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The EMPACT Collection

Planning and Implementing a Real-time Air Pollution Monitoring and Outreach Program for Your Community
The AirBeat Project of Roxbury, Massachusetts
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EMPACT
Environmental Monitoring for Public Access
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United States
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Providing Timely Drinking Water and Source Water Quality Information to Your Community

Des Moines Water Works' Project

EMPACT

Environmental Monitoring for Public Access
& Community Tracking

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EPA/625/R-01/006
April 2002

Providing Timely Drinking Water and Source Water Quality Information to Your Community

Des Moines Water Works' Project

National Risk Management Research Laboratory

Office of Research and Development

U. S. Environmental Protection Agency
Cincinnati, Ohio 45268

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FOREWORD

The Technology Transfer and Support Division of the EPA Office of Research and Development's (ORD's) National Risk Management Research Laboratory initiated the development of this handbook to help interested communities, particularly those with medium and large public water systems, learn more about the Des Moines Water Works (DMWW) EMPACT project. DMWW's EMPACT project provides Des Moines metropolitan community residents with timely information about the factors that affect their drinking water supply. ORD, working with DMWW, produced this handbook to transfer the lessons learned from the project and reduce the resources needed to implement similar projects in other communities.

You can order copies of this handbook (both print and CD-ROM versions) online at ORD's Technology Transfer Web site at *http://www.epa.gov/ttbnrmrl*. You can also download a PDF version of the handbook from this site. In addition, you can order print and CD-ROM versions of the handbook by contacting either ORD Publications or the Office of Water Resource Center at:

EPA ORD Publications
26 W. Martin Luther King Dr.
Cincinnati, OH 45268-0001
EPA NSCEP Toll free: 800-490-9198
EPA NSCEP Local: 513-489-8190

EPA Office of Water Resource Center (RC 4100)
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: 202-260-7786
E-mail: center.water-resource@epa.gov

Please make sure you include the title of the handbook and the EPA document number in your request

.
We hope that you find this handbook worthwhile, informative, and easy to use.

1 INTRODUCTION

Would residents in your community have trouble answering these types of questions:

- How safe is your drinking water today?
- How healthy are the watersheds in and around your community?
- Could simple changes in your lifestyle help improve water quality in your area?
- How would you measure these improvements, and what would they mean to you and your family?

If so, your water utility and the community residents it serves would benefit from a project that uses new and innovative methods and technologies to deliver timely, accurate, and understandable information about the quality of drinking water and source water in your area.

This handbook has been designed with this goal in mind:

> **To show you how one water utility—the Des Moines Water Works (DMWW)—is implementing a project to provide timely drinking water and source water quality information to the Des Moines metropolitan community.**

The handbook provides a detailed case study of DMWW's project to encourage medium and large water utilities (or communities responsible for supplying drinking water) to consider adopting strategies for delivering timely data to the public. Although small water systems and communities not subject to federal drinking water regulations are not likely to have the resources to implement such a project, these entities may also find some portions of this handbook valuable.

ABOUT THE EMPACT PROGRAM

This handbook was developed by the U.S. Environmental Protection Agency's (EPA's) EMPACT program. EPA created EMPACT (Environmental Monitoring for Public Access and Community Tracking) in 1997. The program is now administered by EPA's Office of Environmental Information.

The EMPACT program promotes new and innovative approaches to collecting, managing, and communicating environmental information to the public. Working with communities in 156 of the largest metropolitan areas 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, ground water contamination, smog, ultraviolet radiation, and overall ecosystem quality. To learn more, visit EPA's EMPACT Web site at *http://www.epa.gov/empact.*

1.1 WHAT DO WATER UTILITIES DO?

Water utilities are responsible for producing drinking water of consistently high quality for their consumers. EPA and the states develop and enforce standards to protect the quality of drinking water, and water utilities must meet these standards. Producing high quality drinking water ideally follows an approach with multiple barriers to prevent contaminants from reaching consumers. The earliest possible barrier (i.e., the most ideal barrier) is watershed and wellhead protection, which ensures that contaminants do not enter source water. Therefore, strong environmental stewardship is an essential element of drinking water supply.

DRINKING WATER VS. SOURCE WATER

When considering the responsibilities of water utilities, it is very important to distinguish between drinking water and source water:

Drinking water is water that is conveyed to residences and businesses from a public water system. Typically, this water is treated by a water utility to make it potable. Drinking water is sometimes referred to as finished water.

Source water (i.e., raw water) is ambient water that is accessed by water utilities to treat for distribution as drinking water. Source water can originate in either a surface source (such as a lake, river, or reservoir) or a subsurface source (such as a well).

Water utilities collect and analyze drinking water and source water quality data to facilitate the following:

- Produce and deliver high quality water.
- Assure consumers and regulators that drinking water is of high quality.
- Continue to improve the quality of drinking water through research.

Water utilities are challenged every day. The regulatory environment is changing. Science is also changing, as is our knowledge of water quality and how it impacts consumers and the environment is changing. Water utilities continually strive to improve the performance of their treatment and distribution systems, make improvements to meet new challenges, and communicate with consumers in an honest and timely manner.

THE WATER DATA AND TOOLS PROJECTS

DMWW's EMPACT project is one of four *Time-Critical Water Data* and *Tools Projects*. These projects were formed through a partnership between the EMPACT program and EPA's Office of Water. Through case studies of these four unique projects, the Water Data and Tools initiative is designed to demonstrate local capability to collect and communicate water quality data that are meaningful, defensible, and easily accessible, and build a framework to encourage other communities to do the same through technology transfer and outreach.

WATER DATA AND TOOLS PROJECTS

Project	Locations	Web site	Data and Tools
Chesapeake Bay	Baltimore, MD Washington, DC	*http://mddnr.chesapeakebay.net/empact*	Water quality in support of Pfiesteria surveillance
Jefferson Parish	New Orleans, LA	*http://www.jeffparish.net*	Freshwater diversions and algal blooms
Ohio River	Cincinnati, OH Louiseville, KY Pittsburgh, PA	*http://www.orsanco.org/empact*	Swimming and fishing conditions
Des Moines	Des Moines, IA	*http://www.dmww.com/empact*	Drinking water and source water quality

Visit http://www.epa.gov/surf2/empact/tools.html for more information on the EMPACT Water Data and Tools Projects.

1.2 WHY IS IT IMPORTANT TO COMMUNICATE TIMELY DRINKING WATER AND SOURCE WATER QUALITY INFORMATION TO THE PUBLIC?

All members of a community have a right to know about the current quality of their drinking water because drinking water quality affects public health. The need to provide timely drinking water quality data is most urgent when these data indicate an acute result that can have immediate effects on a utility's customer population. Your efforts to provide your customers with timely information on the quality of their drinking water will build public confidence in your utility's ability to provide safe, healthy, reliable drinking water. Businesses relying on consistently high-quality water to support a production process can use timely water quality information to determine whether to maintain or modify their processes. By disseminating these timely data on a Web site, you may reduce the number of phone calls to your utility from consumers or manufacturers seeking specific water quality test results.

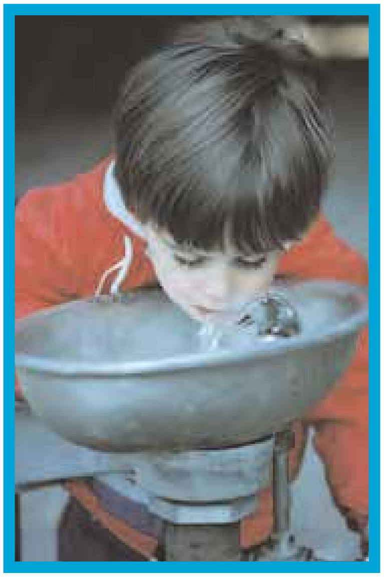
From a human health perspective, the urgency for timely source water quality information is typically less than that for drinking water quality information. However, the timeliness of source water quality information may be critical when spills or other environmental emergencies occur in the watershed. The presentation of timely source water quality data and trends on a Web site can inform and influence the behavior of residents in your watershed. This heightened public awareness would not only enable local residents and public officials to make informed decisions about land use management and water conservation measures, but would also encourage affected groups to take a larger and more proactive role in instituting practices to restore and preserve the quality of source waters.

1.3 DES MOINES WATER WORKS' EMPACT PROJECT

DMWW is the largest water utility in the state of Iowa. Serving over 350,000 people, DMWW operates two major water treatment plants and pumps an average of 43 million gallons of water per day.

In 1998, EPA's EMPACT program funded DMWW's EMPACT project, which provides Des Moines metropolitan community residents with timely information about the factors that affect their drinking water supply. DMWW's EMPACT project is broken into three phases:

- Phase I is the development of a data management protocol, tools, and electronic links required to identify, manage, and deliver **drinking water quality** information to the project Web site.
- Phase II is the periodic collection, Web posting, and updating of **source water quality** information collected from selected monitoring sites within the Racoon River and Des Moines River watersheds.
- Phase III is the adaptation of the methods and tools developed for Phases I and II to existing **urban runoff studies** conducted by DMWW.



DMWW's EMPACT project strives to encourage Des Moines residents, as well as the entire watershed community, to assume a larger role in restoring and preserving the quality of source waters in the community. Project partners include EPA's Office of Groundwater and Drinking Water (OGWDW), EPA Region VII, the Iowa Department of Natural Resources, and the United States Geological Survey (USGS). You can visit DMWW's EMPACT project Web site at *http://www.dmww.com/empact*.

1.3.1 PROJECT COSTS

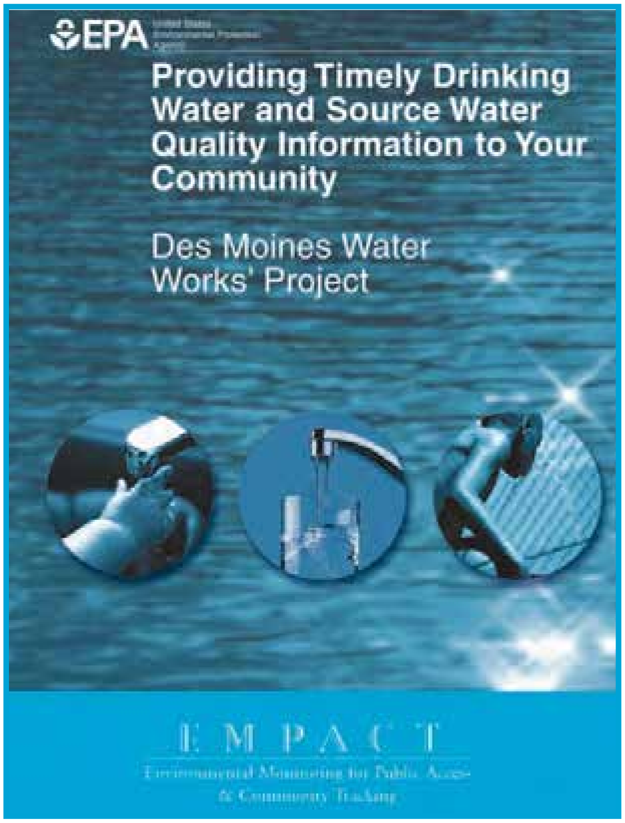
To plan, design, develop, install, and implement the three phases of its EMPACT project, DMWW incurred a total cost of approximately $245,000. This cost should give you an idea of how much a comparable project might cost your utility. However, every project that communicates timely information about drinking water and source water quality is unique to its community. Therefore, the cost of your project will also be unique.

2 HOW TO USE THIS HANDBOOK

This handbook has been designed to show you how DMWW is implementing a project to provide timely drinking water and source water quality information to the Des Moines metropolitan community. The handbook intends to encourage medium and large water utilities (or communities responsible for supplying drinking water) to consider adopting strategies for delivering timely data to the public. Although small water systems and communities not subject to federal drinking water regulations are not likely to have the resources to implement such a project, these entities may also find some portions of this handbook valuable.

The handbook is organized into the following chapters:

- **Chapter 3** presents an overview of water quality monitoring. Specifically, the chapter discusses the federal and state regulations and guidelines applicable to drinking water and source water. It also discusses typical methods used by water systems to collect and disseminate information about drinking water and source water quality. Chapter 3 is targeted toward readers who are not familiar with federal and state drinking water and source water regulations and guidelines. Therefore, water utility personnel are likely already familiar with the material presented in this chapter.
- **Chapter 4** presents an overview of DMWW operations and discusses the key programs and systems that support these operations. Specifically, the chapter discusses DMWW's sample collection/analysis program, data management system, and communications/outreach program. It also discusses the integrated collection of software and hardware components that further supports DMWW's operations. This chapter is targeted toward all readers.



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- **Chapter 5** presents a detailed case study of DMWW's EMPACT project. The chapter describes the three project phases in detail and discusses the EMPACT project area on DMWW's Web site. This chapter is targeted toward all readers.
- **Chapter 6** focuses on communications and outreach. The chapter discusses many of DMWW's communication/outreach efforts. Chapter 6 is targeted toward personnel tasked with implementing an outreach plan.
- **Appendix A** contains brochures and pamphlets related to DMWW's communication/outreach plan, including a Consumer Confidence Report. These materials are discussed in Chapter 6.
- **Appendix B** presents a glossary of terms used in the handbook. This glossary is targeted toward all readers.

- **Appendix C** presents a brief case study of the EMPACT Water Quality Project implemented at the Water Quality Division of Tucson Water in Tucson, Arizona. This appendix is targeted toward all readers.
- **Appendix D** presents general guidance on creating a comprehensive outreach plan and provides a list of resources for presenting water quality information to the public. This appendix is targeted toward personnel tasked with implementing an outreach plan.

Throughout this handbook, you will find lessons learned and success stories related to DMWW's EMPACT project. You will also find references to supplementary information sources, such as Web sites, guidance documents, and other written materials that will provide you with a greater level of detail.

3 WATER QUALITY MONITORING—AN OVERVIEW

All water–even from the healthiest rivers and lakes–contains naturally occurring substances from the soil, surrounding vegetation and wildlife, and biological, physical, and chemical processes. Some water sources may be contaminated by man-made chemicals or the by-products of industrial processes. The purpose of water quality monitoring is to measure the presence and quantity of these constituents or parameters in water. This chapter introduces the concept and measurement of water quality from the perspective of drinking water utilities and discusses some of the regulations and guidelines that public water systems must follow to protect water quality.

Section 3.1 provides a general introduction to the concept of drinking water and source water quality monitoring related to drinking water utilities. Sections 3.2 and 3.3 discuss the federal and state regulations and guidelines that public water systems must follow to protect the quality of drinking water and source water, respectively. These sections also introduce the water quality monitoring and communication requirements associated with these regulations and guidelines.

TO LEARN MORE

To learn more about water quality, consult the following references and Web sites:

- EPA's Water Projects and Programs page at: *http://www.epa.gov/epahome/waterpgram.htm*.
- EPA's Office of Ground Water and Drinking Water (OGWDW) site at: *http://www.epa.gov/safewater/*.
- Drinking Water: Past, Present, and Future. USEPA/OW, February 2000, EPA 816-F-00-002.
- National Library of Medicine drinking water page at: *http://www.nlm.nih.gov/medlineplus/drinkingwater.html.*
- The National Agricultural Library Water Quality Information Center site at: *http://www.nal.usda.gov/wqic.*
- For questions about drinking water requirements under the Safe Drinking Water Act (SDWA), contact the Safe Drinking Water Hotline at (800) 426-4791 or via e-mail at *hotline-sdwa@epa.gov.*
- See Appendix D for additional references.

3.1 INTRODUCTION TO WATER QUALITY MONITORING

The quality of water affects how we are able to use it; conversely, the way we use our water can affect its overall quality. The federal government, states, and localities are all involved in the regulation, monitoring, and control of our nation's waters to protect the quality of water for its intended use. Therefore, it is important to distinguish between the quality of drinking water and the quality of source water.

PUBLIC WATER SYSTEMS

There are approximately 170,000 public water systems in the United States. EPA classifies these water systems according to the number of people they serve, the source of their water, and whether they serve the same people year-round or on an occasional basis. Public water systems, which may be either publicly or privately owned, provide water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serve an average of at least 25 people for at least 60 days per year. EPA has defined three types of public water systems:

Community Water System: A public water system that supplies water to the same population year-round. For example, the water system operated by DMWW (a water utility) is considered a community water system. There are approximately 54,000 community water systems operated in the United States.

Non-Transient Non-Community Water System: A public water system that regularly supplies water to at least 25 of the same people for at least six months per year, but not year-round. Some examples are water systems at schools, factories, office buildings, and hospitals. There are approximately 20,000 non-transient non-community water systems operated in the United States.

Transient Non-Community Water System: A public water system that provides water to at least 25 people per day in a place such as a gas station or campground where people do not remain for long periods of time. There are approximately 93,000 transient non-community water systems operated in the United States.

The federal and state regulations and guidelines designed to protect the quality of these waters are discussed in the following sections.

3.2 REGULATION OF DRINKING WATER

Federal regulation of drinking water quality began in 1914, when the U.S. Public Health Service set standards for certain disease-causing microbes. Today, water quality is protected by a variety of different regulations and guidelines.

Through the **Safe Drinking Water Act** (SDWA) established in 1974 and revised in 1986 and 1996, Congress authorized EPA to set enforceable health standards and required public notification of water utility violations and annual customer reports on contaminants found in drinking water. Under the authority of the SDWA, EPA sets standards for approximately 90 contaminants in drinking water. Currently, standards are set for the following:

- **Microorganisms**, including (but not limited to) *Cryptosporidium, Giardia lamblia, Legionella,* total coliforms (including fecal coliform and *E. coli*), and viruses. Although some of these contaminants occur naturally in the environment, most originate in human and animal fecal waste. Many of these contaminants can cause gastrointestinal illness if ingested. *Legionella* can cause Legionnaire's disease.

- **Disinfectants and disinfection byproducts**, including (but not limited to) bromate, chloramines, chlorine, chlorine dioxide, chlorite, haloacetic acids, and total trihalomethanes. These contaminants are either water additives used to control microbes or byproducts of the disinfection process. Potential health effects vary with each contaminant; they range from eye/nose irritation, stomach discomfort, and anemia to liver, kidney, and nervous system effects and the increased risk of cancer.
- **Inorganic chemicals,** including antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, copper, cyanide, fluoride, lead, mercury, nitrate, nitrite, selenium, and thallium. These contaminants originate from a variety of different sources, including (but not limited to) discharges from industrial processes, erosion of natural deposits, corrosion of pipes, and runoff. Potential health effects are specific to each contaminant; they can include circulatory system problems, skin damage, intestinal polyps and lesions, increased blood pressure, kidney damage, nerve damage, thyroid problems, bone disease, and the increased risk of cancer.
- Various **organic chemicals**. As with the inorganic chemicals, these contaminants originate from a variety of different sources, including (but not limited to) discharges from industrial processes, agricultural and municipal runoff, and leaching from pipes. Potential health effects are specific to each contaminant; they can include kidney, liver, immune system, nervous system, circulatory system, and gastrointestinal problems, reproductive difficulties, anemia, and the increased risk of cancer.
- **Radionuclides**, including alpha particles, beta particles and photon emitters, Radium 226 and Radium 228, and uranium. These contaminants may originate through the erosion and decay of natural and man-made deposits. If ingested, they may potentially increase the risks of cancer. Uranium may also cause kidney toxicity.

For each of these contaminants, EPA sets a legal limit, called a maximum contaminant level (MCL), or requires a certain type of treatment. Water utilities may not distribute drinking water that doesn't meet these standards. Most states have been delegated the authority to enforce the federal standards; state standards must be at least as strict as the federal standards.

National Primary Drinking Water Regulations are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of drinking water contaminants, including microorganisms, disinfectants and disinfection byproducts, inorganic chemicals, organic chemicals, and radionuclides. You can visit *http://www.epa.gov/safewater/mcl.html* for detailed information on the contaminants regulated by national primary drinking water regulations.

National Secondary Drinking Water Regulations are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. Examples of these contaminants include metals, pH, total dissolved solids, odor, and color. You can visit *http://www.epa.gov/safewater/mcl.html* for detailed information on the contaminants regulated by national secondary drinking water regulations. Although EPA recommends secondary standards to public water systems, the Agency does not require that these systems comply. States may, however, choose to adopt secondary standards as enforceable standards.

HEALTH EFFECTS

The health-related contaminants regulated by primary and secondary drinking water regulations fall into two groups according to the health effects they may cause:

Acute effects occur within hours or days of the time that a person consumes a contaminant. People can suffer acute health effects from almost any contaminant if they are exposed to extraordinarily high levels (as in the case of a spill). In drinking water, microbes such as bacteria and viruses are contaminants with the greatest chance of reaching levels high enough to cause acute health effects. Most people's bodies can fight off these microbial contaminants; acute contaminants typically don't have permanent effects. Nonetheless, when high levels occur, acute contaminants can make people ill and may be dangerous or deadly for the very young, the very old, or people with immune systems weakened by HIV/AIDS, chemotherapy, steroid use, or other reasons.

Chronic effects occur after people consume a contaminant at levels over EPA's safety standards for many years. The drinking water contaminants that can have chronic effects are chemicals (such as disinfection by-products, solvents, and pesticides), radionuclides (such as radium), and minerals (such as arsenic). Examples of the chronic effects of drinking water contaminants can include cancer, liver or kidney problems, or reproductive difficulties.

3.2.1 Monitoring Drinking Water Quality

Water utilities perform a wide range of water quality monitoring to meet several purposes. First, water utilities routinely monitor and test public water systems to ensure compliance with the more than 90 contaminants for which EPA has set national primary drinking water regulations. Second, water utilities must also meet more stringent and additional monitoring requirements set by the individual states. Finally, water utilities conduct other routine monitoring as part of their day-to-day operations to ensure treatment effectiveness and to ensure that finished water quality meets both health and aesthetic objectives. This testing includes routine sampling as well as check sampling to confirm the results of any problems discovered during routine sampling. Monitoring locations and frequency are based on the parameters being monitored and are specific to each water utility based on its source water type, size, treatment process, and distribution system. Some drinking water parameters are monitored constantly while others are monitored only every few years.

The table on the following page shows the major groups of contaminants and the minimum testing frequency to comply with the monitoring requirements under EPA's national primary drinking water regulations. If a problem is detected, there are immediate retesting requirements that go into effect and strict instructions for how the public is informed. The retesting is continued until the water system can reliably demonstrate that it is free of problems.

CONTAMINANT	MINIMUM MONITORING FREQUENCY
Acute Contaminants	
Bacteria	For community water systems, samples are collected throughout each monthly monitoring period, ranging from 1 sample per month to 480 samples per month depending on the system size. For non-community water systems, sampling is conducted once per quarter.
Protozoa and Viruses	Continuous monitoring for turbidity and monthly monitoring for total coliforms, as indicators.
Nitrate/Nitrite	Quarterly sampling for surface water systems and annual sampling for groundwater systems.
Chronic Contaminants	
Volatile Organics (e.g., benzene)	Quarterly sampling at each entry point into the water system, reduced to annual (or less frequent) sampling if no detects.
Synthetic Organics (e.g., pesticides)	Quarterly sampling at each entry point into the water system, reduced to annual (or less frequent) sampling if no detects.
Inorganics/Metals	For groundwater systems, sampling is conducted once every 3 years. For surface water systems, sampling is conducted annually.
Lead and Copper	Annual sampling is required, with the number of sites ranging from 5 to 100, based on the size of the system.
Radionuclides	Four consecutive quarters of sampling during initial annual compliance period; subsequent monitoring frequency is reduced if levels are below the detection limit.

Sample Compliance Monitoring Schedule Required Under EPA Regulations.

3.2.2 PUBLIC NOTIFICATION OF DRINKING WATER VIOLATIONS

Federal regulations require that water utilities notify the people they serve when any violation of a drinking water contaminant standard has occurred or any other situation has occurred that may pose a short-term risk to health. As utilities test their water, they may discover that levels of certain contaminants are higher than federal or state standards. These conditions may occur due to a change in local water conditions, heavy rainstorms, or an accidental spill of a hazardous substance. Water utilities may also fail to collect one or a series of their required samples at the scheduled interval. Any time a water utility fails to meet any EPA or state standards for drinking water (including missing required samples or collecting them late), the utility must inform the people who drink the water.

Depending on the severity of the situation, water utilities have from 24 hours to 1 year to notify the people they serve of a violation. EPA specifies three categories, or tiers, of public notification. For each tier, water utilities have different amounts of time to distribute the notice and different ways to deliver the notice:

Immediate notice (Tier 1): Any time a situation creates the potential for immediate human health impacts, water utilities have 24 hours to take whatever steps are necessary to notify people who may drink the water. In these situations, water utilities must use mass media outlets such as television and radio, post their notice in public places, or personally deliver a notice to the people they serve.

Notice as soon as possible (Tier 2): Any time a water utility distributes water that hasn't been treated properly or contains contaminants at levels that exceed EPA or state standards, the utility must notify the people it serves as soon as possible, within 30 days of the violation as long as the situation does not pose an immediate risk to human health. The water utility must provide notice through the mail or via hand delivery to residences and through posting in conspicuous places for other persons served by the water system.

Annual Notice (Tier 3): When a water utility violates a drinking water standard but the violation does not have a direct impact on human health (for example, failing to take a required sample on time), the utility has up to 1 year to provide a notice of this situation to the people it serves. This extra time gives water utilities the opportunity to consolidate these notices and send them with annual water quality reports (Consumer Confidence Reports, described below).

Regardless of their tier classifications, all notices must include the following:

- A description of the violation that occurred, including the potential health effects.
- The population at risk and whether alternate water supplies should be used.
- What the water utility is doing to correct the problem.
- Actions consumers can take.
- When the violation occurred and when the water utility expects it to be resolved.
- How to contact the water utility for more information.
- Language encouraging broader distribution of the notice.

In addition to Tier 1 and Tier 2 notices, EPA requires that water utilities place annual drinking water quality reports into the hands of the people they serve. These reports, called Consumer Confidence Reports (CCRs), enable consumers to make practical, knowledgeable decisions about their health and their environment. Water utilities may enhance their reports as they wish; however, each report must provide consumers with fundamental information about their drinking water.

The first of these reports came out in 1999; water utilities now publish reports by July 1 every year. CCRs are the centerpiece of the "right-to-know" provisions in the 1996 Amendments to the SDWA. The Amendments contain several other provisions aimed at improving public access to information about drinking water, including the annual public water system compliance report and improved public notification in cases where drinking water is not meeting a contaminant standard. You can read more about these reports at *http://www.epa.gov/safewater/ccrl.html.* In addition, examples of CCRs from DMWW are included in Appendix A.

WHAT DETERMINES THE PUBLIC NOTIFICATION TIER?

The following violations, situations, or conditions require Tier 1, Tier 2, or Tier 3 notifications. For more information on the Public Notification Rule, visit *http://www.epa.gov/safewater/pn.html*.

Tier 1

- Fecal coliform violations; failure to test for fecal coliform after an initial total coliform sample tests positive.
- Nitrate, nitrite, or total nitrate/nitrite maximum contaminant level (MCL) violation; failure to collect a confirmation sample.
- Chlorine dioxide maximum residual disinfectant level (MRDL) violation in the distribution system; failure to collect required samples in the distribution system.
- Exceedence of the maximum allowable turbidity level (if elevated to Tier 1 by the primacy agency).
- Special notice for non-community water systems with nitrate exceedences between 10 mg/L and 20 mg/L, where the system is allowed to exceed 10 mg/L by the primacy agency.
- An outbreak of a waterborne disease or other waterborne emergency.
- Other violations or situations determined by the primacy agency.

Tier 2

- All MCL, MRDL, and treatment technique violations, except where a Tier 1 notice is required.
- Monitoring violations, if elevated to Tier 2 by the primacy agency.
- Failure to comply with variance and exemption conditions.
- Turbidity consultation: When public water systems have a treatment technique violation resulting from a single exceedence of the maximum allowable turbidity limit or an MCL violation resulting from an exceedence of the 2-day turbidity limit, they must consult their primacy agency within 24 hours. The primacy agency will then determine whether a Tier 1 notice is necessary. If consultation does not occur within 24 hours, the violation is automatically elevated to Tier 1.

Tier 3

- Monitoring and testing procedure violations, unless the primacy agency elevates the violation to Tier 2.
- Operation under a variance and exemption.
- Special public notices such as a fluoride secondary maximum contaminant level (SMCL) exceedence or the availability of unregulated contaminant monitoring results.

WHAT'S IN A CONSUMER CONFIDENCE REPORT?

CCRs must provide consumers with the following fundamental information about their drinking water:

- Identification of the lake, river, aquifer, or other drinking water source.
- A brief summary of the susceptibility of the drinking water source to contamination based on the source water assessments that states are currently completing.
- Directions on how to get a copy of the water system's complete source water assessment.
- The level (or a range of levels) of any contaminant found in local drinking water along with EPA's legal limit (MCL) for comparison.
- The likely source of that contaminant in the local drinking water supply.
- The potential health effects of any contaminant detected in violation of an EPA health standard and a description of the utility's actions to restore safe drinking water.
- The compliance of the water system with other drinking water-related rules.
- An educational statement for vulnerable populations about avoiding *Cryptosporidium*.
- Educational information on nitrate, arsenic, or lead in areas where these contaminants are detected at levels greater than 50% of EPA's standard.
- Phone numbers for additional sources of information, including the water utility and EPA's Safe Drinking Water Hotline (800-426-4791).

3.3 SOURCE WATER

In contrast with drinking water, federal regulation of source water quality has been less detailed and has allowed for more flexibility in the monitoring and reporting of source water quality. While many states, water utilities, and localities have watershed and wellhead protection/management programs, the 1996 SDWA Amendments placed a new focus on source water quality. The 1996 Amendments require states to implement Source Water Assessment Programs (SWAPs) to assess areas serving as drinking water sources and identify potential threats to these sources. You can read more about source water assessments at *http://www.epa.gov/safewater/protect/assessment.html*.

By 2003, states are required to complete a source water assessment for every public water system. Each SWAP will be uniquely tailored to state water resources and drinking water priorities. However, each assessment must include four major elements:

- A delineation (or map) of the source water assessment area.
- The potential sources of contamination in the delineated area.
- The susceptibility of the water supply to those contamination sources.
- Public release of the assessment results.

State SWAPs have been reviewed and approved by EPA; states and localities are currently in the process of developing source water assessments. These assessment reports will be provided to the public in a variety of ways. Some states plan to convene public workshops, while others will have copies available at public libraries, local government offices, or water suppliers. Many states also plan to post the assessment summaries on the Internet. In addition, the results of the assessments will be included in the annual water quality reports that community water systems are required to prepare for the people they serve. You can find links to each state's drinking water and source water protection pages at *http://www.epa.gov/safewater/dwinfo.html.*

In addition to the source water assessment requirements of the SDWA Amendments, all surface source waters are federally regulated by the Clean Water Act (CWA) and the rules and regulations that have been developed under that authority. The CWA impacts those sources (both point sources and nonpoint sources) that contribute pollutants to the nation's surface waters. Point sources are stationary locations or fixed facilities from which pollutants are discharged. Nonpoint sources are diffuse sources of pollutants associated with land use or groundwater flow. Examples include runoff from agriculture, forestry, or urban activities. You can learn more about the CWA and all associated programs and requirements at *http://www.epa.gov/ow.*

3.3.1 Monitoring Source Water Quality

Typically, source water quality monitoring is conducted by water utilities to determine the quality of water feeding the water treatment system and adjust the treatment process based on raw water characteristics. In addition, many localities and water utilities conduct source water monitoring as part of their watershed and wellhead protection/management programs.

Water utilities are not required by the regulations under the Safe Drinking Water Act to provide source water quality monitoring results to either EPA or the public, but they may choose to do so through program-specific outreach products, such as Web sites.

CLEAN WATER ACT PROGRAMS THAT IMPACT SURFACE SOURCE WATER QUALITY

The Water Quality Criteria and Standards Program. This program includes a compilation of national recommended water quality criteria for the protection of aquatic life and human health for approximately 150 pollutants. These criteria have been published pursuant to Section 304(a) of the CWA and provide guidance for states and tribes to use in adopting water quality standards. These water quality criteria cover the following types: aquatic life, biological, drinking water, human health, and nutrient. You can find out more about this program at *http://www.epa.gov/waterscience/standards.*

The National Pollutant Discharge Elimination System (NPDES) Permitting Program. This program requires that all point sources discharging pollutants into waters of the United States obtain an NPDES permit. These permits implement water quality standards and effluent limitations guidelines that have been developed for specific industrial categories. You can find out more about this program at *http://www.epa.gov/owm/npdes.html.*

Nonpoint source programs such as the Total Maximum Daily Load (TMDL) Program. Under Section 303(d) of the CWA, states, territories, and authorized tribes are required to develop lists of impaired waters. These impaired waters do not meet water quality standards that states, territories, and authorized tribes have set for them, even after point sources have installed minimum required levels of pollution control technology. The TMDL rule requires that these jurisdictions establish priority rankings for waters on the list and develop TMDLs for these waters. A TMDL not only specifies the maximum amount of a pollutant (its loading) that a water body can receive and still meet water quality standards but also allocates pollutant loadings among point and nonpoint sources. While TMDLs have been required by the CWA since 1972, until recently states, territories, tribes, and EPA have not developed many. Several years ago, citizens' organizations began bringing legal actions against EPA seeking the listing of waters and the development of TMDLs. To date, there have been about 40 legal actions in 38 states, and EPA is under court order or consent decrees in many states to ensure that TMDLs are established, either by the state or by EPA. Currently, EPA is working to develop changes to the TMDL regulations. Until then, the current TMDL rule remains in effect. You can find out more about this program at *http://www.epa.gov/owow/tmdl* and at *http://www.epa.gov/owow/nps.*

EPA's Clean Lakes Program. The Clean Lakes Program was established in 1972 as Section 314 of the Federal Water Pollution Control Act to provide financial and technical assistance to states in restoring publicly owned lakes. The early focus of the program was on research and development of lake restoration techniques and evaluation of lake conditions. The Clean Lakes Program regulations promulgated in 1980 redirected the program activities to diagnose the current conditions of individual lakes and their watersheds, determine the extent and sources of pollution, develop feasible lake restoration and protection plans, and implement these plans. The CWA Amendments of 1987 expanded the program to include state-wide assessments of lake conditions. EPA has encouraged states to use these assessment funds to develop the institutional and administrative capabilities needed to carry out their lake programs. You can find out more about this program at *http://www.epa.gov/owow/lakes.*

4 DES MOINES WATER WORKS

DMWW is the largest municipal water utility in the state of Iowa. Serving over 350,000 people, DMWW operates two water treatment plants and pumps an average of 43 million gallons of water per day. This chapter briefly discusses many of the day-to-day operations conducted at DMWW and introduces some of the key programs and systems that support DMWW's operations.

4.1 OVERVIEW OF DMWW OPERATIONS

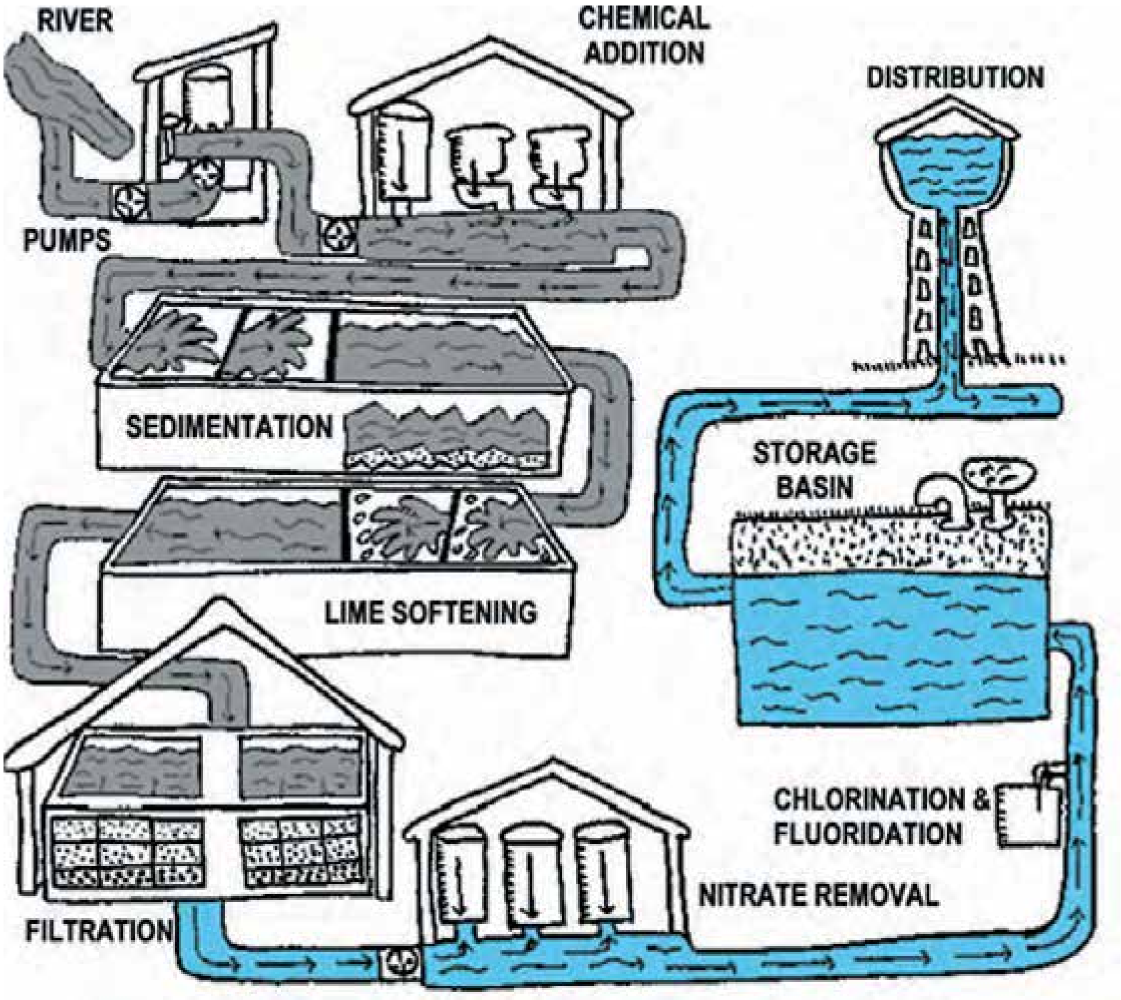
DMWW is located on the banks of the Raccoon River in the city of Des Moines. The utility draws source water from the Raccoon River, the Des Moines River, an infiltration gallery, and several wells. The infiltration gallery is a large horizontal well constructed in the sand and gravel adjacent to the Raccoon River. It yields river water and groundwater that have been naturally filtered through the sand and gravel. DMWW selected these source water supplies based on the quality of these waters and the utility's ability to treat these waters.

DMWW maintains an emergency supply of source water in the Maffitt Reservoir. This reservoir, constructed for DMWW during the 1940s, is located southwest of the Des Moines metropolitan area within 600 acres of wooded land; the area is popular for fishing and hiking. To enhance the quality of water in the reservoir, DMWW recently purchased 105 acres of surrounding farmland to provide watershed protection.

DMWW operates two drinking water treatment plants: the Fleur Drive plant and the Maffitt plant. The Fleur Drive plant (considered the main plant) has the capacity to treat 100 million gallons of source water per day. It is operated by DMWW staff on a continuous basis. The Maffitt plant was constructed to address reliability issues that arose when a serious flood put the Fleur Drive plant underwater and out of service in 1993. In addition to providing a backup for the main plant, the Maffitt plant provides an additional 25 million gallons of drinking water per day for the growing Des Moines population. The Maffitt plant is in service on a continuous basis; it is adjacent to the Maffitt Reservoir, located about 10 miles southwest of the main plant, outside of the Raccoon River flood plain. Typically, DMWW operates the Maffitt plant remotely.

Both of DMWW's treatment plants use a multi-step process to treat source water. The typical treatment process used at the Fleur Drive plant is illustrated in the diagram on page 18 and briefly described below.

- Source water for the Fleur Drive plant is obtained from the Raccoon River, the Des Moines River, and the infiltration gallery system.
- Powdered activated carbon is fed into river water to remove man-made and natural organic chemicals (thereby improving the taste and odor). Ferric chloride is added to remove particulates. The pre-treated river water is then combined with water from the infiltration gallery.
- The combined water is softened with soda ash and/or lime. Alum or ferric chloride is added to remove minerals and other particles from the softened water.


RIVER
CHEMICAL ADDITION
DISTRIBUTION
PUMPS
SEDIMENTATION
STORAGE BASIN
LIME SOFTENING
CHLORINATION & FLUORIDATION
NITRATE REMOVAL
FILTRATION

Typical treatment process used at DMWW's Fleur Drive Plant

- The pH of the water is adjusted with carbon dioxide, and the water is stabilized with polyphosphate.
- The water is filtered through layers of sand to remove any remaining particles.
- When increased levels of nitrate are possible in river water, DMWW treats the water in its nitrate removal process.
- Fluoride is added to the water to aid in the prevention of tooth decay, and chlorine is added as a disinfectant to kill bacteria. The treated drinking water is stored in a clear well until it is pumped into the distribution system.

Water at the Maffitt plant is treated using a similar multi-step process. Because source water for this plant is usually obtained exclusively from wells, DMWW does not pre-treat this water as it does river water. Also, DMWW does not operate a nitrate removal process at the Maffitt plant because nitrate is typically found at low levels in the well water.

Through more than 800 miles of underground water mains and pipe (both iron and plastic), DMWW distributes drinking water from both treatment plants to the Des Moines metropolitan community. DMWW provides total water service (including distribution system maintenance) to the city of Des Moines, Polk County, Windsor Heights, and the Warren County Water System. Through this total water service, DMWW performs preventative maintenance on all valves and hydrants, detects main leaks, repairs main breaks, and replaces and repairs valves and hydrants. In addition, the utility reads meters, makes service calls, prepares bills, and responds to customer service inquiries. DMWW also supplies water to several other cities, communities, and water systems. For example, the utility maintains a partnership with the city of Ankeny. Through this partnership, DMWW provides drinking water, reads meters, manages billing, and responds to customer service inquiries while the city of Ankeny makes service calls and maintains its own distribution system.

In addition to its drinking water treatment and distribution responsibilities, DMWW operates the Water Works Park, about 1,500 acres of land near downtown Des Moines.

4.2 Support Programs and Systems

DMWW relies on several programs and systems to support its day-to-day operations. Sections 4.2.1 through 4.2.3 discuss a few of DMWW's key support programs and systems: the sample collection/analysis program, the data management system, and the communications/outreach program. All of DMWW's operations are further supported by an integrated collection of software and hardware components; this support system is discussed in Section 4.2.4.

4.2.1 Sample Collection/Analysis

DMWW monitors the quality of its drinking water and source water to satisfy both treatment process control and regulatory requirements. (See Chapter 3 for a discussion of applicable regulatory requirements and guidelines.) The utility maintains an in-house laboratory to conduct a variety of analyses on its water samples. To ensure that data are accurate and representative, DMWW follows a comprehensive set of procedures for sampling and laboratory quality assurance/quality control (QA/QC); many of these procedures are required by EPA. DMWW has a quality assurance project plan (QAPP) in place to document its adherence to these procedures.

DMWW'S QUALITY ASSURANCE PROJECT PLAN (QAPP)

DMWW's QAPP provides a detailed framework for the utility's sampling and analytical procedures. Specifically, DMWW's QAPP covers the following:

- The laboratory mission, organizational structure, personnel, the physical facility, laboratory reagents and supplies, reagent standardization, contamination control, and laboratory safety.
- Standard sampling procedures, acceptance criteria, chain-of-custody, a sampling plan for softening analyses, non-routine sampling, and on-site analysis.
- Inorganic, organic, and microbiological analytical procedures.
- Data quality assurance.
- Preventative equipment maintenance schedules, routine maintenance procedures, instrument performance and optimization, protocol for correcting equipment problems, and equipment use and maintenance record-keeping.
- Equipment inventory.

DMWW collects and analyzes samples within its water treatment and distribution system. The table below lists the drinking water parameters typically monitored by DMWW. Asterisks identify the parameters monitored to fulfill regulatory requirements for DMWW's drinking water. [Note that the parameters marked with asterisks do not add to the 90 federally regulated parameters because some listed parameters (e.g., HAAs, SOCs, VOCs) represent more than one standard and others have been omitted because subsequent monitoring has been waived or is very infrequent.] Monitoring frequency (monthly, weekly, daily, or continuous) varies with each analysis. The utility uses Hach® CL-17 analyzers to monitor chlorine levels and Hach® 1720D analyzers to monitor turbidity levels in its drinking water. These analyzers are connected, with other treatment process control monitors, to DMWW's supervisory control and data acquisition (SCADA) system. The SCADA system is equipped with data monitors and alarms with pre-set parameter levels to assist DMWW's water production personnel with monitoring the treatment system around the clock.

The Hach® 1720D Process Turbidimeter

® CL-17 alyzer

DMWW also periodically collects and analyzes source water samples. The table on the next page lists the source water parameters that are typically monitored by DMWW. When the utility is operating its nitrate removal process, DMWW monitors Nitrate-N to fulfill the requirements of its state operating permit. Monitoring frequency (monthly, weekly, daily, or continuous) varies with the source water type and location and each analysis. Samples are collected from selected sites within the Raccoon River and Des Moines River watersheds, wells, and the Maffitt Reservoir.

DRINKING WATER PARAMETERS TYPICALLY MONITORED BY DMWW

- Acetochlor*
- Antimony*
- Arsenic*
- Atrazine*
- Barium*
- Bromide
- Cadmium*
- Calcium hardness
- CCPP*
- Chloride
- Chlorine
- Chromium*
- Conductivity
- Copper
- *Cryptosporidium*
- *E. coli**
- Fluoride*
- HAAs*
- HPC*
- Iron
- Langalier's Index
- Lead*
- Manganese
- Magnesium hardness
- Mercury*
- Metolachlor*
- Nitrate-N*
- Nitrite-N*
- Odors
- O-phosphate
- P-alkalinity
- pH*
- Potassium
- Radionuclides*
- Selenium*
- SOCs*
- Sodium
- Sulfate*
- SUVA*
- Temperature
- Thallium*
- THMs*
- TOC*
- Total coliforms*
- Total hardness
- Turbidity*
- UV-254*
- VOCs*

**Parameters collected to fulfill regulatory requirements are marked with asterisks.*

SOURCE WATER PARAMETERS TYPICALLY MONITORED BY DMWW

Acetochlor
Ammonia
Atrazine
Bromide
Calcium hardness
Chloride
Copper
Cryptosporidium
E. coli
Fluoride
HPC
Iron
Lead
Manganese
Magnesium hardness
Metolachlor
Nitrate-N*
Nitrite-N
O-phosphate
Odors
P-alkalinity
pH
Potassium
Sodium
Sulfate
SUVA
Temperature
TOC*
Total coliforms
Total hardness
Turbidity
UV-254

**Parameters collected to fulfill regulatory requirements are marked with asterisks.*

URBAN RUNOFF STUDIES

DMWW conducted a series of urban runoff studies to determine the microbial and chemical influences of main urban creek watersheds on the utility's source waters. Each of DMWW's source water rivers has a primary urban creek (Walnut Creek for the Raccoon River and Beaver Creek for the Des Moines River) with a branch that not only meanders through residential and business areas but also extends beyond these areas into agricultural land. Walnut Creek is multi-branched and eventually empties into the Raccoon River 2 miles upstream of DMWW's water intake. Beaver Creek has one main creek channel plus a small branch. The mouth of Beaver Creek is located 3 miles upstream of DMWW's Des Moines River water intake.

DMWW conducted its urban runoff studies over a 2-3 year period. To determine the microbial and chemical influences of these creeks, DMWW tested creek water for total *E. coli* counts, nitrate, ammonia, and other chemistry determinations. Samples were collected by a DMWW laboratory technician during a rainfall event. DMWW performed the creek sampling using two different approaches. One approach was to sample water from the creek mouth, water from the river upstream from the creek, and water from DMWW's downstream intake. The second approach involved a complete or nearly complete study that used the basic approach above but included several other creek monitoring sites. DMWW selected 12 mapped sampling sites for the Beaver Creek watershed and up to 20 mapped sampling sites for the Walnut Creek watershed.

The results of DMWW's urban creek studies indicate that bacterial contamination of Des Moines urban creeks sometimes significantly affects the bacterial counts found in DMWW's source water rivers, despite the relatively small amounts of flow from these creeks. DMWW determined that the high bacteria levels in urban creeks are likely the result of pet and wild animal waste deposited in Des Moines metropolitan storm sewers; however, DMWW did locate more than one broken sewer line during its studies. DMWW's results also indicate that urban runoff accounts for very little of the nitrate measured in the utility's source water.

4.2.2 DATA MANAGEMENT

DMWW carefully manages and validates its monitoring data to ensure that only data of known and documented quality are used to make environmental and operational decisions. DMWW's data validation process is illustrated in the flow diagram on page 23.

Data management begins with DMWW's laboratory analyst. All sample analyses must adhere to the laboratory QA/QC procedures documented in DMWW's QAPP. The laboratory analyst enters data that meet these requirements and the QC measurements made during the analysis into a laboratory information management system (LIMS). The LIMS automatically compares the data (both the analytical result and the QC measurements) to a range of acceptable values that DMWW has pre-programmed into the LIMS. The system flags data as suspect if they do not fall within the range. The laboratory analyst carefully reviews the data she has entered to ensure that she has not made a typographical error. The control range feature in the LIMS can help the analyst quickly identify suspect or erroneous data during her review.

After DMWW's data have been reviewed by the laboratory analyst, these data are validated by either DMWW's QA/QC officer or QA/QC supervisor. These personnel conduct their validation reviews in light of their extensive experience with the operation and control of DMWW's treatment process, historical trends in DMWW's water quality, and close communication with DMWW's treatment process operators and supervisors. Specifically, the QA/QC officer and QA/QC supervisor perform the following types of analyses:

- Compare data within the LIMS control range with hard-copy analytical results to locate any incorrectly transcribed data that may have still fallen within the LIMS control range and were therefore not detected by the laboratory analyst.
- Review records and documentation to ensure that samples were collected and nalyzed correctly.
- Review data in light of historical water quality measurements, treatment process expertise, and other known factors that may affect the values of certain parameters. During this review, the QA/QC officer or supervisor determine whether or not the data seem logical.

