permit MAR05B630). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.

Nonpoint Sources of Pollution

- At the golf course located in this subwatershed, vegetation management, irrigation of the fairways and the use of pesticides and fertilizers should be done in accordance with best management practices to protect adjacent waterbodies, watercourses, wetlands and floodplain.
- An inventory of all underground storage tanks, both registered and unregistered, should be maintained to identify areas of risk in the watershed, particularly around the centers of Athol and Orange. This inventory should include the location, age, material and condition of each tank. Priority should be given to areas near drinking water supplies, lakes, ponds, and wetlands and areas where stormwater runoff conditions are intensified by extensive impervious surfaces. Town bylaws that regulate the construction, installation, operation and maintenance of underground storage tanks should be considered by the Town of Athol.
- Efforts should be made to ensure that on-site septic systems are properly sited, maintained and inspected. Particular areas of focus are White Pond/Athol and the outlying rural areas of Athol and Orange that are not served by a municipal sewer system.
- Investigate and evaluate the solid waste dumping along Bridge Street and at the end of Greenwood Terrace (both in Athol). Consideration should be given to offering educational programs to inform residents of the negative affects of illegal solid waste disposal on the environment.
- The abandoned/underutilized industrial sites on West River Street and East River Street in Orange should be investigated and evaluated to determine their status and potential for reuse.
- At the Orange Municipal Airport best management practices should be followed for vegetation control, stormwater management, the use of deicing compounds, and the management of chemical storage and waste disposal.

Hydrology

- Instream flow regimes along this segment of the Millers River (as affected by operation of the FERC-exempt and FERC nonjurisdictional hydropower projects and the ACOE Tully Dam) should be documented and attempts should be made to mimic natural flow regimes to the extent possible. Efforts should be made to reduce aberrant streamflow fluctuations in this segment of the Millers River that have been observed at the USGS gage in Erving.
    - Investigate the operating conditions at the Cresticon Upper Project Number 10163A, Cresticon Lower Project Number 10163B, L.S. Starrett, and New Home Dam North and South Project Numbers 6096A and 6096B, respectively, during periods of low flow. Determine if these projects release their required minimum flows at all times. Evaluate and monitor these operations for compliance with run-of-river requirements.
    - Obtain hourly or daily water elevation records for all dams on the Millers River mainstem to confirm which facilities are operating in a run-of-river manner.
    - Obtain hourly or daily discharge records for all dams on the Millers River mainstem (broken down by turbine flow, gate flow, dam spillage, etc.) The discharge records would be used to determine if the dams are pulsing discharges as well as compliance with fish passage requirements.

- Evaluate hourly or daily discharges for all NPDES facilities. These data would be used to determine what effect discharges have on stream flow.

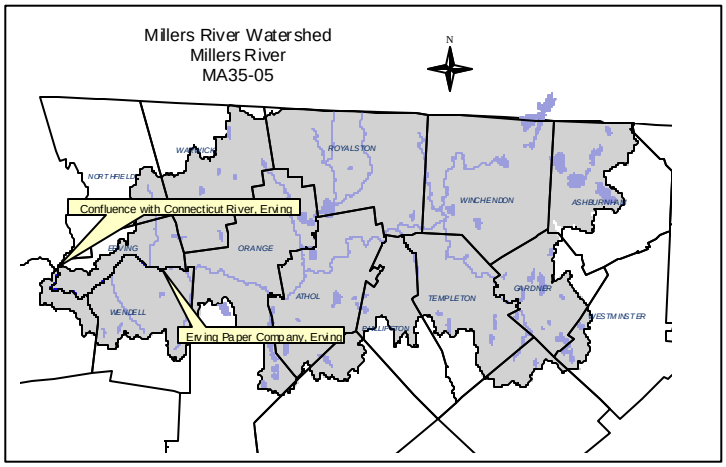
- The Gomez and Sullivan (2003) report also recommended that to ensure run-of-river operations, all dam operators should install, calibrate and maintain a continuous streamflow monitoring gage, or determine some other method to ensure compliance with run-of-river operations.
- In accordance with the requirements of MA DEP's WMA permit program, the Athol and Orange Water Departments and Erving Paper Mills should develop and/or maintain up-to-date water conservation plans to help reduce the need for increased water withdrawals. Residential water consumption should be maintained at 80 gpcd or less and unaccounted-for water should be limited to 10% (Gomez and Sullivan 2003).
- Further evaluate North Pond Brook, which has been rated at a medium stress level based on the magnitude of stream flow using criteria developed by MA DEM. This stress level is based solely on a few low flow statistics and does not consider many other factors such as dam operations, water quality or instream habitat that play a role in river stress. The Gomez and Sullivan (2003) report recommends that future withdrawals be avoided and mitigation of current impacts should be evaluated.

Land Protection

- It is recommended that the Town of Athol continue to work on the UrbanRiver Visions project to explore ways in which the downtown can be revitalized using the Millers River as a focal point. Among the next steps identified in the project are the following: create a partnership that brings together diverse constituencies in support of riverfront renewal, form a committee of local experts and volunteers to map and survey the area's assets and resources, research land ownership and initiate discussions with landowners abutting the river and the proposed riverwalk, and improve water quality in the Millers River watershed. Some of the specific recommendations are: change zoning to guide appropriate development of properties along the river and avoid uses that might be detrimental to water quality; improve water quality, specifically by addressing residual industrial pollution and stormwater management; keep the Millers River wild by leaving it in its natural aspect wherever possible; provide "outdoor classrooms" in open spaces along the river and coordinate programming with the MREC, local schools, the library and YMCA; promote recreational uses of the riverbank and river; provide access points for canoes and kayaks; create festivals to celebrate the river; and promote ecotourism that takes advantage of the natural resources in and around the community and the river.
- It is recommended that the Towns of Royalston, Athol, Orange, Erving and Wendell participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project these towns can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.
- Most of the impervious area for the individual sub-basins in this segment was less than 10% classifying it as sensitive, which predicts a low threat to water quality from impervious surface water runoff. The exception to this was the Shingle Swamp Brook subwatershed with 13.6% impervious area classifying it as impacted (Stoltzfus 2001). The following recommendations should be considered.
  - In order to preserve sensitive areas and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve these areas, and maintain or reduce the impervious cover. The communities of Orange and Athol should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both Athol and Orange continue to work with Montachusett Regional Planning Commission and the Franklin Regional Council of Governments on land use planning issues.
  - For impacted areas consider setting an upper limit on watershed impervious area and limiting on-site impervious cover (e.g., low impact development, reduce parking ratios, narrower streets). Disconnect/remove impervious cover where appropriate. Promote low input lawn/auto care. Increase watershed awareness through education (volunteer monitoring, streamwalks, stormdrain stenciling).

MILLERS RIVER (SEGMENT MA35-05)

Location: Erving Center WWTP (formerly known as Erving Paper Company), Erving to confluence with Connecticut River, Erving.
Segment Length: 9.2 miles.
Classification: Class B, Warm Water Fishery.



The total drainage area to this segment is approximately 389 square miles (310 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	79%
Residential	7%
Agriculture	3%

The impervious cover area for the individual sub-basins within the watershed drainage area of this segment only is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

From the Erving Center WWTP this segment of the Millers River forms the border between Erving and Wendell. It flows in a west-northwest direction for about a mile before turning to the southwest. As the river continues toward the Village of Millers Falls, velocity increases while dropping through twelve sets of rapids. The river slows after it passes through the village, turns due north, and enters the backwater from the Connecticut River south of the French King Bridge at Route 2, Erving.

The Mormon Hollow Demolition Landfill in Wendell is located southeast of the confluence of Lyons Brook and the Millers River. This landfill is partially capped but has experienced slope failure in 2000 (Poirier 2002).

This segment is on the 1998 303(d) List of Waters for priority organics and metals (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3)

Facility WMA Permit # WMA Registration #	Source	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
			1998	1999	2000	2001	2002
International Paper-Strathmore Paper* 9P210709101 10719201	Intake 1A	0.14 reg 0.61 per 0.75 total	0.32	0.35	0.19	0.01	0.01

*Note: A well is also mentioned in the International Paper-Strathmore Paper registration, however they only use their surface water source (Bumgardner 2002).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2)

The Town of Erving is authorized to discharge from the Erving Center Wastewater Treatment Plant (WWTP) into the Millers River (NPDES permit #MA0101052 issued September 1998). The permittee is authorized to discharge 3.15 MGD of treated industrial and domestic wastewater via outfall 001. The treated discharge is comprised of approximately 95% paper mill wastewater and 5% sanitary wastewater. The Erving Paper Company is a de-inking paper mill that uses almost 100% recycled paper as pulp. The facility's acute whole effluent toxicity limit is $LC_{50} \geq 100\%$ and a CNOEC report only requirement with a monitoring frequency of four times per year. The maximum daily TRC limit is 0.21 mg/L. (The TRC in the effluent exceeded the limit in 8 of 19 test events –TOXTD database). This permit, which will include a requirement for total nitrogen monitoring and reporting, is scheduled to be reissued by EPA in 2004 (Hogan 2003).

The Town of Erving is authorized to discharge from the Erving POTW #3 into an unnamed tributary to the Millers River (NPDES permit #MA0102776 issued September 1999). The permittee is authorized to discharge 0.01 MGD of treated sanitary wastewater via outfall 001. The maximum daily TRC limit is 1.0

mg/L. No whole effluent toxicity testing is required. This permit, which will include a requirement for total nitrogen monitoring and reporting, is scheduled to be reissued by EPA in 2004 (Hogan 2003).

The Town of Erving (Village of Millers Falls) is authorized to discharge from the Erving POTW #1 into the Millers River (NPDES permit #MA0101516 issued September 1998). The permittee was authorized to discharge 1.02 MGD of treated industrial domestic wastewater via outfall 001. With the closure of the International Paper Company the average annual discharge flow has been reduced to 0.114 MGD (Schleeweis 2003). The facility's acute whole effluent toxicity limit is $LC_{50} \geq 100\%$ with a monitoring frequency of four times per year. The maximum daily TRC limit is 0.59 mg/L. The highest TRC concentration reported in their discharge monitoring reports was 1.65 mg/L in October of 2000. The facility's CSO was sealed off 16 June 1997 (McCollum 1998). This permit, which will include a requirement for total nitrogen monitoring and reporting, is scheduled to be reissued by EPA in 2004 (Hogan 2003).

Erving Paper Mills (97 East Main Street) Erving is permitted (MAR05C298) to discharge stormwater to the Millers River. As part of this permit the facility is required to develop a SWPPP and conduct quarterly visual monitoring of their stormwater discharge.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Underground Storage Tanks (UST)

Underground storage tanks are located in this subwatershed particularly near the centers of Montague and Erving.

Sand & Gravel Operations

Several sand and gravel operations are located in this subwatershed along the Millers River in Erving and Montague.

Landfills

The Erving Paper Sludge Landfill in Erving is adjacent (on the northern side) to the Millers River just downstream of its confluence with Lyons Brook. The Mormon Hollow Demolition Landfill in Wendell is located southeast of the confluence of Lyons Brook and the Millers River.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Stream gaging data for the Millers River are available from the USGS gage 01166500 located downstream of Bridge Street bridge, Erving (Farley) from 1915 to the present. The drainage area at this gage is 372 mi^2 and the average annual discharge over the period of record is 640 cfs (Socolow *et al.* 2001). The Hydrologic Assessment performed by Gomez & Sullivan indicated that pulsing flows (up to 80 cfs twice each day) were recorded in the hourly hydrographs in the Millers River near Erving during August and September 2000. The cause of this pulsing may be associated with the New Home hydropower project.

Two stream reaches in this segment of the Millers River were sampled by DWM biologists in September 2000 (Appendix C). The most upstream reach sampled was upstream from Farley Road, Wendell/Erving (station - B0446) above the Erving POTW #3 discharge. Here the river was about 30 m wide but more easily wadeable than the reach sampled in South Royalston. Riffles were approximately 0.25 m deep and the runs and pools 0.40 m deep. Substrates were dominated by boulder and cobble and about 75% of the stream bottom within the reach was blanketed with river-weed (*Podostemum ceratophyllum*), while small amounts of waterweed (*Elodea* sp.) were also present. Green algae were observed in the reach as thin films on rocks in less than 5% of the reach. The overall habitat score was 182 (Appendix C).

The second reach sampled by DWM biologists was near the mouth of the Millers River, Montague/Erving (B0444). Although this reach was only a little more than 500 m upstream from the confluence with the Connecticut River it was wadeable during the sampling. The depths in the sample reach were about 0.25 m in the riffles and runs and 0.1 m in the pools near the river's margins. Bottom substrates were primarily cobble. Here the instream vegetation was mostly *Elodea*

sp. with small amounts of moss. Green algae coated the rocks in thin films through approximately 80% of the reach. The overall habitat score was 170 (Appendix C). The riparian zone at both sampling locations was 100% forested, but canopy cover over the channel was no more than 5%.

Biology

Benthic macroinvertebrate sampling in this segment of the Millers River was conducted by DWM in September 2000 at two locations; upstream from Farley Road, Wendell/Erving (station B0446) and near the mouth of the river at Millers Falls (station B0444). The RBP III analysis indicated the benthic community was non-impacted at both stations (Appendix C) when compared to the Lawrence Brook reference station (station B0449).

Toxicity

Ambient

Water from the Millers River was collected approximately 0.25 miles upstream of the Erving POTW #1 discharge (approximately 50' downstream from the Route 63 bridge in Erving/Montague) for use as dilution water in the Erving POTW #1 whole effluent toxicity tests. Between March 1996 and November 2002 survival of *C. dubia* exposed (48-hour) to the river water was good (95%).

Effluent

A total of 19 modified acute and chronic whole effluent toxicity tests were conducted on the Erving Center effluent using *C. dubia* and *P. promelas* between January 1998 and July 2002. Three test events were problematic. The effluent was acutely toxic to *C. dubia* during one of the 16 test events (LC_{50} = 82% effluent April 2000) and failed to meet the NPDES acute toxicity limit of $LC_{50} \geq 100\%$ effluent. The CNOEC results ranged from 6.25 to 100% effluent. Two of the chronic test results (CNOEC = 6.25% effluent in January 1998 and April 2001) were of concern based on a dilution calculation under low flow conditions where the concentration of the effluent in the Millers River would be approximately 9%. With the exception of three tests events, *C. dubia* was consistently the more sensitive test organism. Furthermore, when whole effluent toxicity was of concern (i.e., $LC_{50}<100\%$ or CNOEC<9% effluent) toxic events were detected by *C. dubia*.

A total of 29 definitive acute whole effluent toxicity tests were conducted on the Erving POTW#1 effluent using *C. dubia* between March 1996 and November 2002. The effluent exhibited acute toxicity in only one test (LC_{50} = 92% effluent in August 2002). The $LC_{50's}$ were all $\geq$ 100% effluent in the other tests.

Chemistry – water

As part of the "1998-1999 Connecticut River Nutrient Loading" project, water quality samples were collected by MA DEP DWM on a monthly basis from the Millers River just upstream from the Route 63 Bridge in Erving/Montague (station CT05) from June 1998 through May 1999 (Appendix A, Table 12 and Appendix E).

Water from the Millers River was collected approximately 0.25 miles upstream from the Erving POTW #1 discharge (approximately 50' downstream from the Route 63 bridge in Erving/Montague) for use as dilution water in the Erving POTW #1 whole effluent toxicity tests. Data from these reports (maintained in the TOXTD database) between March 1996 and November 2002 are summarized below.

As part of the MA DEP SMART monitoring program, water quality sampling was conducted on five occasions between March and November of 2000 in the Millers River downstream of Bridge Street in Erving/Wendell (station MI03) (Appendix A, Tables 6 and 7). These data are summarized below.

DO

DO measurements at station MI03 ranged from 8.6 to 13.1 mg/L and percent saturation ranged from 95 to 102%. It should be noted that these data do not represent the worse-case (pre-dawn) conditions.

Temperature
Temperature at station MI03 ranged from a high of 22.4°C in July to a low of 4.6 in March.

pH and Alkalinity
Instream pH measurements upstream of the Erving POTW #1 discharge ranged from 6.2 to 8.6 SU and six of 27 measurements were less than 6.5 SU (TOXTD database). Alkalinity was low ranging from 1.5 to 32 mg/L with 11 of 27 measurements less than 10 mg/L. Further downstream (station MI03) pH measurements ranged from 6.1 to 7.3 SU. With the exception of the March sampling date, pH measurements were above 6.5 SU. Alkalinity measurements at MI03 were low ranging from 3 to 9 mg/L.

Specific Conductance
Specific conductance at 25°C at station MI03 ranged from 89.1 to 142 µS/cm.

Suspended Solids
The maximum suspended solids concentration was 17 mg/L (TOXTD database) and at station MI03 suspended solids ranged from 1.1 to 2.7 mg/L.

Turbidity
Turbidity measurements ranged from 1.0 to 2.8 NTU (station MI03).

Ammonia-Nitrogen
The maximum ammonia-nitrogen concentration in the Millers River upstream of the Erving POTW #1 discharge was 11.9 mg/L (May 2002) although none of the other measurements (n=26) exceeded 0.21 mg/L (TOXTD database). The concentration of ammonia-nitrogen was <0.02 mg/L on all sampling dates at station MI03.

Nitrate-Nitrogen
Nitrate-nitrogen measurements ranged from 0.08 to 0.48 mg/L at station MI03.

Total Kjeldahl Nitrogen
Total Kjeldahl Nitrogen concentrations ranged from 0.18 to 0.44 mg/L at station MI03.

Phosphorus
Total phosphorus measurements at station MI03 ranged from 0.015 to 0.062 mg/L.

Total Residual Chlorine
TRC measurements (n=27) were all below the minimum quantification level of 0.05 mg/L (TOXTD database).

Hardness
Hardness measurements of the Millers River ranged from 8.8 to 71 mg/L and 11 of the 27 measurements were <25 mg/L (TOXTD database). Hardness measured at station MI03 ranged from 11 to 25 mg/L.

Chloride
Chloride measurements at station MI03 ranged from 17 to 25 mg/L.

The *Aquatic Life Use* is assessed as support for the entire length of this segment based primarily on the benthic macroinvertebrate community analyses. This use is identified with an Alert Status, however, because of the documented aberrant flow fluctuations (pulsing twice per day) and potential PCB contamination problems from upstream sources. Additionally, whole effluent toxicity at the Erving Center WWTP discharge is of concern as is slightly elevated levels of total phosphorus.

FISH CONSUMPTION

As a result of the 1987 fish toxics monitoring investigations, which confirmed earlier findings that PCB contamination existed in the Millers River Basin, MA DPH issued a public health advisory regarding consumption of fish from the Millers River (Maietta 1989). Most recently (August 2000) fish toxics

monitoring was conducted by DWM in this segment of the Millers River in the pool under the railroad trestle at Farley Flats in Erving/Wendell (Maietta and Colonna-Romano 2001). The sampling was conducted to support the ongoing PCB contamination evaluation in the Millers River Watershed. These data can be found in Appendix A, Table 15). Because of elevated PCB concentrations, the MA DPH fish consumption advisory recommends the following (MA DPH 2002a).

Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries,"
2. "the general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River," and
3. "the general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Because of the site-specific MA DPH fish consumption advisory, the *Fish Consumption Use* for this segment of the Millers River is assessed as impaired due to mercury and PCB contamination. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The source of mercury is unknown, although atmospheric deposition is suspected. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharges from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

No objectionable deposits of trash/debris, were noted in either of the two stream reaches sampled by DWM biologists in September 2000 (Appendix C). Slight instream turbidity was noted at both sampling locations and a slight sewage odor was present near the confluence with the Connecticut River. Some foam along the northeastern shore of the river (in an area of the strongest flow) downstream from Bridge Street in Erving/Wendell (station MI03) was noted by MA DEP SMART monitoring staff consistently throughout during the 2000 survey season. The foam appeared to be natural in origin. This reach of river was observed to have small quantities of trash including packaging for fishing products and cigarette butts along the shoreline. However, despite this, it is among the most scenic areas in the Millers River Watershed.

Although too limited data are available to assess the *Recreational Uses* the *Aesthetics Use* is assessed as support. However, this use is identified with an Alert Status because of the Mormom Hollow Demolition Landfill in Wendell, which has experienced slope failure that is currently in the process of being stabilized.

Millers River (MA35-05) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT*
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT*

* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS MILLERS RIVER (SEGMENT MA35-05)

Water Quality Monitoring

- Continue to monitor biological and habitat quality in this segment of the Millers River, bracketing point source discharges whenever feasible, to better evaluate the status of the *Aquatic Life Use.*
- Monitor the fish community along this segment of the Millers River to evaluate any changes resulting from efforts to improve/mimic natural flow regimes.
- MA DEP's Bureau of Waste Site Cleanup should continue to work with other agencies and potential principle responsible parties to continue the investigation of PCB contamination and remediation efforts.
- Evaluate the need for additional PCB sampling of sediment and whole fish in this reach of the Millers River.
- Develop an instream monitoring strategy to evaluate the effectiveness of point and nonpoint source nutrient reduction efforts. Such monitoring efforts should include evalutation of primary productivity (e.g., periphyton, phytoplankton, macrophyte) as well as direct chemical measurements.
- Continue to conduct long-term fixed site monitoring at the Millers River Bridge Street site in Erving/Wendell to determine long-term water quality trends.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Point Sources of Pollution

- The Erving Center WWTP NPDES permit should be reissued with appropriate limits and monitoring requirements. The whole effluent toxicity testing could be reduced to *C. dubia* only, however a CNOEC limit of 9% effluent (the instream waste concentration of the discharge under 7Q10 conditions) should also be imposed. An upstream/downstream biological evaluation (e.g., benthic macroinvertebrate study) should be conducted around the Erving Center WWTP discharge to evaluate whether or not there are any instream impacts from the discharge.
- Review Erving Paper Mill's SWPPP (permit MAR05C298). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.

Nonpoint Sources of Pollution

- An inventory of all underground storage tanks, both registered and unregistered, should be maintained to identify areas of risk in the watershed particularly near the centers of Erving and Montague. This inventory should include the location, age, material and condition of each tank. Priority should be given to areas near drinking water supplies, lakes, ponds, and wetlands and areas where stormwater runoff conditions are intensified by extensive impervious surfaces.
- Investigate and confirm the presence of the sand and gravel operations in this subwatershed that are indicated in the MRPC and FRCOG (2002) study. Evaluate these sites to ensure that they are being

operated and maintained properly and that water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, state and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding should be sought to work with communities on this project (e.g., 604b Water Quality Assessment).

Hydrology

- Instream flow regimes along this segment of the Millers River (as affected by operation of the FERC-exempt and FERC nonjurisdictional hydropower projects and the ACOE Tully Dam) should be documented and attempts should be made to mimic natural flow regimes to the extent possible.
  - Investigate the operating conditions at the Cresticon Upper Project Number 10163A , Cresticon Lower Project Number 10163B, L.S. Starrett, and New Home Dam North and South Project Numbers 6096A and 6096B, respectively, during periods of low flow. Determine if these projects release their required minimum flows. Evaluate and monitor these operations for compliance with run-of-river requirements.
  - Reduce aberrant streamflow fluctuations in this segment of the Millers River observed at the USGS gage in Erving.
  - In order to determine the cause of pulsing flows in the Millers River, the Gomez and Sullivan (2003) report recommended that hourly or daily discharges for all NPDES facilities should be evaluated. This data should be used to determine what effect discharges have on stream flow. The owners of the FERC projects should also be required to develop a streamflow compliance and monitoring plan with FERC.

Land Protection

- The impervious cover area for the individual sub-basins within the watershed drainage area of this segment only is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. It is recommended that the Town of Erving review the information generated through the buildout analysis performed by EOEA that created a profile of how each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that the Town of Wendell continue to work with the Franklin Regional Council of Governments and the Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Town of Erving participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Erving can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

OTTER RIVER SUBWATERSHED

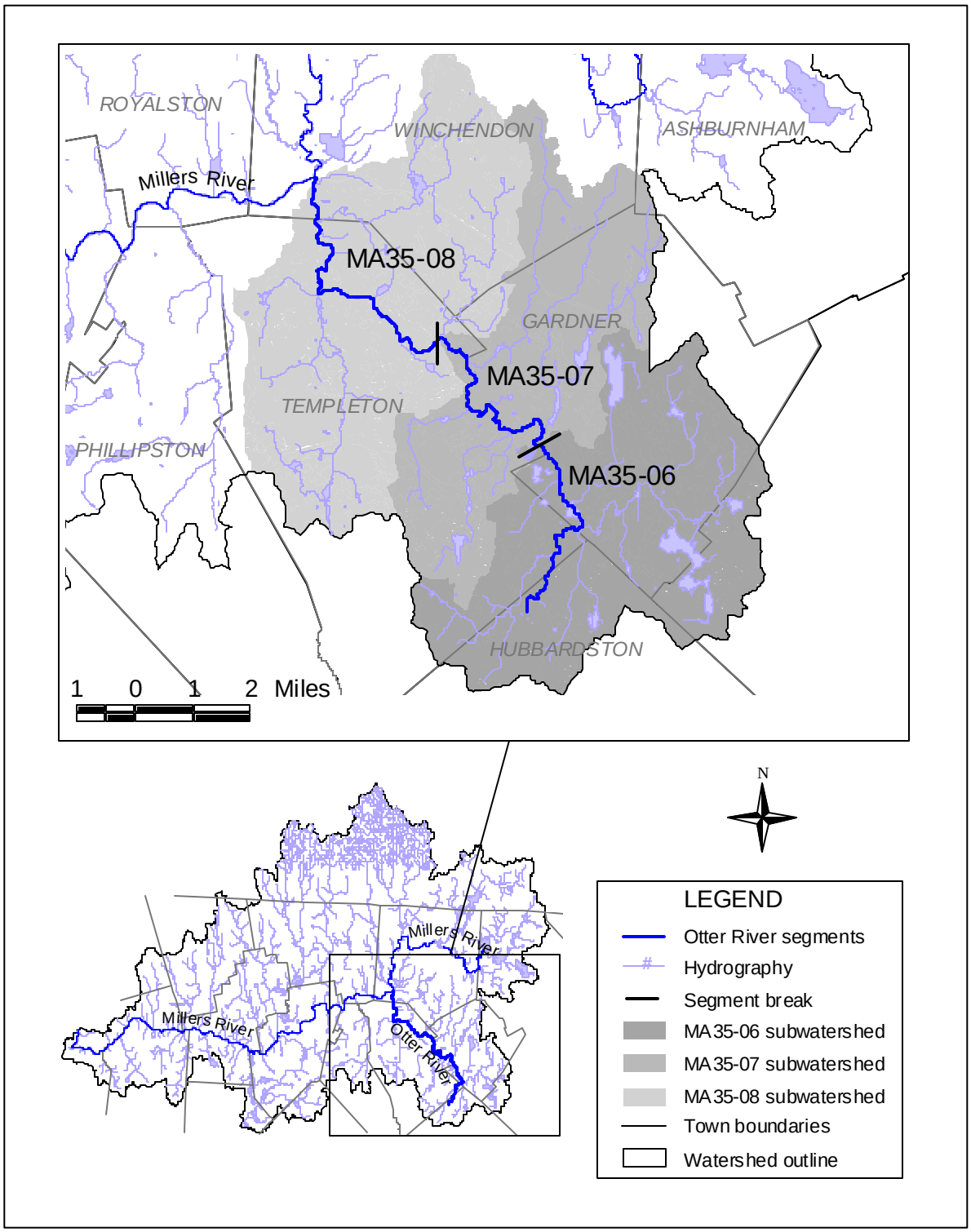
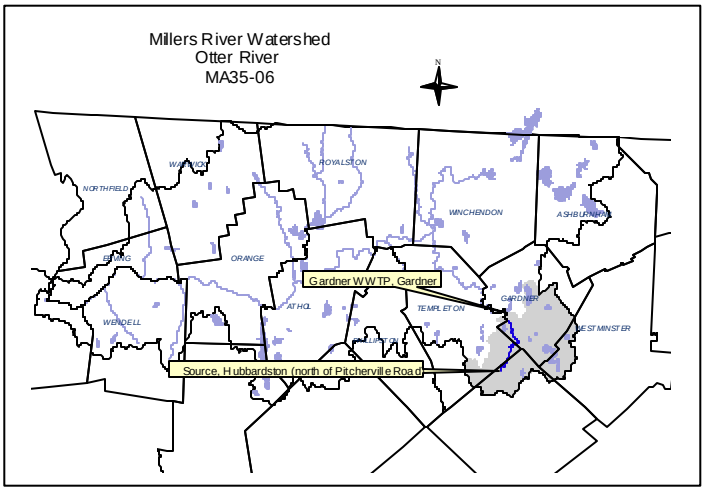


Figure 9. Otter River subwatershed segment locations.

OTTER RIVER (SEGMENT MA35-06)

Location: Source, Hubbardston (north of Pitcherville Road) to Gardner WWTP, Gardner/Templeton.
Segment Length: 4.3 miles.
Classification: Class B, Aquatic Life.



The drainage area of this segment is approximately 20.8 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	60%
Residential	16%
Open Land	6%

The impervious area for the Pond Brook subwatershed drainage area is 38.1% classifying it as nonsupporting, predictive of poor water quality. The Kendall Pond and Snake Pond subwatersheds have impervious areas of 19.9% and 15%, respectively, classifying them as impacted, which is predictive of a decline in water quality. The remainder of the impervious area within the individual sub-basins of this segment is less than 10% classifying it as sensitive, which predicts a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

The Otter River originates just north of Pitcherville Road in Hubbardston and meanders generally north through wetlands into Templeton. It receives the flow from Templeton Brook and flows near the southeastern edge of the Gardner Municipal Airport. It then picks up the flow from Hubbardston Brook and continues to flow north into an impounded area in Gardner. Here it is joined by Pond Brook and then flows under Routes 2 and 2A. The segment ends at the discharge from the Gardner WWTP.

The use assessments for Bents Pond, Hubbardston (MA35006), Bents Pond, Gardner (MA35007), Crystal Lake (MA35014), Dunn Pond (MA35021), Greenwood Pond (MA35025), Kendall Pond (MA35034), Minott Pond (MA35046), Minott Pond South (MA35045), Ramsdell Pond (MA35062), Travers Pond (MA35088), Upper Reservoir (MA35091), and Wrights Reservoir (MA35104) are provided in the Lake Assessment section of this report.

TMDLs for total phosphorus were calculated by MA DEP for Bents Pond (Gardner), Greenwood Pond, Minott Pond, Minott Pond South, Ramsdell Pond, and Wrights Reservoir (MA DEP 2002).

MA DFWELE conducted fish population sampling in three tributaries - Templeton Brook, Bailey Brook and Mahoney Brook as described below.

Templeton Brook was sampled via backpack shocking on 28 June 2000. The sampling site was south of Shady Lane in Hubbardston. Two brook trout (*Salvelinus fontinalis*) were collected. MA DFWELE has proposed that Templeton Brook, a tributary to this segment of the Otter River, be reclassified in the SWQS as a cold water fishery (MassWildlife 2001).

Also on 28 June 2000 fish population sampling was conducted in Bailey Brook on the east side of Bridge Street, Gardner. A total of 31 fish represented by eight species were collected via backpack shocking. The dominant species was white sucker (*Catostomus commersoni*). Other fish species present, in order of abundance, included: brook trout (*Salvelinus fontinalis*), longnose dace (*Rhinicthys cataractae*), golden shiner (*Notemigonus crysoleucas*), fallfish (*Semotilus corporalis*), pumpkinseed (*Lepomis gibbosus*), and yellow bullhead (*Ameiurus natalis*).

Mahoney Brook was sampled at two locations using backpack shocking. On 28 June 2000 a site east of Elm Street, Gardner was sampled. A total of 18 fish represented by six species were collected. The most dominant species was yellow perch (*Perca flavescens*). Other fish species present, in order of abundance, included: white sucker (*Catostomus commersoni*), pumpkinseed (*Lepomis gibbosus*),

largemouth bass (*Micropterus salmoides*), yellow bullhead (*Ameiurus natalis*), and brown bullhead (*Ameiurus nebulosus*). On September 19, 2000 Mahoney Brook was sampled north of Mill Street in Gardner. Of the nine species represented, fallfish (*Semotilus corporalis*) was the most prevalent. Other fish species present were: yellow perch (*Perca flavescens*), creek chubsucker (*Erimyzon oblongus*), white sucker (*Catostomus commersoni*), pumpkinseed (*Lepomis gibbosus*), chain pickerel (*Esox niger*), brown bullhead (*Ameiurus nebulosus*), tesselated darter (*Etheostoma olmstedi*), and yellow bullhead (*Ameiurus natalis*).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3)

Facility WMA Permit # WMA Registration #	Sources	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
			1998	1999	2000	2001	2002
Gardner Water Department* 9P220710302 20710301	Crystal Lake 2103000-01S Otter River Well 2103000-01G	1.69 reg 0.63 per 2.32 total	2.22	2.40	2.02	1.98**	2.22**

*not all sources within this segment

**discrepancies were noted between individual well meters and the master meter

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLES D1 AND D2)

S. Bent & Bros., Inc. (MA0002801) was authorized (permit issued September 1987) to discharge 0.005 MGD of noncontact cooling water from air compressors, a turbine generator and stormwater from roof drains via Outfall 001 to Ramsdell Pond via metal culvert and sluiceway. (Ramsdell Pond is an impoundment of an unnamed tributary to the most upstream segment of the Otter River). The facility was engaged in the manufacturing of hardwood furniture (wood chairs, tables) but went out of business in 2000. The permit file was closed out by EPA in January 2002.

Simplex Time Recorder Co., Inc. of Gardner (MA0002411) tied into the City of Gardner's Wastewater Treatment Facility (WWTF) in September 1993.

The Gardner Department of Public Works is authorized (MAG640041) to discharge effluent from their Water Treatment Facility to Crystal Lake and through the storm drainage system to Pond Brook. The Water Treatment Facility (WTF) went online in May 2000, but has been experiencing operational problems. The Town and their consultants are currently in the planning process to upgrade the facility. The DMRs submitted for this facility indicate that high aluminum concentrations are present in the discharge. Values ranging from 0.87 to 4.1 mg/l were reported for the first quarter of 2003.

C & W Fabricators (35 Wilkins Road) Gardner is permitted (MAR05B882) to discharge stormwater to this subwatershed of the Otter River. As part of this permit the facility is required to develop a SWPPP and conduct quarterly visual monitoring of their stormwater discharge.

Kirk Eastern (79 Wilkins Road) Gardner is permitted (MAR05C291) to discharge stormwater to this subwatershed of the Otter River. As part of this permit the facility is required to develop a SWPPP and conduct quarterly visual monitoring of their stormwater discharge.

Nichols & Stone Co. (232 Sherman Street) Gardner is permitted (MAR05B747) to discharge stormwater to this subwatershed of the Otter River. As part of this permit the facility is required to develop a SWPPP and conduct quarterly visual monitoring of their stormwater discharge.

It should also be noted that Gardner is a Phase II Stormwater community. Gardner was issued a stormwater general permit from EPA and MA DEP in 2003, and is authorized to discharge stormwater from their municipal drainage system (MAR041190). Over the five-year permit term, Gardner will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Otter River were identified in the MRPC and FRCOG (2002) report.

