QUALITY ASSURANCE PROJECT
PLAN

For the

Ipswich River Watershed Association RiverWatch Volunteer Monitoring Program

May 2006

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FOR THE

Ipswich River Watershed Association RiverWatch Volunteer Monitoring Program

May 2006

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### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>EOEIA</td>
<td>Executive Office of Environmental Affairs</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>ft</td>
<td>foot</td>
</tr>
<tr>
<td>g</td>
<td>gram</td>
</tr>
<tr>
<td>IRWA</td>
<td>Ipswich River Watershed Association</td>
</tr>
<tr>
<td>lb</td>
<td>pound</td>
</tr>
<tr>
<td>MADEP</td>
<td>Massachusetts Department of Environmental Protection</td>
</tr>
<tr>
<td>MADFW</td>
<td>Massachusetts Division of Fish and Wildlife</td>
</tr>
<tr>
<td>MBL</td>
<td>Marine Biological Laboratory</td>
</tr>
<tr>
<td>MDL</td>
<td>Method Detection Limit</td>
</tr>
<tr>
<td>mg</td>
<td>Milli-gram</td>
</tr>
<tr>
<td>mL</td>
<td>Milli-liter</td>
</tr>
<tr>
<td>N/A</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>QAPP</td>
<td>Quality Assurance Project Plan</td>
</tr>
<tr>
<td>QA/QC</td>
<td>Quality Assurance/Quality Control</td>
</tr>
<tr>
<td>RL</td>
<td>Reporting Limit</td>
</tr>
<tr>
<td>s</td>
<td>Second</td>
</tr>
<tr>
<td>SOP</td>
<td>Standard Operating Procedure</td>
</tr>
<tr>
<td>TAC</td>
<td>Technical Advisory Committee</td>
</tr>
<tr>
<td>UNH</td>
<td>University of New Hampshire</td>
</tr>
<tr>
<td>USGS</td>
<td>United States Geological Survey</td>
</tr>
</tbody>
</table>
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1.0 PURPOSE AND DESCRIPTION

1.1 Ipswich River Watershed Association

The following documentation consists of the Quality Assurance Project Plan (QAPP) for the Ipswich River Watershed Association (IRWA) RiverWatch Volunteer Monitoring Program. This document provides background information on IRWA, issues surrounding the status of the Ipswich River watershed and technical documentation of the IRWA RiverWatch Volunteer Monitoring Program.

IRWA serves as the voice of the Ipswich River, dedicated to protecting water quality and quantity, fish and wildlife habitat, recreational opportunities and scenic values of the Ipswich River Watershed. IRWA is a 501(c)3 non-profit organization, formed by volunteers in 1976. Our diverse membership includes individuals and families, businesses, municipalities, environmental organizations, anglers, hunters, canoeists, artists, scientists, educators, officials and other concerned citizens. IRWA’s funding comes from membership dues, private donations, fundraising events, private and public grants, and the sale of T-shirts and other items.

IRWA works on a number of ongoing programs dedicated to protecting and monitoring the River as well as educating the public about the River. IRWA’s recent and current programs include:

- Monitoring, including the RiverWatch monthly baseline sampling program, macroinvertebrate sampling and an annual herring count were all conducted by volunteers. Additional studies included: stormwater sampling, flow studies and bacteria contaminant studies.
- River restoration, focusing on assisting the region’s communities in improving management and protection of water resources, as well as evaluating in-stream restoration opportunities such as dam removal, fish passage improvement and culvert replacement.
- Water conservation, focusing on the use of the Ipswich River for the region’s water supply, the environmental costs of this use, and actions that residents and businesses can use water more efficiently indoors and out.
- Watershed education and outreach, including educational programs for municipal officials and the public, as well as teacher workshops based on our interdisciplinary Ipswich River environmental education curricula.
- Stream teams, organizing and supporting citizens in their efforts to lead local watershed protection efforts.
- Advocacy campaign, to ensure that the interests of the River are represented at all levels of decision making. This project includes intervention in legal appeals as well as commentary on proposed projects.

1.2 Overview of study area - Ipswich River Watershed Description

The Ipswich River watershed is 155 square miles and includes all or part of 21 communities in northeastern Massachusetts. The topography of this Atlantic coastal plain basin is characterized by low relief, with an average grade of 3.1 feet per mile. The length of the river is a meandering 40 miles. The surficial geology of the region consists primarily of glacial till with stratified sand and gravel deposits covering about 43 percent of the basin and alluvial deposits covering about 3 percent of the basin. Extensive wetlands are present along the River and streams within the Ipswich River basin. These wetlands protect surrounding areas during flooding as well as positively affect the water quality of the River and streams in the basin.
This small river system supplies water to more than 330,000 people and thousands of businesses, providing all or part of the water supply for 15 communities: Beverly, Boxford, Danvers, Hamilton, Ipswich, Lynn, Lynnfield, Middleton, North Reading, Peabody, Reading, Salem, Topsfield, Wenham, and Wilmington. In 2001, 14.56 billion gallons of water were withdrawn for public water supplies. Under the Massachusetts Surface Water Quality Standards, most of the river is designated as Class B, except for public water supply reservoirs and their tributaries (Class A), as well as the tidally influenced portion of the river, which is classified as SA.

Class A waters are designated as a source of public water supply and should be excellent fish, aquatic life and wildlife habitat as well as suitable for primary and secondary contact recreation (MADEP, 2006). Class SA waters are defined as excellent habitat for fish, aquatic life and wildlife as well as suitable for primary and secondary contact recreation (Ibid). Additionally, SA waters are suitable for shellfish harvesting without depuration (open shellfish areas) (Ibid). Class B waters should be good habitat for fish, other aquatic life, and wildlife, as well as for primary and secondary contact recreation (Ibid). Class B waters may also be designated as a source of public water supply with appropriate treatment and are suitable for irrigation and other agricultural uses (Ibid). Class SB waters are suitable habitat for fish, other aquatic life and wildlife as well as primary and secondary contact recreation (Ibid). In approved areas, shellfish harvesting with depuration (Restricted Shellfish Areas) may also occur in class SB waters (Ibid). In addition to the narrative standards for each water class presented here, there are specific numeric standards for dissolved oxygen, temperature, pH, fecal coliform, solids, oil and grease, and taste and odor.

### Table 1 - Massachusetts surface water quality standards for the Ipswich River Basin and Coastal Drainage Area (MADEP, 1996)

<table>
<thead>
<tr>
<th>BOUNDARY</th>
<th>MILE POINT</th>
<th>CLASS</th>
<th>OTHER RESTRICTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ipswich River</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source to Salem Beverly Waterway Canal</td>
<td>41.1 - 16.4</td>
<td>B</td>
<td>Treated Water Supply, Warm Water, High Quality Water</td>
</tr>
<tr>
<td>Salem Beverly Waterway Canal to tidal portion</td>
<td>16.4 - 4.5</td>
<td>B</td>
<td>Warm Water, High Quality Water</td>
</tr>
<tr>
<td>Tidal portion and tributaries thereto</td>
<td>4.5 - 0.0</td>
<td>SA</td>
<td>Shellfishing (O)</td>
</tr>
<tr>
<td>Middleton Pond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source to outlet in Middleton and those tributaries thereto</td>
<td>-</td>
<td>A</td>
<td>Public Water Supply</td>
</tr>
<tr>
<td>Swan Pond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source to outlet in North Reading and those tributaries thereto</td>
<td>-</td>
<td>A</td>
<td>Public Water Supply</td>
</tr>
<tr>
<td>Mill Pond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source to outlet in Burlington and those tributaries thereto</td>
<td>-</td>
<td>A</td>
<td>Public Water Supply</td>
</tr>
<tr>
<td>Longham Reservoir</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source to outlet in Wenham and those tributaries thereto</td>
<td>-</td>
<td>A</td>
<td>Public Water Supply</td>
</tr>
</tbody>
</table>
In 1997, the Ipswich River was listed as one of the nation’s most threatened rivers because of its severe low-flow problems (Zarriello and Reis, 2000). Much of the upper half of the River dried up or was reduced to isolated stagnant pools in the summers of 1995, 1997 and 1999. In 1999, the River experienced record low-flows in May, June, July and August.

In early 2000, the United States Geological Survey (USGS) completed development of a hydrologic model of the Ipswich River watershed that documented the relationship between water withdrawals and low-flows in the River. The USGS found that groundwater withdrawals in the upper reaches of the watershed are the main factor responsible for reducing summer River flows (Zarriello and Reis, 2000). Additionally, the diversion of wastewater to treatment plants outside the watershed also significantly reduces flow (Ibid).

