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## PREFACE

### 1. Introduction

Water quality has become an increasingly important issue during the past several decades. It is of concern in geographically water rich eastern Massachusetts, with our numerous rivers, streams, ponds, estuaries, and bays. Water quality provides a window on the health and vitality of the hundreds of local ecosystems within the 61 communities served by the MWRA.

Water quality provides a strong basis for educational inquiry. For example, how do the salinity, temperature and chemistry of an estuary change as the tide comes in, peaks and recedes, and what might this information tell us about the flushing action of the tides? Does industrial pollution affect a body of water? Do development and roadways have an impact on local water, and if so, what is that impact?

To help teachers bring these and other concepts related to water quality into their classrooms, the MWRA has developed this water quality testing program. It includes equipment for testing:

- Temperature
- pH
- Dissolved Oxygen (DO)
- Biochemical Oxygen Demand (BOD)
- Nitrates
- Total Dissolved Solids (TDS) and Salinity
- Turbidity
- Total Coliform Bacteria

This manual contains background information, lesson ideas, procedures, data collection and reporting forms, suggestions for interpreting the results, and extension activities.

It is important for teachers to bear in mind that *this is a field testing program*. As such, students will spend time in the field, performing tests on their community's water: oceans, marshes, rivers, bays, lakes, ponds, wetlands and streams. To succeed in the field, students must be assigned specific tasks, and they should practice field techniques in the lab or classroom before going into the field. Sections III and IV of this manual offer suggestions for making the field work successful and ensuring the students' safety.

This program is geared toward a broad student population: grades 6 - 12. We expect that educators will adapt these activities and lessons as necessary to make them suitable and appropriate for their students.

If, at any time, you have suggestions for additional activities, additional tests, or ways to improve this program, please submit your suggestions to the MWRA's School Program. We will make every effort to share them with other participating teachers.

To use the Water Quality Testing Kit, teachers must attend a full-day workshop. If you would like additional information about either the kit or a workshop, please call the MWRA at (617) 242-6000 and ask for the School Program.

The workshops for this program are free, six-hours long, and carry Continuing Education Units (CEUs). Once teachers have attended, they may sign up to borrow the kit at no charge (although a deposit may be required). Preference will be given to schools within the MWRA service area.

## **2. Why the MWRA Provides this Program**

The MWRA provides safe, reliable drinking water and is up-grading sewage treatment for 2.5 million people and 5,500 industries. We make every effort to protect our region's water and watershed lands, and our efforts require many difficult public policy decisions. Ultimately, our success will be measured by the healthfulness of our water resources, the reliability of our water supply, the rates our customers must pay, and the ability of the entire region to work together to confront and solve difficult problems in the fairest and most technologically appropriate manner.

Our customers are well served by efforts to inform the public, which should begin in the schools. Today's young people will be tomorrow's decision makers and rate payers. They will be burdened with the responsibility of confronting and solving tomorrow's

problems, and we want to provide them with the tools they will need to make the best possible choices.

### 3. Program Overview

This testing program for fresh water and salt water consists of eight tests. It is designed for use by middle school and high school students. These tests, while simple and safe, require practice, care, and rigorous adherence to laboratory and safety procedures.

- ◆ *The kit contains some chemicals which, if mishandled, could be dangerous. Proper protective clothing, including rubber gloves, eye protection and lab aprons, is essential!*

In addition, this is a field testing program, with students performing at least some of the tests in the field. Field testing requires proper preparation. Students should know the test procedures before going into the field; they must also be aware of safe field practices and the potential dangers of working in the field. (Chapter 3 of this manual addresses field testing preparation.)

Students using this kit will be able to see a “snapshot” of the quality of a particular body of water. The most interesting and meaningful water quality data emerges when a particular body of water has been tested over time. Such long-term monitoring reveals changes over days, months and seasons. It could also reveal the presence of currently unknown sources of pollution. Long-term monitoring could result in an entire photo album, so you may want to undertake your own monitoring program over a number of years.

This manual contains all of the information you need to carry out the tests. It also contains a *Data Recording Form* that you may reproduce for students, as well as ordering information if you choose to purchase your own kit.