Underground Storage Tanks (UST)
Numerous underground storage tanks are located in this portion of the subwatershed particularly near the center of Gardner.
Sand & Gravel Operations
There are numerous sites of sand and gravel operations in this subwatershed.
Airport
The Gardner Airport is located near the Otter River and extensive wetland areas.
Golf Courses
The Gardner Municipal Golf Course is a 108.6 acre site located on Eaton Street in Gardner adjacent to Crystal Lake.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

In August 1995 the Otter River was between 3 and 5m wide in the reach sampled downstream/north from Route 2A, Gardner (station B0217)(Appendix C). The riffles were shallow (≤ 0.1m) but one pool area was >1m. The water was slightly turbid. The overall habitat score was 135.

Using criteria set forth by the Massachusetts Water Resource Commission the Otter River subwatershed was identified at a medium stress level based on water quantity (Gomez and Sullivan 2003).

The Hydrologic Assessment performed by Gomez & Sullivan 2003 indicated that flow fluctuations occur usually once per day, varying by approximately 2 cfs (recorded in the hourly hydrographs in the Otter River near the Turner Street Bridge, Templeton) during August and September 2000. The cause of this fluctuation has not been determined.

Biology

Benthic macroinvertebrate sampling was conducted by DWM in August 1995 at one station in this segment of the Otter River downstream/north from Route 2A, Gardner which is upstream from the Gardner WWTP discharge (station B0217) (Appendix C). Although this sampling reach was intended as an upstream bracket on the Gardner WWTP, it was downstream from the City of Gardner, an extensive wetland area, and at least one sand and gravel facility. Compared to the West Branch Tully River reference station (station B0225), the RBP III analysis indicated the benthic community was moderately impacted (Appendix C).

Fish population sampling was conducted by MA DFWELE with both gillnet and boat shocking in the Otter River near the airport access in Templeton on 4 August 2000. Using the gillnet, a total of 54 fish represented by 9 species were present. Fish species, in order of abundance, included the following: brown bullhead (*Ameiurus nebulosus*), yellow perch (*Perca flavescens*), white sucker (*Catostomus commersoni*), creek chubsucker (*Erimyzon oblongus*), pumpkinseed (*Lepomis gibbosus*), golden shiner (*Notemigonus crysoleucas*), chain pickerel (*Esox niger*), yellow bullhead (*Ameiurus natalis*) and largemouth bass (*Micropterus salmoides*). With boat shocking, a total of 248 fish represented by 12 species were present with white sucker (*Catostomus commersoni*) being the most common. Other species, in order of abundance, were the following: golden shiner (*Notemigonus crysoleucas*), yellow perch (*Perca flavescens*), pumpkinseed (*Lepomis gibbosus*), creek chubsucker (*Erimyzon oblongus*), brown bullhead (*Ameiurus nebulosus*), largemouth bass (*Micropterus salmoides*), black crappie (*Promoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), American eel (*Anguilla rostrata*), and rainbow trout (*Oncorhynchus mykiss*). Although the fish species collected were almost all macrohabitat generalists, as expected given the low gradient nature of the reach sampled, white sucker, a fluvial dependant species tolerant of low DO and elevated temperatures, dominated the sample. In contrast, the presence of creek chubsucker, an intolerant fluvial specialist, is indicative of good habitat quality.

Chemistry - water

In-situ measurements of the Otter River (DO, %saturation, pH, temperature, and conductivity) and other samples (alkalinity, hardness, chloride, suspended solids, nutrients, and turbidity) were collected by MA DEP DWM near Route 2A bridge, Gardner (station M01). Sampling was conducted

approximately every eight hours on three separate three-day surveys in 1995 (June 27 to 29, July 25 to 27 and August 22 to 24) (Appendix A, Tables 9 and 10). A summary of the data follows.

DO

DO measurements at station MI01 ranged from 2.5 to 4.9 mg/L (30 to 55% saturation).

Temperature

The temperature measurements at station MI01 ranged from 18.9 to 27.3°C.

pH and Alkalinity

Instream pH at station MI01 varied between 6.0 and 6.1 SU. The maximum alkalinity was 14 mg/L.

Hardness

Instream hardness at station MI01 ranged between 13 and 25 mg/L.

Suspended Solids

The maximum suspended solids concentration at station MI01 was 8.5 mg/L (excluding the anomalous result of 90 mg/L).

Turbidity

Turbidity at station MI01 ranged between 6.4 and 13 NTUs.

Ammonia-nitrogen

The maximum measurement of ammonia-nitrogen at station MI01 was 0.11 mg/L.

Total Phosphorus

Total phosphorus concentrations at station MI01 ranged from <0.05 to 0.09 mg/L.

Conductivity

Conductivity measurements at station MI01 ranged from 148 to 235 µS/cm.

Too limited current water quality data are available and, therefore, the *Aquatic Life Use* for this segment of the Otter River is not assessed. This use is identified with an Alert Status, however, since moderate impacts to the benthic macroinvertebrate community and low DO conditions were documented in 1995.

FISH CONSUMPTION

Fish toxics monitoring has not been conducted in this segment and the current Otter River Fish Consumption Advisory only pertains to the most downstream 0.5 mile reach of the Otter River (near to its confluence with the Millers River). However, all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). In addition, a site-specific advisory is in place for Upper Reservoir, which is located in the headwaters of this segment, because of elevated mercury concentrations. Therefore, until site-specific data are generated, and the advisories are clarified, the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharges from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION

Two fecal coliform bacteria samples were collected by MA DEP DWM from the Otter River near Route 2A bridge, Gardner (station M01) in May 1996. The bacteria counts were both low (Appendix A, Table 11).

Too limited data are available and, therefore, the *Recreational* uses are not assessed for this segment of the Otter River.

AESTHETICS

Slight instream turbidity was observed by DWM biologists in the Otter River downstream from Route 2A in Gardner in August 1995 (Appendix C).

A shoreline survey of the Otter River was conducted by the Otter River Stream Team in November/December 2000 (MRPC and FRCOG 2002). Isolated areas of trash and debris were observed near the Gardner Municipal Airport and near Duguay's Restaurant. No other objectionable aesthetic conditions were identified except for the sewage odor detected near the Gardner WWTP.

The *Aesthetics Use* of this segment of the Otter River is assessed as support but is identified with an "Alert Status" because of slight turbidity.

Otter River (MA35-06) Use Summary Table

Designated Uses	Status
Aquatic Life 	NOT ASSESSED*
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT*

* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS OTTER RIVER (SEGMENT MA35-06)

Water Quality Monitoring

- Biomonitoring (benthic macroinvertebrate, habitat quality and fish population) should be conducted in this segment of the Otter River to evaluate changes in conditions since the 1995 Otter River Survey. The effects of the extensive low-gradient, wetland reaches upstream that may be organically rich, with little turbulent flow to reaerate the water and/or natural habitat limitations (limited riffle and other productive habitat) should be considered. Sources of suspended solids loadings to this system, however, should be documented and reduced. Possible sources of the problem include nonpoint source (NPS) pollution from highway runoff, urban runoff (city of Gardner), the municipal airport, or stream-side industrial activities (sand and gravel operations). These data would be also be used to assess the status of the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Point Sources of Pollution

- The Gardner WWTF should collect water from this segment of the Otter River to be used, at a minimum, as a site water control in the facility's whole effluent toxicity tests (the facility discharges to Otter River segment MA35-07).
- An evaluation should be undertaken of the high levels of aluminum reported in the effluent discharge of the Gardner Water Treatment Facility to Crystal Lake.
- Review C & W Fabricators' SWPPP (permit MAR05B882). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.
- Review Kirk Eastern's SWPPP (permit MAR05C291). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.

- Review Nichols & Stone Co.'s SWPPP (permit MAR05B747). Evaluate the quality of the SWPPP, extent of compliance, and the effectiveness in minimizing impacts of stormwater runoff from the facility.

Nonpoint Source Pollution

- An inventory of the numerous underground storage tanks particularly near the center of Gardner should be maintained to identify areas of risk. This inventory should include the location, age, material and condition of each tank. Priority should be given to areas near drinking water supplies, lakes, ponds, and wetlands and areas where stormwater runoff conditions are intensified by extensive impervious surfaces. Town bylaws that regulate the construction, installation, operation and maintenance of underground storage tanks should be considered by the City of Gardner.
- Investigate and confirm the presence of the sand and gravel operations in this subwatershed that are indicated in the MRPC and FRCOG (2002) study. Evaluate these sites to ensure that they are being properly operated and maintained and that water quality is being protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).
- At the Gardner Airport, best management practices should be followed for vegetation control, stormwater management, the use of deicing compounds, and the management of chemical storage and waste disposal.
- Vegetation management and the use of pesticides and fertilizers at the Gardner Municipal Golf Course should be done in accordance with best management practices. It is recommended that a Best Management Plant for these issues be developed.

Hydrology

- Further evaluate the entire Otter River, which has been rated at a medium stress level based on the magnitude of stream flow using criteria developed by MA DEM. This stress level is based solely on a few low flow statistics and does not consider many other factors that play a role in river stress such as dam operations, water quality or instream aquatic habitat. The Gomez and Sullivan (2003) report recommends that future withdrawals be avoided and mitigation of current impacts should be evaluated.
- Further investigation into the flow fluctuations in the Otter River that were noted in the Gomez and Sullivan (2003) report is recommended to pinpoint their sources and reduce artificial fluctuations. Recommendations from the report include evaluating the hourly or daily discharges for the Gardner Water Treatment Facility. These data would be used to determine what effect this discharge may have on stream flow.
- In accordance with the requirements of MA DEP's WMA permit program the Gardner Water Department should develop and/or maintain up-to-date water conservation plans to help reduce the need for increased water withdrawals. Residential water consumption should be maintained at 80 gpcd or less and unaccounted-for water should be limited to 10% (Gomez and Sullivan 2003).

Land Protection

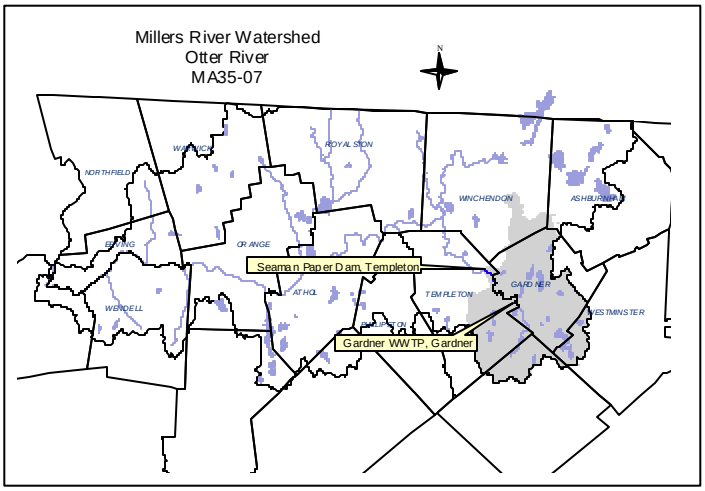
- It is recommended that the City of Gardner and the Town of Hubbardston participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Gardner and Hubbardston can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.
- Most of the impervious area for the individual sub-bains within this segment was less than 10%, classifying it as sensitive which predicts a low threat to water quality from surface water runoff. The

exceptions to this were the Kendall Pond subwatershed with 19.9% impervious area and the Snake Pond subwatershed with 15% impervious area classifying them both as impacted. Additionally, the Pond Brook subwatershed had an 38.1% impervious area classifying it as nonsupporting (Stoltzfus 2001). The following recommendations should be considered.

- In order to preserve sensitive areas and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve these areas, and maintain or reduce the impervious cover. The City of Gardner and the Town of Hubbardston should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both Gardner and Hubbardston should continue to work with Montachusett Regional Planning Commission on land use planning issues.
- For impacted areas consider setting an upper limit on watershed impervious area, limit on-site impervious cover (e.g., low impact development, reduce parking ratios, narrower streets). Remove impervious cover where appropriate. Promote low input lawn/auto care. Increase watershed awareness through education (volunteer monitoring, streamwalks, stormdrain stenciling).
- For non-supporting streams consider encouraging infill and redevelopment. Revitalize existing neighborhoods, advocate development of brownfield sites. Retain/protect public recreation areas, existing forests, and floodplains. Manage buffer as a greenway for recreation and flood protection (Gardner Area Airport). Encourage designs that will prevent increased flooding from new development.

OTTER RIVER (SEGMENT MA35-07)

Location: Gardner WWTP, Gardner/Templeton to Seaman Paper Dam, Templeton.
Segment Length: 4.4 miles.
Classification: Class B, Warm Water Fishery.



The total drainage area to this segment is approximately 35.6 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	65%
Residential	14%
Open Land	5%

The impervious area for the individual sub-basins in this segment of the Otter River only is all less than 10%, therefore, it is classified as sensitive predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

This segment is on the 1998 303(d) List of Waters for nutrients, organic enrichment/low DO, and other habitat alterations (Table 3).

This segment begins at the Gardner WWTP outfall and forms the boundary between Gardner and Templeton as it flows past several large sand and gravel operations. Immediately downstream from the USGS gage at Turner Street the river enters Templeton proper and flows into the impoundment behind the Seaman Paper Company dam, which marks the end of the reach.

The use assessments for Cowee Pond (MA35013), East Templeton Pond (MA35022), Greenwood Pond (MA35026), Hichley Pond (MA35029), Parker Pond (MA35056), Partridgeville Pond (MA35057), and Perley Brook Reservoir (MA35059) are provided in the Lake Assessment section of this report.

TMDLs for total phosphorus were calculated by MA DEP for Cowee Pond, Greenwood Pond, Hichley Pond, and Parker Pond (MA DEP 2002).

MA DFWELE conducted fish population sampling in Wilder Brook using backpack shocking on June 28, 2000. Two chain pickerel (*Esox niger*) were found at the sampling site, which was located south of Route 68. MA DFWELE has proposed that Bailey and Wilder brooks, tributaries in this subwatershed of the Otter River, be reclassified in the SWQS as cold water fisheries (MassWildlife 2001).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3)

Facility WMA Permit # WMA Registration #	Sources	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
			1998	1999	2000	2001	2002
Gardner Water Department* 9P220710302 20710301	Cowee Pond (Marm Johns) (03S) Perley Brook (02S)	1.69 reg 0.63 per 2.32 total	2.22	2.40	2.02	1.98**	2.22**
Templeton Water Department* 9P20729401 20729401	Otter River Well 294-01G Sawyer Street Well 294-06G	0.53 reg 0.42 per 0.95 total	0.68	0.48	0.48	0.53	0.51

* not all sources within this segment. There is a Templeton Wellhead Protection Project (99-14/WHP) currently underway for their Otter River and Sawyer Street wells (Appendix E).
**discrepancies were noted between individual well meters and the master meter

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2)

The Gardner Department of Public Works is authorized to discharge from the Gardner Wastewater Treatment Facility (WWTF) in East Templeton, MA into the Otter River (NPDES permit #MA0100994 issued September 1998). The permittee is authorized to discharge 5.0 MGD of treated wastewater via outfall 001. The facility's whole effluent toxicity limits are the lethal concentration to 50% of the test

organisms (LC_{50}) ≥ 100% and chronic no observed effect concentration (CNOEC) ≥ 63.5% with a monitoring frequency of 4X/year for both. Their maximum daily total residual chlorine (TRC) limit during seasonal chlorination (1 April through 30 September) is ≤ 0.03 mg/L. The facility implemented dechlorination with sodium bisulfite as of February 1996. The maximum daily total phosphorus limit is 1.3 mg/L and during the summer (1 June through 30 September) the daily maximum ammonia-nitrogen concentration is limited to 1.5 mg/L. In 2000/2001, the facility operated with a flow around 3.0 to 3.5 MGD and was generally well run. However, the facility had problems meeting the copper limit and occasional problems meeting the fecal coliform limit (Ostrosky 2003). This permit, which will include a requirement for total nitrogen monitoring and reporting, is scheduled to be reissued by EPA in 2004 (Hogan 2003).

It should also be noted that Gardner and Templeton are Phase II Stormwater communities. Each community was issued a stormwater general permit from EPA and MA DEP in 2003, and is authorized to discharge stormwater from their municipal drainage systems (MAR041190 and MAR041225, respectively). Over the five-year permit term, the communities will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Illegal Junk Yard/Dumping Sites

A couple of illegal junk yard/dumping sites in this segment and solid waste dumping along Riverside Road in Gardner were noted.

Sand & Gravel Operations

Several sand and gravel operations are located in this subwatershed.

Stormwater

Stormwater quality concerns along Coleman Street to Route 2A in Gardner and along Turner and Bridge Streets in Templeton were noted.

Erosion

Minor riverbank erosion along Riverside Road was noted.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Two reaches in this segment of the Otter River were sampled by DWM biologists in August 1995 (Appendix C). The upstream station was located downstream from the Gardner WWTP, just upstream from Route 10, Gardner (station B0218). Upstream from the reach, water was slow and fine sediments had settled into large mudflats. Turbidity persisted as the stream rounded the bend to pass through the sample reach. The reach was 10m wide and depth in riffles was approximately 0.3m. Instream productivity was evidenced by rooted emergent vegetation (75% of the reach was covered) while *Lemna* sp. (Duckweed) floated on the surface and filamentous green algae was observed attached to rocks and streaming from vegetation. Moss covering on the rocks was common. The overall habitat score was 143.

The downstream station was upstream from Turner/ Bridge Street, Templeton/Gardner (station B0219). In August 1995 aquatic vegetative cover included *Sparganium* sp. and mosses. Filamentous algae were present on some rocks. The water was turbid, which was especially noticeable where the water slowed as it passed under the bridge. The total habitat score was 131. This sampling reach was also sampled in September 1996 as part of the MA DEP biocriteria development project (Appendix A, Table 8). As part of the 2000 Millers River Watershed sampling program, this station was sampled again in September. The instream vegetative cover was *Sparganium* sp. and moss(es). *Lemna* sp. was also present at the surface. About 5% of the reach had filamentous green algae streaming from rocks and moss. Turbidity was observed. The overall habitat score was 155.

Stream gaging data for the Otter River are available from the USGS gage 011632000 located upstream from the Turner Street Bridge from 1964 to the present. The drainage area at this gage is 34.1 mi^2 and the average annual discharge over the period of record is 62.8 cfs (Socolow *et al.* 2001).

Using criteria set forth by the Massachusetts Water Resource Commission, the Otter River subwatershed was identified at a medium stress level based on water quantity (Gomez and Sullivan 2003).

The Hydrologic Assessment performed by Gomez & Sullivan 2003 indicated that flow fluctuates usually once per day, varying by approximately 2 cfs (recorded in the hourly hydrographs in the Otter River near Turner Street Bridge, Templeton), during August and September 2000. The cause of this fluctuation has not been determined.

Biology

Benthic macroinvertebrate sampling was conducted by DWM in August 1995 at two stations in this segment of the Otter River - downstream from the Gardner WWTP discharge (just upstream from Route 101, Gardner) (station B0218) and upstream from Turner/ Bridge Street, Templeton/Gardner (station B0219) (Appendix C). Benthic macroinvertebrate samples were collected from the Turner/Bridge Street reach in August 1995 and again in September 2000. As part of the MA DEP biocriteria development project, benthic macroinvertebrate samples were also collected by DWM biologists from the Otter River upstream from the Turner Street Bridge, Templeton/Gardner (station WM05OTT) on 9 September 1996 (Appendix A, Table 8). The RBP III analysis indicated that the benthic macroinvertebrate communities were moderately impacted in 1995 (stations B0218 and B0219) compared to the West Branch Tully River reference condition (station B225). The RBP III analysis of the benthic community from the river near Turner/Bridge Street station, Templeton/Gardner (station B0219) in 2000, however, indicated only slightly impacted conditions compared to the Lawrence Brook reference station (B0449). The higher flow conditions in the Otter River in September 2000 may have resulted in some improvement in the health of this reach of river (Appendix C). However, it is best professional judgment that stress to aquatic life inhabiting this segment of the Otter River is still likely under low-flow conditions. Additional biological sampling (an increase in the spatial coverage of sampling locations) to bracket the point source and potential nonpoint sources of pollution in the Otter River is recommended to document improvements/changes and better assess the status of the *Aquatic Life Use*.

The fish population (sampling conducted on 18 October 1996) in this reach of the Otter River (station WM05OTT upstream from the Turner/Bridge Street, Templeton/Gardner) was comprised of six species including, in order of abundance: fallfish *(Semotilus corporalis*), white sucker (*Catostomus commersoni*), pumpkinseed (*Lepomis gibbosus*) and a single individual each of yellow perch (*Perca flavescens),* longnose dace (*Rhinichthys cataractae*), and brook trout (*Salvelinus fontinalis*) (Appendix A, Table 13). Both fallfish and white suckers are fluvial dependant/specialist species that are tolerant to pollution. Although two intolerant species were present (brown trout and longnose dace) only one individual of each was collected.

Barge shocking was conducted by MA DFWELE on August 24, 2000 east and west of Hamlet Mill Road in Templeton. A total of 56 fish were collected and over 50% of the sample was composed of white sucker (*Catostomus commersoni*). Other species present included: pumpkinseed (*Lepomis gibbosus*), brown trout (*Salmo trutta*), chain pickerel (*Esox niger*), golden shiner (*Notemigonus crysoleucas*), largemouth bass (*Micropterus salmoides*), tesselated darter (*Etheostoma olmstedi*), yellow perch (*Perca flavescens*), fallfish (*Semotilus corporalis*), brown bullhead (*Ameiurus nebulosus*), American eel (*Anguilla rostrata*), and longnose dace (*Rhinicthys cataractae*). Although 12 species were present the sample was dominated by white sucker, and six species (four of which are fluvial specialists/dependants), were represented by only one individual each. White suckers are a fluvial dependant species that are tolerant of many types of environmental stressors including low DO, high temperature and habitat degradation.

Chemistry – water

In-situ measurements of the Otter River (DO, %saturation, pH, temperature, and conductivity) and water quality samples (alkalinity, hardness, chloride, suspended solids, nutrients, and turbidity) were collected by MA DEP DWM at two stations in this segment of the Otter River - near the Route 101 bridge, Gardner/Templeton border (station M02) and near the Turner Street Bridge, Templeton (station M03). Sampling was conducted approximately every eight hours on three separate three-day

surveys in 1995 (June 27 to 29, July 25 to 27 and August 22 to 24) (Appendix A, Tables 9 and 10). *In-situ* measurements of the Otter River near Turner Street Bridge, Templeton/Gardner (station WM05OTT) were also made on 18 October 1996 (Appendix A Table 8).

As part of the MA DEP SMART monitoring program, water quality sampling was conducted on five occasions between March and November of 2000 in this segment of the Otter River approximately 35 meters upstream/southeast of Turner Street in Templeton (approximately 30 feet upstream of the USGS flow gauging station) (station MOT05) (Appendix A).

DO

In the summer of 1995, DO measurements ranged from 3.7 to 7.8 mg/L (44 to 89% saturation) at station M02 and from 6.1 to 8.9 mg/L (75 to 102% saturation) at station M03. DO measurements ranged from 7.2 to 12.0 mg/L (80 to 89% saturation) at station OT05 during the surveys conducted in 2000 although none of these data represented worse-case (pre-dawn) conditions.

Temperature

The temperature measurements ranged from 18.5 to 27.2°C at station M02 and 18.4 to 26.5 at station M03 in the summer of 1995. The temperature ranged from a low of 4.1° C in March to a high of 22.1° C in July at station OT05 in 2000.

pH and Alkalinity

In the summer of 1995, instream pH ranged between 6.1 and 6.4 SU at station M02 and between 6.5 and 7.2 SU at station M03. The maximum alkalinity was 20 mg/L at station M02 and 23 mg/L at station M03. The pH ranged from 5.8 to 6.1 SU at station OT05 and alkalinity was very low (2 to 8 mg/L) during the surveys conducted in 2000.

Hardness

Instream hardness ranged between 28 and 91 mg/L at station M02 and between 25 and 70 mg/L at station M03. The range of hardness at station OT05 was between 22 and 39 mg/L.

Suspended Solids

The maximum suspended solids concentration was 12 mg/L at station M02 and 18 mg/L at station M03 (excluding the anomalous result of 105 mg/L) in the summer of 1995. At station OT05 suspended solids ranged from 1.3 to 8.6 mg/L during the surveys conducted in 2000.

Turbidity

Turbidity ranged between 3.4 and 10 NTUs at station M02 and between 4.7 and 15 NTUs at station M03. Measurements for turbidity at station OT05 ranged from 1.3 to 12 NTU during the surveys conducted in 2000.

Ammonia-nitrogen

The maximum measurement of ammonia-nitrogen was 0.07 mg/L at station M02 and 0.09 mg/L at station M03 during the summer of 1995. The maximum measurement for ammonia-nitrogen was 0.21 mg/L in May 2000 at station OT05 although all the unqualified ammonia-nitrogen values were <0.02 mg/L.

Nitrate-nitrogen

Concentrations between 0.44 to 3.8 mg/L were measured for nitrate-nitrogen at station OT05.

Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen values ranged from 0.21 to 0.94 mg/L at station OT05 during the surveys conducted in 2000.

Total Phosphorus

Total phosphorus concentrations ranged from 0.14 to 0.24 mg/L at station M02 and between 0.14 to 0.25 mg/L at station M03 in the summer of 1995. Total phosphorus values ranged from 0.061 to 0.39 mg/L at station OT05 during the surveys conducted in 2000.

Conductivity

Conductivity measurements ranged from 254 to 482 µS/cm at station M02 and between 279 to 381 µS/cm at station M03 during the summer of 1995. Measurements for Specific Conductance @ 25°C ranged from 226 to 312 µS/cm at station OT05 during the surveys conducted in 2000.

Chlorides

Chloride concentrations at station OT05 ranged from 50 to 68 mg/L.

Toxicity

Effluent

A total of 25 modified acute and chronic whole effluent toxicity tests were conducted on the Gardner WWTF effluent using *C. dubia* and *P. promelas* between February 1996 and December 2002 on their treated effluent (Outfall #001) discharge. The whole effluent exhibited acute toxicity on only one occasion (June 1998 with an LC_{50} = 54.8% effluent) while all other LC_{50}'s were >100% effluent. The CNOECs ranged from <6.25 to 100% effluent. The CNOEC results were less than 63% (permit limit) in 44% (13 out of 29) of the tests conducted. Neither test organism was consistently more sensitive.

Chemistry – sediment

USGS, as part of their NAWQA study, analyzed two sediment samples collected from the Otter River near Turner/Bridge Street in Templeton, MA (near the USGS gage 01163200); one in September 1993 and the second in August 1994. The total PCB concentration was <50 ppb (Harris 1997). The sediment samples were comprised of primarily of sand (>92%), some silt (≤7%), and clay (≤0. 5%) while the total organic carbon (TOC) range was 8.4 to 9.7%. Arsenic (14 and 22 ppm), cadmium (2.4 and 2.6 ppm), one chromium measurement (80 ppm), lead (160 and 180 ppm), mercury (0.31 and 0.46 ppm), nickel (36 and 44 ppm) and zinc (both 250 ppm) exceeded the L-EL guidelines (Persaud *et al.*1993). Copper (110 and 160 ppm), one chromium measurement (110 ppm), iron (6.0 and 6.1%), and manganese (1,400 and 2,100 ppm) exceeded the S-EL guidelines.

*Note: The S-EL guideline for PCB varies depending on the total organic carbon content (TOC) in the sample. Results have been summarized above using a conservative TOC estimate of 1% (where the S-EL = 5.3 PPM) and the maximum guidance allowable TOC of 10% (where the S-EL = 53 PPM).

Chemistry – tissue

At the USGS NAWQA study site on the Otter River near Turner Street Bridge in Templeton, MA (near the USGS gage 01163200) the concentration of PCB in the whole fish composite sample (comprised of five white suckers, *Catastomas commersoni*) collected in August 1994 was 580 µg/kg wet weight (Coles 1998). This level of PCB slightly exceeded (1.16 times) the NAS/NAE guideline for total PCB (in Coles 1998) of 500µg/kg wet weight for the protection of fish-eating wildlife. Neither total DDT nor total chlordane exceeded the NAS/NAE guidelines.

The *Aquatic Life Use* is assessed as impaired for this segment of the Otter River based primarily on the biological monitoring data and best professional judgment. Although the benthic macroinvertebrate community was only slightly impacted it was the opinion of the biologists that stress to aquatic life inhabiting this segment of the Otter River is still likely under low-flow conditions. Turbidity and the accumulation of fine sediments that settle into large mudflats were also documented. The fish community was also dominated by species tolerant of many types of environmental stressors including low DO, high temperature and habitat degradation. Additionally, chronic toxicity in the Gardner WWTP discharge and elevated total phosphorus concentrations in the Otter River were documented. Instream vegetative cover in the reach sampled near Turner/ Bridge Street was estimated at less than 1% in 1995 but 60% in 2000. This segment of the Otter River has been identified at a medium stress level based on water quantity and has experienced flow fluctuations, which is also of concern.

FISH CONSUMPTION

Fish toxics monitoring was conducted by the MA DEP (MA DEQE at the time) in the impoundment upstream of Seaman Paper Dam, Templeton in August 1987. Total PCBs were all less than the MA DPH trigger level of 1.0 mg/Kg (ranged from <Method Detection Limit to 0.88 mg/Kg in an individual white catfish -*Ameiurus catus*). The mercury concentrations ranged from 0.16 in bullhead to 1.0 mg/Kg in a large individual white catfish (*Ameiurus catus*). Although mercury did exceed the MA DPH trigger level of 0.5 mg/Kg in the individual catfish, MA DPH does not issue advisories based on an individual fish sample. The current Otter River Fish Consumption Advisory only pertains to the most downstream 0.5 mile reach of the Otter River (near its confluence with the Millers River). However, all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Therefore, until the advisories are clarified, the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The source of PCBs now in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP. It is likely that this is related to historic discharges from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

Two fecal coliform bacteria samples were collected by MA DEP DWM from the Otter River near both the Route 101 bridge, Gardner/Templeton border (station M02) and near the Turner Street Bridge, Templeton (station M03) in May 1996. The bacteria counts were all low (Appendix A, Table 11).

Instream turbidity was observed by DWM biologists at two stations in this segment of the Otter River during all of the surveys conducted between 1995 and 2000 (Appendix C). The water column was described as chocolate/brown on occasion. Local residents have alleged that the turbidity is associated with operations at the sand and gravel plant a short distance upstream and that the water clears at times as well as on days when the plant is not operating. During their shoreline survey in November/December 2000 the Otter River Stream Team noted two large sand and gravel operations and bridge construction activities at the Turner/Bridge Street bridge that may be contributing sediments to the river (MRPC and FRCOG 2002). They also noted isolated areas of trash and debris along this segment of the river.

Because of the instream turbidity in this segment of the Otter River the *Recreational* and *Aesthetics uses* are assessed as impaired. Suspected sources include sand and gravel operations in this subwatershed and runoff from highway, road, and bridges associated with construction activities.

Otter River (MA35-07) Use Summary Table

Designated Uses	Status
Aquatic Life 	IMPAIRED *Causes*: Combination benthic/fishes bioassessment, habitat indicator bioassessments (*Suspected Causes*: Dissolved oxygen/saturation, phosphate, turbidity, effluent toxicity) *Source*: Unknown (*Suspected Sources*: Municipal point source discharge, sand/gravel/rock mining, highway road bridge runoff non-construction related, discharges from municipal separate storm sewer systems)
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	IMPAIRED *Cause*: Turbidity *Source*: Unknown (*Suspected Sources*: Sand/gravel/rock mining, highway, road, bridge runoff (new construction), discharges from municipal separate storm sewer systems)
Secondary Contact 	IMPAIRED *Cause*: Turbidity *Source*: Unknown (*Suspected Sources*: Sand/gravel/rock mining, highway, road, bridge runoff (new construction), discharges from municipal separate storm sewer systems)
Aesthetics 	IMPAIRED *Cause*: Turbidity *Source*: Unknown (*Suspected Sources*: Sand/gravel/rock mining, highway, road, bridge runoff (new construction), discharges from municipal separate storm sewer systems)

RECOMMENDATIONS OTTER RIVER (SEGMENT MA35-07)

Water Quality Monitoring

- Additional monitoring is needed along this segment to determine the extent of the influence of the Gardner effluent on dissolved oxygen and biological communities (especially primary producers).
- Additional biological sampling (i.e., an increase in the spatial coverage of sampling locations) to bracket the point source and potential nonpoint sources of pollution in the Otter River is recommended to document improvements/changes and better assess the status of the *Aquatic Life Use*.
- Field reconnaissance should be conducted along this segment of the Otter River to identify any source(s) causing turbidity and these sources should be reduced/eliminated.
- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Continue to conduct long-term fixed site monitoring at the Otter River site on Turner Street in Templeton to determine long-term water quality trends.

Point Sources of Pollution

- A toxicity identification evaluation and toxicity reduction evaluation (TIE/TRE) should be considered for the Gardner WWTP NPDES permit. The facility will also be required to conduct a phosphorus loading, evaluation and reduction program. A more stringent total phosphorus limit may be required.

Nonpoint Sources of Pollution

- Investigate and confirm the presence of the sand and gravel operations in this subwatershed that are indicated in the MRPC and FRCOG (2002) study. Evaluate these sites to ensure that they are being operated and maintained properly and that any water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed

by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status, and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).

- Investigate and evaluate reported stormwater quality concerns along Coleman Street to Route 2A and Bridge Street in Gardner and along Turner Street in Templeton.
- Investigate and evaluate the reported minor riverbank erosion along Riverside Road in Gardner noted in MRPC and FRCOG (2002).

Hydrology

- Further evaluate the entire Otter River, which has been rated at a medium stress level based on the magnitude of stream flow using criteria developed by MA DEM. This stress level is based solely on a few low flow statistics and does not consider many other factors that play a role in river stress such as dam operations, water quality or instream habitat. The Gomez and Sullivan (2003) report recommends that future withdrawals be avoided and mitigation of current impacts should be evaluated.
- Further investigation into the pulsing flows in the Otter River that were noted in the Gomez and Sullivan (2003) report is recommended to pinpoint their sources and to reduce artificial pulsing. The report recommended that hourly or daily discharges for all NPDES facilities should be evaluated. These data would be used to determine what effect discharges have on stream flow.
- In accordance with the requirements of MA DEP's WMA permit program, both the Gardner and Templeton Water Departments should develop and/or maintain up-to-date water conservation plans to help reduce the need for increased water withdrawals. Residential water consumption should be maintained at 80 gpcd or less and unaccounted-for water should be limited to 10% (Gomez and Sullivan 2003).

