1 INTRODUCTION

In September 1998, EPA's Long Island Sound Project Office and the University of Connecticut initiated a prototype marine environmental monitoring network for Long Island Sound. This project, known as Monitoring Your Sound or MYSound, provides comprehensive, timely water quality data on Long Island Sound and its harbors and estuaries. The data from the monitoring network, along with educational information about marine water quality, are available in real time[1] on the project Web site, *http://www.mysound.uconn.edu*.

1.1 ABOUT THIS HANDBOOK

This handbook has been designed with two goals in mind. The first goal is to present a case study of the MYSound project, including the successes achieved and challenges faced in acquiring and disseminating real-time marine water quality data. The second goal is to provide information and suggestions for developing similar projects in other communities. Using the MYSound EMPACT project as well as other programs as models, this handbook presents recommendations and tips on ways to:

1. Collect and analyze real-time marine water quality data.
2. Develop systems to manage and deliver real-time marine water quality data.
3. Accurately and effectively communicate marine water quality information to stakeholders and members of the public.
4. Develop a long-term plan to sustain the program through partnerships with key stakeholders.

The handbook is organized into the following chapters:

Chapter 2 discusses marine water quality in the context of coastal and estuarine systems, and its importance to human health and the environment. The chapter begins with an overview of coastal and estuarine systems, circulation patterns, and pollution problems that affect water quality. Particular attention is paid to Long Island Sound and the current pollution problems and water quality status and trends observed in the Sound. The chapter also presents an overview of the role of water quality monitoring and key parameters of interest for coastal and estuarine areas.

Chapter 3 discusses the development of a marine environmental monitoring strategy for coastal and estuarine waters with emphasis on water quality monitoring. It describes the important considerations in forming a water quality monitoring network: who, why, when, where, what, and how. Only when these issues have been thoroughly considered can an implementation plan for the monitoring project be successfully developed. The chapter addresses key steps such as getting to know the marine environment and identifying previous and ongoing monitoring programs; selecting program partners (who); determining the goals of the monitoring program (what will be monitored and why); delineating the scope of the monitoring effort (when and where); and determining the general methodologies and instrumentation to be used in the effort (how). The chapter also discusses the development of a funding strategy.

Chapter 4 focuses on data collection, management, and delivery. It presents general "how-to" information about establishing and operating water quality monitoring stations to collect and transmit real-time

[1] For the purposes of this document, the term "real time" takes into account a lag time of less than 15 minutes between when data is collected and when it is available on the MYSound Web site.

data. It addresses key considerations such as site selection, station configuration, sensor selection, and data processing and power requirements. It describes the basic quality assurance/quality control (QA/QC) activities that must be conducted and provides references to help develop a project-specific QA/QC plan. Chapter 4 also provides general cost estimates for deploying and maintaining the monitoring network.

Chapter 5 presents information on Web site design and operation. It describes how the data can be presented in the form of statistical and time-series data summaries both in real time on the Web, or incorporated into annual reports. Alternative methods of information dissemination are also addressed.

Chapter 6 focuses on the communications/outreach project element. It provides information on how to accurately and effectively communicate various types of information—including timely marine water quality data—to the public at large. The chapter presents the detailed steps needed to create a comprehensive outreach plan and provides resources that can provide help with presenting technical water quality information to the public. It also describes various mechanisms for obtaining feedback about who is using the data and how useful it is.

Chapter 7 addresses the issue of how to sustain a marine water quality monitoring network. It describes some of the future directions and options under consideration for MYSound and how the project has successfully developed a strategy called "distributed stewardship."