When his review is complete, either the QA/QC officer or the QA/QC supervisor marks validated data as "approved" in the LIMS. Because the LIMS package allows for the validation of individual analytical results, DMWW can approve one result and reject another result measured in the same sample. In some cases, DMWW may collect additional samples and/or repeat laboratory analyses to replace certain erroneous results. DMWW's data management process can take anywhere from a few hours to one week, depending on the staff available to perform the separate data reviews. Data are prioritized for review based on the significance of the results to the operation of DMWW's water treatment process.

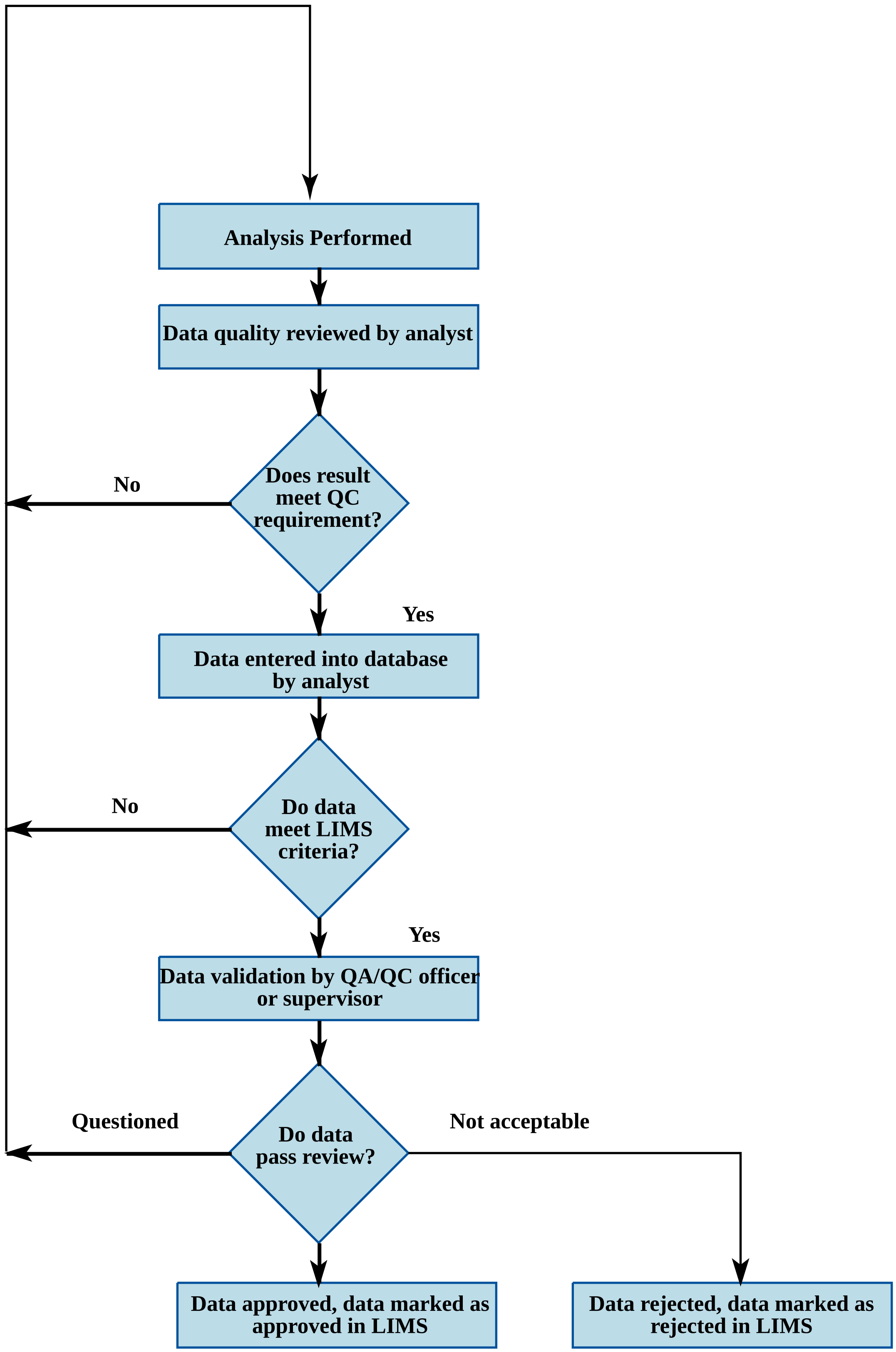
4.2.3 COMMUNICATION AND OUTREACH

DMWW follows a comprehensive plan for communication and outreach. Through this plan, DMWW uses several different mechanisms and products to convey information to the Des Moines metropolitan community. See Chapter 6 for more detailed information about DMWW's outreach plan. Some of DMWW's communications/outreach products and mechanisms are briefly introduced below.

The Monthly Newsletter: H2O Line. DMWW's monthly newsletter provides DMWW's customers with information on current issues related to drinking water and source water quality.

Annual Consumer Confidence Report. DMWW's June newsletter typically functions as a Consumer Confidence Report (CCR). The CCR, required by federal drinking water regulations, enables DMWW community residents to make practical, knowledgeable decisions

DMWW's Data Validation Process


Analysis Performed
Data quality reviewed by analyst
Does result meet QC requirement?
No
Yes
Data entered into database by analyst
Do data meet LIMS criteria?
No
Yes
Data validation by QA/QC officer or supervisor
Questioned
Do data pass review?
Not acceptable
Data approved, data marked as approved in LIMS
Data rejected, data marked as rejected in LIMS

about their health and their environment. See Chapter 3 of this handbook for more information on the CCR and the federal regulations that require its publication.

Welcome Brochure. DMWW sends a "Welcome" brochure to all of its new customers. The pamphlet contains a variety of useful introductory information, including billing and payment options, a description of DMWW's treatment process, information about the services provided by DMWW, and applicable rules/regulations.

Annual Business Report. The main goal of DMWW's annual report is to present financial information to its customers; however, DMWW also includes a few pages of educational materials in the report. The content of these materials depends on issues and concerns of the current year.

Other Outreach Mechanisms. DMWW visits area schools to teach children of all grade levels about drinking water and source water. The utility also offers tours of its facilities to school children and adults. DMWW prepares technical outreach information for conferences held by organizations such as the American Water Works Association. In addition, the utility has prepared a series of fact sheets to answer specific questions from its customers.

The DMWW Web Site. DMWW uses its Web site *(http://www.dmww.com)* to communicate a wide variety of information to the Des Moines community.

4.2.4 Software and Hardware Systems

DMWW operates an integrated collection of software packages and hardware devices designed and programmed to compile, manage, retrieve, and post data and information in support of DMWW's day-to-day operations. This integrated system consists of three general components: the database server, the firewall, and the Web server. Consider these definitions:

- **Database Server**. A database server hosts a database management system, a software package that allows users to store and modify information in a database.
- **Firewall.** A firewall is either a hardware device, a software package, or a combination of these mechanisms designed to protect internal computer systems from intentional, hostile intrusion from outside sources.
- **Web Server.** A Web server hosts a software system that allows for data delivery to outside users over the Internet or internal users over an Intranet.

These system components are briefly discussed below.

Database Server

DMWW uses a database server to support both regulatory and treatment process control requirements for data compilation and management. DMWW's database server, a Hewlett-Packard® UXTM™ workstation, hosts an Oracle™ DBMS (Version 7.3.2) to manage the utility's drinking water and source water data. The Oracle™ database is relational, which means that it allows DMWW to store data in the form of related tables. As discussed previously, DMWW also uses a laboratory information management system (LIMS) package developed by PE Nelson to support its analytical data management requirements. DMWW selected the PE Nelson LIMS package based on its ease of use, system security features, flexibility, minimal hardware and equipment requirements, and compatibility with the utility's existing Oracle™ DBMS.

A request to extract information from the database is made in the form of a query. Although different database management systems support different types of query languages, Structured Query Language (SQL) is typically considered to be the most common format for constructing queries. DMWW's Oracle™ DBMS supports SQL (PL/SQL); DMWW personnel write code in SQL to query data.

DMWW personnel perform all DBMS maintenance and management. The utility has found that this maintenance can be very time consuming. DMWW's QA/QC officer dedicates at least 30 percent of his time to maintaining and managing DMWW's DBMS; he feels that the system typically requires about 50 percent of his time. DMWW conducts daily, monthly, and annual tape backups of all data on its internal network; archived data are stored in a secure location. The utility's monthly archives are maintained for 2 years. DMWW never discards its annual archives.

Firewall

DMWW uses a Borderware™ firewall to protect its internal computer systems and Web site. A firewall examines all data traffic between two networks to determine if the traffic pattern meets certain criteria for security. If the criteria are met, the firewall allows data to flow between the networks. If the criteria are not met, the firewall halts the data transmission. A firewall can filter both inbound and outbound data traffic using a variety of filtering techniques.

Web Server

DMWW's Web server allows DMWW to serve data over the Internet using Hyper Text Markup Language (HTML), a program language used for publishing information on the Web.

DMWW's Web server hosts its Web site, which provides a location on the Internet for the utility's customers to access information. DMWW has an existing high-speed Internet connection and a fully functioning Web site to communicate with its customers.

5 DMWW'S EMPACT PROJECT

In 1998, EPA's EMPACT program funded DMWW's EMPACT project, which provides Des Moines metropolitan community residents with timely information about the factors that affect their drinking water supply. This project is designed to enhance DMWW's day-to-day operations and community outreach program, in part, through the delivery of timely drinking water and source water quality information. The project strives to encourage Des Moines residents, as well as the entire watershed community, to assume a larger role in restoring and preserving the quality of community source waters.

This chapter presents a case study of DMWW's EMPACT project. Section 5.1 discusses the project phases. Section 5.2 discusses DMWW's EMPACT project Web site.

5.1 DMWW'S EMPACT PROJECT PHASES

DMWW's EMPACT project is broken into three phases:

- Phase I is associated with the Web posting and updating of timely **drinking water** quality information.
- Phase II is associated with the Web posting and updating of timely **source water quality** information and supporting static information and documents.
- Phase III is associated with the Web posting of static results from DMWW's **urban runoff studies.**

These phases are discussed in detail below.

5.1.1 DMWW EMPACT PROJECT—PHASE I

Phase I of DMWW's EMPACT project focuses on the posting and updating of timely drinking water quality data to the EMPACT project area of DMWW's Web site. The table on page 28 presents the parameters and sampling frequencies for the Phase I data that are available on DMWW's project Web site. DMWW selected this subset of parameters based on what the utility felt would be of greatest interest to the Des Moines metropolitan community.

All drinking water data associated with the EMPACT project are validated and processed through DMWW's data management system (discussed in Chapter 4). Overall, DMWW's data management process has not been enhanced to support the utility's EMPACT project; DMWW has always required timely water quality data to effectively operate its treatment system. DMWW's EMPACT project does not directly increase or decrease the amount of time required to perform data validation; however, the implementation of the EMPACT project may in some cases require additional resources for QA/QC reviews.

All validated data are available for extraction and posting to the EMPACT project area of DMWW's Web site. Data that fail any of the data management review steps are marked as suspect or rejected; these data are not delivered to the public. Data are prioritized for review based on the significance of the results to the operation of the water treatment process. To ensure that most data are available to Web users within 1 week of collection, DMWW follows a review schedule (e.g., the QA/QC officer or supervisor plans to review data on Wednesday and Friday of each week).

PARAMETER	REGULATED‡	SAMPLING FREQUENCY
Alkalinity (Total)		Daily
Carbonate Precipitation Potential		Weekly
Calcium Hardness as $CaCO_3$		Daily
Chloride		Weekly
Chlorine (Free)	✓	Continuous online
Conductivity		Weekly
Cryptosporidium		Monthly
Fluoride	✓	Daily
Heterotrophic Plate Count Bacteria	✓	Daily
Langeliers Index		Weekly
Magnesium Hardness as $CaCO_3$		Daily
Metals (potassium, sodium, iron, manganese)		Monthly
Metals (lead, copper)	✓	Monthly
Nitrate - N	✓	Weekly/daily when near MCL
Nitrite - N	✓	Weekly
Ortho-Phosphate		Weekly
Pesticides (Metolachlor, Acetochlor, Atrazine)	✓	Weekly (April–October)
pH		Daily
Silica (Reactive)		Annually
Sulfate		Weekly
Temperature		Daily
Total Dissolved Solids (TDS)		Weekly
Total Hardness as $CaCO_3$		Daily
Total Coliforms	✓	Daily
Total Organic Carbon (TOC)		Weekly
Total Trihalomethanes	✓	Weekly
Turbidity	✓	Continuous online

‡Regulated constituents must be reported to the Iowa Department of Natural Resources (IDNR) as part of a regular compliance program. Unregulated constituents are monitored for general water quality and treatment process information but not reported to the IDNR.

Timely data for these drinking water quality constituents are available on the EMPACT project area of DMWW's Web site.

VALIDATING TIMELY DATA

The analysis of drinking water is well regulated and conducted by certified laboratories using EPA-approved methods. A very important part of the data management process is data validation, which must occur before drinking water sample results can be considered final and ready for public release. The reason for this part of the process is to avoid the unnecessary public concern that would occur if invalid positive results were released and then found to be incorrect. For most parameters, the data validation process can occur in only a few days. Thus, in this context, timely data is that which minimizes the time between the generation of validated sample results and the availability of these results to the public. Typically, the time between sampling drinking water and providing the validated sampling results to the public can range from a few days to a maximum of 3 weeks.

To increase the timeliness of water quality data available to the Des Moines community, DMWW could post "provisional" data to the EMPACT project area of its Web site shortly after laboratory analysis. Although provisional data have met the QA/QC requirements for sample collection and laboratory analysis, these data are not validated. DMWW has chosen not to post provisional data to its Web site because the utility feels that the potential disadvantages of posting erroneous data (e.g., causing unnecessary community alarm) outweigh the advantages of increasing the timeliness of these data.

During the design and construction of Phase I, DMWW dedicated its resources to developing the data delivery approach, technical systems, and communications/outreach goals required to support all phases of its EMPACT project. DMWW spent approximately 2 years completing the design and construction of Phase I.

During the design of the data delivery approach and technical systems, DMWW analyzed its hardware and software systems to determine the utility's existing technical resources and expertise, identify the key technical issues to be addressed during EMPACT project design, and identify potential technical challenges. After fully evaluating its existing systems, DMWW chose to dedicate a significant portion of its EMPACT project funding to support the skilled technical labor (both internal and external) necessary create a new DMWW EMPACT project area on the utility's existing Web site and build the mechanisms necessary to deliver timely data to that site.

First, DMWW replaced its existing Web server. The new server runs Microsoft® Internet Information Server (IIS) 4.0™. DMWW selected Microsoft® IIS 4.0™ because it provides the utility with a platform for building more sophisticated Internet applications. At first, DMWW attempted to create an electronic link from the new Web server to its existing Oracle™ database. However, this link proved to be both unreliable and inefficient. DMWW suspects that these issues arose due to certain differences in communication between the Oracle™ and Microsoft® systems. To resolve these differences, DMWW converted an existing SQL Server database into a staging area for the data and electronically linked this database to the Web server. Each night, approved data are extracted from DMWW's Oracle™ database and stored in the SQL Server database. When a user requests information from the EMPACT project area on DMWW's Web site, these data are pulled from the SQL Server database. See Section 5.2 for more information on DMWW's Web site.

In some ways, DMWW's decision to modify some of its existing technical components conserved funding and resources: DMWW was not required to purchase many significant pieces of hardware and software to support its EMPACT project. In other ways, DMWW's decision resulted in some challenges: DMWW and its contractors were required to dedicate extra resources to closely examine and redesign specific features of the existing technical components to create a fully functional and compatible data delivery system.

While designing the data delivery system, DMWW considered its available technical resources (both internal and external) to support not only the design and development of the system but also the long-term implementation of the system. DMWW's project phasing approach allowed the utility to dedicate a portion of its internal technical resources to the EMPACT project while the utility conducted other important non-EMPACT information systems tasks (such as ensuring the Y2K compliance of DMWW's computer systems).

5.1.2 DMWW's EMPACT Project—Phase II

When Phase I of DMWW's EMPACT project was fully implemented, DMWW and its technical contractors modified the Phase I system to support the Phase II delivery of timely source water quality data to community residents. DMWW then dedicated its available technical resources to post key pieces of static data to the EMPACT project area on the utility's Web site to fully implement the subsequent components of Phase II.

Phase II includes the following three components:

- Component I focuses on the posting and updating of timely source water quality data to the EMPACT project area on DMWW's Web site. The complete implementation of this component took only a few weeks because it uses the data delivery approach and technical systems developed for Phase I.
- Through Component II, DMWW places its annual CCR on its Web site. DMWW's CCR enables Des Moines metropolitan community residents to make practical, knowledgeable decisions about their health and their environment. Refer to Chapter 6 for more information on DMWW's CCR, and refer to Chapter 3 for more information on the federal regulations that require its publication.
- Component III provides relevant data extracted from the Iowa Department of Natural Resources (IDNR) source water assessment program (SWAP), which was developed in compliance with Section 1453 of the Safe Drinking Water Act (SDWA). See Chapter 3 for more information on the SWAP and the SDWA.

The table on page 31 presents the parameters and sampling frequencies for the Phase II data available on the EMPACT project area of DMWW's Web site. DMWW selected this subset of parameters based on what the utility felt would be of greatest interest to the Des Moines metropolitan community.

Through the execution of Phase II of its EMPACT project, DMWW procured and installed two early-alert source water monitoring stations at the Racoon River intake and the Des Moines River intake. DMWW uses these monitoring stations to provide treatment plant operators with as much warning as possible when rapid changes in source water quality warrant immediate modifications to the drinking water treatment process. Each early-alert monitoring station contains four Hach® water analyzers to monitor nitrate, ammonia, pH, and turbidity.

Using the early-alert analyzers, DMWW collects and analyzes source water samples for nitrate every 2.5 minutes, samples for ammonia every 7.5 minutes, and samples for pH and turbidity continuously. The analyzers are currently programmed to collect and analyze samples at their maximum frequencies; however, DMWW may consider decreasing the monitoring frequency to reduce costs in the future. The early-alert analyzers are connected, with other treatment process control monitors, to DMWW's SCADA system. Data from these analyzers are not available on the EMPACT area of DMWW's Web site.

PARAMETER	SAMPLING FREQUENCY
Alkalinity (Total)	5/week
Ammonia - N	Weekly*
Calcium Hardness as $CaCO_3$	5/week
Chloride	Weekly
Cryptosporidium	Monthly
E. coli	5/week
Fluoride	Weekly
Heterotrophic Plate Count Bacteria	5/week
Magnesium Hardness as $CaCO_3$	5/week
Metals (potassium, sodium, iron, manganese, lead, copper)	Weekly
Nitrate - N	Weekly/daily when near MCL*
Ortho-Phosphate	Weekly
Pesticides (Metolachlor, Acetochlor, Atrazine)	Weekly (April - October)
Sulfate	Weekly
Temperature	5/week
Total Hardness as $CaCO_3$	5/week
Total Coliforms	5/week
Total Organic Carbon (TOC)	Weekly
Turbidity	5/week*

Timely data for these source water quality constituents are available on the EMPACT project area of DMWW's Web site.

*Note: Frequencies marked with an asterisk are for manual monitoring only. These parameters are monitored on a more frequent basis using automatic analyzers. Only the manual monitoring data are available on the EMPACT area of DMWW's Web site.

DMWW has found that maintenance of the Hach® early-alert analyzers can be very time-consuming. During the spring and summer, DMWW must repeatedly clean mud from the analyzers due to the seasonal turbidity increase in area source water rivers. The utility spends at least 1 hour per day cleaning and maintaining the analyzers at each station during this part of the year. During the fall and winter, the utility spends about 1 hour every 2 weeks maintaining the analyzers at each station.

HACH® ANALYZER	WATER QUALITY PARAMETER
APA 6000	Nitrate
APA 6000	Ammonia
EC 310	pH
Surface Scatter 6	Turbidity

The Hach® APA 6000 Series Analyzer.

EC 310
5.77
24.8C

The Hach® EC 310™ pH Monitor.

The Hach® Surface Scatter 6 Turbidimeter

The nitrate and ammonia analyzers are self-calibrating; DMWW reviews the calibration periodically. DMWW manually calibrates the pH and turbidity analyzers each month. Because the Hach® analyzers are modular instruments, DMWW can repair the analyzers on site simply by removing and replacing the broken part. DMWW keeps a large supply of spare parts on site to support routine and emergency replacements.

THE CHALLENGES OF REAL-TIME QA/QC

The data provided by the early-alert analyzers have allowed DMWW to become more proactive in modifying its treatment process in response to sudden changes in source water quality. However, DMWW is still developing a QA/QC protocol for using these analyzers. When an early-alert analyzer indicates a sudden change in source water quality, DMWW water production personnel immediately collect and analyze a manual sample to verify the reading for that parameter. However, when the analyzers indicate a very large change in source water quality, DMWW personnel sometimes modify the water treatment process prior to verifying the analyzer reading. To develop a continuing log of accuracy measurements, DMWW programs its analyzers to collect periodic quality samples. For every seven source water samples analyzed, the analyzer will collect one sample from a separate intake line that DMWW has connected to a sample of water with a known quantity of parameters. DMWW periodically checks the results of the QC sample to ensure the accuracy of the analyzer readings. With time, DMWW hopes to decrease the amount of manual and QC samples it takes to verify the accuracy of its early-alert analyzers.

5.1.3 DMWW'S EMPACT PROJECT—PHASE III

Through the execution of Phase III of its EMPACT project, DMWW will post the results from its urban runoff studies to the EMPACT project area of its Web site to enable its customers to observe the effects of urban watersheds on the quality of their drinking water. As discussed in Chapter 4, the urban runoff studies attempted to determine the microbial and chemical influences of main urban creek watersheds on the utility's source waters. DMWW expects to post the results of these studies on its Web site by spring 2002.

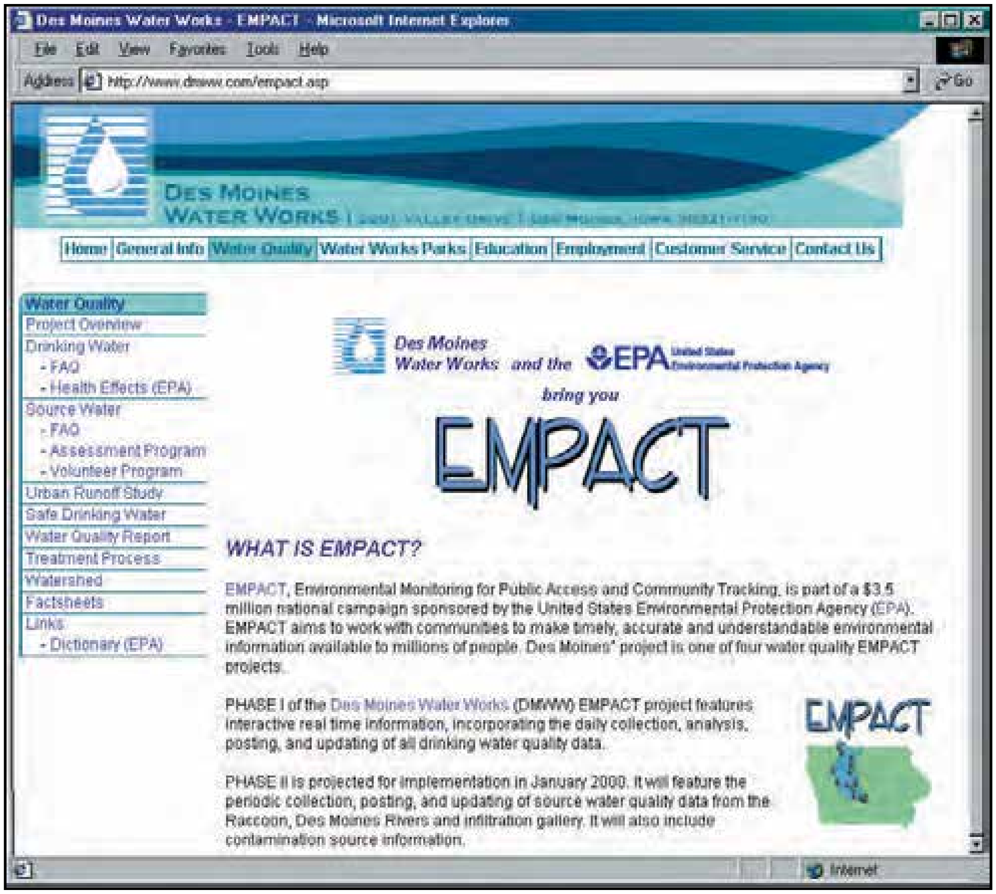
When Phase III of the EMPACT project has been fully implemented, DMWW will dedicate its available technical resources to operating, maintaining, and periodically enhancing its EMPACT project data delivery system and Web site, while continuing to support other important day-to-day information systems tasks (such as redesigning the utility's electronic billing system).

5.2 DMWW'S EMPACT PROJECT WEB SITE

Because DMWW's EMPACT project phases represent unique topics and different implementation schedules, the EMPACT project area on DMWW's Web site is organized around these phases.

The EMPACT project area on DMWW's Web site is located at *http://www.dmww.com/empact.asp.* This site provides the following:

- An answer to the question, "What is safe drinking water?"
- Answers to frequently asked questions about drinking water and source water.
- A diagram of DMWW's drinking water treatment process.


Des Moines Water Works - EMPACT - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.dmww.com/empact.asp
Go
Des Moines Water Works
Home | General Info | Water Quality | Water Works Parks | Education | Employment | Customer Service | Contact Us
Water Quality
Project Overview
Drinking Water
- FAQ
- Health Effects (EPA)
Source Water
- FAQ
- Assessment Program
- Volunteer Program
Urban Runoff Study
Safe Drinking Water
Water Quality Report
Treatment Process
Watershed
Factsheets
Links
- Dictionary (EPA)
Des Moines Water Works and the EPA United States Environmental Protection Agency
bring you
EMPACT
EMPACT
Internet

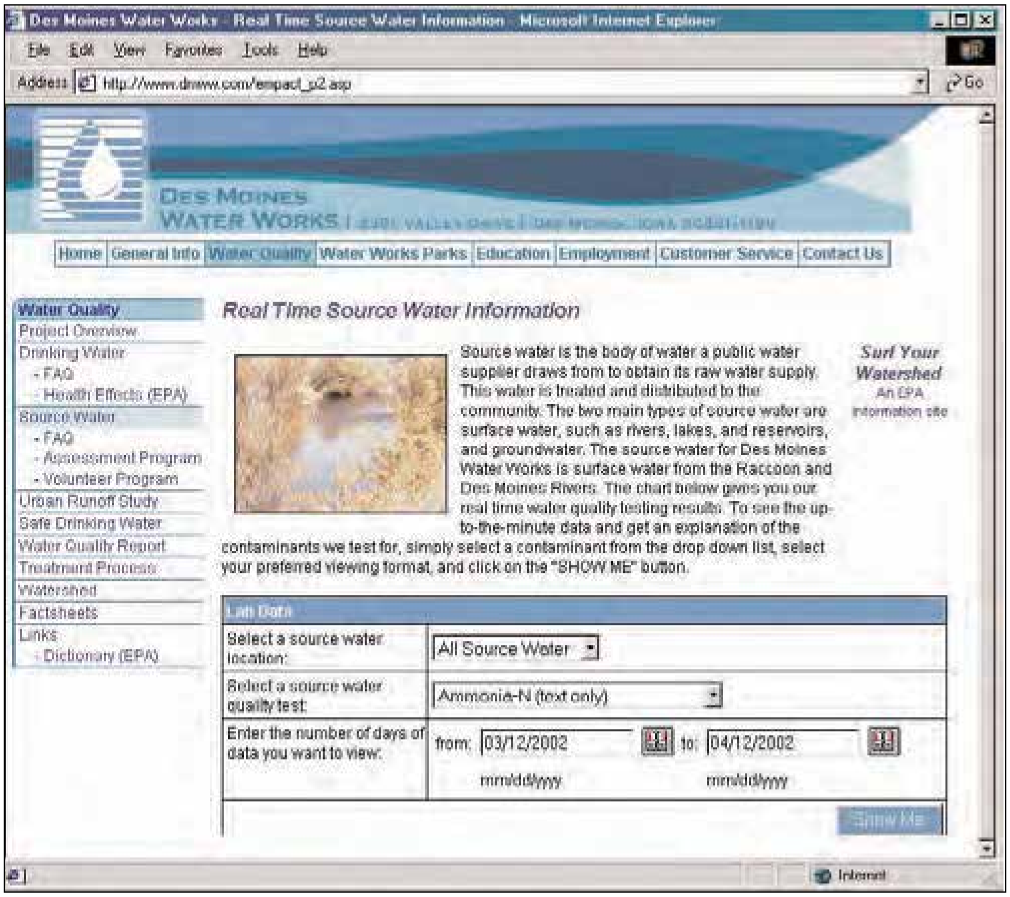
WHAT IS EMPACT?

EMPACT, Environmental Monitoring for Public Access and Community Tracking, is part of a $3.5 million national campaign sponsored by the United States Environmental Protection Agency (EPA). EMPACT aims to work with communities to make timely, accurate and understandable environmental information available to millions of people. Des Moines' project is one of four water quality EMPACT projects.

PHASE I of the Des Moines Water Works (DMWW) EMPACT project features interactive real time information, incorporating the daily collection, analysis, posting, and updating of all drinking water quality data.

PHASE II is projected for implementation in January 2000. It will feature the periodic collection, posting, and updating of source water quality data from the Raccoon, Des Moines Rivers and infiltration gallery. It will also include contamination source information.

The EMPACT project area on the DMWW's Web site.


Des Moines Water Works - Real Time Source Water Information - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Go
Des Moines Water Works
Home
General Info
Water Quality
Water Works Parks
Education
Employment
Customer Service
Contact Us
Water Quality
Project Overview
Drinking Water
- FAQ
- Health Effects (EPA)
Source Water
- FAQ
- Assessment Program
- Volunteer Program
Urban Runoff Study
Safe Drinking Water
Water Quality Report
Treatment Process
Watershed
Factsheets
Links
- Dictionary (EPA)
Surf Your Watershed
An EPA information site
Show Me
Internet

Address: http://www.dmww.com/empact_s2.asp

Real Time Source Water Information

Source water is the body of water a public water supplier draws from to obtain its raw water supply. This water is treated and distributed to the community. The two main types of source water are surface water, such as rivers, lakes, and reservoirs, and groundwater. The source water for Des Moines Water Works is surface water from the Raccoon and Des Moines Rivers. The chart below gives you our real time water quality testing results. To see the up-to-the-minute data and get an explanation of the contaminants we test for, simply select a contaminant from the drop down list, select your preferred viewing format, and click on the "SHOW ME" button.

Lab Data	
Select a source water location:	All Source Water
Select a source water quality test:	Ammonia-N (text only)
Enter the number of days of data you want to view:	from: 03/12/2002 to: 04/12/2002 mm/dd/yyyy mm/dd/yyyy

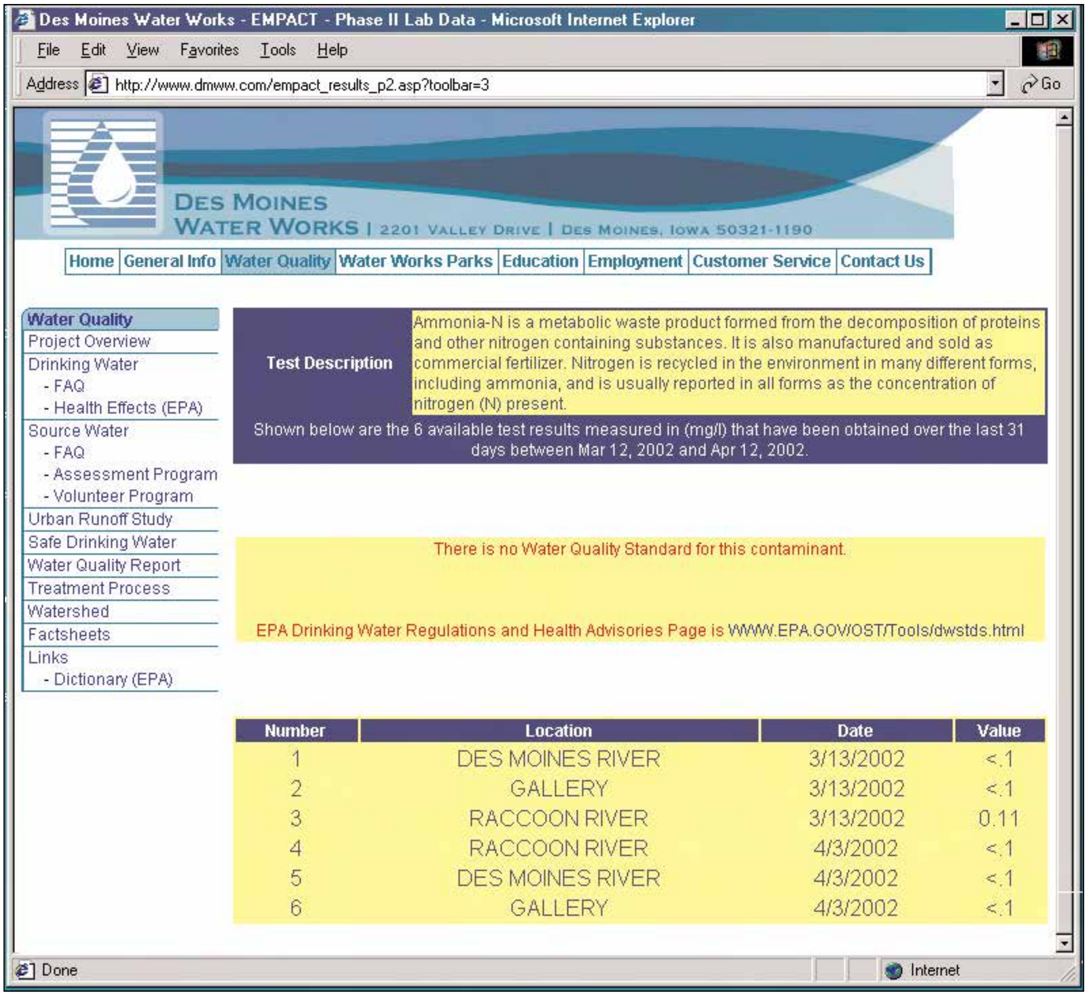
A user can request source water data from the EMPACT project area on DMWW's Web site.

- Information about the Des Moines River and Raccoon River watersheds.
- The DMWW service map.
- The most recent annual Consumer Confidence Report (CCR).
- An overview of the DMWW EMPACT project and descriptions of project Phases I, II, and III.
- Timely data on the presence and/or quantity of specific parameters found in Des Moines drinking water or source water.

From this site, Des Moines community residents can request timely water quality information from two links: Phase I—Drinking Water Information and Phase II—Source Water Information. Users can learn about the presence and/or quantity of specific parameters found in their drinking water or source water by selecting the parameter from a drop-down list of options.

From the user's computer, a data request works like this:

- The user selects a specific analytical parameter from a drop-down list.
- The user selects the desired range of sampling dates for that particular parameter. If the user does not specify a date, the Web site automatically defaults to a range beginning 1 month prior to the present date.
- The user clicks the "Show Me" button.


Des Moines Water Works - EMPACT - Phase II Lab Data - Microsoft Internet Explorer
File
Edit
View
Favorites
Tools
Help
Address
http://www.dmww.com/empact_results_p2.asp?toolbar=3
Go
DES MOINES WATER WORKS | 2201 VALLEY DRIVE | DES MOINES, IOWA 50321-1190
Home
General Info
Water Quality
Water Works Parks
Education
Employment
Customer Service
Contact Us
Water Quality
Project Overview
Drinking Water
- FAQ
- Health Effects (EPA)
Source Water
- FAQ
- Assessment Program
- Volunteer Program
Urban Runoff Study
Safe Drinking Water
Water Quality Report
Treatment Process
Watershed
Factsheets
Links
- Dictionary (EPA)
Done
Internet

Test Description Ammonia-N is a metabolic waste product formed from the decomposition of proteins and other nitrogen containing substances. It is also manufactured and sold as commercial fertilizer. Nitrogen is recycled in the environment in many different forms, including ammonia, and is usually reported in all forms as the concentration of nitrogen (N) present.

Shown below are the 6 available test results measured in (mg/l) that have been obtained over the last 31 days between Mar 12, 2002 and Apr 12, 2002.

There is no Water Quality Standard for this contaminant.

EPA Drinking Water Regulations and Health Advisories Page is WWW.EPA.GOV/OST/Tools/dwstds.html

Number	Location	Date	Value
1	DES MOINES RIVER	3/13/2002	<.1
2	GALLERY	3/13/2002	<.1
3	RACCOON RIVER	3/13/2002	0.11
4	RACCOON RIVER	4/3/2002	<.1
5	DES MOINES RIVER	4/3/2002	<.1
6	GALLERY	4/3/2002	<.1

Requested source water data are presented to the user in a table on a results page.

At DMWW, the data retrieval process works like this:

- DMWW's Web server accepts the user's request in the form of HTML and repackages the request into SQL.
- The Web server sends the SQL request through the firewall.
- Inside the firewall, the SQL request is processed by DMWW's SQL Server, and the requested validated data are extracted from the staging database. Recall that DMWW uploads data from the LIMS/OracleTM database to the SQL Server database nightly.
- The extracted data are sent back through the firewall to the Web server.
- The Web server formats the data and displays a results page.

The results page contains the following features:

- A brief, succinct description of the selected parameter.
- An explanation of the data returned by the user's inquiry.

- The MCL and Maximum Contaminant Level Goal (MCLG) established by EPA for that parameter (applicable only to the drinking water page).
- A link to EPA's Drinking Water Regulations and Health Advisories page for more information about the health effects related to that parameter.
- A tabular or graphical representation of the data.
- A link to EPA's Drinking Water Regulations and Health Advisories page: *http://www.epa.gov/safewater/mcl.html* for information about the health effects of certain parameters in drinking water.
- Links to other Web sites providing information consistent with the topic and message of DMWW's EMPACT site.
- A link to EPA's "Terms of Environment" site *http://www.epa.gov/OCEPAterms*.
- A link that allows the customer to send an email to DMWW.

PLUG-INS

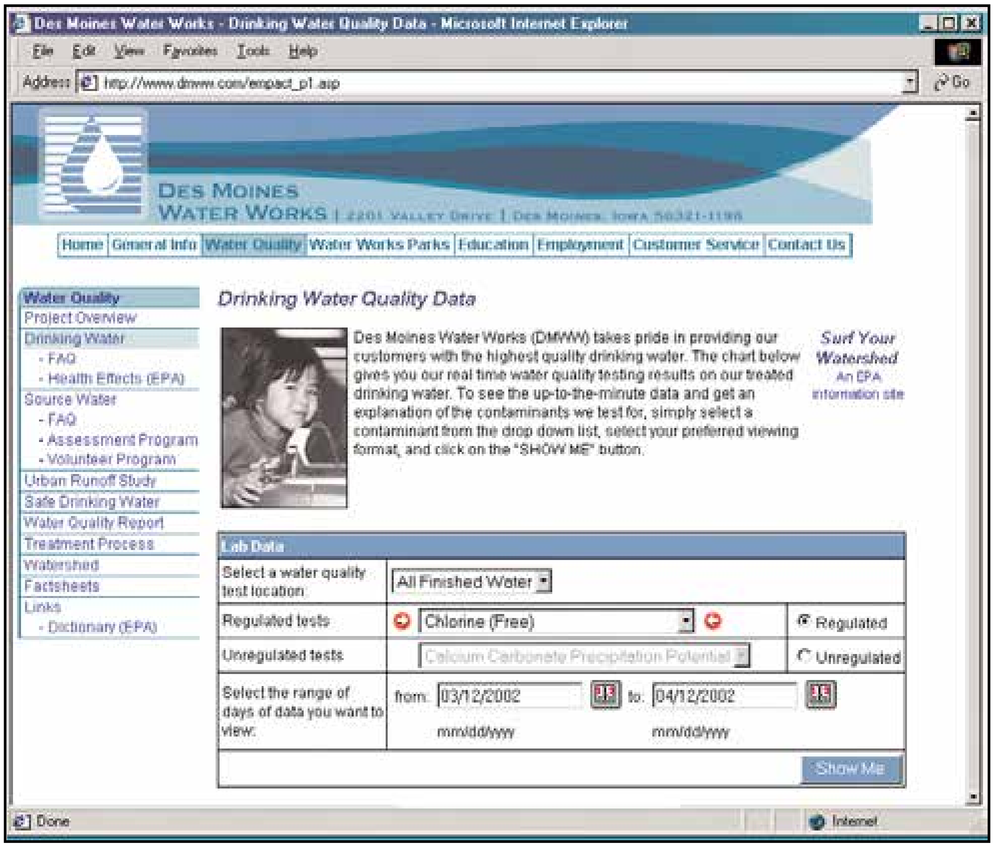
A "plug-in" is a software module that works along with an Internet browser to add a specific feature to a Web site. For example, a plug-in can allow users to listen to music or view videos on a Web site. If a Web site requires a plug-in to execute a specific feature, users must download the plug-in program to experience that feature. DMWW selected a software package, Chart FX™, to display certain pieces of requested data in a chart format on the EMPACT project area of its Web site. To use this feature, users must download Chart FX™ (a "plug-in"). The first time a user requests charted data from his or her personal computer, the Web site displays a "warning" asking the user to agree to download the plug-in. The Internet browser then guides the user through the downloading process. The user is required to download the plug-in only once; the user's computer will automatically access the plug-in for viewing charts in the future.

DMWW feels that this plug-in increases the number of options for viewing data on the site, thereby enhancing the user-friendliness of the site. Although DMWW could program its site to display charts, the plug-in allows DMWW to offer this feature without dedicating valuable resources to formatting data. DMWW has found that many of its customers are comfortable and familiar with plug-ins; the utility has received only a few questions and concerns about the requirement to download this module.

The EMPACT project area on DMWW's Web site is programmed to present data in either a table or a chart. The table format allows the user to view individual analytical results for a selected parameter measured on selected dates at selected sampling locations. The chart format allows the user to view and compare analytical results for a selected parameter over the entire range of selected dates and sampling locations. The charting function also allows the user to view information about a specific data point (e.g., parameter concentration, sample collection date, and sample description) by holding the cursor over that data point in the chart.

5.2.1 Designing the Web Site

The designers of the EMPACT project area on DMWW's Web site included water treatment and laboratory personnel, information systems personnel, technical contractors, and a communications specialist. This team found the design process to be iterative. The team's design initially focused on answering the following question: "Is my drinking water safe?" However, when the initial design


Des Moines Water Works - Drinking Water Quality Data - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.dmww.com/empact_p1.asp
Go
DES MOINES WATER WORKS | 2201 VALLEY DRIVE | DES MOINES, IOWA 50321-1190
Home
General Info
Water Quality
Water Works Parks
Education
Employment
Customer Service
Contact Us
Water Quality
Project Overview
Drinking Water
- FAQ
- Health Effects (EPA)
Source Water
- FAQ
- Assessment Program
- Volunteer Program
Urban Runoff Study
Safe Drinking Water
Water Quality Report
Treatment Process
Watershed
Factsheets
Links
- Dictionary (EPA)
Surf Your Watershed
An EPA information site
Show Me
Done
Internet

Drinking Water Quality Data

Des Moines Water Works (DMWW) takes pride in providing our customers with the highest quality drinking water. The chart below gives you our real time water quality testing results on our treated drinking water. To see the up-to-the-minute data and get an explanation of the contaminants we test for, simply select a contaminant from the drop down list, select your preferred viewing format, and click on the "SHOW ME" button.

Lab Data

Select a water quality test location:	All Finished Water	
Regulated tests	Chlorine (Free)	● Regulated
Unregulated tests	Calcium Carbonate Precipitation Potential	○ Unregulated
Select the range of days of data you want to view:	from: 03/12/2002 mm/dd/yyyy to: 04/12/2002 mm/dd/yyyy	

The EMPACT project area on DMWW's Web site. Note the simple instructions (in the center frame) and explained links (in the right frame) for beginners and the direct links for experienced users (in the left frame).

was reviewed, the team determined that a simple answer to this question would not necessarily benefit DMWW's customers. The team also considered that this question cannot always be answered simply. For example, when DMWW measured high levels of nitrate in its treated drinking water in 1999, the utility felt that customers should have access to detailed information about the condition of the water due to the increased risk of "blue baby syndrome" (methemoglobinemia) to infants under 6 months of age. However, DMWW could not simply answer "no" to the above question because nitrate levels in the water never exceeded the legal limits (MCLs) established for nitrate. (Refer to Chapter 3 of this handbook for public notification requirements and additional information on the regulation of drinking water.)

WEB SITE DESIGN AND CONSTRUCTION OPTIONS

There are many software packages available to assist you with designing and constructing your Web site. These programs prompt you to design your Web pages in desktop publishing format and automatically convert your designs into HTML. These programs can greatly simplify Web page design and construction for inexperienced users. However, DMWW relied only partially on these tools–a large amount of automatically generated code can increase the complexity of a site's technical architecture. DMWW used Microsoft® FrontPage™ to create a conceptual design of the EMPACT project area on its Web site; the utility then passed these conceptual designs over to its technical contractor, who coded this area of the site based on the design proofs.

After reviewing the initial design, DMWW moved to a news-style design format with water quality data charting options prominently featured on both the drinking water and source water portions of the site. The team decided to address drinking water and source water on separate areas of the site because the information and messages associated with these water types differ greatly. The news-style design format allows DMWW to address water quality issues currently of interest to the media on the "front page" of the EMPACT project area on its Web site. DMWW feels that the current design of its site provides customers with direct access to important information while ensuring user friendliness, functionality, and user confidence in the information provided.

The EMPACT project area of DMWW's Web site is designed to keep written content brief, succinct, informative, and enhanced with illustrations. To maintain the attention and interest of the user, the site provides "quick hits" of written information followed by graphical representations of applicable data. DMWW feels that one of its biggest communication challenges is making sure that the timely water quality information presented on the Web is not too technical for the average audience member. When deciding on the content and technical detail to include on the site, DMWW was careful to avoid re-creating information that could already be accessed via links to other sites.

DMWW's Web site design included common navigational features (drop-down lists, radio buttons, dialogue boxes, and action buttons) that are familiar to Web users. DMWW felt that these features would make users more comfortable with navigating about the site. Also, by incorporating these common features, DMWW controlled user request options, streamlining data requests with available data to reduce error messages and user frustration. By making direct links constantly accessible on the site's left frame, DMWW organized the site to make navigational options simple and logical. The team also ensured that all links for additional information were related to the concept and purpose of the site to avoid leading users away from the site's topic and message.

Early in the design planning of DMWW's EMPACT site, the team realized that users would need to scroll down to fully view data charts. The team felt that this requirement diminished the overall effect of the results display, so the team had the page reconstructed to remove the DMWW EMPACT header when data results and charts are displayed. The trade-off, however, is that results are depicted on a separate Web page, and users must use the browser's "back" button (rather than a site link) to return to the previous page and continue navigation through the site.

DMWW designed the EMPACT project area of its Web site to be fairly complex. The project area includes several Web pages and offers different options for timely data requests and display. Many different SQL statements are required to support these options. The Web pages in the EMPACT project area are designed in framed format. Although this format simplified the initial technical design of the project area, DMWW feels that the frames now limit certain modifications to the look and organization of this area on the Web site.

To quantify the effectiveness and overall success of the EMPACT project area on its Web site, DMWW uses the following measurements:

- Total number of visits to the site.
- Visit patterns vs. time of day.
- The number of visits made by each type of user.
- Customer surveys.
- Customer feedback from the Web site.

LESSON LEARNED: USING CONTRACTORS

DMWW's first Web contractor went out of business during the design and construction of the EMPACT project area of DMWW's Web site. DMWW hired a second Web contractor to move ahead with the design and construction. In light of project resource and schedule constraints, DMWW chose to move ahead with the frame format initiated by the first contractor. DMWW feels that this format currently limits some of its options for revising the Web design. Eventually, the utility would like to eliminate the frames from the EMPACT project area of its Web site.

It is important for a utility to require detailed and thorough written documentation of the work performed by contractors, especially when the utility plans to use internal personnel to implement technical systems that have been developed by its contractors.

FEEDBACK

DMWW receives feedback on its Web site through its e-mail system. Most of the feedback regarding the EMPACT project area on DMWW's Web site has been positive and congratulatory in nature. Many times, customers request additional or more detailed information about a specific topic after having visited the Web site in search of basic information. DMWW sees this trend as a very positive sign that it is reaching out to its customers and sparking a new level of interest in community water quality–especially source water quality. DMWW has received some negative feedback as well. Some customers have asked to see more detailed technical information posted on DMWW's site, but DMWW feels that responding individually to requests for more information is the best way to ensure that the Web site is reaching out to the average member of its target audience.

A water utility in Sydney, Australia had some specific technical questions about the EMPACT project area on DMWW's Web site. After repeated communications with DMWW, the Sydney Water System is in the process of constructing a similar Web site for disseminating timely water quality data to its customers!

6 COMMUNICATING DRINKING WATER AND SOURCE WATER QUALITY INFORMATION

Even the best programs and systems for data collection/analysis, data management, and data delivery won't ensure project success unless information has been accurately and effectively communicated with community residents and consumers. This chapter discusses DMWW's communication/outreach program. For general guidance on creating an outreach plan and a list of resources you can use to enhance your outreach efforts, see Appendix D.

6.1 OUTREACH PLAN

At DMWW, a communications specialist coordinates and leads all outreach efforts. She works closely with DMWW's experts in water quality and information systems to implement the utility's outreach plan.