Land Protection

- The impervious area for the sub-basins located in this segment of the Otter River is all less than 10%, therefore, it is classified as sensitive predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Templeton and the City of Gardner should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both Templeton and Gardner continue to work with Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Town of Templeton and the City of Gardner participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Templeton and Gardner can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

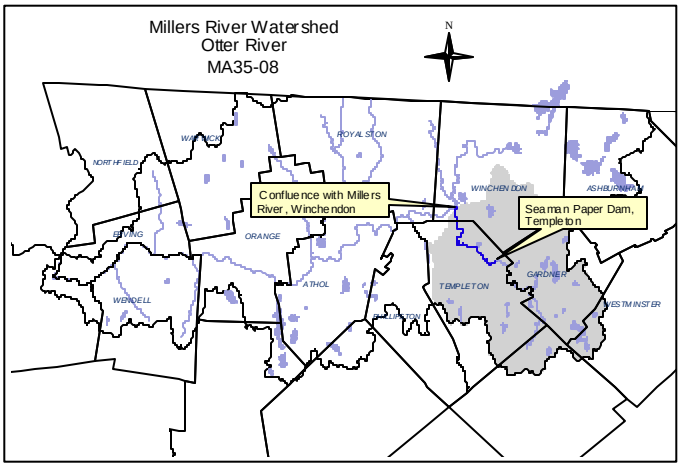
OTTER RIVER (SEGMENT MA35-08)

Location: Seaman Paper Dam, Templeton to confluence with Millers River, Winchendon.
Segment Length: 5.5 miles.
Classification: Class B, Warm Water Fishery.

The total drainage area to this segment is approximately 61.3 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	67%
Residential	13%
Open Land	5%

The impervious area for the sub-basins within this segment only is less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).



From the Seaman Paper Company dam the river flows through a short section of rapids before slowing again and entering the impoundment formed by the partially-breached dam at the old Baldwinville Products Mill. Just downstream from here the river receives effluent from the Templeton WWTP. From here the river flows more rapidly through the Village of Baldwinville, but slows again downstream in a wetland area that is part of Otter River State Forest. As the Otter River meanders northward toward the end of the segment at its confluence with the Millers River in Winchendon, it is joined by Trout Brook.

The Templeton Sludge Landfill is located adjacent to the Otter River at the Templeton WWTP off Reservoir Street in Templeton. In accordance with the requirements of a MA DEP Administrative Consent Order (ACO-CE-02-1019, effective 8/8/03) a monitoring plan and monitoring wells are in place for this facility. A long term plan is being developed for continued operation/monitoring and possibly partial or total closure of the landfill as part of the ACO requirements (Poirier 2003).

This segment is on the 1998 303(d) List of Waters for priority organics, metals, nutrients, organic enrichment/low DO, salinity/TDS/chlorides, other habitat alterations, and pathogens (Table 3).

The use assessments for Bourn-Hadley Pond (MA35008), Brazell Pond (MA35010), Depot Pond (MA35018), and Stoddard Pond (MA35083) are provided in the Lake Assessment section of this report. TMDLs for total phosphorus were calculated by MA DEP for all of these waterbodies (MA DEP 2002).

MA DFWELE conducted fish population sampling in Beaman Brook using a backpack electroshocker east of Route 202 in Winchendon on 18 September 2000. The sample was dominated by fallfish (*Semotilus corporalis*), but also included one largemouth bass (*Micropterus salmoides*) and one tesselated darter (*Etheostoma olmstedi*).

MA DFWELE has proposed that Norcross Hill Brook, a tributary to this segment of the Otter River, be reclassified in the SWQS as a cold water fishery (MassWildlife 2001).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3)

Facility WMA Permit # WMA Registration #	Sources	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
			1998	1999	2000	2001	2002
American Tissue Mills of Mass, Inc. no permit 10709101	Otter River Depot Pond	2.02	0	0	0	0	0
Seaman Paper Co. of Mass, Inc no permit 20729402	Otter River Otter River Well	1.19	1.07	1.08	1.05	1.07	0.99
Templeton Water Department* 9P20729401 20729401	Birch Hill Well #1 294-04G Birch Hill Well #2 294-05G	0.53 reg 0.42 per 0.95 total	0.68	0.48	0.48	0.53	0.51

* not all sources within this segment

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2)

The Seaman Paper Company of Massachusetts, Inc. is authorized to discharge treated industrial waste from its Wastewater Treatment Facility (WWTF) in East Templeton, MA into the Otter River (NPDES permit #MA0000469 issued September 1998). The permittee is authorized to discharge 1.4 MGD of treated process wastewater via outfall 001. The facility's whole effluent toxicity limits are $LC_{50} \geq 100\%$ and CNOEC $\geq 21\%$ with a monitoring frequency of 4X/year for both. Their maximum daily temperature limit is 90°F. The maximum daily total phosphorus limit is 1.5 mg/L. A review of their DMR data indicates that with the exception of one failed chronic toxicity test in March of 2000, this facility has been operating within its permit limits (Keohane 2003). EPA is scheduled to reissue this permit in 2004 (Hogan 2003).

The Town of Templeton is authorized to discharge treated municipal waste from the Templeton Wastewater Treatment Facility (WWTF) into the Otter River (NPDES permit #MA0100340 issued September 1999). The permittee is authorized to discharge 2.8 MGD of treated wastewater via outfall 001. The facility's whole effluent toxicity limits are $LC_{50} \geq 100\%$ and CNOEC $\geq 30\%$ with a monitoring frequency of 4X/year for both using *C. dubia*. The facility's maximum daily TRC limit is 0.06 mg/L. In all but one of the facility's whole effluent toxicity test reports, the effluent TRC concentration has met this limit; the maximum reported TRC concentration was 0.07 mg/L. The facility implemented dechlorination with sodium bisulfite in April 1991. The facility does not have limits for total phosphorus and ammonia-nitrogen but is required to monitor and report these effluent parameters. Effluent total phosphorus concentrations (average monthly) between January 2000 and February 2002 have ranged from 2.3 to 40 mg/L while total ammonia-nitrogen concentrations in that same time period have ranged from 0.2 to 113 mg/L (EPA 2003). According to a recent administrative consent order (ACO) issued to the Town of Templeton from the MA DEP, Central Regional Office, the facility was constructed in 1979 and was designed to provide secondary treatment to sanitary wastewater generated by the municipality and industrial wastewater generated by the American Tissue Mills of Mass, Inc. (ATM) (approximately 90% of the flow to the plant). ATM was under contract with the Town to operate the WWTP. However, ATM ceased operation of their facility in 1995 and has since stopped contributing wastewater to the plant. The municipality has accepted septage, sludge and industrial wastewater shipments from outside the town to maintain the biomass in their lagoon (Fine 2002). ATM has withdrawn from all of its contractual agreements with the Town and in April 2002 the Town took over full operational control of the plant (Ostrosky 2003). Odor problems have been reported and have been linked to the septage receiving process. The facility currently relies heavily on septage to offset the lack of wastewater to sustain the biological treatment processes (Ostrosky 2003). The facility has problems meeting the copper limit and recently (2001/2002) has occasionally had problems meeting the BOD and total suspended solids limits (Ostrosky 2003). Because of problems associated with lack of flow (current discharge is approximately 0.2 to 0.3 MGD and septage is approximately one-third of that flow), the ACO has required the Town to prepare a facility upgrade plan to address operational problems due to the lack of flow. EPA is scheduled to reissue this permit in 2004 (Hogan 2003).

It should also be noted that Gardner and Templeton are Phase II Stormwater communities. Each community was issued a stormwater general permit from EPA and MA DEP in 2003, and is authorized to discharge stormwater from their municipal drainage systems (MAR041190 and MAR041225, respectively). Over the five-year permit term, the communities will develop, implement and enforce a stormwater management program to reduce the discharge of pollutants from the storm sewer system to protect water quality (Domizio 2004).

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Underground Storage Tanks (UST)

Underground storage tanks are located in this portion of the subwatershed in the Baldwinville section.

Industrial Sites

An abandoned/underutilized industrial site was indicated on Mill Street in Templeton.

Illegal Junk Yard/Dumping Site

Solid waste dumping was noted along Michaels Lane and Cottage Street in Templeton. An unauthorized disposal of paper occurred at the Baldwinville Products site. MA DEP is aware of this site, which will require remediation (Poirier 2003).

Sand & Gravel Operations

Several sand and gravel operations are located in this subwatershed in the vicinity of the wetland areas near Trout Brook and Bourn-Hadley Pond.

Stormwater

Stormwater quality concerns were reported along Michael Lane and Cottage Street in Templeton.

Golf Courses

The Templewood Golf Course is a 46 acre site located at Brooks Road in Templeton near the Otter River.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

The Seaman Paper Company owns and operates the Otter River Dam the purpose of which is to divert water for processing needs for the paper mill. There is a sluice gate at the dam that is used to control water levels. A minimum impoundment level is required to divert water to the mill.

Using criteria set forth by the Massachusetts Water Resource Commission the Otter River subwatershed was identified at a medium stress level based on water quantity (Gomez and Sullivan 2003). The Hydrologic Assessment performed by Gomez & Sullivan (2003) indicated that flow fluctuates usually once per day, varying by approximately two cfs (recorded in the hourly hydrographs in the Otter River near Turner Street Bridge, Templeton), during August and September 2000. The cause of this fluctuation has not been determined.

A total of four reaches in this segment of the Otter River were surveyed in August 1995 by DWM biologists (Appendix C). The most upstream station was downstream from Main Street, Templeton (station B0220). This reach was downstream from an impoundment and upstream from the Seaman Paper Company discharge. The overall habitat score was 111. The next station was upstream from Route 202, Templeton (station B0221). This station was upstream from the Templeton WWTP and downstream from a water diversion dam behind American Tissue Products. Water spilled over the dam, creating fast-flowing riffle habitat for about 15 m downstream, before the channel deepened and the wastewater effluent entered. The overall habitat score was 124. The third sampling reach was roughly 200 m downstream from Route 202, Templeton and served as the downstream bracket on the Templeton WWTP effluent (station B0222). Here about 80% of the stream bottom area was a mix of cobble and gravel with a few large boulders. Many of the rocks were covered with moss, which itself served as substrate for some sort of brown filamentous periphyton. Also observed instream were remnants of an industrial site (bricks, old pipe, cement blocks) and trash (scrap metal and plastic). The overall habitat score was 145. The most downstream reach sampled on the Otter River in 1995 was located approximately 320 meters upstream from its confluence with the Millers River, Winchendon (station B0223). This was the last riffle stretch on the Otter River before it joined the mainstem Millers River. The presence of this short riffle stretch was due to the remaining footings from an old railroad bridge that constricted the river and accelerated the flow a bit. This portion of the river was otherwise wide and moved slowly through flooded wetlands. Nevertheless, substrates within the riffle stretch were mostly cobble and boulders. The water was brown and somewhat turbid. The overall habitat score was 130.

In September 2000 DWM biologists sampled only one reach in this segment of the Otter River downstream from route 202, Templeton (station B0460) (Appendix C). This reach was a couple hundred meters farther downstream than the site used in 1995. During this survey the river was about 15 m wide with riffles and runs between 0.5 and 0.75m deep, and depth in the pool habitat of about 0.5 m. The inorganic substrates were mostly cobble and boulder. This section of the river was channelized and there was some evidence of slight bank erosion within the reach. The river carried a heavy load of particulates, giving the water a murky brown appearance. Rooted vegetation was absent instream but mosses covered about 40% of the reach. Algal coverage was about 30% and was in both mat and filamentous forms. The overall habitat score was 186.

Biology

Benthic macroinvertebrate sampling was conducted by DWM in August 1995 at four stations in this segment of the Otter River - downstream from Main Street, Templeton (station B0220), upstream from Route 202, Templeton (station B0221), downstream from Route 202, Templeton (station B0222), and approximately 320 meters upstream from its confluence with the Millers River, Winchendon (station B0223) (Appendix C). Benthic macroinvertebrate samples were also collected downstream from Route 202, Templeton (station B0460) in September 2000 (slightly further downstream from station B0222 sampled in 1995). The RBP III analysis of the most upstream reach (B0220) sampled in 1995 indicated the benthic community was non-impacted. With the exception of this upstream reach (station B0220), the RBP III analysis indicated that the three downstream stations (B0221, B0222, and B02232) were moderately impacted in 1995 compared to the West Branch Tully River reference station (Appendix C). At station B0221, located just upstream from the Templeton WWTP discharge, the proportion of the filter-feeding hydropsychid caddisflies (65%) more than doubled over that of the upstream site, suggesting an increase in the loading of suspended particulates, and nearly all metrics indicated a deterioration in water quality. Downstream from the Templeton WWTP effluent taxa richness dropped to half that documented upstream from the discharge and the Hilsenhoff Biotic Index (HBI) also increased. Near the mouth of the Otter River (station B0223) total richness increased while Ephemeroptera, Plecoptera, and Trichoptera (EPT) remained the same and the HBI increased. These results suggest a stress from low dissolved oxygen concentrations perhaps resulting from the low gradient/wetland nature of the river corridor.

The RPB III analysis of the benthic macroinvertebrate community collected downstream from Route 202, Templeton (station B0460) in September 2000 indicated slightly impacted conditions; an improvement over conditions documented in 1995. (Station B0460 was slightly further downstream from station B0222 sampled in 1995). Both higher flow conditions in the Otter River in September 2000 and the cessation of the American Tissue Mill discharge to the Templeton WWTP (ceased operation in September 1995) may have resulted in some improvement in the health of this reach of river (Appendix C). However, it is best professional judgment that stress to aquatic life inhabiting this segment of the Otter River is still likely under low-flow conditions. Additional biological sampling (to increase the spatial coverage of sampling locations) and bracket the point source and potential nonpoint sources of pollution in the Otter River is recommended to document improvements/changes and better assess the status of the *Aquatic Life Use*.

MA DFWELE conducted fish population sampling in the Otter River using a barge electroshocker east of Route 202 in Templeton on 23 August 2000. The predominant species was white sucker (*Catostomus commersoni*) followed by fallfish (*Semotilus corporalis*) and common shiner (*Luxilus cornutus*). Other fish species present included: yellow perch (*Perca flavescens*), longnose dace (*Rhinicthys cataractae*), pumpkinseed (*Lepomis gibbosus*), chain pickerel (*Esox niger*), golden shiner (*Notemigonus crysoleucas*), largemouth bass (*Micropterus salmoides*), yellow bullhead (*Ameiurus natalis*), and brown bullhead (*Ameiurus nebulosus*). The fish assemblage was dominated by four fluvial species that comprised 90% of the sample, however, all others are either tolerant or moderately tolerant to pollution. The absence of intolerant species is indicative of environmental degradation. White suckers, the most abundant fish present, are extremely tolerant of low DO, elevated temperature and habitat degradation (e.g., sedimentation).

Another Otter River site sampled on that same date by barge shocking was located upstream from Trout Brook in Templeton. The sample was dominated by macrohabitat generalists including pumpkinseed (*Lepomis gibbosus*) and bluegill (*Lepomis macrochirus*). Other species present included: white sucker (*Catostomus commersoni*), yellow perch (*Perca flavescens*), fallfish (*Semotilus corporalis*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), tesselated darter (*Etheostoma olmstedi*), yellow bullhead (*Ameiurus natalis*), common shiner (*Luxilus cornutus*) and brown bullhead (*Ameiurus nebulosus*). The presence of large numbers of pumpkinseed, bluegill and yellow perch are typical of low gradient, silty, wetlands-dominated streams. Although there were four species present that are considered fluvial dependent/specialists three of these species were represented by only twenty individuals (less than 6% of the total collected). The most dominant of the fluvial dependent/specialists was white sucker, which is tolerant of environmental degradation.

In August 2000 gillnets set in the Otter River just upstream of the railroad crossing near to the confluence with the Millers River in Winchendon resulted in the capture of white suckers, chain pickerel, and yellow perch (Maietta and Colonna-Romano 2001). The goal of this sampling was to obtain white suckers for fish toxics monitoring.

Toxicity

Ambient

Surface water samples from the Otter River were collected at three locations within this segment; at the Main Street Bridge upstream of the Seaman Paper Company discharge (station OTMIA4), downstream from the Seaman Paper Company discharge near the railroad bridge (station OTURR5), and the Route 202 Bridge downstream from the Templeton WWTP discharge (station OT2026). These three Templeton locations were sampled on 1, 4 and 6 November 2000 by EPA NERL personnel as a follow up to the detection of instream toxicity in the river in August 1995 (Barr 1995). No instream toxicity to either *C. dubia* or *P. promelas* was detected during the 7-day chronic toxicity tests (McDonald 2001). Survival of both test species at all three stations was $\geq$ 83% at the end of tests.

The Seaman Paper Company of Massachusetts, Inc. collects water from the Otter River approximately 400' upstream from their discharge at the Main Street bridge in Templeton for use as dilution water in their whole effluent toxicity tests. Between January 1996 and January 2003, survival of *C. dubia* exposed (7-day) to the river water was good ($\geq$ 90% survival) in the 28 tests conducted (TOXTD database).

The Templeton WWTP collects water from the Otter River approximately 200 yards upstream from their discharge near the American Tissue Paper Mill in Templeton for use as dilution water in their whole effluent toxicity tests. Between January 1996 and October 2002, survival of *C. dubia* and *P. promelas* exposed (7-day) to the river water was good ($\geq$ 88% survival) in the 27 tests conducted (TOXTD database).

Toxicity

Effluent

A total of 28 modified acute and chronic whole effluent toxicity tests were conducted on the Seaman Paper Company of Massachusetts, Inc. effluent using *C. dubia* between January 1996 and January 2003 on their treated effluent (Outfall #001) discharge. Whole effluent LC_{50}s ranged between 77.1 and >100% effluent with two of the 26 test results not meeting the LC_{50} permit limit of $\geq$ 100% (January 1999 and January 2001). The CNOECs ranged from 12.5 to 100% effluent with five of the 28 tests not meeting the CNOEC permit limit of 21% effluent.

A total of 27 and 22 modified acute and chronic whole effluent toxicity tests were conducted on the Templeton WWTP effluent using *C. dubia* and *P. promelas*, respectively, between January 1996 and October 2002 on their treated effluent (Outfall #001) discharge. Acute toxicity was detected in only one test (July 2002 with LC_{50} = 71% effluent to *C. dubia*) while the CNOECs ranged from 6.25 to 100% effluent. Two of the 27 *C. dubia* tests and one of the 22 *P. promelas* tests did not meet the CNOEC permit limit of 30%. With one exception *C. dubia* was consistently the more sensitive test organism.

Chemistry – water

Water quality sampling was conducted by MA DEP DWM on two occasions at one location in this segment of the Otter River in the summer of 2000 (Station OT03 - located upstream/east of the Route 202 Bridge in Templeton) (Appendix A, Tables 6 and 7). More intensive sampling had been conducted by MA DEP DWM in this segment of the Otter River during the summer of 1995 when *in-situ* measurements of the river (DO, %saturation, pH, temperature, and conductivity) and other samples (alkalinity, hardness, chloride, suspended solids, nutrients, and turbidity) were collected approximately every eight hours on three separate three-day surveys at four stations (Appendix A, Tables 9 and 10). Those stations were:

- below dam at Seaman Paper Company, Templeton (station M04),
- below the impoundment behind the American Tissue Mills, Templeton (station M05),
- downstream from the Route 202 bridge, Templeton (station M06), and
- near the abandoned railroad bridge, Winchendon (station M07).

Otter River water was also collected from two locations for use as dilution water for facilities conducting whole effluent toxicity tests as required by their NPDES permits. Data from these reports, which are maintained in the TOXTD database by DWM, were summarized for the period indicated in parentheses.

- Main Street bridge, Templeton (approximately 300 yards upstream of the Seaman Paper Company discharge) (26 occasions January 1996 to January 2003)
- Approximately 200' upstream of the Templeton WWTP discharge (27 occasions January 1996 to October 2002)

These data sets are summarized below.

DO

DO measurements generally met criteria during the summer 1995 surveys although oxygen saturation at the most downstream sampling station (station M07) was less than 60% in 19% of the measurements (Appendix A, Table 9). In the 2000 survey DO measurements met the criteria with readings of 8.1 mg/L and 9.1 mg/L and an oxygen saturation of 94% on both dates, however, these data were not representative of worse-case (pre-dawn) conditions (Appendix A, Table 6).

Temperature

The maximum temperatures measured in the summer of 1995 were in the late afternoon of 27 August (maximum temperature was 29.8°C station M07) although all other measurements were below 28.3°C (Appendix A, Table 9). The highest temperature measurement in 2000 (23.4°C) was in July (Appendix A, Table 6).

pH and Alkalinity

Instream pH ranged between 6.8 and 7.8 SU at stations sampled during the 1995 surveys (Appendix A, Table 9). Alkalinity was low at the most upstream sampling location (station M04) but increased downstream from the Templeton WWTP discharge (station M06). At station OT03 in the 2000 survey pH readings were at 6.6 and 6.8 SU with alkalinity measurements of 10 and 13 mg/L. The pH for this segment of the Otter River (TOXTD database) from the two locations described above between January 1996 and January 2003 ranged from 5.9 and 7.8 SU and 24% of the 55 measurements reported were less than 6.5 SU.

Hardness

Instream hardness ranged between 23 and 180 mg/L at the most upstream sampling location (station M04) but like alkalinity, increased (maximum of 340 mg/L) downstream from the Templeton WWTP discharge (station M06) (Appendix A, Table 10). At station OT03 during the 2000 surveys, hardness measurements were 39 and 51 mg/L (Appendix A, Table 7). Hardness measurements reported for the Otter River (TOXTD database) from the two locations described above between January 1996 and January 2003 ranged from 12 to 124 mg/L and 31% of the measurements were less than 25 mg/L.

Suspended Solids

The maximum suspended solids concentration in the river at the four sampling locations during the summer 1995 was 31 mg/L (Appendix A, Table 10). During the 2000 survey suspended solids concentrations were 7.5 and 11 mg/L (Appendix A, Table 7). The suspended solids concentrations for this segment of the Otter River (recorded in the TOXTD database from the two locations described above) between January 1996 and January 2003 ranged between less than 5.0 and 34 mg/L. However, 96% of the 55 measurements reported were less than 25 mg/L.

Turbidity

The maximum turbidity measurement at all four stations during the summer 1995 was 10 NTUs (Appendix A, Table 10). This was also the maximum measurement during the 2000 survey at station OT03 (Appendix A, Table 7).

Ammonia-nitrogen

The maximum measurement of ammonia-nitrogen at the four sampling locations during the summer 1995 surveys was 1.4 mg/L at station M05 (Appendix A, Table 10). During the 2000 survey, ammonia-nitrogen was <0.02 mg/L in July (Appendix A, Table 7). The ammonia-nitrogen concentrations for this segment of the Otter River (TOXTD database) from the two locations described above) between January 1996 and January 2003 ranged from <0.1 to 1.12 mg/L. These measurements were all below the acute and chronic water quality criteria for ammonia-nitrogen.

Nitrate Nitrogen and Total Kjeldahl Nitrogen (TKN)

The concentration of nitrate nitrogen measured at station OT03 during the 2000 survey was $\leq$ 2.2 mg/L and the concentration of TKN ranged from 0.64 to 0.81 mg/L (Appendix A, Table 7).

Total Phosphorus

Total phosphorus concentrations were elevated in this segment of the Otter River during the summer 1995 ranging from 0.06 to a high of 0.41 mg/L at the four stations sampled (Appendix A, Table 10). The concentrations measured during the 2000 survey at station OT03 were 0.17 mg/L and 0.13 mg/L (Appendix A, Table 7).

Conductivity

Conductivity measurements ranged from 249 to 337 µS/cm at station M04, 451 to 1,092µS/cm at station M05 (downstream from Seaman Paper Company discharge), 519 to 1,408µS/cm at station M06 (downstream from Templeton WWTP discharge) and between 377 and 912 µS/cm at station M07 (near the mouth of the Otter River) during the summer 1995 surveys (Appendix A, Table 9). Conductivity measurements at station OT03 (close to station MI06 sampled in the 1995 survey) in 2000 were lower than in 1995 (297 and 347 µS/cm) (Appendix A, Table 6). The conductivity measurements for this segment of the Otter River (TOXTD database) from the two locations described above between January 1996 and January 2003 ranged between ranged between 112 and 900 mg/L.

Total Residual Chlorine

No TRC was detected in this segment of the Otter River based on the 55 measurements (TOXTD database) from the two locations described above between January 1996 and January 2003.

Chemistry – sediment

Total PCB concentrations in surficial sediment screening samples collected in July and August 1999 from 50 stations along this segment of the Otter River ranged from < 2 ppm to >25 ppm (ENSR 2000). In the vicinity of the Seaman Paper Company Dam, total PCB concentrations were <2 ppm. Here the river has a generally rocky bottom. Further downstream, in the vicinity of Baldwinville, the Otter River is wider with a soft, sandy bottom. In this area, four of 12 screening samples had PCB concentrations between 2 and 25 ppm (downstream from the Templeton WWTP discharge), the other eight samples were <2 ppm. Continuing downstream, the Otter River meanders through a floodplain and is characterized by a soft, silty bottom. In this section of the river five of six surficial sediment screening samples had >25 ppm total PCB. In the most downstream reach, where the river is characterized with a sandy/rocky bottom, total PCB concentrations ranged between 2 and 25 ppm (ENSR 2000).

Sediments in this segment of the Otter River, particularly downstream from the Templeton WWTP discharge, are contaminated with PCBs. The highest concentration of PCBs was detected in a 14" deep subsurface sample (250 ppm) taken from this segment of the Otter River (Coleman 2001).

Chemistry – tissue

A total of seven fish were collected from this segment of the Otter River in September 1999 through the ACOE site assessment and risk characterization study. These included a 3 and a 4-year old chain pickerel, two 2-year old brown bullheads, a 5-year old yellow perch, a 5-year old largemouth bass, and a 5-year old white sucker. The total PCB concentrations in the "whole fish" samples of these fish collected ranged from 341 to 18,922 ppb wet weight (ENSR 2000). Six of the seven "whole fish" had levels of total PCB that exceeded (4.1 to 38 times) the NAS/NAE guideline for total PCB (in Coles 1998) of 500 ppb wet weight for the protection of fish-eating wildlife.

The *Aquatic Life Use* is assessed as impaired for this segment of the Otter River because of PCB contamination in sediment and whole fish, the biological monitoring data and best professional judgment. Although the benthic macroinvertebrate community was only slightly impacted during the 2000 survey, it was the opinion of the biologists that stress to aquatic life inhabiting this segment of the Otter River is still likely under low-flow conditions. The fish community was also dominated by species tolerant of many types of environmental stressors including low DO, high temperature and habitat degradation. Additionally, chronic toxicity was occasionally detected in the Seaman Paper Company WWTP discharge and elevated total phosphorus concentrations in the Otter River were documented. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of

sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP. It probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River. This segment of the Otter River has been identified at a medium stress level based on water quantity and has experienced flow fluctuations which is also of concern (Gomez and Sullivan 2003).

FISH CONSUMPTION

As a result of the 1987 fish toxics monitoring investigations, which confirmed earlier findings that PCB contamination existed in the Millers River Basin, MA DPH issued a public health advisory regarding consumption of fish from the Millers River Basin (Maietta 1989). In September 1999 edible fillet samples from each of the seven fish (see description above in *Aquatic Life Use* chemistry-tissue) collected from this segment of the Otter River were analyzed for PCB as part of the site assessment and risk characterization of PCBs at Birch Hill Reservoir (ENSR 2000). The concentration of total PCB in the edible fillet samples of these fish ranged from 0.345 to 3.302 ppm wet weight. Of the seven fish collected, four were over the 1.0 ppm trigger level for total PCBs; chain pickerel - 1.196 mg/Kg, brown bullhead – 1.602 mg/Kg, yellow perch – 1.935 mg/Kg and white sucker – 3.302 mg/Kg.

In August 2000 fish toxics monitoring was conducted by DWM in this segment of the Otter River just upstream from the railroad crossing near the confluence with the Millers River in Winchendon (Maietta and Colonna-Romano 2001). Five individual white suckers were retained for analysis to support the ongoing PCB contamination evaluation in the Millers River Watershed. These data can be found in Appendix A, Table 15.

Because of elevated PCB concentrations the MA DPH fish consumption advisory for the Otter River recommends the following (MA DPH 2002a).

Otter River, within ½ mile of the Millers River (Templeton and Winchendon) because of PCBs:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish taken from this waterbody."
2. "The general public should not consume any white sucker or brown bullhead taken from this waterbody."

Furthermore, the MA DPH has issued the following advisory for the Millers River based on mercury and PCBs (MA DPH 2002a).

Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries."
2. "The general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River."
3. "The general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

The current Otter River Fish Consumption advisory only pertains to the most downstream 0.5 mile reach of the Otter River (near its confluence with the Millers River). However, all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Therefore, until the advisories are clarified the *Fish Consumption Use* is assessed as impaired because of mercury and PCB contamination. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The source of mercury is unknown, although atmospheric deposition is suspected. The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and most likely is related to historic discharges from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

In May 1996 fecal coliform bacteria samples were collected by MA DEP DWM at four stations in this segment of the Otter River – below dam at Seaman Paper Company, Templeton (station M04); below the impoundment behind the American Tissue Mills, Templeton (station M05); downstream from the Route 202 bridge, Templeton (station M06); and near the abandoned railroad bridge, Winchendon (station M07). Four of the six bacteria counts were low, while two counts (station M05 and M06) were $\geq$ 1000 cfu/100mLs (Appendix A, Table 11).

A total of four reaches in this segment of the Otter River were surveyed in August 1995 and one reach in September 2000 by DWM biologists (Appendix C). Instream turbidity was documented during these surveys at the sampling stations. In September 2000, DWM biologists noted that the river downstream from Route 202, Templeton carried a heavy load of particulates, giving the water a murky brown appearance, which, combined with sewage odors and an accumulation of trash along the banks and in the water, made for poor aesthetics. The Otter River Stream Team made these same observations during their shoreline survey in November/December 2000 (MRPC and FRCOG 2002).

While current bacteria data are insufficient, because of the instream turbidity in this segment of the Otter River the *Recreational* and *Aesthetics uses* are assessed as impaired. Suspected sources include sand and gravel operations in this subwatershed and runoff from highway, road, and bridges associated with construction activities. Trash and debris were problematic in the vicinity of Baldwinville.

Otter River (MA35-08) Use Summary Table

Designated Uses	Status
Aquatic Life 	IMPAIRED *Causes*: PCB, combination benthic/fishes bioassessment, habitat indicator bioassessments (*Suspected Causes*: Dissolved oxygen/saturation, phosphate, turbidity, effluent toxicity) *Sources*: Contaminated sediment, releases from waste sites or dumps (*Suspected Sources*: Municipal point source discharge, sand/gravel/rock mining, highway road bridge runoff non-construction related, discharges from municipal separate storm sewer systems)
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sedim ent, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	IMPAIRED *Causes*: Turbidity, odor *Source*: Unknown (*Suspected Sources*: Sand/gravel/rock mining, highway, road, bridge runoff (new construction), discharges from municipal separate storm sewer systems)
Secondary Contact 	IMPAIRED *Causes*: Turbidity, odor *Source*: Unknown (*Suspected Sources*: Sand/gravel/rock mining, highway, road, bridge runoff (new construction), discharges from municipal separate storm sewer systems)
Aesthetics 	IMPAIRED *Causes*: Turbidity, odor, trash and debris *Source*: Unknown (*Suspected Sources*: Sand/gravel/rock mining, highway, road, bridge runoff (new construction), discharges from municipal separate storm sewer systems, urbanized high density area)

RECOMMENDATIONS OTTER RIVER (SEGMENT MA35-08)

Water Quality Monitoring

- Additional biological sampling (an increase in the spatial coverage of sampling locations) to bracket the point source and potential nonpoint sources of pollution in the Otter River is recommended to document improvements/changes and better assess the status of the *Aquatic Life Use*.
- MA DEP's Division of Waste Site Cleanup should continue to work with other agencies and potential principle responsible parties to continue the investigation of PCB contamination and remediation efforts.
- Field reconnaissance should be conducted along this segment of the Otter River to identify any source(s) causing turbidity and these sources should be reduced/eliminated.

- Monitor bacteria levels to document the effectiveness of bacteria source reduction activities including the Phase II community stormwater management programs and to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Point Sources of Pollution

- The Seaman Paper Company NDPES permit should be reissued with appropriate limits and monitoring requirements.
- Templeton WWTF whole effluent toxicity testing requirements should be limited to using *C. dubia,* consistently the more sensitive test organism. After the facility upgrade is completed, consideration should be given to requiring whole effluent toxicity testing on both *C. dubia* and *P. promelas*. Water quality improvements from the facility upgrade at the Templeton WWTF should be assessed by biomonitoring of downstream aquatic communities.

Nonpoint Source Pollution

- Investigate and confirm the presence of the sand and gravel operations in this subwatershed that are indicated in the MRPC and FRCOG (2002) study, particularly in the vicinity of wetland areas near Trout Brook and Bourn-Hadley Pond. Evaluate these sites to ensure that they are being operated and maintained properly and that surface water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status, and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).
- An inventory of all underground storage tanks, both registered and unregistered, should be maintained to identify areas of risk in the watershed. This inventory should include the location, age, material and condition of each tank. Priority should be given to areas near drinking water supplies, lakes, ponds, and wetlands and areas where stormwater runoff conditions are intensified by extensive impervious surfaces. It is recommended that the Town of Templeton consider bylaws that regulate the construction, installation, operation and maintenance of underground storage tanks.
- The abandoned/underutilized industrial site on Mill Street in Templeton should be investigated and evaluated as to whether or not water quality impacts may be originating from the site.
- The reported solid waste dumping along Michaels Lane and Cottage Street in Templeton should be investigated and evaluated. Consideration should be given to offering educational programs to inform residents of the negative impacts of illegal solid waste disposal on the environment.
- Stormwater quality concerns reported along Michael Lane and Cottage Street in Templeton should be investigated.
- At the golf course located in this subwatershed, vegetation management, irrigation of the greenways and the use of pesticides and fertilizers should be done in accordance with best management practices to protect adjacent waterbodies, watercourses, wetlands and floodplain from adverse impacts. It is recommended that a BMP plan be developed to address these issues.

Hydrology

- Further evaluate the hydrology of the entire Otter River, which has been rated at a medium stress level based on the magnitude of stream flow using criteria developed by MA DEM. This stress level is based solely on a few low flow statistics and does not consider many other factors that play a role in river stress such as dam operations, water quality or instream aquatic habitat. The report, Hydrologic Assessment of the Millers River by Gomez and Sullivan (2003), recommends that future withdrawals be avoided and mitigation of current impacts should be evaluated.
- Further investigation into the pulsing flows in the Otter River, which were noted in the Gomez and Sullivan (2003) report, is recommended to pinpoint their source and reduce artificial pulsing. The report recommended that the following data be collected and evaluated.

  - Hourly or daily water elevation records for the Otter River Dam to confirm that it is being operated in a run-of-river manner.
  - Hourly or daily discharge records for the Otter River Dam (broken down by turbine flow, gate flow, dam spillage, etc.). This would determine if the dam is pulsing discharges.
  - Hourly or daily discharge data for all NPDES facilities to determine what effect discharges have on streamflow.
- To ensure run-of-river operations and prevent pulsing flows, the Gomez and Sullivan (2003) study recommended that all dam operators (which would include Seaman Paper Company of Mass Inc.) install, calibrate and maintain a continuous streamflow monitoring gage or determine some other method to ensure compliance.
- In accordance with the requirements of MA DEP's WMA permit program, the Templeton Water Department and Seaman Paper Company of Mass Inc. should develop and/or maintain up-to-date water conservation plans to help reduce the need for increased water withdrawals. Residential water consumption should be maintained at 80 gpcd or less and unaccounted-for water should be limited to 10% (Gomez and Sullivan 2003).
- The potential removal of dams (particularly the partially breached dam) along this segment of the Otter River should continue to be considered by the RiverRestore Program since removal will return the river to its natural state.