A companion study by USGS and the Massachusetts Division of Fisheries and Wildlife (MADFW) found that the Ipswich River’s fisheries have been degraded by low-flow problems and the River has experienced a decrease in biodiversity due to the loss of river dependent fish species (Armstrong et al., 2001). The study identified critical aquatic habitats and recommended minimum flows necessary to preserve those habitats. The Ipswich River Fisheries Restoration Task Group then developed recommendations to restore healthy fisheries to the Ipswich River (2002).

### 1.2.1 Current Status of Waters in the Ipswich River Watershed

Major water quality issues have been identified in the Ipswich River and the Ipswich River watershed by both independent researchers and the State of Massachusetts. The most current list of water quality impairments (303(d) list) provided by the State of Massachusetts includes impairments for: low dissolved oxygen levels, repeated, exaggerated low flow episodes, excessive nutrient and fecal coliform loadings, and many others (Tables 2 and 3).
Table 2 - Massachusetts Year 2004 Integrated List of Waters (Proposed) - Category 4c Waters "Impairment not caused by a pollutant" in Ipswich River Watershed (EOEA, 2004). Monitoring sites that correspond to segments are also listed.

<table>
<thead>
<tr>
<th>Name and Segment ID</th>
<th>Description</th>
<th>Size</th>
<th>Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Pond (92019) / MA92019_2004</td>
<td>Andover</td>
<td>56.7 acres</td>
<td>Exotic species</td>
</tr>
<tr>
<td>Lower Boston Brook Pond (92031) / MA92031_2004</td>
<td>Middleton</td>
<td>9.3 acres</td>
<td>Exotic species</td>
</tr>
<tr>
<td>Lower Four Mile Pond (92032) / MA92032_2004</td>
<td>Boxford</td>
<td>18.4 acres</td>
<td>Exotic species</td>
</tr>
<tr>
<td>Lubber Pond East (92035) / MA92035_2004</td>
<td>Wilmington</td>
<td>6.2 acres</td>
<td>Siltation &amp; Exotic species</td>
</tr>
<tr>
<td>Lubber Pond West (92036) / MA92036_2004</td>
<td>Wilmington</td>
<td>9.6 acres</td>
<td>Siltation &amp; Exotic species</td>
</tr>
<tr>
<td>Maple Meadow Brook (9254100) / MA92-04_2004</td>
<td>Outlet of Mill Pond, Burlington to confluence with Lubbers Brook, Wilmington. Includes monitoring site MMB.</td>
<td>4.2 miles</td>
<td>Flow alteration</td>
</tr>
<tr>
<td>Stevens Pond (92062) / MA92062_2004</td>
<td>Boxford</td>
<td>11.1 acres</td>
<td>Exotic species</td>
</tr>
</tbody>
</table>
### Table 3 - Massachusetts Year 2004 Integrated List of Waters (Proposed) - Category 5 Waters “Waters requiring a TMDL” in Ipswich River Watershed (EOEA, 2004). Monitoring sites that correspond to segments are also listed.

<table>
<thead>
<tr>
<th>Name and Segment ID</th>
<th>Description</th>
<th>Size</th>
<th>Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brackett Pond (92004)  / MA92004_2004</td>
<td>Andover</td>
<td>15.7 acres</td>
<td>Turbidity</td>
</tr>
<tr>
<td>Collins Pond (92010)  / MA92010_2004</td>
<td>Andover</td>
<td>2.1 acres</td>
<td>Noxious aquatic plants &amp; turbidity</td>
</tr>
<tr>
<td>Crystal Pond (92013)  / MA92013_2004</td>
<td>Peabody</td>
<td>8.2 acres</td>
<td>Nutrients, noxious aquatic plants &amp; turbidity</td>
</tr>
<tr>
<td>Devils Dishfull Pond / (92015) MA92015_2004</td>
<td>Peabody</td>
<td>14.3 acres</td>
<td>Nutrients, organic enrichment/low dissolved oxygen, noxious aquatic plants, turbidity &amp; exotic species</td>
</tr>
<tr>
<td>Frye Pond (92023)  / MA92023_2004</td>
<td>Andover</td>
<td>7.3 acres</td>
<td>Noxious aquatic plants</td>
</tr>
<tr>
<td>Hood Pond (92025)  / MA92025_2004</td>
<td>Ipswich</td>
<td>67.4 acres</td>
<td>Metals</td>
</tr>
</tbody>
</table>
| Howlett Brook (9253750) / MA92-17_2004 | Headwaters north of Great Hill, Topsfield to confluence with Ipswich River, Topsfield.  
*Includes monitoring site HB.* | 2.5 miles | Cause unknown & pathogens                                                  |
| Ipswich River (9253500) / MA92-02_2004 | Ipswich Dam (formerly known as Sylvania Dam), Ipswich to mouth at Ipswich Bay, Ipswich.  
*Includes monitoring sites IP24, IP25, and IP26.* | 0.44 sq Mi | Pathogens                                                                 |
| Ipswich River (9253500) / MA92-06_2004 | Source at confluence of Maple Meadow Brook and Lubbers Brook, Wilmington, to Salem Beverly Waterway Canal, Topsfield.  
*Includes monitoring sites IP00 through IP16.* | 20.4 miles | Nutrients, organic enrichment/low dissolved oxygen & flow alteration      |
| Ipswich River (9253500) / MA92-15_2004 | Salem Beverly Waterway Canal, Topsfield to Ipswich Dam (formerly known as Sylvania Dam), Ipswich.  
*Includes monitoring sites IP18 through IP22.* | 11.0 miles | Organic enrichment/low dissolved oxygen & flow alteration                  |
<p>| Kimball Brook (9253625) / | Headwaters, west of Scott Hill, Ipswich to | 2.2 miles | Organic enrichment/low dissolved oxygen &amp; |</p>
<table>
<thead>
<tr>
<th>Name and Segment ID</th>
<th>Description</th>
<th>Size</th>
<th>Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA92-21_2004</td>
<td>confluence with Ipswich River, Ipswich.</td>
<td></td>
<td>pathogens</td>
</tr>
<tr>
<td>Labor In Vain Creek (9253600) / MA92-22_2004</td>
<td>South of Argilla Road, Ipswich to confluence with Ipswich River Estuary, Ipswich.</td>
<td>0.03 sq mi</td>
<td>Organic enrichment/low dissolved oxygen &amp; pathogens</td>
</tr>
<tr>
<td>Lowe Pond (92034) / MA92034_2004</td>
<td>Boxford</td>
<td>35.8 acres</td>
<td>Metals &amp; exotic species</td>
</tr>
<tr>
<td>Martins Brook (9254000) / MA92-08_2004</td>
<td>Outlet of Martins Pond, North Reading to the confluence with the Ipswich River, North Reading. <em>Includes monitoring site MB.</em></td>
<td>4.6 miles</td>
<td>Organic enrichment/low dissolved oxygen, other habitat alterations &amp; pathogens</td>
</tr>
<tr>
<td>Martins Pond (92038) / A92038_2004</td>
<td>North Reading</td>
<td>89.0 acres</td>
<td>Metals, noxious aquatic plants, turbidity &amp; exotic species</td>
</tr>
<tr>
<td>Miles River (9253650) / MA92-03_2004</td>
<td>Outlet Longham Reservoir, Beverly to confluence with Ipswich River, Ipswich.</td>
<td>8.9 miles</td>
<td>Cause unknown, organic enrichment/low dissolved oxygen &amp; pathogens</td>
</tr>
<tr>
<td>Mill Pond (92041) / MA92041_2004</td>
<td>Burlington</td>
<td>59.1 acres</td>
<td>Metals</td>
</tr>
<tr>
<td>Norris Brook (9253950) / MA92-11_2004</td>
<td>Outlet of Elginwood Pond, Peabody to confluence with Ipswich River, Danvers</td>
<td>1.5 miles</td>
<td>Organic enrichment/low dissolved oxygen, suspended solids &amp; turbidity</td>
</tr>
<tr>
<td>Salem Pond (92057) / MA92057_2004</td>
<td>North Andover</td>
<td>14.7 acres</td>
<td>Turbidity</td>
</tr>
<tr>
<td>Unnamed Tributary (9253585) / MA92-23_2004</td>
<td>Headwaters, east of Jeffreys Neck Road, north of Newmarch Street to confluence with Ipswich River Estuary, Ipswich. (locally known as Greenwood Creek)</td>
<td>0.03 sq mi</td>
<td>Pathogens</td>
</tr>
<tr>
<td>Unnamed Tributary (9253945) / MA92-12_2004</td>
<td>Outlet of Middleton Pond, Middleton to confluence with Ipswich River, Middleton.</td>
<td>1.3 miles</td>
<td>Pathogens</td>
</tr>
<tr>
<td>Wills Brook (9253975) / MA92-10_2004 Headwater</td>
<td>Lynnfield (just north of Lowell Street) to confluence with Ipswich River, Lynnfield.</td>
<td>1.7 miles</td>
<td>Organic enrichment/low dissolved oxygen &amp; pathogens</td>
</tr>
</tbody>
</table>
1.3 Problem Definition - Monitoring Questions and Purpose

The purposes of sampling the Ipswich River and associated tributaries are to:

- Define the baseline water quality condition of the Ipswich River and key tributaries.
- Define dissolved oxygen concentrations over the range of annual conditions in both mainstem and tributary locations.
- Reveal trends in dissolved oxygen concentrations and conductivity over time and River location.
- Reveal the relative water level and flow at a variety of ungauged locations around the Ipswich River Watershed.
- Define the water temperature of the River over a range of annual conditions in both the mainstem and key tributary locations.