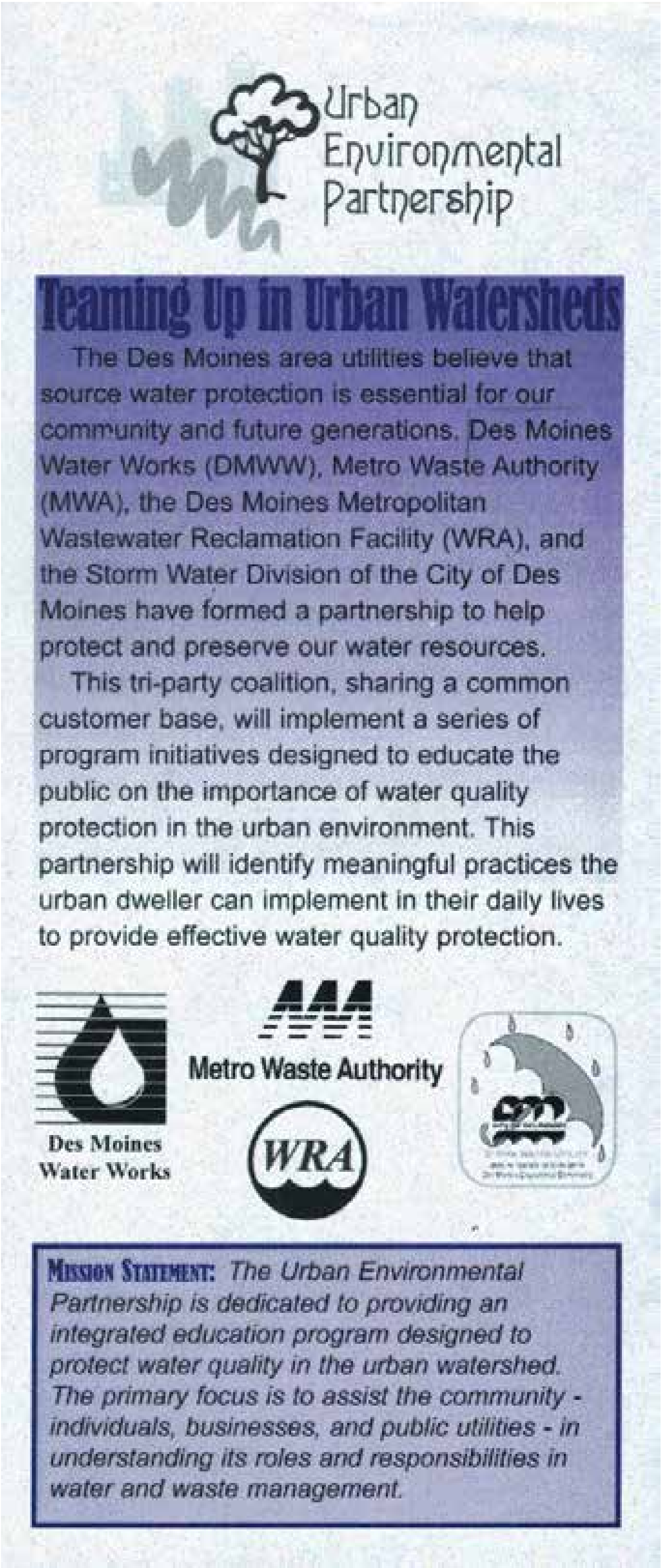
DMWW has an ongoing partnership with three municipal organizations in Des Moines: Metro Waste Authority, the Des Moines Metropolitan Wastewater Reclamation Facility, and the Storm Water Division of the City of Des Moines. DMWW and these organizations have joined to form the Urban Environmental Partnership. The partnership will implement a series of cooperative outreach efforts to communicate the importance of water quality protection in the urban environment. Working together, they avoid duplicating outreach efforts, increase their resources, and reach a greater number of people with their cohesive outreach message. The partnership is advertised with a flyer.

DMWW also partnered with the Natural Resources Conservation Service to offer a watershed tour that provided information about existing voluntary programs for watershed conservation and efforts to reduce nitrate in agricultural runoff. In addition, DMWW is partnering with Pheasants Forever, a group that promotes environmental responsibility as a way to conserve recreational opportunities like hunting. This partnership strives to communicate the importance of environmental responsibility to children in Des Moines.

The overall goal of DMWW's outreach program is to educate all members of the Des Moines community. DMWW is currently running a public relations campaign called "DMWW: Your Pipeline to Water Information." Through this campaign, DMWW is teaching its customers that the utility's purpose is not only to provide them with clean, safe drinking water but also to respond to any questions or concerns they may have about their drinking water and source water.

DMWW tailors many of its outreach efforts to fulfill the overall goal of the information pipeline campaign. Here are some examples of DMWW's specific outreach goals:

1. Provide Des Moines community residents with information on current issues related to drinking water and source water quality.
2. Enable Des Moines community residents to make practical, knowledgeable decisions about their health and their environment.
3. Present DMWW business and financial information to its customers.
4. Provide Des Moines community residents with convenient access to timely drinking water and source water quality information.



Urban Environmental Partnership

Teaming Up in Urban Watersheds

The Des Moines area utilities believe that source water protection is essential for our community and future generations. Des Moines Water Works (DMWW), Metro Waste Authority (MWA), the Des Moines Metropolitan Wastewater Reclamation Facility (WRA), and the Storm Water Division of the City of Des Moines have formed a partnership to help protect and preserve our water resources.

This tri-party coalition, sharing a common customer base, will implement a series of program initiatives designed to educate the public on the importance of water quality protection in the urban environment. This partnership will identify meaningful practices the urban dweller can implement in their daily lives to provide effective water quality protection.

Mission Statement: *The Urban Environmental Partnership is dedicated to providing an integrated education program designed to protect water quality in the urban watershed. The primary focus is to assist the community - individuals, businesses, and public utilities - in understanding its roles and responsibilities in water and waste management.*

DMWW has formed a partnership with three municipal organizations to communicate the importance of water quality protection in the urban area.

DMWW's broad and diversified target audience includes the entire Des Moines community. DMWW has divided its audience into several categories, including youngsters, students, parents, senior citizens, new customers, business owners, and various organizations. DMWW has become familiar with the characteristics of its audience categories by providing over 80 years of water utility service to the Des Moines metropolitan area. DMWW continues to profile its audience categories by soliciting public feedback through a variety of different mechanisms. These mechanisms are discussed in Section 6.3.

6.2 OUTREACH PRODUCTS

DMWW has developed several different outreach products to communicate with its target audience categories. Some of these products are discussed below.

THE DMWW WEB SITE

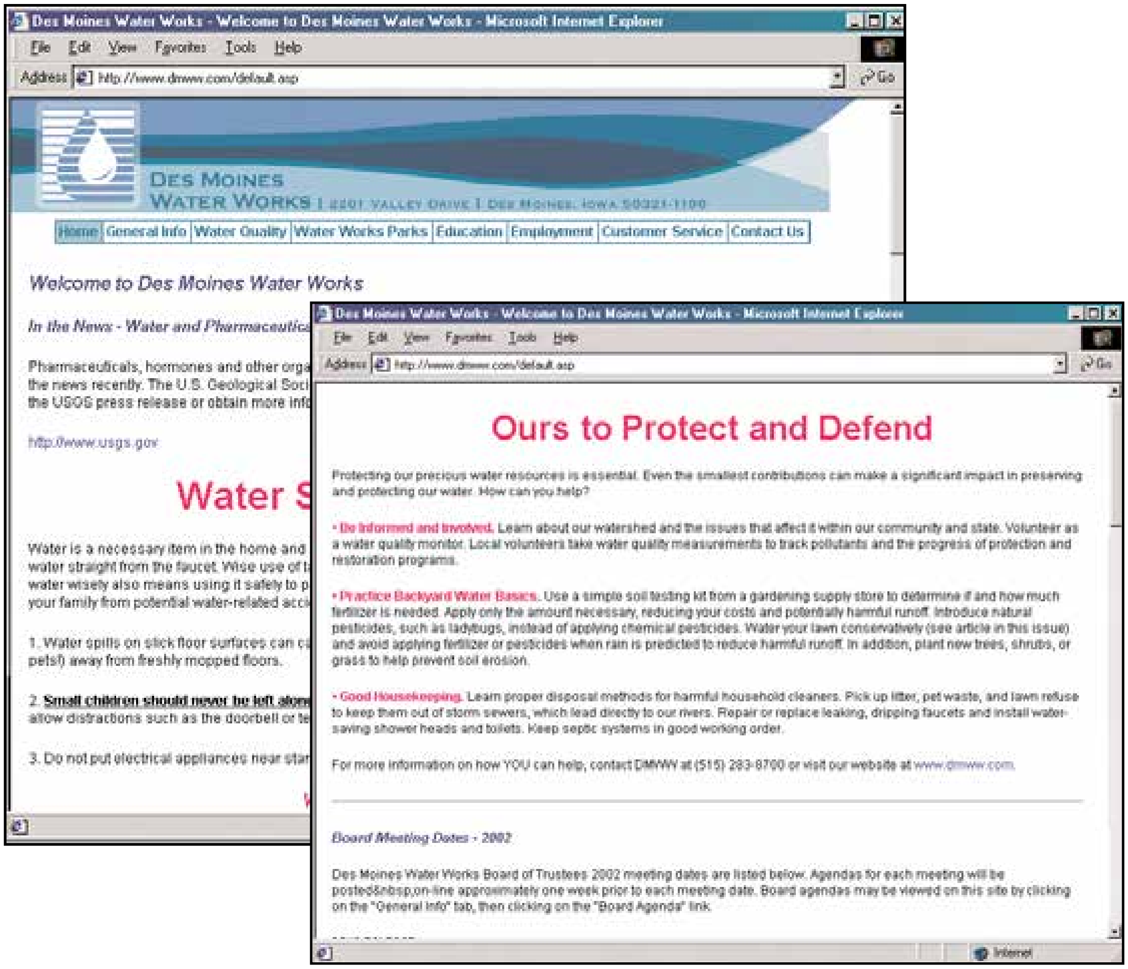
DMWW uses its Web site *(http://www.dmww.com)* to communicate a variety of information to the Des Moines community. The Web site provides community residents with convenient access to the following:

- General information about DMWW.
- Information on area parks and recreation.
- A customer service page.
- Utility engineering and construction information.
- Education for all users, from businesses and parents to teachers and students.
- Employment opportunities.
- A video clip and photos of the Des Moines flood of 1993.
- The DMWW EMPACT project area.

In response to customer requests, DMWW hopes to expand the Web services available to its customers by spring 2002.

MONTHLY NEWSLETTER: H2O LINE

DMWW's monthly newsletter provides DMWW's customers with information on current issues related to drinking water and source water quality. DMWW introduced its information pipeline campaign in its January 2001 newsletter. Subsequent newsletters have


Des Moines Water Works - Welcome to Des Moines Water Works - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.dmww.com/default.asp
Go
DES MOINES WATER WORKS | 2201 VALLEY DRIVE | DES MOINES, IOWA 50321-1190
Home
General Info
Water Quality
Water Works Parks
Education
Employment
Customer Service
Contact Us
Internet

Welcome to Des Moines Water Works

In the News - Water and Pharmaceutica

Pharmaceuticals, hormones and other orga
the news recently. The U.S. Geological Soci
the USGS press release or obtain more info

http://www.usgs.gov

Water S

Water is a necessary item in the home and
water straight from the faucet. Wise use of t
water wisely also means using it safely to p
your family from potential water-related acci

1. Water spills on slick floor surfaces can c
pets!) away from freshly mopped floors.

2. **Small children should never be left alone**
allow distractions such as the doorbell or te

3. Do not put electrical appliances near stan

Ours to Protect and Defend

Protecting our precious water resources is essential. Even the smallest contributions can make a significant impact in preserving and protecting our water. How can you help?

- **Be Informed and Involved.** Learn about our watershed and the issues that affect it within our community and state. Volunteer as a water quality monitor. Local volunteers take water quality measurements to track pollutants and the progress of protection and restoration programs.

- **Practice Backyard Water Basics.** Use a simple soil testing kit from a gardening supply store to determine if and how much fertilizer is needed. Apply only the amount necessary, reducing your costs and potentially harmful runoff. Introduce natural pesticides, such as ladybugs, instead of applying chemical pesticides. Water your lawn conservatively (see article in this issue) and avoid applying fertilizer or pesticides when rain is predicted to reduce harmful runoff. In addition, plant new trees, shrubs, or grass to help prevent soil erosion.

- **Good Housekeeping.** Learn proper disposal methods for harmful household cleaners. Pick up litter, pet waste, and lawn refuse to keep them out of storm sewers, which lead directly to our rivers. Repair or replace leaking, dripping faucets and install water-saving shower heads and toilets. Keep septic systems in good working order.

For more information on how YOU can help, contact DMWW at (515) 283-8700 or visit our website at www.dmww.com.

Board Meeting Dates - 2002

Des Moines Water Works Board of Trustees 2002 meeting dates are listed below. Agendas for each meeting will be posted on-line approximately one week prior to each meeting date. Board agendas may be viewed on this site by clicking on the "General Info" tab, then clicking on the "Board Agenda" link.

DMWW’s Web site at ***http:/www.dmww.com***

discussed the watersheds and watershed protection, the presence of nitrate in treated drinking water, and “pros and cons” of water filtering devices. DMWW’s monthly newsletters for January 2001 through April 2001 are included in Appendix A.

ANNUAL CONSUMER CONFIDENCE REPORT

DMWW’s June newsletter typically functions as a Consumer Confidence Report (CCR). The CCR, required by federal drinking water regulations, enables DMWW community residents to make practical, knowledgeable decisions about their health and their environment. See Chapter 3 of this handbook for more information on the CCR and the federal regulations that require its publication. An example of DMWW’s CCR is included in Appendix A.

WELCOME BROCHURE

DMWW sends a “Welcome” brochure to all of its new customers. The pamphlet contains information about the following topics:

- DMWW’s mission, location, business hours, and contact information.
- Billing information and payment options.
- Responsibilities of DMWW and its customers.
- Procedures for water meter readings and maintenance.

- DMWW's drinking water treatment process.
- Utility tours.
- Parks and recreation.
- Community tree plantings.
- Rules/regulations.

ANNUAL BUSINESS REPORT

The main goal of DMWW's annual report is to present financial information to its customers; however, DMWW also includes a few pages of educational materials. The content of these materials depends on issues and concerns of the current year. To encourage customers to keep its 2001 report, DMWW incorporated a note pad into the report. For 2002, DMWW has incorporated a planning calendar into the report. The calendar includes water and health facts, in addition to DMWW's contact information, on each page.

OTHER OUTREACH PRODUCTS AND TOOLS

In addition to the products and tools discussed above, DMWW uses these outreach mechanisms:

- DMWW visits area schools to teach children of all grade levels about drinking water and source water.
- DMWW offers tours of its facilities to adults and school children.
- DMWW prepares technical outreach information for conferences held by organizations such as the American Water Works Association.
- DMWW has prepared a series of fact sheets to answer specific questions from its customers. These fact sheets provide information on a wide range of topics, including the presence of alkalinity, lead and copper, nitrate, and *Cryptosporidium* in drinking water.

SPECIAL OUTREACH EFFORTS

Occasionally, DMWW will prepare outreach products to address specific issues. For example, DMWW prepared one fact sheet on how to winterize a home. The target audience for this fact sheet lived in one particular Des Moines metropolitan neighborhood. This neighborhood had a higher percentage of water pipes break during the winter months due to poor maintenance practices. Because the occupants of this neighborhood were predominantly Hispanic, DMWW had the fact sheet prepared in Spanish. The fact sheet was disseminated to neighborhood residents by DMWW service workers.

6.3 DISTRIBUTION AND FEEDBACK

DMWW uses a variety of mechanisms to distribute its outreach products. For example, DMWW's Web site is "distributed" to Web users via the Internet. Many of DMWW's newsletters, pamphlets, and fact sheets are distributed through the mail; some outreach flyers are included in customer bills. Also, through school visits, during tours of DMWW and area watersheds, and even through customer phone calls, DMWW conveys outreach messages by speaking directly with its customers.

DMWW tries to increase the longevity of many of its outreach products, thereby increasing the number of product distribution mechanisms available to the utility. For example, by making its

Annual Business Report into a notepad or a calendar, DMWW can distribute this product throughout the year not only to customers but also to visitors and convention groups.

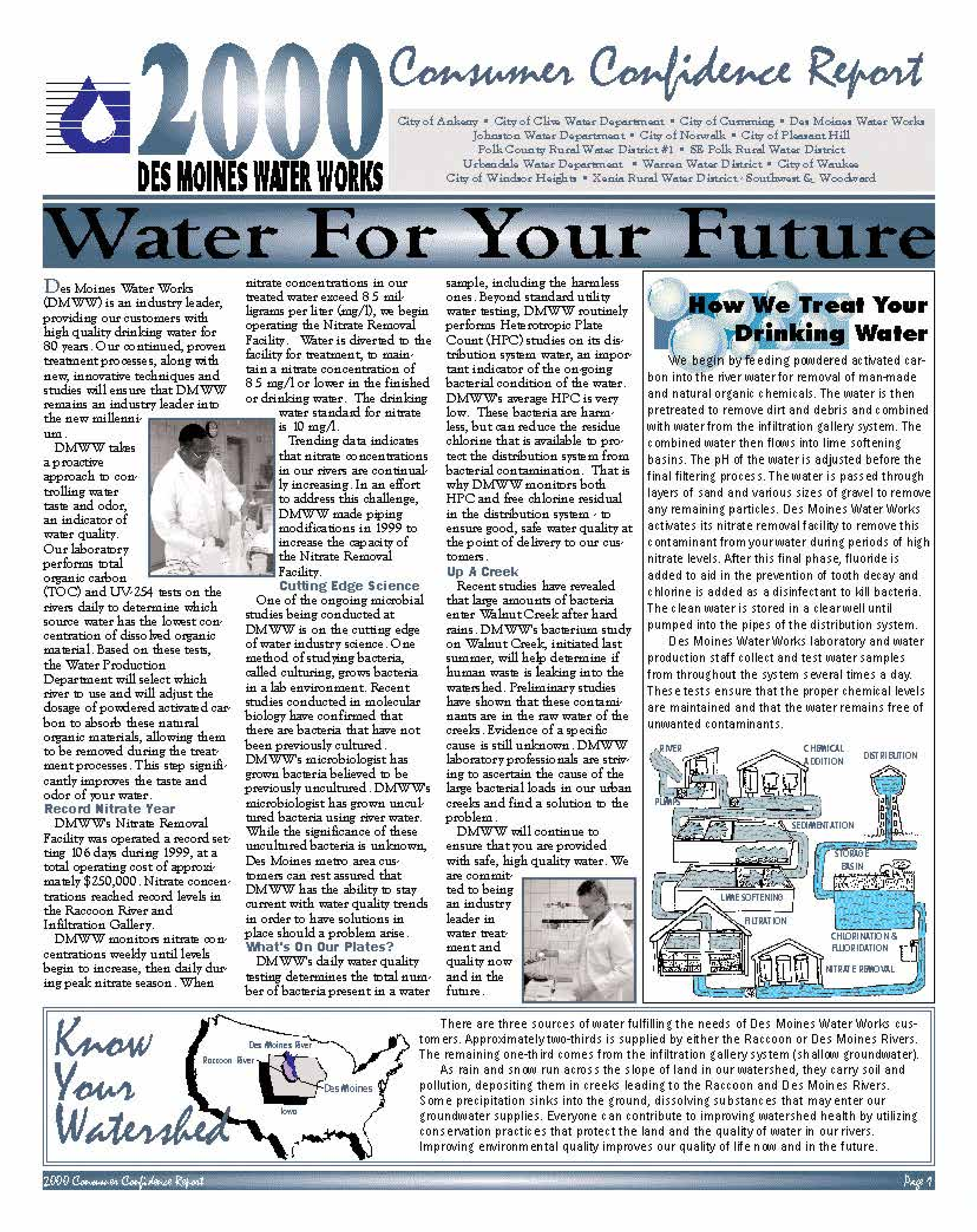
DMWW has established several mechanisms for outreach follow-up and public feedback. For example, the utility held focus group meetings to solicit customer input and feedback on DMWW's CCR. Also, through its information pipeline campaign, DMWW encourages its customers to contact the utility with any questions or concerns they have about Des Moines drinking water or source water.

FOCUS GROUP SUCCESS

DMWW conducted two focus group meetings on its CCR. The first meeting was held prior to the publication of the CCR to solicit input from customers on the ideal format and content of the report. A follow-up meeting was then held after the publication of the first CCR to solicit feedback. One of the CCR features that especially pleased this follow-up focus group was the "kids corner," which has games and activities for children. The customer feedback indicated that this tool is a very effective way to increase the longevity of the CCR and encourage parents and children to talk about Des Moines water issues.

DMWW's Web site provides customers with the option of providing feedback directly to the utility via e-mail. A central point of contact (DMWW's communications specialist) is responsible for either responding directly to the feedback or forwarding the comment, question, or request to the appropriate team member at DMWW. Technical feedback about water quality information is forwarded to the water laboratory or water production department, feedback about DMWW's history or educational opportunities is forwarded to DMWW's education specialist, and feedback about the general appearance and functionality of the Web site is forwarded to DMWW's information systems department. In all cases, DMWW responds to each customer's feedback as soon as possible.

APPENDIX A
DMWW OUTREACH MATERIALS



2000 Consumer Confidence Report

DES MOINES WATER WORKS

City of Ankeny ▪ City of Clive Water Department ▪ City of Cumming ▪ Des Moines Water Works
Johnston Water Department ▪ City of Norwalk ▪ City of Pleasant Hill
Polk County Rural Water District #1 ▪ SE Polk Rural Water District
Urbandale Water Department ▪ Warren Water District ▪ City of Waukee
City of Windsor Heights ▪ Xenia Rural Water District - Southwest & Woodward

Water For Your Future

Des Moines Water Works (DMWW) is an industry leader, providing our customers with high quality drinking water for 80 years. Our continued, proven treatment processes, along with new, innovative techniques and studies will ensure that DMWW remains an industry leader into the new millennium.

DMWW takes a proactive approach to controlling water taste and odor, an indicator of water quality. Our laboratory performs total organic carbon (TOC) and UV-254 tests on the rivers daily to determine which source water has the lowest concentration of dissolved organic material. Based on these tests, the Water Production Department will select which river to use and will adjust the dosage of powdered activated carbon to absorb these natural organic materials, allowing them to be removed during the treatment processes. This step significantly improves the taste and odor of your water.

Record Nitrate Year

DMWW's Nitrate Removal Facility was operated a record setting 106 days during 1999, at a total operating cost of approximately $250,000. Nitrate concentrations reached record levels in the Raccoon River and Infiltration Gallery.

DMWW monitors nitrate concentrations weekly until levels begin to increase, then daily during peak nitrate season. When nitrate concentrations in our treated water exceed 8.5 milligrams per liter (mg/l), we begin operating the Nitrate Removal Facility. Water is diverted to the facility for treatment, to maintain a nitrate concentration of 8.5 mg/l or lower in the finished or drinking water. The drinking water standard for nitrate is 10 mg/l.

Trending data indicates that nitrate concentrations in our rivers are continually increasing. In an effort to address this challenge, DMWW made piping modifications in 1999 to increase the capacity of the Nitrate Removal Facility.

Cutting Edge Science

One of the ongoing microbial studies being conducted at DMWW is on the cutting edge of water industry science. One method of studying bacteria, called culturing, grows bacteria in a lab environment. Recent studies conducted in molecular biology have confirmed that there are bacteria that have not been previously cultured. DMWW's microbiologist has grown bacteria believed to be previously uncultured. DMWW's microbiologist has grown uncultured bacteria using river water. While the significance of these uncultured bacteria is unknown, Des Moines metro area customers can rest assured that DMWW has the ability to stay current with water quality trends in order to have solutions in place should a problem arise.

What's On Our Plates?

DMWW's daily water quality testing determines the total number of bacteria present in a water sample, including the harmless ones. Beyond standard utility water testing, DMWW routinely performs Heterotropic Plate Count (HPC) studies on its distribution system water, an important indicator of the on-going bacterial condition of the water. DMWW's average HPC is very low. These bacteria are harmless, but can reduce the residue chlorine that is available to protect the distribution system from bacterial contamination. That is why DMWW monitors both HPC and free chlorine residual in the distribution system - to ensure good, safe water quality at the point of delivery to our customers.

Up A Creek

Recent studies have revealed that large amounts of bacteria enter Walnut Creek after hard rains. DMWW's bacterium study on Walnut Creek, initiated last summer, will help determine if human waste is leaking into the watershed. Preliminary studies have shown that these contaminants are in the raw water of the creeks. Evidence of a specific cause is still unknown. DMWW laboratory professionals are striving to ascertain the cause of the large bacterial loads in our urban creeks and find a solution to the problem.

DMWW will continue to ensure that you are provided with safe, high quality water. We are committed to being an industry leader in water treatment and quality now and in the future.

How We Treat Your Drinking Water

We begin by feeding powdered activated carbon into the river water for removal of man-made and natural organic chemicals. The water is then pretreated to remove dirt and debris and combined with water from the infiltration gallery system. The combined water then flows into lime softening basins. The pH of the water is adjusted before the final filtering process. The water is passed through layers of sand and various sizes of gravel to remove any remaining particles. Des Moines Water Works activates its nitrate removal facility to remove this contaminant from your water during periods of high nitrate levels. After this final phase, fluoride is added to aid in the prevention of tooth decay and chlorine is added as a disinfectant to kill bacteria. The clean water is stored in a clearwell until pumped into the pipes of the distribution system.

Des Moines Water Works laboratory and water production staff collect and test water samples from throughout the system several times a day. These tests ensure that the proper chemical levels are maintained and that the water remains free of unwanted contaminants.

Know Your Watershed

There are three sources of water fulfilling the needs of Des Moines Water Works customers. Approximately two-thirds is supplied by either the Raccoon or Des Moines Rivers. The remaining one-third comes from the infiltration gallery system (shallow groundwater).

As rain and snow run across the slope of land in our watershed, they carry soil and pollution, depositing them in creeks leading to the Raccoon and Des Moines Rivers. Some precipitation sinks into the ground, dissolving substances that may enter our groundwater supplies. Everyone can contribute to improving watershed health by utilizing conservation practices that protect the land and the quality of water in our rivers. Improving environmental quality improves our quality of life now and in the future.

2000 Consumer Confidence Report Page 1

1999 Drinking Water Quality Report

SUBSTANCE	HIGHEST LEVEL ALLOWED (MCL)	DMWW RANGE USING DES MOINES RIVER WATER	DMWW RANGE USING RACCOON RIVER WATER	DMWW MAXIMUM DETECTED LEVEL	EPA MCLG (EPA GOAL)	SOURCES OF CONTAMINANT
MICROBIOLOGICAL CONTAMINANTS						
Turbidity	0.5 NTU	n/d-0.10 NTU	n/d-0.8 NTU	0.10 NTU	N/A	Soil Runoff
INORGANIC CONTAMINANTS						
Fluoride	4.0 mg/l	0.60-1.3 mg/l	0.81-1.2 mg/l	1.3 mg/l	4.0 mg/l	Additive to Promote Strong Teeth
Nitrate (as N)	10.0 mg/l	1.3-10.0 mg/l	1.1-9.3 mg/l	10.0 mg/l	10.0 mg/l	Runoff from Fertilizer Use
Sodium	unregulated	7.8-20.0 mg/l	9.4-26.0 mg/l	26.0 mg/l	unregulated	Erosion of Natural Deposits
Sulfate	unregulated	28.0-93.0 mg/l	38.0-64.0 mg/l	93.0 mg/l	unregulated	Erosion of Natural Deposits
ORGANIC CONTAMINANTS						
Atrazine	3.0 µg/l	n/d-0.21 µg/l	0.20 µg/l	0.21 µg/l	3.0 µg/l	Runoff from Herbicide Use
Metolachlor	N/A	n/d-0.27 µg/	n/d	0.27 µg/	N/A	Runoff from Fertilizer Use
Total Trihalomethane	100.0 µg/l	27.0-41.0 µg/l	25.0-30.0 µg/l	41.0 µg/l	0 µg/l	By-product of Chlorine Disinfection

SUBSTANCE	ACTION LEVEL (AL)	DMWW 90th PERCENTILE **		SOURCES OF CONTAMINANT
DMWW COPPER AND LEAD - Regulated at Customer Tap				
Copper	1.3 mg/l	n/d		Corrosion of Home Plumbing
Lead	15.0 µg/l	10.0 µg/l	(5 sites above AL)	Corrosion of Home Plumbing

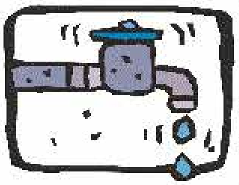
**Health Advisory Level*

***90% of samples must be below Action Level*

LEAD: Infants and young children are typically more vulnerable to lead in drinking water than the general population. It is possible that lead levels at your home may be higher than at other homes in your community as a result of materials used in your home's plumbing. If you are concerned about elevated lead levels in your home's water, you may wish to have your water tested and flush your tap for 30 seconds to 2 minutes before using tap water. Additional information is available from the Safe Drinking Water Hotline at (800) 426-4791.

NOTE: The EPA requires monitoring of over 80 drinking water contaminants. Those listed above are the only contaminants detected in your drinking water. For a complete list, contact Des Moines Water Works or your local water utility.

Distribution Violations



The following utilities had distribution violations in 1999. The specifics of each violation and corrective actions are provided in detail. If you have any questions, please contact the utility.

UTILITY	VIOLATION	CORRECTIVE ACTION
City of Clive	Home water filtration system nonacute Coliform detect	Repeat samples at origination point; notice mailed to customers
City of Cumming	Unsatisfactory Coliform Bacteria test 6/99	Four repeat samples 6/19/99; all negative; 5 routine samplings in 7/99
	Bacterial Coliform monitoring & reporting violation 9/99 - 5 samples not collected 7/99; 12/99 Coliform monitoring	Need to meet resampling requirements; Resampled; implemented new scheduling system for testing
City of Norwalk	Nonacute coliform bacteria violation 6/99 & 11/99; 12/99 Coliform monitoring	Resampled; implemented new scheduling system for testing
City of Waukee	Lead exceeded 90th percentile Action Level	Resume lead & copper testing; educated customers about lead

Definitions

Action Level (AL) - The concentration of a contaminant that, if exceeded, triggers a treatment or other requirement that a water system must follow.

Inorganic Chemicals - Chemical substances of mineral origin, such as lead and copper.

Maximum Contaminant Level (MCL) - The highest level of a contaminant allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

Microbiological Contaminants - Very small organisms, such as bacteria, algae, plankton, and fungi.

N/A - Not applicable

n/d - Not detected

NTU - Nephelometric Turbidity Units.

Organic Contaminants - Naturally occurring or synthetic substances containing mainly carbon, hydrogen, nitrogen, and oxygen. This includes most pesticides and industrial chemicals.

pCi/l - picocuries per liter; measure of radioactivity.

µg/l - micrograms per liter; parts of contaminant per billion parts of water. One part per billion (ppb) is equivalent to a single penny in ten million dollars.

mg/l - milligrams per liter; parts of contaminant per million parts of water. One part per million (ppm) is equivalent to a single penny in ten thousand dollars.

Radionuclides - Contaminants giving off ionizing radiation.

Treatment Technique (TT) - A required process intended to reduce the level of a contaminant in drinking water.

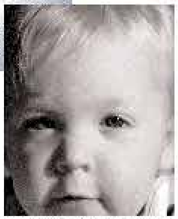
Important Health Information

Inadequately treated water may contain disease-causing organisms. These organisms include bacteria, viruses, and parasites, which can cause symptoms such as nausea, cramps, diarrhea, and associated headaches. Some people may be more vulnerable to contaminants in drinking water than the general population.

Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV / AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. The Center for Disease Control has guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants. They are available from the Safe Drinking Water Hotline.

In order to ensure that tap water is safe to drink, the Environmental Protection Agency (EPA) prescribes regulations, which limit the amount of certain contaminants in water provided by public water systems.

Nitrate in drinking water at levels above 10 ppm is a health risk for infants of less than six months of age. High nitrate levels in drinking water can cause blue baby syndrome. Nitrate levels may rise quickly for short periods of time because of rainfall or agricultural activity. If you are caring for an infant, you should ask for advice from your health care provider.



FDA regulations establish limits for contaminants in bottled water that must provide the same protection for public health. Any bottled water that is labeled "drinking water" has to meet EPA's drinking water regulations. Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk.

More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline.

SAFE DRINKING WATER HOTLINE:

1-800-426-4791

Cryptosporidium is a microscopic organism found in rivers and streams that can cause diarrhea, fever and gastrointestinal distress if ingested. It finds its way into the watershed through animal and human wastes. Cryptosporidium is effectively eliminated by a treatment process that includes sedimentation, filtration, and disinfection.

Cryptosporidium has **NEVER** been found in your drinking water.

DMWW recently concluded a study to determine the amount of *Cryptosporidium* we eliminate from our source water through the treatment process. *Cryptosporidium* is a microscopic organism, known to cause intestinal illnesses, found in the feces of infected animals and humans. It is rarely found in the rivers from which we draw water.

After extensive studies, DMWW's microbiologist determined that we effectively eliminate 99.99% of the *Cryptosporidium* from the raw water. The combination of DMWW's water treatment capability and the fact that the Des Moines and Raccoon Rivers contain very low numbers of *Cryptosporidium* are very encouraging data.

Cryptosporidium

Urban Environmental Partnership

To promote both improved service to our customers and environmental protection of our watershed, Des Moines Water Works (DMWW) has formed a new partnership with three other Des Moines area utilities: Wastewater Reclamation Authority (WRA), Metro Waste Authority (MWA), and the City of Des Moines' Storm Water Utility. The partnership is targeting three areas to enhance customer education and communication:

- Training of Customer Service employees in the functions and operations of each utility to assist them in answering customer calls about other local water utilities.
- Developing and presenting curriculum in the Des Moines area schools, emphasizing the interdependent relationship between the utilities and teaching children about protecting our water resources.
- Educating our customers about good water stewardship as it relates to all of the water utilities through publications such as existing utility newsletters, bill inserts, web pages, and press releases.

Contact DMWW or any of the Urban Environmental Partners for more information.

DEWEY™

- Baking soda, borax, and white vinegar are effective, earth-friendly cleaning products.
- The greatest single cause of an increased water bill is a leaking or running toilet, wasting 250 to 5000 gallons of water a day!
- Bottled water costs up to 1000 times more than DMWW water from your tap.
- Using mulch around gardens, bushes, and trees is a great way to trap moisture, reducing your need to water more often. Mulch also becomes a rich nutrient for plants.
- An acre of corn contributes more to humidity than a lake of the same size.
- A 1/8th inch crack in a pipe can spew up to 250 gallons of water a day, wrecking floors, furniture, and valuable possessions in addition to wasting water.
- A leak of one drop per second wastes 2,400 gallons of water per year.
- As water flows in streams, sits in lakes, or filters through layers of soil and rock in the ground, it dissolves or absorbs the substances that it touches.
- Dispose used motor oil, antifreeze, paints, and other hazardous materials at the Regional Collection Center rather than down the drain.

2000 Consumer Confidence Report Page 3

KIDS CORNER

Word Find Fun!

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Z T R B H K G N I N E T F O S E M I L S
A C C R R M J D T C U M M I N G Q V O U
S A F E L A B O R A T O R Y I Z B F A E
S P W A T E R S H E D K B M T E V A Q M
S M R H N J L T Y N C H L O R I N E U X
G E N D A M E R O L S I N W A T O I I F
M M D Y N A N O X I E T I T T Y D T F I
E R R I I T C O R Y C C O L E I I M E L
A X A M M C E W A U K E E N R R I C R T
A N E X A E H I L E R A T O E I N G T R
P E R R T P N E T U A L P U M P S I M A
A N K E N Y T T I O N S D I O A F N N T
O S E P O L K A A T O E E T V F R U S I
D E K A C H L I B T E N R T A Y H Y S O
I T E R I C A L P A I I N M L O N U Y N
S M O U S F O Y L D E O R C W A R R E N
T O N E D I R O U L F M N V E R T B E D
R P O L K C O U N T Y S A U R U S A V M
I Q H H E S S T H G I E H R O S D N I W
B U U O A L I T Y W E D E B S T E D L W
U A S T D I G N I R O T I N O M C A C I
T L O L N A R P L E A S A N T H I L L Y
I I W I T V Q M K W K E R E A I N E X A
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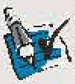
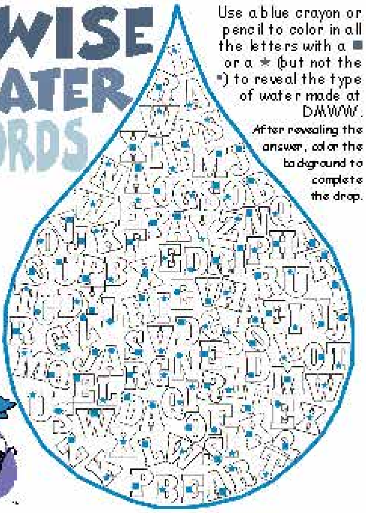
Word List



Ankeny
aquifer
CCR
chlorine
Clive
contaminant
Cryptosporidium
Cumming
distribution
DMWW
EMPACT
EPA
filtration
fluoride
hotline
infiltration gallery
Johnston
laboratory
lime softening
Maffitt
monitoring
nitrate
Norwalk
Pleasant Hill
Polk County
pumps
quality
Raccoon
safe
sedimentation
SE Polk
Urbandale
Warren
water
watershed
Waukee
Windsor Heights
Xenia

WISE WATER WORDS



Use a blue crayon or pencil to color in all the letters with a ■ or a ★ (but not the ▪) to reveal the type of water made at DMWW.

After revealing the answer, color the background to complete the drop.

Public Meeting Information

We encourage our customers to attend and participate in the meetings of our water utility. Public meeting information is listed below.

ANKENY
Ankeny City Council ▪ 1st and 3rd Monday of each month at 5:00 p.m.
410 West 1st Street ▪ Ankeny, Iowa 50021

CLIVE
Clive City Council ▪ 1st, 3rd, & 5th* Thursday of each month
(*5 week months)
Clive City Hall ▪ 1900 NW 114th St. ▪ Clive, Iowa 50325

CUMMING
Cumming City Council ▪ 2nd and 4th Monday each month
City Hall ▪ Cumming, Iowa 50061

DES MOINES
Board of Water Works Trustees ▪ 4th Tuesday each month at 9:00 a.m.
Des Moines Water Works ▪ 2201 Valley Drive ▪ Des Moines, Iowa 50321

JOHNSTON
Johnston City Council ▪ 1st and 3rd Monday of each month
City Hall ▪ 6221 Merle Hay Road ▪ Johnston, Iowa 50131

NORWALK
Norwalk City Council ▪ 1st and 3rd Thursday of each month at 5:30 p.m.
705 North Avenue ▪ Norwalk, Iowa 50211

PLEASANT HILL
Pleasant Hill City Council ▪ 2nd and 4th Tuesday of each month at 6:30 p.m.
Pleasant Hill City Hall ▪ 5151 Maple Drive ▪ Pleasant Hill, Iowa 50317

POLK COUNTY RURAL WATER DISTRICT #1
Annual Meeting in January each year ▪ Call for date
660 NW 66th Avenue, Suite 2 ▪ Des Moines, Iowa 50313

SOUTHEAST POLK RURAL WATER DISTRICT
Water Board ▪ 3rd Wednesday of each month ▪ Contact office for time
6540 NE 12th Avenue ▪ Altoona, Iowa 50009

URBANDALE
Water Board of Trustees ▪ Meets monthly ▪ Call 278-3940 for information
Urbandale Water Department ▪ 3720 86th Street ▪ Urbandale, Iowa 50322

WARREN WATER
Board of Directors ▪ 3rd Monday each month at 7:30 p.m.
Warren Water Office ▪ 1204 East 2nd Avenue ▪ Indianola, Iowa 50125

WAUKEE
Waukee City Council ▪ 1st and 3rd Monday each month
Waukee City Hall ▪ 230 Highway 6 ▪ Waukee, Iowa 50263

WINDSOR HEIGHTS
Windsor Heights City Council ▪ 1st and 3rd Monday each month at 4 p.m.
Windsor Heights City Hall ▪ 1133 66th Street ▪ Windsor Heights, Iowa 50311

XENIA - Southwest & Woodward
Board of Directors ▪ Thursday of 3rd full week of each month
2398 141st Street ▪ Bouton, Iowa 50039

Utility Contact Information

For more information on the Consumer Confidence Report or water quality, please contact your local water utility:

- **City of Ankeny:** Customer Service
  410 West 1st Street, Ankeny, Iowa 50021
  Phone: (515) 283-8700 ▪ Fax: (515) 283-8727
  E-mail: jmckenH2O@aol.com
- **City of Clive Water Department:**
  Bart Weller, Public Works Director
  9289 Swanson Blvd., Clive, Iowa 50325
  Phone: (515) 223-6231 ▪ Fax (515) 223-6013
  E-mail: bweller@ci.clive.ia.us
- **City of Cumming:** Kathie Hungerford
  P.O. Box 100, Cumming, Iowa 50061
  Phone: (515) 981-9214 ▪ Fax: (515) 981-9214
- **Des Moines Water Works:** Customer Service
  2201 Valley Drive, Des Moines, Iowa 50321
  Phone: (515) 283-8700 ▪ Fax: (515) 283-8727
  E-mail: webmaster@dmww.com
- **Johnston Water Department:** Jerry R. Meyers or Donna Kluss
  P.O. Box 410, Johnston, Iowa 50131-0410
  Phone: (515) 278-0822 ▪ Fax (515) 727-8092
- **City of Norwalk:** Dean Yordi, Director of Public Works
  705 North Avenue, Norwalk, Iowa 50211
  Phone: (515) 981-0808 ▪ Fax: (515) 981-0933
  E-mail: deanyordi@ci.norwalk.ia.us
- **City of Pleasant Hill:** Gary Patterson, Public Works Director
  5151 Maple Drive, Suite 1, Pleasant Hill, Iowa 50317-8494
  Phone: (515) 262-9368 ▪ Fax: (515) 262-9570
- **Polk County Rural Water District #1:** Francis E. Schlueter
  6666 NW 5th Street, Des Moines, Iowa 50313
  Phone: (515) 289-1877 ▪ E-mail: feschlueter@worldnet.att.net
- **Southeast Polk Rural Water District:** Shirley J. Bos, General Manager
  6540 NE 12th Avenue, Altoona, Iowa 50009
  Phone: (515) 262-8581 ▪ Fax: (515) 262-4536
  E-mail: shirley.bos@worldnet.att.net
- **Urbandale Water Department:** Customer Service
  3720 86th Street, Urbandale, Iowa 50322
  Phone: (515) 278-3940 ▪ Fax (515) 278-3944
- **Warren Water District:** Peggy Crabbs, Systems Manager
  1204 East 2nd Avenue, Indianola, Iowa 50125
  Phone: (515) 962-1200 ▪ Fax: (515) 962-9328
- **City of Waukee:** John R. Gibson - Director of Public Works
  230 Highway 6, Box 847, Waukee, Iowa 50263
  Phone: (515) 987-4363 ▪ Fax: (515) 987-3979 ▪ E-mail: gibsonjon@aol.com
- **City of Windsor Heights:** Customer Service
  1133 66th Street, Windsor Heights, Iowa 50311
  Phone: (515) 283-8700 ▪ Fax: (515) 283-8727
- **Xenia Rural Water District - Southwest & Woodward:** Dave Modlin
  2398 141st Street, P.O. Box 39, Bouton, Iowa 50039-0039
  Phone: (515) 676-2117 ▪ Fax: (515) 676-2208 ▪ E-mail: Xenia@netins.net

Water Works Your Body

Pure water has been said to be our most important nutrient, and possibly the most underestimated. Drinking water not only quenches our thirst, but it aids in the building and maintenance of a healthy body. Some of the numerous health benefits of drinking water include maintaining fitness, fighting illness, reducing effects of aging, and boosting energy. Simply turn on the faucet for a drink that works wonders for your body!

- Drinking adequate amounts of water helps your digestion and metabolism work at full capacity.
- Water can boost your endurance, making exercise more effective and helping you work out at higher levels.
- You can hold off hunger and prevent over eating by drinking more water.
- Research has found that water plays an active role in reducing the risk of some diseases or ailments like bladder cancer, urinary tract cancer, and kidney stones.
- Health officials consider water to be a weapon against the common cold and cough.
- Consuming plenty of water keeps your skin supple, helping you look younger.
- Drinking water when traveling can help reduce fatigue.
- Dehydration can contribute to migraine headaches; getting enough water is important in fighting them.

DEWEY™ TIPS

Drink More Water!
™

Health experts recommend drinking at least eight 8-ounce glasses of water each day. DMWW has some tips on how to make sure you get enough water.

- Drink moderate-sized portions of water spread throughout the day.
- Drink a glass when you wake up, before and after exercising, and make water available at all times.
- Try carrying a water bottle with you during the day.
- Have one glass of water for each caffeinated beverage you drink.

DMWW: Your pipeline for timely, accurate water information.

A monthly publication of
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2201 Valley Drive
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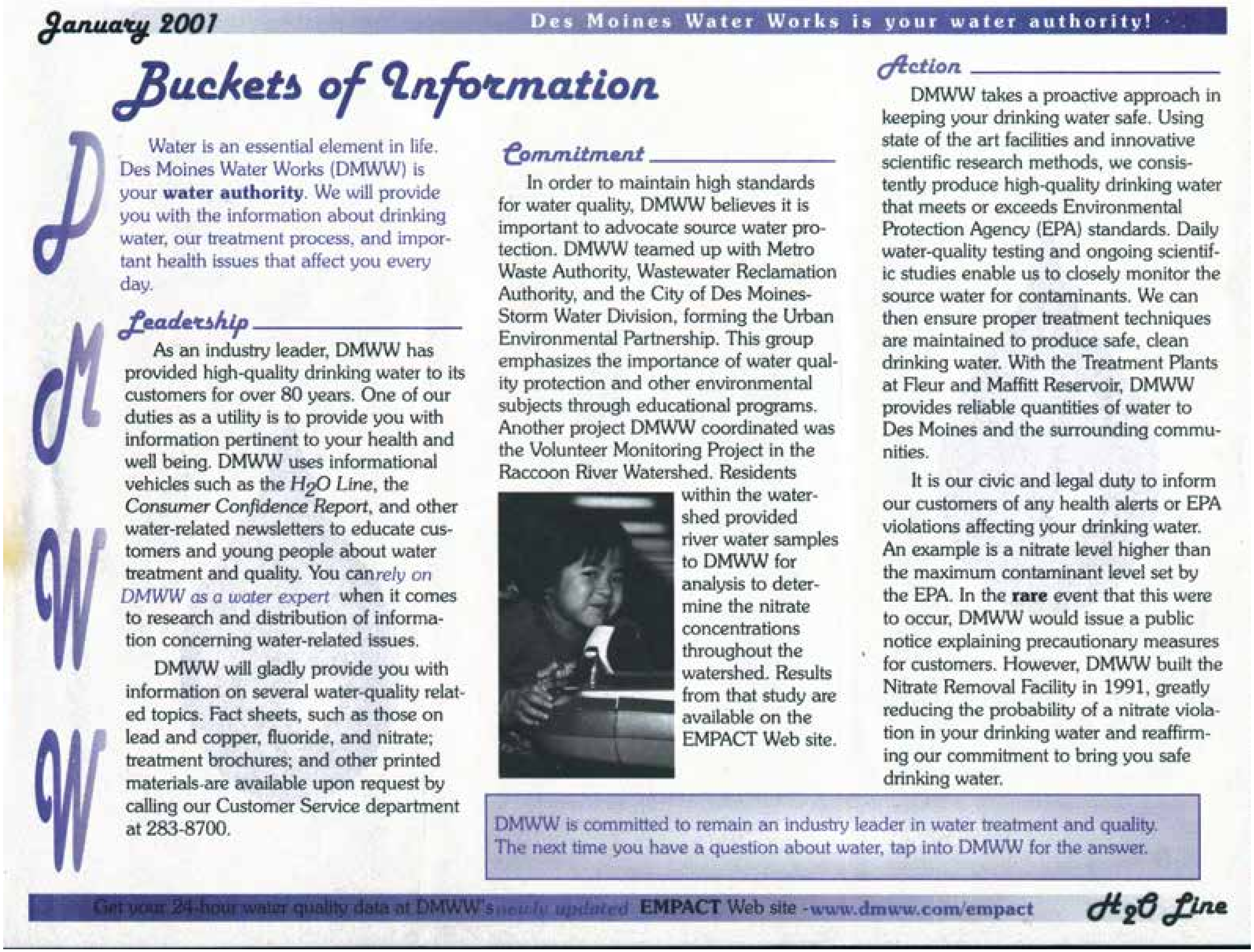
DES MOINES WATER WORKS

H_2O line

January 2001

DMWW: Your Pipeline to Water Information



January 2001

Des Moines Water Works is your water authority!

Buckets of Information

Water is an essential element in life. Des Moines Water Works (DMWW) is your **water authority**. We will provide you with the information about drinking water, our treatment process, and important health issues that affect you every day.

Leadership

As an industry leader, DMWW has provided high-quality drinking water to its customers for over 80 years. One of our duties as a utility is to provide you with information pertinent to your health and well being. DMWW uses informational vehicles such as the *H_2O Line*, the *Consumer Confidence Report*, and other water-related newsletters to educate customers and young people about water treatment and quality. You can *rely on DMWW as a water expert* when it comes to research and distribution of information concerning water-related issues.

DMWW will gladly provide you with information on several water-quality related topics. Fact sheets, such as those on lead and copper, fluoride, and nitrate; treatment brochures; and other printed materials-are available upon request by calling our Customer Service department at 283-8700.