Land Protection

- The impervious area for the sub-basins within this segment of the Otter River only is less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Templeton and Winchendon should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both Templeton and Winchendon continue to work with the Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Towns of Templeton and Winchendon participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Templeton and Winchendon can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

TULLY RIVER SUBWATERSHED

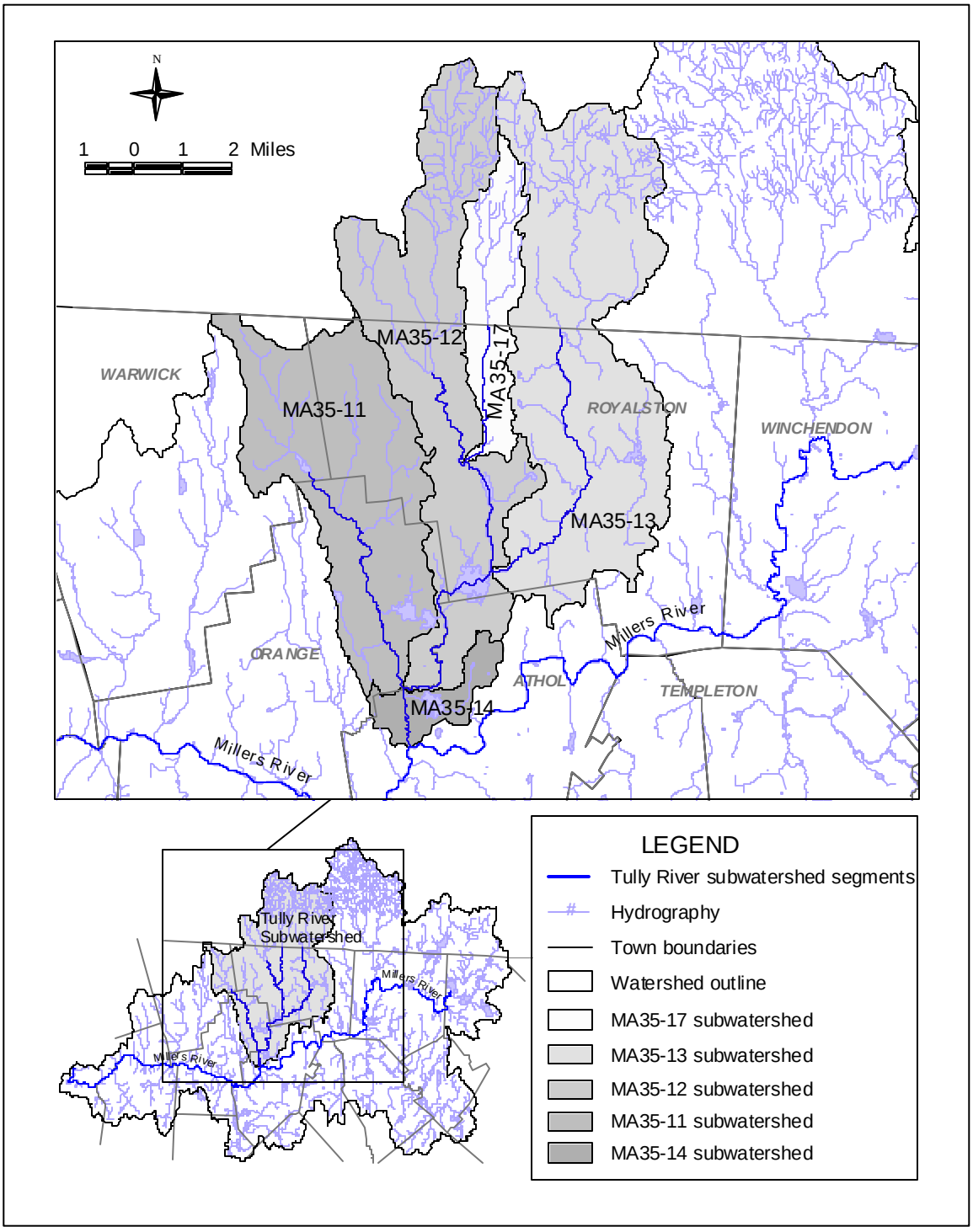


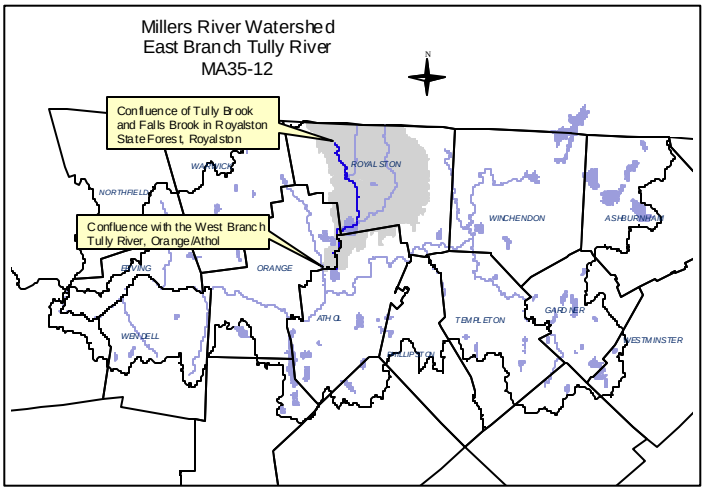
Figure 10. Tully River subwatershed segment locations.

EAST BRANCH TULLY RIVER (SEGMENT MA35-12)

Location: Confluence of Tully Brook and Falls Brook in Royalston State Forest, Royalston through Long Pond and Tully Lake to confluence with the West Branch Tully River forming headwaters Tully River, Orange/Athol.

Segment Length: 10.1 miles.

Classification: Class B.



The total drainage area to this segment is approximately 52.5 square miles (28.3 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	85%
Wetlands	4%
Agriculture	4%

The impervious area for sub-bains within this segment is all less than 10%, therefore it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

This segment is on the 1998 303(d) List of Waters for cause unknown, priority organics, and metals (Table 3).

The East Branch Tully River is formed by the confluence of Tully Brook and Falls Brook in Royalston State Forest. It flows southwestward for approximately three miles before entering Long Pond, and then continues south to Tully Lake. Tully Lake was formed by Tully Dam, built and operated by the US Army Corps of Engineers. From the dam the river flows south and then west, forming the boundary between Orange and Athol for most of the distance, to its confluence with the West Branch in Athol Center.

The ACOE New England District maintains a flood control project, Tully Lake in the Town of Royalston, within this segment of the East Branch Tully River. Tully Dam is a Class II project (i.e., minor or suspected water quality problems identified by the ACOE), which is part of a system of two ACOE flood control dams in the Millers River Basin. The Tully Dam is a 1,570' long, 62' high earthen dam with stone slope protection. Peak storage capacity of the project is 7.17 billion gallons (ACOE 1995). Construction of Tully Dam began in 1947 and was completed in 1949 to provide flood storage along the Millers and Connecticut rivers. The flood storage area of the lake is 1,130-acre while the total of the project and associated project lands covers 1,263 acres. Tully Lake consists of a recreation pool that fluctuates seasonally. From spring to fall the lake has a maximum depth of 16' and covers 300 acres. From fall to spring the pool is drawn down to a depth of 11' (ACOE 1995). The reservoir and associated land offer recreational opportunities that include swimming, boating, picnicking, hiking, fishing, and hunting.

The Athol Municipal Sanitary Landfill is located adjacent to the East Branch Tully River along Route 32 in Orange (slightly north of Sportsman Pond). The landfill was capped and has been closed since 1993, however, a leachate plume from the site has been observed and is of concern (MRPC and FRCOG 2002).

The use assessments for Little Pond (MA35037), Packard Pond (MA35053), and Tully Lake (MA35111) are provided in the Lake Assessment section of this report.

MA DFWELE has proposed that the East Branch Tully River and Tully Brook, a tributary to this segment of the East Branch Tully River, be reclassified in the SWQS as cold water fisheries (MassWildlife 2001).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Septic Systems

Septic system concerns were noted at Packard Pond in Orange.

Sand & Gravel Operations

Sand and gravel operations are located in the vicinity of the lower East Branch Tully River.

Landfills and Illegal Dump Areas

Solid waste dumping along Royalston and Packard Roads in Athol was reported by Stream Team members. An orange plume was observed from the closed Athol Municipal Sanitary Landfill.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Stream gaging data for the East Branch Tully River are available, but no longer published, from the USGS gage 01165000 located 300' downstream from Tully Dam (USGS 1 July 2002b). The drainage area at this gage is 50.5 mi^2 and the period of record for published data is 1916 to 1990 (Socolow *et al.* 2001). The ACOE New England District owns and operates a flood control project at Tully Lake on the East Branch Tully River. Tully Lake is a Class II project identified by ACOE as having minor water quality problems (ACOE 2001). The recreation pool is manipulated by the ACOE seasonally. From spring to fall the lake has a maximum depth of 16' and covers 300 acres. From fall to spring the pool is drawn down to a depth of 11' (ACOE 1995). Tully Dam is also operated to maintain flows for the River Rat and Farley Flats river races in April. Other than these specific events, the dam is operated as a run-of-river facility under normal conditions. During high flow conditions water is impounded to reduce downstream flooding. Currently the gates are manually operated by the ACOE. The lake encompasses approximately 0.9 miles of the East Branch Tully River, although the potential flood storage area covers approximately 4.9 miles of the river. There is a spillway on the southwest corner of the lake. Any discharge over this spillway is not measured at the USGS gage.

DWM biologists sampled two reaches of the East Branch Tully River downstream from Tully Lake between September 1995 and September 2000. The most upstream reach was located above Fryeville Road, Athol/Orange in September 1995 (station B0226). The stream bottom in this reach was nearly all bedrock. Because of the nature of the streambed there were no rooted plants instream nor were growths of periphyton noted. The riparian zone was forested. The overall habitat score was 149 (Appendix C).

The more downstream reach, located above Tully Road/Pinedale Avenue, Athol/Orange (station B0227), was sampled by DWM biologists in September 1995, September 1996 and again in September 2000. Here the bottom substrates were dominated by cobble and boulder. The stream bottom appeared to be very black, though when examined closely rocks lifted from the bottom did not appear to be coated with oil or tarry substances. There were areas of rust-red deposits and silt. Much of the moss on the rocks had entrained black mucky sediments. In September 1995 aquatic vegetation in the sampling reach was limited (nearly all *Sparganium* sp. - burreed). Mats of algae could be seen attached to moss in some places and filamentous algae were also noted. In September 1995 the overall habitat score was 147 (Appendix C). This sampling reach was also sampled in September 1996 as part of the MA DEP biocriteria development project (Appendix E). During the September 2000 sampling event the same reach was approximately 15 m wide with depths in the riffles and runs ranging between 15 and 40 cm, and the deeper pools about 0.5 m. There was a substantial accumulation of fine particulate organic matter (FPOM) on much of the substrates. On areas of exposed substrates an oily, tarry coating was evident. The water appeared slightly turbid and had a slight tea color. Aquatic vegetation covered about 60% of the reach, most of it moss. Only about 3% was attributable to *Sparganium* sp. Mats of green algae were found attached to rocks, wood, and sediment in about 20% of the reach. The total habitat score was 179 (Appendix C).

Biology

MA DFWELE conducted fish population sampling in the East Branch Tully River south of Route 68 using backpack shocking on 10 July 2000. A total of 16 fish were collected. Fish species present, in

order of abundance, included: yellow perch (*Perca flavescens*), chain pickerel (*Esox niger*), white sucker (*Catostomus commersoni*), creek chubsucker (*Erimyzon oblongus*) and one brook trout parr (*Salvelinus fontinalis*). The fish community was dominated by two macrohabitat generalists and the total numbers of fish were very low. It is unclear whether these macrohabitat generalists are resident or have migrated from Long Pond (located downstream from this sampling reach). The river is bordered by wetlands, which suggests a low stream gradient.

Benthic macroinvertebrate sampling was conducted by DWM biologists in two reaches of this segment of the East Branch Tully River. The most upstream reach was located upstream of Fryeville Road, Athol/Orange (station B0226) and was sampled in September 1995 while the downstream reach was located upstream from Tully Road/Pinedale Avenue, Athol/Orange (station B0227). The downstream site (station B0227) was sampled in September 1995, September 1996 (as part of the MA DEP biocriteria development project -- Appendix E) and again as part of the Millers River Watershed survey in September 2000 (Appendix C).

Compared to the West Branch Tully River reference station (station B0225) the RBP III analysis indicated the benthic community in the East Branch Tully River upstream of Fryeville Road, Athol/Orange (station B0226) was moderately-impacted in 1995 (Appendix C). Impoundment effects (evidenced by the trophic structure of the benthos, which was comprised primarily of a filter-feeding based community), habitat effects (substrate comprised primarily of bedrock) and the extremely low flow conditions encountered during the 1995 benthic survey likely resulted in the stressed community.

During the MA DEP biocriteria development project, benthic macroinvertebrate samples were collected by the DWM biologists from East Branch Tully River upstream from Tully Road/Pinedale Avenue, Athol/Orange (WM16EBT) on 12 September 1996 (Appendix E). The fish sample on 18 October 1996 from this section of the East Branch Tully River was comprised of 10 species including, in order of abundance; longnose dace (*Rhinichthys cataractae*), tessellated darter (*Etheostoma olmstedi*), fallfish (*Semotilus corporalis*) and brown trout (*Salmo trutta*), blacknose dace (*Rhinichthys atratulus*) and white sucker (*Catostomus commersoni*), and an individual each of yellow bullhead (*Ameiurus natalis*), common shiner (*Luxilus cornutus*), chain pickerel (*Esox niger*) and one brook trout parr (*Salvelinus fontinalis*) (Appendix A). It was noted that four of the 11 longnose dace had tumors. In addition two brown trout were noted as having deformed pectoral fins, however, these types of deformities are common with hatchery fish. This community was comprised primarily of fluvial species, but their numbers were very low. The presence of three intolerant species suggests excellent water quality.

When compared to the West Branch Tully River reference station in 1995 (station B0225) the RBP III analysis indicated a slightly impacted benthic community in the East Branch Tully River near Tully Road/Pinedale Avenue, Athol/Orange (station B0227). Compared to the Lawrence Brook reference station (station B0449) in September 2000, however, the RBP III analysis of this same stream reach (station B0227) was non-impacted (Appendix C).

Chemistry - water

In-situ measurements of the East Branch Tully River (DO, %saturation, pH, temperature, conductivity, and turbidity) near Tully Road in Orange/Athol (WM16EBT) were made by MA DEP DWM on 18 October 1996 (Appendix A, Table 8). The pH of the brook was low (5.9 SU).

The *Aquatic Life Use* is assessed as support based primarily on the benthic macroinvertebrate community analysis. However, in light of the conflicting results of the benthic macroinvertebrate analyses between 1995 and 2000 downstream from Tully Lake, the oily/tarry coating evident on streambed substrates, the low numbers of fish sampled by DWM, the presence of tumors on longnose dace, and the low number of fish sampled by MA DFWELE upstream from Tully Lake, this use is identified with an Alert Status. Potential stressors include flow alteration and leachate from the Athol Municipal Sanitary Landfill.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in the East Branch Tully River all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of the sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharges from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

Two reaches in the East Branch Tully River were surveyed between September 1995 and September 2000 by DWM biologists (Appendix C). No objectionable conditions were documented in the river near Fryville Road. The river was noted to have rust/red deposits of silt and on areas of exposed substrates an oily, tarry coating was evident in the sampling reach near Pinedale Avenue. The oily/tarry globs were noted as a concern. The water appeared slightly turbid and had a slight tea color.

The Tully River Stream Team noted isolated areas of trash and debris along the East Branch Tully River between the outlet of Tully Lake and the confluence with the West Branch Tully River during their shoreline survey in November/December 2000 (MRPC and FRCOG 2002). Leachate from the Athol Municipal Sanitary Landfill was also noted and is of concern.

Too limited data are available and, therefore, the *Recreational* and *Aesthetics* uses are currently not assessed. The *Aesthetics Use,* however*,* is identified with an Alert Status because of the oily/tarry substance observed on exposed substrate and leachate problems from the landfill.

East Branch Tully River (MA35-12)

Designated Uses	Status
Aquatic Life 	SUPPORT*
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	NOT ASSESSED*

* "Alert Status" issues identified, see details in use assessment section

RECOMMENDATIONS EAST BRANCH TULLY RIVER (SEGMENT MA35-12)

<u>Water Quality Monitoring</u>

- Continue monitoring the fish population in the East Branch Tully River both upstream and downstream of Tully Lake. Document presence of salmonid reproduction to support MA DFWELE request to classify the East Branch and Tully Brook as a Class B, cold water fishery.
- Continue to conduct biological sampling bracketing potential nonpoint sources of pollution in the East Branch Tully River to assess the status of the *Aquatic Life Use.*
- Field reconnaissance should be conducted to identify any source(s) of habitat quality degradation (e.g., oily/tarry coating on substrates).
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Sources of Pollution

- Investigate leachate from the Athol Municipal Sanitary Landfill to determine the extent of contamination and any appropriate remedial actions.
- The Tully River Stream Team should continue with its cleanup and other efforts to preserve this area.
- Oily/tarry substances noted on stream substrates need further investigation during low flow because the Stream Team did not note these conditions during their shoreline survey in December 2000.
- Investigate and confirm the presence of the sand and gravel operations in this subwatershed that are indicated in the MRPC and FRCOG (2002) study. Evaluate these sites to ensure that they are being operated and maintained properly and that water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).
- Investigate and evaluate the solid waste dumping along Royalston and Packard Roads that was reported in the MRPC and FRCOG (2002) report.
- The MRPC and FRCOG (2002) study indicated concerns of potential septic system problems at Packard Pond in the town of Orange. This area should be investigated and efforts should be made to ensure that on-site systems are properly sited, maintained and inspected.

Hydrology

- Pulsing flows were observed in the 2000 hourly hydrographs in the Millers River near Athol. Further investigation to pinpoint their source and reduce it to match a natural cycle should be done by collecting and evaluating the following data from the Tully Lake Dam.
  - Hourly or daily water elevation records to confirm the dam is operating in a run-of-river manner.
  - Hourly or daily discharge records (broken down by turbine flow, gate flow, dam spillage, etc.). The discharge records would be used to determine if the dam is pulsing discharges.
- To ensure run-of-river operations the Gomez and Sullivan (2003) study recommends that all dam operators install, calibrate and maintain a continuous streamflow monitoring gage or determine some other method to ensure compliance with run-of-river operations.
- The Tully Lake Dam has a large impact on the timing, magnitude, duration and frequency of flows in the East Branch Tully River. The Gomez and Sullivan (2003) report recommends that discussions between the ACOE and the USFWS continue and that the following issues be discussed: a) seasonal minimum flows, b) flushing flows, c) whitewater releases and d) ramping flows. The objective is to operate this facility to mimic the natural runoff cycle while preserving the purpose of the dam to reduce flood flows.

Fish Consumption

- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption should be limited, body burdens of PCB and mercury in the edible portions of fish from the East Branch Tully River should be further investigated. Determination of natural or man-made barriers to migration in tributaries of the Millers River, including the East Branch Tully River to the point of the Tully Dam, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

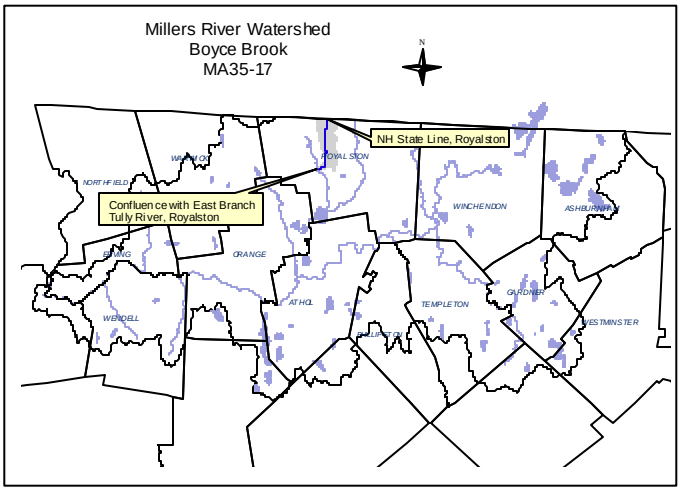
Land Protection

- The impervious area for sub-bains within this segment is all less than 10%, therefore it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Royalston, Orange and Athol should review the information generated through the buildout analysis performed by EOEA that created a profile of how

each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002), the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that the communities of Royalston, Athol and Orange continue to work with the Franklin Regional Council of Governments and the Montachusett Regional Planning Commission on land use planning issues.

- It is recommended that the Towns of Royalston, Athol and Orange participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Royalston, Athol and Orange can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

BOYCE BROOK (SEGMENT MA35-17)
Location: NH State Line, Royalston to confluence with East Branch Tully River, Royalston.
Segment Length: 3.2 miles.
Classification: Class B.



The drainage area of this segment is approximately 5.7 square miles (2.1 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	94%
Agriculture	3%
Wetlands	1%

The impervious area for the sub-bains within this subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

MA DFWELE has proposed that Boyce Brook be reclassified in the SWQS as a cold water fishery (MassWildlife 2001).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY
Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

USE ASSESSMENT
AQUATIC LIFE
Habitat and Flow

DWM biologists sampled one reach in Boyce Brook (300m upstream of Falls Road in Royalston-station WM17BOY) in September 1995 and September 2000. Instream habitat in September 2000 appeared to be most limited by the amount of flow (Appendix C). The brook was approximately 2m wide and depths in the riffles/runs were estimated at 0.1 m. There was only one small pool (0.25m in depth).

Biology

As part of the MA DEP biocriteria development project benthic macroinvertebrate samples were collected by DWM biologists from Boyce Brook approximately 300m upstream of Falls Road in Royalston (WM17BOY) on 12 September 1996 and again on 12 September 2000 (Appendix C). Fish sampling conducted on 2 October 1996 and 21 September 2000 indicated that Boyce Brook was comprised of only of brook trout (*Salvelinus fontinalis*) (Appendix A, Table 13). A total of 29 fish (multiple age classes) were collected in 2000. The presence of multiple age classes of brook trout is indicative of excellent water quality and is consistent with conditions typically found in the headwaters of cold water streams.

Chemistry - water

In-situ measurements (DO, %saturation, pH, temperature, conductivity, and turbidity) of Boyce Brook approximately 300m upstream of Falls Road in Royalston (station WM17BOY) were made by MA DEP DWM on 2 October 1996 (Appendix A, Table 8). The pH of the brook was low (5.8 SU).

The *Aquatic Life Use* is assessed as support based primarily on the fish population information. Although only brook trout were present this can be typical in headwaters of cold water streams.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in Boyce Brook all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). However, it should be noted that Boyce Brook is upstream from a major barrier to migration – the Tully Dam on the East Branch Tully River. Until site-specific data are generated, the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

One reach in the Boyce Brook was surveyed in September 1995 and September 2000 by DWM biologists (Appendix C). No objectionable conditions were documented in the brook near Falls Road in Royalston. There was no evidence of objectionable deposits, odors, or oil and the brook was clear.

Although too limited data are available to assess the *Recreational Uses* for Boyce Brook the *Aesthetics Use* is assessed as support.

Boyce Brook (MA35-17) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

RECOMMENDATIONS BOYCE BROOK (SEGMENT MA35-17)

Water Quality Classification

- Boyce Brook should be reclassified in the next revision of the SWQS as a cold water fishery.

Water Quality Monitoring

- Continue to periodically conduct biological sampling in Boyce Brook to assess the status of the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Fish Consumption

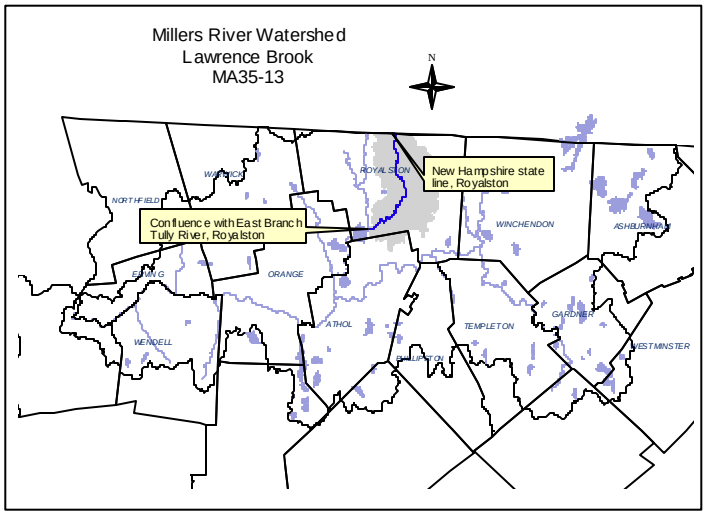
- The MA DPH has recommended that fish taken from the tributaries of the Millers River should not be eaten or consumption be limited. However, since Boyce Brook is upstream from a major barrier to migration – the Tully Dam on the East Branch Tully River and there are no known sources of pollution in Boyce Brook, body burdens of PCB and mercury in the edible portions of fish from Boyce Brook should be further investigated.

Land Protection

- The impervious area for the sub-bains within this subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Royalston should review the information generated through the buildout analysis performed by EOEA that created a profile of how each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that the community of Royalston continue to work with the Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Town of Royalston participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Royalston can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

LAWRENCE BROOK (SEGMENT MA35-13)

Location: New Hampshire state line, Royalston through Doane Falls to confluence with East Branch Tully River, Royalston.
Segment Length: 7.1 miles.
Classification: Class B.



The drainage area of this segment is approximately 26.2 square miles (14.6 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	86%
Wetlands	5%
Agriculture	5%

The impervious area for sub-bains within this subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

This segment begins at the MA-NH state line, although Lawrence Brook actually originates at the outlet of Sportsman Pond in Fitzwilliam, NH. Almost immediately downstream from the state line the brook enters a large wetland where it meanders southward, then to the west, and finally northward. As it finally flows in a southerly direction once again it is joined by several small tributaries and the velocity increases with gradient. Just south of Northeast Fitzwilliam Road Lawrence Brook enters another wetland, where it flows slowly until it reaches Doanes Falls immediately west of Athol Road. Here the stream drops almost 150 feet before entering Tully Lake (East Branch Tully River).

The Royalston Landfill, located just south of the intersection of Route 68 and Athol Road near Lawrence Brook, was closed in 1999. This municipal sanitary landfill is neither capped nor lined (Poirier 2002 and MRPC and FRCOG 2002).

This segment is on the 1998 303(d) List of Waters for cause unknown, priority organics, and metals (Table 3).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information, there are no WMA regulated water withdrawals or NPDES surface wastewater discharges in this subwatershed area.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Sand & Gravel Operations

There are sand and gravel operations located throughout this subwatershed.

Unpaved Roads

There are unpaved roads in the town of Royalston along Dunham Brook and along a portion of Lawrence Brook.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

A total of three stream reaches in Lawrence Brook were sampled by DWM biologists between September 1995 and September 2000. The most upstream reach, above Northeast Fitzwilliam Road, Royalston (station B0449) was sampled by DWM in September 2000. Upstream from the influence of beaver activity at this sampling site, Lawrence Brook was roughly 5 m wide, with depths ranging from 0.3 m to 0.5 m. The substrates were comprised primarily of boulder and cobble. The overall habitat score was 195 (Appendix C). Lawrence Brook was sampled by DWM biologists upstream from Athol Road, Royalston in September 1996 (as part of the MA DEP biocriteria

development project -- Appendix E) and again as part of the Millers River Watershed survey in September 2000 (Appendix C). Here the bottom substrates were primarily boulder. At the time of the September 2000 survey the brook was about 5 m wide with riffle/run depths between 0.3 to 0.4m and pools approximately 0.6 m. Aquatic vegetation was primarily moss with some rooted submergent vascular plants. *Sparganium* sp. and water cress covered close to 98% of the reach. No algal coverage was detected but sponges were observed. Beaver activity was noted downstream from the sampling reach where sampling had been conducted in 1995. The overall habitat score was 180 (Appendix C). Where sampling of Lawrence Brook was conducted in 1995 (a short distance upstream from Athol Road and Doane Falls –station B0224), bottom substrates were dominated by boulders, bedrock, and slabs. These surfaces were covered with mosses and liverworts. The overall habitat score for the reach sampled in 1995 was 154 (Appendix C).

Biology

A total of three stream reaches in Lawrence Brook were sampled by DWM biologists between September 1995 and September 2000. Benthic macroinvertebrate samples were collected from the brook upstream from Northeast Fitzwilliam Road, Royalston on 12 September 2000 (station B0449) (Appendix C). Since this reach was used as the reference station condition for the 2000 Millers River Watershed Biomonitoring Survey and richness (33) and the EPT indices (14) were the highest of any stations sampled during the 2000 Millers River Biomonitoring Survey the benthic community was considered to be non-impacted.

Benthic macroinvertebrate samples were also collected approximately 300m upstream of Athol Road in Royalston on 13 September 1996 (station WM19LAW) as part of the MA DEP biocriteria development project (Appendix E) and again in September 2000 (station B0447) as part of the Millers River Watershed survey (Appendix C). Compared to the upstream reference station (station B0449), the RBP III analysis indicated the benthic community was slightly-impacted in Lawrence Brook 300m upstream of Athol Road in Royalston (station B0447) in September 2000 (Appendix C). During the fish population survey in Lawrence Brook conducted on 18 October 1996 (station WM19LAW) the community was comprised of, in order of abundance: chain pickerel (*Esox niger*) and white sucker (*Catostomus commersoni*), brown bullhead (*Ameiurus nebulosus*), and an individual largemouth bass (*Micropterus salmoides*) (Appendix A, Table 13). The fish community was composed primarily of macrohabitat generalists and one tolerant fluvial dependant species. The numbers of fish collected were very low (only 14 fish were collected) and atypical of the habitat present. It is unclear what is limiting the fish community in this stream reach.

The benthos were also sampled by DWM biologists just upstream from Athol Road, Royalston (station B0224) in September 1995. Compared to the reference station on the West Branch Tully River at Tully Road in Orange (station B0225) the RBP III analysis indicated the benthic community was non-impacted (Appendix C).

Chemistry - water

In-situ measurements (DO, %saturation, pH, temperature, conductivity, and turbidity) of Lawrence Brook upstream of Athol Road in Royalston (station WM19LAW) were made by MA DEP DWM on 18 October 1996 (Appendix A, Table 8). The pH of the brook was low (5.1 SU).

The *Aquatic Life Use* is assessed as support primarily on the benthic macroinvertebrate community analysis. However, because of the very low numbers of fish present this use is identified with an Alert Status.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in Lawrence Brook all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). However, it should be noted that Boyce Brook is upstream of a major barrier to migration – the Tully Dam on the East Branch Tully River. Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the

Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

While Lawrence Brook is very tea-colored, it was always clear during the biological monitoring surveys conducted by DWM biologists between September 1995 and September 2000 (Appendix C). Turbidity was not evident nor were any objectionable deposits, odors or conditions noted.

Although too limited data are available to assess the recreational uses the *Aesthetics Use* is assessed as support.

Lawrence Brook (MA35-13) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT*
Fish Consumption 	IMPAIRED *Cause*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

*Alert Status issues identified, see details in use assessment section

RECOMMENDATIONS LAWRENCE BROOK (SEGMENT MA35-13)

Water Quality Monitoring

- Continue to conduct biological sampling in Lawrence Brook to assess the status of the *Aquatic Life Use*. Since low numbers of fish collected were collected and were atypical of the habitat present, additional fish population monitoring and habitat characterization should be conducted at upstream locations in Lawrence Brook to better assess the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Fish Consumption

- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption be limited, body burdens of PCB and mercury in the edible portions of fish from Lawrence Brook should be further investigated. Determination of natural or man-made barriers to migration in tributaries of the Millers River, including Lawrence Brook, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

Nonpoint Sources of Pollution

- Investigate and confirm the presence of the sand and gravel operations in this subwatershed that are indicated in the MRPC and FRCOG (2002) study. Evaluate these sites to ensure that they are being operated and maintained properly and that water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit program should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An

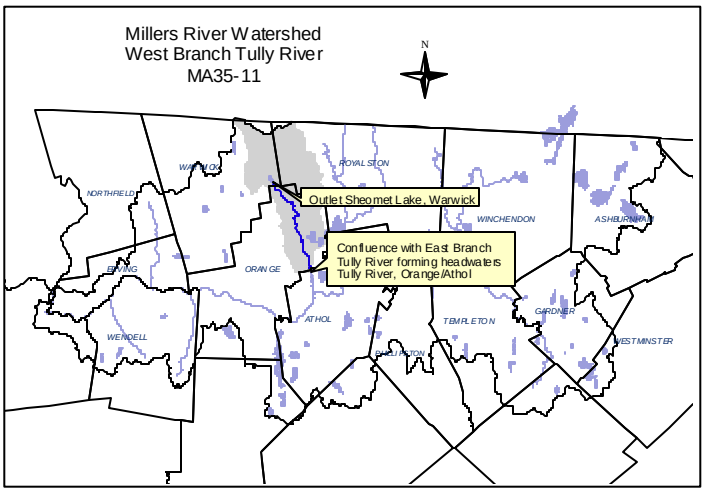
evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).

- The unpaved roads in the town of Royalston along Dunham Brook and along a portion of Lawrence Brook should be field checked to confirm their location and condition. An evaluation should be performed to determine if there are any impacts from these roads on the adjacent watercourses that may affect water quality. Best management practices, as described in Unpaved Roads BMP Manual (Berkshire Regional Planning Commission 2001), should then be implemented as appropriate.

Land Protection

- The impervious area for sub-bains within this subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Royalston should review the information generated through the buildout analysis performed by EOEA that created a profile of how each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that Royalston continue to work with the Montachusett Regional Planning Commission and on land use planning issues.
- It is recommended that the Town of Royalston participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Royalston can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

WEST BRANCH TULLY RIVER (SEGMENT MA35-11)
Location: Outlet Sheomet Lake, Warwick to confluence with East Branch Tully River forming headwaters Tully River, Orange/Athol.
Segment Length: 6.6 miles.
Classification: Class B.



The drainage area of this segment is approximately 17.9 square miles, almost all of which lie in MA. Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	88%
Agriculture	5%
Residential	3%

The impervious area for the sub-basins in this segment only is less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

The West Branch Tully River originates in Warwick, MA at the outlet of Sheomet Lake, which is itself fed by Tully Brook. The river flows rapidly southeastward to Tully Meadow where it is joined by Collar Brook. From here the river flows more southerly while slowly passing through a wetland area just west of Tully Mountain. Downstream the West Branch and East Branch Tully Rivers join at the Orange-Athol corporate boundary.

This segment is on the 1998 303(d) List of Waters for priority organics and metals (Table 3).