In defining the River's range of temperature, conductivity, flow and dissolved oxygen, IRWA will be able to better define changes in the River over time to determine the success of restoration efforts and any further degradation of the system.

1.4 Intended Use

Data collected by IRWA will be reported to IRWA members, state agencies, interested organizations, and conservation commissions through reports and presentations on the collected data.

Atypical data will be reported to the appropriate agencies. Atypical data include dissolved oxygen data that vary significantly from adjacent sites over one or more months. Extended periods of no flow or extremely low dissolved oxygen (less than 2 mg/L) are also considered extremely important and will be presented to state agencies. (When dissolved oxygen levels fall below 2 mg/L the health of fish and other aquatic organisms can be severely impacted.)

1.5 IRWA RiverWatch Monitoring Project Description

As it has since 1997, the RiverWatch Monitoring program will use a trained and coordinated volunteer base to collect monthly water quality data as described below. These data will be used to document existing conditions and build on baseline trends.

EPA approved IRWA’s first QAPP in 2000. The development of this and previous QAPPs were funded through various EOEA grants as well as IRWA general funds.

1.5.1 RiverWatch Volunteer Monitoring Organization

The RiverWatch Volunteer Monitoring Program is a volunteer based water quality monitoring program that is managed by IRWA. Overall management of the monitoring program is provided by the Director of the IRWA with assistance from the Monitoring Project Coordinator, Quality Assurance Officer, Field Coordinator and IRWA staff members (figure 1). The program Director is responsible for overall operation and direction of IRWA. The Monitoring Project Coordinator is responsible for all aspects of the monitoring program including organization of the volunteers, data management and documentation/reporting. The Field Coordinator assists the Monitoring Project Coordinator with coordination between volunteer monitors and IRWA; they are also responsible for field audits of volunteers. The Quality Assurance Officer is responsible for the collection and evaluation of QA/QC data. Additional assistance with technical and research questions is provided by the Technical Advisory Committee (TAC). The TAC is made up of researchers, state scientists and
volunteer monitors. A list of TAC members is provided in Appendix B. Table 4 provides an overview of the responsibilities of key personnel.

1.5.1.1 **Qualifications of key personnel**

The Director of the IRWA shall have at least a Masters degree in a field related to water resources management and five years of relevant experience. The Monitoring Project Coordinator and Field Coordinator will hold a Bachelors of Science in natural resources or a related field and have experience working on water quality issues. The Quality Assurance Officer will hold at least a Bachelors of Science in natural resources or a related field and have experience with data quality control. Positions are currently filled by staff with experience much greater than that mandated for their positions. Appendix C contains staff resumes.

**Figure 1 - IRWA RiverWatch Volunteer Monitoring Program Structure**
Table 4 - Roles and Responsibilities

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Responsible Party</th>
<th>Address/Phone/E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiscal management of the project, project objectives, data uses &amp; program changes.</td>
<td>IRWA Director Kerry Mackin</td>
<td>PO Box 576 Ipswich, MA 01938 978.887.2313</td>
</tr>
<tr>
<td>Assists in identification of project objectives, data quality objectives and methods, and oversight of project assessment.</td>
<td>TAC See Appendix B for list of TAC members</td>
<td></td>
</tr>
<tr>
<td>Directs all monitoring project activities and oversees development and evaluation of the QAPP and Monitoring Manual. Provides training to volunteers and assesses field monitoring performance.</td>
<td>Monitoring Project Coordinator Jessica Darling</td>
<td>PO Box 576 Ipswich, MA 01938 978.887.2313</td>
</tr>
<tr>
<td>Assists with or writes the QAPP and ensures that all elements of the project follow QA procedures in the QAPP. Reviews data for QC prior to publication. Leads TAC reviewing data for QC</td>
<td>Quality Assurance Officer Jessica Darling</td>
<td>PO Box 576 Ipswich, MA 01938 978.887.2313</td>
</tr>
<tr>
<td>Coordinates all elements of the field monitoring.</td>
<td>Field Coordinator Frances Doyle</td>
<td>PO Box 576 Ipswich, MA 01938 978.887.2313</td>
</tr>
<tr>
<td>Reviews QAPP for accuracy and completeness.</td>
<td>MassDEP QA Officer Richard Chase</td>
<td>627 Main Street Worcester, MA 01608 508.767.2859</td>
</tr>
<tr>
<td>CZM Technical Reviewer</td>
<td>Mass CZM Todd Callaghan</td>
<td>251 Causeway St, Suite 800 Boston, MA, 02114-2138 617.626.1200</td>
</tr>
</tbody>
</table>

1.5.2 Monitoring parameters, type, schedule and location

IRWA’s monitoring focuses on the water quality impacts associated with low dissolved oxygen and flow. The monthly monitoring includes data collection for weather, rain in the last 48 hours, water color, water odor, water temperature, dissolved oxygen, velocity and depth. Conductivity is also collected at select stations: IP00, MMB, IP06, IP04 and FB-MI. It is the intent that conductivity will be collected at additional stations once funds become available. River cross sectional information is collected twice a year, once in the spring and fall, to estimate River flow based on the monthly collection of velocity and River depth. The spring cross section collection will preferably occur in April, corresponding to high flow in the River and the fall collection preferably in September, corresponding to a low flow period.

Additional monitoring data is often made available by the University of New Hampshire (UNH) and the Marine Biological Laboratory (MBL), both of which are actively completing research in the Ipswich River watershed and continue to generously share their data with IRWA. This QAPP only covers sampling completed by the IRWA.
Volunteer monitors are responsible for monthly monitoring which takes place in the morning of the last Sunday of each month from March through December (as of the spring of 2006, sampling in January and February became optional) unless the date conflicts with a holiday. If there is a conflict, the previous or next Sunday will be chosen and volunteers notified via phone or email. All samples must be collected between 8 am and 12:30 pm, except for the tidal locations, which are sampled within 1 hour of the low tide closest to the 8 am to 12:30 pm time span. Sampling will be performed under both wet and dry conditions, except in case of lightning.

Sampling in the morning is extremely important because the lowest dissolved oxygen values are generally observed in the early morning, close to sunrise. IRWA desires to record these low values because they have the most potential to affect the organisms living in the Ipswich River. Since the sampling effort is conducted by volunteers it was not practical to ask them to sample before or at sunrise. Therefore, it was requested that volunteers sample between 8 and 12:30 pm; samples collected before 8 am are also acceptable. As of the spring of 2006, sampling in January and February became optional. Historically volunteers sampled during these months, but the River was often frozen and the data collected during these months was generally not used in management decisions.

Sampling locations were selected based on establishing a network of coverage along the River to provide baseline data for the watershed. Initially, 30 sampling sites were selected along the River and tributary system (table 5 and figure 2). A total of 28 sites were monitored in 2005. New monitoring sites will be added along tributaries as new volunteers are trained and monitoring kits can be purchased. Sites referred to the program for monitoring will be reviewed to determine if they are accessible by a volunteer, if the site will provide spatially unique data and if the site will provide data that is not currently available (lake and pond sites with no historic data have priority). New sites will be reviewed by the TAC to provide additional opinions on the value of adding a specific new site.