Commitment

In order to maintain high standards for water quality, DMWW believes it is important to advocate source water protection. DMWW teamed up with Metro Waste Authority, Wastewater Reclamation Authority, and the City of Des Moines-Storm Water Division, forming the Urban Environmental Partnership. This group emphasizes the importance of water quality protection and other environmental subjects through educational programs. Another project DMWW coordinated was the Volunteer Monitoring Project in the Raccoon River Watershed. Residents within the watershed provided river water samples to DMWW for analysis to determine the nitrate concentrations throughout the watershed. Results from that study are available on the EMPACT Web site.

Action

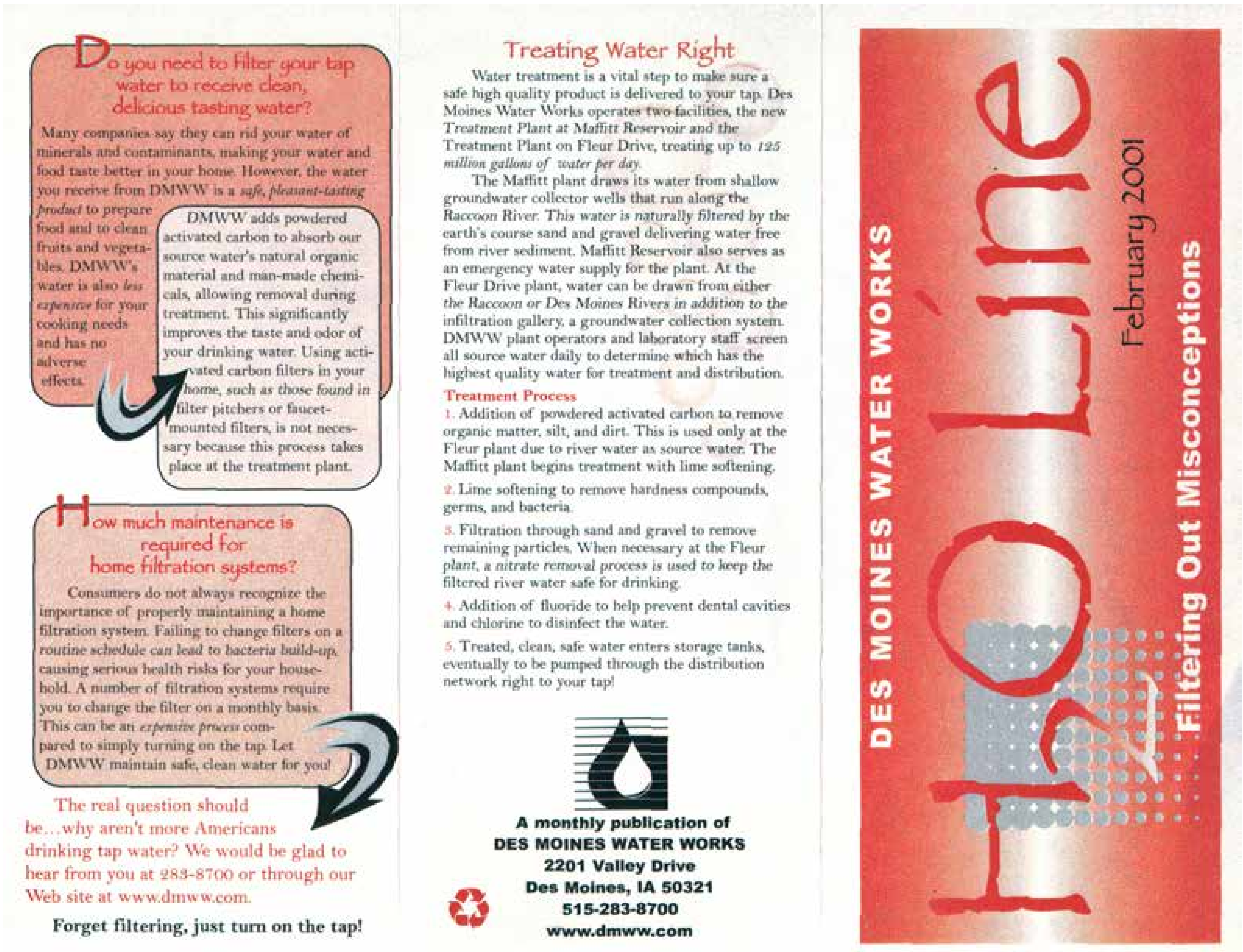
DMWW takes a proactive approach in keeping your drinking water safe. Using state of the art facilities and innovative scientific research methods, we consistently produce high-quality drinking water that meets or exceeds Environmental Protection Agency (EPA) standards. Daily water-quality testing and ongoing scientific studies enable us to closely monitor the source water for contaminants. We can then ensure proper treatment techniques are maintained to produce safe, clean drinking water. With the Treatment Plants at Fleur and Maffitt Reservoir, DMWW provides reliable quantities of water to Des Moines and the surrounding communities.

It is our civic and legal duty to inform our customers of any health alerts or EPA violations affecting your drinking water. An example is a nitrate level higher than the maximum contaminant level set by the EPA. In the **rare** event that this were to occur, DMWW would issue a public notice explaining precautionary measures for customers. However, DMWW built the Nitrate Removal Facility in 1991, greatly reducing the probability of a nitrate violation in your drinking water and reaffirming our commitment to bring you safe drinking water.

DMWW is committed to remain an industry leader in water treatment and quality. The next time you have a question about water, tap into DMWW for the answer.

Get your 24-hour water quality data at DMWW's newly updated **EMPACT** Web site -www.dmww.com/empact

H_2O Line



Do you need to filter your tap water to receive clean, delicious tasting water?

Many companies say they can rid your water of minerals and contaminants, making your water and food taste better in your home. However, the water you receive from DMWW is a *safe, pleasant-tasting product* to prepare food and to clean fruits and vegetables. DMWW's water is also *less expensive* for your cooking needs and has no adverse effects.

DMWW adds powdered activated carbon to absorb our source water's natural organic material and man-made chemicals, allowing removal during treatment. This significantly improves the taste and odor of your drinking water. Using activated carbon filters in your *home, such as those found in* filter pitchers or faucet-mounted filters, is not necessary because this process takes place at the treatment plant.

How much maintenance is required for home filtration systems?

Consumers do not always recognize the importance of properly maintaining a home filtration system. Failing to change filters on a *routine schedule can lead to bacteria build-up,* causing serious health risks for your household. A number of filtration systems require you to change the filter on a monthly basis. This can be an *expensive process* compared to simply turning on the tap. Let DMWW maintain safe, clean water for you!

The real question should be…why aren't more Americans drinking tap water? We would be glad to hear from you at 283-8700 or through our Web site at www.dmww.com.

Forget filtering, just turn on the tap!

Treating Water Right

Water treatment is a vital step to make sure a safe high quality product is delivered to your tap. Des Moines Water Works operates two facilities, the new *Treatment Plant at Maffitt Reservoir* and the Treatment Plant on Fleur Drive, treating up to *125 million gallons of water per day.*

The Maffitt plant draws its water from shallow groundwater collector wells that run along the Raccoon River. *This water is naturally filtered by the* earth's course sand and gravel delivering water free from river sediment. Maffitt Reservoir also serves as an emergency water supply for the plant. At the Fleur Drive plant, water can be drawn from either *the Raccoon or Des Moines Rivers in addition to the* infiltration gallery, a groundwater collection system. DMWW plant operators and laboratory staff screen all source water daily to determine which has the highest quality water for treatment and distribution.

Treatment Process

1. Addition of powdered activated carbon to remove organic matter, silt, and dirt. This is used only at the Fleur plant due to river water as source water. The Maffitt plant begins treatment with lime softening.

2. Lime softening to remove hardness compounds, germs, and bacteria.

3. Filtration through sand and gravel to remove remaining particles. When necessary at the Fleur *plant, a nitrate removal process is used to keep the* filtered river water safe for drinking.

4. Addition of fluoride to help prevent dental cavities and chlorine to disinfect the water.

5. Treated, clean, safe water enters storage tanks, eventually to be pumped through the distribution network right to your tap!

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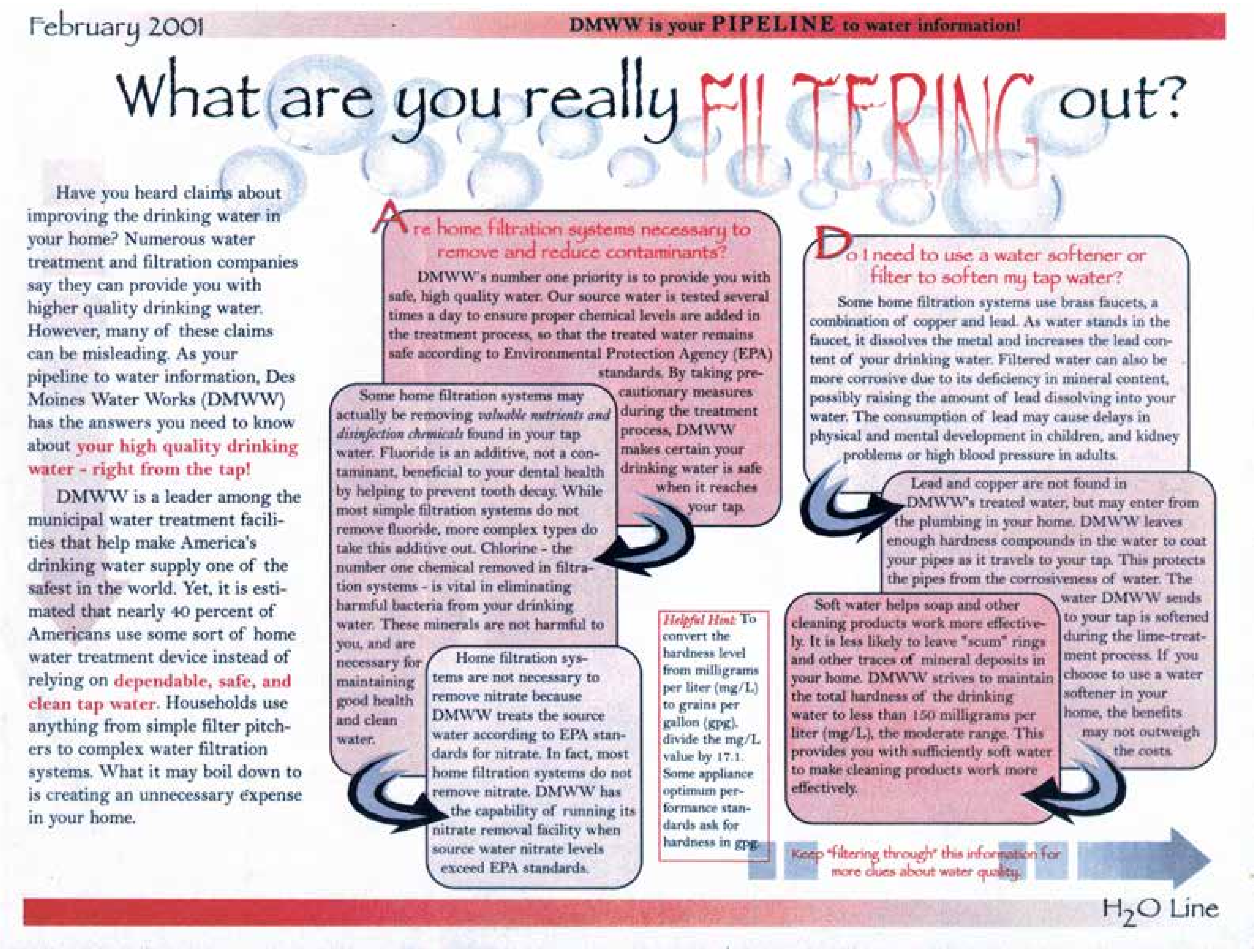
DES MOINES WATER WORKS

H2O Line

February 2001

Filtering Out Misconceptions



February 2001

DMWW is your **PIPELINE** to water information!

What are you really FILTERING out?

Have you heard claims about improving the drinking water in your home? Numerous water treatment and filtration companies say they can provide you with higher quality drinking water. However, many of these claims can be misleading. As your pipeline to water information, Des Moines Water Works (DMWW) has the answers you need to know about **your high quality drinking water - right from the tap!**

DMWW is a leader among the municipal water treatment facilities that help make America's drinking water supply one of the safest in the world. Yet, it is estimated that nearly 40 percent of Americans use some sort of home water treatment device instead of relying on **dependable, safe, and clean tap water.** Households use anything from simple filter pitchers to complex water filtration systems. What it may boil down to is creating an unnecessary expense in your home.

Are home filtration systems necessary to remove and reduce contaminants?

DMWW's number one priority is to provide you with safe, high quality water. Our source water is tested several times a day to ensure proper chemical levels are added in the treatment process, so that the treated water remains safe according to Environmental Protection Agency (EPA) standards. By taking precautionary measures during the treatment process, DMWW makes certain your drinking water is safe when it reaches your tap.

Some home filtration systems may actually be removing *valuable nutrients and disinfection chemicals* found in your tap water. Fluoride is an additive, not a contaminant, beneficial to your dental health by helping to prevent tooth decay. While most simple filtration systems do not remove fluoride, more complex types do take this additive out. Chlorine - the number one chemical removed in filtration systems - is vital in eliminating harmful bacteria from your drinking water. These minerals are not harmful to you, and are necessary for maintaining good health and clean water.

Home filtration systems are not necessary to remove nitrate because DMWW treats the source water according to EPA standards for nitrate. In fact, most home filtration systems do not remove nitrate. DMWW has the capability of running its nitrate removal facility when source water nitrate levels exceed EPA standards.

Helpful Hint: To convert the hardness level from milligrams per liter (mg/L) to grains per gallon (gpg), divide the mg/L value by 17.1. Some appliance optimum performance standards ask for hardness in gpg.

Do I need to use a water softener or filter to soften my tap water?

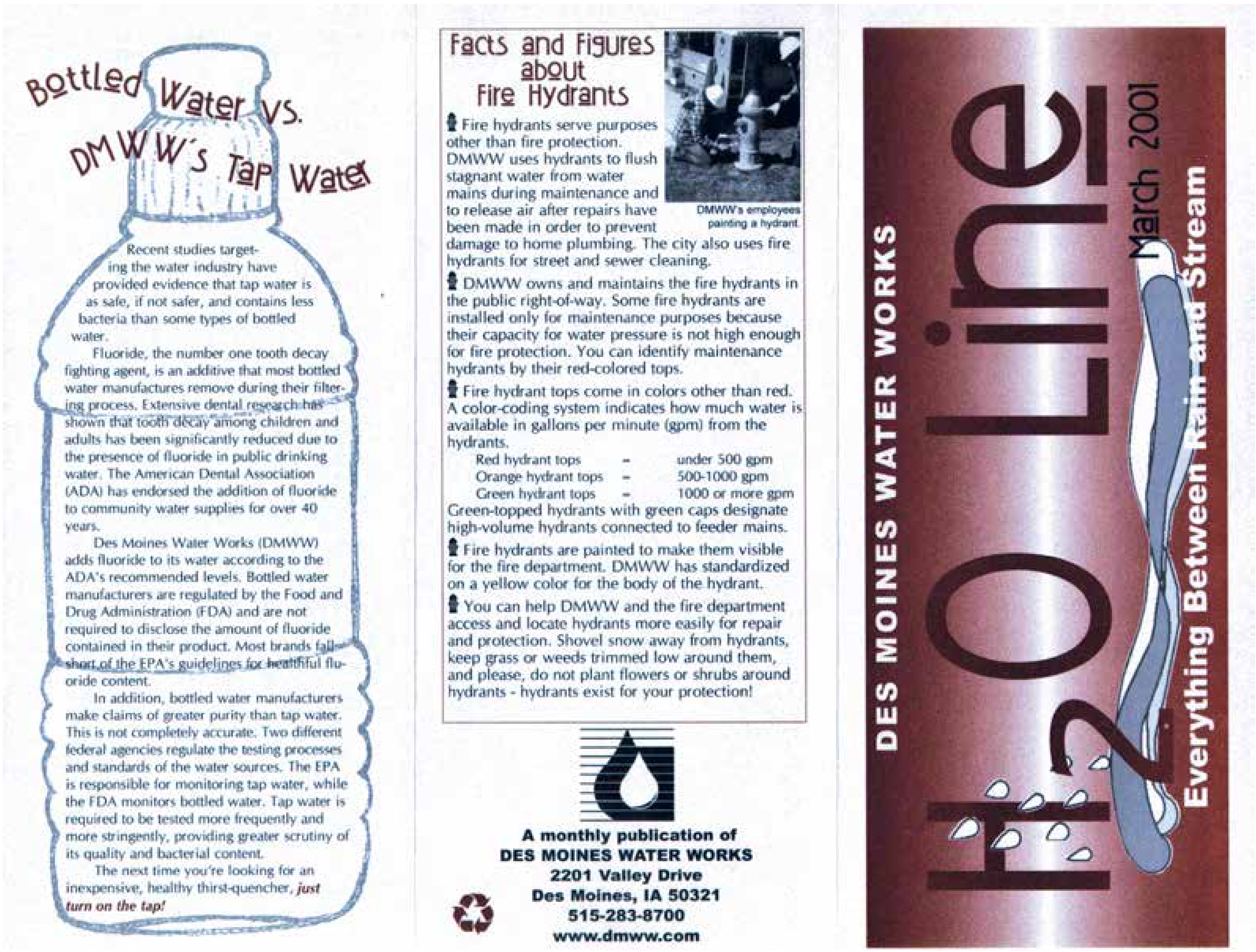
Some home filtration systems use brass faucets, a combination of copper and lead. As water stands in the faucet, it dissolves the metal and increases the lead content of your drinking water. Filtered water can also be more corrosive due to its deficiency in mineral content, possibly raising the amount of lead dissolving into your water. The consumption of lead may cause delays in physical and mental development in children, and kidney problems or high blood pressure in adults.

Lead and copper are not found in DMWW's treated water, but may enter from the plumbing in your home. DMWW leaves enough hardness compounds in the water to coat your pipes as it travels to your tap. This protects the pipes from the corrosiveness of water. The water DMWW sends to your tap is softened during the lime-treatment process. If you choose to use a water softener in your home, the benefits may not outweigh the costs.

Soft water helps soap and other cleaning products work more effectively. It is less likely to leave "scum" rings and other traces of mineral deposits in your home. DMWW strives to maintain the total hardness of the drinking water to less than 150 milligrams per liter (mg/L), the moderate range. This provides you with sufficiently soft water to make cleaning products work more effectively.

Keep "filtering through" this information for more clues about water quality.

H_2O Line



Bottled Water vs. DMWW's Tap Water

Recent studies targeting the water industry have provided evidence that tap water is as safe, if not safer, and contains less bacteria than some types of bottled water.

Fluoride, the number one tooth decay fighting agent, is an additive that most bottled water manufactures remove during their filtering process. Extensive dental research has shown that tooth decay among children and adults has been significantly reduced due to the presence of fluoride in public drinking water. The American Dental Association (ADA) has endorsed the addition of fluoride to community water supplies for over 40 years.

Des Moines Water Works (DMWW) adds fluoride to its water according to the ADA's recommended levels. Bottled water manufacturers are regulated by the Food and Drug Administration (FDA) and are not required to disclose the amount of fluoride contained in their product. Most brands fall short of the EPA's guidelines for healthful fluoride content.

In addition, bottled water manufacturers make claims of greater purity than tap water. This is not completely accurate. Two different federal agencies regulate the testing processes and standards of the water sources. The EPA is responsible for monitoring tap water, while the FDA monitors bottled water. Tap water is required to be tested more frequently and more stringently, providing greater scrutiny of its quality and bacterial content.

The next time you're looking for an inexpensive, healthy thirst-quencher, ***just turn on the tap!***

Facts and Figures about Fire Hydrants

DMWW's employees painting a hydrant

- Fire hydrants serve purposes other than fire protection. DMWW uses hydrants to flush stagnant water from water mains during maintenance and to release air after repairs have been made in order to prevent damage to home plumbing. The city also uses fire hydrants for street and sewer cleaning.
- DMWW owns and maintains the fire hydrants in the public right-of-way. Some fire hydrants are installed only for maintenance purposes because their capacity for water pressure is not high enough for fire protection. You can identify maintenance hydrants by their red-colored tops.
- Fire hydrant tops come in colors other than red. A color-coding system indicates how much water is available in gallons per minute (gpm) from the hydrants.

Red hydrant tops	-	under 500 gpm
Orange hydrant tops	-	500-1000 gpm
Green hydrant tops	-	1000 or more gpm

Green-topped hydrants with green caps designate high-volume hydrants connected to feeder mains.

- Fire hydrants are painted to make them visible for the fire department. DMWW has standardized on a yellow color for the body of the hydrant.
- You can help DMWW and the fire department access and locate hydrants more easily for repair and protection. Shovel snow away from hydrants, keep grass or weeds trimmed low around them, and please, do not plant flowers or shrubs around hydrants - hydrants exist for your protection!

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DES MOINES WATER WORKS

H_2O Line

March 2001

Everything Between Rain and Stream

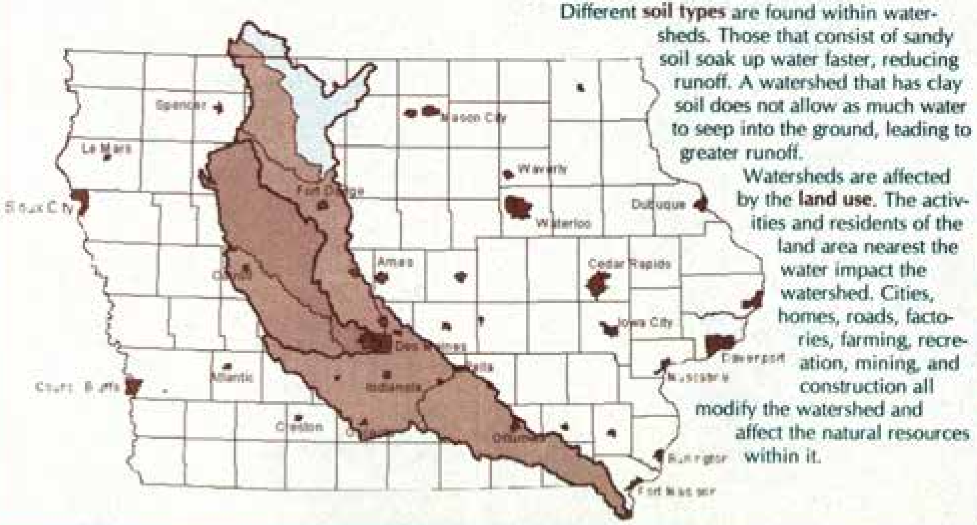
over under around and across

Winding Through Your Watershed

No matter where we live, we are all in a watershed.

Watersheds are areas where water flows across or under the land and drains into a river, lake, stream, pond, or other body of water. It includes the people who live in the area as well as land, air, plants, and animals. According to the Iowa Watershed Task Force, "A watershed is everything between the rain and the stream."

Des Moines Water Works Watershed



Several features make watersheds unique.

Watersheds vary in **shape and size**. Some are large, including millions of acres of land and smaller watersheds within them. Others can be as small as a city block, or a puddle in your back yard. As a Des Moines Water Works' customer, you live in both the Raccoon and Des Moines River watersheds. Each is a part of the Mississippi River watershed, which is made up of thousands of smaller watersheds.

A geographical **boundary** around the watershed is formed by a ridge or high area. This forces water to drain toward or away from your watershed. But watersheds are also interconnected. The water that travels through one land area - including farm fields, forestland, suburban lawns, and city streets - will eventually affect and flow through another.

Watersheds are composed of different **terrain**. The flatness or steepness of the land (terrain) impacts how quickly the water empties into a body of water. If the water drains faster, there is more potential for flooding and soil erosion.

Different **soil types** are found within watersheds. Those that consist of sandy soil soak up water faster, reducing runoff. A watershed that has clay soil does not allow as much water to seep into the ground, leading to greater runoff.

Watersheds are affected by the **land use**. The activities and residents of the land area nearest the water impact the watershed. Cities, homes, roads, factories, farming, recreation, mining, and construction all modify the watershed and affect the natural resources within it.

You play an important role in helping maintain a healthy watershed.

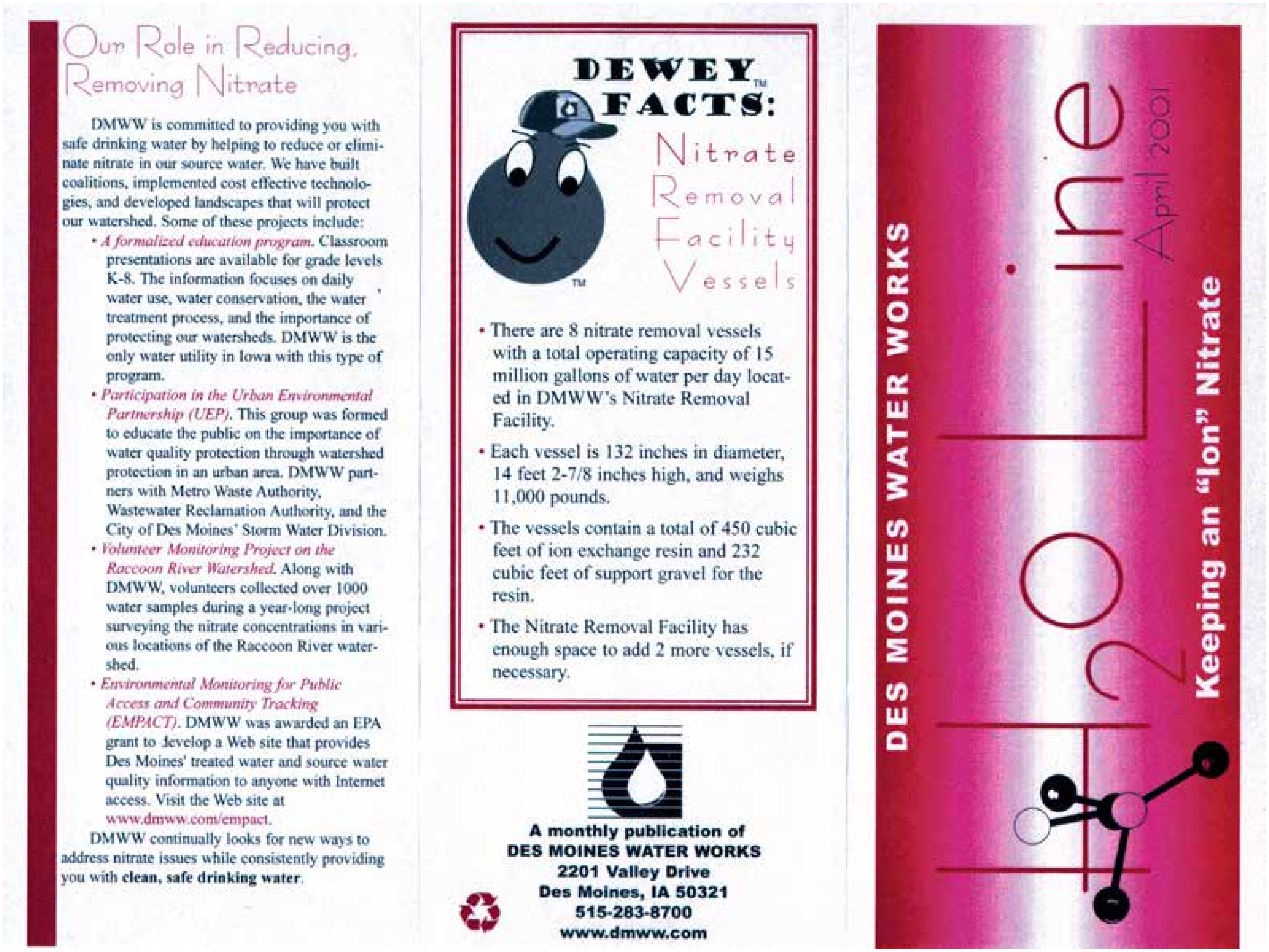
Pollutants traveling through your watershed affect your entire home, work, and play areas. Water and other natural resources are necessary to live, and what we do in the watershed can change the quality and availability of these materials.

There are two types of watershed pollution: point-source and nonpoint-source. **Point-source pollution** begins from the leakage of contaminants from a specific, easily identifiable source. Examples include pollution coming from industrial or sewage discharge pipes, hog lots, or storm sewers. **Nonpoint-source pollution** comes from many different areas as water runs across or through the ground. This type of pollution is harder to identify, measure, and control. Some examples include runoff from fields or forestland, parking lots, failing septic systems, construction sites, and automobile exhaust.

By following **Best Management Practices** (BMPs), you can help keep your watershed clean and safe. BMPs are positive ways to control pollutants and prevent them from contaminating the water supply. You can use BMPs in your home, yard, and community to enjoy and maintain a healthy living environment.

BMPs . . . at home & in your community

- Do not dump hazardous household chemicals, such as fertilizer, oil-based paint, or antifreeze, down the drain! Take them to the MWA's Regional Collection Center in Bondurant (967-5512) for safe disposal, or use environmentally safe cleaning products.
- Recycle your newspapers, magazines, milk jugs, juice bottles, metal cans, clear glass, and anything else possible to reduce the quantity of garbage you send to the landfill.
- Plant grass, trees, and shrubs to prevent soil from blowing or washing away. Bag leaves and grass clippings for compost collection to keep them from washing into storm sewers.
- Do not dump chemicals or anything else down storm sewers - most lead straight to our rivers.
- Keep your vehicles in good condition to prevent oil and antifreeze leaks from entering storm sewers from the street or your driveway.
- Do not litter! You can volunteer to help clean up area parks.



Our Role in Reducing, Removing Nitrate

DMWW is committed to providing you with safe drinking water by helping to reduce or eliminate nitrate in our source water. We have built coalitions, implemented cost effective technologies, and developed landscapes that will protect our watershed. Some of these projects include:

- *A formalized education program.* Classroom presentations are available for grade levels K-8. The information focuses on daily water use, water conservation, the water treatment process, and the importance of protecting our watersheds. DMWW is the only water utility in Iowa with this type of program.
- *Participation in the Urban Environmental Partnership (UEP).* This group was formed to educate the public on the importance of water quality protection through watershed protection in an urban area. DMWW partners with Metro Waste Authority, Wastewater Reclamation Authority, and the City of Des Moines' Storm Water Division.
- *Volunteer Monitoring Project on the Raccoon River Watershed.* Along with DMWW, volunteers collected over 1000 water samples during a year-long project surveying the nitrate concentrations in various locations of the Raccoon River watershed.
- *Environmental Monitoring for Public Access and Community Tracking (EMPACT).* DMWW was awarded an EPA grant to develop a Web site that provides Des Moines' treated water and source water quality information to anyone with Internet access. Visit the Web site at www.dmww.com/empact.

DMWW continually looks for new ways to address nitrate issues while consistently providing you with **clean, safe drinking water**.

DEWEY™ FACTS: Nitrate Removal Facility Vessels

- There are 8 nitrate removal vessels with a total operating capacity of 15 million gallons of water per day located in DMWW's Nitrate Removal Facility.
- Each vessel is 132 inches in diameter, 14 feet 2-7/8 inches high, and weighs 11,000 pounds.
- The vessels contain a total of 450 cubic feet of ion exchange resin and 232 cubic feet of support gravel for the resin.
- The Nitrate Removal Facility has enough space to add 2 more vessels, if necessary.

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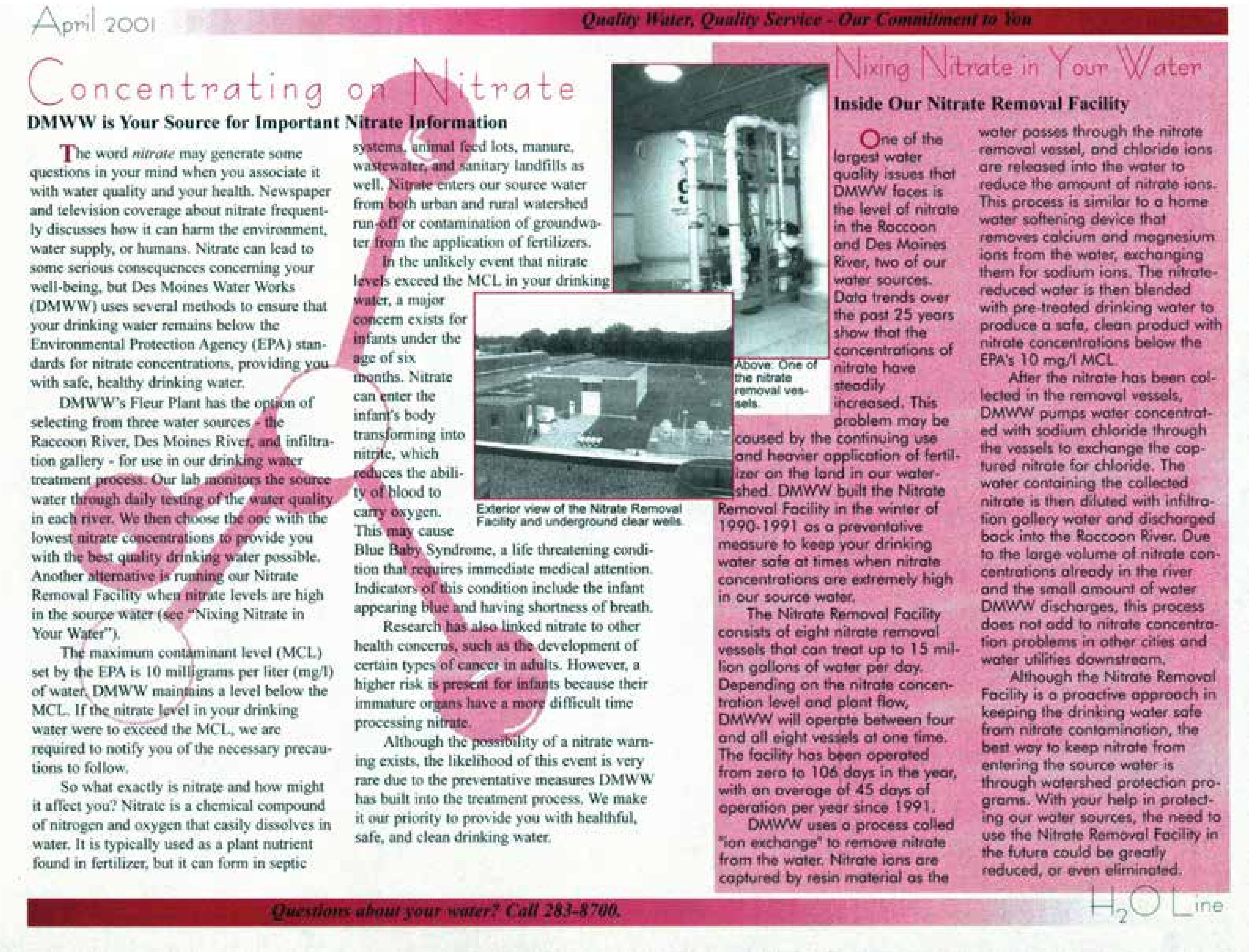
H2O Line

April 2001

Keeping an "Ion" Nitrate



April 2001

Quality Water, Quality Service - Our Commitment to You

Concentrating on Nitrate

DMWW is Your Source for Important Nitrate Information

The word *nitrate* may generate some questions in your mind when you associate it with water quality and your health. Newspaper and television coverage about nitrate frequently discusses how it can harm the environment, water supply, or humans. Nitrate can lead to some serious consequences concerning your well-being, but Des Moines Water Works (DMWW) uses several methods to ensure that your drinking water remains below the Environmental Protection Agency (EPA) standards for nitrate concentrations, providing you with safe, healthy drinking water.

DMWW's Fleur Plant has the option of selecting from three water sources - the Raccoon River, Des Moines River, and infiltration gallery - for use in our drinking water treatment process. Our lab monitors the source water through daily testing of the water quality in each river. We then choose the one with the lowest nitrate concentrations to provide you with the best quality drinking water possible. Another alternative is running our Nitrate Removal Facility when nitrate levels are high in the source water (see "Nixing Nitrate in Your Water").

The maximum contaminant level (MCL) set by the EPA is 10 milligrams per liter (mg/l) of water. DMWW maintains a level below the MCL. If the nitrate level in your drinking water were to exceed the MCL, we are required to notify you of the necessary precautions to follow.

So what exactly is nitrate and how might it affect you? Nitrate is a chemical compound of nitrogen and oxygen that easily dissolves in water. It is typically used as a plant nutrient found in fertilizer, but it can form in septic systems, animal feed lots, manure, wastewater, and sanitary landfills as well. Nitrate enters our source water from both urban and rural watershed run-off or contamination of groundwater from the application of fertilizers.

In the unlikely event that nitrate levels exceed the MCL in your drinking water, a major concern exists for infants under the age of six months. Nitrate can enter the infant's body transforming into nitrite, which reduces the ability of blood to carry oxygen. This may cause Blue Baby Syndrome, a life threatening condition that requires immediate medical attention. Indicators of this condition include the infant appearing blue and having shortness of breath.

Research has also linked nitrate to other health concerns, such as the development of certain types of cancer in adults. However, a higher risk is present for infants because their immature organs have a more difficult time processing nitrate.

Although the possibility of a nitrate warning exists, the likelihood of this event is very rare due to the preventative measures DMWW has built into the treatment process. We make it our priority to provide you with healthful, safe, and clean drinking water.

Exterior view of the Nitrate Removal Facility and underground clear wells.

Above: One of the nitrate removal vessels.

Nixing Nitrate in Your Water

Inside Our Nitrate Removal Facility

One of the largest water quality issues that DMWW faces is the level of nitrate in the Raccoon and Des Moines River, two of our water sources. Data trends over the past 25 years show that the concentrations of nitrate have steadily increased. This problem may be caused by the continuing use and heavier application of fertilizer on the land in our watershed. DMWW built the Nitrate Removal Facility in the winter of 1990-1991 as a preventative measure to keep your drinking water safe at times when nitrate concentrations are extremely high in our source water.

The Nitrate Removal Facility consists of eight nitrate removal vessels that can treat up to 15 million gallons of water per day. Depending on the nitrate concentration level and plant flow, DMWW will operate between four and all eight vessels at one time. The facility has been operated from zero to 106 days in the year, with an average of 45 days of operation per year since 1991.

DMWW uses a process called "ion exchange" to remove nitrate from the water. Nitrate ions are captured by resin material as the water passes through the nitrate removal vessel, and chloride ions are released into the water to reduce the amount of nitrate ions. This process is similar to a home water softening device that removes calcium and magnesium ions from the water, exchanging them for sodium ions. The nitrate-reduced water is then blended with pre-treated drinking water to produce a safe, clean product with nitrate concentrations below the EPA's 10 mg/l MCL.

After the nitrate has been collected in the removal vessels, DMWW pumps water concentrated with sodium chloride through the vessels to exchange the captured nitrate for chloride. The water containing the collected nitrate is then diluted with infiltration gallery water and discharged back into the Raccoon River. Due to the large volume of nitrate concentrations already in the river and the small amount of water DMWW discharges, this process does not add to nitrate concentration problems in other cities and water utilities downstream.

Although the Nitrate Removal Facility is a proactive approach in keeping the drinking water safe from nitrate contamination, the best way to keep nitrate from entering the source water is through watershed protection programs. With your help in protecting our water sources, the need to use the Nitrate Removal Facility in the future could be greatly reduced, or even eliminated.

Questions about your water? Call 283-8700.

H_2O Line

APPENDIX B
GLOSSARY OF TERMS

A

Acetochlor: A herbicide sold under the trade name of Harness. It is an unregulated contaminant with no maximum contaminant level (MCL).

Alkalinity: A measure of the acid-neutralizing property of water.

Anion: A negatively charged ion.

Aquifer: A water-bearing stratum of permeable rock, sand, or gravel.

Atrazine: A herbicide and SDWA-regulated contaminant with a maximum contaminant level (MCL) of 0.003 mg/l.

B

C

Calcium Carbonate Precipitation Potential (**CCPP**): The amount of hardness that can come out of the water to form protective scale on plumbing surfaces.

Calcium Hardness as $CaCO_3$: A measure of the calcium mineral contribution to total hardness.

Chloride: A common table salt component found in all natural waters. Concentrations greater than 250 mg/l can cause the water to taste salty and contribute to metal corrosion.

Chlorine: A gas that is commonly added to drinking water as a disinfectant to make the water safe to drink.

Coliforms: Microorganisms that live in the digestive tracts of humans and animals. The detection of coliform bacteria in treated drinking water suggests that a treatment or distribution system is not working properly.

Conductivity: The ability to carry an electric current. Its measurement in water indicates the amount of dissolved salts or minerals in the water.

Consumer Confidence Report (**CCR**): An annual drinking water quality report required by the Safe Drinking Water Act (SDWA) for customers of public water supply systems.

Copper: A metal that can be present in drinking water through the corrosion of plumbing materials such as copper pipes.

Cryptosporidium: A microscopic organism found in rivers and streams that can cause diarrhea, fever, and gastrointestinal distress if ingested. It finds its way into the watershed through animal and human wastes.

D

Disinfection byproduct: A compound formed by the reaction of a disinfectant such as chlorine with organic material in the water supply.

Database: A collection of data organized by fields, records, and files. A field is a single piece of information, a record is a complete set of fields, and a file is a collection of records.
(Definition from *http://www.webopedia.com.*)

Database management system: A collection of computer programs that enables you to store, modify, and extract information from a database. (Definition from *http://www.webopedia.com.)*

Domain name: A name that identifies one or more Internet Protocol (IP) addresses. Domain names are used in Uniform Resource Locators (URLs) to identify particular Web pages.
(Definition from *http://www.webopedia.com.*)

Drinking water: Water that is conveyed to residences and businesses from a public water system. Typically, this water is treated by a water utility to make it potable. Drinking water is sometimes referred to as finished water.

E

E. coli: Bacteria whose presence indicates that the water may be contaminated with human or animal wastes.

Ecosystem: All of the interacting organisms in a defined space in association with their interrelated physical and chemical environment.

F

Fecal Coliform: Bacteria found in the intestinal tracts of warm-blooded animals. The presence of fecal coliform in water is an indicator of pollution and possible contamination by pathogens.

Finished water: See “Drinking Water."

Firewall: A system designed to prevent unauthorized access to or from a private network. Firewalls can be implemented in hardware, software, or a combination of both. (Definition from *http://www.webopedia.com.*)

Fluoride: A naturally occurring mineral added to water to help reduce cavities in young people.

G

H

Hardness: The amount of soap-precipitating minerals in the water. Both calcium and magnesium combine with soap to make it less effective. A hardness measurement is expressed as the amount of $CaCO_3$ (pure limestone) that would produce the hardness.

Hardware: Computer devices that you can actually touch, such as disks, disk drives, display screens, keyboards, printers, boards, and chips. (Definition from *http://www.webopedia.com.*)

Heterotrophic Plate Count (HPC) bacteria: All bacteria found growing on a non-selective food media. These are not indicators of disease, but large numbers in a drinking water distribution system indicate stale water, minimal disinfection and, therefore, an increased risk of disease. HPC bacteria can also cause unpleasant tastes and odor in the water.

HyperText Markup Language (HTML): Programming language for publishing hypertext on the Web.
(Definition from *http://www.webopedia.com.*)

I

Infiltration Gallery: A sub-surface groundwater collection system, typically shallow in depth, constructed with open-jointed or perforated pipes that discharge collected water into a watertight chamber from which the water is pumped to treatment facilities and into the distribution system. Usually located close to streams or ponds.

Inorganic Contaminants: Mineral-based compounds such as metals, nitrates, and asbestos. These contaminants are naturally-occurring in some water, but can also get into water through farming, chemical manufacturing, and other human activities. EPA has set legal limits on 15 inorganic contaminants.

Internet Browser: A software application used to locate and display Web pages. The two most popular browsers are Netscape® Navigator™ and Microsoft® Internet Explorer™. (Definition from *http://www.webopedia.com.*)

J

K

L

Langeliers Index: A corrosion indicator based on pH. A positive number means that the water will deposit protective minerals on plumbing to prevent metal pipe corrosion.

Lead: A metal that can be present in drinking water through the corrosion of plumbing materials such as lead solder.

M

Magnesium Hardness as $CaCO_3$: The magnesium contribution to total hardness. It is measured and expressed as the equivalent amount of $CaCO_3$ (pure limestone) that would produce this hardness.

Maximum Contaminant Level (MCL): The highest level of a contaminant that EPA allows in drinking water. MCLs ensure that drinking water does not pose either a short-term or long-term health risk. EPA sets MCLs at levels that are economically and technologically feasible. Some states set MCLs that are more strict than EPA's.

Methemoglobinemia: A blood disorder caused when nitrite interacts with the hemoglobin in red blood cells. Unlike hemoglobin, the methemoglobin formed in this interaction cannot carry sufficient oxygen to the body's cells and tissues. Although methemoglobinemia is rare among adults, cases have been reported among infants, where nitrate-contaminated water was used to prepare formula and other baby foods.

Metolachlor: A herbicide sold under the trade name of Dual. It is an unregulated contaminant with no maximum contaminant level (MCL); however, a health advisory concentration for this pesticide has been set at 0.070 mg/l.

Microorganisms: Tiny living organisms that can be seen only with the aid of a microscope. Some microorganisms can cause acute health problems when consumed in drinking water. Also known as microbes.

N

Nitrate-N: A form of nitrogen fertilizer that is readily available to plants. This form of nitrogen is very water soluble and moved through the soil into groundwater and surface water.

Nitrite-N: The actual form of nitrogen that can combine with hemoglobin to form methemoglobinemia or "blue baby syndrome." It is an intermediate compound that is formed when ammonia is converted to nitrate by bacteria.

Nonpoint source: Any source of pollution not associated with a distinct discharge point.

O

Organic Contaminants: Carbon-based chemicals, such as solvents and pesticides, which can get into water through runoff from cropland or discharge from factories. EPA has set legal limits on 56 organic contaminants.

Ortho-phosphate: A naturally occurring substance that is sometimes added to the water for additional corrosion protection.

P

Pfiesteria: toxic dinoflagellate (microscopic, free-swimming, single-celled organisms, usually classified as a type of alga) associated with fish lesions and fish kills in mid-Atlantic Coastal Waters.

pH: A measure of the strength of an acid on a 0-14 scale, where 7 is neutral, less than 7 is acidic, and greater than 7 is basic.

Plug-in: A hardware or software module that adds a specific feature or service to a larger system. For example, there are a number of plug-ins for Internet browsers to enable the display of different types of audio or video messages.

Point source: A stationary location or fixed facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Pollutant loading: The quantity of a pollutant entering the environment (soil, water, air).

Potable (drinking) water: Water that meets U.S. EPA and/or state water quality standards and is considered safe and fit for human consumption.

Potassium: A common element found at low levels in drinking water.

Protazoa: Single-celled, eucaryotic microorganisms without cell walls. Most protozoa are free-living although many are parasitic.

Q

R

Radionuclides: Any man-made or natural element that emits radiation. Radionuclides may cause cancer after many years of exposure through drinking water.

S

Server: A computer or device on a network that manages network resources. For example, a database server is a computer system that processes database queries. (Definition from *http://www.webopedia.com.*)

Silica (SiO_2): A common, naturally occurring substance in the earth's crust. It can contribute to scale formation and reduce pipe corrosion.

Sodium: One of the two components in ordinary table salt (sodium chloride). It is a common substance in nature and is a needed mineral in the diet. The amount of sodium in water is generally small relative to the amount present in food.

Software: Computer instructions or data. Anything that can be stored electronically.
(Definition from *http://www.webopedia.com.*)

Source water: Ambient water that is accessed by water utilities to treat for distribution as drinking water. Source water can originate in either a surface source (such as a lake, river, or reservoir) or a subsurface source (such as a well). Source water is sometimes referred to as raw water.

Structured Query Language (SQL): A standardized query language for requesting information from a database. SQL was first introduced as a commercial database system in 1979 by Oracle Corporation.
(Definition from http://www.webopedia.com.)

Sulfate: A stable form of sulfur common in natural waters, especially where gypsum is present. It can produce a taste in drinking water when present in concentrations over 200 mg/l and may produce a laxative effect when present in concentrations over 750 mg/l.

Synthetic Organic Chemicals (SOCs): Man-made (anthropogenic) organic chemicals. Some SOCs are volatile; others tend to stay dissolved in water instead of evaporating.

T

Total Dissolved Solids (TDS): The amount of dissolved substances, such as salts or minerals, in water.

Total Organic Carbon (TOC): A measure of carbon compounds in water that are from an organic (living) origin. In combination with a disinfectant such as chlorine, the presence of TOC can result in the formation of trihalomethanes.

Trihalomethane (THM): One of a class of compounds known as disinfection byproducts that result from chlorinating water containing naturally occurring organic material.

Turbidity: A measurement of scattered light (cloudiness) in a column of water. Light is scattered when it strikes suspended particles such as clay, silt, or microscopic organisms.

Volatile Organics: Chemicals that, as liquid, evaporate into the air.

W

Quality: A measure of the presence and quantity of certain constituents or parameters (like naturally occurring substances, man-made chemicals, and industrial contaminants) in water.

Web server: A computer that delivers (serves up) Web pages. Every Web server has an IP address and possibly a domain name. Any computer can be turned into a Web server by installing server software and connecting the machine to the Internet. (Definition from *http://www.webopedia.com.*)

Wellhead: A particular well site location, as differentiated from other well site locations, that exist in the same water system.

Wetland: an area that is regularly saturated by surface or groundwater and subsequently is characterized by prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include swamps, bogs, fens, marshes, and estuaries.