The use assessments for Royalston Road Pond (MA35071), Sheomet Lake (MA35074), and Tully Pond (MA350089) are provided in the Lake Assessment section of this report.

Collar Brook, which is a tributary to the West Branch Tully River, was sampled for fish population by MA DFWELE on 10 July 2000. Backpack shocking was conducted in this brook south of Butterworth Road in Royalston. The dominant species found were blacknosed dace (*Rhinichthys atratulus*) and brook trout (*Salvelinus fontinalis*) with a smaller population of slimy sculpin (*Cottus cognatus*).

MA DFWELE has proposed that the West Branch Tully River and three of its tributaries, Collar, Fish and Tully brooks, be reclassified in the SWQS as cold water fisheries (MassWildlife 2001).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY
Based on the available information there are no WMA regulated water withdrawals or NPDES surface wastewater discharges in this subwatershed area.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)
The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Septic Systems
Potential septic system problems were noted at Tully Pond in the town of Orange.

Illegal Junk Yard/Dumping Site
Solid waste dumping near Western Avenue, Athol was noted.

Unpaved Roads
In the northern portion of this subwatershed there are several unpaved roads that are close to or cross watercourses.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Two stream reaches in the West Branch Tully River were sampled by DWM biologists between September 1995 and September 2000. The most upstream reach was located approximately 150m upstream from Flagg Road in Orange (station WM15WBT) and was surveyed as part of the MA DEP biocriteria development project in September/October 1996 and again in September 2000. In September 2000 the river was approximately 4 m wide with depths ranging from 0.3 to 0.5 m in riffle and pool habitats, respectively, although there had been heavy rain within the previous week (MA DEP 2000b). The total habitat assessment score was 172. The second reach was located upstream from Tully Road, Orange (station B0225). This reach was surveyed in September 1995 to serve as the reference (representing the "least impacted") condition for the Millers River Watershed survey (Appendix C). Here the river flowed through a primarily forested landscape. In September 1995 the water level was very low, exposing many otherwise useful fish cover or epifaunal substrate features (undercut banks, overhanging vegetation, fallen logs), and effectively making them unavailable. Overall the habitat received a score of 135.

Biology

As part of the MA DEP biocriteria development project, benthic macroinvertebrate samples were collected by DWM biologists from the West Branch Tully River approximately 150m upstream of Flagg Road in Orange (station WM15WBT) on 12 September 1996 and again on 13 September 2000 (Appendix C). The fish population in the river at this location (sampling conducted on 2 October 1996) was comprised of 14 fish represented by six species including, in order of abundance: blacknose dace (*Rhinichthys atratulus*), brown trout (*Salmo trutta*), brown bullhead (*Ameiurus nebulosus*) and longnose dace (*Rhinichthys cataractae*), and an individual each chain pickerel (*Esox niger*) and white sucker (*Catostomus commersoni*) (Appendix A, Table 13). Four of these species were fluvial specialists/dependants and two were intolerant (one of which was likely stocked fish). It should be noted that the fish numbers were low, but it is unclear whether this was due to slightly colored water and/or leaf fall. The second reach was located upstream from Tully Road, Orange (station B0225). This reach was surveyed in September 1995 and was selected to serve as the reference (representing the "least impacted") condition for the 1995 Millers River Watershed survey (Appendix C). Both taxa richness (30) and the EPT indices (13) were the second highest of any stations sampled by DWM in 1995. The benthic community in the West Branch Tully River was, therefore, considered to be non-impacted.

MA DFWELE sampled fish populations in the West Branch Tully River on 10 July 2000 and 30 August 2000. Backpack shocking was done during the July sampling date, east of Tully Road in Orange. The most dominant species was longnose dace (*Rhinicthys cataractae*, an intolerant fluvial specialist) with blacknose dace (*Rhinichthys atratulus*) as the next most prevalent species. Other species in lesser amounts were: brook trout (*Salvelinus fontinalis*), tesselated darter (*Etheostoma olmstedi*), yellow perch (*Perca flavescens*), golden shiner (*Notemigonus crysoleucas*), pumpkinseed (*Lepomis gibbosus*), and white sucker (*Catostomus commersoni*). The abundance of fluvial species is indicative of excellent water quality and stable flow regimes. And, although three macrohabitat generalist species were collected, only five individuals were noted. During the August survey sampling was conducted with a barge electroshocker north of Tully Road in Orange. A total of 24 fish represented by 9 species were collected. Fish species present, in order of abundance, included: yellow perch (*Perca flavescens*), white sucker (*Catostomus commersoni*), fallfish (*Semotilus corporalis*), brook trout (*Salvelinus fontinalis*), chain pickerel (*Esox niger*), bluegill (*Lepomis macrochirus*), common shiner (*Luxilus cornutus*), pumpkinseed (*Lepomis gibbosus*), and brown trout (*Salmo trutta*). The fish sample was a mix of macrohabitat generalist and fluvial species, however, the number of fish was very low. Whether or not this was due to poor sampling efficiency (reduced visibility and/or excessive depth) or some other water quality or habitat issue is undetermined.

Chemistry - water

In-situ measurements (DO, % saturation, pH, temperature, conductivity, and turbidity) of the West Branch Tully River approximately 150m upstream from Flagg Road in Orange (station WM15WBT) were made by MA DEP DWM on 2 October 1996 (Appendix A, table 8). The pH of the brook was good (6.5 SU).

The *Aquatic Life Use* is assessed as support based primarily on the benthic macroinvertebrate and fish population information.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in the West Branch Tully River all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated, the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

No objectionable deposits, oils, odors, trash or debris were noted by DWM biologists at their sampling stations on the West Branch Tully River between September 1995 and September 2000 (Appendix C and G). There was some slight turbidity noted in the river near Flagg Road in Orange during the September 2000 survey although heavy rains had occurred during the week prior to the survey. The Tully River Stream Team surveyed the majority of the West Branch Tully River in November/December 2000 (MRPC and FRCOG 2002). Other than the isolated area of trash/debris along the banks of the river near Tully Road and a small dirt road, no objectionable deposits/conditions were observed.

Too limited data are available and, therefore, the recreational uses are currently not assessed. The *Aesthetics Use* is assessed as support.

West Branch Tully River (MA35-11) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

RECOMMENDATIONS WEST BRANCH TULLY RIVER (SEGMENT MA35-11)

Water Quality Classification

- The West Branch Tully River, Collar, Fish and Tully Brooks should be reclassified as cold water fisheries in the SWQS.

Water Quality Monitoring

- Continue to periodically conduct biological sampling in the West Branch Tully River to assess the status of the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Fish Consumption

- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption should be limited body burdens of PCB and mercury in the edible portions of fish from the West Branch Tully River should be further investigated. Determination of natural or man-made barriers to migration in tributaries of the Millers River, including the West Branch Tully River, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

Nonpoint Sources of Pollution

- The MRPC and FRCOG (2002) study indicated potential septic system problems at Tully Pond in the town of Orange. This area should be investigated and efforts should be made to ensure that on-site systems are properly sited, maintained and inspected.
- Investigate and evaluate the solid waste dumping along Western Avenue in Athol. Consideration should be given to offering educational programs to inform residents of the negative affects of illegal solid waste disposal on the environment.
- Unpaved roads in the northern portions of this subwatershed should be field checked to confirm their location and an evaluation should be performed to determine if there are any impacts from these roads on adjacent watercourses that may affect water quality. Best management practices, as described in Unpaved Roads BMP Manual (Berkshire Regional Planning Commission 2001), should then be implemented as appropriate.
- A river cleanup should be conducted to remove objectionable deposits of trash and debris near Tully Road and the small road near it.

Land Protection

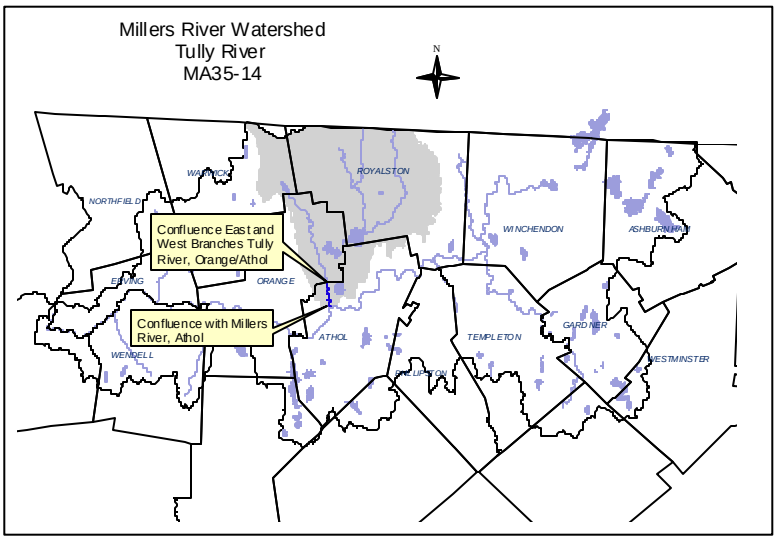
- The impervious area for the sub-basins in this segment only is less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Warwick, Orange and Athol should review the information generated through the buildout analysis performed by EOEA that created a profile of how each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002), the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that the communities of Warwick, Athol and Orange continue to work with the Franklin Regional Council of Governments and the Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Towns of Warwick, Athol and Orange participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project these towns can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

TULLY RIVER (SEGMENT MA35-14)

Location: Confluence East and West Branches Tully River, Orange/Athol to confluence with Millers River, Athol.

Segment Length: 1.6 miles.

Classification: Class B.



The total drainage area to this segment is approximately 72.8 square miles (48.6 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	85%
Agriculture	5%
Residential	4%

The impervious area for the sub-basins within this segment is less than 10%, therefore it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

The Tully River begins at the confluence of its east and west branches at the Orange-Athol corporate boundary. From there it flows southward through a wetland for 1.5 miles before emptying into the Millers River, just north and west of the center of Athol. Several small tributaries join the Tully River along its course.

This segment is on the 1998 303(d) List of Waters for priority organics and metals (Table 3).

The use assessment for Sportsmans Pond (MA35082) is provided in the Lake Assessment section of this report.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3)

Facility WMA Permit # WMA Registration #	Sources	Authorized Withdrawal (MGD)	Reported Actual Use (MGD)				
			1998	1999	2000	2001	2002
347422208/* 9P220701501 20701501	Tully Well #1 (02G) Tully Well #2 (03G) Tully Well #3 (04G)	1.04 reg 0 per 1.04 total	0.95	0.97	0.84	0.91	1.05

* not all sources within this segment.

NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information there are no NPDES regulated surface wastewater discharges in this subwatershed.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Illegal Junk Yard/Dumping Sites

Solid waste dumping was noted by members of the Stream Team along Pinedale Road in Athol.

Lead Shot

Lead shot was observed by the Stream Team in the small pond near Sportsman Pond, Athol.

USE ASSESSMENT

AQUATIC LIFE

Biology

MA DFWELE conducted fish population sampling in the Tully River using a barge electroshocker near the Athol Conservation Area on 30 August 2000. A total of 53 fish represented by 10 species were collected. The most dominant species was white sucker (*Catostomus commersoni*). Other fish species present, in order of abundance, included: yellow perch (*Perca flavescens*), fallfish (*Semotilus corporalis*), chain pickerel (*Esox niger*), longnose dace (*Rhinicthys cataractae*), tesselated darter (*Etheostoma olmstedi*), yellow bullhead (*Ameiurus natalis*), brown trout (*Salmo trutta*), smallmouth bass (*Micropterus dolomieu*), and pumpkinseed (*Lepomis gibbosus*). The fish community was comprised of a mix of fluvial specialists/dependants and macrohabitat generalists. The fish assemblage in this reach appears to be influenced by its proximity to the mainstem Millers River. The slow moving section in the middle of this reach offers habitat for the generalist species present.

Too limited data are available and, therefore, the *Aquatic Life Use* is not assessed. Concerns regarding lead shot from a shooting range near a small pond, which drains to this segment of the Tully River, were identified and needs further investigation.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in the Tully River all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs).
The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and most likely is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

The Tully River Stream Team surveyed the entire length of Tully River in November/December 2000 (MRPC and FRCOG 2002). Other than the isolated area of trash/debris along the banks of the river near Lenox Street no objectionable deposits/conditions were observed.

Although too little data are available to assess the *Recreational* uses the *Aesthetics Use* is assessed as support.

Tully River (MA35-14) Use Summary Table

Designated Uses	Status
Aquatic Life 	NOT ASSESSED
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

RECOMMENDATIONS TULLY RIVER (SEGMENT MA35-14)

Water Quality Monitoring

- Continue to conduct biomonitoring data (e.g., benthic macroinvertebrate and fish population) to assess the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Source Pollution

- Investigate and evaluate the solid waste dumping along Pinedale Road in Athol. Consideration should be given to offering educational programs to inform residents of the negative affects of illegal solid waste disposal on the environment.
- Concerns regarding lead shot from a shooting range near a small pond near Sportmans Pond, which drains to this segment of the Tully River, were identified and need further investigation. Coordinate with MA DEP CERO's Lead Shot Initiative on this issue.

Hydrology

- As part of the WMA 5-year review process, MA DEP should continue to evaluate the Athol Water Department compliance with their WMA registration.
- In accordance with the requirements of MA DEP's WMA permit program, the Athol Water Department should develop and/or maintain up-to-date water conservation plans to help reduce the need for increased water withdrawals. Residential water consumption should be maintained at 80 gpcd or less and unaccounted-for water should be limited to 10% (Gomez and Sullivan 2003).

Fish Consumption

- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption be limited body burdens of PCB and mercury and lead in the edible portions of fish from the Tully River should be further investigated.

Land Protection

- The impervious area for the sub-basins within this segment is less than 10%, therefore it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Orange and Athol should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both Athol and Orange continue to work with the Franklin Regional Council of Governments and the Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Towns of Athol and Orange participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Athol and Orange can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.
- A comprehensive biological and wetland survey of 162 acres of land along the Tully River in Athol, which was proposed as an EOEA Millers River Watershed Team project, should be pursued. This land is in multiple ownership which includes MA DFWELE, the Millers River Greenway, and the Athol Conservation Commission and Department of Public Works. The proposed survey will serve as a base line to provide information needed to make informed decisions regarding the management of this area to protect the biological diversity and ecological processes of the area. This will serve to preserve the water quality of the Tully River.

OTHER TRIBUTARIES

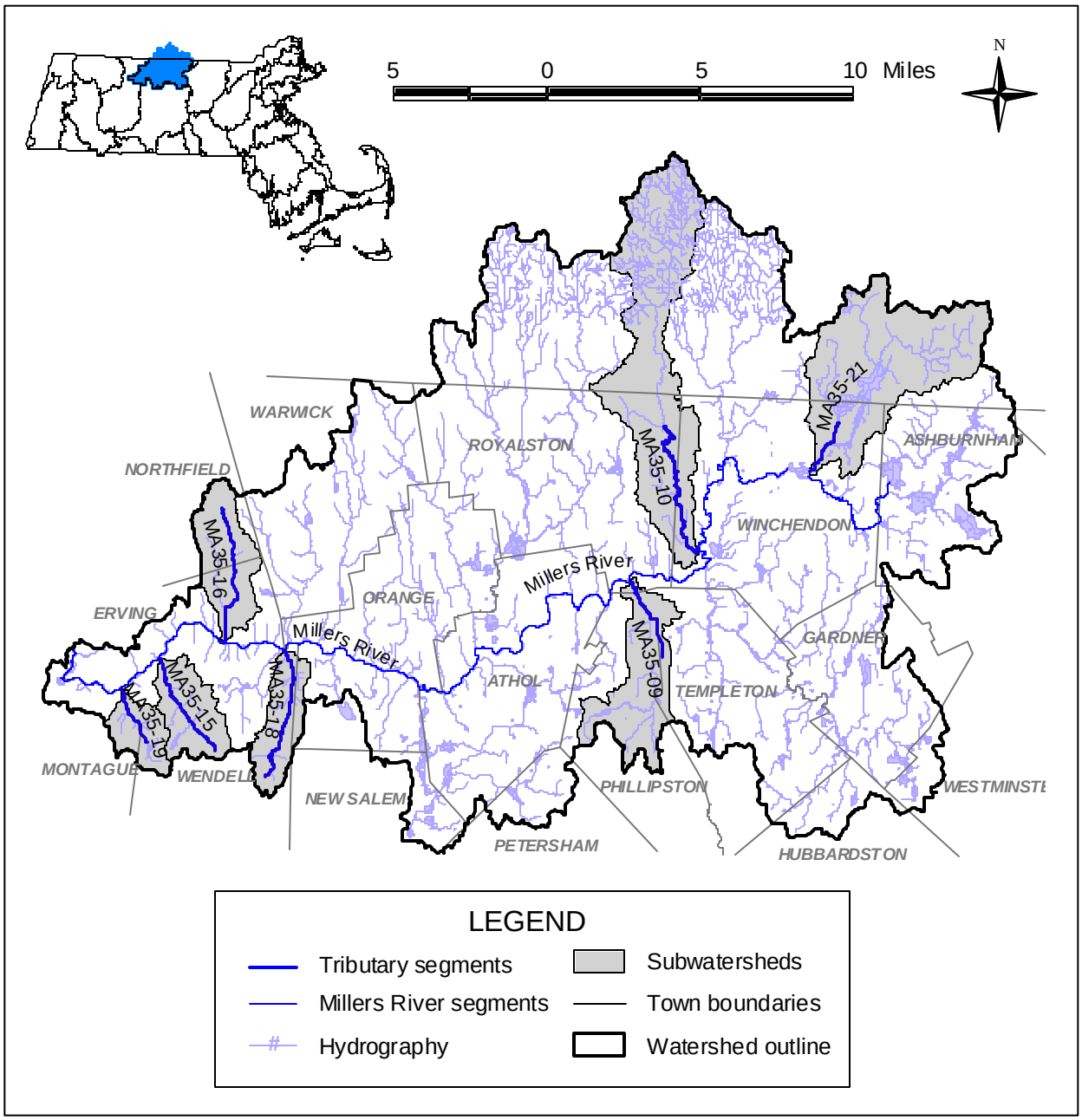
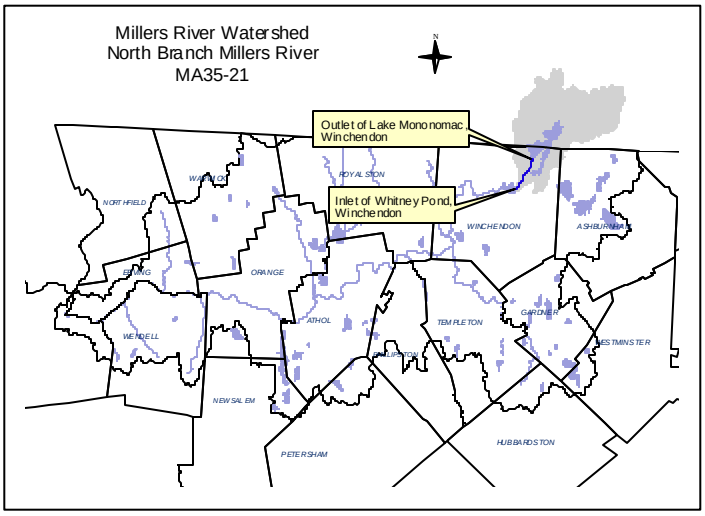


Figure 11. Millers River tributary segment locations.

NORTH BRANCH MILLERS RIVER (SEGMENT MA35-21)

Location: Outlet of Lake Mononomac, Winchendon to inlet of Whitney Pond, Winchendon.
Segment Length: 2.0 miles
Classification: Class B.



The drainage area of this segment is approximately 20.9 square miles (4.5 of which lie in Massachusetts). Land-use estimates (top three) for the portion of the subwatershed in MA (map inset, gray shaded area):

Forest	75%
Residential	10%
Open Land	3%

The impervious cover area for sub-basins within this subwatershed is less than 10%, therefore, the North Branch Millers River is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

The North Branch Millers River begins at the outlet of Lake Mononomac in Winchendon. The river flows in a generally southwest direction, receives the flow from one unnamed tributary draining White Mill Pond, and then flows into Whitney Pond in Winchendon. The segment ends at the inlet to Whitney Pond.

The use assessments for Lake Mononomac (MA35047) and Whites Mill Pond (MA35099) are provided in the Lake Assessment section of this report. TMDLs for total phosphorous were calculated by MA DEP for both of these waterbodies (MA DEP 2002).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in the North Branch Millers River were identified in the MRPC and FRCOG (2002) report.

Septic Systems

In the town of Winchendon private septic systems serve 67% of the population. Particularly vulnerable areas in this subwatershed are any unsewered areas around major waterbodies such as Lake Mononomac.

Sand and Gravel Operations

A sand and gravel operation is located in this subwatershed near Whites Mill Pond.

Stormwater

Stormwater from road drainage near Lake Monomonac was identified by the Stream Team as an area of concern.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

According to USGS (remarks of their gaging station on the Millers River in Winchendon – 01162000), the flow of the North Branch Millers River is regulated by reservoir operations at Lake Monomonac (Socolow *et al*. 2001). The Town of Winchendon operates the Lake Monomonac Dam. There are three dams that currently impound Lake Monomonac. The main dam, which has a siphon through it, will eventually be breached and replaced with a box culvert. Red Dam, located downstream from the main dam was constructed to hold water against the main dam. On the west side of the lake there is an emergency spillway with 2ft x 6ft flashboards. The flashboards are removed in the fall and replaced just after spring runoff. There are no low-level outlets to release flow. The Town strives to maintain a stable lake elevation throughout the summer period (Gomez & Sullivan 2003).

Biology

MA DFWELE conducted fish population sampling in the North Branch Millers River, south of Maple Street on 24 July 2000. Using a backpack electroshocker, a total of 108 fish represented by 11 species were collected. Species present, in order of abundance, included: yellow perch (*Perca flavescens*), fallfish (*Semotilus corporalis*), white sucker (*Catostomus commersoni*), redbreast sunfish (*Lepomis auritus*), brown bullhead (*Ameiurus nebulosus*), tesselated darter (*Etheostoma olmstedi*), largemouth bass (*Micropterus salmoides*), creek chubsucker (*Erimyzon oblongus*), banded sunfish (*Enneacanthus obesus*), bluegill (*Lepomis macrochirus*) and chain pickerel (*Esox niger*). Yellow perch, a macrohabitat generalist, dominated the fish sample, and more than half of the species present were macrohabitat generalists. Five species are fluvial specialists or dependant species, which require flowing water during all or part of their life cycle. However, they only represent 38% of the fish sample. Most of the fish species present are tolerant/moderately tolerant to pollution (exception is the creek chubsucker which is intolerant).

Too limited data are available and, therefore, the *Aquatic Life Use* is not assessed for the North Branch Millers River. However, this use is identified with an Alert Status because of dam operations that may affect instream habitat/flow.

FISH CONSUMPTION

In August 1987 fish toxics monitoring was conducted by MA DEP (MA DEQE at that time) in Whitney Pond in Winchendon. These data were published in the *Millers River Basin 1987 Water Quality Analysis* report (Austin *et al.* 1990). Mercury in fish collected from Whitney Pond exceeded the MA DPH action level of 0.5 mg/Kg. However, PCB levels in fish from Whitney Pond did not exceed the MA DPH action level of 1.0 mg/Kg. Furthermore, New Hampshire Department of Environemtal Services (NH DES) also reported elevated mercury in fish tissue from Lake Monomonac. The MA DPH recommends the following (MA DPH 2002a).

Millers River (all towns from Erving to Winchendon) because of mercury and PCBs:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries,"
2. "the general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River," and
3. "the general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Because of the MA DPH fish consumption advisory the *Fish Consumption Use* for the North Branch Millers River is assessed as impaired. However, PCB levels in fish from Whitney Pond did not exceed the MA DPH action level of 1.0 mg/Kg. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The *Fish Consumption Use* is assessed as impaired because of the existing site-specific advisory, however, the cause of impairment is limited to mercury.

North Branch Millers River (MA35-21)

Designated Uses	Status
Aquatic Life 	NOT ASSESSED*
Fish Consumption 	IMPAIRED *Cause*: Mercury *Source*: Unknown (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	NOT ASSESSED

* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS NORTH BRANCH MILLERS RIVER (MA35-21)

Water Quality Monitoring

- Conduct water quality and biological monitoring (e.g., benthic macroinvertebrate and fish population) in the North Branch Millers River to assess the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Sources of Pollution

- Since a majority of residents in the town of Winchendon rely on individual on-site septic systems, efforts to ensure that these systems are properly sited, maintained and inspected should continue particularly around Lake Mononomac.
- Investigate and confirm the presence of the sand and gravel sites that were identified in this subwatershed. Evaluate these sites to ensure that they are being properly operated and maintained and that water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for town boards to provide town officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).

Hydrology

- Instream flows along this segment of the North Branch Millers River should be documented and attempts should be made to mimic natural flow regimes to the extent possible.
    - The Town of Winchendon should optimize their control practices at the outlets of Lake Monomonac and Red Dam to minimize impacts on the flow regime in the Millers River.
    - Instream habitat evaluations should be conducted to assess the effects of streamflow manipulation and to determine if there are any impacts.
    - Since pulsing flows were observed in the 2000 hourly hydrographs in the Millers River near Winchendon operations at Lake Monomonac and Red Dam should be evaluated. All dam operators should install, calibrate and maintain a continuous streamflow monitoring gage or determine some other method to ensure compliance with run-of-river operations and/or document stream flows (Gomez and Sullivan 2003).

Fish Consumption

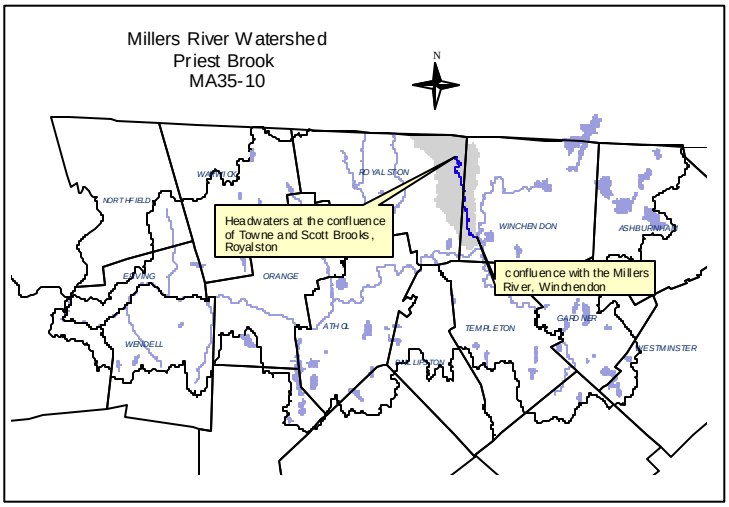
- MA DPH is currently reevaluating their Fish Consumption Advisory for the Millers River Watershed. Additional fish toxics monitoring should be considered for this segment of the North Branch Millers River and lakes in the North Branch Millers River subwatershed (Lake Monomonac and Whites Mill Pond).

Land Protection

- The impervious cover area for sub-basins within this subwatershed is less than 10%, therefore, the North Branch Millers River is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Winchendon should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that Winchendon continue to work with the Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Town of Winchendon participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project the Town can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

PRIEST BROOK (SEGMENT MA35-10)

Location: Headwaters at the confluence of Towne and Scott Brooks, Royalston to the confluence with the Millers River, Winchendon.
Segment Length: 6.8 miles.
Classification: Class B.



The drainage area of this segment is approximately 24.0 square miles (9.8 of which lie in Massachusetts). Land-use estimates (top three) for the MA portion of the subwatershed (map inset, gray shaded area):

Forest	91%
Wetlands	4%
Open Land/ Residential	2% each

The impervious area for sub-basins within this subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

Priest Brook begins at the confluence of Scott and Towne brooks, which both originate in Fitzwilliam, NH. Over the first mile the brook flows through wetlands with occasional riffles. For the remainder of its length it alternates between riffles, pools, and wetland areas as it flows south-southeast to the Millers River, west of Lake Denison, in Templeton. Much of this subwatershed is protected in the Birch Hill State Wildlife Management Area.

MA DFWELE conducted fish population sampling in Scott Brook north of Templeton Turnpike Road using a barge electroshocker in August 2000. A total of 137 fish, represented by 8 species, were collected. Fish species present, in order of abundance, included: fallfish (*Semotilus corporalis*), chain pickerel (*Esox niger*), white sucker (*Catostomus commersoni*), banded sunfish (*Enneacanthus obesus*), tesselated darter (*Etheostoma olmstedi*), pumpkinseed (*Lepomis gibbosus*), creek chubsucker (*Erimyzon oblongus*) and brown bullhead (*Ameiurus nebulosus*).

This segment is on the 1998 303(d) List of Waters for unknown toxicity, priority organics, and metals (Table 3).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Scott/Priest Brook subwatershed were identified in the MRPC and FRCOG (2002) report.

Sand & Gravel Operations

A sand and gravel operation is located to the north of Priest Brook.

Unpaved Roads

There are several unpaved roads that are close to water courses. One road runs parallel to Priest Brook and Scott Brook and crosses Towne Brook.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

Stream gaging data for Priest Brook are available from the USGS gage 01162500 located 100' downstream from Winchendon Road bridge in Royalston from 1916 to the present. The drainage area at this gage is 19.4 mi^2 and the average annual discharge over the period of record is 33.1 cfs (Socolow *et al.* 2001).

In September 2000, Priest Brook was about 3m wide in the reach sampled downstream from Winchendon Road, Royalston (Appendix C). The riffles were shallow (about 15 cm) but some run and pool areas were approximately a half meter deep. The water was tea-colored but clear. A lot of beaver activity was also observed making it difficult to find a riffle reach to sample. The total habitat score was 163.

Biology

Benthic macroinvertebrate sampling in Priest Brook was conducted by DWM in September 2000 downstream from Winchendon Road in Royalston (station B0448). Compared to the Lawrence Brook reference station (station B0449) the RBP III analysis indicated the benthic community was non-impacted (Appendix C).

MA DFWELE conducted fish population sampling in Priest Brook using a barge electroshocker near Birch Hill in August 2000. A total of 99 fish represented by 9 species were collected. Fish species present, in order of abundance, included: fallfish (*Semotilus corporalis*), chain pickerel (*Esox niger*), brown trout (*Salmo trutta*), brown bullhead (*Ameiurus nebulosus*), banded sunfish (*Enneacanthus obesus*), creek chubsucker (*Erimyzon oblongus*), yellow perch (*Perca flavescens*), tesselated darter (*Etheostoma olmstedi*), and white sucker (*Catostomus commersoni*). Fluvial specialists/dependant species dominated the fish sample although the brown trout were likely stocked. The presence of brown trout and creek chubsucker, both of which are intolerant to pollution, indicated good water quality conditions.

It should also be noted that in May 2003 MA DEP SMART staff observed a wood turtle crossing a trail near Priest Brook in Royalston. The turtle was positively identified as being *Clemmys insculpta* and an application has been made to the MA DFWELE to have this area designated as a Priority Habitat by the Natural and Endangered Species Program (Beaudoin 2003).

Toxicity

Ambient

Surface water samples from Priest Brook were collected near Winchendon Road and the USGS gaging station in Royalston (station PRWIN3) on 1, 4 and 6 November 2000 by EPA NERL personnel as a follow up to the detection of instream toxicity in the brook near Goodnow Road in Winchendon in August 1995 (Barr 1995). No instream toxicity to either *C. dubia* or *P. promelas* was detected during the 7-day chronic toxicity tests in November 2000 (McDonald 2001). Survival of both test species was $\geq$ 80% at the end of tests.

Chemistry – water

As part of the MA DEP SMART monitoring program, water quality sampling was conducted on five occasions between March and November 2000 in Priest Brook approximately 10 meters downstream/south of Winchendon Road at the USGS flow gauging station in Royalston (station PR01). The data that were collected are summarized below (Appendix A, Tables 6 and 7).

DO

DO measurements ranged from 5.3 to 11.4 mg/L. Percent saturation ranged from 54 to 84% with two of the five measurements less than 60%. It should be noted that these data do not represent the worst-case (pre-dawn) conditions.

Temperature

Temperature measurements ranged from a low of 4.0°C in March to a high of 22.2°C in July.

pH and Alkalinity

Instream pH measurements were very low ranging between 4.9 and 5.3 SU. Alkalinity was also very low ranging from <2 to 4 mg/L.

Suspended Solids

The maximum concentration for suspended solids was 2.4 mg/L while concentrations of total dissolved solids ranged from 26.2 to 30.2 mg/L. These are all low concentrations.

Turbidity
Turbidity was very low ranging from 0.30 to 1.5 NTU.

Specific Conductance
Specific conductance @ 25°C measurements ranged from 41.0 to 47.1 µS/cm which is low.

Ammonia-Nitrogen
Ammonia-nitrogen concentrations were all <0.02 mg/L.

Nitrate-Nitrogen
Concentrations of nitrate-nitrogen were all <0.02 mg/L.

Total Kjeldahl Nitrogen (TKN)
TKN concentrations ranged between 0.10 and 0.41 mg/L.

Total Phosphorus
Total phosphorus measurements ranged from <0.005 to 0.045 mg/L.

Chlorides
The level of chlorides ranged from 6.0 to 10 mg/L.

Hardness
Hardness measurements were all low ranging from 5.0 to 6.6 mg/L.

Dissolved metals
Although no instream toxicity was detected the dissolved aluminum and lead concentrations reported by EPA NERL in Priest Brook exceeded (up to 2 times) the national water quality criteria at a hardness of 25 mg/L (McDonald 2001).

Chemistry – sediment
Total PCB concentrations in surficial sediment screening samples collected in July 1999 from four stations along the lower 1.5 miles of Priest Brook were less than 2 ppm (ENSR 2000).

The *Aquatic Life Use* is assessed as support for Priest Brook based primarily on the benthic macroinvertebrate community and the fish population sample. However, it should be noted that low pH, hardness and alkalinity are exhibited in Priest Brook and that dissolved aluminum and lead concentrations slightly exceed water quality criteria. These low pH/alkalinity waters are naturally occurring but are also potentially impacted by or exacerbated by atmospheric deposition. This needs further investigation and documentation and, therefore, this use is also identified with an Alert Status.

FISH CONSUMPTION
Although no fish toxics monitoring has been conducted in Priest Brook all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP. It probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS
One fecal coliform bacteria sample was collected by MA DEP DWM from Priest Brook downstream from Goodnow Road, Winchendon (station M105) in May 1996. The bacteria count was low (Appendix A, Table 11).

No objectionable conditions in Priest Brook (odors, turbidity, surface oils, trash/debris) were noted by DWM biologists during the benthic survey conducted in September 2000 (Appendix C). Furthermore, the majority of this brook is protected within the Birch Hill State Wildlife Management Area. Observations by MA DEP SMART monitoring staff during their surveys indicated that Priest Brook

has a natural, deep red tannic color and that small, apparently natural, patches of foam were common. There is a small area that receives illegal dumping (trash and debris).

Although too little data are available to assess the *Recreational* uses the *Aesthetics Use* is assessed as support.