Sites where conductivity will be monitored were chosen along River tributaries because the tributaries are expected to vary from each other due to differences in stormwater flow, geology and land use. Mainstem conductivity sites were selected to provide a comparison of conductivity between the River and associated tributaries and are expected to vary less.
Table 5 - Monitoring Sites

<table>
<thead>
<tr>
<th>SITE ID</th>
<th>DESCRIPTION</th>
<th>TOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMB</td>
<td>Maple Meadow Brook at Wildwood Street</td>
<td>Wilmington</td>
</tr>
<tr>
<td>LB</td>
<td>Lubbers Brook @ Glen Rd.</td>
<td>Wilmington</td>
</tr>
<tr>
<td>IP00</td>
<td>Woburn St.</td>
<td>Wilmington</td>
</tr>
<tr>
<td>IP00.5</td>
<td>Reading Town Forest</td>
<td>Reading</td>
</tr>
<tr>
<td>IP01</td>
<td>Mill St.</td>
<td>Reading</td>
</tr>
<tr>
<td>IP02</td>
<td>Route 28</td>
<td>Reading</td>
</tr>
<tr>
<td>MB</td>
<td>Martin’s Brook at Park Street</td>
<td>North Reading</td>
</tr>
<tr>
<td>IP03</td>
<td>Central St.</td>
<td>North Reading</td>
</tr>
<tr>
<td>IP04</td>
<td>Route 62</td>
<td>North Reading</td>
</tr>
<tr>
<td>IP06</td>
<td>South Middleton Gage</td>
<td>Middleton</td>
</tr>
<tr>
<td>IP08</td>
<td>Log Bridge Road</td>
<td>Middleton</td>
</tr>
<tr>
<td>IP10</td>
<td>Route 62</td>
<td>Middleton</td>
</tr>
<tr>
<td>IP11</td>
<td>Peabody St.</td>
<td>Middleton</td>
</tr>
<tr>
<td>IP12</td>
<td>Thunder Bridge</td>
<td>Middleton</td>
</tr>
<tr>
<td>IP13</td>
<td>Rowley Bridge Road</td>
<td>Topsfield</td>
</tr>
<tr>
<td>IP14</td>
<td>Salem Road</td>
<td>Topsfield</td>
</tr>
<tr>
<td>IP16</td>
<td>IRWS - Boat Launch</td>
<td>Topsfield</td>
</tr>
<tr>
<td>IP18</td>
<td>Asbury Road</td>
<td>Topsfield</td>
</tr>
<tr>
<td>IP19</td>
<td>Willowdale Dam</td>
<td>Ipswich</td>
</tr>
<tr>
<td>IP20</td>
<td>Winthrop Street</td>
<td>Ipswich</td>
</tr>
<tr>
<td>IP22</td>
<td>Mill Road</td>
<td>Ipswich</td>
</tr>
<tr>
<td>IP24</td>
<td>Sylvania Dam</td>
<td>Ipswich</td>
</tr>
<tr>
<td>IP25</td>
<td>Green Street</td>
<td>Ipswich</td>
</tr>
<tr>
<td>IP26</td>
<td>Town Landing</td>
<td>Ipswich</td>
</tr>
<tr>
<td>GC</td>
<td>Greenwood Creek</td>
<td>Ipswich</td>
</tr>
<tr>
<td>FB-BV</td>
<td>Fish Brook at Brookview Rd.</td>
<td>Boxford</td>
</tr>
<tr>
<td>FB-MI</td>
<td>Fish Brook at Middleton Rd.</td>
<td>Boxford</td>
</tr>
<tr>
<td>FB-WA</td>
<td>Fish Brook at Washington St.</td>
<td>Boxford</td>
</tr>
<tr>
<td>HB</td>
<td>Howlett Brook at Topsfield Rd</td>
<td>Ipswich</td>
</tr>
<tr>
<td>MR-1A</td>
<td>Miles River at 1A</td>
<td>Ipswich</td>
</tr>
</tbody>
</table>
1.5.3 Monitoring Objectives

The goal of the RiverWatch Program is to produce data of sufficient quality to be acceptable for its intended use and audience, as defined below:

a. Weather
   - To determine if the collected data is related to weather conditions. Dissolved oxygen, water temperature, water color, water odor and velocity are affected by precipitation. Cloud cover and other climatic factors may also affect DO and temperature.

b. Rain in the last 48 hours
   - To determine if the collected data is related to weather conditions. Dissolved oxygen, water temperature, water color, water odor and velocity are affected by precipitation.

c. Water Color
   - To record any abnormal coloration of the water potentially indicating a pollution issue.

d. Water Clarity
   - To record any abnormal sediment loading of the water potentially indicating a pollution issue.
e. Water Odor
   • Assessment of potential pollution concerns

f. Water Temperature:
   • To determine if the MADEP defined water quality standards are met;
   • To determine what wildlife the temperature of the river will support;
   • To investigate the relationship between low flow and temperature and
   • To determine dissolved oxygen saturation levels

g. Dissolved Oxygen
   • To determine if the MADEP defined water quality standards are met and
   • To determine areas/periods of low DO

h. Flow
   • To determine if flow present is able to support designated uses and habitat
   • To establish timeline trend of baseline indices of velocity for each site to act as an indicator
     for flow, which cannot be measured within accuracy limits.
   • Flow is calculated based on river cross-section, velocity and depth information.

i. Conductivity
   • To establish baseline conditions and potentially identify stormwater contributions to stream
     and River flow.

1.5.4 Project Schedule

The QAPP will be reviewed annually, generally in January of each year. Major changes in the QAPP will
necessitate approval from MADEP. Major changes in the QAPP will consist of adding additional analyses or
procedures, or major modification of existing methods (new instrument, method, etc). Volunteer monitor
training/retraining will occur at least annually and is discussed in further detail in section 1.5.5.

Table 6 - Project Schedule

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Date</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete QAPP</td>
<td>Current</td>
<td>June 2006</td>
</tr>
<tr>
<td>Sample monthly</td>
<td>Current</td>
<td>Continuous</td>
</tr>
<tr>
<td>Data management and review</td>
<td>Current</td>
<td>Continuous</td>
</tr>
<tr>
<td>Annual data review, QA/QC, and compilation into report</td>
<td>Annually in January</td>
<td>Continuous</td>
</tr>
<tr>
<td>Review QAPP, if any major changes in QAPP protocol, obtain</td>
<td>Annually in January</td>
<td>Continuous</td>
</tr>
<tr>
<td>approval from MADEP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitor Retraining</td>
<td>Annually in spring</td>
<td>Continuous</td>
</tr>
</tbody>
</table>


1.5.5 Training Requirements/Certifications

1.5.5.1 New Monitor Training

Each new monitor must attend an initial monitoring training that includes: a description of the program, a walk-through of the monitoring manual and hands-on monitoring at a monitoring site. The Monitoring Program Coordinator will lead this training. New monitors will be trained as they are acquired and prior to monitoring a RiverWatch site. New monitor training may occur during the yearly monitoring training or separately. Records of the monitoring training will be kept by IRWA.

1.5.5.2 Yearly Monitoring Training

Each monitor must also attend a yearly monitoring training that includes at a minimum:

1. An overview of the monitoring program;
2. A discussion of any changes to the monitoring program;
3. A check of the calibration of thermometers;
4. Collection and analysis of a dissolved oxygen sample for comparison with the group present at the training;
5. Collection and analysis of a conductivity sample for comparison with the group present at the training (for those sites where conductivity is collected);
6. Information on quality assurance methods and
7. A question and answer session.

The Monitoring Project Coordinator will lead these training events. Trainings will be held at a central location in the watershed. Records of data generated during this training as well as attendance records will be retained by IRWA.

1.5.5.3 Yearly audit

Each site will be audited annually by the Monitoring Project Coordinator or the Field Coordinator. The site audit will consist of the observation of the volunteer by the auditor. Any errors in procedure will be recorded on the project audit sheet and problems discussed and resolved with the volunteers. The auditing form is located in the RiverWatch Water Quality Volunteer Monitoring Manual 2006 (Version 3) (Appendix A).

1.5.5.4 Trainer Qualifications

The trainer for all RiverWatch trainings will be the Monitoring Project Coordinator or an equally qualified individual. The trainer will have substantial water quality monitoring experience through professional experience and/or education.

2.0 SAMPLING PROCESS DESIGN AND DATA QUALITY OBJECTIVES

2.1 Site Safety Plan

The RiverWatch Monitoring Manual is provided to all volunteers (Appendix A). This manual, as well as trainings, instruct volunteers to take appropriate precautions to ensure their safety during monitoring. Required safety measures include wearing a safety vest and/or using safety cones when monitoring at bridge locations, informing a third party of expected return time, not performing monitoring under adverse weather conditions, not wading into the river at times of high water and not leaning on or sitting on bridge railings.
2.2 Sample measurement type

Samples are collected either directly from the River by wading or from a bridge using a bucket. Water collection methods are outlined in the RiverWatch Water Quality Volunteer Monitoring Manual 2006 (Version 3) (Appendix A). Sites where wading into the River is necessary to collect a sample are: IP00.5, IP08, IP16, IP19, IP26 and GC. At these sites, it is preferable for the volunteer to collect the sample directly from the River, but the volunteer may use a bucket to collect a grab sample and then bring the bucket of water ashore to sample from. The method of water collection for the wading sites is left to monitor discretion, within the safety caveats noted above.