This handbook addresses multiple audiences, including prospective monitoring project partners (such as environmental managers, researchers, and educators) as well as stakeholders (key user groups who can champion the project and often provide in-kind logistics and outreach support). It is designed to be understandable to both technical and non-technical individuals and provide useful information to both. *Chapter 2* presents an overview of water quality issues for readers who are not familiar with the subject of water quality, as well as the general goals and strategies for implementing a water quality monitoring program. Managers and decision-makers will likely find the introductory sections in *Chapters 4* and *5* to be most helpful. The latter sections of these chapters present more detailed guidance most applicable to technicians, operators, and professionals tasked with implementing a timely water quality data delivery project. *Chapter 6* is targeted towards personnel tasked with implementing the communications an outreach portions of the project. *Chapter 7* is useful for managers and decision-makers contemplating beginning or expanding a marine monitoring program, and seeking to make it sustainable in the long term.

About the EMPACT Program

This handbook was developed by EPA's Environmental Monitoring for Public Access and Community Tracking (EMPACT) program. EPA created EMPACT to promote new and innovative approaches to collecting, managing, and communicating environmental information to the public. Working with communities across the country, the program takes advantage of new technologies to provide community members with timely, accurate, and understandable environmental information they can use to make informed day-to-day decisions about their lives. EMPACT projects cover a wide range of environmental issues, including water quality, groundwater contamination, smog, ultraviolet radiation, and overall ecosystem quality. While some of these projects were launched by EPA, others were launched directly by EMPACT communities.

In addition to MYSound, EMPACT funded several other water quality monitoring projects involving real-time water quality monitoring and data distribution, including the Lake Access—Minneapolis Project *(http://www.lakeaccess.org)*, the Chesapeake Bay Project, and the Jefferson Parish (Louisiana) Project (described in Appendix D). Although the monitoring strategy, parameters measured, and instrumentation employed differs from project to project, there are similarities and lessons learned that are noteworthy in each. Comprehensive technology transfer handbooks similar to this one have been prepared for these three projects.

Following Chapter 7 is a glossary of terms used throughout this handbook *(Appendix A). Appendix B* contains a MYSound outreach brochure. *Appendix C* contains selected E-mails from visitors to MYSound's Web site. *Appendix D* contains brief overviews of two other coastal water quality monitoring programs: the Jefferson Parish, Louisiana and Chesapeake Bay EMPACT projects.

Throughout this handbook are lessons learned and success stories related to the MYSound EMPACT project. Also provided are references to supplementary sources of information, such as Web sites, guidance documents, and other written materials that present a greater level of technical detail.

1.2 HISTORY AND OVERVIEW OF THE MYSOUND PROJECT

Monitoring the health of coastal and estuarine ecosystems has become increasingly important over the past decade. As human activities continue to affect these waters, the nation is becoming more aware of the need to take a more comprehensive approach to protecting freshwater and marine water resources. The health of an estuary is subject to many factors and can be manifested in both short-term events and subtler long-term trends. An ideal environmental monitoring program requires continuous, long-term measurement of a variety of physical, chemical, and biological parameters over a wide geographic area to represent the overall health of the ecosystem.

Numerous environmental data collection efforts have been undertaken in Long Island Sound and other estuarine systems over the years. Government agencies and university researchers have conducted intensive data collection efforts as part of specific projects (such as an environmental impact assessment for a dredging project or nuclear power plant), specific research efforts, or specific pollution problems (such as toxic chemical contamination in a certain location). Monitoring of an entire estuary typically consists of sampling a few parameters, at a handful of points over a wide area, at specific times of the year. While such sampling provides a general indication of environmental trends in the estuary on a month-to-month or year-to-year basis, it does not provide enough information to detect episodic water quality degradation and its causes and impacts, or to understand the long-term dynamics that govern the estuarine ecosystem.

The monitoring technologies used in these efforts have had limitations. Most programs have relied on point sampling in the field and analysis in the laboratory, which can be time-consuming and expensive. Often the data from these monitoring efforts become available to the wider community of users and other interested parties only after a significant period of time has elapsed.