Priest Brook (MA35-10) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT*
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

* "Alert Status" issues identified, see details in use assessment section

RECOMMENDATIONS PRIEST BROOK (SEGMENT MA35-10)

Water Quality Monitoring

- The low pH/alkalinity in Priest Brook is probably naturally occurring but is also potentially impacted by or exacerbated by atmospheric deposition. This needs further investigation and documentation.
- Continue to periodically conduct biological monitoring (e.g., benthic macroinvertebrate and fish population) in Priest Brook to assess the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.
- Continue to conduct long-term fixed site monitoring at the Priest Brook site on Winchendon Road in Royalston to determine long-term water quality trends.

Nonpoint Sources of Pollution

- The sand and gravel operation located near the northern end of Priest Brook noted in the MRPC and FRCOG (2002) study should be field checked to confirm its presence. An evaluation should be performed to determine its status, to ensure that it is being operated and maintained properly, and to protect water quality. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status, and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).

Fish Consumption

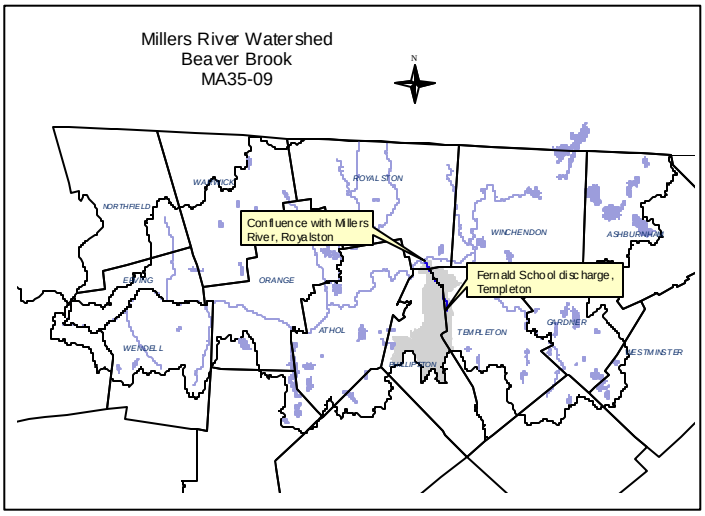
- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption should be limited body burdens of PCB and mercury in the edible portions of fish from Priest Brook should be further investigated. Determination of natural or man-made barriers to migration in tributaries of the Millers River, including Priest Brook, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

Land Protection

- The impervious area for sub-basins within this subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Royalston and Winchendon should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both Royalston and Winchendon continue to work with the Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Towns of Royalston and Winchendon participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Royalston and Winchendon can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

BEAVER BROOK (SEGMENT MA35-09)

Location: Templeton Developmental Center (formerly Fernald School) discharge, Templeton to confluence with Millers River, Royalston.
Segment Length: 3.4 miles.
Classification: Class B, Cold Water Fishery.



The drainage area of this segment is approximately 9.5 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	80%
Residential	7%
Agriculture	5%

The impervious area for the sub-basins within the Beaver Brook watershed drainage is all less than 10%, therefore it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

Although this brook is actually formed by the confluence of Chickerling and Dunn brooks in Phillipston, this segment begins at the outfall of the Templeton Developmental Center (formerly Fernald School) WWTP discharge in Templeton. The brook flows rapidly in a north-northwesterly direction as it forms the boundary between Templeton and Phillipston. As it passes under Royalston Road it slows and enters an extensive wetland area before joining the Millers River in South Royalston.

This segment is on the 1998 303(d) List of Waters for confirmation of priority organics, metals, and pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY

Based on the available information there are no WMA regulated water withdrawals in this subwatershed area.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2)

The Massachusetts Department of Mental Health is authorized to discharge from the Templeton Development Center (formerly the Fernald School) Wastewater Treatment Facility (WWTF) Templeton, MA into Beaver Brook (NPDES permit #MA0102156 issued September 1999). The permittee is authorized to discharge an average monthly flow of 0.05 MGD of treated sanitary wastewater via outfall 001. The facility has a seasonal ammonia-nitrogen limit of 10 mg/L. Effluent total ammonia-nitrogen concentrations (average monthly) between April 2000 and October 2001 have ranged from 0.6 to 2.1 mg/L (EPA 2003). The facility's whole effluent toxicity limits are $LC_{50} \geq 100\%$ and $CNOEC \geq 30\%$ with a monitoring frequency of 4X/year for both. The maximum daily TRC limit is 0.06 mg/L. Effluent TRC concentrations reported in the facility's toxicity testing evaluations have been highly variable and were reported as high as 15.6 mg/L. The facility recently implemented ultraviolet light for disinfection, which went on-line in August 2002 (Ostrosky 2003). Between 2000 and 2002 the facility operated with a flow between 0.02 to 0.025 MGD. During a site visit it was noted that a dairy operation at this facility was tied into the wastewater treatment plant. Over the course of the past year at least two fuel oil leaks have been released to the sanitary system. One floor drain was sealed off to prevent future problems of this nature (Ostrosky 2003). EPA is scheduled to reissue this permit in 2004 and will likely include a requirement for total nitrogen monitoring and reporting.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

DWM biologists sampled one reach of Beaver Brook downstream from the Templeton Development Center Wastewater Treatment Facility (in Templeton) in September 2000 (station B0450). The brook was approximately 4m wide and depth ranged from 0.25m in riffles up to 0.75 m in one or more of the

pools. Boulder and cobble dominated the substrates. There was a small amount of fine particulate organic matter (FPOM) visible settling out in some limited areas of the reach. The water was tea-colored and may have been slightly turbid. Instream vegetative cover included moss, water cress, water starwort (*Callitriche* sp.), and small areas with a thin-film green algae. The overall habitat score was 190 (Appendix C).

Biology

Benthic macroinvertebrate sampling in Beaver Brook was conducted by DWM in September 2000 downstream from the Templeton Development Center Wastewater Treatment Facility in Templeton, MA (station B0450). Compared to the Lawrence Brook reference station (station B0449) the RBP III analysis indicated the benthic community was slightly impacted (Appendix C).

In September 2000 MA DFWELE conducted fish population sampling in Beaver Brook just downstream from a private road near the Templeton Development Center (formerly Fernald School) in Templeton. This site is also downstream from the discharge from the Templeton Development Center WWTF. Using backpack shocking, a total of 81 fish represented by 6 species were collected. The dominant species were white sucker (*Catostomus commersoni*) and fallfish (*Semotilus corporalis*). Other fish species present, in order of abundance, included: blacknosed dace (*Rhinichthys atratulus*), tesselated darter (*Etheostoma olmstedi*), brook trout (*Salvelinus fontinalis*), and chain pickerel (*Esox niger*). The fish sample being dominated by fluvial dependant/specialists and the presence of multiple age-classes of eastern brook trout are indicative of good water quality and stable flow regimes.

Toxicity

Ambient

Water is collected from Beaver Brook approximately 25 yards upstream of the Templeton Development Center discharge for use as dilution water in the Templeton Development Center's whole effluent toxicity tests. Between February 2000 and January 2003 survival of *C. dubia* exposed (7-day) to the river water was good ($\geq$ 80% survival) in the 14 valid tests conducted.

Effluent

A total of 15 modified acute and chronic whole effluent toxicity tests were conducted on the Templeton WWTP treated effluent (Outfall #001) using *C. dubia* between February 2000 and January 2003. The effluent was very acutely toxic (LC_{50} = 8.84% effluent) during the April 2001 test, but with the exception of this one test event the LC_{50}'s were all reported as >100% effluent. Seven of the 14 effluent evaluations exhibited some chronic toxicity with CNOECs ranging from <6.25 to 100% effluent. In the 7-day chronic renewal test organisms are sequentially exposed to three separate composite effluent samples collected over the course of the test. For most of the seven tests that exhibited chronic toxicity, it was noted that the toxicity in these tests manifested very soon after the second or third effluent renewal. That is, the chronic endpoints in these effluent evaluations appeared to be caused by acute events within each test. The CNOEC permit limit of $\geq$ 30% effluent was not met in four of the 14 valid tests.

Chemistry – water

Water from Beaver Brook was collected approximately 25 yards upstream from the discharge for use as dilution water in the Templeton Development Center WWTP whole effluent toxicity tests on 10 occasions between February 2000 and January 2003. Data from these reports (TOXTD database) are summarized below.

Water quality sampling was also conducted by MA DEP DWM in July and August of 2000 in Beaver Brook (station BB01) upstream/south of the Main Road bridge (south of Route 68) in Phillipston (Appendix A, Tables 6 and 7). This sampling location was downstream from the Templeton Development Center discharge. These data are also summarized below.

DO
Measurements for DO at in the brook (station BB01) were 3.8 mg/L in July and 6.6 mg/L in August while percent saturation was 42% and 66%, respectively. It should be noted that these data do not represent the worse-case (pre-dawn conditions).

Temperature
Temperature in the brook (station BB01) was highest in July at 20.5°C while the August measurement was somewhat lower (16.1°C).

pH and Alkalinity
Instream pH ranged between 5.8 and 7.1 SU, with 7 of the 15 measurements (47%) <6.5 SU (TOXTD database). Measurements for pH in the brook (station BB01) were 5.3 and 5.7 SU with alkalinities of 6 and 3 mg/L.

Suspended and Dissolved Solids
None of the suspended solids concentrations exceeded 10 mg/L (TOXTD database). At station BB01 values of 2.7 and 1.6 mg/L were reported for the July and August sampling dates for suspended solids. Total dissolved solids at this site were measured at 96.0 and 88.7 mg/L.

Turbidity
Measurements for turbidity in the brook (station BB01) were 3.3 NTU in July and 2.0 NTU in August.

Specific Conductance
Measurements for specific conductance@ 25°C in the brook (station BB01) were 150 and 139 µS/cm.

Ammonia-Nitrogen
The maximum ammonia-nitrogen measurement was 0.29 mg/L (TOXTD database). Both measurements in the brook (station BB01) were <0.02 mg/L. These measurements were below the acute and chronic water quality criteria for ammonia-nitrogen (based on the maximum pH and temperatures recorded).

Nitrate –Nitrogen
Measurements for nitrate-nitrogen were 0.08 mg/L on both sampling dates in the brook (station BB01).

Total Kjeldahl Nitrogen
Measurements for Total Kjeldahl Nitrogen in the brook (station BB01) were 0.68 and 0.61 mg/L.

Total Phosphorus
Total phosphorus concentrations in the brook (station BB01) were 0.17 mg/L in July and 0.091 mg/L in August.

Total Residual Chlorine
TRC measurements were all below the minimum quantification level of 0.05 mg/L (TOXTD database).

Hardness
Hardness measurements taken at Beaver Brook (TOXTD database) ranged from 13 to 30 mg/L (only 2 of 13 measurements were >25 mg/L). Hardness measurements in the brook (station BB01) were 15 and 12 mg/L.

Chloride
The chloride concentrations in the brook (station BB01) were 40 mg/L in July and 31 mg/L in August.

The *Aquatic Life Use* is assessed as support for Beaver Brook based primarily on the benthic macroinvertebrate community, the fish population sample, and the high survival of test organisms exposed to Beaver Brook. However, it should be noted that low pH, hardness and alkalinity are exhibited in Beaver Brook. These low pH/alkalinity waters are likely naturally occurring but are also potentially impacted by or exacerbated by atmospheric deposition -- this needs further investigation and documentation. Since low

DO/saturation, elevated total phosphorus concentrations, and chronic toxicity in whole effluent toxicity tests were also documented, the *Aquatic Life Use* is identified with an Alert Status.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in Beaver Brook all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

The water at this station was a deep tannic color and small patches of foam (naturally occurring) were present. With the exception of some slight turbidity no objectionable conditions were observed by DWM biologists during their survey in Beaver Brook in September 2000 (Appendix C). There was no odor nor any evidence of surface oils, trash or debris.

Although too little data are available to assess the *Recreational* uses the *Aesthetics Use* is assessed as support based on observations made by DWM biologists.

Beaver Brook (MA35-09) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT*
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

*"Alert Status" issue identified see details in use assessment section

RECOMMENDATIONS BEAVER BROOK (SEGMENT MA35-09)

Water Quality Monitoring

- Continue to monitor water quality conditions (benthic macroinvertebrate, *in-situ* monitoring) in Beaver Brook upstream and downstream from the Templeton Development Center's discharge to monitor any potential effects from the discharge as well as to assess the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Point Sources of Pollution

- Continue to evaluate the Templeton Development Center's compliance with their NPDES permit limits. If toxicity continues to be detected in the whole effluent a toxicity identification/reduction evaluation should be required. Their permit should be reissued with appropriate limits and monitoring requirements including a requirement for a phosphorus loading, evaluation and reduction program (a total phosphorus limit will also likely be imposed) (Appendix D, Table D1).

Hydrology

- In order to determine the cause of pulsing flows in the Millers River, the Gomez and Sullivan (2003) report recommended that hourly or daily discharges for all NPDES facilities should be evaluated. These data should be collected at the Templeton Development Center Wastewater Treatment Facility and should be used to determine what affect discharges have on stream flow.

Fish Consumption

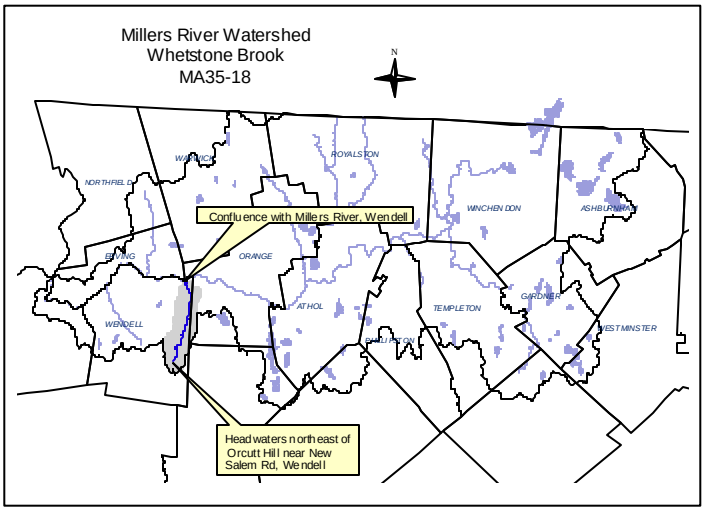
- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption should be limited body burdens of PCB and mercury in the edible portions of fish from Beaver Brook should be further investigated. Determination of natural and/or man-made barriers to migration in tributaries of the Millers River, including Beaver Brook, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

Land Protection

- It is recommended that MA DCR and the Department of Mental Retardation continue to coordinate their land management conservation efforts at the Templeton Development Center.
- The impervious area for the sub-basins within the Beaver Brook watershed drainage is all less than 10%, therefore it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Royalston and Templeton should review the information generated through the buildout analysis performed by EOEA that created a profile of how the community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Greater Gardner Sustainable Growth Management Plan (MRPC and Daylor Consulting Group, Inc. 1999) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both Templeton and Winchendon continue to work with the Montachusett Regional Planning Commission on land use planning issues.
- It is recommended that the Towns of Templeton and Royalston participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Royalston and Templeton can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

WHETSTONE BROOK (SEGMENT MA35-18)

Location: Headwaters northeast of Orcutt Hill near New Salem Rd, Wendell to confluence with Millers River, Wendell.
Segment Length: 4.9 miles.
Classification: Class B.



The drainage area of this segment is approximately 5.2 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	96%
Wetlands	2%
Open Land	1%

The impervious area for the sub-bains in the Whetstone Brook subwatershed is less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

MA DFWELE has proposed that Whetstone Brook be reclassified in the SWQS as a cold water fishery (MassWildlife 2001). Whetstone Brook was the location of an experimental liming project conducted by the MA DFWELE in the late 1980's and early 1990's to counteract the effects of acidity. Monitoring was conducted four years prior to and three years following treatment of the brook with limestone. The density of brook trout was found to increase significantly during the limestone treatment (Simmons *et al*. 1996).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

NONPOINT SOURCES OF POLLUTION

Unpaved Roads

The MRPC and FRCOG (2002) report indicates a few unpaved roads in this subwatershed that are located close to the unnamed tributaries to Whetstone Brook.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

One stream reach in Whetstone Brook was sampled by DWM biologists between September 1996 and September 2000. The reach was located approximately 50m downstream from the Kentfield (Kempfield) Road in Wendell (station WM04WHE) and was surveyed as part of the MA DEP biocriteria development project in September 1996, 1998 and 2000. In September 2000 the river was approximately 3 m wide with depths ranging from 0.15 to 0.2 m in riffle and pool habitats, respectively (MA DEP 2000b). The total habitat assessment score was 164. Stream gaging data for Whetstone Brook were collected by USGS between December 1985 and September 1991 from their gage 01165105 located downstream from Depot Road Bridge near Wendell Depot (drainage area 5.22 mi^2). The mean annual discharge of Whetstone Brook over the period of record was 9.94 cfs and the discharge exceeded 2.0 cfs 90% of the time (Gadoury *et al.* 1992).

Biology

As part of the MA DEP biocriteria development project benthic macroinvertebrate samples were collected by DWM biologists from Whetstone Brook approximately 50m downstream from the Kentfield (Kempfield) Road in Wendell (station WM04WHE) on 9 September 1996 and again on 11 September 2000 (Appendix C). No RBP III analyses have been conducted on these data.

The fish population sample in Whetstone Brook (station WM04WHE) was comprised of multiple age classes of brook trout (*Salvelinus fontinalis*) and an individual brown trout (*Salmo trutta*) in 1996 and

only *S. fontinalis* in 1998 and 2000 (sampling conducted on 27 September 1996, 21 September 1998, and 21 September 2000) (Appendix A, Table 13). The total number of fish sampled in 1996 was 10. In 1998 it was 15, and in 2000 it was 16. MA DFWELE also conducted fish population sampling in this same reach of Whetstone Brook using a backpack electroshocker on 13 September 2000. A total of 13 fish, all brook trout (*Salvelinus fontinalis*), were collected. Although the number of fish was low the presence of multiple age classes of brook trout, an intolerant, fluvial specialist, indicated excellent habitat and water quality conditions.

Chemistry - water

In-situ measurements (DO, %saturation, pH, temperature, conductivity, and turbidity) of Whetstone Brook approximately 50m downstream from the Kentfield (Kempfield) Road in Wendell (station WM04WHE) were made by MA DEP DWM on 27 September 1996 and 21 September 1998 (Appendix A, Table 8).

DO and % saturation
Instream DO measurements were not less than 9.5 mg/L or 97% saturation.

Temperature
The highest instream temperature was 17.1°C.

pH
One of two instream pH measurements was low (5.8 SU).

Conductivity
Instream conductivity 18 µS/cm on both occasions.

Turbidity
On both sampling dates turbidity was 7 mg/L.

The *Aquatic Life Use* is assessed as support based primarily on the fish population information. The presence of multiple age classes of brook trout is indicative of excellent habitat and water quality. Furthermore, these fish are fluvial specialists, which suggests that the flow regime has not been compromised in this brook. However, the consistently low number of fish present may be indicative of environmental stress (suspected to be associated with low pH) and, therefore, this use is identified with an Alert Status.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in Whetstone Brook all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

No objectionable deposits, oils, odors, trash or debris were noted by DWM biologists in their sampling reach on the Whetstone Brook in September 2000 (MA DEP 2000b).

Although too limited data are available to assess the *Recreational Uses* for Whetstone Brook the *Aesthetics Use* is assessed as support based on on observations made by DWM biologists.

Whetstone Brook (MA35-18) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT*
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS WHETSTONE BROOK (SEGMENT MA35-18)

Water Quality Classification

- Whetstone Brook should be reclassified in the next revision of the SWQS as a cold water fishery.

Water Quality Monitoring

- The low pH in Whetstone Brook is probably naturally occurring but is also potentially impacted by or exacerbated by atmospheric deposition -- this needs further investigation and documentation.
- Continue to periodically conduct biological monitoring (e.g., benthic macroinvertebrate and fish population) in Whetstone Brook to assess the *Aquatic Life Use*. Since low numbers of fish were collected, continue to monitor the fish population in Whetstone Brook in order to better estimate densities and determine the affect of any environmental stress such as low pH.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Sources of Pollution

- The unpaved roads in close proximity to watercourses in this subwatershed should be field checked to confirm their condition and location. An evaluation should be performed to determine if there are any impacts from these roads on the adjacent watercourses that may affect water quality. Best management practices, as described in Unpaved Roads BMP Manual (Berkshire Regional Planning Commission 2001), should then be implemented, as appropriate.

Fish Consumption

- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption should be limited, body burdens of PCB and mercury in the edible portions of fish from Whetstone Brook should be further investigated. Determination of natural or man-made barriers to migration in tributaries of the Millers River, including Whetstone Brook, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

Land Protection

- The impervious area for the subbasins in the Whetstone Brook subwatershed is less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Wendell should review the information generated through the buildout analysis performed by EOEA that created a profile of how each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports

should be undertaken and appropriate recommendations should be implemented. It is recommended that Wendell continue to work with the Franklin Regional Council of Governments on land use planning issues.

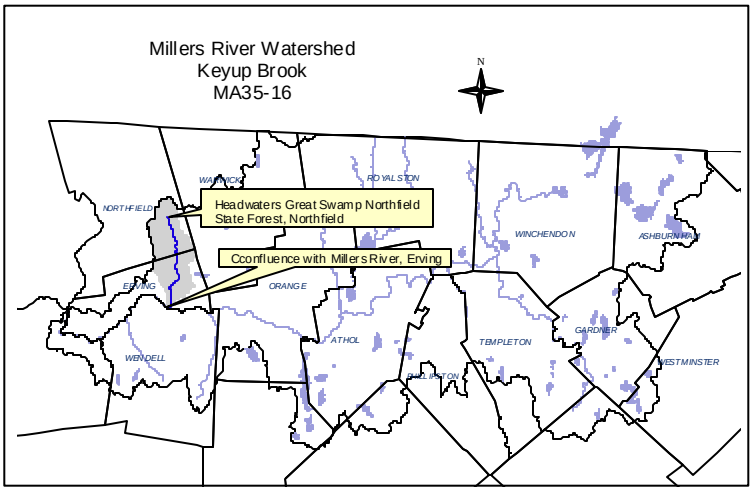
- It is recommended that the Town of Wendell participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Wendell can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

KEYUP BROOK (SEGMENT MA35-16)

Location: Headwaters Great Swamp Northfield State Forest, Northfield, to confluence with Millers River, Erving.

Segment Length: 5.0 miles.

Classification: Class B.



The drainage area of this segment is approximately 7.1 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	93%
Residential	3%
Agriculture	2%

The impervious area for the sub-basins within the Keyup Brook subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

MA DFWELE has proposed that Keyup Brook and its tributary, Jacks Brook, be reclassified in the SWQS as a cold water fishery (MassWildlife 2001).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Sand & Gravel Operations

A sand and gravel operation is located in the southern portion of this subwatershed.

Unpaved Roads

An unpaved road runs along a good portion of the length of Keyup Brook.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

A total of three stream reaches in Keyup Brook were surveyed by DWM biologists as part of the MA DEP biocriteria development project in September 1996 and/or September 2000 (Appendix A, Table 13). The most upstream reach sampled was downstream from the intersection of Swamp Road with Laurel Lake Road in Erving (station WM13KEY). In September 2000 the brook was approximately 4m wide with riffle/run and pool habitats approximately 0.1 and 0.25 m deep, respectively. There was some slight erosion noted on the one bank. Habitat quality during this survey appeared to be most limited by the amount of water (brook was shallow and the channel was not full). The next downstream reach was sampled on 19 September 2000. This reach was located upstream from the confluence with Jacks Brook and downstream from the first Laurel Lake Road crossing in Erving (station WM13KEYa). Here the reach was comprised of pool, riffle, and run habitat of a moderate gradient. A large area of erosion, however, was noted upstream of the sampling reach next to the driveway of a house and barn on the streams southern bank. This erosion was seriously compromising habitat integrity (sedimentation) of the reach surveyed (MA DEP 2000b). The most downstream reach sampled was located downstream from the Jacks Brook confluence in Erving (station WM11KEY) on 11 September 1996.

Biology

As part of the MA DEP biocriteria development project benthic macroinvertebrate samples were collected by DWM biologists from two reaches of Keyup Brook; downstream from the intersection of Swamp Road with Laurel Lake Road in Erving (station WM13KEY) on 11 September 1996 and on 11

September 2000 and the second reach downstream from the confluence with Jacks Brook in Erving (station WM11KEY) on 11 September 1996 (Appendix A, Table 13). No RBP III analyses have been conducted on these data.

Fish population sampling was also conducted by DWM in these two reaches in Keyup Brook on 26 September 1996. The fish population sample in Keyup Brook (station WM13KEY) was comprised entirely of native brook trout while the downstream reach (WM11KEY) was comprised, in order of abundance, of blacknose dace (*Rhinichthys atratulus*), longnose dace (*Rhinichthys cataractae*), *Salmo trutta* (brown trout), white sucker (*Catostomus commersoni*) and an individual brook trout (*Salvelinus fontinalis*) (Appendix A, Table 13). On 19 September 2000 fish population sampling was conducted in the brook upstream from the confluence with Jacks Brook and downstream from the first Laurel Lake Road crossing in Erving (station WM13KEYa) by MA DEP DWM biologists. Blacknose dace (*Rhinichthys atratulus)* dominated the fish sample, while brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*) and white sucker (*Catostomus commersoni*) were also present (Appendix A, Table 13). All fish collected were fluvial specialists or fluvial dependant species. MA DFWELE also conducted fish population sampling in Keyup Brook in the vicinity of the intersection of Swamp Road with Laurel Lake Road in Erving (DWM station WM13KEY) using backpack shocking on 30 August 30 2000. A total of 76 fish represented by 4 species were collected. Fish species present, in order of abundance, included: brook trout (*Salvelinus fontinalis*), pumpkinseed (*Lepomis gibbosus*), white sucker (*Catostomus commersoni*) and blacknose dace (*Rhinichthys atratulus*). The dominant species was brook trout (n = 71). The presence of multiple age classes of brook and brown trout is indicative of excellent water and habitat quality.

Chemistry - water

In-situ measurements (DO, %saturation, pH, temperature, conductivity, and turbidity) of Keyup Brook downstream from the intersection of Swamp Road with Laurel Lake Road in Erving (station WM13KEY) were made on 26/27 September 1996 (Appendix A, table 8). Although not representative of worse-case (pre-dawn) conditions DO and oxygen saturation in the brook was good. The pH of the brook was extremely low at the upstream sampling station (4.6 and 4.9 SU) and was higher (6.0 SU) in the sampling reach downstream from the confluence with Jacks Brook in Erving (station WM11KEY).

The *Aquatic Life Use* is assessed as support for Keyup Brook based primarily on the fish population information. The presence of multiple age classes of brook and brown trout (including young of the year) is indicative of excellent habitat and water quality. All fish collected are examples of fluvial specialists or fluvial dependant species, which suggests that the flow regime has not been compromised at this location. However, this use is identified with an Alert Status because of the erosion problem noted upstream from the confluence with Jacks Brook and downstream from the first Laurel Lake Road crossing in Erving and because of the extremely low pH levels.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in Keyup Brook all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

No objectionable deposits, oils, odors, trash or debris were noted by DWM biologists in their sampling downstream from Laurel Lake Road in Erving on Keyup Brook in September 1996 and September 2000 (Appendix A, Table 13 and Appendix G).

Although too limited data are available to assess the *Recreational Uses* for Keyup Brook the *Aesthetics Use* is assessed as support based on on observations made by DWM biologists.

Keyup Brook (MA35-16) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT*
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS KEYUP BROOK (SEGMENT MA35-16)

Water Quality Classification

- Keyup Brook and Jacks Brook should be reclassified in the next revision of the SWQS as a cold water fishery.

Water Quality Monitoring

- The low pH in Keyup Brook is probably naturally occurring but is also potentially impacted by or exacerbated by atmospheric deposition. This needs further investigation and documentation.
- Continue to periodically conduct biological monitoring (e.g., benthic macroinvertebrate and fish population) in Keyup Brook to assess the *Aquatic Life Use*.
- Continue to periodically conduct habitat quality evaluations in Keyup Brook to evaluate any potential impacts from erosion resulting in instream habitat quality degradation, determine the need to develop and implement an instream habitat restoration/improvement project, and to better assess the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Sources of Pollution

- Long-term stabilization of the southern stream bank (upstream from the confluence with Jacks Brook and downstream from the first Laurel Lake Road crossing in Erving) in the vicinity of the house and barn is essential to maintaining the habitat quality within this and downstream reaches. This area constitutes a high risk for significant additional erosion and subsequent sedimentation. It was also noted that the riparian zone on the southern side of the stream was stabilized with tires and cement slabs at locations adjacent to the house and barn respectively. These stabilization efforts appeared to be a number of years old and relatively effective in preventing erosion.
- Investigate and confirm the presence of the sand and gravel operation in this subwatershed. Evaluate this site to ensure that it is being operated and maintained properly and that any water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for municipal boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).

- The unpaved roads that are in close proximity to watercourses should be field checked to verify their location and an evaluation should be performed to determine if there are any impacts from these roads on adjacent watercourses that may affect water quality. Best management practices, as described in Unpaved Roads BMP Manual (Berkshire Regional Planning Commission 2001), should then be implemented as appropriate.

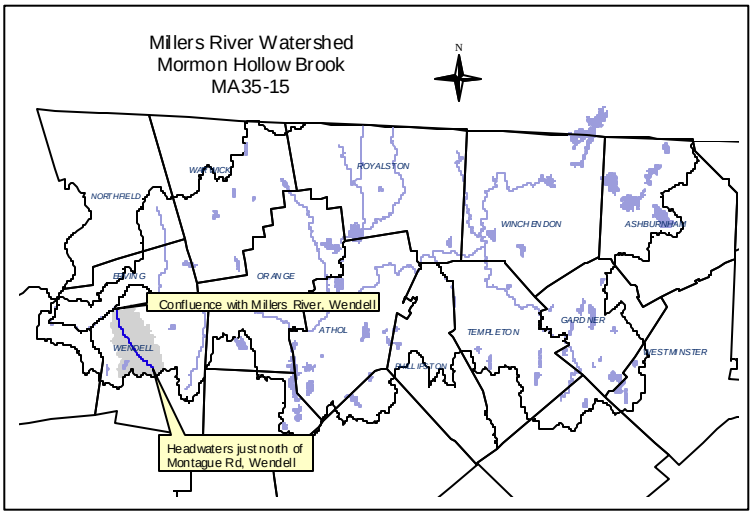
Fish Consumption

- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption should be limited body burdens of PCB and mercury in the edible portions of fish from Keyup Brook should be further investigated. Determination of natural or man-made barriers to migration in tributaries of the Millers River, including Keyup Brook, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

Land Protection

- The impervious area for the sub-basins within the Keyup Brook subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Erving and Northfield should review the information generated through the buildout analysis performed by EOEA that created a profile of how each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both the communities of Erving and Northfield continue to work with the Franklin Regional Council of Governments on land use planning issues.
- It is recommended that the Towns of Erving and Northfield participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Erving and Northfield can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

MORMON HOLLOW BROOK (SEGMENT MA35-15)
Location: Headwaters just north of Montague Rd, Wendell to confluence with Millers River, Wendell.
Segment Length: 3.9 miles.
Classification: Class B.



The drainage area of this segment is approximately 5.6 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	90%
Open Land	3%
Residential	2%

The impervious area for the sub-basins in the Mormom Hollow Brook subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

The use assessment for Wickett Pond (MA35102) can be found in the Lake Assessment section of this report.

MA DFWELE has proposed that Mormon Hollow Brook be reclassified in the SWQS as a cold water fishery (MassWildlife 2001).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY
Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)
Unpaved Roads
The MRPC and FRCOG 2002 report indicated that there are numerous unpaved roads that are close to waterbodies and watercourses in this subwatershed.

USE ASSESSMENT
AQUATIC LIFE
Habitat and Flow
One stream reach in Mormon Hollow Brook was sampled by DWM biologists between September 1996 and September 2000 (Appendix A, Table 13). The reach was located downstream from the confluence with Baker Brook near Farley Road in Wendell (station WM09MOR) and was surveyed as part of the MA DEP biocriteria development project in September 1996, 1998 and 2000. In September 2000 the river was approximately 4 m wide with depths ranging from 0.15 to 0.4 m in riffle and pool habitats, respectively. Instream habitat during both surveys appeared to be most limited by the amount of flow. The total habitat assessment score was 171.

Biology
As part of the MA DEP biocriteria development project benthic macroinvertebrate samples were collected by DWM biologists from Mormon Hollow Brook downstream from the confluence with Baker Brook near Farley Road in Wendell (station WM09MOR) on 11 September 1996, 17 September 1998 and again on 11 September 2000 (Appendix C). No RBP III analyses for these data have been conducted.

Fish population surveys were also conducted on 27 September 1996, 21 September 1998, and 19 September 2000. The samples were primarily comprised of multiple age classes of brook trout (*Salvelinus fontinalis*)(Appendix A, Table 13), which are intolerant, fluvial specialists. In 1998 a pumpkinseed (*Lepomis gibbosus*) and a brown trout (*Salmo trutta*) were also captured. The presence of multiple age classes of brook trout is indicative of excellent water and habitat quality.

MA DFWELE conducted fish population sampling in Mormon Hollow Brook using a backpack electroshocker at the Metacomet & Monadnock Trail crossing in September 2000. A total of 12 fish represented by 3 species were collected. Fish species present, in order of abundance, included: brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*) and pumpkinseed (*Lepomis gibbosus*). Multiple age classes of brook and brown trout were present. The pumpkinseed likely originated from Wickett Pond (located upstream).

Chemistry - water

In-situ measurements (DO, %saturation, pH, temperature, conductivity, and turbidity) of Mormon Hollow Brook downstream from the confluence with Baker Brook near Farley Road in Wendell (station WM09MOR) were made by MA DEP DWM on 27 September 1996 and 21 September 1998 (Appendix A, Table 8).

DO and % saturation

Although not representative of worse-case (pre-dawn) conditions the instream DOs were not less than 8.3 mg/L or 83% saturation.

Temperature

The maximum instream temperature was 16.7°C.

pH

One of two instream pH measurements was low (5.7 SU).

The *Aquatic Life Use* is assessed as support based primarily on the fish population information (supports a native population of brook trout).

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in Mormon Hollow Brook all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

No objectionable deposits, oils, odors, trash or debris were noted by DWM biologists in their sampling reach on Mormon Hollow Brook (station WM09MOR) in September 1996, 1998 or 2000 (MA DEP 2000b and Appendices A, C and G).

Although too limited data are available to assess the *Recreational Uses* for Mormon Hollow Brook the *Aesthetics Use* is assessed as support based on on observations made by DWM biologists.

Mormon Hollow Brook (MA35-15) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT

RECOMMENDATIONS MORMON HOLLOW BROOK (SEGMENT MA35-15)

Water Quality Classification

- Mormon Hollow Brook should be reclassified in the next revision of the SWQS as a cold water fishery.