APPENDIX C

TUCSON WATER'S EMPACT WATER QUALITY PROJECT

The Water Quality Management Division of Tucson Water, in Tucson, Arizona, delivers more than 37 billion gallons of water annually to approximately 675,000 customers. The city of Tucson, Arizona is one of the largest U.S. cities that currently obtains its drinking water supply from groundwater wells. To ensure future sustainability, Tucson has started to supplement its groundwater supply with water from the Colorado River through the Central Arizona Project (CAP). Tucson's selected blend of recharged Colorado River water and groundwater is known as the Clearwater Supply. The Tucson Water EMPACT project seeks to introduce this alternate and necessary supply of water to the public by providing timely information on the quality of the blended drinking water at taps in homes and businesses. Tucson's EMPACT project not only provides a resource for water quality information, but also results in environmental benefits through a focused consumer outreach effort.

PARTNER ORGANIZATIONS

Tucson Water has received a 2-year grant from EPA's EMPACT program. Tucson's EMPACT project partners include the following:

- Arizona Department of Environmental Quality
- Tucson Unified School District, David T. Smith Resource Center
- Tucson-Pima Public Library
- University of Arizona, Water Resources Research Center
- University of Arizona, Southwest Environmental Health Sciences Center
- Pima County Health Department
- Pima County Waste Water Management
- Tucson Hispanic Chamber of Commerce
- University of Arizona, National Science Foundation, Water Quality Center
- Citizens and Neighborhood Services

SAMPLE COLLECTION/ANALYSIS

Tucson Water's EMPACT project increases the number of water quality parameters currently measured by the utility and adds continuous on-line monitoring. Specifically, the utility has added continuous on-line monitoring of the quality of potable water and the quantity and general quality of recycled wastewater and secondary effluent discharged to the Santa Cruz River. One objective of the EMPACT project is to expand the utility's monitoring technology to include a new process for measuring total trihalomethanes. Trihalomethanes are suspected human carcinogens that can form when drinking water that contains organic material is disinfected with chlorine.

Also under the EMPACT project, Tucson Water has selected 22 locations for on-line monitoring to track the conveyance of finished water throughout the utility's distribution system. Tucson is installing the on-line instrumentation over the next year to continuously track chlorine residual, conductivity, estimated total dissolved solids, pH, and temperature. This special monitoring program will provide Tucson Water's customers with information on water quality throughout the utility's distribution system.

Data Management/Data Delivery

The objective of Tucson Water's EMPACT project data management, processing, and delivery system is to improve the time relevancy of water quality data related to the potable distribution system. To do this, Tucson Water is developing timely methods for transmitting and verifying the quality of data from the on-line and manual monitoring programs and posting these data to the project Web site. The EMPACT project will allow community residents to identify their street addresses on a Web site map, receive easily understandable results from nearby water monitoring stations, and obtain a timely report on the quality of their drinking water.

Communications/Outreach

The outreach objectives for Tucson's EMPACT project include identifying the water quality/quantity data desired by targeted groups and developing effective, state-of-the art methods to communicate these data. Building on existing city programs, the EMPACT project will identify specific constituencies and solicit feedback on the water quality data desired and the best formats for individualizing data by location and creating a context for understanding water resources. Through its outreach products, Tucson hopes to eliminate any misperception about community water quality and provide a source of reliable, authoritative information on fast-breaking water quality issues.

For More Information

For more information about Tucson Water's EMPACT water quality project, visit

http://www.ci.tucson.az.us/water.

APPENDIX D
COMMUNICATIONS/OUTREACH PLANNING AND RESOURCES

This appendix will assist you with developing and implementing an outreach plan for communicating a variety of information to the public. Section D.1 provides general step-by-step guidance on creating an outreach plan. Section D.2 includes guidelines for effectively communicating technical information and provides a list of resources you can use to enhance your outreach efforts.

D.1 CREATING AN OUTREACH PLAN

Your outreach efforts will be most effective if you plan them carefully. An outreach plan ensures that you have thoroughly considered all aspects of your outreach efforts before you begin. Your plan does not need to be lengthy or complicated! You can develop a plan simply by documenting your answers to these questions, which are discussed in the following subsections:

- Who are your partners?
- What are your outreach goals?
- Whom are you trying to reach?
- What information do you want to communicate?
- What outreach products will you develop?
- How will your outreach products reach your audiences?
- What follow-up mechanisms will you establish?
- What is your schedule for implementation?

TIP: Outreach planning is a creative and iterative process that involves a number of interrelated steps. As you move through each of the planning steps discussed below, you should revisit the decisions you have made for previous steps to make sure you are creating a fully integrated, comprehensive, and achievable outreach plan.

D.1.1 WHO ARE YOUR PARTNERS?

Try to involve a variety of people in the design and development of your outreach plan. When possible, consider involving the following:

- A communications specialist or someone who has experience with developing and implementing outreach plans.
- Technical experts (e.g., experts in water quality, policy, information systems).
- Representatives of your target audience categories.
- Key individuals who will be involved in implementing your outreach plan.

Consider inviting community organizations to partner with you in planning or implementing your outreach efforts. Potential partners might include local businesses and trade associations, environmental organizations, schools, community groups, local health departments, local planning and zoning authorities, and other local or state agencies. Partners can help you with outreach planning, product development and review, and/or product distribution. Partnerships can be valuable mechanisms for leveraging resources while enhancing the quality, credibility, and overall success of your outreach efforts.

D.1.2 What Are Your Outreach Goals?

Outreach goals should be clear, simple, action-oriented statements about what you hope to accomplish through your outreach efforts. Every other aspect of your outreach plan should relate to your goals.

Try to rank and prioritize your goals in terms of relative importance. Consider the importance of your goals as you move through the planning process. For goals of greater importance, you will want to tailor your partnerships, outreach products, and information dissemination strategies to allow you to reach a greater number of affected people in a shorter amount of time.

D.1.3 Whom Are You Trying to Reach?

To answer this question, you must both identify and profile your target audience. The identification and profiling processes are discussed below.

Identifying Your Audience

As you design your outreach plan, you will need to clearly identify the target audience for your outreach efforts. The types of audiences targeted for a water quality outreach program might include the general public, local businesses and trade associations, decision-makers, educators and students, and community groups (e.g., homeowners associations, fishing/boating organizations, and gardening clubs). Some types of target audiences, such as educators and community groups, might serve as pathways to help you disseminate information to other types of audiences, such as students and the general public.

If you have more than one target audience, you may want to consider dividing the group into audience categories. For example, if the water quality information you intend to provide to the general public differs from the information you intend to provide to businesses, you may want to consider these targets as separate audience categories.

Profiling Your Audience Categories

Your outreach efforts will be most effective if you tailor the type, content, and distribution of your outreach products to the characteristics of your target audience categories. To do this, you will want to profile the situations, interests, and concerns of your audience members. These profiles will help you identify the most effective ways to reach each audience category. Consider how you would describe your audience members:

- What is their current level of knowledge about drinking water and source water?
- What is their average education level? What language do they speak?
- What should they know about drinking water and source water quality in your community? What actions would you like them to take?
- What information is likely to be of immediate interest to them?
- Once they develop an awareness of water quality issues in your community, what information will they want to know?

- How much information will they want to see? How much time are they willing to spend to understand the information?
- How do they generally receive information? How would they prefer to receive your information?
- In what types of professional, recreational, and domestic activities do they typically engage? Are there any organizations or centers that might represent pathways for your outreach efforts?

When you answer these questions, talk with representatives of your target audience categories and with colleagues who have successfully reached out to your audience categories.

D.1.4 WHAT INFORMATION DO YOU WANT TO COMMUNICATE?

In this step, think about the key points, or “messages," you want to relate to your audience. A message is the “bottom-line” information you want your audience to remember, even if they forget the details. A message is usually phrased in a brief (often one-sentence) statement. Outreach products often have multiple related messages.

D.1.5 WHAT OUTREACH PRODUCTS WILL YOU DEVELOP?

You will want to determine what types of outreach products or tools will most effectively reach each of your target audience categories. There are many different types of outreach products available in print, audiovisual, electronic, event, and novelty formats.

Your outreach goals and target audience profiles will help you select appropriate and effective outreach products and tools. A communications specialist can provide you with valuable guidance on choosing the most appropriate products to meet your goals within your resource and time constraints. When selecting your products, consider your answers to the following questions:

- How much information does your audience really need to have? How much does your audience need to know immediately? (Keep in mind that the simplest, most straightforward product is generally the most effective.)
- Is the outreach product likely to appeal to your audience? How much time will it take your average audience member to interact with the product? Is your audience likely to make that time?
- Will the distribution and organization of your product be easy and cost-effective?
- How many people will the product reach?
- What time frame is needed to develop and distribute/organize the product?
- How much will it cost to develop the product? Do you have access to the talent and resources needed for product development?
- What other related products are already available? Can you build on existing products?
- When will the information be out of date? (Keep in mind that you will want to spend fewer resources on products with shorter life spans.)

- Would it be effective to have distinct phases of products over time? (For example, consider the first phase of a product designed to raise awareness, followed by a second phase of products at later dates to encourage changes in behavior.)
- How newsworthy is the information you are trying to communicate? (Information with inherent news value is more likely to be rapidly and widely disseminated by the media.)

OUTREACH PRODUCTS

Print	Brochures Educational curricula Newsletters Posters Question-and-answer sheets	Editorials Fact sheets Newspapers and magazine articles Press releases Utility bill inserts
Audiovisual	Cable television programs Exhibits and kiosks	Public service announcements (radio) Videos
Electronic	E-mail messages Web pages	Subscriber list servers Interactive compact disks
Events	Briefings Fairs and festivals One-on-one meetings Public meetings	Community days Media interviews Press conferences Speeches
Novelty Items	Banners Buttons Floating key chains for boaters Magnets	Bumper stickers Coloring books Frisbee discs Mouse pads

D.1.6 How Will Your Outreach Products Reach Your Audiences?

You have many outreach product distribution options available to you. Consider the following examples:

- Mailing lists belonging to your organization or partner organizations.
- Phone and fax.
- E-mail.
- Internet.
- Journals or newsletters put out by partner organizations.
- Television.
- Radio.
- Print media.
- A hotline that distributes products upon request.
- Meetings, events, or locations (e.g., libraries, schools, community centers) where products are made available to the public.

You should consider how each of your products will be distributed and determine who will be responsible for distribution. For some products, your organization might manage the distribution. For other products, you might rely on intermediaries (e.g., the media or educators) or organizational partners. You should consult with a communications specialist to obtain information about the time and resources required for various distribution options. Consider the following issues when you select your distribution mechanisms:

- How does your audience typically receive information? How would they prefer to receive your information?
- What distribution mechanisms has your organization used in the past for this audience category? Were these mechanisms effective?
- Can you identify a partner organization that would be willing to assist you with distribution?
- Can the media play a role in distribution?
- Will your distribution mechanism really reach the intended audience? For example, although the Internet can be an effective distribution mechanism, certain audience categories may have limited access to it.
- How many people will your product reach through the distribution mechanism you are considering?
- Do you have sufficient resources available to fund and implement the distribution mechanisms you are considering?

D.1.7 WHAT FOLLOW-UP MECHANISMS WILL YOU ESTABLISH?

If you have successfully reached out to your target audiences, you may receive requests for additional information. Your audience members may become concerned about the issues you have communicated to them. As part of your outreach plan, you should determine if and how you will respond to the follow-up interests of people in your community. Consider the following questions:

- What types of reactions or concerns are audience members likely to have in response to the outreach information?
- Who will be responsible for handling requests for additional information?
- Should you indicate on your outreach products where people can go for additional information? Will you provide a contact name, phone number, and/or Internet, mail, or e-mail address? Will you establish a hotline?
- How will you track and analyze feedback?
- How and when will you use feedback to improve your outreach efforts?

D.1.8 WHAT IS YOUR SCHEDULE FOR IMPLEMENTATION?

Once you have selected the most effective combination of goals, audience categories, messages, products, and distribution mechanisms for your project, you should develop an implementation schedule for your outreach plan. First, consider the relative importance of each of your outreach goals. You should have a shorter implementation schedule associated with your most important goals. For each of your outreach products, consider how much time will be needed for design, development, and distribution. Be sure to factor in sufficient time for product review. When possible, also factor in some time for testing and evaluation by representatives of your target audience category to solicit feedback on the effectiveness of your product.

D.2 RESOURCES FOR PRESENTING WATER QUALITY INFORMATION TO THE PUBLIC

As you begin to implement your outreach plan and develop outreach products, you should make sure that these products present your messages and information as clearly and accurately as possible. This section discusses methods for effectively communicating technical information to the public and provides resources to help you shape the style and content of your outreach products.

D.2.1 HOW DO YOU PRESENT TECHNICAL INFORMATION TO THE PUBLIC?

Environmental topics are often technical in nature, and water quality is no exception. Nevertheless, this information can be conveyed in simple, clear terms to nonspecialists. Principles of effective writing for the public include avoiding jargon, translating technical terms into everyday language, using the active voice, keeping sentences short, and using headings and other formatting devices to provide a very clear, well-organized structure. You can refer to the following Web sites for more ideas about how to write clearly and effectively for a general audience:

- The National Partnership for Reinventing Government has developed a guidance document, Writing User-Friendly Documents, which is available at *http://www.plainlanguage.gov/.*
- The Web site of the American Bar Association, *http://www.abanet.org/lpm/writing/styl.html*, has links to important online style manuals, dictionaries, and grammar primers.
- The Web site of the Environmental Education and Training Partnership, *http://eee.eetap.org,* has guides for developing environmental education documents.

As you develop outreach products for a specific audience, remember to consider what your audience members are already likely to know, what you want them to know, and what they are likely to understand. Then tailor your information accordingly. Provide only the information that will be valuable and interesting to the target audience. For example, local businesses might be interested in the hardness of the potable water they are using for manufacturing processes; however, senior citizens interested in the overall safety of their drinking water are not likely to be engaged by this topic.

When developing outreach products, you should consider any special needs of the target audience. For example, if your community has a substantial number of people who speak little or no English, you will need to prepare communication materials in their native language.

The remainder of this section provides some online resources that you can consult when developing your outreach projects. Some of the Web sites listed below contain products, such as downloadable fact sheets, that you can use to support your communication and outreach efforts.

FEDERAL RESOURCES

EPA's Office of Groundwater and Drinking Water (OGWDW)
http://www.epa.gov/safewater

This site provides information on a variety of topics, from drinking water and health, source water protection, and training to applicable regulations, standards, and guidance. The site also includes a kid's page, which contains games and activities to help children learn about drinking water.

EPA's Office of Wetlands, Oceans, and Watersheds (OWOW)
http://www.epa.gov/owow

This site provides a variety of information related to wetlands, oceans, and watersheds. The site provides new information, resources for concerned citizens, and answers to frequently asked questions. Specific to watersheds, the site provides information on water quality monitoring and watershed pollution issues.

EPA's Surf Your Watershed
http://www.epa.gov/surf3

EPA provides this service to locate, use, and share environmental information on watersheds. One section of this site, "Locate Your Watershed," allows users to enter the names of rivers, schools, or a zip code to learn more about the water resources in their local watersheds. Users can also access the Index of Watershed Indicators (IWI) from this site. The IWI is a compilation of information on the health of aquatic resources in the U.S. The index uses a variety of indicators to determine whether rivers, lakes, streams, wetlands, and coastal areas can be described as "well" or "ailing".

EPA's NonPoint Source Pointers
http://www.epa.gov/owow/nps/facts

This Web site features a series of fact sheets on nonpoint source pollution. The series covers topics including programs and opportunities for public involvement in nonpoint source control, managing urban runoff, and managing nonpoint pollution from various sources (e.g., agriculture, boating, households).

U.S. Department of Agriculture Natural Resources Conservation Service
http://www.wcc.nrcs.usda.gov/water/quality/frame/wqam

This site includes guidance documents that provide the following resources: a simple tool to estimate the sensitivity of a water body to nutrients, a procedure to evaluate the conditions of a stream based on visual characteristics, and information on how to design a monitoring system to observe changes in water quality associated with agricultural nonpoint source controls.

EDUCATIONAL RESOURCES

Project WET (Water Education for Teachers)
http://www.montana.edu/wwwwet

The goal of Project WET is to promote awareness, appreciation, knowledge, and stewardship of water resources by developing and disseminating classroom-ready teaching aids and establishing state and internationally sponsored Project WET programs. This site includes a list of all state Project WET Program Coordinators to help you locate a contact in your area.

Water Science for Schools
http://wwwga.usgs.gov/edu/index.html

The U.S. Geological Survey's (USGS's) Water Science for School Web site offers information on many aspects of water quality, along with pictures, data, maps, and an interactive forum where students can give opinions and test their water knowledge.

Global Rivers Environmental Education Network (GREEN)
http://www.earthforce.org/green

The Global Rivers Environmental Education Network (GREEN) helps young people protect the rivers, streams, and other vital water resources in their communities. This program merges hands-on, scientific learning with civic action. GREEN is working with EcoNet to compile pointers on water-related resources on the Internet. This site (http://www.igc.apc.org/green/resources.html) includes a comprehensive list of water quality projects across the country and around the world.

Adopt–A–Watershed
http://www.adopt-a-watershed.org/about.htm

Adopt-A-Watershed is a K-through-12 school/community learning experience that uses local watersheds as living laboratories in which students can engage in hands-on activities. The goal is to make science applicable and relevant to students' lives.

National Institutes for Water Resources
http://wrri.nmsu.edu/niwr/niwr.html

The National Institutes for Water Resources (NIWR) is a network of 54 research institutes throughout the U.S. They conduct basic and applied research to solve water problems unique to their areas and establish cooperative programs with local governments, state agencies, and industries.

OTHER ORGANIZATIONS

The Watershed Management Council
http://watershed.org/wmc/aboutwmc.html

The Watershed Management Council is a not-for-profit organization whose members represent a broad range of watershed management interests and disciplines. Members include professionals, students, teachers, and individuals who are interested in promoting proper watershed management.

Providing Timely Drinking Water and Source Water Quality Information to Your Community

Des Moines Water Works' Project

National Risk Management Research Laboratory

Office of Research and Development

U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

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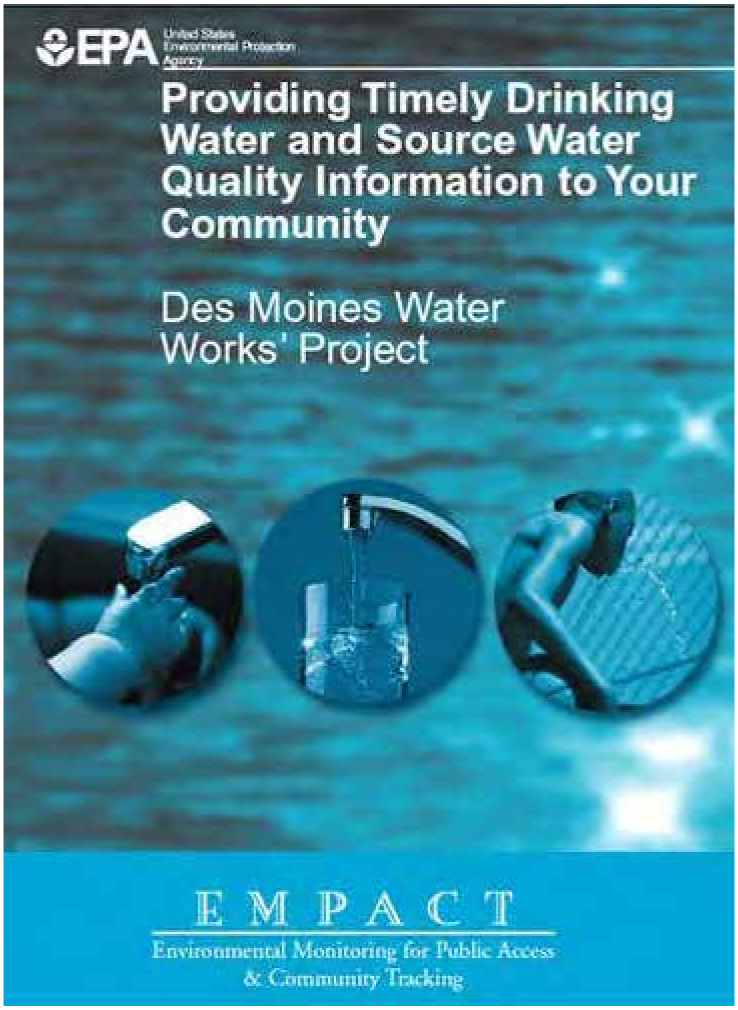

EPA United States Environmental Protection Agency

Providing Timely Drinking Water and Source Water Quality Information to Your Community

Des Moines Water Works' Project

EMPACT
Environmental Monitoring for Public Access
& Community Tracking

Continue >>

Foreword

The Technology Transfer and Support Division of the EPA Office of Research and Development's (ORD's) National Risk Management Research Laboratory initiated the development of this handbook to help interested communities, particularly those with medium and large public water systems, learn more about the Des Moines Water Works (DMWW) EMPACT project. DMWW's EMPACT project provides Des Moines metropolitan community residents with timely information about the factors that affect their drinking water supply. ORD, working with DMWW, produced this handbook to transfer the lessons learned from the project and reduce the resources needed to implement similar projects in other communities.

You can order copies of this handbook (both print and CD-ROM versions) online at ORD's Technology Transfer Web site at http://www.epa.gov/ttbnrmrl. You can also download a PDF version of the handbook from this site. In addition, you can order print and CD-ROM versions of the handbook by contacting either ORD Publications or the Office of Water Resource Center at:

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Please make sure you include the title of the handbook and the EPA document number in your request.

We hope that you find this handbook worthwhile, informative, and easy to use.

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Disclaimer

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1. Introduction

Would residents in your community have trouble answering these types of questions:

- How safe is your drinking water today?
- How healthy are the watersheds in and around your community?
- Could simple changes in your lifestyle help improve water quality in your area?
- How would you measure these improvements, and what would they mean to you and your family?

If so, your water utility and the community residents it serves would benefit from a project that uses new and innovative methods and technologies to deliver timely, accurate, and understandable information about the quality of drinking water and source water in your area.

This handbook has been designed with this goal in mind:

> **To show you how one water utility—the Des Moines Water Works (DMWW)—is implementing a project to provide timely drinking water and source water quality information to the Des Moines metropolitan community.**

The handbook provides a detailed case study of DMWW's project to encourage medium and large water utilities (or communities responsible for supplying drinking water) to consider adopting strategies for delivering timely data to the public. Although small water systems and communities not subject to federal drinking water regulations are not likely to have the resources to implement such a project, these entities may also find some portions of this handbook valuable.

ABOUT THE EMPACT PROGRAM

This handbook was developed by the U.S. Environmental Protection Agency's (EPA's) EMPACT program. EPA created EMPACT (Environmental Monitoring for Public Access and Community Tracking) in 1997. The program is now administered by EPA's Office of Environmental Information.

The EMPACT program promotes new and innovative approaches to collecting, managing, and communicating environmental information to the public. Working with communities in 156 of the largest metropolitan areas 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, ground water contamination, smog, ultraviolet radiation, and overall ecosystem quality. To learn more, visit EPA's EMPACT Web site at http://www.epa.gov/empact.

1.1 What Do Water Utilities Do?

Water utilities are responsible for producing drinking water of consistently high quality for their consumers. EPA and the states develop and enforce standards to protect the quality of drinking water, and water utilities must meet these standards. Producing high quality drinking water ideally follows an approach with multiple barriers to prevent contaminants from reaching consumers. The earliest possible barrier (i.e., the most ideal barrier) is watershed and wellhead protection, which ensures that contaminants do not enter source water. Therefore, strong environmental stewardship is an essential element of drinking water supply.

DRINKING WATER VS. SOURCE WATER

When considering the responsibilities of water utilities, it is very important to distinguish between drinking water and source water:

Drinking water is water that is conveyed to residences and businesses from a public water system. Typically, this water is treated by a water utility to make it potable. Drinking water is sometimes referred to as finished water.

Source water (i.e., raw water) is ambient water that is accessed by water utilities to treat for distribution as drinking water. Source water can originate in either a surface source (such as a lake, river, or reservoir) or a subsurface source (such as a well).

Water utilities collect and analyze drinking water and source water quality data to facilitate the following:

- Produce and deliver high quality water.
- Assure consumers and regulators that drinking water is of high quality.
- Continue to improve the quality of drinking water through research.

Water utilities are challenged every day. The regulatory environment is changing. Science is also changing, as is our knowledge of water quality and how it impacts consumers and the environment is changing. Water utilities continually strive to improve the performance of their treatment and distribution systems, make improvements to meet new challenges, and communicate with consumers in an honest and timely manner.

THE WATER DATA AND TOOLS PROJECTS

DMWW's EMPACT project is one of four *Time-Critical Water Data* and *Tools Projects*. These projects were formed through a partnership between the EMPACT program and EPA's Office of Water. Through case studies of these four unique projects, the Water Data and Tools initiative is designed to demonstrate local capability to collect and communicate water quality data that are meaningful, defensible, and easily accessible, and build a framework to encourage other communities to do the same through technology transfer and outreach.

WATER DATA AND TOOLS PROJECTS

Project	Locations	Web site	Data and Tools
Chesapeake Bay	Baltimore, MD Washington, DC	http://mddnr.chesapeakebay.net/empact	Water quality in support of Pfiesteria surveillance
Jefferson Parish	New Orleans, LA	http://www.jeffparish.net	Freshwater diversions and algal blooms
Ohio River	Cincinnati, OH Louisville, KY Pittsburgh, PA	http://www.orsanco.org/empact	Swimming and fishing conditions
Des Moines	Des Moines, IA	http://www.dmww.com/empact	Drinking water and source water quality

Visit http://www.epa.gov/surf2/empact/tools.html for more information on the EMPACT Water Data and Tools Projects.

1.2 Why is it Important to Communicate Timely Drinking Water and Source Water Quality Information to the Public?

All members of a community have a right to know about the current quality of their drinking water because drinking water quality affects public health. The need to provide timely drinking water quality data is most urgent when these data indicate an acute result that can have immediate effects on a utility's customer population. Your efforts to provide your customers with timely information on the quality of their drinking water will build public confidence in your utility's ability to provide safe, healthy, reliable drinking water. Businesses relying on consistently high-quality water to support a production process can use timely water quality information to determine whether to maintain or modify their processes. By disseminating these timely data on a Web site, you may reduce the number of phone calls to your utility from consumers or manufacturers seeking specific water quality test results.

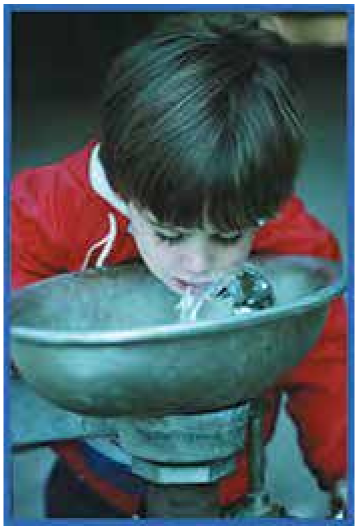
From a human health perspective, the urgency for timely source water quality information is typically less than that for drinking water quality information. However, the timeliness of source water quality information may be critical when spills or other environmental emergencies occur in the watershed. The presentation of timely source water quality data and trends on a Web site can inform and influence the behavior of residents in your watershed. This heightened public awareness would not only enable local residents and public officials to make informed decisions about land use management and water conservation measures, but would also encourage affected groups to take a larger and more proactive role in instituting practices to restore and preserve the quality of source waters.

1.3 Des Moines Water Works' EMPACT Project

DMWW is the largest water utility in the state of Iowa. Serving over 350,000 people, DMWW operates two major water treatment plants and pumps an average of 43 million gallons of water per day.

In 1998, EPA's EMPACT program funded DMWW's EMPACT project, which provides Des Moines metropolitan community residents with timely information about the factors that affect their drinking water supply. DMWW's EMPACT project is broken into three phases:

- Phase I is the development of a data management protocol, tools, and electronic links required to identify, manage, and deliver **drinking water quality** information to the project Web site.
- Phase II is the periodic collection, Web posting, and updating of **source water quality** information collected from selected monitoring sites within the Racoon River and Des Moines River watersheds.
- Phase III is the adaptation of the methods and tools developed for Phases I and II to existing **urban runoff studies** conducted by DMWW.



DMWW's EMPACT project strives to encourage Des Moines residents, as well as the entire watershed community, to assume a larger role in restoring and preserving the quality of source waters in the community. Project partners include EPA's Office of Groundwater and Drinking Water (OGWDW), EPA Region VII, the Iowa Department of Natural Resources, and the United States Geological Survey (USGS). You can visit DMWW's EMPACT project Web site at http://www.dmww.com/empact.

1.3.1 Project Costs

To plan, design, develop, install, and implement the three phases of its EMPACT project, DMWW incurred a total cost of approximately $245,000. This cost should give you an idea of how much a comparable project might cost your utility. However, every project that communicates timely information about drinking water and source water quality is unique to its community. Therefore, the cost of your project will also be unique.

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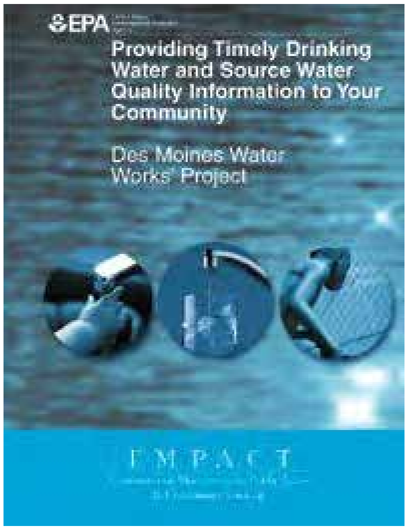
2. How To Use This Handbook

This handbook has been designed to show you how DMWW is implementing a project to provide timely drinking water and source water quality information to the Des Moines metropolitan community. The handbook intends to encourage medium and large water utilities (or communities responsible for supplying drinking water) to consider adopting strategies for delivering timely data to the public. Although small water systems and communities not subject to federal drinking water regulations are not likely to have the resources to implement such a project, these entities may also find some portions of this handbook valuable.

The handbook is organized into the following chapters:

- **Chapter 3** presents an overview of water quality monitoring. Specifically, the chapter discusses the federal and state regulations and guidelines applicable to drinking water and source water. It also discusses typical methods used by water systems to collect and disseminate information about drinking water and source water quality. Chapter 3 is targeted toward readers who are not familiar with federal and state drinking water and source water regulations and guidelines. Therefore, water utility personnel are likely already familiar with the material presented in this chapter.
- **Chapter 4** presents an overview of DMWW operations and discusses the key programs and systems that support these operations. Specifically, the chapter discusses DMWW's sample collection/analysis program, data management system, and communications/outreach program. It also discusses the integrated collection of software and hardware components that further supports DMWW's operations. This chapter is targeted toward all readers.
- **Chapter 5** presents a detailed case study of DMWW's EMPACT project. The chapter describes the three project phases in detail and discusses the EMPACT project area on DMWW's Web site. This chapter is targeted toward all readers.
- **Chapter 6** focuses on communications and outreach. The chapter discusses many of DMWW's communication/outreach efforts. Chapter 6 is targeted toward personnel tasked with implementing an outreach plan.
- **Appendix A** (PDF, 6.63MB) contains brochures and pamphlets related to DMWW's communication/outreach plan, including a Consumer Confidence Report. These materials are discussed in Chapter 6.
- **Appendix B** presents a glossary of terms used in the handbook. This glossary is targeted toward all readers.


EPA
Providing Timely Drinking Water and Source Water Quality Information to Your Community
Des Moines Water Works' Project
EMPACT

- **Appendix C** presents a brief case study of the EMPACT Water Quality Project implemented at the Water Quality Division of Tucson Water in Tucson, Arizona. This appendix is targeted toward all readers.
- **Appendix D** presents general guidance on creating a comprehensive outreach plan and provides a list of resources for presenting water quality information to the public. This appendix is targeted toward personnel tasked with implementing an outreach plan.

Throughout this handbook, you will find lessons learned and success stories related to DMWW's EMPACT project. You will also find references to supplementary information sources, such as Web sites, guidance documents, and other written materials that will provide you with a greater level of detail.

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3. Water Quality Monitoring—An Overview

All water—even from the healthiest rivers and lakes—contains naturally occurring substances from the soil, surrounding vegetation and wildlife, and biological, physical, and chemical processes. Some water sources may be contaminated by man-made chemicals or the byproducts of industrial processes. The purpose of water quality monitoring is to measure the presence and quantity of these constituents or parameters in water. This chapter introduces the concept and measurement of water quality from the perspective of drinking water utilities and discusses some of the regulations and guidelines that public water systems must follow to protect water quality.

Section 3.1 provides a general introduction to the concept of drinking water and source water quality monitoring related to drinking water utilities. Sections 3.2 and 3.3 discuss the federal and state regulations and guidelines that public water systems must follow to protect the quality of drinking water and source water, respectively. These sections also introduce the water quality monitoring and communication requirements associated with these regulations and guidelines.

TO LEARN MORE

To learn more about water quality, consult the following references and Web sites:

- EPA's Water Projects and Programs page at: http://www.epa.gov/epahome/waterpgram.htm.
- EPA's Office of Ground Water and Drinking Water (OGWDW) site at: http://www.epa.gov/safewater/.
- Drinking Water: Past, Present, and Future. USEPA/OW, February 2000, EPA 816-F-00-002.
- National Library of Medicine drinking water page at: http://www.nlm.nih.gov/medlineplus/drinkingwater.html.
- The National Agricultural Library Water Quality Information Center site at: http://www.nal.usda.gov/wqic.
- For questions about drinking water requirements under the Safe Drinking Water Act (SDWA), contact the Safe Drinking Water Hotline at (800) 426-4791 or via e-mail at hotline-sdwa@epa.gov.
- See Appendix D for additional references.

3.1 Introduction to Water Quality Monitoring

The quality of water affects how we are able to use it; conversely, the way we use our water can affect its overall quality. The federal government, states, and localities are all involved in the regulation, monitoring, and control of our nation's waters to protect the quality of water for its intended use. Therefore, it is important to distinguish between the quality of drinking water and the quality of source water.

PUBLIC WATER SYSTEMS

There are approximately 170,000 public water systems in the United States. EPA classifies these water systems according to the number of people they serve, the source of their water, and whether they serve the same people year-round or on an occasional basis. Public water systems, which may be either publicly or privately owned, provide water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serve an average of at least 25 people for at least 60 days per year. EPA has defined three types of public water systems:

Community Water System: A public water system that supplies water to the same population year-round. For example, the water system operated by DMWW (a water utility) is considered a community water system. There are approximately 54,000 community water systems operated in the United States.

Non-Transient Non-Community Water System: A public water system that regularly supplies water to at least 25 of the same people for at least six months per year, but not year-round. Some examples are water systems at schools, factories, office buildings, and hospitals. There are approximately 20,000 non-transient non-community water systems operated in the United States.

Transient Non-Community Water System: A public water system that provides water to at least 25 people per day in a place such as a gas station or campground where people do not remain for long periods of time. There are approximately 93,000 transient non-community water systems operated in the United States.

The federal and state regulations and guidelines designed to protect the quality of these waters are discussed in the following sections.

3.2 Regulation of Drinking Water

Federal regulation of drinking water quality began in 1914, when the U.S. Public Health Service set standards for certain disease-causing microbes. Today, water quality is protected by a variety of different regulations and guidelines.

Through the **Safe Drinking Water Act** (SDWA) established in 1974 and revised in 1986 and 1996, Congress authorized EPA to set enforceable health standards and required public notification of water utility violations and annual customer reports on contaminants found in drinking water. Under the authority of the SDWA, EPA sets standards for approximately 90 contaminants in drinking water. Currently, standards are set for the following:

- **Microorganisms**, including (but not limited to) *Cryptosporidium*, *Giardia lamblia*, *Legionella*, total coliforms (including fecal coliform and *E. coli*), and viruses. Although some of these contaminants occur naturally in the environment, most originate in human and animal fecal waste. Many of these contaminants can cause gastrointestinal illness if ingested. *Legionella* can cause Legionnaire’s disease.

- **Disinfectants and disinfection byproducts**, including (but not limited to) bromate, chloramines, chlorine, chlorine dioxide, chlorite, haloacetic acids, and total trihalomethanes. These contaminants are either water additives used to control microbes or byproducts of the disinfection process. Potential health effects vary with each contaminant; they range from eye/nose irritation, stomach discomfort, and anemia to liver, kidney, and nervous system effects and the increased risk of cancer.

- **Inorganic chemicals**, including antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, copper, cyanide, fluoride, lead, mercury, nitrate, nitrite, selenium, and thallium. These contaminants originate from a variety of different sources, including (but not limited to) discharges from industrial processes, erosion of natural deposits, corrosion of pipes, and runoff. Potential health effects are specific to each contaminant; they can include circulatory system problems, skin damage, intestinal polyps and lesions, increased blood pressure, kidney damage, nerve damage, thyroid problems, bone disease, and the increased risk of cancer.

- Various **organic chemicals**. As with the inorganic chemicals, these contaminants originate from a variety of different sources, including (but not limited to) discharges from industrial processes, agricultural and municipal runoff, and leaching from pipes. Potential health effects are specific to each contaminant; they can include kidney, liver, immune system, nervous system, circulatory system, and gastrointestinal problems, reproductive difficulties, anemia, and the increased risk of cancer.

- **Radionuclides**, including alpha particles, beta particles and photon emitters, Radium 226 and Radium 228, and uranium. These contaminants may originate through the erosion and decay of natural and man-made deposits. If ingested, they may potentially increase the risks of cancer. Uranium may also cause kidney toxicity.

For each of these contaminants, EPA sets a legal limit, called a maximum contaminant level (MCL), or requires a certain type of treatment. Water utilities may not distribute drinking water that doesn’t meet these standards. Most states have been delegated the authority to enforce the federal standards; state standards must be at least as strict as the federal standards.

National Primary Drinking Water Regulations are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of drinking water contaminants, including microorganisms, disinfectants and disinfection byproducts, inorganic chemicals, organic chemicals, and radionuclides. You can visit http://www.epa.gov/safewater/mcl.html for detailed information on the contaminants regulated by national primary drinking water regulations.

National Secondary Drinking Water Regulations are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. Examples of these contaminants include metals, pH, total dissolved solids, odor, and color. You can visit http://www.epa.gov/safewater/mcl.html for detailed information on the contaminants regulated by national secondary drinking water regulations. Although EPA recommends secondary standards to public water systems, the Agency does not require that these systems comply. States may, however, choose to adopt secondary standards as enforceable standards.

HEALTH EFFECTS

The health-related contaminants regulated by primary and secondary drinking water regulations fall into two groups according to the health effects they may cause:

Acute effects occur within hours or days of the time that a person consumes a contaminant. People can suffer acute health effects from almost any contaminant if they are exposed to extraordinarily high levels (as in the case of a spill). In drinking water, microbes such as bacteria and viruses are contaminants with the greatest chance of reaching levels high enough to cause acute health effects. Most people’s bodies can fight off these microbial contaminants; acute contaminants typically don’t have permanent effects. Nonetheless, when high levels occur, acute contaminants can make people ill and may be dangerous or deadly for the very young, the very old, or people with immune systems weakened by HIV/AIDS, chemotherapy, steroid use, or other reasons.

Chronic effects occur after people consume a contaminant at levels over EPA’s safety standards for many years. The drinking water contaminants that can have chronic effects are chemicals (such as disinfection by-products, solvents, and pesticides), radionuclides (such as radium), and minerals (such as arsenic). Examples of the chronic effects of drinking water contaminants can include cancer, liver or kidney problems, or reproductive difficulties.

3.2.1 Monitoring Drinking Water Quality

Water utilities perform a wide range of water quality monitoring to meet several purposes. First, water utilities routinely monitor and test public water systems to ensure compliance with the more than 90 contaminants for which EPA has set national primary drinking water regulations. Second, water utilities must also meet more stringent and additional monitoring requirements set by the individual states. Finally, water utilities conduct other routine monitoring as part of their day-to-day operations to ensure treatment effectiveness and to ensure that finished water quality meets both health and aesthetic objectives. This testing includes routine sampling as well as check sampling to confirm the results of any problems discovered during routine sampling. Monitoring locations and frequency are based on the parameters being monitored and are specific to each water utility based on its source water type, size, treatment process, and distribution system. Some drinking water parameters are monitored constantly while others are monitored only every few years.

The table on the following page shows the major groups of contaminants and the minimum testing frequency to comply with the monitoring requirements under EPA’s national primary drinking water regulations. If a problem is detected, there are immediate retesting requirements that go into effect and strict instructions for how the public is informed. The retesting is continued until the water system can reliably demonstrate that it is free of problems.

CONTAMINANT	MINIMUM MONITORING FREQUENCY
Acute Contaminants	
Bacteria	For community water systems, samples are collected

	throughout each monthly monitoring period, ranging from 1 sample per month to 480 samples per month depending on the system size. For non-community water systems, sampling is conducted once per quarter.
Protozoa and Viruses	Continuous monitoring for turbidity and monthly monitoring for total coliforms, as indicators.
Nitrate/Nitrite	Quarterly sampling for surface water systems and annual sampling for groundwater systems.
Chronic Contaminants	
Volatile Organics (e.g., benzene)	Quarterly sampling at each entry point into the water system, reduced to annual (or less frequent) sampling if no detects.
Synthetic Organics (e.g., pesticides)	Quarterly sampling at each entry point into the water system, reduced to annual (or less frequent) sampling if no detects.
Inorganics/Metals	For groundwater systems, sampling is conducted once every 3 years. For surface water systems, sampling is conducted annually.
Lead and Copper	Annual sampling is required, with the number of sites ranging from 5 to 100, based on the size of the system.
Radionuclides	Four consecutive quarters of sampling during initial annual compliance period; subsequent monitoring frequency is reduced if levels are below the detection limit.

Sample Compliance Monitoring Schedule Required Under EPA Regulations.

3.2.2 Public Notification of Drinking Water Violations

Federal regulations require that water utilities notify the people they serve when any violation of a drinking water contaminant standard has occurred or any other situation has occurred that may pose a short-term risk to health. As utilities test their water, they may discover that levels of certain contaminants are higher than federal or state standards. These conditions may occur due to a change in local water conditions, heavy rainstorms, or an accidental spill of a hazardous substance. Water utilities may also fail to collect one or a series of their required samples at the scheduled interval. Any time a water utility fails to meet any EPA or state standards for drinking water (including missing required samples or collecting them late), the utility must inform the people who drink the water.

Depending on the severity of the situation, water utilities have from 24 hours to 1 year to notify the people they serve of a violation. EPA specifies three categories, or tiers, of public notification. For each tier, water utilities have different amounts of time to distribute the notice and different ways to deliver the notice:

Immediate notice (Tier 1): Any time a situation creates the potential for immediate human health impacts, water utilities have 24 hours to take whatever steps are necessary to notify people who may drink the water. In these situations, water utilities must use mass media outlets such as television and radio, post their notice in public places, or personally deliver a notice to the people they serve.

Notice as soon as possible (Tier 2): Any time a water utility distributes water that hasn't been treated properly or contains contaminants at levels that exceed EPA or state standards, the utility must notify the people it serves as soon as possible, within 30 days of the violation as long as the situation does not pose an immediate risk to human health. The water utility must provide notice through the mail or via hand delivery to residences and through posting in conspicuous places for other persons served by the water system.

Annual Notice (Tier 3): When a water utility violates a drinking water standard but the violation does not have a direct impact on human health (for example, failing to take a required sample on time), the utility has up to 1 year to provide a notice of this situation to the people it serves. This extra time gives water utilities the opportunity to consolidate these notices and send them with annual water quality reports (Consumer Confidence Reports, described below).

Regardless of their tier classifications, all notices must include the following:

- A description of the violation that occurred, including the potential health effects.
- The population at risk and whether alternate water supplies should be used.
- What the water utility is doing to correct the problem.
- Actions consumers can take.
- When the violation occurred and when the water utility expects it to be resolved.
- How to contact the water utility for more information.
- Language encouraging broader distribution of the notice.

In addition to Tier 1 and Tier 2 notices, EPA requires that water utilities place annual drinking water quality reports into the hands of the people they serve. These reports, called Consumer Confidence Reports (CCRs), enable consumers to make practical, knowledgeable decisions about their health and their environment. Water utilities may enhance their reports as they wish; however, each report must provide consumers with fundamental information about their drinking water.

The first of these reports came out in 1999; water utilities now publish reports by July 1 every year. CCRs are the centerpiece of the "right-to-know" provisions in the 1996 Amendments to the SDWA. The Amendments contain several other provisions aimed at improving public access to information about drinking water, including the annual public water system compliance report and improved public notification in cases where drinking water is not meeting a contaminant standard. You can read more about these reports at http://www.epa.gov/safewater/ccr1.html. In addition, examples of CCRs from DMWW are included in Appendix A (PDF 6.63MB).

WHAT DETERMINES THE PUBLIC NOTIFICATION TIER?

The following violations, situations, or conditions require Tier 1, Tier 2, or Tier 3 notifications. For more information on the Public Notification Rule, visit http://www.epa.gov/safewater/pn.html.

Tier 1

- Fecal coliform violations; failure to test for fecal coliform after an initial total coliform sample tests positive.
- Nitrate, nitrite, or total nitrate/nitrite maximum contaminant level (MCL) violation; failure to collect a confirmation sample.
- Chlorine dioxide maximum residual disinfectant level (MRDL) violation in the distribution system; failure to collect required samples in the distribution system.
- Exceedence of the maximum allowable turbidity level (if elevated to Tier 1 by the primacy agency).
- Special notice for non-community water systems with nitrate exceedences between 10 mg/L and 20 mg/L, where the system is allowed to exceed 10 mg/L by the primacy agency.

- An outbreak of a waterborne disease or other waterborne emergency.
- Other violations or situations determined by the primacy agency.

Tier 2

- All MCL, MRDL, and treatment technique violations, except where a Tier 1 notice is required.
- Monitoring violations, if elevated to Tier 2 by the primacy agency.
- Failure to comply with variance and exemption conditions.
- Turbidity consultation: When public water systems have a treatment technique violation resulting from a single exceedence of the maximum allowable turbidity limit or an MCL violation resulting from an exceedence of the 2-day turbidity limit, they must consult their primacy agency within 24 hours. The primacy agency will then determine whether a Tier 1 notice is necessary. If consultation does not occur within 24 hours, the violation is automatically elevated to Tier 1.

Tier 3

- Monitoring and testing procedure violations, unless the primacy agency elevates the violation to Tier 2.
- Operation under a variance and exemption.
- Special public notices such as a fluoride secondary maximum contaminant level (SMCL) exceedence or the availability of unregulated contaminant monitoring results.

WHAT’S IN A CONSUMER CONFIDENCE REPORT?

CCRs must provide consumers with the following fundamental information about their drinking water:

- Identification of the lake, river, aquifer, or other drinking water source.
- A brief summary of the susceptibility of the drinking water source to contamination based on the source water assessments that states are currently completing.
- Directions on how to get a copy of the water system’s complete source water assessment.
- The level (or a range of levels) of any contaminant found in local drinking water along with EPA’s legal limit (MCL) for comparison.
- The likely source of that contaminant in the local drinking water supply.
- The potential health effects of any contaminant detected in violation of an EPA health standard and a description of the utility’s actions to restore safe drinking water.
- The compliance of the water system with other drinking water-related rules.
- An educational statement for vulnerable populations about avoiding *Cryptosporidium*.
- Educational information on nitrate, arsenic, or lead in areas where these contaminants are detected at levels greater than 50% of EPA’s standard.
- Phone numbers for additional sources of information, including the water utility and EPA’s Safe Drinking Water Hotline (800-426-4791).

3.3 Source Water

In contrast with drinking water, federal regulation of source water quality has been less detailed and has allowed for more flexibility in the monitoring and reporting of source water quality. While many states, water utilities, and localities have watershed and wellhead protection/management programs, the 1996 SDWA Amendments placed a new focus on source water quality. The 1996 Amendments require states to implement Source Water Assessment Programs (SWAPs) to assess areas serving as drinking water sources and identify potential threats to these sources. You can read more about source water assessments at http://www.epa.gov/safewater/protect/assessment.html.

By 2003, states are required to complete a source water assessment for every public water system. Each SWAP will be uniquely tailored to state water resources and drinking water priorities. However, each assessment must include four major elements:

- A delineation (or map) of the source water assessment area.
- The potential sources of contamination in the delineated area.
- The susceptibility of the water supply to those contamination sources.
- Public release of the assessment results.

State SWAPs have been reviewed and approved by EPA; states and localities are currently in the process of developing source water assessments. These assessment reports will be provided to the public in a variety of ways. Some states plan to convene public workshops, while others will have copies available at public libraries, local government offices, or water suppliers. Many states also plan to post the assessment summaries on the Internet. In addition, the results of the assessments will be included in the annual water quality reports that community water systems are required to prepare for the people they serve. You can find links to each state’s drinking water and source water protection pages at http://www.epa.gov/safewater/source/contacts.html.

In addition to the source water assessment requirements of the SDWA Amendments, all surface source waters are federally regulated by the Clean Water Act (CWA) and the rules and regulations that have been developed under that authority. The CWA impacts those sources (both point sources and nonpoint sources) that contribute pollutants to the nation’s surface waters. Point sources are stationary locations or fixed facilities from which pollutants are discharged. Nonpoint sources are diffuse sources of pollutants associated with land use or groundwater flow. Examples include runoff from agriculture, forestry, or urban activities. You can learn more about the CWA and all associated programs and requirements at http://www.epa.gov/ow.

3.3.1 Monitoring Source Water Quality

Typically, source water quality monitoring is conducted by water utilities to determine the quality of water feeding the water treatment system and adjust the treatment process based on raw water characteristics. In addition, many localities and water utilities conduct source water monitoring as part of their watershed and wellhead protection/management programs.

Water utilities are not required by the regulations under the Safe Drinking Water Act to provide source water quality monitoring results to either EPA or the public, but they may choose to do so through program-specific outreach products, such as Web sites.

CLEAN WATER ACT PROGRAMS THAT IMPACT SURFACE SOURCE WATER QUALITY

The Water Quality Criteria and Standards Program. This program includes a compilation of national recommended water quality criteria for the protection of aquatic life and human health for approximately 150 pollutants. These criteria have been published pursuant to Section 304(a) of the CWA and provide guidance for states and tribes to use in adopting water quality standards. These water quality criteria cover the following types: aquatic life, biological, drinking water, human health, and nutrient. You can find out more about this program at http://www.epa.gov/waterscience/standards.