All measurements collected, except dissolved oxygen, velocity and flow are direct measurements. Direct measurements provide the value of interest directly, without further calculation (ie: temperature). Indirect measurements necessitate further calculation of the value of interest from another parameter. Dissolved oxygen is an indirect measurement because after the water sample is collected the dissolved oxygen is converted into another compound, this compound is then titrated and the value used to calculate the dissolved oxygen concentration. Unlike collection of dissolved oxygen using a meter, where the value is directly provided, using the titration method necessitates further calculation and is therefore an indirect measurement. Likewise, the calculation of velocity is completed indirectly by recording the movement of a floating particle. Velocity is then calculated using the time it takes the particle to travel a given distance. The estimated velocity and River cross sectional information is then used to calculate flow, another indirect measurement.

Table 7 - Parameters and Sample Types

<table>
<thead>
<tr>
<th>Property</th>
<th>Parameter/Indicator</th>
<th>Direct or indirect measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>Dissolved Oxygen</td>
<td>Indirect (titration)</td>
</tr>
<tr>
<td>Physical</td>
<td>Weather</td>
<td>Direct (visual observation)</td>
</tr>
<tr>
<td></td>
<td>Rain in last 48 Hours</td>
<td>Direct (visual observation)</td>
</tr>
<tr>
<td></td>
<td>Water Color</td>
<td>Direct (visual observation)</td>
</tr>
<tr>
<td></td>
<td>Water Clarity</td>
<td>Direct (visual observation)</td>
</tr>
<tr>
<td></td>
<td>Water Odor</td>
<td>Direct (olfactory estimate)</td>
</tr>
<tr>
<td></td>
<td>Water Temperature</td>
<td>Direct (thermometer)</td>
</tr>
<tr>
<td></td>
<td>Velocity</td>
<td>Indirect (visual assessment)</td>
</tr>
<tr>
<td></td>
<td>Depth</td>
<td>Direct (measured line)</td>
</tr>
<tr>
<td></td>
<td>Cross section</td>
<td>Direct (measured line)</td>
</tr>
<tr>
<td></td>
<td>River Flow</td>
<td>Indirect (calculated from depth, velocity and River cross section)</td>
</tr>
<tr>
<td></td>
<td>Conductivity</td>
<td>Direct (conductivity meter)</td>
</tr>
</tbody>
</table>

2.3 Method Detection Limits and Reporting Limits

Data quality objectives and for each parameter of interest are defined below. Although weather, rain in the last 48 hours, water color and odor are monitored, they are qualitative measures and are not included in this table. Qualitative measures are those parameters that cannot be defined numerically but are descriptive.

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terms. Quantitative measures are parameters that can be defined numerically, such as the temperature of water.

The method detection limit (MDL) is the analyte concentration where there is 99% confidence that the sample concentration is different from zero. Below the MDL it is uncertain if the concentration is not zero. The reporting limit (RL) is the value above which data have definable accuracy and precision. Further discussion of accuracy and precision is found in section 2.6.

Table 8 - Parameter Method Detection Limit and Reporting limits

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Units</th>
<th>Method Detection Limit (MDL)</th>
<th>Reporting Limit (RL)</th>
<th>Range of results expected</th>
<th>Sampling Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather, rain in last 48 hours, water color and water odor</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>mg/l</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0 - 15.0</td>
<td>LaMotte modified Winkler Method Dissolved Oxygen Kit</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>°C</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0 - 30.0</td>
<td>Envirosafe® Armored Thermometer</td>
</tr>
<tr>
<td>Velocity</td>
<td>ft/s</td>
<td>0</td>
<td>0</td>
<td>0 - 4</td>
<td>Stop watch, floatable</td>
</tr>
<tr>
<td>Depth</td>
<td>ft</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0 - 10.0</td>
<td>Measuring tape with 5 lb. weight attached</td>
</tr>
<tr>
<td>River Cross Section</td>
<td>ft</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0 – 10.0</td>
<td>Measuring tape with 5 lb. weight attached</td>
</tr>
<tr>
<td>River Flow</td>
<td>ft/s</td>
<td>0</td>
<td>0</td>
<td>0 – 50</td>
<td>Calculated based on river cross section, depth and velocity</td>
</tr>
<tr>
<td>Conductivity</td>
<td>µS/cm</td>
<td>0</td>
<td>20</td>
<td>100-1,500</td>
<td>Oakton Big Display Conductivity ECTestestr Low</td>
</tr>
</tbody>
</table>

Notes:

1. The range of sample values expected during the course of sampling activities

2.4 Sampling and Preservation Requirements

The following section provides an overview of the methods utilized in the RiverWatch Water Quality Monitoring Program. Detailed Standard Operating Procedures (SOPs) are provided in Appendix A – RiverWatch Volunteer Monitoring Program Manual.
Table 9 - Sampling Methods by Parameter

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Matrix</th>
<th>Container Type</th>
<th>Sampling Equipment</th>
<th>Minimum Sample Quantity</th>
<th>Sample Type¹</th>
<th>Preservation</th>
<th>Maximum Holding Time</th>
<th>Sampling Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather</td>
<td>Immediate Environment</td>
<td>None</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Direct visual Observation</td>
</tr>
<tr>
<td>Rain in Last 48 Hours</td>
<td>Immediate Environment</td>
<td>None</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Direct visual Observation</td>
</tr>
<tr>
<td>Water Color</td>
<td>Water</td>
<td>None</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Direct visual Observation</td>
</tr>
<tr>
<td>Water Clarity</td>
<td>Water</td>
<td>None</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Direct visual Observation</td>
</tr>
<tr>
<td>Water Odor</td>
<td>Water</td>
<td>None</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Direct visual Observation</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>Water</td>
<td>Bucket or directly in River</td>
<td>Envirosafe® Armored Thermometer</td>
<td>100 mL Grab</td>
<td>Analyze immediately</td>
<td>Analyze immediately</td>
<td>Direct (thermometer)</td>
<td></td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>Water</td>
<td>LaMotte Water Sampling Bottle</td>
<td>LaMotte modified Winkler Method Dissolved Oxygen Kit</td>
<td>50 mL Grab</td>
<td>Analyze immediately</td>
<td>Analyze immediately</td>
<td>Indirect (Modified Winkler Method)</td>
<td></td>
</tr>
<tr>
<td>Velocity</td>
<td>Water</td>
<td>None</td>
<td>Stop watch, floatable</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Indirect (time floatable)</td>
</tr>
<tr>
<td>Depth</td>
<td>Water</td>
<td>None</td>
<td>Measuring tape with 5 lb weight attached</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Direct (use of measured line)</td>
</tr>
<tr>
<td>River Cross Section</td>
<td>Water</td>
<td>None</td>
<td>Measuring tape with 5 lb weight attached</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Direct (use of measured line)</td>
</tr>
<tr>
<td>Flow</td>
<td>Water</td>
<td>None</td>
<td>Calculated</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Indirect [calculated based on velocity (using 0.85 correction for surface velocity), depth and river cross section]</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Water</td>
<td>Bucket or directly in River</td>
<td>Oakton Big Display Conductivity ECTestr Low</td>
<td>50 mL Grab</td>
<td>None</td>
<td>Analyze immediately</td>
<td>Direct (conductivity meter)</td>
<td></td>
</tr>
</tbody>
</table>
2.5 Analytical Methods Requirements

Dissolved oxygen and conductivity are the only analytical measurements collected in the RiverWatch Water Quality Monitoring program. The Standard Operating Procedures (SOPs) for dissolved oxygen and conductivity collection and analysis are provided in the RiverWatch Water Quality Volunteer Monitoring Manual 2006 (Version 3) (Appendix A).

Table 10 - Analytical Method for Dissolved Oxygen

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Method Number</th>
<th>Source</th>
<th>Reporting Units</th>
<th>Modifications or options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved Oxygen</td>
<td>LaMotte Dissolved Oxygen Kit #5860 manual based on Azide Modification of Winkler Method</td>
<td>LaMotte</td>
<td>mg/l</td>
<td>None</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Oakton Big Display Conductivity ECTestr Low instruction manual</td>
<td>Oakton</td>
<td>μS/cm</td>
<td>None</td>
</tr>
</tbody>
</table>

2.6 Quality Assurance/Quality Control

2.6.1 Precision and accuracy of measurements

Precision is a measure of the degree to which two or more measurement of the same sample are in agreement as well as a measurement of random error. Accuracy is an evaluation of the degree to which a measured value and a known reference value or true value are in agreement. This is a measurement of systematic error and is often referred to as "bias". Accuracy is determined by the analysis of reference material and comparison of the resulting value to that of the accepted value.