Several developments in the past decade hold the promise of streamlining this process. First, recent advances in physical and chemical oceanographic instrumentation, improvements in data transmission technologies (via radio, cell phone and satellite telemetry), and advances in on-board microcomputer data processing have made real-time oceanographic data acquisition and transmission feasible. A number of real-time coastal marine environmental monitoring systems are now up and running around the country, such as the Chesapeake Bay Observing System (CBOS) inaugurated by the University of Maryland's Center for Environmental Science, the Rutgers University Long-Term Ecosystem Observatory (LEO) Project begun in 1996, and the Gulf of Maine Ocean Observing System (GOMOOS) begun in 1999. Smaller regional and local real-time monitoring efforts are under way in various estuaries, rivers, and harbors around the country. These projects gather and integrate data from real-time continuous monitoring stations, wide-area survey sampling by vessels, and satellite remote sensing data to provide a comprehensive, long-term view of the physical, chemical, and in some cases, biological environmental parameters throughout the estuary.

Second, additional stakeholders, such as local schools and environmental organizations, have become active in marine environmental monitoring efforts. Their efforts usually target a particular coastal area or estuary, and often a specific harbor, river, or wildlife preserve within the estuary. Often these volunteer monitoring efforts are supported by federal agencies, university outreach and extension services, or a larger umbrella organization. Data are generally acquired through conventional, low-technology sampling procedures and are limited to near-shore locations and favorable weather conditions. However, the cumulative contribution of these more focused sampling efforts can be significant, particularly if the data are subject to approved quality assurance and quality control (QA/QC) procedures, and the data can be compiled and made accessible to other stakeholders.

These new developments provide an emerging opportunity to significantly upgrade coastal and estuary environmental monitoring programs. Recognizing this opportunity, EPA's Long Island Sound Office and the University of Connecticut undertook the MYSound project, a marine environmental monitoring network for Long Island Sound.

The goal of the project is to provide comprehensive, real-time marine water quality monitoring data on Long Island Sound (LIS) and its harbors and estuaries, both to serve the needs of specific users and to increase public understanding of water quality. The first step in providing these data was to establish estuarine water quality monitoring stations in the vicinity of Bridgeport and New London, Connecticut, in the first year of the project (1998). Data from these stations are collected, analyzed, supplemented, and integrated with complementary data from other agency, municipal, and volunteer water quality monitoring efforts. Real-time data are compiled and disseminated on the project Web site *(http://www.mysound.uconn.edu)* along with interpretive information to enhance understanding of the data by students, teachers, and the public at large.

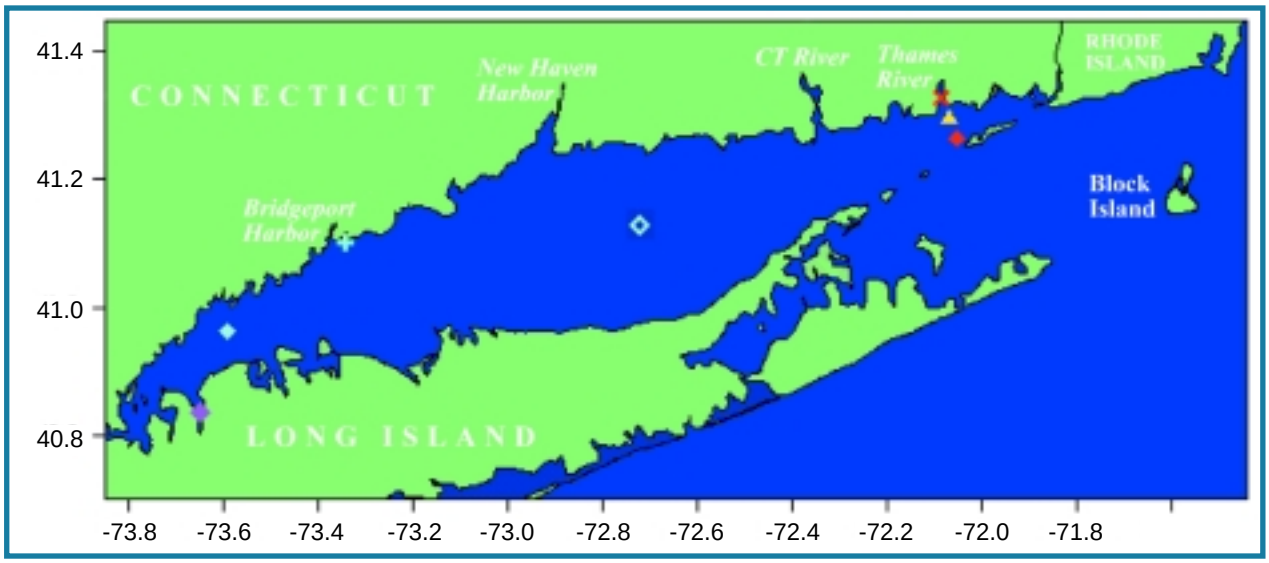
Four monitoring stations currently form the basic network. These are deployed in the vicinity of Bridgeport, New London, and at the western end of the Sound. MYSound has also established a link with a real-time monitoring station in Hempstead Harbor on the New York side of the Sound (operated by the Hempstead Harbor Protection Committee and the Coalition to Save Hempstead Harbor). Table 1 below shows the locations of all five monitoring stations. Figure 1.1 shows the distribution of stations throughout Long Island Sound.