### 4. Program Objectives

- A. *To enable students to learn basic water quality tests and techniques.*
  - B. *To increase student awareness of the importance of water quality.*
  - C. *To increase student understanding of the factors that contribute to water quality.*
  - D. *To lead students to an understanding that each of us has responsibility for maintaining the quality of our water.*
- A. *To enable students to learn basic water quality tests and techniques.*

These tests will expose students to field testing techniques and lab methods. The results will be valid, even if they are not as accurate as more refined testing methods. In certain cases, we have chosen test equipment based on the technique it can

teach over the accuracy of results. For pH, for example, we could have selected a simple digital meter. While the results from the meter would have been more accurate, its use would convey little about lab methods. Instead, we have included two pH tests: a reagent/colorimeter test for more accurate testing results, and pH paper for spontaneous testing of liquids in the environment. We selected a digital meter for Total Dissolved Solids (TDS) and Salinity because it is the only reasonably simple test for TDS, and analyzing the results requires slightly more effort than simply reading numbers from a digital face. Likewise, the Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) tests use a standard process called the Winkler Method. Easier options exist, but we felt that the lab practice and technique made this a more valuable student exercise.

*B. To increase student awareness of the importance of water quality.*

Water quality is critical to human survival. Civilizations grew and flourished in areas with ample supplies of high quality water, and where water quality declined, those cultures either ended or faced the horrors of epidemics.

With the industrial revolution came changes in human-made pollution. For almost three centuries now, humans have tested the ability of the earth to adapt. While we have learned that the earth is highly adaptable, we have also learned that there are limits. Increased knowledge of diseases and the environment, and the resulting requirements of strict legislation, such as the Clean Water Act and the Safe Drinking Water Act, have compelled us to pay greater attention to and spend more money on the quality of our waterways. In the waning years of the twentieth century, it has become clear just how much a community depends on the quality of its water.

This program will help students become aware of the condition of the waterways within their own communities.

*C. To increase student understanding of the factors that contribute to water quality.*

Pure water -  $H_2O$  - is a laboratory concept. Because water is a "universal solvent," virtually everything around us affects the quality of our water. Atmospheric gases and contaminants dissolve in rainwater on its trip to earth. Once on the ground, water continues to dissolve a broad range of solids, gases and liquids. In addition, plant life, sunlight, nutrients and other variables affect the levels of oxygen and carbon dioxide in the water, and they in turn affect the plant and bacterial life. The digestive processes of animals introduce bacteria to water, and coliform bacteria serve as an effective indicator for other pathogens that might be dangerous to

humans. Fertilizers, natural and chemical, are washed into the waterways by rain, raising the level of nutrients, such as nitrogen, in the water, and the nutrients in turn promote the growth of algae and plant life.

High levels of algae and other non-dissolved solids block sunlight, and decreased sunlight leads to decreased photosynthesis, decreased plant life, and increased plant decay. These factors lead to lower oxygen levels, providing an important window on the overall health of our region's water.

***D. To lead students to an understanding that each of us has responsibility for maintaining the quality of our water.***

Water quality is affected by a wide range of factors, the most significant of which is human activity. Most human activities occur collectively, as part of the operations of society. While the impact of individual actions may seem insignificant, each individual can make an important contribution to water quality by not dumping harmful chemicals down the drain or onto the ground; by understanding the impact of pesticides and fertilizers; or by respecting the importance of wetlands and saltwater marshes. When massed together, these individual contributions can have a large positive effect.

## **5. Target Audience**

This program is intended for use by middle school and high school students in a wide range of classes, such as chemistry, earth science, physical science, ecology, biology, and non-science disciplines. It could also be used in AP and special needs classes, with environmental clubs, or it could be integrated with other disciplines, such as government, geography, and social studies. In addition to being used at school, it is also appropriate for use by scout troops, clubs and other organizations.

## **6. The Structure of Each Lesson**

In this manual, each test contains enough information to make it a full lesson. Each test unit contains the following sections:

- a. The Brief Summary section provides a quick glimpse into the test and test procedure.
- b. The Background section puts the lesson into context. What is the water quality issue under discussion? What factors might cause results to be out of the normal range? What are the implications of this test on humans and human health? Animals? Nature? Agriculture? Recreation? Industry?