Often error is associated with either the analytical methodology or the sampling method. Error associated with analytical methodology is related to the actual method of analysis. When sampling for dissolved oxygen, sampling errors introduced during the titration are considered analytical errors; errors introduced during the collection of the water sample are sampling errors. It is useful to separate out sampling and analytical errors so that if there is a problem with the analysis it can be linked to either the analytical or sampling methodology. Linking the source of the error to either sampling or analysis reduces the number of areas to investigate to find the error.

2.6.2 Quality Control Data

The following data will be collected by volunteers, assessed for quality control by the IRWA QA Officer, and presented in a field, training, and data QA/QC summary report (included in the annual report of results) generated by IRWA:

- Dissolved Oxygen: field duplicate collection and analysis
- Velocity: replicate measurement and analysis
- River cross-section: replicate measurement and analysis
- Conductivity: field duplicate collection and analysis

Table 11 details the types of quality control data collected and quality assurance procedures undertaken.
2.7 Comparability

All field analytical procedures and sample collection methods utilized in this QAPP are based on procedures found in the following sources:


Field Test Kit instructions from the manufacturer (LaMotte) at www.lamotte.com

Instruction Manual for EC/TDS/SALT Testr from EUTECH Instruments and OAKTON.

2.8 Completeness

Completeness is a measure of the amount of valid data obtained compared to the amount that was expected to be obtained under normal conditions. Greater than 80% completeness of field analytical procedures is expected. Completeness is calculated as follows:

Completeness = \( \frac{\text{Number of valid field measurements}}{\text{Number of field measurements planned}} \times 100 \)
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Activity used to assess measurement performance and frequency</th>
<th>Acceptance Criteria</th>
<th>Corrective action</th>
<th>Person responsible for Corrective Action</th>
<th>Data quality indicator</th>
<th>QA sample address sample (S) or analytical (A) error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved Oxygen</td>
<td>Volunteer monitors from each site will collect and analyze a sample during annual training and compare to group average as well as sample analyzed by trainer</td>
<td>All samples within +/-1.0 mg/L of trainers sample</td>
<td>Retrain volunteer, if problem persists replace reagents</td>
<td>IRWA</td>
<td>Precision and accuracy</td>
<td>S &amp; A</td>
</tr>
<tr>
<td></td>
<td>Volunteer monitors from each site will collect and analyze a duplicate (&quot;side-by-side&quot;) sample annually</td>
<td>Difference between measurements not greater than 1 mg/L DO</td>
<td>Collect an additional sample and analyze again, Record all results</td>
<td>Volunteer monitor</td>
<td>Precision</td>
<td>S &amp; A</td>
</tr>
<tr>
<td>Site audit</td>
<td>Auditor watches to be sure volunteer is correctly completing procedure</td>
<td>Retrain volunteer</td>
<td>IRWA site auditor</td>
<td>Accuracy and precision</td>
<td>S &amp; A</td>
<td></td>
</tr>
<tr>
<td>Water Temperature</td>
<td>Collection and analysis of a sample at two different temperatures (between 0 and 30 ºC) during annual training and compare to YSI 55. YSI 55 annually checked against a NIST traceable thermometer (difference between YSI 55 and NIST thermometer not greater than 1 ºC)</td>
<td>Difference between thermometer and YSI 55 not greater than +/- 1.0 ºC</td>
<td>Replace thermometers outside acceptable range</td>
<td>IRWA staff</td>
<td>Precision and Accuracy</td>
<td>S</td>
</tr>
<tr>
<td>Site audit</td>
<td>Auditor watches to be sure volunteer is correctly completing procedure</td>
<td>Retain volunteer</td>
<td>IRWA site auditor</td>
<td>Precision and Accuracy</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Velocity</td>
<td>Replicate measurements</td>
<td>Not greater than 200% different</td>
<td>Collect additional measurement</td>
<td>Volunteer monitor</td>
<td>Precision</td>
<td>S</td>
</tr>
<tr>
<td>Site audit</td>
<td>Auditor watches to be sure volunteer is correctly</td>
<td>Retrain volunteer</td>
<td>IRWA site auditor</td>
<td>Precision and Accuracy</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Indicator</td>
<td>Activity used to assess measurement performance and frequency</td>
<td>Acceptance Criteria</td>
<td>Corrective action</td>
<td>Person responsible for Corrective Action</td>
<td>Data quality indicator</td>
<td>QA sample address sample (S) or analytical (A) error</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-----------------------------------------</td>
<td>------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Depth</td>
<td>Site audit</td>
<td>Auditor watches to be sure volunteer is correctly completing procedure</td>
<td>Retrain volunteer</td>
<td>IRWA site auditor</td>
<td>Precision and Accuracy</td>
<td>S</td>
</tr>
<tr>
<td>River Cross Section</td>
<td>Compare to previous years data</td>
<td>Cross sectional width will not change more than 100%</td>
<td>Retrain volunteer</td>
<td>IRWA</td>
<td>Precision</td>
<td>S</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Instrument will be calibrated before each use</td>
<td>Instrument accepts calibration</td>
<td>Replace battery, if still not working replace meter</td>
<td>Volunteer monitor and IRWA</td>
<td>Accuracy</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Volunteer monitors from each site will collect and analyze a sample during annual training and compare to group average as well as sample analyzed by trainer.</td>
<td>All samples within +/- 60 µS/cm of average</td>
<td>Recalibrate meter, retrain volunteer, if problem persists replace calibrant and/or instrument</td>
<td>IRWA</td>
<td>Precision and accuracy</td>
<td>S &amp; A</td>
</tr>
<tr>
<td></td>
<td>Volunteer monitors from each site will collect and analyze a duplicate sample annually</td>
<td>Difference between measurements not greater than 60 µS/cm</td>
<td>Recalibrate meter, collect an additional sample and analyze again, Record all results</td>
<td>Volunteer monitor</td>
<td>Precision</td>
<td>S &amp; A</td>
</tr>
<tr>
<td></td>
<td>Site audit</td>
<td>Auditor watches to be sure completing calibration and sample collection/analysis procedure</td>
<td>Retrain volunteer</td>
<td>IRWA site auditor</td>
<td>Accuracy and precision</td>
<td>S &amp; A</td>
</tr>
</tbody>
</table>
## 2.8.1 Field equipment maintenance, testing and inspection table

### Table 12 - Equipment Inspection and Maintenance Plan

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Maintenance activity and frequency</th>
<th>Inspection activity and Frequency</th>
<th>Responsible person</th>
<th>Acceptance criteria</th>
<th>Corrective Action, and Record Keeping</th>
</tr>
</thead>
<tbody>
<tr>
<td>LaMotte Dissolved Oxygen Kit</td>
<td>After each use - Rinse all syringes and glassware with tap water and allow to dry</td>
<td>Before each sampling check that: 1. adequate chemical quantities are available, 2. syringes and glassware are not damaged and 3. reagents have not changed color nor is not precipitate in the chemicals. Both changes indicate chemicals need to be replaced.</td>
<td>Volunteer Monitor</td>
<td>No equipment is damaged and enough reagent is available for next sampling round</td>
<td>Contact IRWA for replacement chemicals and kit components. IRWA keeps records of replacements of chemical and equipment.</td>
</tr>
<tr>
<td></td>
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<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anually - replace starch indicator and sodium thiosulfate titrant</td>
<td>N/A</td>
<td>IRWA</td>
<td>Reagents are replaced annually</td>
<td>IRWA records volunteer monitors that receive new reagents.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Every 3 years – Replace manganous sulfate, sulfuric acid and alkaline potassium iodide azide reagents</td>
<td>N/A</td>
<td>IRWA</td>
<td>Reagents replaced every 3 years</td>
<td>IRWA records volunteer monitors that receive new reagents</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oakton Conductivity Meter</td>
<td>After each use – rinse with tap water and allow to dry</td>
<td>Before each sampling check that the probe is clean, the batteries are not dead and enough calibration solution is available</td>
<td>Volunteer Monitor</td>
<td>Clean probe, instrument indicates batteries have at least 25% of life left and enough calibration solution is available</td>
<td>Clean probe and/or replace batteries</td>
</tr>
<tr>
<td>Equipment Type</td>
<td>Maintenance activity and frequency</td>
<td>Inspection activity and Frequency</td>
<td>Responsible person</td>
<td>Acceptance criteria</td>
<td>Corrective Action, and Record Keeping</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------------</td>
<td>----------------------------------</td>
<td>--------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Depth Measuring Tape</td>
<td>N/A</td>
<td>Before each sampling date - Visual inspection of weight attachment</td>
<td>Volunteer Monitor</td>
<td>Measuring tape is not damaged and weight is attached properly to measuring tape</td>
<td>Contact IRWA for replacement if measuring tape is damaged.</td>
</tr>
<tr>
<td>Envirosafe® Armored Thermometer</td>
<td>N/A</td>
<td>Before each sampling date check that – 1. spirit is continuous in the thermometer (no breaks in internal fluid) and, 2. thermometer probe is not damaged</td>
<td>Volunteer Monitor</td>
<td>Spirit is continuous and probe is not damaged</td>
<td>Contact IRWA for replacement thermometer. IRWA will record replacements.</td>
</tr>
<tr>
<td>5 Gallon Bucket with Rope</td>
<td>Before and after each use – rinse with river water (see monitoring manual)</td>
<td>Before each sampling date - Visual inspection of rope and bucket to be sure bucket is not cracked</td>
<td>Volunteer Monitor</td>
<td>Bucket not cracked and rope attached to bucket properly</td>
<td>Contact IRWA to obtain a new bucket.</td>
</tr>
<tr>
<td>Stop Watch</td>
<td>N/A</td>
<td>Before each sampling date – make sure stop watch is operating properly and battery is not dead</td>
<td>Volunteer Monitor</td>
<td>Stop watch is operating properly and battery is not dead</td>
<td>Replace battery. If stop watch is still not functioning properly, contact IRWA for a replacement.</td>
</tr>
</tbody>
</table>
2.9 Inspection/Acceptance Requirements for Expendable Supplies