Table 1 - Long Island Sound Marine Environmental Monitoring Network Stations

Station	Offshore New London	Inshore New London	Inshore Bridgeport	Offshore Western LIS	Inshore Hempstead Harbor
General Location	Eastern LIS Dredging Disposal Site	Thames River Near Coast Guard Academy	Bridgeport Harbor	Offshore Greenwich	Adjacent to Glen Cove Marina
Location Coordinates	41-16N 72-04W	41-22N 72-05N	41-10N 73-10W	40-57N 73-35W	40-49N 73-39W

The baseline suite of observations includes measurement of water temperature, salinity/conductivity, and dissolved oxygen. Measurements are obtained at two points on the vertical (near bottom and immediate sub-surface [1 meter depth]) at 15-minute intervals. Meteorological stations are installed and operating on Ledge Light at the entrance to New London Harbor, and on the Central LIS buoy located southeast of New Haven Harbor. In the future, additional parameters, including nutrient/nitrate concentration and chlorophyll *a*, may be measured at selected sites by in situ sensor measurement and/or water sample capture and laboratory analysis.

Figure 1.1 Map showing the general location of MYSound water quality monitoring and meteorological stations.



Real-time data from all stations are available on the MYSound Web site. Archived data can be retrieved directly from the Web site via FTP download. The Web site also provides a wealth of interpretive and educational material, links to other data sources, and an online survey to query users on the usefulness of the site and their understanding of its content.

The primary customer for the project is the public at large in the communities surrounding Long Island Sound. Other users of the data include:

Federal, state, and local environmental managers, who can use the data to gauge the effectiveness of coastal zone management and pollution control initiatives (e.g. local non-point source management initiatives)

Policy-makers, who can use the data to illustrate the need for improved water protection policies.

University researchers, who can use the data to support specific ecological investigations and to calibrate and verify predictive models. The site-specific, time-series data will provide an excellent opportunity to assess the temporal and spatial variability of water quality in the Sound, and study changes in water quality and the resulting biological regime due to short-term, high-energy aperiodic events such as high winds, heavy rainfall, or extreme temperature fluctuations.

Marine educators (at both the K-12 level and university level), who can use the information in developing marine and environmental science curricula, and can integrate use of the Web page into class projects.

Non-government organizations (NGOs), which can use the data to complement their own volunteer water quality monitoring efforts, and to focus attention on the Sound and the importance of marine water quality to its health.

Marine transportation companies and fishermen, who can use the data on wind, wave, and current conditions in the Sound in planning operations.

Aquaculture companies (companies that cultivate the natural produce of water, such as fish and shellfish), which can use the information in selecting aquaculture sites.

Marine environmental monitoring sensor development companies, which can use the data to develop design parameters for their instruments, and can use the monitoring stations as test and evaluation platforms for prototype sensors.