Water Quality Monitoring

- The low pH in Mormon Hollow Brook is probably naturally occurring but is also potentially impacted by or exacerbated by atmospheric deposition -- this needs further investigation and documentation.
- Continue to periodically conduct biological monitoring (e.g., benthic macroinvertebrate and fish population) in Mormon Hollow Brook to assess the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Sources of Pollution

- The unpaved roads that are close to waterbodies should be field checked to verify their location and an evaluation should be performed to determine if there are any impacts from these roads on the adjacent waterbodies that may affect water quality. Best management practices, as described in Unpaved Roads BMP Manual (Berkshire Regional Planning Commission 2001), should then be implemented as appropriate.

Fish Consumption

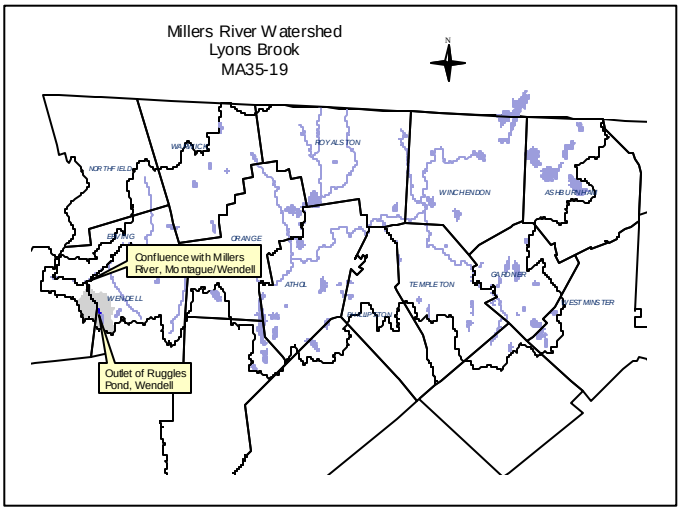
- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption be limited body burdens of PCB and mercury in the edible portions of fish from Mormon Hollow Brook should be further investigated. Determination of natural or man-made barriers to migration in tributaries of the Millers River, including Mormon Hollow Brook, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

Land Protection

- The impervious area for the sub-basins in the Mormom Hollow Brook subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Wendell should review the information generated through the buildout analysis performed by EOEA that created a profile of how each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that the community of Wendell continue to work with the Franklin Regional Council of Governments on land use planning issues.
- It is recommended that the Town of Wendell participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Wendell can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

LYONS BROOK (SEGMENT MA35-19)

Location: Outlet of Ruggles Pond, Wendell to confluence with Millers River, Montague/Wendell.
Segment Length: 2.1 miles.
Classification: Class B.



The drainage area of this segment is approximately 3.5 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	91%
Open Land	2%
Agriculture	2%

The impervious area for the sub-bains within the Lyons Brook subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001).

The Mormon Hollow Demolition Landfill in Wendell is located southeast of the confluence of Lyons Brook and the Millers River. This landfill is partially capped but experienced slope failure in 2000. MA DEP's Western Regional Office is overseeing the stabilization of the landfill and conducts water quality monitoring of groundwater and nearby surface waters on an annual basis (Howland June 3 2003).

The use assessment for Ruggles Pond (MA35072) can be found in the Lake Assessment section of this report.

MA DFWELE has proposed that Lyons Brook be reclassified in the SWQS as a cold water fishery (MassWildlife 2001).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY

Based on the available information there are no WMA regulated water withdrawals or NPDES regulated surface wastewater discharges in this subwatershed.

NONPOINT SOURCES OF POLLUTION (POTENTIAL)

The following potential sources of nonpoint pollution in this segment of the Millers River were identified in the MRPC and FRCOG (2002) report.

Sand & Gravel Operations

A sand and gravel operation is located in the southern portion of Lyons Brook near Ruggles Pond.

Unpaved Roads

There are several unpaved roads in this subwatershed that are close to watercourses and waterbodies.

USE ASSESSMENT

AQUATIC LIFE

Habitat and Flow

DWM biologists sampled one reach in Lyons Brook near its mouth between the railroad bridge and the Millers River confluence (station B0445), Wendell/Montague in September 2000. The brook was approximately 3 m wide and depth ranged from 0.1 m in riffles up to 0.2 m in one or more of the pools. Cobble dominated the substrates. No rooted vegetation was found instream, but filamentous green algae were attached to rocks in approximately 5% of the area. Instream habitat appeared to be most limited by the amount of flow. The habitat score total was 159 (Appendix C).

Biology

Benthic macroinvertebrate sampling in Lyons Brook was conducted by DWM in September 2000 at the mouth of the brook between the railroad bridge and the confluence with the Millers River (station B0445). Compared to the Lawrence Brook reference station (station B0449) the RBP III analysis indicated the benthic community was non-impacted (Appendix C). The fish population sample from

Lyons Brook just upstream from the confluence with the Millers River (station LB01) was comprised, in order of abundance, of longnose dace (*Rhinichthys cataractae)*, native brook trout (*Salvelinus fontinalis*), fallfish (*Semotilus corporalis*), and white sucker (*Catostomus commersoni*) (sampling conducted on 19 September 2000) (Appendix A, Table 13). The dominance of longnose dace and the presence of multiple age classes of brook trout indicate excellent water quality. White sucker and fallfish were also collected. All fish collected are examples of fluvial specialists or fluvial dependant species, which suggests that the flow regime is stable.

In August of 2001 MA DFWELE conducted fish population sampling in Lyons Brook using backpack shocking near the outflow of Ruggles Pond. A total of 8 fish were collected, all of which were brook trout (*Salvelinus fontinalis*). The presence of multiple age classes of brook trout is indicative of excellent water quality and is consistent with conditions typically found in the headwaters of cold-water streams.

The *Aquatic Life Use* is assessed as support for Lyons Brook based on the benthic macroinvertebrate and fish community information.

FISH CONSUMPTION

Although no fish toxics monitoring has been conducted in Lyons Brook all tributaries to the Millers River are included in the current Millers River Fish Consumption Advisory (MA DPH 2002a). Until site-specific data are generated the *Fish Consumption Use* is assessed as impaired (mercury and PCBs). The current source of PCBs in river water is contaminated sediments in the Otter and Millers Rivers. The original source of sediment contamination is believed to be located near the former Baldwinville Products Mill (property currently owned by American Tissue Mills, Inc.) and the Templeton WWTP and probably is related to historic discharge from the former Baldwinville Products Mill to the Otter River.

PRIMARY CONTACT AND SECONDARY CONTACT RECREATION AND AESTHETICS

With the exception of some evidence of the Mormom Hollow Demolition Landfill's presence, no objectionable deposits, oils, odors, or trash were noted by DWM biologists in their sampling reach on Lyons Brook (station WM09MOR) in September 2000 (MA DEP 2000b, Appendix C and G).

Although too limited data are available to assess the *Recreational Uses* for Lyons Brook the *Aesthetics Use* is assessed as support. However, this use is identified with an Alert Status because of the Mormom Hollow Demolition Landfill in Wendell, which has experienced slope failure and is currently in the process of being stabilized.

Lyons Brook (MA35-19) Use Summary Table

Designated Uses	Status
Aquatic Life 	SUPPORT
Fish Consumption 	IMPAIRED *Causes*: Mercury and PCB *Sources*: Unknown for mercury, contaminated sediment, releases from waste sites or dumps (*Suspected Source*: Atmospheric deposition)
Primary Contact 	NOT ASSESSED
Secondary Contact 	NOT ASSESSED
Aesthetics 	SUPPORT*

* "Alert Status" issues identified, see details in the use assessment section

RECOMMENDATIONS LYONS BROOK (SEGMENT MA35-19)

Water Quality Classification

- Lyons Brook should be reclassified in the next revision of the SWQS as a cold water fishery.

Water Quality Monitoring

- Continue to periodically conduct biological monitoring (e.g., benthic macroinvertebrate and fish population) in Lyons Brook to assess the *Aquatic Life Use*.
- Monitor bacteria levels to assess the status of the *Primary* and *Secondary Contact Recreation* uses.

Nonpoint Sources of Pollution

- Investigate and confirm the presence of the sand and gravel operation that was indicated in the MRPC and FRCOG (2002) study. Evaluate this site to ensure that it is being operated and maintained properly and that water quality is protected. Best management practices should be followed for controlling stormwater pollutants, restricting erosion and dust, limiting the extent of excavation, and containing spills. The applicability of these sites for jurisdiction under MA DEP's WMA and NPDES permit programs should also be determined. A project was proposed by EOEA's Millers River Watershed Team to perform a comprehensive identification and assessment of all sand and gravel areas in the watershed to determine their location, ownership, status and history. Also proposed in this project was an education program for town boards to provide municipal officials with a good understanding of gravel operations and how to regulate them effectively. An evaluation of sand and gravel operation bylaws and regulations with recommendations on how to strengthen them was also included. Funding to work with communities on this project should be sought (e.g., 604b Water Quality Assessment).
- The unpaved roads that are close to waterbodies should be field checked to verify their location and an evaluation should be performed to determine if there are any impacts from these roads on the adjacent waterbodies and watercourses that may affect water quality. Best management practices, as described in Unpaved Roads BMP Manual (Berkshire Regional Planning Commission 2001), should then be implemented as appropriate.

Fish Consumption

- Despite the MA DPH recommendation that fishes taken from the tributaries of the Millers River should not be eaten or consumption should be limited body burdens of PCB and mercury in the edible portions of fish from Lyons Brook should be further investigated. Determination of natural or man-made barriers to migration in tributaries of the Millers River, including Lyons Brook, would assist in the identification of stream reaches where the potential for PCB contaminated fishes is greatest.

Land Protection

- The impervious area for the sub-bains within the Lyons Brook subwatershed is all less than 10%, therefore, it is classified as sensitive, predicting a low threat to water quality from impervious surface water runoff (Stoltzfus 2001). In order to preserve this subwatershed and prevent degradation of water quality, it is recommended that land use planning techniques be applied to direct development (smart growth), preserve sensitive areas, and maintain or reduce the impervious cover. The Towns of Montague and Wendell should review the information generated through the buildout analysis performed by EOEA that created a profile of how each community would look at full buildout according to its current zoning (EOEA 2000-2001). Additionally, a review of the Western Millers River Watershed Growth Management Plan (RGMPC and FRCOG 2002) and the Assessment of Non-Point Source Pollution (MRPC and FRCOG 2002) reports should be undertaken and appropriate recommendations should be implemented. It is recommended that both the communities of Montague and Wendell should continue to work with the Franklin Regional Council of Governments on land use planning issues.
- It is recommended that the Towns of Montague and Wendell participate in the ongoing Millers River Watershed Regional Open Space Plan, which was initiated by the Mass. Watershed Initiative/Millers River Watershed Team and is being conducted by McGregor and Associates. Through this project Montague and Wendell can work cooperatively with other watershed communities to determine regional open space priorities and environmental goals including the protection of water quality.

MILLERS RIVER WATERSHED - LAKE ASSESSMENTS

A total of 100 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) have been identified and assigned PALIS code numbers in the Millers River Watershed (Ackerman 1989 and MA DEP 2004). The total surface area of the Millers River Watershed lakes in Massachusetts is 4,121 acres (only 185 acres of 594 acre Lake Monomonac and only one acre of 43 acre Robbins Pond are located in Massachusetts, the remainder of the lake acreage is in New Hampshire). They range in size from one to 305 acres. This report presents information on 64 of the Millers River Watershed lakes that are listed in the WBS database (Figure 12). The remaining 36 lakes with PALIS codes, which total 288 acres, are unassessed and are not currently included as segments in the WBS/ADB database.

The 64 lakes assessed in this report represent 3,833 acres of the 4,121 total lake surface area or 93% of the lake acreage in the Massachusetts portion of the Millers River Watershed. They lie wholly or partly within 15 of the basin's 17 communities (Figure 12). Baseline lake surveys were conducted on two of these lakes (TMDL sampling) in the summer of 2000 (Appendix B, Tables B2 and B3). With the exception of Lake Mattawa synoptic surveys were conducted by DWM at all of these lakes in 1995 (Appendix B, Table B1).

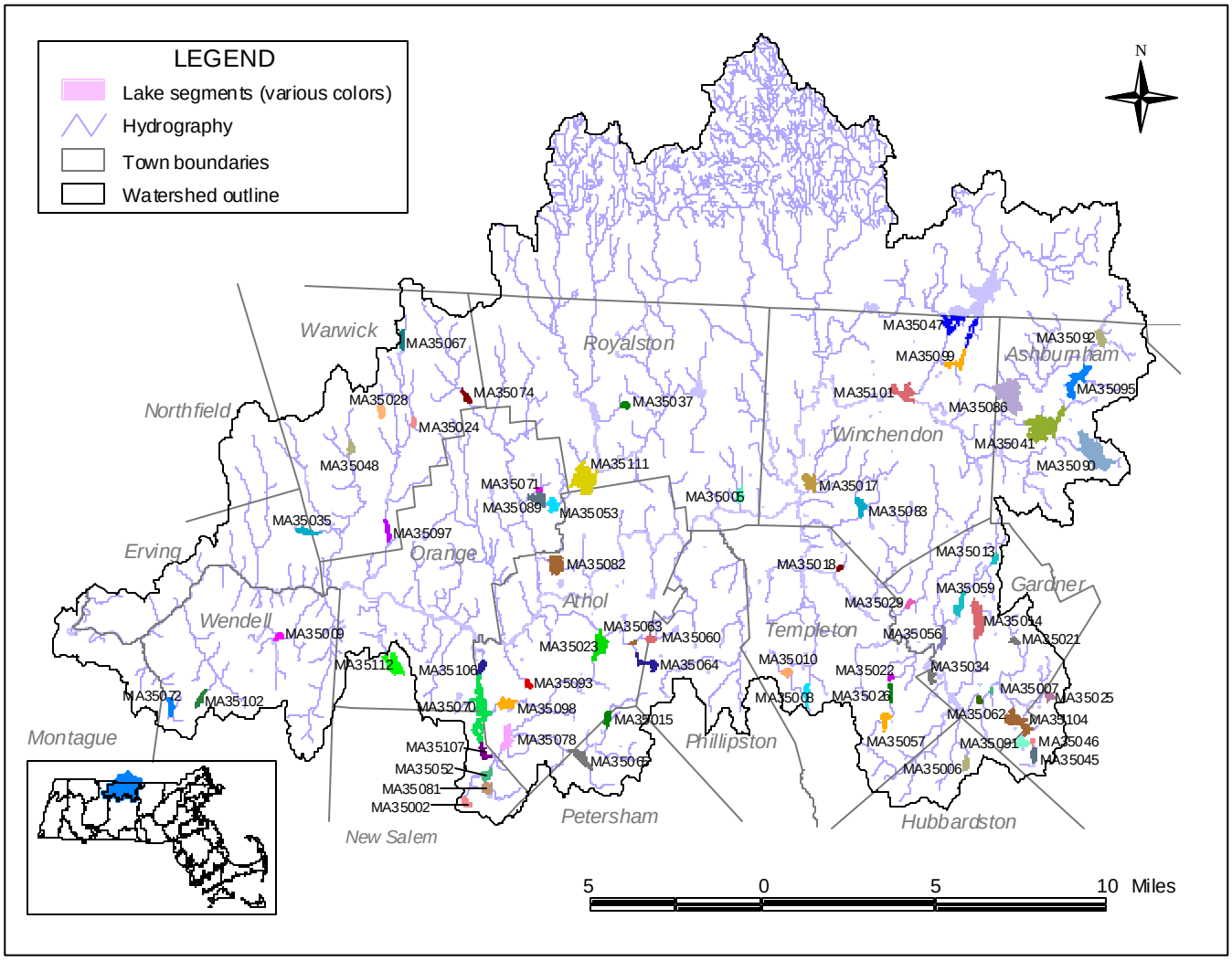


Figure 12. Millers River Watershed – lake segments locations identified by WBID.

LAKE USE ASSESSMENTS

Lake assessments are based on information gathered during DWM surveys (recent and historic) as well as pertinent information from other reliable sources (e.g., abutters, herbicide applicators, diagnostic/feasibility studies, MA DPH, etc.). The 1995 DWM synoptic surveys focused on general observations of water quality and quantity (e.g., water level, sedimentation, etc.), the presence of native and non-native aquatic plants (as well as distribution and aerial cover), and presence/severity of algal blooms (Appendix B, Table B1). During 2000 more intensive in-lake sampling was conducted by DWM in two lakes (Stoddard and Whitney ponds) in the Millers River Watershed as part of the TMDL program. This sampling included in-lake measurements of dissolved oxygen, pH, temperature, Secchi disk transparency, nutrients, and chlorophyll *a* and detailed macrophyte mapping (Appendix B, Tables B2 and B3). While these surveys provided additional information to assess the status of the designated uses fecal coliform bacteria data were unavailable and, therefore, the *Primary Contact Recreational Use* was usually not assessed. To determine the status of the *Fish Consumption Use* fish consumption advisory information was obtained from the MA DPH (MA DPH 2002a). Although the *Drinking Water Use* was not assessed in this water quality assessment report the Class A waters were identified. Information on drinking water source protection and finish water quality is available at http://www.mass.gov/dep/brp/dws/dwshome.htm and from the Millers River Watershed's public water suppliers.

The use assessments and supporting information are entered into an EPA assessment database (either the WBS or the ADB). Data on the presence of non-native plants were entered into the MA DEP DWM informal non-native plant-tracking database.

AQUATIC LIFE

Habitat and Flow

Using guidelines developed by MA DEM to identify a river basin's stress level the Upper Naukeag Lake with a watershed drainage area of 1.90 square miles was rated at a high stress level based on the magnitude of stream flow. The criteria established for the high stress classification is net outflow equals or exceeds estimated natural August median flow (Gomez and Sullivan 2003). Because of the water withdrawals the *Aquatic Life Use* is identified with an Alert Status for this lake (Table 5).

Biology

Non-native aquatic macrophytes were observed in eight of the 65 lakes surveyed by DWM in 1995 and/or 2000 (Table 10 and Appendix B, Table B1). The three non-native aquatic species documented in the Millers River Watershed lakes were *Myriophyllum heterophyllum* (variable water milfoil), *M. spicatum* (Eurasian water milfoil) and *Cabomba caroliniana* (fanwort) (Figure 13). The mere presence of these species is considered an imbalance to the native biotic community and so these lakes are listed as impaired (808.9 acres). Additionally, these species have a high potential for spreading and are likely to have established themselves in downstream lake and river segments in the Millers River Watershed which may not have been surveyed. Figure 13 indicates where these non-native aquatic species were observed and the likely, or potential, avenues of downstream spreading.

Two non-native wetland species, *Lythrum salicaria* (purple loosestrife) and *Phragmites australis* (reed grass), were identified at three of the lakes surveyed by DWM in 1995 and/or 2000 (Table 5 and Appendix B, Table B1). Although the presence of these species is not generally a cause of impairment to lakes their invasive growth habit can result in the impairment of wetland habitat associated with lakes. Because of an unconfirmed report of a non-native species presence (*Myriophyllum heterophyllum*) in Sunset Lake (Ashburnham/Winchendon) the *Aquatic Life Use* there is identified with an Alert Status (Table 5).

Fish sampling using electrofishing, gillnetting, and shoreline seining was conducted in Stoddard and Whitney ponds in the Millers River Watershed by MA DFWELE in 2000 as part of the Lakes Survey for TMDL Development (Appendix E, Project 99-06/104). The fish sampling consisted of electrofishing at night during the spring and gillnetting and shoreline seining in the fall. A total of 10 species were collected in Stoddard Pond. The species collected, in order of abundance, were: yellow perch (*Perca flavescens*), golden shiner (*Notemigonus crysoleucas)*, pumpkinseed (*Lepomis gibbosus*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides)*, chain pickerel (*Esox niger*), yellow bullhead *(Ictalurus natalis),* creek chubsucker (*Erimyzon oblongus)*, brown bullhead (*Ictalurus nebulosus)*, and bluegill (*Lepomis macrochirus*). A total of 13 species were collected in Whitney Pond. The species collected, in order of abundance, were: yellow perch, bluegill, black crappie, white sucker (*Castosomus commersoni*),

pumpkinseed, golden shiner, largemouth bass, chain pickerel, creek chubsucker, brown bullhead, yellow bullhead, white perch (*Morone americana*), and tessellated darter (*Etheostoma olmstedi*).

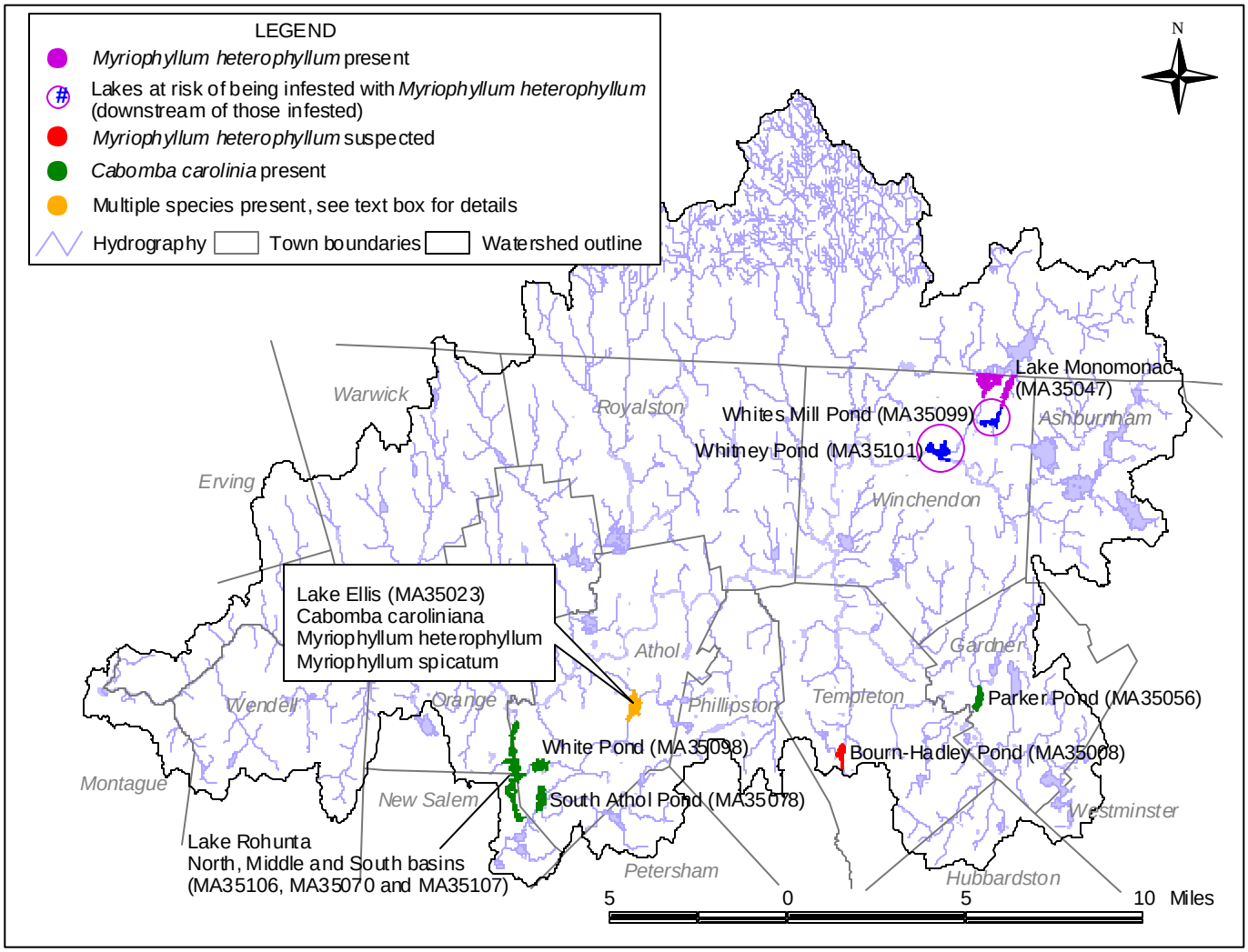


Figure 13. Millers River Watershed Lakes – presence of non-native aquatic vegetation and potential for downstream spreading in Massachusetts.

Beaver Flowage Pond

MA DFWELE conducted fish population sampling on Beaver Flowage Pond in Royalston using gillnet, angling and a barge electroshocker on August 29, 2000. Using the gillnet, a total of 62 fish represented by 7 species were collected. Fish species present, in order of abundance, were the following: largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), bluegill (*Lepomis macrochirus*), golden shiner (*Notemigonus crysoleucas*), chain pickerel (*Esox niger*), black crappie (*Pomoxis nigromaculatus*) and creek chubsucker (*Erimyzon oblongus*). Using angling, a total of 35 fish were collected. The most prevalent fish species was yellow perch (*Perca flavescens*). Other species present were black crappie (*Pomoxis nigromaculatus*) and bluegill (*Lepomis macrochirus*). Using a barge electroshocker the following species were collected: golden shiner (*Notemigonus crysoleucas*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), and chain pickerel (*Esox niger*).

Minott Pond South

Fish population sampling was conducted by MA DFWELE at the north end of South Minot Pond/Westminster on 30 August 2000. Both gillnet and angling techniques were used. With gillnetting the following species were collected: golden shiner (*Notemigonus crysoleucas*), yellow perch (*Perca flavescens*), white sucker (*Catostomus commersoni*), chain pickerel (*Esox niger*), and pumpkinseed (*Lepomis gibbosus*). Pumpkinseed (*Lepomis gibbosus*) and chain pickerel (*Esox niger*) were collected by angling.

Lake Rohunta (Middle Basin)
MA DFWELE conducted fish population sampling in the Middle Basin of Lake Rohunta/Orange by boat shocking on 11 August 2000. Largemouth bass (*Micropterus salmoides*) and golden shiner (*Notemigonus crysoleucas*) were the dominant species collected. Other fish species present, in order of abundance, included: bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), chain pickerel (*Esox niger*), black crappie (*Pomoxis nigromaculatus*), white sucker (*Catostomus commersoni*), and pumpkinseed (*Lepomis gibbosus*).

White Pond
White Pond in Athol was sampled by MA DFWELE using both gillnetting and angling on 28 July 2000. The fish population sample from angling was dominated by bluegill (*Lepomis macrochirus*). Other species present included: yellow perch (*Perca flavescens*), pumpkinseed (*Lepomis gibbosus*), black crappie (*Pomoxis nigromaculatus*), and largemouth bass (*Micropterus salmoides*). Using gillnetting the dominant species was chain pickerel (*Esox niger*). Other fish species that were collected included: white sucker (*Catostomus commersoni*), largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), brown bullhead (*Ameiurus nebulosus*), and black crappie (*Promoxis nigromaculatus*).

Tully Lake
On 12 September 2000 MA DFWELE conducted fish population sampling on Tully Lake in Royalston. A total of 220 fish were collected using boat shocking. The most dominant species was yellow perch (*Perca flavescens*), followed by largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), and chain pickerel (*Esox niger*). Other species present included: black crappie (*Pomoxis nigromaculatus*), golden shiner (*Notemigonus crysoleucas*) and creek chubsucker (*Erimyzon oblongus*).

Snake Pond
Fish population sampling was conducted by MA DFWELE on Snake Pond in Gardner on 15 August 2000. Yellow perch (*Perca flavescens*) was the dominant species collected by gillnetting while largemouth bass (*Micropterus salmoides*) was the dominant species collected by angling. Other species present included pumpkinseed (*Lepomis gibbosus*) and chain pickerel (*Esox niger*).

Martin Lake
Yellow perch (*Perca flavescens*) was the dominant fish species found in Martin Lake/Winchendon in sampling conducted by MA DFWELE. Both angling and gillnetting were used to collect fish on 17 July 2000.

Chemistry – tissue
Beaver Flowage Pond (Beaver Pond)
A total of four fish were collected from this pond in September 1999. These included a 4-year old brown bullhead and three yellow perch (two of which were estimated as 9-year olds and one was not aged). The total PCB concentrations in the "whole fish" samples of these fish ranged from 47 to 214 ppb wet weight (ENSR 2000). None of these "whole fish" samples had levels of total PCB that exceeded the NAS/NAE guideline for total PCB (Coles 1998) of 500 ppb wet weight for the protection of fish-eating wildlife.

Lake Denison
A total of three fish were collected from this pond in October 1999. These included a 7-year old yellow perch and two 5-year old largemouth bass. The total PCB concentrations in the "whole fish" samples of these fish ranged from 227 to 1,245 ppb wet weight (ENSR 2000). Both of the largemouth bass samples had levels of total PCB that exceeded (2.0 and 2.5 times) the NAS/NAE guideline for total PCB (Coles 1998) of 500 ppb wet weight for the protection of fish-eating wildlife.

Chemistry-water
Oxygen depletion occurred below 1.0 m in September 2000 in both Whitney and Stoddard ponds (Appendix B, Table B2). However, it is suspected that these ponds are highly influenced by wetland drainage as evidenced by high color values and low pH and alkalinity and, therefore, these low dissolved oxygen conditions may be naturally occurring. The total phosphorus concentrations were moderately high and the deep-water samples show evidence of phosphorus release due to the anoxic conditions in Whitney Pond.

Total phosphorus concentrations were low to moderately high in Stoddard Pond. Despite these results, there are too little data (some data were censored) to assess the status of the *Aquatic Life Uses* for either of these ponds. Because oxygen depletion occurs at such shallow depth, however, this use is identified with an Alert Status for both ponds. Additional data/information needs to be researched to determine if these conditions are naturally occurring or anthropogenically induced.

Chemistry-sediment

Surficial sediment sampling was conducted at two lakes (Beaver Flowage Pond in Royalston and Lake Denison in Winchendon) in August 1999. Sediment samples were collected from three stations at each waterbody and analyzed for PCBs. None of the samples had detectable levels of PCBs (ENSR 2000).

The *Aquatic Life Use* was assessed as impaired in eight lakes (including the three basins of Lake Rohunta) based on the confirmed presence of non-native macrophyte(s) representing a total of 808.9 acres (Table 5). While Stoddard and Whitney ponds in Winchendon were not assessed for the *Aquatic Life Use* the use was identified with an Alert Status because of oxygen depletion at shallow depth and slight to moderately elevated phosphorus concentrations (Appendix B, Table B2). Crystal Lake in Gardner was not assessed for this use but was identified with an Alert Status because of elevated aluminum concentrations in the Gardner Water Treatment Facility discharge. Because of elevated PCB levels in "whole fish" samples the *Aquatic Life Use* for Lake Denison is identified with an Alert Status (Table 5). The *Aquatic Life Use* is also identified with an Alert Status in Sunset Lake since there is an unconfirmed report of a non-native species (*Myriophyllum heterophyllum*). The remaining 57 lakes, representing 3,185.1 acres, in the Millers River Watershed were not assessed for the *Aquatic Life Use* because of the cursory nature of the 1995 synoptic surveys and/or the lack of dissolved oxygen data and other more recent observations.

FISH CONSUMPTION

In July 2001 MA DPH issued new consumer advisories on fish consumption and mercury contamination. The MA DPH "…is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age to refrain from eating the following marine fish; shark, swordfish, king mackerel, tuna steak and tilefish. In addition, MA DPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination, to now include women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age (MA DPH 2001)." Additionally, MA DPH "…is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about 2 meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to two (2) cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury (MA DPH 2001)." MA DPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially. The advisory encompasses all freshwaters in Massachusetts and, therefore, the *Fish Consumption Use* for lakes in the Millers River Basin cannot be assessed as support.

Fish from a total of six lakes in the Millers River Basin were sampled in either 1994 or 1995 as part of a research and development study on mercury contamination developed by the Department's Office of Research and Standards (ORS). The lakes included Upper Naukeag Lake (Ashburnham), Hilchey Pond (Gardner), Sheomet Lake (Warwick), Upper Reservoir (Westminster), Laurel Lake (Erving/Warwick), and Gales Pond (Warwick). Fish toxics monitoring (metals, PCB, and organochlorine pesticide in edible fillets) was conducted by DWM in Lake Rohunta (Athol/New Salem/Orange) in July 1995 and in Lake Denison (Winchendon) in August 1995 and again in June 1996. These data can be found in Appendix A, Table 14. Upper Reservoir (Westminster) was sampled again in 2001 and 2002 as part of a seasonal ORS study of mercury. Mercury concentrations in largemouth bass and yellow perch all exceeded the MA DPH action level. Upper Reservoir will continue to be sampled as part of an ongoing long-term study being conducted by DEP ORS.

Fish from two lakes, Beaver Flowage Pond and Lake Denison, were sampled in 1999 (September and October, respectively) as part of a site assessment and risk characterization of PCBs at Birch Hill Reservoir (ENSR 2000). The concentration of total PCB in four individual fish fillet samples (one brown bullhead and

three yellow perch) from Beaver Flowage Pond ranged from 0.001 to 0.004 ppm wet weight. The concentration of total PCB in three individual fish fillet samples (one yellow perch and two largemouth bass) from Lake Denison ranged from 0.051 to 0.161 ppm wet weight (ENSR 2000).

The most recent MA DPH Fish Consumption List recommends the following for lakes in the Millers River Watershed (MA DPH 2002a).

Lake Denison (Winchendon) because of mercury.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass from this waterbody."
2. "The general public should limit consumption of largemouth bass from this waterbody to two meals per month."

Lake Rohunta - north, middle, south basins (Athol, New Salem, Orange) because of mercury.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body."
2. "The general public should limit consumption of all fish from this water body to two meals per month."

Gales Pond (Warwick) because of mercury.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any yellow perch from this waterbody."
2. "The general public should limit consumption of yellow perch from this waterbody to two meals per month."

Upper Naukeag Lake (Ashburnham) because of mercury.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any small mouth bass or yellow perch from this waterbody."
2. "The general public should limit consumption of small mouth bass or yellow perch from this waterbody to two meals per month."

Upper Reservoir (Westminster) because of mercury.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body."
2. "The general public should limit consumption of all fish from this water body to two meals per month."

Additionally, the Millers River advisory is also in place and covers Whitney Pond (all towns from Erving to Winchendon) because of mercury and PCBs.

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries."
2. "The general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River."
3. "The general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month."

Eight lakes (including the above mentioned six lakes plus the other two basins of Lake Rohunta), representing a total of 956 acres, are assessed as impaired (due to mercury contamination) for the *Fish Consumption Use* (Table 5). The remaining 57 lakes, representing 3,038 acres, are not assessed for the *Fish Consumption Use*. It should be noted, however, that the *Fish Consumption Use* for Lake Monomonac is identified with an Alert Status because of elevated levels of mercury in fish were reported by the NH DES (NH DES 2003). [NOTE: The MA DPH fish consumption advisory list contains the status of each water body for which an advisory has been issued. If a water body is not on the list it may be because either an advisory was not warranted or the water body has not been sampled. MA DPH's most current Fish Consumption Advisory list is available online at http://www.state.ma.us/dph/beha/fishlist.htm.] The source of mercury is unknown although atmospheric deposition is suspected.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

In 1995 DWM conducted synoptic surveys of 64 lakes in the Millers River Watershed. These surveys included general observations of water quality and quantity, the presence of native and non-native aquatic plants (and presence/severity of algal blooms (Appendix B, Table B1). Additional data were collected in two of these lakes by DWM in 2000 for the purpose of TMDL development. These data, combined with the 1998 303(d) List of Waters, MA DEM and public bathing beach bacteria data, MA DPH beach posting data and diagnostic/feasibility studies were used to assess the recreational and aesthetics uses.