Expendable supplies such as chemical for the dissolved oxygen analysis are inspected upon arrival at IRWA. The date of arrival and the date chemicals were opened will be written on the packaging of the chemicals.

3.0 DOCUMENTATION AND RECORDS

3.1 Data Obtained from Outside Sources

IRWA obtains data from outside sources for use in its RiverWatch newsletter and reports. The table below documents the outside source of information and data quality notes.

Table 13 - Data Acquisition Sources

<table>
<thead>
<tr>
<th>Data</th>
<th>Source</th>
<th>Measurement Locations</th>
<th>Quality Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow and precipitation data</td>
<td>USGS</td>
<td>Streamflow gages: 1) Just below IP19 (Willowdale Dam) in Ipswich 2) At IP06 in South Middleton</td>
<td>Real time flow gage data not reviewed by IRWA. Quality controlled by USGS.</td>
</tr>
<tr>
<td>Nutrients data</td>
<td>UNH and MBL</td>
<td>Monitoring site at IP24 (Sylvania Dam)</td>
<td>Data collected under QAPP protocols established by UNH and MBL.</td>
</tr>
</tbody>
</table>

3.2 RiverWatch Water Quality Volunteer Monitoring Data

The purpose of the RiverWatch data management plan is to ensure that final annual data sets are error checked, complete, exist in original data sheet form and computerized form, and are easy to access.

Volunteers are asked to record field data on a Monthly Monitoring Data sheet (Appendix A). They may also record this information in a waterproof field book, if they choose to. The field book is retained by volunteers until such time as they retire from volunteer service. Monthly Monitoring Data Sheets are sent to IRWA via fax or mail, after each monthly monitoring event. Some volunteers also enter their monthly data into a data spreadsheet and forward this datasheet via email to IRWA monthly, this reduces the time IRWA needs to enter data electronically.

All data is entered in the IRWA RiverWatch Microsoft Excel Spreadsheet for that year, in worksheets organized by site. Data entered by IRWA or by volunteers are reviewed by the IRWA QA Officer. At the end of the calendar year the spreadsheet is printed by site and mailed to all volunteers for their review and to cross check with their field books or copies of the monthly monitoring data sheets.

Each volunteer is audited onsite by the Field Coordinator or Monitoring Project Coordinator once per year. The results of this audit are recorded on Field Audit Sheets (Appendix A), which are then signed by the volunteers present and the auditor. All Field Audit Sheets are kept by the Monitoring Project Coordinator at the IRWA offices.
All data sheets, audit forms and returned field books are stored in IRWA's central files. The databases are stored on computer hard drive and are backed up onto zip disk. Data is also presented in reports and data appendices.

3.3 Sample Handling and Chain of Custody

All samples will be analyzed on-site. Therefore no Chain-of-Custody procedure is necessary.

4.0 ASSESSMENT AND RESPONSE ACTIONS

The Project Monitoring Coordinator or Field Coordinator will audit all volunteer monitors at least once annually. A copy of the audit sheet is located in the RiverWatch Water Quality Volunteer Monitoring Manual 2006 (Version 3) (Appendix A). During the course of the audit the auditor will evaluate and provide feedback to the volunteer regarding his or her data collection, equipment handling and recording methods. At the completion of the audit, the audit sheet is signed by both the volunteer and the auditor to verify that the audit took place, and feedback was received and understood. The auditor also records any data quality comments on the audit sheet, as necessary.

If a volunteer repeatedly submits atypical data, the volunteer will be prioritized for auditing. Atypical data include dissolved oxygen data that varies significantly from adjacent sites over 1 or more months. Likewise if depth data is reported in a manner consistent with inches as opposed to tenths of inches as required, volunteers will be prioritized. Consistent misinterpretation of calculations or methodology instructions that become apparent in reporting are also grounds for prioritizing auditing of a specific volunteer monitor. If after auditing, data quality does not improve the volunteer will be asked to resign. Likewise, if a volunteer proves unreliable by repeatedly missing monitoring dates without requesting a substitute monitor, or fails to provide their data to IRWA, they will be asked to retire.

5.0 REPORTS, DATA REVIEW AND VALIDATION

Each year the Project Monitoring Coordinator/QA Officer will review the monitoring data collected that year to be sure that all calculations and calibrations have been properly performed. This will be accomplished by reviewing the Auditing Forms, Quality assurance/Quality control (QA/QC) samples, data sheets and training records generated in the monitoring year. In addition, the TAC will meet before the previous year’s data are released to review the program, the data and any quality assurance / quality control concerns. If data quality objectives are not met for any reason this will be noted in data reports. Steps will then be taken to correct the methodology, application of the methodology, or any process errors leading to the failure. The QAPP will be adjusted as necessary, if the TAC finds that field requirements cannot be accommodated by the QAPP in its current form. In the event of QAPP modifications, MADEP’s review approval will be solicited.

Data appendices will be published when reporting on the results of the IRWA monitoring program. These appendices will contain all relevant data. Reports are generally available in hard copy as well as on the IRWA web-site. Presentations on IRWA monitoring data are also offered to IRWA members, interested municipalities and organizations, at their request.

6.0 RECONCILIATION WITH DATA QUALITY OBJECTIVES

As discussed throughout the QAPP, training and communication with volunteer monitors is the main method of corrective action utilized by IRWA. Yearly equipment checks of accuracy and precision are completed to be sure accuracy and precision objectives are met. Equipment replacement will be utilized if necessary to reach accuracy and precision objectives. If the completeness objective is not met because volunteers are unable to monitor at specified times, then alternate volunteers will be obtained. If completeness objectives
are not met due to equipment failure then additional spare equipment will be obtained and available for volunteers.

7.0 REFERENCES


Commonwealth of Massachusetts Executive Office of Environmental Affairs (EOEA), Massachusetts Year 2004 Integrated List of Waters Proposed listing of the condition of Massachusetts’ waters pursuant to Sections 303(d) and 305(b) of the Clean Water Act. April, 2004.