The National Pollutant Discharge Elimination System (NPDES) Permitting Program. This program requires that all point sources discharging pollutants into waters of the United States obtain an NPDES permit. These permits implement water quality standards and effluent limitations guidelines that have been developed for specific industrial categories. You can find out more about this program at http://cfpub.epa.gov/npdes/.

Nonpoint source programs such as the Total Maximum Daily Load (TMDL) Program. Under Section 303(d) of the CWA, states, territories, and authorized tribes are required to develop lists of impaired waters. These impaired waters do not meet water quality standards that states, territories, and authorized tribes have set for them, even after point sources have installed minimum required levels of pollution control technology. The TMDL rule requires that these jurisdictions establish priority rankings for waters on the list and develop TMDLs for these waters. A TMDL not only specifies the maximum amount of a pollutant (its loading) that a water body can receive and still meet water quality standards but also allocates pollutant loadings among point and nonpoint sources. While TMDLs have been required by the CWA since 1972, until recently states, territories, tribes, and EPA have not developed many. Several years ago, citizens' organizations began bringing legal actions against EPA seeking the listing of waters and the development of TMDLs. To date, there have been about 40 legal actions in 38 states, and EPA is under court order or consent decrees in many states to ensure that TMDLs are established, either by the state or by EPA. Currently, EPA is working to develop changes to the TMDL regulations. Until then, the current TMDL rule remains in effect. You can find out more about this program at http://www.epa.gov/owow/tmdl and at http://www.epa.gov/owow/nps.

EPA's Clean Lakes Program. The Clean Lakes Program was established in 1972 as Section 314 of the Federal Water Pollution Control Act to provide financial and technical assistance to states in restoring publicly owned lakes. The early focus of the program was on research and development of lake restoration techniques and evaluation of lake conditions. The Clean Lakes Program regulations promulgated in 1980 redirected the program activities to diagnose the current conditions of individual lakes and their watersheds, determine the extent and sources of pollution, develop feasible lake restoration and protection plans, and implement these plans. The CWA Amendments of 1987 expanded the program to include state-wide assessments of lake conditions. EPA has encouraged states to use these assessment funds to develop the institutional and administrative capabilities needed to carry out their lake programs. You can find out more about this program at http://www.epa.gov/owow/lakes.

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4. Des Moines Water Works

DMWW is the largest municipal water utility in the state of Iowa. Serving over 350,000 people, DMWW operates two water treatment plants and pumps an average of 43 million gallons of water per day. This chapter briefly discusses many of the day-to-day operations conducted at DMWW and introduces some of the key programs and systems that support DMWW's operations.

4.1 Overview of DMWW Operations

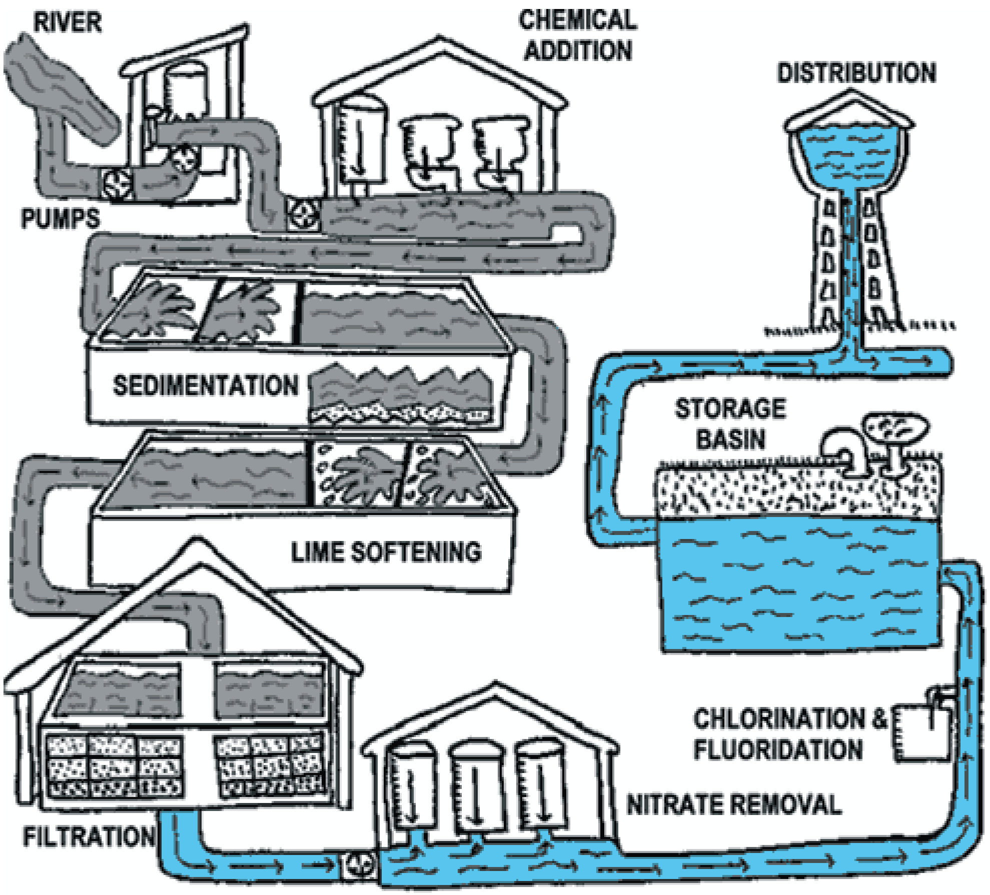
DMWW is located on the banks of the Raccoon River in the city of Des Moines. The utility draws source water from the Raccoon River, the Des Moines River, an infiltration gallery, and several wells. The infiltration gallery is a large horizontal well constructed in the sand and gravel adjacent to the Raccoon River. It yields river water and groundwater that have been naturally filtered through the sand and gravel. DMWW selected these source water supplies based on the quality of these waters and the utility's ability to treat these waters.

DMWW maintains an emergency supply of source water in the Maffitt Reservoir. This reservoir, constructed for DMWW during the 1940s, is located southwest of the Des Moines metropolitan area within 600 acres of wooded land; the area is popular for fishing and hiking. To enhance the quality of water in the reservoir, DMWW recently purchased 105 acres of surrounding farmland to provide watershed protection.

DMWW operates two drinking water treatment plants: the Fleur Drive plant and the Maffitt plant. The Fleur Drive plant (considered the main plant) has the capacity to treat 100 million gallons of source water per day. It is operated by DMWW staff on a continuous basis. The Maffitt plant was constructed to address reliability issues that arose when a serious flood put the Fleur Drive plant underwater and out of service in 1993. In addition to providing a backup for the main plant, the Maffitt plant provides an additional 25 million gallons of drinking water per day for the growing Des Moines population. The Maffitt plant is in service on a continuous basis; it is adjacent to the Maffitt Reservoir, located about 10 miles southwest of the main plant, outside of the Raccoon River flood plain. Typically, DMWW operates the Maffitt plant remotely.

Both of DMWW's treatment plants use a multi-step process to treat source water. The typical treatment process used at the Fleur Drive plant is illustrated in the diagram on page 18 and briefly described below.

- Source water for the Fleur Drive plant is obtained from the Raccoon River, the Des Moines River, and the infiltration gallery system.
- Powdered activated carbon is fed into river water to remove man-made and natural organic chemicals (thereby improving the taste and odor). Ferric chloride is added to remove particulates. The pre-treated river water is then combined with water from the infiltration gallery.
- The combined water is softened with soda ash and/or lime. Alum or ferric chloride is added to remove minerals and other particles from the softened water.



Typical treament process used at DMWW's Fleur Drive Plant

The pH of the water is adjusted with carbon dioxide, and the water is stabilized with polyphosphate.

The water is filtered through layers of sand to remove any remaining particles.

When increased levels of nitrate are possible in river water, DMWW treats the water in its nitrate removal process.

Fluoride is added to the water to aid in the prevention of tooth decay, and chlorine is added as a disinfectant to kill bacteria. The treated drinking water is stored in a clear well until it is pumped into the distribution system.

Water at the Maffitt plant is treated using a similar multi-step process. Because source water for this plant is usually obtained exclusively from wells, DMWW does not pre-treat this water as it does river water. Also, DMWW does not operate a nitrate removal process at the Maffitt plant because nitrate is typically found at low levels in the well water.

Through more than 800 miles of underground water mains and pipe (both iron and plastic), DMWW distributes drinking water from both treatment plants to the Des Moines metropolitan community. DMWW provides total water service (including distribution system maintenance) to the city of Des Moines, Polk County, Windsor Heights, and the Warren County Water System. Through this total water service, DMWW performs preventative maintenance on all valves and hydrants, detects main leaks, repairs main breaks, and replaces and repairs valves and hydrants. In addition, the utility reads meters, makes service calls, prepares bills, and responds to customer service inquiries. DMWW also supplies water to several other cities, communities, and water systems. For example, the utility maintains a partnership with the city of Ankeny. Through this partnership, DMWW provides drinking water, reads meters, manages billing, and responds to customer service inquiries while the city of Ankeny makes service calls and maintains its own distribution system.

In addition to its drinking water treatment and distribution responsibilities, DMWW operates the Water Works Park, about 1,500 acres of land near downtown Des Moines.

4.2 Support Programs and Systems

DMWW relies on several programs and systems to support its day-to-day operations. Sections 4.2.1 through 4.2.3 discuss a few of DMWW's key support programs and systems: the sample collection/analysis program, the data management system, and the communications/outreach program. All of DMWW's operations are further supported by an integrated collection of software and hardware components; this support system is discussed in Section 4.2.4.

4.2.1 Sample Collection/Analysis

DMWW monitors the quality of its drinking water and source water to satisfy both treatment process control and regulatory requirements. (See Chapter 3 for a discussion of applicable regulatory requirements and guidelines.) The utility maintains an in-house laboratory to conduct a variety of analyses on its water samples. To ensure that data are accurate and representative, DMWW follows a comprehensive set of procedures for sampling and laboratory quality assurance/quality control (QA/QC); many of these procedures are required by EPA. DMWW has a quality assurance project plan (QAPP) in place to document its adherence to these procedures.

DMWW'S QUALITY ASSURANCE PROJECT PLAN (QAPP)

DMWW's QAPP provides a detailed framework for the utility's sampling and analytical procedures. Specifically, DMWW's QAPP covers the following:

- The laboratory mission, organizational structure, personnel, the physical facility, laboratory reagents and supplies, reagent standardization, contamination control, and laboratory safety.
- Standard sampling procedures, acceptance criteria, chain-of-custody, a sampling plan for softening analyses, non-routine sampling, and on-site analysis.
- Inorganic, organic, and microbiological analytical procedures.
- Data quality assurance.
- Preventative equipment maintenance schedules, routine maintenance procedures, instrument performance and optimization, protocol for correcting equipment problems, and equipment use and maintenance record-keeping.
- Equipment inventory.

The Hach® 1720D Process Turbidimeter

The Hach® CL-17 Chlorine Analyzer

DMWW collects and analyzes samples within its water treatment and distribution system. The table below lists the drinking water parameters typically monitored by DMWW. Asterisks identify the parameters monitored to fulfill regulatory requirements for DMWW's drinking water. [Note that the parameters marked with asterisks do not add to the 90 federally regulated parameters because some listed parameters (e.g., HAAs, SOCs, VOCs) represent more than one standard and others have been omitted because subsequent monitoring has been waived or is very infrequent.] Monitoring frequency (monthly, weekly, daily, or continuous) varies with each analysis. The utility uses Hach® CL-17 analyzers to monitor chlorine levels and Hach® 1720D analyzers to monitor turbidity levels in its drinking water. These analyzers are connected, with other treatment process control monitors, to DMWW's supervisory control and data acquisition (SCADA) system. The SCADA system is equipped with data monitors and alarms with pre-set parameter levels to assist DMWW's water production personnel with monitoring the treatment system around the clock.

DMWW also periodically collects and analyzes source water samples. The table on the next page lists the source water parameters that are typically monitored by DMWW. When the utility is operating its nitrate removal process, DMWW monitors Nitrate-N to fulfill the requirements of its state operating permit. Monitoring frequency (monthly, weekly, daily, or continuous) varies with the source water type and location and each analysis. Samples are collected from selected sites ithin the Raccoon River and Des Moines River watersheds, wells, and the Maffitt Reservoir.

DRINKING WATER PARAMETERS TYPICALLY MONITORED BY DMWW

Acetochlor*	Conductivity	Mercury*	Sulfate*

Antimony*
Arsenic*
Atrazine*
Barium*
Bromide
Cadmium*
Calcium hardness
CCPP*
Chloride
Chlorine
Chromium*

Copper
Cryptosporidium
*E. coli**
Fluoride*
HAAs*
HPC*
Iron
Langalier's Index
Lead*
Manganese
Magnesium hardness

Metolachlor*
Nitrate-N*
Nitrite-N*
Odors
O-phosphate
P-alkalinity
pH*
Potassium
Radionuclides*
Selenium*
SOCs*
Sodium

SUVA*
Temperature
Thallium*
THMs*
TOC*
Total coliforms*
Total hardness
Turbidity*
UV-254*
VOCs*

**Parameters collected to fulfill regulatory requirements are marked with asterisks.*

SOURCE WATER PARAMETERS TYPICALLY MONITORED BY DMWW

Acetochlor
Ammonia
Atrazine
Bromide
Calcium hardness
Chloride
Copper
Cryptosporidium
E. coli
Fluoride
HPC

Iron
Lead
Manganese
Magnesium hardness
Metolachlor
Nitrate-N*
Nitrite-N
O-phosphate
Odors
P-alkalinity
pH

Potassium
Sodium
Sulfate
SUVA
Temperature
TOC*
Total coliforms
Total hardness
Turbidity*
UV-254

**Parameters collected to fulfill regulatory requirements are marked with asterisks.*

URBAN RUNOFF STUDIES

DMWW conducted a series of urban runoff studies to determine the microbial and chemical influences of main urban creek watersheds on the utility's source waters. Each of DMWW's source water rivers has a primary urban creek (Walnut Creek for the Raccoon River and Beaver Creek for the Des Moines River) with a branch that not only meanders through residential and business areas but also extends beyond these areas into agricultural land. Walnut Creek is multi-branched and eventually empties into the Raccoon River 2 miles upstream of DMWW's water intake. Beaver Creek has one main creek channel plus a small branch. The mouth of Beaver Creek is located 3 miles upstream of DMWW's Des Moines River water intake.

DMWW conducted its urban runoff studies over a 2-3 year period. To determine the microbial and chemical influences of these creeks, DMWW tested creek water for total *E. coli* counts, nitrate, ammonia, and other chemistry determinations. Samples were collected by a DMWW laboratory technician during a rainfall event. DMWW performed the creek sampling using two different approaches. One approach was to sample water from the creek mouth, water from the river upstream from the creek, and water from DMWW's downstream intake. The second approach involved a complete or nearly complete study that used the basic approach above but included several other creek monitoring sites. DMWW selected 12 mapped sampling sites for the Beaver Creek watershed and up to 20 mapped sampling sites for the Walnut Creek watershed.

The results of DMWW's urban creek studies indicate that bacterial contamination of Des Moines urban creeks sometimes significantly affects the bacterial counts found in DMWW's source water rivers, despite the relatively small amounts of flow from these creeks. DMWW determined that the high bacteria levels in urban creeks are likely the result of pet and wild animal waste deposited in Des Moines metropolitan storm sewers; however, DMWW did locate more than one broken sewer line during its studies. DMWW's results also indicate that urban runoff accounts for very little of the nitrate measured in the utility's source water.

4.2.2 Data Management

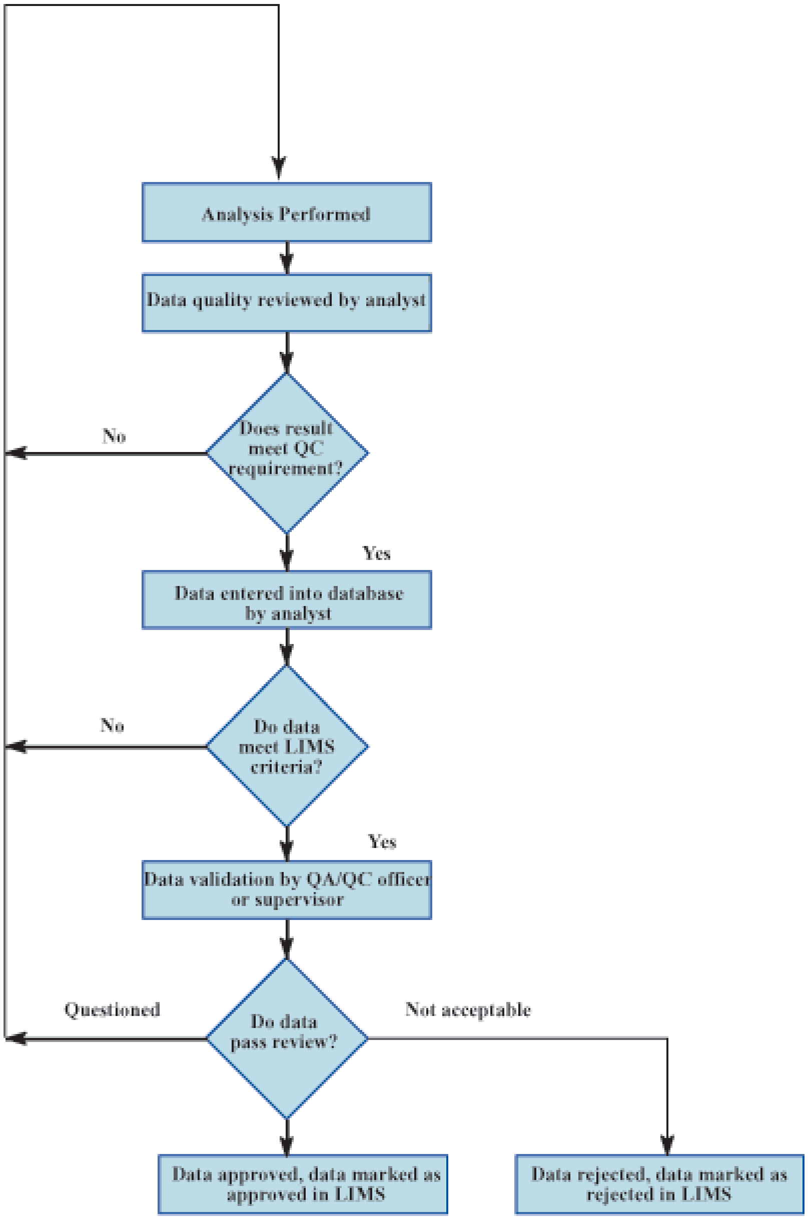
DMWW carefully manages and validates its monitoring data to ensure that only data of known and documented quality are used to make environmental and operational decisions. DMWW's data validation process is illustrated in the flow diagram on page 23.

Data management begins with DMWW's laboratory analyst. All sample analyses must adhere to the laboratory QA/QC procedures documented in DMWW's QAPP. The laboratory analyst enters data that meet these requirements and the QC measurements made during the analysis into a laboratory information management system (LIMS). The LIMS automatically compares the data (both the analytical result and the QC measurements) to a range of acceptable values that DMWW has pre-programmed into the LIMS. The system flags data as suspect if they do not fall within the range. The laboratory analyst carefully reviews the data she has entered to ensure that she has not made a typographical error. The control range feature in the LIMS can help the analyst quickly identify suspect or erroneous data during her review.

After DMWW's data have been reviewed by the laboratory analyst, these data are validated by either DMWW's QA/QC officer or QA/QC supervisor. These personnel conduct their validation reviews in light of their extensive experience with the operation and control of DMWW's treatment process, historical trends in DMWW's water quality, and close communication with DMWW's treatment process operators and supervisors. Specifically, the QA/QC officer and QA/QC supervisor perform the following types of analyses:

- Compare data within the LIMS control range with hard-copy analytical results to locate any incorrectly transcribed data that may have still fallen within the LIMS control range and were therefore not detected by the laboratory analyst.
- Review records and documentation to ensure that samples were collected and analyzed correctly.
- Review data in light of historical water quality measurements, treatment process expertise, and other known factors that may affect the values of certain parameters. During this review, the QA/QC officer or supervisor determine whether or not the data seem logical.

When his review is complete, either the QA/QC officer or the QA/QC supervisor marks validated data as "approved" in the LIMS. Because the LIMS package allows for the validation of individual analytical results, DMWW can approve one result and reject another result measured in the same sample. In some cases, DMWW may collect additional samples and/or repeat laboratory analyses to replace certain erroneous results. DMWW's data management process can take anywhere from a few hours to one week, depending on the staff available to perform the separate data reviews. Data are prioritized for review based on the significance of the results to the operation of DMWW's water treatment process.


Analysis Performed
Data quality reviewed by analyst
Does result meet QC requirement?
No
Yes
Data entered into database by analyst
Do data meet LIMS criteria?
No
Yes
Data validation by QA/QC officer or supervisor
Do data pass review?
Questioned
Not acceptable
Data approved, data marked as approved in LIMS
Data rejected, data marked as rejected in LIMS

DMWW's Data Validation Process

4.2.3 Communication and Outreach

DMWW follows a comprehensive plan for communication and outreach. Through this plan, DMWW uses several different mechanisms and products to convey information to the Des Moines metropolitan community. See Chapter 6 for more detailed information about DMWW's outreach plan. Some of DMWW's communications/outreach products and mechanisms are briefly introduced below.

The Monthly Newsletter: H2O Line. DMWW's monthly newsletter provides DMWW's customers with information on current issues related to drinking water and source water quality.

Annual Consumer Confidence Report. DMWW's June newsletter typically functions as a Consumer Confidence Report (CCR). The CCR, required by federal drinking water regulations, enables DMWW community residents to make practical, knowledgeable decisions about their health and their environment. See Chapter 3 of this handbook for more information on the CCR and the federal regulations that require its publication.

Welcome Brochure. DMWW sends a "Welcome" brochure to all of its new customers. The pamphlet contains a variety of useful introductory information, including billing and payment options, a description of DMWW's treatment process, information about the services provided by DMWW, and applicable rules/regulations.

Annual Business Report. The main goal of DMWW's annual report is to present financial information to its customers; however, DMWW also includes a few pages of educational materials in the report. The content of these materials depends on issues and concerns of the current year.

Other Outreach Mechanisms. DMWW visits area schools to teach children of all grade levels about drinking water and source water. The utility also offers tours of its facilities to school children and adults. DMWW prepares technical outreach information for conferences held by organizations such as the American Water Works Association. In addition, the utility has prepared a series of fact sheets to answer specific questions from its customers.

The DMWW Web Site. DMWW uses its Web site (http://www.dmww.com) to communicate a wide variety of information to the Des Moines community.

4.2.4 Software and Hardware Systems

DMWW operates an integrated collection of software packages and hardware devices designed and programmed to compile, manage, retrieve, and post data and information in support of DMWW's day-to-day operations. This integrated system consists of three general components: the database server, the firewall, and the Web server. Consider these definitions:

- **Database Server.** A database server hosts a database management system, a software package that allows users to store and modify information in a database.
- **Firewall.** A firewall is either a hardware device, a software package, or a combination of these mechanisms designed to protect internal computer systems from intentional, hostile intrusion from outside sources.
- **Web Server.** A Web server hosts a software system that allows for data delivery to outside users over the Internet or internal users over an Intranet.

These system components are briefly discussed below.

Database Server

DMWW uses a database server to support both regulatory and treatment process control requirements for data compilation and management. DMWW's database server, a Hewlett-Packard® UXTM™ workstation, hosts an Oracle™ DBMS (Version 7.3.2) to manage the utility's drinking water and source water data. The Oracle™ database is relational, which means that it allows DMWW to store data in the form of related tables. As discussed previously, DMWW also uses a laboratory information management system (LIMS) package developed by PE Nelson to support its analytical data management requirements. DMWW selected the PE Nelson LIMS package based on its ease of use, system security features, flexibility, minimal hardware and equipment requirements, and compatibility with the utility's existing Oracle™ DBMS.

A request to extract information from the database is made in the form of a query. Although different database management systems support different types of query languages, Structured Query Language (SQL) is typically considered to be the most common format for constructing queries. DMWW's Oracle™ DBMS supports SQL (PL/SQL); DMWW personnel write code in SQL to query data.

DMWW personnel perform all DBMS maintenance and management. The utility has found that this maintenance can be very time consuming. DMWW's QA/QC officer dedicates at least 30 percent of his time to maintaining and managing DMWW's DBMS; he feels that the system typically requires about 50 percent of his time. DMWW conducts daily, monthly, and annual tape backups of all data on its internal network; archived data are stored in a secure location. The utility's monthly archives are maintained for 2 years. DMWW never discards its annual archives.

Firewall

DMWW uses a Borderware™ firewall to protect its internal computer systems and Web site. A firewall examines all data traffic between two networks to determine if the traffic pattern meets certain criteria for security. If the criteria are met, the firewall allows data to flow between the networks. If the criteria are not met, the firewall halts the data transmission. A firewall can filter both inbound and outbound data traffic using a variety of filtering techniques.

Web Server

DMWW's Web server allows DMWW to serve data over the Internet using Hyper Text Markup Language (HTML), a program language used for publishing information on the Web.

DMWW’s Web server hosts its Web site, which provides a location on the Internet for the utility’s customers to access information. DMWW has an existing high-speed Internet connection and a fully functioning Web site to communicate with its customers.

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5. DMWW's EMPACT Project

In 1998, EPA’s EMPACT program funded DMWW’s EMPACT project, which provides Des Moines metropolitan community residents with timely information about the factors that affect their drinking water supply. This project is designed to enhance DMWW’s day-to-day operations and community outreach program, in part, through the delivery of timely drinking water and source water quality information. The project strives to encourage Des Moines residents, as well as the entire watershed community, to assume a larger role in restoring and preserving the quality of community source waters.

This chapter presents a case study of DMWW’s EMPACT project. Section 5.1 discusses the project phases. Section 5.2 discusses DMWW’s EMPACT project Web site.

5.1 DMWW's EMPACT Project Phases

DMWW’s EMPACT project is broken into three phases:

- Phase I is associated with the Web posting and updating of timely **drinking water** quality information.
- Phase II is associated with the Web posting and updating of timely **source water quality** information and supporting static information and documents.
- Phase III is associated with the Web posting of static results from DMWW’s **urban runoff studies.**

These phases are discussed in detail below.

5.1.1 DMWW EMPACT Project—Phase I

Phase I of DMWW’s EMPACT project focuses on the posting and updating of timely drinking water quality data to the EMPACT project area of DMWW’s Web site. The table on page 28 presents the parameters and sampling frequencies for the Phase I data that are available on DMWW’s project Web site. DMWW selected this subset of parameters based on what the utility felt would be of greatest interest to the Des Moines metropolitan community.

All drinking water data associated with the EMPACT project are validated and processed through DMWW’s data management system (discussed in Chapter 4). Overall, DMWW’s data management process has not been enhanced to support the utility’s EMPACT project; DMWW has always required timely water quality data to effectively operate its treatment system. DMWW’s EMPACT project does not directly increase or decrease the amount of time required to perform data validation; however, the implementation of the EMPACT project may in some cases require additional resources for QA/QC reviews.

All validated data are available for extraction and posting to the EMPACT project area of DMWW’s Web site. Data that fail any of the data management review steps are marked as suspect or rejected; these data are not delivered to the public. Data are prioritized for review based on the significance of the results to the operation of the water treatment process. To ensure that most data are available to Web users within 1 week of collection, DMWW follows a review schedule (e.g., the QA/QC officer or supervisor plans to review data on Wednesday and Friday of each week).

PARAMETER	REGULATED‡	SAMPLING FREQUENCY
Alkalinity (Total)		Daily
Carbonate Precipitation Potential		Weekly
Calcium Hardness as CaCO		Daily

3		
Chloride		Weekly
Chlorine (Free)	✓	Continuous online
Conductivity		Weekly
Cryptosporidium		Monthly
Fluoride	✓	Daily
Heterotrophic Plate Count Bacteria	✓	Daily
Langeliers Index		Weekly
Magnesium Hardness as $CaCO_3$		Daily
Metals (potassium, sodium, iron, manganese)		Monthly
Metals (lead, copper)	✓	Monthly
Nitrate - N	✓	Weekly/daily when near MCL
Nitrite - N	✓	Weekly
Ortho-Phosphate		Weekly
Pesticides (Metolachlor, Acetochlor, Atrazine)	✓	Weekly (April-October)
pH		Daily
Silica (Reactive)		Annually
Sulfate		Weekly
Temperature		Daily
Total Dissolved Solids (TDS)		Weekly
Total Hardness as $CaCO_3$		Daily

Total Coliforms	✓	Daily
Total Organic Carbon (TOC)		Weekly
Total Trihalomethanes	✓	Weekly
Turbidity	✓	Continuous online

‡Regulated constituents must be reported to the Iowa Department of Natural Resources (IDNR) as part of a regular compliance program. Unregulated constituents are monitored for general water quality and treatment process information but not reported to the IDNR.

Timely data for these drinking water quality constituents are available on the EMPACT project area of DMWW's Web site.

VALIDATING TIMELY DATA

The analysis of drinking water is well regulated and conducted by certified laboratories using EPA-approved methods. A very important part of the data management process is data validation, which must occur before drinking water sample results can be considered final and ready for public release. The reason for this part of the process is to avoid the unnecessary public concern that would occur if invalid positive results were released and then found to be incorrect. For most parameters, the data validation process can occur in only a few days. Thus, in this context, timely data is that which minimizes the time between the generation of validated sample results and the availability of these results to the public. Typically, the time between sampling drinking water and providing the validated sampling results to the public can range from a few days to a maximum of 3 weeks.

To increase the timeliness of water quality data available to the Des Moines community, DMWW could post "provisional" data to the EMPACT project area of its Web site shortly after laboratory analysis. Although provisional data have met the QA/QC requirements for sample collection and laboratory analysis, these data are not validated. DMWW has chosen not to post provisional data to its Web site because the utility feels that the potential disadvantages of posting erroneous data (e.g., causing unnecessary community alarm) outweigh the advantages of increasing the timeliness of these data.

During the design and construction of Phase I, DMWW dedicated its resources to developing the data delivery approach, technical systems, and communications/outreach goals required to support all phases of its EMPACT project. DMWW spent approximately 2 years completing the design and construction of Phase I.

During the design of the data delivery approach and technical systems, DMWW analyzed its hardware and software systems to determine the utility's existing technical resources and expertise, identify the key technical issues to be addressed during EMPACT project design, and identify potential technical challenges. After fully evaluating its existing systems, DMWW chose to dedicate a significant portion of its EMPACT project funding to support the skilled technical labor (both internal and external) necessary create a new DMWW EMPACT project area on the utility's existing Web site and build the mechanisms necessary to deliver timely data to that site.

First, DMWW replaced its existing Web server. The new server runs Microsoft® Internet Information Server (IIS) 4.0™. DMWW selected Microsoft® IIS 4.0™ because it provides the utility with a platform for building more sophisticated Internet applications. At first, DMWW attempted to create an electronic link from the new Web server to its existing Oracle™ database. However, this link proved to be both unreliable and inefficient. DMWW suspects that these issues arose due to certain differences in communication between the Oracle™ and Microsoft® systems. To resolve these differences, DMWW converted an existing SQL Server database into a staging area for the data and electronically linked this database to the Web server. Each night, approved data are extracted from DMWW's Oracle™ database and stored in the SQL Server database. When a user requests information from the EMPACT project area on DMWW's Web site, these data are pulled from the SQL Server database. See Section 5.2 for more information on DMWW's Web site.

In some ways, DMWW's decision to modify some of its existing technical components conserved funding and resources: DMWW was not required to purchase many significant pieces of hardware and software to support its EMPACT project. In other ways, DMWW's decision resulted in some challenges: DMWW and its contractors were required to dedicate extra resources to closely examine and redesign specific features of the existing technical components to create a fully functional and compatible data delivery system.

While designing the data delivery system, DMWW considered its available technical resources (both internal and external) to support not only the design and development of the system but also the long-term implementation of the system. DMWW's project phasing approach allowed the utility to dedicate a portion of its internal technical resources to the EMPACT project while the utility conducted other important non-EMPACT information systems tasks (such as ensuring the Y2K compliance of DMWW's computer systems).

5.1.2 DMWW's EMPACT Project—Phase II

When Phase I of DMWW's EMPACT project was fully implemented, DMWW and its technical contractors modified the Phase I system to support the Phase II delivery of timely source water quality data to community residents. DMWW then dedicated its available technical resources to post key pieces of static data to the EMPACT project area on the utility's Web site to fully implement the subsequent components of Phase II.

Phase II includes the following three components:

- Component I focuses on the posting and updating of timely source water quality data to the EMPACT project area on DMWW's Web site. The complete implementation of this component took only a few weeks because it uses the data delivery approach and technical systems developed for Phase I.
- Through Component II, DMWW places its annual CCR on its Web site. DMWW's CCR enables Des Moines metropolitan community residents to make practical, knowledgeable decisions about their health and their environment. Refer to Chapter 6 for more information on DMWW's CCR, and refer to Chapter 3 for more information on the federal regulations that require its publication.
- Component III provides relevant data extracted from the Iowa Department of Natural Resources (IDNR) source water assessment program (SWAP), which was developed in compliance with Section 1453 of the Safe Drinking Water Act (SDWA). See Chapter 3 for more information on the SWAP and the SDWA.

The table on page 31 presents the parameters and sampling frequencies for the Phase II data available on the EMPACT project area of DMWW's Web site. DMWW selected this subset of parameters based on what the utility felt would be of greatest interest to the Des Moines metropolitan community.

Through the execution of Phase II of its EMPACT project, DMWW procured and installed two early-alert source water monitoring stations at the Racoon River intake and the Des Moines River intake. DMWW uses these monitoring stations to provide treatment plant operators with as much warning as possible when rapid changes in source water quality warrant immediate modifications to the drinking water treatment process. Each early-alert monitoring station contains four Hach® water analyzers to monitor nitrate, ammonia, pH, and turbidity.

Using the early-alert analyzers, DMWW collects and analyzes source water samples for nitrate every 2.5 minutes, samples for ammonia every 7.5 minutes, and samples for pH and turbidity continuously. The analyzers are currently programmed to collect and analyze samples at their maximum frequencies; however, DMWW may consider decreasing the monitoring frequency to reduce costs in the future. The early-alert analyzers are connected, with other treatment process control monitors, to DMWW's SCADA system. Data from these analyzers are not available on the EMPACT area of DMWW's Web site.

PARAMETER	SAMPLING FREQUENCY
Alkalinity (Total)	5/week
Ammonia - N	Weekly*
Calcium Hardness as $CaCO_3$	5/week

Chloride	Weekly
Cryptosporodium	Monthly
E. coli	5/week
Fluoride	Weekly
Heterotrophic Plate Count Bacteria	5/week
Magnesium Hardness as $CaCO_3$	5/week
Metals (potassium, sodium, iron, manganese, lead, copper)	Weekly
Nitrate - N	Weekly/daily when near MCL*
Ortho-Phosphate	Weekly
Pesticides (Metolachlor, Acetochlor, Atrazine)	Weekly (April-October)
Sulfate	Weekly
Temperature	5/week
Total Hardness as $CaCO_3$	5/week
Total Coliforms	5/week
Total Organic Carbon (TOC)	Weekly
Turbidity	5/week*

Timely data for these source water quality constituents are available on the EMPACT project area of DMWW's Web site.

*Note: Frequencies marked with an asterisk are for manual monitoring only. These parameters are monitored on a more frequent basis using automatic analyzers. Only the manual monitoring data are available on the EMPACT area of DMWW's Web site.

DMWW has found that maintenance of the Hach® early-alert analyzers can be very time-consuming. During the spring and summer, DMWW must repeatedly clean mud from the analyzers due to the seasonal turbidity increase in area source water rivers. The utility spends at least 1 hour per day cleaning and maintaining the analyzers at each station during this part of the year. During the fall and winter, the utility spends about 1 hour every 2 weeks maintaining the analyzers at each station.

HACH® ANALYZER	**WATER QUALITY PARAMETER**
APA 6000	Nitrate

APA 6000	Ammonia
EC 310	pH
Surface Scatter 6	Turbidity

The Hach® APA 6000 Series Analyzer.

The Hach® EC 310™ pH Monitor.

The Hach® Surface Scatter 6 Turbidimeter

The nitrate and ammonia analyzers are self-calibrating; DMWW reviews the calibration periodically. DMWW manually calibrates the pH and turbidity analyzers each month. Because the Hach® analyzers are modular instruments, DMWW can repair the analyzers on site simply by removing and replacing the broken part. DMWW keeps a large supply of spare parts on site to support routine and emergency replacements.

THE CHALLENGES OF REAL-TIME QA/QC

The data provided by the early-alert analyzers have allowed DMWW to become more proactive in modifying its treatment process in response to sudden changes in source water quality. However, DMWW is still developing a QA/QC protocol for using these analyzers. When an early-alert analyzer indicates a sudden change in source water quality, DMWW water production personnel immediately collect and analyze a manual sample to verify the reading for that parameter. However, when the analyzers indicate a very large change in source water quality, DMWW personnel sometimes modify the water treatment process prior to verifying the analyzer reading. To develop a continuing log of accuracy measurements, DMWW programs its analyzers to collect periodic quality samples. For every seven source water samples analyzed, the analyzer will collect one sample from a separate intake line that DMWW has connected to a sample of water with a known quantity of parameters. DMWW periodically checks the results of the QC sample to ensure the accuracy of the analyzer readings. With time, DMWW hopes to decrease the amount of manual and QC samples it takes to verify the accuracy of its early-alert analyzers.

5.1.3 DMWW's EMPACT Project—Phase III

Through the execution of Phase III of its EMPACT project, DMWW will post the results from its urban runoff studies to the EMPACT project area of its Web site to enable its customers to observe the effects of urban watersheds on the quality of their drinking water. As discussed in Chapter 4, the urban runoff studies attempted to determine the microbial and chemical influences of main urban creek watersheds on the utility’s source waters. DMWW expects to post the results of these studies on its Web site by spring 2002.

When Phase III of the EMPACT project has been fully implemented, DMWW will dedicate its available technical resources to operating, maintaining, and periodically enhancing its EMPACT project data delivery system and Web site, while continuing to support other important day-to-day information systems tasks (such as redesigning the utility’s electronic billing system).

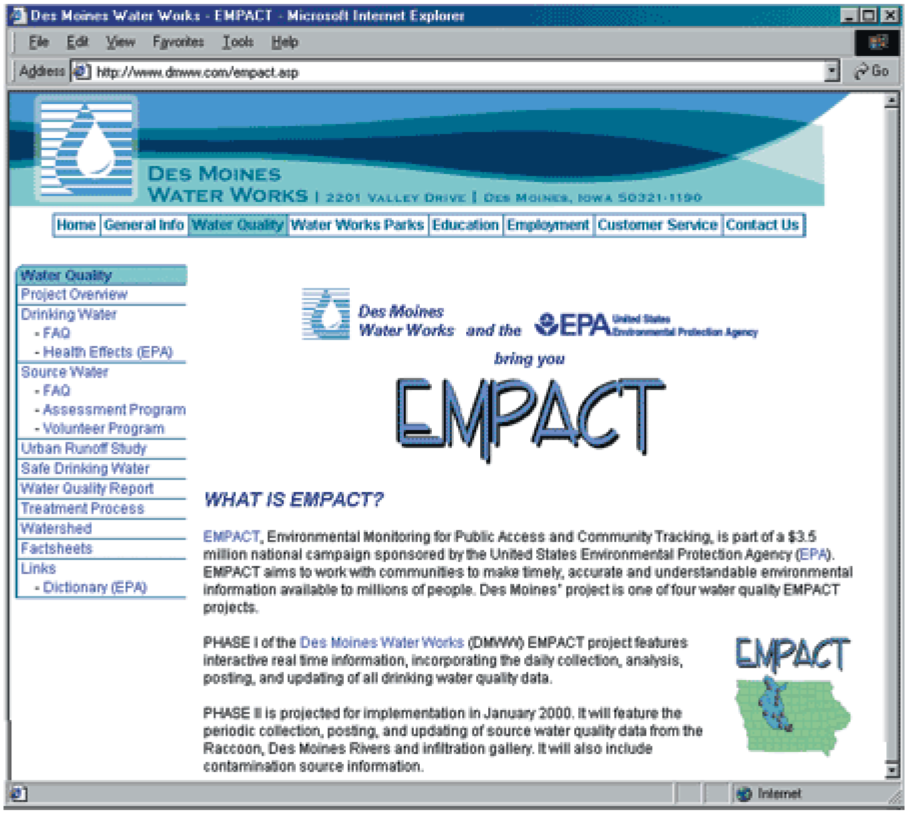
5.2 DMWW's EMPACT Project Web Site

Because DMWW’s EMPACT project phases represent unique topics and different implementation schedules, the

EMPACT project area on DMWW's Web site is organized around these phases.

The EMPACT project area on DMWW's Web site is located at http://www.dmww.com/empact.asp. This site provides the following:

- An answer to the question, "What is safe drinking water?"
- Answers to frequently asked questions about drinking water and source water.
- A diagram of DMWW's drinking water treatment process
- Information about the Des Moines River and Raccoon River watersheds.
- The DMWW service map.
- The most recent annual Consumer Confidence Report (CCR).
- An overview of the DMWW EMPACT project and descriptions of project Phases I, II, and III.
- Timely data on the presence and/or quantity of specific parameters found in Des Moines drinking water or source water.


Des Moines Water Works - EMPACT - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.dmww.com/empact.asp
Go
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- Health Effects (EPA)
Source Water
- FAQ
- Assessment Program
- Volunteer Program
Urban Runoff Study
Safe Drinking Water
Water Quality Report
Treatment Process
Watershed
Factsheets
Links
- Dictionary (EPA)
Des Moines Water Works and the EPA United States Environmental Protection Agency
bring you
EMPACT
EMPACT
Internet

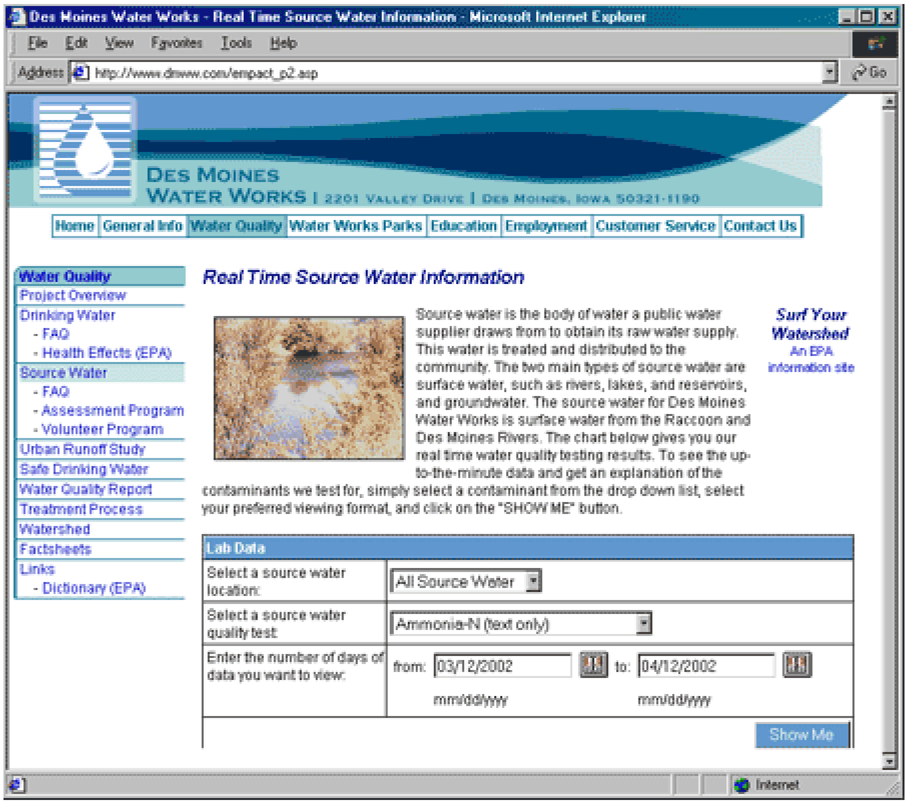
WHAT IS EMPACT?

EMPACT, Environmental Monitoring for Public Access and Community Tracking, is part of a $3.5 million national campaign sponsored by the United States Environmental Protection Agency (EPA). EMPACT aims to work with communities to make timely, accurate and understandable environmental information available to millions of people. Des Moines' project is one of four water quality EMPACT projects.

PHASE I of the Des Moines Water Works (DMWW) EMPACT project features interactive real time information, incorporating the daily collection, analysis, posting, and updating of all drinking water quality data.

PHASE II is projected for implementation in January 2000. It will feature the periodic collection, posting, and updating of source water quality data from the Raccoon, Des Moines Rivers and infiltration gallery. It will also include contamination source information.

The EMPACT Project area on the DMWW's Web site.


Des Moines Water Works - Real Time Source Water Information - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.dmww.com/empact_p2.asp
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- Volunteer Program
Urban Runoff Study
Safe Drinking Water
Water Quality Report
Treatment Process
Watershed
Factsheets
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- Dictionary (EPA)
Surf Your Watershed
An EPA information site
Show Me
Internet

Real Time Source Water Information

Source water is the body of water a public water supplier draws from to obtain its raw water supply. This water is treated and distributed to the community. The two main types of source water are surface water, such as rivers, lakes, and reservoirs, and groundwater. The source water for Des Moines Water Works is surface water from the Raccoon and Des Moines Rivers. The chart below gives you our real time water quality testing results. To see the up-to-the-minute data and get an explanation of the contaminants we test for, simply select a contaminant from the drop down list, select your preferred viewing format, and click on the "SHOW ME" button.

Lab Data

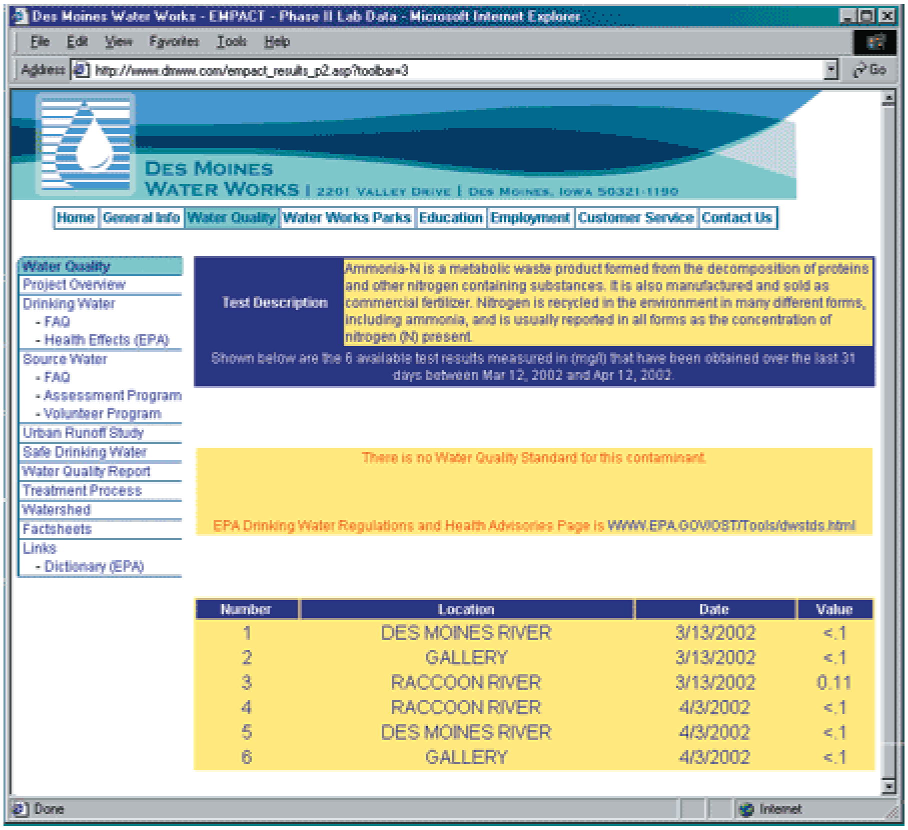
Select a source water location:	All Source Water
Select a source water quality test:	Ammonia-N (text only)
Enter the number of days of data you want to view:	from: 03/12/2002 mm/dd/yyyy to: 04/12/2002 mm/dd/yyyy

A user can request some water data from the EMPACT project area on DMWW's Web site.

From this site, Des Moines community residents can request timely water quality information from two links: Phase I—Drinking Water Information and Phase II—Source Water Information. Users can learn about the presence and/or quantity of specific parameters found in their drinking water or source water by selecting the parameter from a drop-down list of options.

From the user’s computer, a data request works like this:

- The user selects a specific analytical parameter from a drop-down list.
- The user selects the desired range of sampling dates for that particular parameter. If the user does not specify a date, the Web site automatically defaults to a range beginning 1 month prior to the present date.
- The user clicks the “Show Me” button.


Des Moines Water Works - EMPACT - Phase II Lab Data - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.dmww.com/empact_results_p2.asp?toolbar=3
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Safe Drinking Water
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Treatment Process
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Factsheets
Links
- Dictionary (EPA)
Done
Internet

Test Description Ammonia-N is a metabolic waste product formed from the decomposition of proteins and other nitrogen containing substances. It is also manufactured and sold as commercial fertilizer. Nitrogen is recycled in the environment in many different forms, including ammonia, and is usually reported in all forms as the concentration of nitrogen (N) present.

Shown below are the 6 available test results measured in (mg/l) that have been obtained over the last 31 days between Mar 12, 2002 and Apr 12, 2002.

There is no Water Quality Standard for this contaminant.