Bacteria samples were collected at the following MA DEM beaches: Dunn Pond State Park in Gardner, Ruggles Pond in the Wendell State Forest in Wendell, Laurel Lake in the Erving State Forest in Erving/Warwick, Beamans Pond in the Otter River State Forest in Templeton/Winchendon and the Lake Denison Recreational Area in the Otter River State Park in Winchendon. With the exception of Beamans Pond none of these beaches were reported closed or posted during the 2001 or 2002 swimming season. Although it is not a named segment in this report Beamans Pond campground beach at Otter River State Forest was closed due to elevated bacteria counts between 9 and 12 July 2001. The beach was also closed between 28 and 31 May 2002 due to elevated bacteria counts (MA DPH 2001 and 2002).

Bacteria samples were collected from two town bathing beaches during the summer of 2000 and 2001 (Kendall Pond in Gardner and Lake Mattawa in Orange), however, no quality assurance data were available. Elevated fecal coliform bacteria counts were reported from Kendall Pond (City of Gardner 2002), however, no postings were reported. Due to the elevated bacteria levels detected in Kendall Pond, the *Primary Contact Recreational Use* is identified with an Alert Status. It should be noted, however, that a sanitary sewer project was completed in 1999 for sewering the homes around Kendall Pond (Asen 2003). A total of eight fecal coliform bacteria samples were collected from Lake Mattawa between June and September 2000. None of the counts exceeded 150 cfu/100mls and no beach closures have been reported (Town of Orange 2002). It should also be noted that the beach at Silver Lake in Athol (not a segment in this report) was closed between 2 and 9 July 2001 because of elevated bacteria counts.

The *Primary* and *Secondary Contact Recreational* and *Aesthetic* uses were assessed as support in five lakes (Dunn Pond, Lake Denison, Lake Mattawa, Laurel Lake, and Ruggles Pond), representing a total of 282 acres (Table 5). The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses are not assessed in the remaining 60 lakes (3,712 acres) in the Millers River Watershed because of a lack of bacteria, transparency and in-lake survey data.

SUMMARY

A total of 13 of the 65 lakes in the Millers River Watershed assessed in this report were impaired for either the *Aquatic Life Use* and/or the *Fish Consumption Use* (Table 5). Causes of impairment included non-native plant infestation and mercury contamination. Eight lakes, totaling 956 acres, were impaired for the *Fish Consumption Use* due to mercury contamination. Five lakes, totaling 282 acres, supported the *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses. A total of 48 lakes (1,581.9 out of 3,994 acres) were not assessed for any uses.

Due to the focus of the lake surveys (synoptic surveys and surveys conducted for the TMDL program) the major cause for use impairment was non-native aquatic vegetation. Mercury contamination was also a cause for impairment. Beach closure information from MA DEM and town beaches was used to assess the recreational and aesthetics uses for the Millers River Watershed.

Table 5. Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Bassett Pond, New Salem	MA35002	26	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Beaver Flowage Pond (Beaver Pond), Royalston	MA35005	38	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Fish population (MA DFWELE sampling in August 2000) was dominated by largemouth bass and yellow perch. Total PCB concentrations in "whole fish" samples (sampling conducted in September 1999) did not exceed NAS/NAE guideline (data reported in ENSR 2000). No PCBs were detected in surficial sediment screening samples (sampling conducted in August 1999 (data reported in ENSR 2000). Total PCB concentrations in the edible fillets (sampling conducted in September 1999) did not exceed the MA DPH guideline of 1.0 ppm (data reported in ENSR 2000). Beaver Flowage Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants and turbidity (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this pond is to maintain its current estimated loading of 56 kg/year (MA DEP 2002).							
Bents Pond, Hubbardston	MA35006	29	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Bents Pond, Gardner	MA35007	6	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
The non-native wetland species, *Lythrum salicaria*, was observed at Bents Pond in the summer of 1995 (Appendix B, Table B1). Bents Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants and turbidity (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 501 kg/year to a target load of 227 kg/year (55% reduction) (MA DEP 2002).							
Bourn-Hadley Pond, Templeton	MA35008	26	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Bourn-Hadley Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 168 kg/year to a target load of 81 kg/year (52% reduction) (MA DEP 2002). It was also noted that there is one new unregulated sand and gravel operation that is adjacent to the western shore of this pond.							
Bowens Pond, Wendell	MA35009	17	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Bowens Pond is on the 1998 303(d) List of Waters because of turbidity (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring (turbidity was associated with natural water color).							
Brazell Pond, Templeton	MA35010	15	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Brazell Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 117 kg/year to a target load of 41 kg/year (65% reduction) (MA DEP 2002).							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Cowee Pond, Gardner	MA35013	18	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Note: Cowee Pond is a Class A, Public Water Supply. Gardner Water Department has a surface water intake in Cowee Pond (WMA registration 20710301). Additional information in Appendix D, Table D3. The City of Gardner Surface Water Supply Protection Plan for Cowee Pond was completed in October 2002 (Tighe and Bond 2002 and Appendix E Project 00-06/SWT). Cowee Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this pond is to maintain its current estimated loading of 39 kg/year (MA DEP 2002).							
Crystal Lake, Gardner	MA35014	142	NOT ASSESSED "Alert Status"	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Note: Crystal Lake is a Class A, Public Water Supply. Gardner Water Department (WMA registration/permit 20710301/9P220710302) has a surface water intake in Crystal Lake. Additional information is available in Appendix D, Table D3. The City of Gardner Surface Water Supply Protection Plan for Crystal Lake was completed in October 2002 (Tighe and Bond 2002 and Appendix E Project 00-06/SWT and 1998 – *Gardner Crystal Lake Water Filtration Plant*). A discharge from the Gardner Water Treatment Facility is authorized (MAG640041) to the lake (Appendix D, Table D1). Because of high aluminum concentrations in WTF discharge the *Aquatic Life Use* is identified with an "Alert Status". The MRPC and FRCOG (2002) study note the Gardner Municipal Golf Course is located on Eaton Street adjacent to Crystal Lake.							
Davenport Pond, Athol/Petersham	MA35015	30	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Note: Davenport Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this pond is to maintain its current estimated loading of 59 kg/year (MA DEP 2002).							
Depot Pond (Railroad Pond), Templeton	MA35018	15	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Note: American Tissue Mills of Mass, Inc. has a surface water intake in Depot Pond (WMA permit 10709101). Additional information in Appendix D, Table D3. Depot Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 43 kg/year to a target load of 20 kg/year (53% reduction) (MA DEP 2002).							
Dunn Pond, Gardner	MA35021	18	NOT ASSESSED	NOT ASSESSED	SUPPORT	SUPPORT	SUPPORT
Note: Dunn Pond MA DEM State Park in Gardner has a public bathing beach. This beach was posted for a 3-day period in July 2001 because of elevated bacteria and no postings were recorded for the 2002 swimming season. Because the beach was open for the majority of the 2001 and 2002 bathing seasons the *Recreational* and Aesthetic uses are assessed as support.							
East Templeton Pond, Templeton.	MA35022	9	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Note: East Templeton Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants and siltation (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Ellis Pond (Lake Ellis), Athol	MA35023	88	IMPAIRED (Non-native aquatic plants – *Myriophyllum heterophyllum, M. spicatum, Cabomba caroliniana*)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Note: Ellis Pond is a Class A, Public Water Supply. A diagnostic/feasibility study for lake is available documenting both *M. heterophyllum* and *M. spicatum* (BEC, Inc. 1987). Town received MA DEM Lakes and Ponds Grant (2000) to control the spread of the non-native nuisance aquatic plant *Cabomba caroliniana* with the use of herbicides; an educational brochure on in-lake and watershed best management practices was also included. *Eichhornia crassipes* (water hyacinth), a non-native tropical aquatic plant not capable of overwintering, was also observed in this lake in 1995 (Appendix B, Table B1). Ellis Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 195 kg/year to a target load of 167 kg/year (14% reduction) (MA DEP 2002). The MRPC and FRCOG (2002) report indicated the golf course at Ellinwood Country Club in Athol is in close proximity to Lake Ellis and surrounding wetland and floodplain areas.							
Gales Pond, Warwick	MA35024	12	NOT ASSESSED	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Fish toxics monitoring for PCBs, organochlorine pesticides and selected metals (including Hg, As, Se, Pb, and Cd) was conducted in Gales Pond as part of MA DEP ORS R&D study in 1994 (Rose et *al*. 1999). Because of elevated mercury MA DPH issued a fish consumption advisory recommending "Children younger than 12 years, pregnant women, and nursing mothers should not eat any yellow perch from this waterbody and the general public should limit consumption of yellow perch from this waterbody to two meals per month." Because of the site-specific advisory the *Fish Consumption Use* is assessed as impaired. Gales Pond is on the 1998 303(d) List of Waters because of turbidity (Table 3).							
Greenwood Pond, Westminster	MA35025	27	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Greenwood Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this pond is to maintain its current estimated loading of 25 kg/year (MA DEP 2002).							
Greenwood Pond, Templeton	MA35026	12	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Greenwood Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 140 kg/year to a target load of 58 kg/year (59% reduction) (MA DEP 2002).							
Hastings Pond, Warwick	MA35028	18	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Hastings Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Hilchey Pond, Gardner	MA35029	8	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Note: Fish toxics monitoring for PCBs, organochlorine pesticides and selected metals (including Hg, As, Se, Pb, and Cd) was conducted in Hilchey Pond as part of MA DEP ORS R&D study in 1994 (Rose et *al*. 1999). Since there was no site-specific advisory issued the *Fish Consumption Use* is not assessed. It should be noted, however, that no top level predator fish (e.g., largemouth bass) were captured and/or analyzed. Hilchey Pond is on the 1998 303(d) List of Waters because of turbidity (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 174 kg/year to a target load of 122 kg/year (30% reduction) (MA DEP 2002).							
Kendall Pond, Gardner	MA35034	22	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED "Alert Status"	NOT ASSESSED	NOT ASSESSED
Note: A diagnostic/feasibility study for pond is available (IEP, Inc. 1991). Kendall Pond has a public bathing beach. Although no beach postings were reported elevated bacteria counts were documented and therefore the *Primary Contact Recreational Use* is identified with an "Alert Status". Town received MA DEM Lake and Pond Grant (1995, 1997, 2001) to control nuisance, native plants (bladderwort and milfoil) with an herbicide because of an increasing problem for recreational users. Kendall Pond is on the 1998 303(d) List of Waters because of organic enrichment/low DO and noxious aquatic plants (Table 3). A sanitary sewer project was completed in 1999 for sewering the homes around the pond (Asen 2003).							
Lake Denison, Winchendon	MA35017	83	NOT ASSESSED "Alert Status"	IMPAIRED (Mercury)	SUPPORT	SUPPORT	SUPPORT
The fish population sample in Lake Denison (MA DFWELE sampling in September 2000) was dominated by white sucker, yellow perch and largemouth bass. Total PCB concentrations in "whole fish" samples (sampling conducted in October 1999) exceeded the NAS/NAE guideline of by a factor of 2.0 to 2.5 times (data reported in ENSR 2000). Surficial sediment screening samples collected in August 1999 at three sites in the deep hole, total PCB concentrations <2 ppm (ENSR 2000). Because of the elevated PCB in "whole fish" which exceeded the NAS/NAE guidelines, the *Aquatic Life Use* is identified with an "Alert Status". Total PCB concentrations in the edible fillets (sampling conducted in September 1999) did not exceed the MA DPH guideline of 1.0 ppm (data reported in ENSR 2000). Fish toxics monitoring was conducted by MA DEP in Lake Denison in August 1995 and June 1996. Because of elevated mercury concentrations MA DPH issued a Fish Consumption Advisory recommending that "Children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass from this waterbody, and the general public should limit consumption of largemouth bass from this waterbody to two meals per month." Therefore, the *Fish Consumption Use* is assessed as impaired. Lake Denison has a public access site (MA DFWELE 2002) as well as a public bathing beach (Lake Denison State Recreational Area in the Otter River State Park in Winchendon). No beach closures have been reported and therefore the *Recreational* and *Aesthetic* uses are assessed as support. Lake Denison is on the 1998 303(d) List of Waters because of organic enrichment/low DO (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 210 kg/year to a target load of 157 kg/year (25% reduction) (MA DEP 2002). The MRPC and FRCOG (2002) report noted underground storage tanks, sand and gravel operations and stormwater as potential nonpoint sources of pollution.							
Lake Mattawa (North Pond Brook Reservoir), Orange	MA35112	112	NOT ASSESSED	NOT ASSESSED	SUPPORT	SUPPORT	SUPPORT
Note: Lake Mattawa is a Class A , Public Water Supply. This lake's southern outlet drains to the Quabbin Reservoir on occasion. Lake Mattawa has a public bathing beach. No beach closures have been reported (Town of Orange 2002) and, therefore, the *Recreational* and *Aesthetic* uses are assessed as support.							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Lake Monomonac, Winchendon/Rindge, NH (MA portion only)	MA35047	185	IMPAIRED (Non-native plants – *M. heterophyllum*)	NOT ASSESSED "Alert Status"	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lake Monomonac was treated with Diquat in 2000 (MA DEM Lake and Pond Grant to town) and June 2002 (Connor 2002) to control the spread of the non-native aquatic plant *M. heterophyllum* (Variable water milfoil). A minimum drawdown determination study is also available as an option to control the nuisance aquatic plant problem. Lake Monomonac is also on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond, other than the presence of the non-native aquatic species, were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this pond is to maintain its current estimated loading of 887 kg/year (MA DEP 2002). Although no site-specific advisory for fish consumption use NH DES does indicate elevated mercury in fish tissue. Therefore, the *Fish Consumption Use* is identified with an "Alert Status" (NH DES 2003). Septic system problems and stormwater from road drainage were identified as potential nonpoint source areas of concern in the MRPC and FRCOG (2002) study.							
Lake Rohunta (Middle Basin), Athol/Orange/New Salem	MA35070	209	IMPAIRED (Non-native plants – *Cabomba caroliniana*)	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lake Rohunta is infested with the non-native aquatic species *Cabomba caroliniana* and, therefore, the *Aquatic Life Use* is assessed as impaired. Largemouth bass and golden shiner dominated the population (sampling conducted by MA DFWELE in August 2000). Fish toxics monitoring was conducted by MA DEP in July 1995 (Appendix A, Table 14). Because of elevated mercury in fish tissue the MA DPH issued a Fish Consumption Advisory recommending "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body and the general public should limit consumption of all fish from this water body to two meals per month." Since there is a site specific advisory, the *Fish Consumption Use* is assessed as impaired. Lake Rohunta has a public access site (MA DFWELE 2002). Lake Rohunta is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3).							
Lake Rohunta (North Basin), Athol/Orange	MA35106	34	IMPAIRED (Non-native plants – *Cabomba caroliniana*)	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lake Rohunta is infested with the non-native aquatic species *Cabomba caroliniana* and, therefore, the *Aquatic Life Use* is assessed as impaired. MA DPH Fish Consumption Advisory recommends "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body and the general public should limit consumption of all fish from this water body to two meals per month." Since there is a site specific advisory, the *Fish Consumption Use* is assessed as impaired. Lake Rohunta has a public access site (MA DFWELE 2002).							
Lake Rohunta (South Basin), New Salem	MA35107	42	IMPAIRED (Non-native plants – *Cabomba caroliniana*)	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lake Rohunta is infested with the non-native aquatic species *Cabomba caroliniana* and, therefore, the *Aquatic Life Use* is assessed as impaired. The non-native wetland species *Phragmites australis* was observed at Lake Rohunta (South Basin) in the summer of 1995 (Appendix A, Table 14). MA DPH Fish Consumption Advisory recommends "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body and the general public should limit consumption of all fish from this water body to two meals per month." Since there is a site specific advisory the *Fish Consumption Use* is assessed as impaired. Lake Rohunta has a public access site (MA DFWELE 2002). Lake Rohunta is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3).							
Lake Watatic, Ashburnham	MA35095	133	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Laurel Lake, Erving/Warwick	MA35035	44	NOT ASSESSED	NOT ASSESSED	SUPPORT	SUPPORT	SUPPORT
Note: Fish toxics monitoring for PCBs, organochlorine pesticides and selected metals (including Hg, As, Se, Pb, and Cd) was conducted in Laurel Lake as part of MA DEP ORS R&D study in 1994 (Rose et *al*. 1999). Since no advisory was issued the *Fish Consumption Use* is not assessed. Laurel Lake has a public access site (MA DFWELE 2002) and there is a public bathing beach on Laurel Lake in the Erving Forest State Park in Warwick. No beach closures have been reported and, therefore, the *Recreational* and *Aesthetic* uses are assessed as support. Laurel Lake is on the 1998 303(d) List of Waters because of organic enrichment/low DO and noxious aquatic plants (Table 3).							
Little Pond, Royalston	MA35037	10	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lower Naukeag Lake, Ashburnham	MA35041	295	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Lake has been treated with Diquat between 1992 and 2001 to control very dense growths of aquatic macrophytes (MA DEP 2002). Lower Naukeag Lake is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this lake is to maintain its current estimated loading of 507 kg/year (MA DEP 2002). The MRPC and FRCOG (2002) report identified unpaved roads near Lower Naukeag Lake as a potential nonpoint source of pollution.							
Minott Pond, Westminster	MA35046	8	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Minott Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 44 kg/year to a target load of 40 kg/year (9% reduction) (MA DEP 2002).							
Minott Pond South, Westminster	MA35045	27	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
The fish population in Minott Pond South was dominated by golden shiner (sampled by MA DFWELE in August 2000). Minott Pond South is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this lake is to maintain its current estimated loading of 507 kg/year (MA DEP 2002).							
Moores Pond, Warwick	MA35048	39	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Moores Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							
North Spectacle Pond, New Salem	MA35052	43	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Packard Pond, Orange	MA35053	43	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
The MRPC and FRCOG (2002) report noted septic system concerns at Packard Pond.							
Parker Pond, Gardner.	MA35056	32	IMPAIRED (Non-native plants – *Cabomba caroliniana*)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Parker Pond is infested with the non-native aquatic species *Cabomba caroliniana* (Appendix B, Table B1) and, therefore, the *Aquatic Life Use* is assessed as impaired. The City was granted a MA DEM Lake and Pond Grant (1996) for Phase I of a restoration project, which included watershed and in-lake evaluation, analysis of alternatives and a management program. The *Parker Pond Restoration, Gardner* project (#01-03/319, see Appendix E) is currently underway and should be completed by June 2004 (Appendix E). A report on alternatives for aquatic habitat restoration is being prepared by the ACOE, New England District. Sedimentation and encroaching vegetation has reduced and degraded fish habitat and a plan to excavate 178,000 cubic yards of sediment has been proposed but is on hold until a disposal site is identified (ACOE 2001). Parker Pond is also on the 1998 303(d) List of Waters because of flow alteration and noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 432 kg/year to a target load of 216 kg/year (50% reduction) (MA DEP 2002).							
Partridgeville Pond, Templeton	MA35057	38	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Perley Brook Reservoir, Gardner	MA35059	55	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Perley Brook Reservoir is a Class A, Public Water Supply. Gardner Water Department has a surface water intake in Perley Brook Reservoir (WMA registration 20710301). Additional information in Appendix D, Table D3. The City of Gardner Surface Water Supply Protection Plan for Perley Brook Reservoir was completed in October 2002 (Tighe and Bond 2002 and Appendix E Project 00-06/SWT).							
Phillipston Reservoir, Athol/Phillipston	MA35060	20	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Phillipston Reservoir is a Class A, Public Water Supply. Athol Water Department had a surface water intake in Phillipston Reservoir (WMA registration 20701501). Additional information in Appendix D, Table D3. This source has been abandoned (Levangie 2002).							
Ramsdall Pond, Gardner	MA35062	2	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Ramsdall Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 561 kg/year to a target load of 269 kg/year (52% reduction) (MA DEP 2002).							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Reservoir #1, Athol	MA35063	8	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Reservoir #1 is a Class A, Public Water Supply and is also on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 71 kg/year to a target load of 50 kg/year (30% reduction) (MA DEP 2002).							
Reservoir #2 (Secret Lake), Athol/Phillipston	MA35064	48	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Reservoir #2 is a Class A, Public Water Supply and is also on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this lake is to maintain its current estimated loading of 16 kg/year (MA DEP 2002).							
Riceville Pond, Athol/Petersham	MA35065	61	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Riceville Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for this lake is to essentially maintain its current estimated loading of 206 kg/year (target load of 204 kg/year <1% reduction) (MA DEP 2002).							
Richards Reservoir, Warwick	MA35067	21	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Richards Reservoir is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							
Royalston Road Pond, Orange	MA35071	5	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Royalston Road Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							
Ruggles Pond, Wendell	MA35072	15	NOT ASSESSED	NOT ASSESSED	SUPPORT	SUPPORT	SUPPORT
There is a public bathing beach at Ruggles Pond in the Wendell State Forest in Wendell. No beach closures have been reported and, therefore, the *Recreational* and *Aesthetic* uses are assessed as support. Ruggles Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. The MRPC and FRCOG (2002) report noted a sand and gravel operation is located in the southern portion of Lyons Brook near Ruggles Pond.							
Sheomet Lake, Warwick	MA35074	31	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Fish toxics monitoring for PCBs, organochlorine pesticides and selected metals (including Hg, As, Se, Pb, and Cd) was conducted in Sheomet Lake as part of MA DEP ORS R&D study in 1994 (Rose et *al*. 1999). Since no site-specific advisory was issued the *Fish Consumption Use* is not assessed.							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
South Athol Pond, Athol	MA35078	83	IMPAIRED (Non-native plants – *Cabomba caroliniana*)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
South Athol Pond is infested with the non-native aquatic species *Cabomba caroliniana* (Appendix B, Table B1) and, therefore, the *Aquatic Life Use* is assessed as impaired. South Athol Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 386 kg/year to a target load of 330 kg/year (14% reduction) (MA DEP 2002).							
South Spectacle Pond, New Salem	MA35081	38	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
South Spectacle Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							
Sportsmans Pond, Athol	MA35082	93	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Sportsmans Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							
Stoddard Pond, Winchendon	MA35083	52	NOT ASSESSED "Alert Status"	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
TMDL survey conducted in 2000 and synoptic survey in 1995 (Appendix B, Tables B1, B2, and B3). This pond had low dissolved oxygen/saturation at depths below 1.0m, low pH and alkalinity, and high color (Appendix B, Table B2). These data are likely indicative of natural conditions associated with the wetlands upstream. While there are low to moderate levels of total phosphorus in the pond (concentrations ranging between 0.024 to 0.037mg/L), they did not result in high lake productivity (i.e., low to moderate chlorophyll *a* concentrations). Biovolume density estimated as 85% dense/very dense cover and no non-native aquatic plants were identified (Appendix B). The fish population sample was dominated by yellow perch. The *Aquatic Life Use* is identified with an "Alert Status", however, because it is undetermined if the phosphorus concentrations were elevated as a result of anthropogenic sources. The Secchi disc depths ranged from 1.4 to >1.8 m (meeting the bathing beach guidelines) even though the water was colored. No fecal coliform bacteria data are currently available and, therefore, the *Primary* and *Secondary Contact Recreationa*l uses are currently not assessed. There is no public bathing beach on the pond. Stoddard Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 179 kg/year to a target load of 127 kg/year (29% reduction) (MA DEP 2002).							
Sunset Lake, Ashburnham/ Winchendon	MA35086	274	NOT ASSESSED "Alert Status"	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Unconfirmed report of a non-native aquatic species (*Myriophyllum heterophyllum*) needs confirmation so the *Aquatic Life Use* is identified with an "Alert Status". This lake has been treated because of nuisance aquatic plants. The MRPC and FRCOG (2002) report identified unpaved roads near Sunset Lake and its tributaries as a potential nonpoint pollution source.							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Tully Lake, Royalston	MA35111	214	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
The ACOE New England District maintains a flood control project, Tully Lake, in the town of Royalston. Tully Dam is a Class II project (i.e., minor or suspect water quality problems), which is part of a system of two ACOE flood control dams in the Millers River Basin. Yellow perch and largemouth bass dominated the fish population samples (conducted by MA DFWELE in August 2000). Although Tully Lake has no official swimming area the ACOE did monitor *E. coli* bacteria weekly at one station in the lake. No "closures" were reported in 2002 (Barker 2003).							
Tully Pond, Orange	MA35089	70	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Tully Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. The MRPC and FRCOG (2002) report noted septic system concerns around Tully Pond.							
Upper Naukeag Lake, Ashburnham	MA35090	305	NOT ASSESSED "Alert Status"	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Upper Naukeag Lake is a Class A, Public Water Supply. Both Ashburnham and Winchendon Water Departments are registered to withdraw water from Upper Naukeag Lake (0.18 and 0.67 MGD, respectively); additional information is provided in the Millers River segment MA35-20 and Appendix D, Table D3. Using criteria set forth by the Massachusetts Water Resource Commission, Upper Naukeag Lake, with a watershed drainage area of 1.90 mi^2, was identified at a high stress level based on water quantity (Gomez and Sullivan 2003). Because of the water withdrawals the *Aquatic Life Use* is identified with an "Alert Status". A discharge from the Ashburnham & Winchendon Water Treatment Plant (WTP) is authorized (MAG640045) to the lake (Appendix D, Table D1). Fish toxics monitoring for PCBs, organochlorine pesticides and selected metals (including Hg, As, Se, Pb, and Cd) was conducted in Upper Naukeag Lake as part of MA DEP ORS R&D study in 1994 (Rose et *al*. 1999). Because of elevated mercury levels MA DPH recommends "Children younger than 12 years, pregnant women, and nursing mothers should not eat any smallmouth bass or yellow perch from this waterbody and the general public should limit consumption of smallmouth bass or yellow perch from this waterbody to two meals per month." Because of the site-specific advisory the *Fish Consumption Use* is assessed as impaired.							
Upper Reservoir, Westminster	MA35091	42	NOT ASSESSED	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Fish toxics monitoring for PCBs, organochlorine pesticides and selected metals (including Hg, As, Se, Pb, and Cd) was conducted in Upper Reservoir as part of MA DEP ORS R&D study in 1994 (Rose et *al*. 1999). Because of elevated mercury levels MA DPH recommends "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body and the general public should limit consumption of all fish from this water body to two meals per month." Because of the site-specific advisory the *Fish Consumption Use* is assessed as impaired. Upper Reservoir was sampled again in 2001 and 2002; mercury concentrations in largemouth bass and yellow perch all exceeded the MA DPH action level. Upper Reservoir will continue to be sampled as part of an ongoing long-term study being conducted by MA DEP ORS.							
Wallace Pond, Ashburnham	MA35092	46	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Observations by DWM indicated possible trap and skeet facility/sportsman club near the pond. This should be investigated further to determine if it is active or not and whether or not lead shot is a concern. Wallace Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for Wallace Pond is to maintain its current estimated loading of 129 kg/year (MA DEP 2002).							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Ward Pond, Athol	MA35093	6	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Ward Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for Ward Pond is to maintain its current estimated loading of 19 kg/year (MA DEP 2002).							
Wheelers Pond, Warwick	MA35097	28	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Wheelers Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring.							
White Pond, Athol	MA35098	63	IMPAIRED (Non-native plants – *Cabomba caroliniana*)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
White Pond is infested with the non-native aquatic species *Cabomba caroliniana* (Appendix B, Table B1) and, therefore, the *Aquatic Life Use* is assessed as impaired. The MRPC and FRCOG (2002) study noted septic system concerns around White Pond.							
Whites Mill Pond, Winchendon	MA35099	42	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Whites Mill Pond is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). The TMDL of Phosphorus for Whites Mill Pond is to be reduced from the current estimated loading of 776 kg/year to a target load of 589 kg/year (24% reduction) (MA DEP 2002). The MRPC and FRCOG (2002) report identified a sand and gravel operation in the vicinity of Whites Mill Pond as potential nonpoint pollution source.							

Table 5 (cont). Millers River Watershed Lake Assessments.

Lake, Location	WBID	Size (Acres)	Aquatic Life (Impairment Cause)	Fish Consumption (Impairment Cause)	Primary Contact (Impairment Cause)	Secondary Contact (Impairment Cause)	Aesthetics (Impairment Cause)
Whitney Pond, Winchendon	MA35101	97	NOT ASSESSED "Alert Status"	IMPAIRED (Mercury)	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
TMDL survey conducted in 2000 and synoptic survey in 1995 (Appendix B, Tables B1, B2, and B3). This pond had low dissolved oxygen/saturation at depths below 1.0m, low pH and alkalinity, and high color (Appendix B, Tables B2 and B3). These data are likely indicative of natural conditions associated with the wetlands upstream. While there are moderate levels of total phosphorus at the surface (concentrations ranging between 0.034 to 0.045 mg/L) and high concentrations near the lake bottom (ranging from 0.057 to 0.092 mg/L) they did not result in high lake productivity (i.e., low to moderate chlorophyll *a* concentrations). Biovolume density was estimated as 37% dense/very dense cover and no non-native aquatic plants were identified (Appendix B, Table B1). The *Aquatic Life Use* is identified with an "Alert Status", however because it is undetermined if the phosphorus concentrations were elevated as a result of anthropogenic sources. The MRPC and FRCOG (2002) study noted stormwater concern along High Street. Additionally, the Winchendon Country Club with a golf course is in close proximity. Fish toxics monitoring was conducted by MA DEP in Whitney Pond in 1987 (Austin *et al*. 1990). Mercury exceeded the MA DPH action level of 0.5 mg/Kg. The current MA DPH advisory for the Millers River (all towns from Erving to Winchendon, which includes Whitney Pond) recommends "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody and its tributaries, the general public should not consume any brown trout or American eel taken from this waterbody downstream from its confluence with the Otter River, and the general public should limit consumption of all non-affected fish from this waterbody and its tributaries to two meals per month" because of mercury and PCBs. However, PCB levels in fish from Whitney Pond did not exceed the MA DPH action level of 1.0 mg/Kg. The MA DPH is currently in the process of reevaluating the advisory for the Millers River Watershed. The *Fish Consumption Use* is assessed as impaired because of the existing site-specific advisory, however, the cause of impairment is limited to mercury. The Secchi disc depths ranged from 1.2 to 1.5 m (just meeting the bathing beach guidelines), however, it is best professional judgment that these conditions are naturally occurring (a result of the highly colored water). No fecal coliform bacteria data are currently available and, therefore, the *Primary* and *Secondary Contact Recreational* uses are currently not assessed. The *Aesthetics Use* is currently not assessed, however, the presence of a non-native wetlands species (*Lythrum salicaria*) was identified. Whitney Pond is on the 1998 303(d) List of Waters because of metals, noxious aquatic plants, and turbidity (Table 3). The TMDL of Phosphorus for this pond is to be reduced from the current estimated loading of 1918 kg/year to a target load of 1552 kg/year (19% reduction) (MA DEP 2002). Fish toxics monitoring was conducted in this pond in 1987 (Maietta 1988).							
Wickett Pond, Wendell	MA35102	30	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Wrights Reservoir, Gardner/Westminster	MA35104	131	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED	NOT ASSESSED
Wrights Reservoir is on the 1998 303(d) List of Waters because of noxious aquatic plants (Table 3). After reevaluating information it was determined that the conditions in this pond were likely naturally occurring. Further corroborating this evaluation the TMDL of Phosphorus for Wrights Reservoir is to maintain its current estimated loading of 157 kg/year (MA DEP 2002).							

RECOMMENDATIONS – LAKES

- Careful consideration should be given to WMA permits for the Ashburnham and Winchendon Water Departments since Upper Naukeag Lake was identified at a high stress level based on water quantity (Gomez and Sullivan 2003). Furthermore, some of the water withdrawn from Upper Naukeag Lake is transferred out of the upper Millers River subwatershed to the Otter River subwatershed, the Middle River subwatershed, and the Nashua River Basin.

- MPDH is currently reevaluating their Fish Consumption Advisory for the Millers River Watershed. MA DEP has recommended that a site-specific advisory be issued for Whitney Pond because of elevated mercury. Additional fish toxics monitoring in the lakes in the Upper Millers River and North Branch Millers River subwatersheds should be conducted (Sunset Lake, Lower Naukeag, Lake Monomonac, Lake Watatic, and Wallace Pond).

- Confirm the presence of *Myriophyllum heterophyllum*, which is suspected to occur in Sunset Lake (Ashburnham/Winchendon).

- Coordinate with MA DCR and/or other groups conducting lake surveys to generate quality assured lakes data. Conduct more intensive lake surveys to better determine the lake trophic and use support status and identify causes and sources of impairment. As sources are identified within lake watersheds they should be eliminated or, at least, minimized through the application of appropriate point or non-point source control techniques.

- Implement recommendations identified in the TMDLs and lake diagnostic/feasibility studies, including lake watershed surveys to identify sources of impairment. Specific recommendations from the TMDL study include the following:
  - Bourn-Hadley Pond has an unregulated sand and gravel operation on the western shore. This site should be investigated to ensure that best management practices are being utilized and that it is in compliance with the Wetlands Protection Act.
  - Lake Ellis has initiated a program to treat the lake with herbicides that have been effective in controlling the plants in the lake. Designated use zoning is recommended to target areas for plant control.
  - South Athol Pond has a gravel operation on the eastern shore that should be investigated to ensure that best management practices are being utilized so that water quality is protected.

- In-lake management of rooted aquatic plants is recommended for the following recreational lakes that have public access and are deep enough to offer recreational opportunities such as swimming and boating: Lake Ellis, Lower Naukeag Lake, Lake Monomonac, Parker Pond and Whitney Pond. Designated use zoning is recommended to target areas for plant control (MA DEP 2002).

- Continue to review data from “Beaches Bill” required water quality testing (bacteria sampling at all formal bathing beaches) to assess the status of the recreational uses.

- Quick action is necessary to manage non-native aquatic or wetland plant species that are isolated in one or a few location(s), in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations to determine the extent of the infestation. And, "spot" treatments (refer to the draft Generic Environmental Impact Report for Eutrophication and Aquatic Plant Management in Massachusetts [Mattson et *al.* 2004] for advantages and disadvantages of each) should be undertaken to control populations at these sites. These treatments include careful hand-pulling of individual plants in small areas. In larger areas other techniques, such as selective herbicide application, may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These actions will minimize the spreading of the populations. This draft aquatic plant report (Mattson et *al*. 2004) should be consulted prior to the development of any lake management plan to control non-native aquatic or wetland plant species.

- Where non-native plant infestations are more extensive, conduct additional monitoring to determine the extent of the problem. The draft Generic Environmental Impact Report for Eutrophication and Aquatic Plant Management in Massachusetts (Mattson et *al.* 2004) should be consulted prior to the development of any lake management plan to control non-native aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for some invasive species of these plants to reproduce and spread vegetatively (from cuttings).

- Prevent spreading of invasive plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations in unaffected areas, and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert lake-users to the problem and responsibility of spreading these species.

- Review the MA DEP Drinking Water Program Source Water Assessment Program evaluations are when they are completed to develop and implement recommendations for the protection of Class A lakes in the Millers River Basin including Upper Naukeag Lake, Crystal Lake, Cowee Pond and Perley Brook Reservoir.

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