Appendix A
Appendix B
List of Technical Assistance Advisory Committee Members
Wayne Castonguay  
Trustees of Reservations  
General Manager, Appleton Farms  
219 County Road  
Ipswich, MA 01938  
978.356.5728

Jerry Schoen  
Mass Water Watch Partnership  
Blaisdell House - UMASS Box 30820  
Amherst, MA 01003-0820  
413.545.5532

Arthur Clark  
United States Environmental Protection Agency  
11 Technology Drive  
N. Chelmsford, MA 01863  
617.918.8374

Gina Snyder  
United States Environmental Protection Agency, Region 1  
1 Congress St. Suite 1100  
Boston, MA 02114-2023  
617.918.1837

Cindy Delpapa  
Massachusetts Riverways Programs  
Dept. of Fisheries, Wildlife and Environmental Law Enforcement  
251 Causeway Ste, Suite 400  
Boston, MA 02114  
617.626.1545

Richard Tomczyk  
Executive Office of Environmental Affairs-Northeast Regional Office  
2053 Lowell St  
Wilmington, MA 01887

John Felix  
Massachusetts Dept. of Environmental Protection  
1 Winter St.  
Boston, MA 02108  
617.348.4045

Wll Wolheim  
Univ. of New Hampshire Complex Systems Research Center  
University of New Hampshire - Morse Hall  
Durham, NH 03824  
603.862.0812

Chuck Hopkinson  
The Ecosystem Center - Marine Biological Laboratories  
7 MBL Street  
Woods Hole, MA 02543  
(508) 548-3705

Anne Monnelly  
Executive Office of Environmental Affairs  
251 Causeway Street  
Boston, MA 02114  
(617) 626-1250
Appendix C
Resumes of Key Personnel
Kerry L. Mackin  
76 Little Neck Road  
Ipswich, MA 01938  
978-356-2027

Education:  
♦ M.S. in Natural Resource Management and Administration, Antioch University, 1990  
♦ B.A. in Humanities, Magna cum laude, Harpur College, State University of New York at Binghamton, 1970

Professional Experience:  
♦ 1993-: Executive Director, Ipswich River Watershed Association, Ipswich, MA  
  Increased IRWA’s organizational effectiveness, budget, staffing and resources. Responsibilities include project management, organizing and representing the Association in public forums, conferences and meetings; convening and facilitating the Ipswich River Task Force; developing and implementing watershed protection and restoration programs; strategic planning; advocacy; public speaking; public relations; outreach/education; fundraising and proposal writing; member development; staff hiring and supervision; budgeting and financial management; organizational capacity-building and development.

♦ 1988-1994: Conservation Administrator, Town of Topsfield, MA  
  Responsibilities included providing technical expertise and administrative support to the Topsfield Conservation Commission, including the following: evaluating project plans and wetland delineations; providing testimony on wetlands issues at public hearings; writing Orders of Conditions; drafting bylaws and regulations; organizing the Open Space Committee; publicizing the Commission’s work; and providing education for the Commission and the public on wetlands/water resource protection issues.

♦ 1980-81: pro bono Consultant, Institute for Community Economics, Greenfield, MA  
  Member of a team of community land trust experts who produced The Community Land Trust Handbook, published by Rodale Press. This book has become an important resource to many groups wishing to protect open space and provide affordable housing. Responsibilities included project planning and scoping; outlining the book; conducting interviews for case studies; editing and finalizing text; and producing the photographs used in the book.

♦ 1979-1987: Assistant Manager, Black & White Photo Laboratory, Boston, MA  
  Responsibilities included supervision of lab operations; quality control; staff hiring and review; customer relations; financial management; hazardous waste management; planning and administration.

♦ 1977-1987: Instructor, Timberline Seminars, Appalachian Mountain Club  
  Led educational seminars in the White Mountains; responsibilities included group training and leadership in the mountain environment; supervision of program personnel; presentations on photography and natural history; class evaluations.

Committees, Task Forces  
♦ Massachusetts Watershed Coalition, former President and Board Member
♦ Massachusetts Safe Drinking Water Act Assessment Advisory Committee
♦ Ipswich River Task Force (founder, former chair); Steering Committee (chair); Master Plan Committee; Water Conservation Committee (chair)
♦ Ipswich River Restoration Partnership (founder)
♦ Massachusetts Instream Flow Task Force (co-founder, chair)
♦ Massachusetts Water Resource Commission Stressed Basin Committee
♦ Interbasin Transfer Act Wastewater Working Group
♦ Upper Ipswich Planning for Growth Steering Committee
♦ Ipswich River Watershed Communities Connected by Water Steering Committee
♦ Town of Ipswich Growth Management Steering Committee
♦ Town of Ipswich Planning Board Great Neck Rezoning Committee (chair), 1992
♦ Town of Ipswich Mosquito Control Advisory Committee (vice-chair), 1995-6

Workshops and Publications:
♦ Community Land Trust Handbook, Rodale Press, 1982: (contributor and member of team which produced book). User-friendly guide to establishing community land trusts to protect open space and provide affordable housing. Handbook includes case studies from urban and rural areas throughout the United States, and chapters on land use and environmental planning, financial considerations, land ethic and other relevant topics.
♦ Protecting a River, Ipswich River Watershed Association, 1994. Regulatory and non-regulatory tools for watershed protection, focusing on providing information to citizens wishing to take an active role in protecting land and water resources.
♦ Great Places: The Ipswich River Watershed (to be released 2003)
♦ Keynote presentation, Rhode Island Instream Flow Conference, 2002
♦ General Wetlands Bylaw (amended) and Wetlands Protection Regulations, Town of Topsfield
♦ Great Neck Zoning Regulations, Town of Ipswich
♦ Technical Papers for Topsfield Conservation Commission:
  Impacts of Stormwater Discharges on Wetlands Lake and Pond Management
♦ Organized public forums, workshops and conferences on land use planning, watershed protection, water conservation, water quality and other related topics.
♦ Co-authored the State of the Ipswich River 2003 and wrote many outreach publications, including the Ipswich River Watershed Association newsletter, and brochures on pollution prevention and instream flow issues
JESSICA L. DARLING
34 Zeler St., Roslindale, MA 02131 * 617-276-7932 * jdarling@ipswichriver.org

EDUCATION

YALE UNIVERSITY, SCHOOL OF FORESTRY AND ENVIRONMENTAL STUDIES, New Haven, CT
Master of Environmental Management, Concentration in Water Science, Policy, and Management 2006
* Relevant Coursework: Estuarine Ecology and Anthropogenic Impacts; River Processes and Restoration; Biogeochemistry and Pollution; Organic Pollutants in the Environment; Restoration Ecology Seminar; Coastal Ecosystem Governance; Local Environmental Law and Land-use Practices; Strategies for Land Conservation; Water Resources Management
* Master’s Project: Controls of Aboveground Productivity in Three Salt Marshes on Long Island Sound
* Co-leader of student chapter of American Water Resources Association (AWRA)

UNIVERSITY OF COLORADO, BOULDER, Boulder, CO
Bachelor of Arts, Geology 1999
Minor, Astrophysical, Planetary, and Atmospheric Sciences

RELEVANT EXPERIENCE

PROGRAM COORDINATOR, The Ipswich River Watershed Association, Topsfield, MA 2006-

* Maintained several web sites containing general and technical information for a variety of audiences including: the National Drinking Water Advisory Council (NDWAC) Contaminant Candidate List (CCL) Classification Process Workgroup, Region and State drinking water staff, and the general public. Assisted with the coordination and delivery of web-based training to EPA Region and State drinking water staff.
* Wrote source water protection case studies of community source water protection efforts. Prepared best management practices bulletin describing techniques to reduce source water contamination at airports resulting from deicing activities. Conducted research on source water protection issues.
* Researched and prepared case studies of community Smoke-free Homes Pledge programs and school district Indoor Air Quality programs. Supported effort to develop outcome measures for these programs.

Contract through the Environmental Careers Organization, Boston, MA.
* Conducted research, compiled data, and created figures and graphs in support of manuscripts.
* Prepared laboratory sediment samples for micropaleontological analysis.
* Identified and counted species of planktic and benthic microfossils for paleoclimate studies of the Gulf of Mexico region.

ENVIRONMENTAL INTERN, Exponent Environmental Group, Boulder, CO Summer and Fall 1998
* Gathered information from Internet, library, industry contacts, and organizations in support of soil remediation projects.
* Compiled pollution indicators for endangered watersheds across the U.S.
* Laboratory preparation of soil samples for EPA analysis.

ENVIRONMENTAL SCIENCE INTERN, Nat’l Oceanographic and Atmospheric Administration, Boulder, CO Summer 1997
* Assisted development of an online glossary associated with a coastal ecological characterization.
WORK DAY VOLUNTEER, The Nature Conservancy and Potomac Conservancy, DC and MD
2002-2004

PUBLICATION
Richard Z. Poore, Jessica Darling, Harry J. Dowsett, and Liana Wright. (2001) Variations in river flow to the
Gulf of Mexico: Implications for paleoclimate studies of Gulf of Mexico Sediments. U.S. Geological Survey e-
Bulletin #2187. Available at: http://pubs.usgs.gov/bul/b2187/

SKILLS
COMPUTER OPERATING SYSTEMS: Macintosh OS 10, Windows 95/98/2000/NT/XP
COMPUTER APPLICATIONS: Microsoft Office Suite (Word, Excel, PowerPoint, Access), Corel Wordperfect,
HTML, Macromedia Dreamweaver, Microsoft FrontPage, Adobe Illustrator 7.0/8.0, Adobe Photoshop 5.0,
ArcView 9.0, ER Mapper