EPA Drinking Water Regulations and Health Advisories Page is WWW.EPA.GOV/OST/Tools/dwstds.html

Number	Location	Date	Value
1	DES MOINES RIVER	3/13/2002	<.1
2	GALLERY	3/13/2002	<.1
3	RACCOON RIVER	3/13/2002	0.11
4	RACCOON RIVER	4/3/2002	<.1
5	DES MOINES RIVER	4/3/2002	<.1
6	GALLERY	4/3/2002	<.1

Requested source water data are presented to the user in a table on a results page.

At DMWW, the data retrieval process works like this:

- DMWW's Web server accepts the user's request in the form of HTML and repackages the request into SQL.
- The Web server sends the SQL request through the firewall.
- Inside the firewall, the SQL request is processed by DMWW's SQL Server, and the requested validated data are extracted from the staging database. Recall that DMWW uploads data from the LIMS/OracleTM database to the SQL Server database nightly.
- The extracted data are sent back through the firewall to the Web server.
- The Web server formats the data and displays a results page.

The results page contains the following features:

- A brief, succinct description of the selected parameter.
- An explanation of the data returned by the user's inquiry.
- The MCL and Maximum Contaminant Level Goal (MCLG) established by EPA for that parameter (applicable only to the drinking water page).
- A link to EPA's Drinking Water Regulations and Health Advisories page for more information about the health effects related to that parameter.
- A tabular or graphical representation of the data.
- A link to EPA's Drinking Water Regulations and Health Advisories page: http://www.epa.gov/safewater/mcl.html for information about the health effects of certain parameters in drinking water.
- Links to other Web sites providing information consistent with the topic and message of DMWW's EMPACT site.

- A link to EPA’s “Terms of Environment” site http://www.epa.gov/OCEPAterms.
- A link that allows the customer to send an email to DMWW.

PLUG-INS

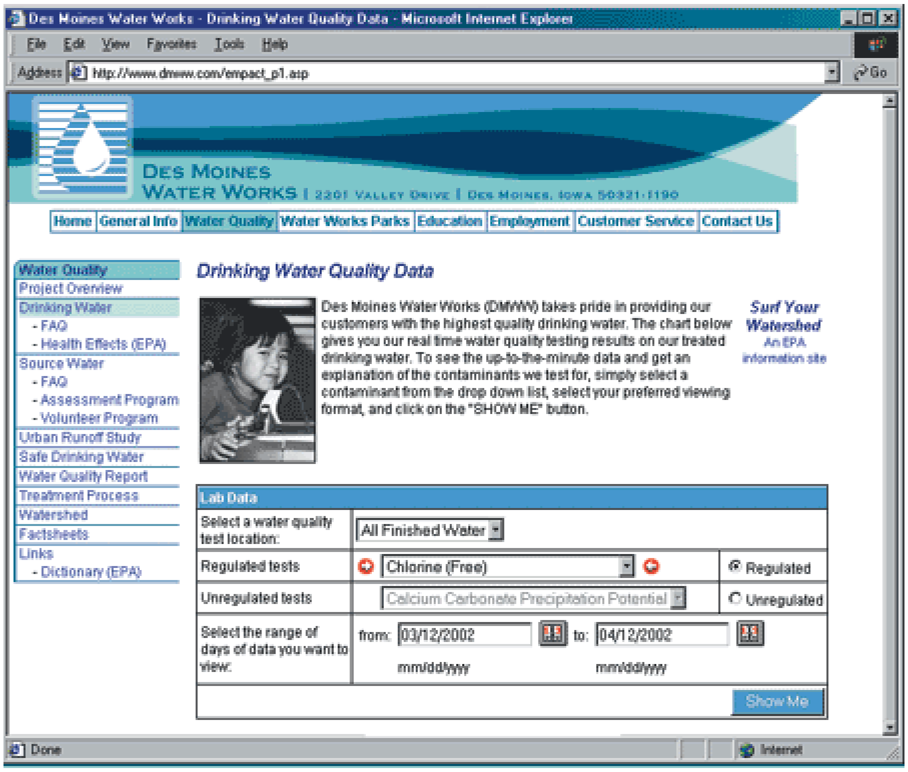
A “plug-in” is a software module that works along with an Internet browser to add a specific feature to a Web site. For example, a plug-in can allow users to listen to music or view videos on a Web site. If a Web site requires a plug-in to execute a specific feature, users must download the plug-in program to experience that feature. DMWW selected a software package, Chart FX™, to display certain pieces of requested data in a chart format on the EMPACT project area of its Web site. To use this feature, users must download Chart FX™ (a “plug-in”). The first time a user requests charted data from his or her personal computer, the Web site displays a “warning” asking the user to agree to download the plug-in. The Internet browser then guides the user through the downloading process. The user is required to download the plug-in only once; the user’s computer will automatically access the plug-in for viewing charts in the future.

DMWW feels that this plug-in increases the number of options for viewing data on the site, thereby enhancing the user-friendliness of the site. Although DMWW could program its site to display charts, the plug-in allows DMWW to offer this feature without dedicating valuable resources to formatting data. DMWW has found that many of its customers are comfortable and familiar with plug-ins; the utility has received only a few questions and concerns about the requirement to download this module.

The EMPACT project area on DMWW’s Web site is programmed to present data in either a table or a chart. The table format allows the user to view individual analytical results for a selected parameter measured on selected dates at selected sampling locations. The chart format allows the user to view and compare analytical results for a selected parameter over the entire range of selected dates and sampling locations. The charting function also allows the user to view information about a specific data point (e.g., parameter concentration, sample collection date, and sample description) by holding the cursor over that data point in the chart.

5.2.1 Designing the Web Site

The designers of the EMPACT project area on DMWW’s Web site included water treatment and laboratory personnel, information systems personnel, technical contractors, and a communications specialist. This team found the design process to be iterative. The team’s design initially focused on answering the following question: “Is my drinking water safe?” However, when the initial design was reviewed, the team determined that a simple answer to this question would not necessarily benefit DMWW’s customers. The team also considered that this question cannot always be answered simply. For example, when DMWW measured high levels of nitrate in its treated drinking water in 1999, the utility felt that customers should have access to detailed information about the condition of the water due to the increased risk of “blue baby syndrome” (methemoglobinemia) to infants under 6 months of age. However, DMWW could not simply answer “no” to the above question because nitrate levels in the water never exceeded the legal limits (MCLs) established for nitrate. (Refer to Chapter 3 of this handbook for public notification requirements and additional information on the regulation of drinking water.)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Surf Your Watershed
An EPA information site
Show Me
Done
Internet

Drinking Water Quality Data

Des Moines Water Works (DMWW) takes pride in providing our customers with the highest quality drinking water. The chart below gives you our real time water quality testing results on our treated drinking water. To see the up-to-the-minute data and get an explanation of the contaminants we test for, simply select a contaminant from the drop down list, select your preferred viewing format, and click on the "SHOW ME" button.

Lab Data

Select a water quality test location: All Finished Water

Regulated tests: Chlorine (Free) ● Regulated

Unregulated tests: Calcium Carbonate Precipitation Potential ○ Unregulated

Select the range of days of data you want to view: from: 03/12/2002 mm/dd/yyyy to: 04/12/2002 mm/dd/yyyy

The EMPACT project area on DMWW's Web site. Note the simple instructions (in the center frame) and explained links (in the right frame) for beginners and the direct links for experienced users (in the left frame).

WEB SITE DESIGN AND CONSTRUCTION OPTIONS

There are many software packages available to assist you with designing and constructing your Web site. These programs prompt you to design your Web pages in desktop publishing format and automatically convert your designs into HTML. These programs can greatly simplify Web page design and construction for inexperienced users. However, DMWW relied only partially on these tools—a large amount of automatically generated code can increase the complexity of a site's technical architecture. DMWW used Microsoft® FrontPageTM to create a conceptual design of the EMPACT project area on its Web site; the utility then passed these conceptual designs over to its technical contractor, who coded this area of the site based on the design proofs.

After reviewing the initial design, DMWW moved to a news-style design format with water quality data charting options prominently featured on both the drinking water and source water portions of the site. The team decided to address drinking water and source water on separate areas of the site because the information and messages associated with these water types differ greatly. The news-style design format allows DMWW to address water quality issues currently of interest to the media on the "front page" of the EMPACT project area on its Web site. DMWW feels that the current design of its site provides customers with direct access to important information while ensuring user friendliness, functionality, and user confidence in the information provided.

The EMPACT project area of DMWW's Web site is designed to keep written content brief, succinct, informative, and enhanced with illustrations. To maintain the attention and interest of the user, the site provides "quick hits" of written information followed by graphical representations of applicable data. DMWW feels that one of its biggest communication challenges is making sure that the timely water quality information presented on the Web is not too technical for the average audience member. When deciding on the content and technical detail to include on the site, DMWW was careful to avoid re-creating information that could already be accessed via links to other sites.

DMWW's Web site design included common navigational features (drop-down lists, radio buttons, dialogue boxes, and action buttons) that are familiar to Web users. DMWW felt that these features would make users more comfortable with navigating about the site. Also, by incorporating these common features, DMWW controlled user request options, streamlining data requests with available data to reduce error messages and user frustration. By making direct links constantly accessible on the site's left frame, DMWW organized the site to make navigational options simple and logical. The team also ensured that all links for additional information were related to the concept and purpose of the site to avoid leading users away from the site's topic and message.

Early in the design planning of DMWW's EMPACT site, the team realized that users would need to scroll down to fully view data charts. The team felt that this requirement diminished the overall effect of the results display, so the team had the page reconstructed to remove the DMWW EMPACT header when data results and charts are displayed. The trade-off, however, is that results are depicted on a separate Web page, and users must use the browser's "back" button (rather than a site link) to return to the previous page and continue navigation through the site.

DMWW designed the EMPACT project area of its Web site to be fairly complex. The project area includes several Web pages and offers different options for timely data requests and display. Many different SQL statements are required to support these options. The Web pages in the EMPACT project area are designed in framed format. Although this format simplified the initial technical design of the project area, DMWW feels that the frames now limit certain modifications to the look and organization of this area on the Web site.

To quantify the effectiveness and overall success of the EMPACT project area on its Web site, DMWW uses the following measurements:

- Total number of visits to the site.
- Visit patterns vs. time of day.
- The number of visits made by each type of user.
- Customer surveys.
- Customer feedback from the Web site.

LESSON LEARNED: USING CONTRACTORS

DMWW's first Web contractor went out of business during the design and construction of the EMPACT project area of DMWW's Web site. DMWW hired a second Web contractor to move ahead with the design and construction. In light of project resource and schedule constraints, DMWW chose to move ahead with the frame format initiated by the first contractor. DMWW feels that this format currently limits some of its options for revising the Web design. Eventually, the utility would like to eliminate the frames from the EMPACT project area of its Web site.

It is important for a utility to require detailed and thorough written documentation of the work performed by contractors, especially when the utility plans to use internal personnel to implement technical systems that have been developed by its contractors.

FEEDBACK

DMWW receives feedback on its Web site through its e-mail system. Most of the feedback regarding the EMPACT project area on DMWW's Web site has been positive and congratulatory in nature. Many times, customers request additional or more detailed information about a specific topic after having visited the Web site in search of basic information. DMWW sees this trend as a very positive sign that it is reaching out to its customers and sparking a new level of interest in community water quality—especially source water quality. DMWW has received some negative feedback as well. Some customers have asked to see more detailed technical information posted on DMWW's site, but DMWW feels that responding individually to requests for more information is the best way to ensure that the Web site is reaching out to the average member of its target audience.

A water utility in Sydney, Australia had some specific technical questions about the EMPACT project area on DMWW's Web site. After repeated communications with DMWW, the Sydney Water System is in the process of constructing a similar Web site for disseminating timely water quality data to its customers!

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6. Communicating Drinking Water and Source Water Quality Information

Even the best programs and systems for data collection/analysis, data management, and data delivery won't ensure project success unless information has been accurately and effectively communicated with community residents and consumers. This chapter discusses DMWW's communication/outreach program. For general guidance on creating an outreach plan and a list of resources you can use to enhance your outreach efforts, see Appendix D.

6.1 Outreach Plan

At DMWW, a communications specialist coordinates and leads all outreach efforts. She works closely with DMWW's experts in water quality and information systems to implement the utility's outreach plan.

DMWW has an ongoing partnership with three municipal organizations in Des Moines: Metro Waste Authority, the Des Moines Metropolitan Wastewater Reclamation Facility, and the Storm Water Division of the City of Des Moines. DMWW and these organizations have joined to form the Urban Environmental Partnership. The partnership will implement a series of cooperative outreach efforts to communicate the importance of water quality protection in the urban environment. Working together, they avoid duplicating outreach efforts, increase their resources, and reach a greater number of people with their cohesive outreach message. The partnership is advertised with a flyer.

DMWW also partnered with the Natural Resources Conservation Service to offer a watershed tour that provided information about existing voluntary programs for watershed conservation and efforts to reduce nitrate in agricultural runoff. In addition, DMWW is partnering with Pheasants Forever, a group that promotes environmental responsibility as a way to conserve recreational opportunities like hunting. This partnership strives to communicate the importance of environmental responsibility to children in Des Moines.

The overall goal of DMWW's outreach program is to educate all members of the Des Moines community. DMWW is currently running a public relations campaign called “DMWW: Your Pipeline to Water Information.” Through this campaign, DMWW is teaching its customers that the utility's purpose is not only to provide them with clean, safe drinking water but also to respond to any questions or concerns they may have about their drinking water and source water.

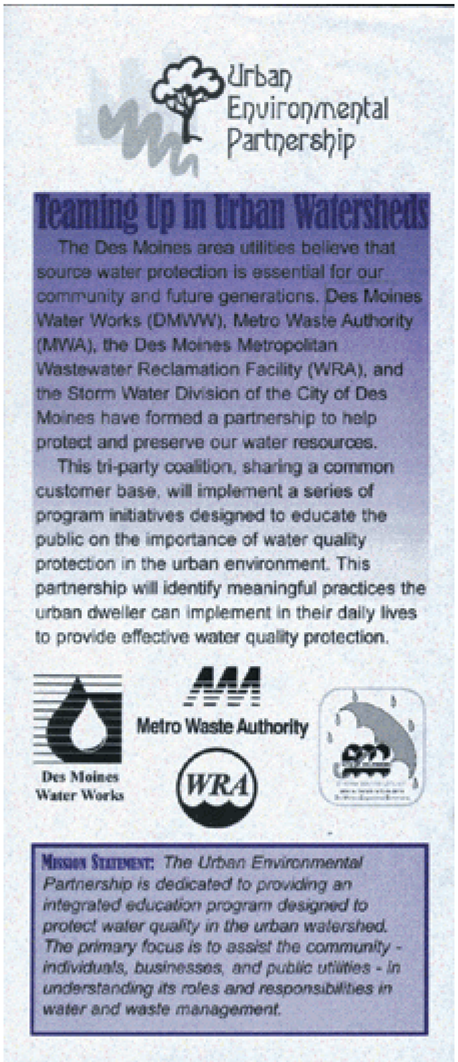
DMWW tailors many of its outreach efforts to fulfill the overall goal of the information pipeline campaign. Here are some examples of DMWW's specific outreach goals:

1. Provide Des Moines community residents with information on current issues related to drinking water and source water quality.
2. Enable Des Moines community residents to make practical, knowledgeable decisions about their health and their environment.
3. Present DMWW business and financial information to its customers.
4. Provide Des Moines community residents with convenient access to timely drinking water and source water quality information.

DMWW's broad and diversified target audience includes the entire Des Moines community. DMWW has divided its audience into several categories, including youngsters, students, parents, senior citizens, new customers, business owners, and various organizations. DMWW has become familiar with the characteristics of its audience categories by providing over 80 years of water utility service to the Des Moines metropolitan area. DMWW continues to profile its audience categories by soliciting public feedback through a variety of different mechanisms. These mechanisms are discussed in Section 6.3.

6.2 Outreach Products

DMWW has developed several different outreach products to communicate with its target audience categories. Some of these products are discussed below.



Urban Environmental Partnership

Teaming Up in Urban Watersheds

The Des Moines area utilities believe that source water protection is essential for our community and future generations. Des Moines Water Works (DMWW), Metro Waste Authority (MWA), the Des Moines Metropolitan Wastewater Reclamation Facility (WRA), and the Storm Water Division of the City of Des Moines have formed a partnership to help protect and preserve our water resources.

This tri-party coalition, sharing a common customer base, will implement a series of program initiatives designed to educate the public on the importance of water quality protection in the urban environment. This partnership will identify meaningful practices the urban dweller can implement in their daily lives to provide effective water quality protection.

Des Moines Water Works

Metro Waste Authority

WRA

Mission Statement: *The Urban Environmental Partnership is dedicated to providing an integrated education program designed to protect water quality in the urban watershed. The primary focus is to assist the community - individuals, businesses, and public utilities - in understanding its roles and responsibilities in water and waste management.*

DMWW has formed a partnership with three municipal organizations to communicate the importance of water quality protection in the urban area.

The DMWW Web Site

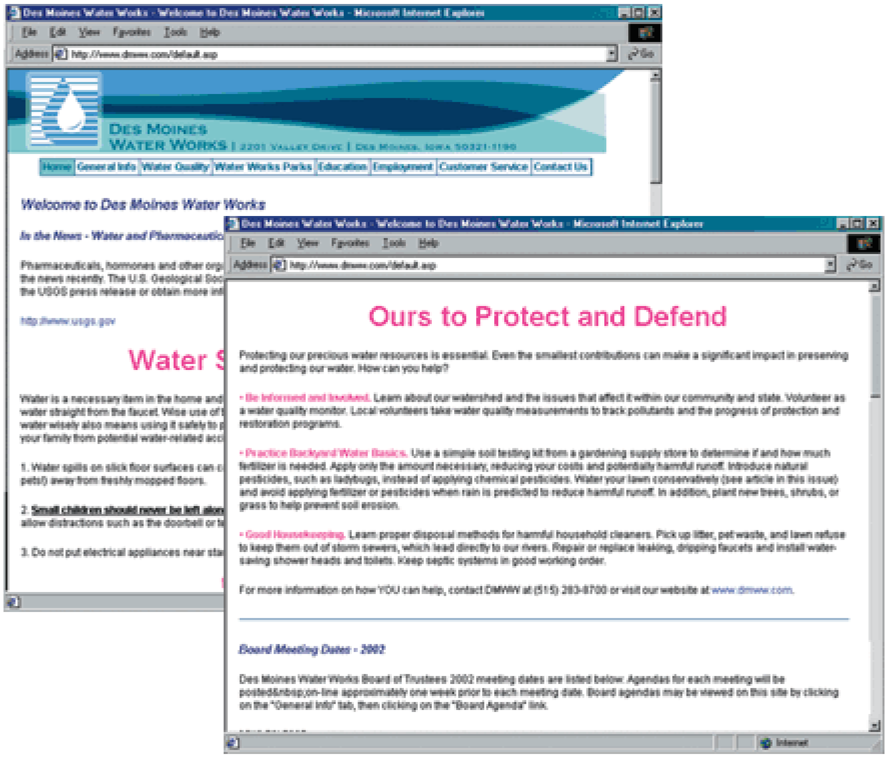
DMWW uses its Web site (http://www.dmww.com) to communicate a variety of information to the Des Moines community. The Web site provides community residents with convenient access to the following:

- General information about DMWW.
- Information on area parks and recreation.
- A customer service page.
- Utility engineering and construction information.
- Education for all users, from businesses and parents to teachers and students.
- Employment opportunities.
- A video clip and photos of the Des Moines flood of 1993.
- The DMWW EMPACT project area.

In response to customer requests, DMWW hopes to expand the Web services available to its customers by spring 2002.

Monthly Newsletter: H2O Line

DMWW's monthly newsletter provides DMWW's customers with information on current issues related to drinking water and source water quality. DMWW introduced its information pipeline campaign in its January 2001 newsletter. Subsequent newsletters have discussed the watersheds and watershed protection, the presence of nitrate in treated drinking water, and "pros and cons" of water filtering devices. DMWW's monthly newsletters for January 2001 through April 2001 are included in Appendix A (PDF, 6.63MB).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In the News - Water and Pharmaceutic
http://www.usgs.gov
Water S
Internet

Ours to Protect and Defend

Protecting our precious water resources is essential. Even the smallest contributions can make a significant impact in preserving and protecting our water. How can you help?

• Be Informed and Involved. Learn about our watershed and the issues that affect it within our community and state. Volunteer as a water quality monitor. Local volunteers take water quality measurements to track pollutants and the progress of protection and restoration programs.

• Practice Backyard Water Basics. Use a simple soil testing kit from a gardening supply store to determine if and how much fertilizer is needed. Apply only the amount necessary, reducing your costs and potentially harmful runoff. Introduce natural pesticides, such as ladybugs, instead of applying chemical pesticides. Water your lawn conservatively (see article in this issue) and avoid applying fertilizer or pesticides when rain is predicted to reduce harmful runoff. In addition, plant new trees, shrubs, or grass to help prevent soil erosion.

• Good Housekeeping. Learn proper disposal methods for harmful household cleaners. Pick up litter, pet waste, and lawn refuse to keep them out of storm sewers, which lead directly to our rivers. Repair or replace leaking, dripping faucets and install water-saving shower heads and toilets. Keep septic systems in good working order.

For more information on how YOU can help, contact DMWW at (515) 283-8700 or visit our website at www.dmww.com.

Board Meeting Dates - 2002

Des Moines Water Works Board of Trustees 2002 meeting dates are listed below. Agendas for each meeting will be posted on-line approximately one week prior to each meeting date. Board agendas may be viewed on this site by clicking on the "General Info" tab, then clicking on the "Board Agenda" link.

DMWW's Web site at *http://www.dmww.com*

Annual Consumer Confidence Report

DMWW's June newsletter typically functions as a Consumer Confidence Report (CCR). The CCR, required by federal drinking water regulations, enables DMWW community residents to make practical, knowledgeable decisions about their health and their environment. See Chapter 3 of this handbook for more information on the CCR and the federal regulations that require its publication. An example of DMWW's CCR is included in Appendix A (PDF, 6.63MB).

Welcome Brochure

DMWW sends a "Welcome" brochure to all of its new customers. The pamphlet contains information about the following topics:

- DMWW's mission, location, business hours, and contact information.
- Billing information and payment options.
- Responsibilities of DMWW and its customers.
- Procedures for water meter readings and maintenance.
- DMWW's drinking water treatment process.
- Utility tours.
- Parks and recreation.
- Community tree plantings.
- Rules/regulations.

Annual Business Report

The main goal of DMWW's annual report is to present financial information to its customers; however, DMWW also includes a few pages of educational materials. The content of these materials depends on issues and concerns of the current year. To encourage customers to keep its 2001 report, DMWW incorporated a note pad into the report. For 2002, DMWW has incorporated a planning calendar into the report. The calendar includes water and health facts, in addition to DMWW's contact information, on each page.

Other Outreach Products and Tools

In addition to the products and tools discussed above, DMWW uses these outreach mechanisms:

- DMWW visits area schools to teach children of all grade levels about drinking water and source water.
- DMWW offers tours of its facilities to adults and school children.
- DMWW prepares technical outreach information for conferences held by organizations such as the American Water Works Association.
- DMWW has prepared a series of fact sheets to answer specific questions from its customers. These fact sheets provide information on a wide range of topics, including the presence of alkalinity, lead and copper, nitrate, and *Cryptosporidium* in drinking water.

Special Outreach Efforts

Occasionally, DMWW will prepare outreach products to address specific issues. For example, DMWW prepared one fact sheet on how to winterize a home. The target audience for this fact sheet lived in one particular Des Moines metropolitan neighborhood. This neighborhood had a higher percentage of water pipes break during the winter months due to poor maintenance practices. Because the occupants of this neighborhood were predominantly Hispanic, DMWW had the fact sheet prepared in Spanish. The fact sheet was disseminated to neighborhood residents by DMWW service workers.

6.3 Distribution and Feedback

DMWW uses a variety of mechanisms to distribute its outreach products. For example, DMWW's Web site is "distributed" to Web users via the Internet. Many of DMWW's newsletters, pamphlets, and fact sheets are distributed through the mail; some outreach flyers are included in customer bills. Also, through school visits, during tours of DMWW and area watersheds, and even through customer phone calls, DMWW conveys outreach messages by speaking directly with its customers.

DMWW tries to increase the longevity of many of its outreach products, thereby increasing the number of product distribution mechanisms available to the utility. For example, by making its Annual Business report into a notepad or a calendar, DMWW can distribute this product throughout the year not only to customers but also to visitors and convention groups.

DMWW has established several mechanisms for outreach follow-up and public feedback. For example, the utility held focus group meetings to solicit customer input and feedback on DMWW's CCR. Also, through its information pipeline campaign, DMWW encourages its customers to contact the utility with any questions or concerns they have about Des Moines drinking water or source water.

FOCUS GROUP SUCCESS

DMWW conducted two focus group meetings on its CCR. The first meeting was held prior to the publication of the CCR to solicit input from customers on the ideal format and content of the report. A follow-up meeting was then held after the publication of the first CCR to solicit feedback. One of the CCR features that especially pleased this follow-up focus group was the "kids corner," which has games and activities for children. The customer feedback indicated that this tool is a very effective way to increase the longevity of the CCR and encourage parents and children to talk about Des Moines water issues.

DMWW's Web site provides customers with the option of providing feedback directly to the utility via e-mail. A central point of contact (DMWW's communications specialist) is responsible for either responding directly to the feedback or forwarding the comment, question, or request to the appropriate team member at DMWW. Technical feedback about water quality information is forwarded to the water laboratory or water production department, feedback about DMWW's history or educational opportunities is forwarded to DMWW's education specialist, and feedback about the general appearance and functionality of the Web site is forwarded to DMWW's information systems department. In all cases, DMWW responds to each customer's feedback as soon as possible.

<< Back | Table of Contents

2000 Consumer Confidence Report

DES MOINES WATER WORKS

City of Ankeny ▪ City of Clive Water Department ▪ City of Cumming ▪ Des Moines Water Works
Johnston Water Department ▪ City of Norwalk ▪ City of Pleasant Hill
Polk County Rural Water District #1 ▪ SE Polk Rural Water District
Urbandale Water Department ▪ Warren Water District ▪ City of Waukee
City of Windsor Heights ▪ Xenia Rural Water District - Southwest & Woodward

Water For Your Future

Des Moines Water Works (DMWW) is an industry leader, providing our customers with high quality drinking water for 80 years. Our continued, proven treatment processes, along with new, innovative techniques and studies will ensure that DMWW remains an industry leader into the new millennium.

DMWW takes a proactive approach to controlling water taste and odor, an indicator of water quality. Our laboratory performs total organic carbon (TOC) and UV-254 tests on the rivers daily to determine which source water has the lowest concentration of dissolved organic material. Based on these tests, the Water Production Department will select which river to use and will adjust the dosage of powdered activated carbon to absorb these natural organic materials, allowing them to be removed during the treatment processes. This step significantly improves the taste and odor of your water.

Record Nitrate Year

DMWW's Nitrate Removal Facility was operated a record setting 106 days during 1999, at a total operating cost of approximately $250,000. Nitrate concentrations reached record levels in the Raccoon River and Infiltration Gallery.

DMWW monitors nitrate concentrations weekly until levels begin to increase, then daily during peak nitrate season. When nitrate concentrations in our treated water exceed 8 5 milligrams per liter (mg/l), we begin operating the Nitrate Removal Facility. Water is diverted to the facility for treatment, to maintain a nitrate concentration of 8 5 mg/l or lower in the finished or drinking water. The drinking water standard for nitrate is 10 mg/l.

Trending data indicates that nitrate concentrations in our rivers are continually increasing. In an effort to address this challenge, DMWW made piping modifications in 1999 to increase the capacity of the Nitrate Removal Facility.

Cutting Edge Science

One of the ongoing microbial studies being conducted at DMWW is on the cutting edge of water industry science. One method of studying bacteria, called culturing, grows bacteria in a lab environment. Recent studies conducted in molecular biology have confirmed that there are bacteria that have not been previously cultured. DMWW's microbiologist has grown bacteria believed to be previously uncultured. DMWW's microbiologist has grown uncultured bacteria using river water. While the significance of these uncultured bacteria is unknown, Des Moines metro area customers can rest assured that DMWW has the ability to stay current with water quality trends in order to have solutions in place should a problem arise.

What's On Our Plates?

DMWW's daily water quality testing determines the total number of bacteria present in a water sample, including the harmless ones. Beyond standard utility water testing, DMWW routinely performs Heterotropic Plate Count (HPC) studies on its distribution system water, an important indicator of the on-going bacterial condition of the water. DMWW's average HPC is very low. These bacteria are harmless, but can reduce the residue chlorine that is available to protect the distribution system from bacterial contamination. That is why DMWW monitors both HPC and free chlorine residual in the distribution system - to ensure good, safe water quality at the point of delivery to our customers.

Up A Creek

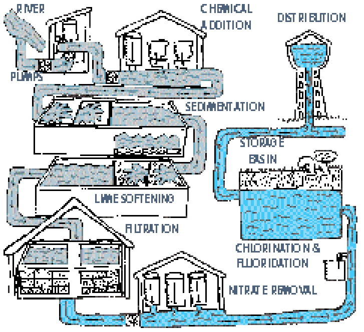
Recent studies have revealed that large amounts of bacteria enter Walnut Creek after hard rains. DMWW's bacterium study on Walnut Creek, initiated last summer, will help determine if human waste is leaking into the watershed. Preliminary studies have shown that these contaminants are in the raw water of the creeks. Evidence of a specific cause is still unknown. DMWW laboratory professionals are striving to ascertain the cause of the large bacterial loads in our urban creeks and find a solution to the problem.

DMWW will continue to ensure that you are provided with safe, high quality water. We are committed to being an industry leader in water treatment and quality now and in the future.

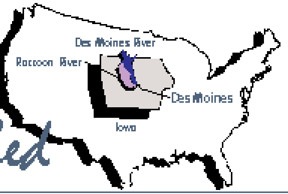
How We Treat Your Drinking Water

We begin by feeding powdered activated carbon into the river water for removal of man-made and natural organic chemicals. The water is then pretreated to remove dirt and debris and combined with water from the infiltration gallery system. The combined water then flows into lime softening basins. The pH of the water is adjusted before the final filtering process. The water is passed through layers of sand and various sizes of gravel to remove any remaining particles. Des Moines Water Works activates its nitrate removal facility to remove this contaminant from your water during periods of high nitrate levels. After this final phase, fluoride is added to aid in the prevention of tooth decay and chlorine is added as a disinfectant to kill bacteria. The clean water is stored in a clearwell until pumped into the pipes of the distribution system.

Des Moines Water Works laboratory and water production staff collect and test water samples from throughout the system several times a day. These tests ensure that the proper chemical levels are maintained and that the water remains free of unwanted contaminants.



Know Your Watershed



There are three sources of water fulfilling the needs of Des Moines Water Works customers. Approximately two-thirds is supplied by either the Raccoon or Des Moines Rivers. The remaining one-third comes from the infiltration gallery system (shallow groundwater).

As rain and snow run across the slope of land in our watershed, they carry soil and pollution, depositing them in creeks leading to the Raccoon and Des Moines Rivers. Some precipitation sinks into the ground, dissolving substances that may enter our groundwater supplies. Everyone can contribute to improving watershed health by utilizing conservation practices that protect the land and the quality of water in our rivers. Improving environmental quality improves our quality of life now and in the future.

1999 Drinking Water Quality Report

SUBSTANCE	HIGHEST LEVEL ALLOWED (MCL)	DMWW RANGE USING DES MOINES RIVER WATER	DMWW RANGE USING RACCOON RIVER WATER	DMWW MAXIMUM DETECTED LEVEL	EPA MCLG (EPA GOAL)	SOURCES OF CONTAMINANT
MICROBIOLOGICAL CONTAMINANTS						
Turbidity	0.5 NTU	n/d-0.10 NTU	n/d-0.8 NTU	0.10 NTU	N/A	Soil Runoff
INORGANIC CONTAMINANTS						
Fluoride	4.0 mg/l	0.60-1.3 mg/l	0.81-1.2 mg/l	1.3 mg/l	4.0 mg/l	Additive to Promote Strong Teeth
Nitrate (as N)	10.0 mg/l	1.3-10.0 mg/l	1.1-9.3 mg/l	10.0 mg/l	10.0 mg/l	Runoff from Fertilizer Use
Sodium	unregulated	7.8-20.0 mg/l	9.4-26.0 mg/l	26.0 mg/l	unregulated	Erosion of Natural Deposits
Sulfate	unregulated	28.0-93.0 mg/l	38.0-64.0 mg/l	93.0 mg/l	unregulated	Erosion of Natural Deposits
ORGANIC CONTAMINANTS						
Atrazine	3.0 µg/l	n/d-0.21 µg/l	0.20 µg/l	0.21 µg/l	3.0 µg/l	Runoff from Herbicide Use
Metolachlor	N/A	n/d-0.27 µg/	n/d	0.27 µg/	N/A	Runoff from Fertilizer Use
Total Trihalomethane	100.0 µg/l	27.0-41.0 µg/l	25.0-30.0 µg/l	41.0 µg/l	0 µg/l	By-product of Chlorine Disinfection

SUBSTANCE	ACTION LEVEL (AL)	DMWW 90th PERCENTILE **		SOURCES OF CONTAMINANT
DMWW COPPER AND LEAD - Regulated at Customer Tap				
Copper	1.3 mg/l	n/d		Corrosion of Home Plumbing
Lead	15.0 µg/l	10.0 µg/l	(5 sites above AL)	Corrosion of Home Plumbing

**Health Advisory Level*

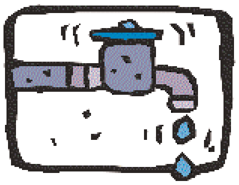
***90% of samples must be below Action Level*

LEAD: Infants and young children are typically more vulnerable to lead in drinking water than the general population. It is possible that lead levels at your home may be higher than at other homes in your community as a result of materials used in your home's plumbing. If you are concerned about elevated lead levels in your home's water, you may wish to have your water tested and flush your tap for 30 seconds to 2 minutes before using tap water. Additional information is available from the Safe Drinking Water Hotline at (800) 426-4791.

NOTE: The EPA requires monitoring of over 80 drinking water contaminants. Those listed above are the only contaminants detected in your drinking water. For a complete list, contact Des Moines Water Works or your local water utility.

Distribution Violations

The following utilities had distribution violations in 1999. The specifics of each violation and corrective actions are provided in detail. If you have any questions, please contact the utility.



UTILITY	VIOLATION	CORRECTIVE ACTION
City of Clive	Home water filtration system nonacute Coliform detect	Repeat samples at origination point; notice mailed to customers
City of Cumming	Unsatisfactory Coliform Bacteria test 6/99	Four repeat samples 6/19/99; all negative; 5 routine samplings in 7/99
	Bacterial Coliform monitoring & reporting violation 9/99 - 5 samples not collected 7/99; 12/99 Coliform monitoring	Need to meet resampling requirements; Resampled; implemented new scheduling system for testing
City of Norwalk	Nonacute coliform bacteria violation 6/99 & 11/99; 12/99 Coliform monitoring	Resampled; implemented new scheduling system for testing
City of Waukee	Lead exceeded 90th percentile Action Level	Resume lead & copper testing; educated customers about lead

Definitions

Action Level (AL) - The concentration of a contaminant that, if exceeded, triggers a treatment or other requirement that a water system must follow.

Inorganic Chemicals - Chemical substances of mineral origin, such as lead and copper.

Maximum Contaminant Level (MCL) - The highest level of a contaminant allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

Microbiological Contaminants - Very small organisms, such as bacteria, algae, plankton, and fungi.

N/A - Not applicable

n/d - Not detected

NTU - Nephelometric Turbidity Units.

Organic Contaminants - Naturally occurring or synthetic substances containing mainly carbon, hydrogen, nitrogen, and oxygen. This includes most pesticides and industrial chemicals.

pCi/l - picocuries per liter; measure of radioactivity.

µg/l - micrograms per liter; parts of contaminant per billion parts of water. One part per billion (ppb) is equivalent to a single penny in ten million dollars.

mg/l - milligrams per liter; parts of contaminant per million parts of water. One part per million (ppm) is equivalent to a single penny in ten thousand dollars.

Radionuclides - Contaminants giving off ionizing radiation.

Treatment Technique (TT) - A required process intended to reduce the level of a contaminant in drinking water.

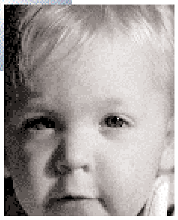
Important Health Information

Inadequately treated water may contain disease-causing organisms. These organisms include bacteria, viruses, and parasites, which can cause symptoms such as nausea, cramps, diarrhea, and associated headaches. Some people may be more vulnerable to contaminants in drinking water than the general population.

Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV / AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. The Center for Disease Control has guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants. They are available from the Safe Drinking Water Hotline.

In order to ensure that tap water is safe to drink, the Environmental Protection Agency (EPA) prescribes regulations, which limit the amount of certain contaminants in water provided by public water systems.

Nitrate in drinking water at levels above 10 ppm is a health risk for infants of less than six months of age. High nitrate levels in drinking water can cause blue baby syndrome. Nitrate levels may rise quickly for short periods of time because of rainfall or agricultural activity. If you are caring for an infant, you should ask for advice from your health care provider.



FDA regulations establish limits for contaminants in bottled water that must provide the same protection for public health. Any bottled water that is labeled "drinking water" has to meet EPA's drinking water regulations. Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk.

More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline.

SAFE DRINKING WATER HOTLINE:

1-800-426-4791

Cryptosporidium

Cryptosporidium is a microscopic organism found in rivers and streams that can cause diarrhea, fever and gastrointestinal distress if ingested. It finds its way into the watershed through animal and human wastes. Cryptosporidium is effectively eliminated by a treatment process that includes sedimentation, filtration, and disinfection.

Cryptosporidium has **NEVER** been found in your drinking water.

DMWW recently concluded a study to determine the amount of *Cryptosporidium* we eliminate from our source water through the treatment process. *Cryptosporidium* is a microscopic organism, known to cause intestinal illnesses, found in the feces of infected animals and humans. It is rarely found in the rivers from which we draw water.

After extensive studies, DMWW's microbiologist determined that we effectively eliminate 99.99% of the *Cryptosporidium* from the raw water. The combination of DMWW's water treatment capability and the fact that the Des Moines and Raccoon Rivers contain very low numbers of *Cryptosporidium* are very encouraging data.

Urban Environmental Partnership

To promote both improved service to our customers and environmental protection of our watershed, Des Moines Water Works (DMWW) has formed a new partnership with three other Des Moines area utilities: Wastewater Reclamation Authority (WRA), Metro Waste Authority (MWA), and the City of Des Moines' Storm Water Utility. The partnership is targeting three areas to enhance customer education and communication:

- Training of Customer Service employees in the functions and operations of each utility to assist them in answering customer calls about other local water utilities.
- Developing and presenting curriculum in the Des Moines area schools, emphasizing the interdependent relationship between the utilities and teaching children about protecting our water resources.
- Educating our customers about good water stewardship as it relates to all of the water utilities through publications such as existing utility newsletters, bill inserts, web pages, and press releases.

Contact DMWW or any of the Urban Environmental Partners for more information.

DEWEY™

- Baking soda, borax, and white vinegar are effective, earth-friendly cleaning products.
- The greatest single cause of an increased water bill is a leaking or running toilet, wasting 250 to 5000 gallons of water a day!
- Bottled water costs up to 1000 times more than DMWW water from your tap.
- Using mulch around gardens, bushes, and trees is a great way to trap moisture, reducing your need to water more often. Mulch also becomes a rich nutrient for plants.
- An acre of corn contributes more to humidity than a lake of the same size.
- A 1/8th inch crack in a pipe can spew up to 250 gallons of water a day, wrecking floors, furniture, and valuable possessions in addition to wasting water.
- A leak of one drop per second wastes 2,400 gallons of water per year.
- As water flows in streams, sits in lakes, or filters through layers of soil and rock in the ground, it dissolves or absorbs the substances that it touches.
- Dispose used motor oil, antifreeze, paints, and other hazardous materials at the Regional Collection Center rather than down the drain.

KIDS CORNER

Word List

- Ankeny
- aquifer
- CCR
- chlorine
- Clive
- contaminant
- Cryptosporidium
- Cumming
- distribution
- DMWW
- EMPACT
- EPA
- filtration
- fluoride
- hotline
- infiltration gallery
- Johnston
- laboratory
- lime softening
- Maffitt
- monitoring
- nitrate
- Norwalk
- Pleasant Hill
- Polk County
- pumps
- quality
- Raccoon
- safe
- sedimentation
- SE Polk
- Urbandale
- Warren
- water
- watershed
- Waukee
- Windsor Heights
- Xenia

Word Find Fun!

Z	T	R	B	H	K	G	N	I	N	E	T	F	O	S	E	M	I	L	S
A	C	C	R	R	M	J	D	T	C	U	M	M	I	N	G	Q	V	O	U
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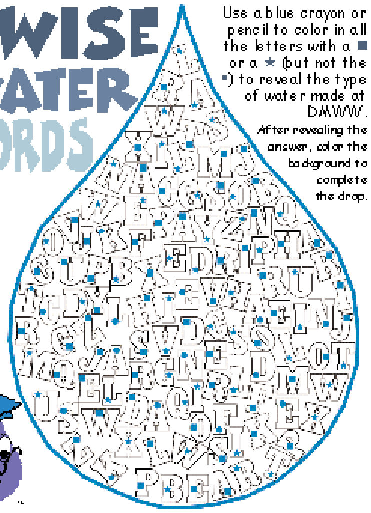
N	Y	R	E	L	L	A	G	N	O	I	T	A	R	T	L	I	F	N	I

WISE WATER WORDS

Use a blue crayon or pencil to color in all the letters with a ■ or a ★ (but not the ▪) to reveal the type of water made at DMWW.

After revealing the answer, color the background to complete the drop.



Public Meeting Information

We encourage our customers to attend and participate in the meetings of our water utility. Public meeting information is listed below.

ANKENY
Ankeny City Council ▪ 1st and 3rd Monday of each month at 5:00 p.m.
410 West 1st Street ▪ Ankeny, Iowa 50021

CLIVE
Clive City Council ▪ 1st, 3rd, & 5th* Thursday of each month
(*5 week months)
Clive City Hall ▪ 1900 NW 114th St. ▪ Clive, Iowa 50325

CUMMING
Cumming City Council ▪ 2nd and 4th Monday each month
City Hall ▪ Cumming, Iowa 50061

DES MOINES
Board of Water Works Trustees ▪ 4th Tuesday each month at 9:00 a.m.
Des Moines Water Works ▪ 2201 Valley Drive ▪ Des Moines, Iowa 50321

JOHNSTON
Johnston City Council ▪ 1st and 3rd Monday of each month
City Hall ▪ 6221 Merle Hay Road ▪ Johnston, Iowa 50131

NORWALK
Norwalk City Council ▪ 1st and 3rd Thursday of each month at 5:30 p.m.
705 North Avenue ▪ Norwalk, Iowa 50211

PLEASANT HILL
Pleasant Hill City Council ▪ 2nd and 4th Tuesday of each month at 6:30 p.m.
Pleasant Hill City Hall ▪ 5151 Maple Drive ▪ Pleasant Hill, Iowa 50317

POLK COUNTY RURAL WATER DISTRICT #1
Annual Meeting in January each year ▪ Call for date
660 NW 66th Avenue, Suite 2 ▪ Des Moines, Iowa 50313

SOUTHEAST POLK RURAL WATER DISTRICT
Water Board ▪ 3rd Wednesday of each month ▪ Contact office for time
6540 NE 12th Avenue ▪ Altoona, Iowa 50009

URBANDALE
Water Board of Trustees ▪ Meets monthly ▪ Call 278-3940 for information
Urbandale Water Department ▪ 3720 86th Street ▪ Urbandale, Iowa 50322

WARREN WATER
Board of Directors ▪ 3rd Monday each month at 7:30 p.m.
Warren Water Office ▪ 1204 East 2nd Avenue ▪ Indianola, Iowa 50125

WAUKEE
Waukee City Council ▪ 1st and 3rd Monday each month
Waukee City Hall ▪ 230 Highway 6 ▪ Waukee, Iowa 50263

WINDSOR HEIGHTS
Windsor Heights City Council ▪ 1st and 3rd Monday each month at 4 p.m.
Windsor Heights City Hall ▪ 1133 66th Street ▪ Windsor Heights, Iowa 50311

XENIA - Southwest & Woodward
Board of Directors ▪ Thursday of 3rd full week of each month
2398 141st Street ▪ Bouton, Iowa 50039

Utility Contact Information

For more information on the Consumer Confidence Report or water quality, please contact your local water utility:

- **City of Ankeny:** Customer Service
  410 West 1st Street, Ankeny, Iowa 50021
  Phone: (515) 283-8700 ▪ Fax: (515) 283-8727
  E-mail: jmckenH2O@aol.com
- **City of Clive Water Department:**
  Bart Weller, Public Works Director
  9289 Swanson Blvd., Clive, Iowa 50325
  Phone: (515) 223-6231 ▪ Fax (515) 223-6013
  E-mail: bweller@ci.clive.ia.us
- **City of Cumming:** Kathie Hungerford
  P.O. Box 100, Cumming, Iowa 50061
  Phone: (515) 981-9214 ▪ Fax: (515) 981-9214
- **Des Moines Water Works:** Customer Service
  2201 Valley Drive, Des Moines, Iowa 50321
  Phone: (515) 283-8700 ▪ Fax: (515) 283-8727
  E-mail: webmaster@dmww.com
- **Johnston Water Department:** Jerry R. Meyers or Donna Kluss
  P.O. Box 410, Johnston, Iowa 50131-0410
  Phone: (515) 278-0822 ▪ Fax (515) 727-8092
- **City of Norwalk:** Dean Yordi, Director of Public Works
  705 North Avenue, Norwalk, Iowa 50211
  Phone: (515) 981-0808 ▪ Fax: (515) 981-0933
  E-mail: deanyordi@ci.norwalk.ia.us
- **City of Pleasant Hill:** Gary Patterson, Public Works Director
  5151 Maple Drive, Suite 1, Pleasant Hill, Iowa 50317-8494
  Phone: (515) 262-9368 ▪ Fax: (515) 262-9570
- **Polk County Rural Water District #1:** Francis E. Schlueter
  6666 NW 5th Street, Des Moines, Iowa 50313
  Phone: (515) 289-1877 ▪ E-mail: feschlueter@worldnet.att.net
- **Southeast Polk Rural Water District:** Shirley J. Bos, General Manager
  6540 NE 12th Avenue, Altoona, Iowa 50009
  Phone: (515) 262-8581 ▪ Fax: (515) 262-4536
  E-mail: shirley.bos@worldnet.att.net
- **Urbandale Water Department:** Customer Service
  3720 86th Street, Urbandale, Iowa 50322
  Phone: (515) 278-3940 ▪ Fax (515) 278-3944
- **Warren Water District:** Peggy Crabbs, Systems Manager
  1204 East 2nd Avenue, Indianola, Iowa 50125
  Phone: (515) 962-1200 ▪ Fax: (515) 962-9328
- **City of Waukee:** John R. Gibson - Director of Public Works
  230 Highway 6, Box 847, Waukee, Iowa 50263
  Phone: (515) 987-4363 ▪ Fax: (515) 987-3979 ▪ E-mail: gibsonjon@aol.com
- **City of Windsor Heights:** Customer Service
  1133 66th Street, Windsor Heights, Iowa 50311
  Phone: (515) 283-8700 ▪ Fax: (515) 283-8727
- **Xenia Rural Water District - Southwest & Woodward:** Dave Modlin
  2398 141st Street, P.O. Box 39, Bouton, Iowa 50039-0039
  Phone: (515) 676-2117 ▪ Fax: (515) 676-2208 ▪ E-mail: Xenia@netins.net

DES MOINES WATER WORKS

H_2O line

January 2001

DMWW: Your Pipeline to Water Information

Water Works Your Body

Pure water has been said to be our most important nutrient, and possibly the most underestimated. Drinking water not only quenches our thirst, but it aids in the building and maintenance of a healthy body. Some of the numerous health benefits of drinking water include maintaining fitness, fighting illness, reducing effects of aging, and boosting energy. Simply turn on the faucet for a drink that works wonders for your body!

- Drinking adequate amounts of water helps your digestion and metabolism work at full capacity.
- Water can boost your endurance, making exercise more effective and helping you work out at higher levels.
- You can hold off hunger and prevent over eating by drinking more water.
- Research has found that water plays an active role in reducing the risk of some diseases or ailments like bladder cancer, urinary tract cancer, and kidney stones.
- Health officials consider water to be a weapon against the common cold and cough.
- Consuming plenty of water keeps your skin supple, helping you look younger.
- Drinking water when traveling can help reduce fatigue.
- Dehydration can contribute to migraine headaches; getting enough water is important in fighting them.

DEWEY™ TIPS

Drink More Water!
™

Health experts recommend drinking at least eight 8-ounce glasses of water each day. DMWW has some tips on how to make sure you get enough water.

- Drink moderate-sized portions of water spread throughout the day.
- Drink a glass when you wake up, before and after exercising, and make water available at all times.
- Try carrying a water bottle with you during the day.
- Have one glass of water for each caffeinated beverage you drink.

DMWW: Your pipeline for timely, accurate water information.

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Buckets of Information

DMWW

Water is an essential element in life. Des Moines Water Works (DMWW) is your **water authority**. We will provide you with the information about drinking water, our treatment process, and important health issues that affect you every day.

Leadership

As an industry leader, DMWW has provided high-quality drinking water to its customers for over 80 years. One of our duties as a utility is to provide you with information pertinent to your health and well being. DMWW uses informational vehicles such as the *H_2O Line*, the *Consumer Confidence Report*, and other water-related newsletters to educate customers and young people about water treatment and quality. You can *rely on DMWW as a water expert* when it comes to research and distribution of information concerning water-related issues.

DMWW will gladly provide you with information on several water-quality related topics. Fact sheets, such as those on lead and copper, fluoride, and nitrate; treatment brochures; and other printed materials are available upon request by calling our Customer Service department at 283-8700.

Commitment

In order to maintain high standards for water quality, DMWW believes it is important to advocate source water protection. DMWW teamed up with Metro Waste Authority, Wastewater Reclamation Authority, and the City of Des Moines-Storm Water Division, forming the Urban Environmental Partnership. This group emphasizes the importance of water quality protection and other environmental subjects through educational programs. Another project DMWW coordinated was the Volunteer Monitoring Project in the Raccoon River Watershed. Residents within the watershed provided river water samples to DMWW for analysis to determine the nitrate concentrations throughout the watershed. Results from that study are available on the EMPACT Web site.

Action

DMWW takes a proactive approach in keeping your drinking water safe. Using state of the art facilities and innovative scientific research methods, we consistently produce high-quality drinking water that meets or exceeds Environmental Protection Agency (EPA) standards. Daily water-quality testing and ongoing scientific studies enable us to closely monitor the source water for contaminants. We can then ensure proper treatment techniques are maintained to produce safe, clean drinking water. With the Treatment Plants at Fleur and Maffitt Reservoir, DMWW provides reliable quantities of water to Des Moines and the surrounding communities.

It is our civic and legal duty to inform our customers of any health alerts or EPA violations affecting your drinking water. An example is a nitrate level higher than the maximum contaminant level set by the EPA. In the **rare** event that this were to occur, DMWW would issue a public notice explaining precautionary measures for customers. However, DMWW built the Nitrate Removal Facility in 1991, greatly reducing the probability of a nitrate violation in your drinking water and reaffirming our commitment to bring you safe drinking water.

DMWW is committed to remain an industry leader in water treatment and quality. The next time you have a question about water, tap into DMWW for the answer.

DES MOINES WATER WORKS

H_2O Line

February 2001

Filtering Out Misconceptions

Do you need to filter your tap water to receive clean, delicious tasting water?

Many companies say they can rid your water of minerals and contaminants, making your water and food taste better in your home. However, the water you receive from DMWW is a *safe, pleasant-tasting product* to prepare food and to clean fruits and vegetables. DMWW's water is also *less expensive* for your cooking needs and has no adverse effects.

DMWW adds powdered activated carbon to absorb our source water's natural organic material and man-made chemicals, allowing removal during treatment. This significantly improves the taste and odor of your drinking water. Using activated carbon filters in your *home, such as those found in* filter pitchers or faucet-mounted filters, is not necessary because this process takes place at the treatment plant.

How much maintenance is required for home filtration systems?

Consumers do not always recognize the importance of properly maintaining a home filtration system. Failing to change filters on a *routine schedule can lead to bacteria build-up,* causing serious health risks for your household. A number of filtration systems require you to change the filter on a monthly basis. This can be an *expensive process* compared to simply turning on the tap. *Let* DMWW maintain safe, clean water for you!

The real question should be…why aren't more Americans drinking tap water? We would be glad to hear from you at 283-8700 or through our Web site at www.dmww.com.

Forget filtering, just turn on the tap!

Treating Water Right

Water treatment is a vital step to make sure a safe high quality product is delivered to your tap. Des Moines Water Works operates two facilities, the new *Treatment Plant at Maffitt Reservoir* and the Treatment Plant on Fleur Drive, treating up to *125 million gallons of water per day.*

The Maffitt plant draws its water from shallow groundwater collector wells that run along the *Raccoon River. This water is naturally filtered by the* earth's course sand and gravel delivering water free from river sediment. Maffitt Reservoir also serves as an emergency water supply for the plant. At the Fleur Drive plant, water can be drawn from either *the Raccoon or Des Moines Rivers in addition to the* infiltration gallery, a groundwater collection system. DMWW plant operators and laboratory staff screen all source water daily to determine which has the highest quality water for treatment and distribution.

Treatment Process

1. Addition of powdered activated carbon to remove organic matter, silt, and dirt. This is used only at the Fleur plant due to river water as source water. The Maffitt plant begins treatment with lime softening.

2. Lime softening to remove hardness compounds, germs, and bacteria.

3. Filtration through sand and gravel to remove remaining particles. When necessary at the Fleur *plant, a nitrate removal process is used to keep the* filtered river water safe for drinking.

4. Addition of fluoride to help prevent dental cavities and chlorine to disinfect the water.

5. Treated, clean, safe water enters storage tanks, eventually to be pumped through the distribution network right to your tap!

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What are you really FILTERING out?

Have you heard claims about improving the drinking water in your home? Numerous water treatment and filtration companies say they can provide you with higher quality drinking water. However, many of these claims can be misleading. As your pipeline to water information, Des Moines Water Works (DMWW) has the answers you need to know about **your high quality drinking water - right from the tap!**

DMWW is a leader among the municipal water treatment facilities that help make America's drinking water supply one of the safest in the world. Yet, it is estimated that nearly 40 percent of Americans use some sort of home water treatment device instead of relying on **dependable, safe, and clean tap water.** Households use anything from simple filter pitchers to complex water filtration systems. What it may boil down to is creating an unnecessary expense in your home.

Are home filtration systems necessary to remove and reduce contaminants?

DMWW's number one priority is to provide you with safe, high quality water. Our source water is tested several times a day to ensure proper chemical levels are added in the treatment process, so that the treated water remains safe according to Environmental Protection Agency (EPA) standards. By taking precautionary measures during the treatment process, DMWW makes certain your drinking water is safe when it reaches your tap.

Some home filtration systems may actually be removing *valuable nutrients and disinfection chemicals* found in your tap water. Fluoride is an additive, not a contaminant, beneficial to your dental health by helping to prevent tooth decay. While most simple filtration systems do not remove fluoride, more complex types do take this additive out. Chlorine - the number one chemical removed in filtration systems - is vital in eliminating harmful bacteria from your drinking water. These minerals are not harmful to you, and are necessary for maintaining good health and clean water.

Home filtration systems are not necessary to remove nitrate because DMWW treats the source water according to EPA standards for nitrate. In fact, most home filtration systems do not remove nitrate. DMWW has the capability of running its nitrate removal facility when source water nitrate levels exceed EPA standards.

Helpful Hint: To convert the hardness level from milligrams per liter (mg/L) to grains per gallon (gpg), divide the mg/L value by 17.1. Some appliance optimum performance standards ask for hardness in gpg.

Do I need to use a water softener or filter to soften my tap water?

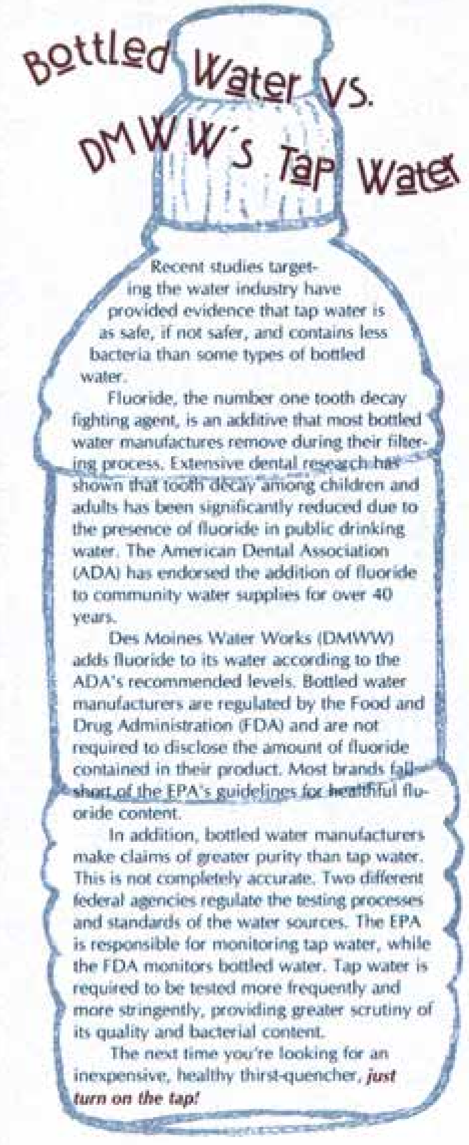
Some home filtration systems use brass faucets, a combination of copper and lead. As water stands in the faucet, it dissolves the metal and increases the lead content of your drinking water. Filtered water can also be more corrosive due to its deficiency in mineral content, possibly raising the amount of lead dissolving into your water. The consumption of lead may cause delays in physical and mental development in children, and kidney problems or high blood pressure in adults.

Lead and copper are not found in DMWW's treated water, but may enter from the plumbing in your home. DMWW leaves enough hardness compounds in the water to coat your pipes as it travels to your tap. This protects the pipes from the corrosiveness of water. The water DMWW sends to your tap is softened during the lime-treatment process. If you choose to use a water softener in your home, the benefits may not outweigh the costs.

Soft water helps soap and other cleaning products work more effectively. It is less likely to leave "scum" rings and other traces of mineral deposits in your home. DMWW strives to maintain the total hardness of the drinking water to less than 150 milligrams per liter (mg/L), the moderate range. This provides you with sufficiently soft water to make cleaning products work more effectively.

Keep "filtering through" this information for more clues about water quality.

Bottled Water vs. DMWW's Tap Water



Recent studies targeting the water industry have provided evidence that tap water is as safe, if not safer, and contains less bacteria than some types of bottled water.

Fluoride, the number one tooth decay fighting agent, is an additive that most bottled water manufactures remove during their filtering process. Extensive dental research has shown that tooth decay among children and adults has been significantly reduced due to the presence of fluoride in public drinking water. The American Dental Association (ADA) has endorsed the addition of fluoride to community water supplies for over 40 years.

Des Moines Water Works (DMWW) adds fluoride to its water according to the ADA's recommended levels. Bottled water manufacturers are regulated by the Food and Drug Administration (FDA) and are not required to disclose the amount of fluoride contained in their product. Most brands fall short of the EPA's guidelines for healthful fluoride content.

In addition, bottled water manufacturers make claims of greater purity than tap water. This is not completely accurate. Two different federal agencies regulate the testing processes and standards of the water sources. The EPA is responsible for monitoring tap water, while the FDA monitors bottled water. Tap water is required to be tested more frequently and more stringently, providing greater scrutiny of its quality and bacterial content.

The next time you're looking for an inexpensive, healthy thirst-quencher, *just turn on the tap!*

Facts and Figures about Fire Hydrants

DMWW's employees painting a hydrant.

Fire hydrants serve purposes other than fire protection. DMWW uses hydrants to flush stagnant water from water mains during maintenance and to release air after repairs have been made in order to prevent damage to home plumbing. The city also uses fire hydrants for street and sewer cleaning.

DMWW owns and maintains the fire hydrants in the public right-of-way. Some fire hydrants are installed only for maintenance purposes because their capacity for water pressure is not high enough for fire protection. You can identify maintenance hydrants by their red-colored tops.

Fire hydrant tops come in colors other than red. A color-coding system indicates how much water is available in gallons per minute (gpm) from the hydrants.

Red hydrant tops - under 500 gpm
Orange hydrant tops - 500-1000 gpm
Green hydrant tops - 1000 or more gpm

Green-topped hydrants with green caps designate high-volume hydrants connected to feeder mains.

Fire hydrants are painted to make them visible for the fire department. DMWW has standardized on a yellow color for the body of the hydrant.

You can help DMWW and the fire department access and locate hydrants more easily for repair and protection. Shovel snow away from hydrants, keep grass or weeds trimmed low around them, and please, do not plant flowers or shrubs around hydrants - hydrants exist for your protection!

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DES MOINES WATER WORKS

H2O Line

March 2001

Everything Between Rain and Stream

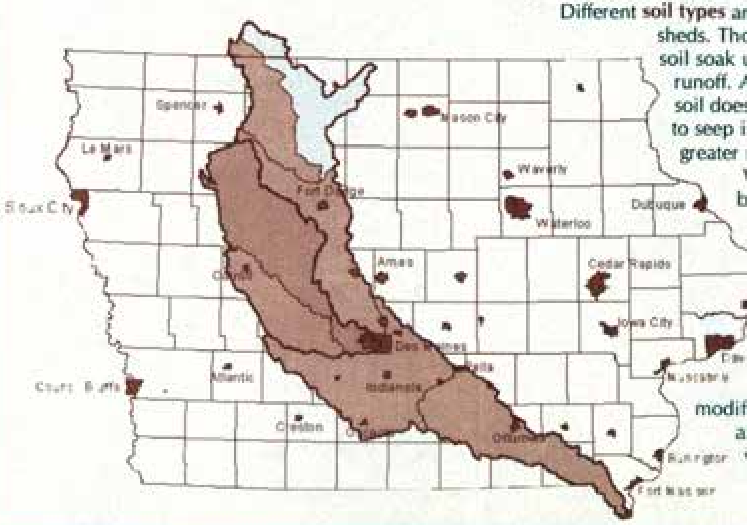
over under around and across

Winding Through Your Watershed

No matter where we live, we are all in a watershed.

Watersheds are areas where water flows across or under the land and drains into a river, lake, stream, pond, or other body of water. It includes the people who live in the area as well as land, air, plants, and animals. According to the Iowa Watershed Task Force, "A watershed is everything between the rain and the stream."

Des Moines Water Works Watershed



Several features make watersheds unique.

Watersheds vary in **shape and size**. Some are large, including millions of acres of land and smaller watersheds within them. Others can be as small as a city block, or a puddle in your back yard. As a Des Moines Water Works' customer, you live in both the Raccoon and Des Moines River watersheds. Each is a part of the Mississippi River watershed, which is made up of thousands of smaller watersheds.

A geographical **boundary** around the watershed is formed by a ridge or high area. This forces water to drain toward or away from your watershed. But watersheds are also interconnected. The water that travels through one land area - including farm fields, forestland, suburban lawns, and city streets - will eventually affect and flow through another.

Watersheds are composed of different **terrain**. The flatness or steepness of the land (terrain) impacts how quickly the water empties into a body of water. If the water drains faster, there is more potential for flooding and soil erosion.

Different **soil types** are found within watersheds. Those that consist of sandy soil soak up water faster, reducing runoff. A watershed that has clay soil does not allow as much water to seep into the ground, leading to greater runoff.

Watersheds are affected by the **land use**. The activities and residents of the land area nearest the water impact the watershed. Cities, homes, roads, factories, farming, recreation, mining, and construction all modify the watershed and affect the natural resources within it.

You play an important role in helping maintain a healthy watershed.

Pollutants traveling through your watershed affect your entire home, work, and play areas. Water and other natural resources are necessary to live, and what we do in the watershed can change the quality and availability of these materials.

There are two types of watershed pollution: point-source and nonpoint-source. **Point-source pollution** begins from the leakage of contaminants from a specific, easily identifiable source. Examples include pollution coming from industrial or sewage discharge pipes, hog lots, or storm sewers. **Nonpoint-source pollution** comes from many different areas as water runs across or through the ground. This type of pollution is harder to identify, measure, and control. Some examples include runoff from fields or forestland, parking lots, failing septic systems, construction sites, and automobile exhaust.

By following **Best Management Practices** (BMPs), you can help keep your watershed clean and safe. BMPs are positive ways to control pollutants and prevent them from contaminating the water supply. You can use BMPs in your home, yard, and community to enjoy and maintain a healthy living environment.

BMPs . . . at home & in your community

- Do not dump hazardous household chemicals, such as fertilizer, oil-based paint, or antifreeze, down the drain! Take them to the MWA's Regional Collection Center in Bondurant (967-5512) for safe disposal, or use environmentally safe cleaning products.
- Recycle your newspapers, magazines, milk jugs, juice bottles, metal cans, clear glass, and anything else possible to reduce the quantity of garbage you send to the landfill.
- Plant grass, trees, and shrubs to prevent soil from blowing or washing away. Bag leaves and grass clippings for compost collection to keep them from washing into storm sewers.
- Do not dump chemicals or anything else down storm sewers - most lead straight to our rivers.
- Keep your vehicles in good condition to prevent oil and antifreeze leaks from entering storm sewers from the street or your driveway.
- Do not litter! You can volunteer to help clean up area parks.

Our Role in Reducing, Removing Nitrate

DMWW is committed to providing you with safe drinking water by helping to reduce or eliminate nitrate in our source water. We have built coalitions, implemented cost effective technologies, and developed landscapes that will protect our watershed. Some of these projects include:

- *A formalized education program.* Classroom presentations are available for grade levels K-8. The information focuses on daily water use, water conservation, the water treatment process, and the importance of protecting our watersheds. DMWW is the only water utility in Iowa with this type of program.
- *Participation in the Urban Environmental Partnership (UEP).* This group was formed to educate the public on the importance of water quality protection through watershed protection in an urban area. DMWW partners with Metro Waste Authority, Wastewater Reclamation Authority, and the City of Des Moines' Storm Water Division.
- *Volunteer Monitoring Project on the Raccoon River Watershed.* Along with DMWW, volunteers collected over 1000 water samples during a year-long project surveying the nitrate concentrations in various locations of the Raccoon River watershed.
- *Environmental Monitoring for Public Access and Community Tracking (EMPACT).* DMWW was awarded an EPA grant to develop a Web site that provides Des Moines' treated water and source water quality information to anyone with Internet access. Visit the Web site at www.dmww.com/empact.

DMWW continually looks for new ways to address nitrate issues while consistently providing you with **clean, safe drinking water**.

DEWEY™ FACTS: Nitrate Removal Facility Vessels

- There are 8 nitrate removal vessels with a total operating capacity of 15 million gallons of water per day located in DMWW's Nitrate Removal Facility.
- Each vessel is 132 inches in diameter, 14 feet 2-7/8 inches high, and weighs 11,000 pounds.
- The vessels contain a total of 450 cubic feet of ion exchange resin and 232 cubic feet of support gravel for the resin.
- The Nitrate Removal Facility has enough space to add 2 more vessels, if necessary.

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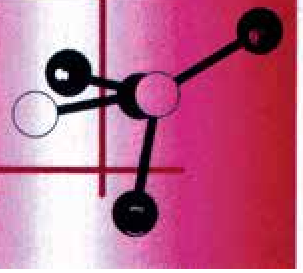


Keeping an "Ion" Nitrate

Concentrating on Nitrate

DMWW is Your Source for Important Nitrate Information

The word *nitrate* may generate some questions in your mind when you associate it with water quality and your health. Newspaper and television coverage about nitrate frequently discusses how it can harm the environment, water supply, or humans. Nitrate can lead to some serious consequences concerning your well-being, but Des Moines Water Works (DMWW) uses several methods to ensure that your drinking water remains below the Environmental Protection Agency (EPA) standards for nitrate concentrations, providing you with safe, healthy drinking water.

DMWW's Fleur Plant has the option of selecting from three water sources - the Raccoon River, Des Moines River, and infiltration gallery - for use in our drinking water treatment process. Our lab monitors the source water through daily testing of the water quality in each river. We then choose the one with the lowest nitrate concentrations to provide you with the best quality drinking water possible. Another alternative is running our Nitrate Removal Facility when nitrate levels are high in the source water (see "Nixing Nitrate in Your Water").

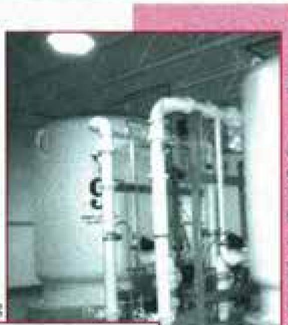
The maximum contaminant level (MCL) set by the EPA is 10 milligrams per liter (mg/l) of water. DMWW maintains a level below the MCL. If the nitrate level in your drinking water were to exceed the MCL, we are required to notify you of the necessary precautions to follow.

So what exactly is nitrate and how might it affect you? Nitrate is a chemical compound of nitrogen and oxygen that easily dissolves in water. It is typically used as a plant nutrient found in fertilizer, but it can form in septic systems, animal feed lots, manure, wastewater, and sanitary landfills as well. Nitrate enters our source water from both urban and rural watershed run-off or contamination of groundwater from the application of fertilizers.

In the unlikely event that nitrate levels exceed the MCL in your drinking water, a major concern exists for infants under the age of six months. Nitrate can enter the infant's body transforming into nitrite, which reduces the ability of blood to carry oxygen. This may cause Blue Baby Syndrome, a life threatening condition that requires immediate medical attention. Indicators of this condition include the infant appearing blue and having shortness of breath.

Research has also linked nitrate to other health concerns, such as the development of certain types of cancer in adults. However, a higher risk is present for infants because their immature organs have a more difficult time processing nitrate.

Although the possibility of a nitrate warning exists, the likelihood of this event is very rare due to the preventative measures DMWW has built into the treatment process. We make it our priority to provide you with healthful, safe, and clean drinking water.



Above: One of the nitrate removal vessels.

Exterior view of the Nitrate Removal Facility and underground clear wells.

Nixing Nitrate in Your Water

Inside Our Nitrate Removal Facility

One of the largest water quality issues that DMWW faces is the level of nitrate in the Raccoon and Des Moines River, two of our water sources. Data trends over the past 25 years show that the concentrations of nitrate have steadily increased. This problem may be caused by the continuing use and heavier application of fertilizer on the land in our watershed. DMWW built the Nitrate Removal Facility in the winter of 1990-1991 as a preventative measure to keep your drinking water safe at times when nitrate concentrations are extremely high in our source water.

The Nitrate Removal Facility consists of eight nitrate removal vessels that can treat up to 15 million gallons of water per day. Depending on the nitrate concentration level and plant flow, DMWW will operate between four and all eight vessels at one time. The facility has been operated from zero to 106 days in the year, with an average of 45 days of operation per year since 1991.

DMWW uses a process called "ion exchange" to remove nitrate from the water. Nitrate ions are captured by resin material as the water passes through the nitrate removal vessel, and chloride ions are released into the water to reduce the amount of nitrate ions. This process is similar to a home water softening device that removes calcium and magnesium ions from the water, exchanging them for sodium ions. The nitrate-reduced water is then blended with pre-treated drinking water to produce a safe, clean product with nitrate concentrations below the EPA's 10 mg/l MCL.

After the nitrate has been collected in the removal vessels, DMWW pumps water concentrated with sodium chloride through the vessels to exchange the captured nitrate for chloride. The water containing the collected nitrate is then diluted with infiltration gallery water and discharged back into the Raccoon River. Due to the large volume of nitrate concentrations already in the river and the small amount of water DMWW discharges, this process does not add to nitrate concentration problems in other cities and water utilities downstream.

Although the Nitrate Removal Facility is a proactive approach in keeping the drinking water safe from nitrate contamination, the best way to keep nitrate from entering the source water is through watershed protection programs. With your help in protecting our water sources, the need to use the Nitrate Removal Facility in the future could be greatly reduced, or even eliminated.

Appendix B—Glossary of Terms

A

Acetochlor: A herbicide sold under the trade name of Harness. It is an unregulated contaminant with no maximum contaminant level (MCL).

Alkalinity: A measure of the acid-neutralizing property of water.

Anion: A negatively charged ion.

Aquifer: A water-bearing stratum of permeable rock, sand, or gravel.

Atrazine: A herbicide and SDWA-regulated contaminant with a maximum contaminant level (MCL) of 0.003 mg/l.

B

C

Calcium Carbonate Precipitation Potential (CCPP): The amount of hardness that can come out of the water to form protective scale on plumbing surfaces.

Calcium Hardness as $CaCO_3$: A measure of the calcium mineral contribution to total hardness.

Chloride: A common table salt component found in all natural waters. Concentrations greater than 250 mg/l can cause the water to taste salty and contribute to metal corrosion.

Chlorine: A gas that is commonly added to drinking water as a disinfectant to make the water safe to drink.

Coliforms: Microorganisms that live in the digestive tracts of humans and animals. The detection of coliform bacteria in treated drinking water suggests that a treatment or distribution system is not working properly.

Conductivity: The ability to carry an electric current. Its measurement in water indicates the amount of dissolved salts or minerals in the water.

Consumer Confidence Report (CCR): An annual drinking water quality report required by the Safe Drinking Water Act (SDWA) for customers of public water supply systems.

Copper: A metal that can be present in drinking water through the corrosion of plumbing materials such as copper pipes.

Cryptosporidium: A microscopic organism found in rivers and streams that can cause diarrhea, fever, and gastrointestinal distress if ingested. It finds its way into the watershed through animal and human wastes.

D

Disinfection byproduct: A compound formed by the reaction of a disinfectant such as chlorine with organic material in the water supply.

Database: A collection of data organized by fields, records, and files. A field is a single piece of information, a record is a complete set of fields, and a file is a collection of records. (Definition from http://www.webopedia.com.)

Database management system: A collection of computer programs that enables you to store, modify, and extract information from a database. (Definition from http://www.webopedia.com.)

Domain name: A name that identifies one or more Internet Protocol (IP) addresses. Domain names are used in Uniform Resource Locators (URLs) to identify particular Web pages. (Definition from http://www.webopedia.com.)

Drinking water: Water that is conveyed to residences and businesses from a public water system. Typically, this water is treated by a water utility to make it potable. Drinking water is sometimes referred to as finished water.

E

E. coli: Bacteria whose presence indicates that the water may be contaminated with human or animal wastes.

Ecosystem: All of the interacting organisms in a defined space in association with their interrelated physical and chemical environment.

F

Fecal Coliform: Bacteria found in the intestinal tracts of warm-blooded animals. The presence of fecal coliform in water is an indicator of pollution and possible contamination by pathogens.

Finished water: See “Drinking Water."

Firewall: A system designed to prevent unauthorized access to or from a private network. Firewalls can be implemented in hardware, software, or a combination of both. (Definition from http://www.webopedia.com.)

Fluoride: A naturally occurring mineral added to water to help reduce cavities in young people.

G

H

Hardness: The amount of soap-precipitating minerals in the water. Both calcium and magnesium combine with soap to make it less effective. A hardness measurement is expressed as the amount of $CaCO_3$ (pure limestone) that would produce the hardness.

Hardware: Computer devices that you can actually touch, such as disks, disk drives, display screens, keyboards, printers, boards, and chips. (Definition from http://www.webopedia.com.)

Heterotrophic Plate Count (HPC) bacteria: All bacteria found growing on a non-selective food media. These are not indicators of disease, but large numbers in a drinking water distribution system indicate stale water, minimal disinfection and, therefore, an increased risk of disease. HPC bacteria can also cause unpleasant tastes and odor in the water.

HyperText Markup Language (HTML): Programming language for publishing hypertext on the Web. (Definition from http://www.webopedia.com.)

I

Infiltration Gallery: A sub-surface groundwater collection system, typically shallow in depth, constructed with open-jointed or perforated pipes that discharge collected water into a watertight chamber from which the water is pumped to treatment facilities and into the distribution system. Usually located close to streams or ponds.

Inorganic Contaminants: Mineral-based compounds such as metals, nitrates, and asbestos. These contaminants are naturally-occurring in some water, but can also get into water through farming, chemical manufacturing, and other human activities. EPA has set legal limits on 15 inorganic contaminants.

Internet Browser: A software application used to locate and display Web pages. The two most popular browsers are Netscape® Navigator™ and Microsoft® Internet Explorer™. (Definition from http://www.webopedia.com.)

J

K

L

Langeliers Index: A corrosion indicator based on pH. A positive number means that the water will deposit protective minerals on plumbing to prevent metal pipe corrosion.

Lead: A metal that can be present in drinking water through the corrosion of plumbing materials such as lead solder.

M

Magnesium Hardness as $CaCO_3$: The magnesium contribution to total hardness. It is measured and expressed as the equivalent amount of $CaCO_3$ (pure limestone) that would produce this hardness.

Maximum Contaminant Level (MCL): The highest level of a contaminant that EPA allows in drinking water. MCLs ensure that drinking water does not pose either a short-term or long-term health risk. EPA sets MCLs at levels that are economically and technologically feasible. Some states set MCLs that are more strict than EPA's.

Methemoglobinemia: A blood disorder caused when nitrite interacts with the hemoglobin in red blood cells. Unlike hemoglobin, the methemoglobin formed in this interaction cannot carry sufficient oxygen to the body's cells and tissues. Although methemoglobinemia is rare among adults, cases have been reported among infants, where nitrate-contaminated water was used to prepare formula and other baby foods.

Metolachlor: A herbicide sold under the trade name of Dual. It is an unregulated contaminant with no maximum contaminant level (MCL); however, a health advisory concentration for this pesticide has been set at 0.070 mg/l.

Microorganisms: Tiny living organisms that can be seen only with the aid of a microscope. Some microorganisms can cause acute health problems when consumed in drinking water. Also known as microbes.

N

Nitrate-N: A form of nitrogen fertilizer that is readily available to plants. This form of nitrogen is very water soluble and moved through the soil into groundwater and surface water.

Nitrite-N: The actual form of nitrogen that can combine with hemoglobin to form methemoglobinemia or “blue baby syndrome." It is an intermediate compound that is formed when ammonia is converted to nitrate by bacteria.

Nonpoint source: Any source of pollution not associated with a distinct discharge point.

O

Organic Contaminants: Carbon-based chemicals, such as solvents and pesticides, which can get into water through runoff from cropland or discharge from factories. EPA has set legal limits on 56 organic contaminants.

Ortho-phosphate: A naturally occurring substance that is sometimes added to the water for additional corrosion protection.

P

Pfiesteria: toxic dinoflagellate (microscopic, free-swimming, single-celled organisms, usually classified as a type of alga) associated with fish lesions and fish kills in mid-Atlantic Coastal Waters.

pH: A measure of the strength of an acid on a 0-14 scale, where 7 is neutral, less than 7 is acidic, and greater than 7 is basic.

Plug-in: A hardware or software module that adds a specific feature or service to a larger system. For example, there are a number of plug-ins for Internet browsers to enable the display of different types of audio or video messages.

Point source: A stationary location or fixed facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Pollutant loading: The quantity of a pollutant entering the environment (soil, water, air).

Potable (drinking) water: Water that meets U.S. EPA and/or state water quality standards and is considered safe and fit for human consumption.

Potassium: A common element found at low levels in drinking water.

Protazoa: Single-celled, eucaryotic microorganisms without cell walls. Most protozoa are free-living although many are parasitic.

Q

R

Radionuclides: Any man-made or natural element that emits radiation. Radionuclides may cause cancer after many years of exposure through drinking water.

S

Server: A computer or device on a network that manages network resources. For example, a database server is a computer system that processes database queries. (Definition from http://www.webopedia.com.)

Silica (SiO_2): A common, naturally occurring substance in the earth’s crust. It can contribute to scale formation and reduce pipe corrosion.

Sodium: One of the two components in ordinary table salt (sodium chloride). It is a common substance in nature and is a needed mineral in the diet. The amount of sodium in water is generally small relative to the amount present in food.

Software: Computer instructions or data. Anything that can be stored electronically. (Definition from http://www.webopedia.com.)

Source water: Ambient water that is accessed by water utilities to treat for distribution as drinking water. Source water can originate in either a surface source (such as a lake, river, or reservoir) or a subsurface source (such as a well). Source water is sometimes referred to as raw water.

Structured Query Language (SQL): A standardized query language for requesting information from a database. SQL was first introduced as a commercial database system in 1979 by Oracle Corporation. (Definition from http://www.webopedia.com.)

Sulfate: A stable form of sulfur common in natural waters, especially where gypsum is present. It can produce a taste in drinking water when present in concentrations over 200 mg/l and may produce a laxative effect when present in concentrations over 750 mg/l.

Synthetic Organic Chemicals (SOCs): Man-made (anthropogenic) organic chemicals. Some SOCs are volatile; others tend to stay dissolved in water instead of evaporating.

T

Total Dissolved Solids (TDS): The amount of dissolved substances, such as salts or minerals, in water.

Total Organic Carbon (TOC): A measure of carbon compounds in water that are from an organic (living) origin. In combination with a disinfectant such as chlorine, the presence of TOC can result in the formation of trihalomethanes.

Trihalomethane (THM): One of a class of compounds known as disinfection byproducts that result from chlorinating water containing naturally occurring organic material.

Turbidity: A measurement of scattered light (cloudiness) in a column of water. Light is scattered when it strikes suspended particles such as clay, silt, or microscopic organisms.

U

V

Volatile Organics: Chemicals that, as liquid, evaporate into the air.

W

Water Quality: A measure of the presence and quantity of certain constituents or parameters (like naturally occurring substances, man-made chemicals, and industrial contaminants) in water.

Web server: A computer that delivers (serves up) Web pages. Every Web server has an IP address and possibly a domain name. Any computer can be turned into a Web server by installing server software and connecting the machine to the Internet. (Definition from http://www.webopedia.com.)

Wellhead: A particular well site location, as differentiated from other well site locations, that exist in the same water system.

Wetland: an area that is regularly saturated by surface or groundwater and subsequently is characterized by prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include swamps, bogs, fens, marshes, and estuaries.

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Appendix C—Tucson Water's EMPACT Water Quality Project

The Water Quality Management Division of Tucson Water, in Tucson, Arizona, delivers more than 37 billion gallons of water annually to approximately 675,000 customers. The city of Tucson, Arizona is one of the largest U.S. cities that currently obtains its drinking water supply from groundwater wells. To ensure future sustainability, Tucson has started to supplement its groundwater supply with water from the Colorado River through the Central Arizona Project (CAP). Tucson’s selected blend of recharged Colorado River water and groundwater is known as the Clearwater Supply. The Tucson Water EMPACT project seeks to introduce this alternate and necessary supply of water to the public by providing timely information on the quality of the blended drinking water at taps in homes and businesses. Tucson’s EMPACT project not only provides a resource for water quality information, but also results in environmental benefits through a focused consumer outreach effort.

Partner Organizations

Tucson Water has received a 2-year grant from EPA’s EMPACT program. Tucson’s EMPACT project partners include the following:

- Arizona Department of Environmental Quality
- Tucson Unified School District, David T. Smith Resource Center
- Tucson-Pima Public Library
- University of Arizona, Water Resources Research Center
- University of Arizona, Southwest Environmental Health Sciences Center
- Pima County Health Department
- Pima County Waste Water Management
- Tucson Hispanic Chamber of Commerce
- University of Arizona, National Science Foundation, Water Quality Center
- Citizens and Neighborhood

Services

Sample Collection/Analysis

Tucson Water’s EMPACT project increases the number of water quality parameters currently measured by the utility and adds continuous on-line monitoring. Specifically, the utility has added continuous on-line monitoring of the quality of potable water and the quantity and general quality of recycled wastewater and secondary effluent discharged to the Santa Cruz River. One objective of the EMPACT project is to expand the utility’s monitoring technology to include a new process for measuring total trihalomethanes. Trihalomethanes are suspected human carcinogens that can form when drinking water that contains organic material is disinfected with chlorine.

Also under the EMPACT project, Tucson Water has selected 22 locations for on-line monitoring to track the conveyance of finished water throughout the utility’s distribution system. Tucson is installing the on-line instrumentation over the next year to continuously track chlorine residual, conductivity, estimated total dissolved solids, pH, and temperature. This special monitoring program will provide Tucson Water’s customers with information on water quality throughout the utility’s distribution system.

Data Management/Data Delivery

The objective of Tucson Water’s EMPACT project data management, processing, and delivery system is to improve the time relevancy of water quality data related to the potable distribution system. To do this, Tucson Water is developing timely methods for transmitting and verifying the quality of data from the on-line and manual monitoring programs and posting these data to the project Web site. The EMPACT project will allow community residents to identify their street addresses on a Web site map, receive easily understandable results from nearby water monitoring stations, and obtain a timely report on the quality of their drinking water.

Communications/Outreach

The outreach objectives for Tucson's EMPACT project include identifying the water quality/quantity data desired by targeted groups and developing effective, state-of-the art methods to communicate these data. Building on existing city programs, the EMPACT project will identify specific constituencies and solicit feedback on the water quality data desired and the best formats for individualizing data by location and creating a context for understanding water resources. Through its outreach products, Tucson hopes to eliminate any misperception about community water quality and provide a source of reliable, authoritative information on fast-breaking water quality issues.

For More Information

For more information about Tucson Water's EMPACT water quality project, visit

http://www.ci.tucson.az.us/water.

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Appendix D—Communications/Outreach Planning and Resources

This appendix will assist you with developing and implementing an outreach plan for communicating a variety of information to the public. Section D.1 provides general step-by-step guidance on creating an outreach plan. Section D.2 includes guidelines for effectively communicating technical information and provides a list of resources you can use to enhance your outreach efforts.

D.1 Creating an Outreach Plan

Your outreach efforts will be most effective if you plan them carefully. An outreach plan ensures that you have thoroughly considered all aspects of your outreach efforts before you begin. Your plan does not need to be lengthy or complicated! You can develop a plan simply by documenting your answers to these questions, which are discussed in the following subsections:

- Who are your partners?
- What are your outreach goals?
- Whom are you trying to reach?
- What information do you want to communicate?
- What outreach products will you develop?
- How will your outreach products reach your audiences?
- What follow-up mechanisms will you establish?
- What is your schedule for implementation?

TIP: Outreach planning is a creative and iterative process that involves a number of interrelated steps. As you move through each of the planning steps discussed below, you should revisit the decisions you have made for previous steps to make sure you are creating a fully integrated, comprehensive, and achievable outreach plan.

D.1.1 Who Are Your Partners?

Try to involve a variety of people in the design and development of your outreach plan. When possible, consider involving the following:

- A communications specialist or someone who has experience with developing and implementing outreach plans.
- Technical experts (e.g., experts in water quality, policy, information systems).
- Representatives of your target audience categories.
- Key individuals who will be involved in implementing your outreach plan.

Consider inviting community organizations to partner with you in planning or implementing your outreach efforts. Potential partners might include local businesses and trade associations, environmental organizations, schools, community groups, local health departments, local planning and zoning authorities, and other local or state agencies. Partners can help you with outreach planning, product development and review, and/or product distribution. Partnerships can be valuable mechanisms for leveraging resources while enhancing the quality, credibility, and overall success of your outreach efforts.

D.1.2 What Are Your Outreach Goals?

Outreach goals should be clear, simple, action-oriented statements about what you hope to accomplish through your outreach efforts. Every other aspect of your outreach plan should relate to your goals.

Try to rank and prioritize your goals in terms of relative importance. Consider the importance of your goals as you move through the planning process. For goals of greater importance, you will want to tailor your partnerships, outreach products, and information dissemination strategies to allow you to reach a greater number of affected people in a shorter amount of time.

D.1.3 Whom Are You Trying to Reach?

To answer this question, you must both identify and profile your target audience. The identification and profiling processes are discussed below.

Identifying Your Audience

As you design your outreach plan, you will need to clearly identify the target audience for your outreach efforts. The types of audiences targeted for a water quality outreach program might include the general public, local businesses and trade associations, decision-makers, educators and students, and community groups (e.g., homeowners associations, fishing/boating organizations, and gardening clubs). Some types of target audiences, such as educators and community groups, might serve as pathways to help you disseminate information to other types of audiences, such as students and the general public.

If you have more than one target audience, you may want to consider dividing the group into audience categories. For example, if the water quality information you intend to provide to the general public differs from the information you intend to provide to businesses, you may want to consider these targets as separate audience categories.

Profiling Your Audience Categories

Your outreach efforts will be most effective if you tailor the type, content, and distribution of your outreach products to the characteristics of your target audience categories. To do this, you will want to profile the situations, interests, and concerns of your audience members. These profiles will help you identify the most effective ways to reach each audience category. Consider how you would describe your audience members:

- What is their current level of knowledge about drinking water and source water?
- What is their average education level? What language do they speak?
- What should they know about drinking water and source water quality in your community? What actions would you like them to take?
- What information is likely to be of immediate interest to them?
- Once they develop an awareness of water quality issues in your community, what information will they want to know?
- How much information will they want to see? How much time are they willing to spend to understand the information?
- How do they generally receive information? How would they prefer to receive your information?
- In what types of professional, recreational, and domestic activities do they typically engage? Are there any organizations or centers that might represent pathways for your outreach efforts?

When you answer these questions, talk with representatives of your target audience categories and with colleagues who have successfully reached out to your audience categories.

D.1.4 What Information Do You Want To Communicate?

In this step, think about the key points, or “messages," you want to relate to your audience. A message is the “bottom-line” information you want your audience to remember, even if they forget the details. A message is usually phrased in a brief (often one-sentence) statement. Outreach products often have multiple related messages.

D.1.5 What Outreach Products Will You Develop?

You will want to determine what types of outreach products or tools will most effectively reach each of your target audience categories. There are many different types of outreach products available in print, audiovisual, electronic, event, and novelty formats.

Your outreach goals and target audience profiles will help you select appropriate and effective outreach products and tools. A communications specialist can provide you with valuable guidance on choosing the most appropriate products to meet your goals within your resource and time constraints. When selecting your products, consider your answers to the following questions:

- How much information does your audience really need to have? How much does your audience need to know immediately? (Keep in mind that the simplest, most straightforward product is generally the most effective.)
- Is the outreach product likely to appeal to your audience? How much time will it take your average audience member to interact with the product? Is your audience likely to make that time?
- Will the distribution and organization of your product be easy and cost-effective?
- How many people will the product reach?
- What time frame is needed to develop and distribute/organize the product?
- How much will it cost to develop the product? Do you have access to the talent and resources needed for product development?
- What other related products are already available? Can you build on existing products?
- When will the information be out of date? (Keep in mind that you will want to spend fewer resources on products with shorter life spans.)
- Would it be effective to have distinct phases of products over time? (For example, consider the first phase of a product designed to raise awareness, followed by a second phase of products at later dates to encourage changes in behavior.)
- How newsworthy is the information you are trying to communicate? (Information with inherent news value is more likely to be rapidly and widely disseminated by the media.)

OUTREACH PRODUCTS		
Print	Brochures Educational curricula Newsletters Posters Question-and-answer sheets	Editorials Fact sheets Newspapers and magazine articles Press releases Utility bill inserts
Audiovisual	Cable television programs Exhibits and kiosks	Public service announcements (radio) Videos
Electronic	E-mail messages Web pages	Subscriber list servers Interactive compact disks
Events	Briefings Fairs and festivals One-on-one meetings Public meetings	Community days Media interviews Press conferences Speeches
Novelty Items	Banners	Bumper stickers

Buttons
Floating key chains for boaters
Magnets
Coloring books
Frisbee discs
Mouse pads

D.1.6 How Will Your Outreach Products Reach Your Audiences?

You have many outreach product distribution options available to you. Consider the following examples:

- Mailing lists belonging to your organization or partner organizations.
- Phone and fax.
- E-mail.
- Internet.
- Journals or newsletters put out by partner organizations.
- Television.
- Radio.
- Print media.
- A hotline that distributes products upon request.
- Meetings, events, or locations (e.g., libraries, schools, community centers) where products are made available to the public.

You should consider how each of your products will be distributed and determine who will be responsible for distribution. For some products, your organization might manage the distribution. For other products, you might rely on intermediaries (e.g., the media or educators) or organizational partners. You should consult with a communications specialist to obtain information about the time and resources required for various distribution options. Consider the following issues when you select your distribution mechanisms:

- How does your audience typically receive information? How would they prefer to receive your information?
- What distribution mechanisms has your organization used in the past for this audience category? Were these mechanisms effective?
- Can you identify a partner organization that would be willing to assist you with distribution?
- Can the media play a role in distribution?
- Will your distribution mechanism really reach the intended audience? For example, although the Internet can be an effective distribution mechanism, certain audience categories may have limited access to it.
- How many people will your product reach through the distribution mechanism you are considering?
- Do you have sufficient resources available to fund and implement the distribution mechanisms you are considering?

D.1.7 What Follow-up Mechanisms Will You Establish?

If you have successfully reached out to your target audiences, you may receive requests for additional information. Your audience members may become concerned about the issues you have communicated to them. As part of your outreach plan, you should determine if and how you will respond to the follow-up interests of people in your community. Consider the following questions:

- What types of reactions or concerns are audience members likely to have in response to the outreach information?
- Who will be responsible for handling requests for additional information?

- Should you indicate on your outreach products where people can go for additional information? Will you provide a contact name, phone number, and/or Internet, mail, or e-mail address? Will you establish a hotline?
- How will you track and analyze feedback?
- How and when will you use feedback to improve your outreach efforts?

D.1.8 What is Your Schedule for Implementation?

Once you have selected the most effective combination of goals, audience categories, messages, products, and distribution mechanisms for your project, you should develop an implementation schedule for your outreach plan. First, consider the relative importance of each of your outreach goals. You should have a shorter implementation schedule associated with your most important goals. For each of your outreach products, consider how much time will be needed for design, development, and distribution. Be sure to factor in sufficient time for product review. When possible, also factor in some time for testing and evaluation by representatives of your target audience category to solicit feedback on the effectiveness of your product.

D.2 Resources for Presenting Water Quality Information to the Public

As you begin to implement your outreach plan and develop outreach products, you should make sure that these products present your messages and information as clearly and accurately as possible. This section discusses methods for effectively communicating technical information to the public and provides resources to help you shape the style and content of your outreach products.

D.2.1 How Do You Present Technical Information to the Public?

Environmental topics are often technical in nature, and water quality is no exception. Nevertheless, this information can be conveyed in simple, clear terms to nonspecialists. Principles of effective writing for the public include avoiding jargon, translating technical terms into everyday language, using the active voice, keeping sentences short, and using headings and other formatting devices to provide a very clear, well-organized structure. You can refer to the following Web sites for more ideas about how to write clearly and effectively for a general audience:

- The National Partnership for Reinventing Government has developed a guidance document, Writing User-Friendly Documents, which is available at http://www.plainlanguage.gov/.
- The Web site of the American Bar Association, http://www.abanet.org/lpm/bp160_front.shtml, has links to important online style manuals, dictionaries, and grammar primers.
- The Web site of the Environmental Education and Training Partnership, http://eetap.org/, has guides for developing environmental education documents.

As you develop outreach products for a specific audience, remember to consider what your audience members are already likely to know, what you want them to know, and what they are likely to understand. Then tailor your information accordingly. Provide only the information that will be valuable and interesting to the target audience. For example, local businesses might be interested in the hardness of the potable water they are using for manufacturing processes; however, senior citizens interested in the overall safety of their drinking water are not likely to be engaged by this topic.

When developing outreach products, you should consider any special needs of the target audience. For example, if your community has a substantial number of people who speak little or no English, you will need to prepare communication materials in their native language.

The remainder of this section provides some online resources that you can consult when developing your outreach projects. Some of the Web sites listed below contain products, such as downloadable fact sheets, that you can use to support your communication and outreach efforts.

Federal Resources

EPA’s Office of Groundwater and Drinking Water (OGWDW)

http://www.epa.gov/safewater

This site provides information on a variety of topics, from drinking water and health, source water protection, and training to applicable regulations, standards, and guidance. The site also includes a kid's page, which contains games and activities to help children learn about drinking water.

EPA's Office of Wetlands, Oceans, and Watersheds (OWOW)
http://www.epa.gov/owow

This site provides a variety of information related to wetlands, oceans, and watersheds. The site provides new information, resources for concerned citizens, and answers to frequently asked questions. Specific to watersheds, the site provides information on water quality monitoring and watershed pollution issues.

EPA's Surf Your Watershed
http://www.epa.gov/surf3

EPA provides this service to locate, use, and share environmental information on watersheds. One section of this site, "Locate Your Watershed," allows users to enter the names of rivers, schools, or a zip code to learn more about the water resources in their local watersheds. Users can also access the Index of Watershed Indicators (IWI) from this site. The IWI is a compilation of information on the health of aquatic resources in the U.S. The index uses a variety of indicators to determine whether rivers, lakes, streams, wetlands, and coastal areas can be described as "well" or "ailing".

EPA's NonPoint Source Pointers
http://www.epa.gov/owow/nps/facts

This Web site features a series of fact sheets on nonpoint source pollution. The series covers topics including programs and opportunities for public involvement in nonpoint source control, managing urban runoff, and managing nonpoint pollution from various sources (e.g., agriculture, boating, households).

U.S. Department of Agriculture Natural Resources Conservation Service
http://www.wcc.nrcs.usda.gov/water/quality/frame/wqam

This site includes guidance documents that provide the following resources: a simple tool to estimate the sensitivity of a water body to nutrients, a procedure to evaluate the conditions of a stream based on visual characteristics, and information on how to design a monitoring system to observe changes in water quality associated with agricultural nonpoint source controls.

Educational Resources

Project WET (Water Education for Teachers)
http://www.montana.edu/wwwwet

The goal of Project WET is to promote awareness, appreciation, knowledge, and stewardship of water resources by developing and disseminating classroom-ready teaching aids and establishing state and internationally sponsored Project WET programs. This site includes a list of all state Project WET Program Coordinators to help you locate a contact in your area.

Water Science for Schools
http://wwwga.usgs.gov/edu/index.html

The U.S. Geological Survey's (USGS's) Water Science for School Web site offers information on many aspects of water quality, along with pictures, data, maps, and an interactive forum where students can give opinions and test their water knowledge.

Global Rivers Environmental Education Network (GREEN)
http://www.earthforce.org/green

The Global Rivers Environmental Education Network (GREEN) helps young people protect the rivers, streams, and other vital water resources in their communities. This program merges handson, scientific learning with civic action. GREEN is working with EcoNet to compile pointers on water-related resources on the Internet. This site (http://www.green.org/resources/) includes a comprehensive list of water quality projects across the country and around the world.

Adopt–A–Watershed

http://www.adopt-a-watershed.org/about.htm

Adopt-A-Watershed is a K-through-12 school/community learning experience that uses local watersheds as living laboratories in which students can engage in hands-on activities. The goal is to make science applicable and relevant to students' lives.

National Institutes for Water Resources
http://wrri.nmsu.edu/niwr/niwr.html

The National Institutes for Water Resources (NIWR) is a network of 54 research institutes throughout the U.S. They conduct basic and applied research to solve water problems unique to their areas and establish cooperative programs with local governments, state agencies, and industries.

Other Organizations

The Watershed Management Council
http://watershed.org/wmc/aboutwmc.html

The Watershed Management Council is a not-for-profit organization whose members represent a broad range of watershed management interests and disciplines. Members include professionals, students, teachers, and individuals who are interested in promoting proper watershed management.

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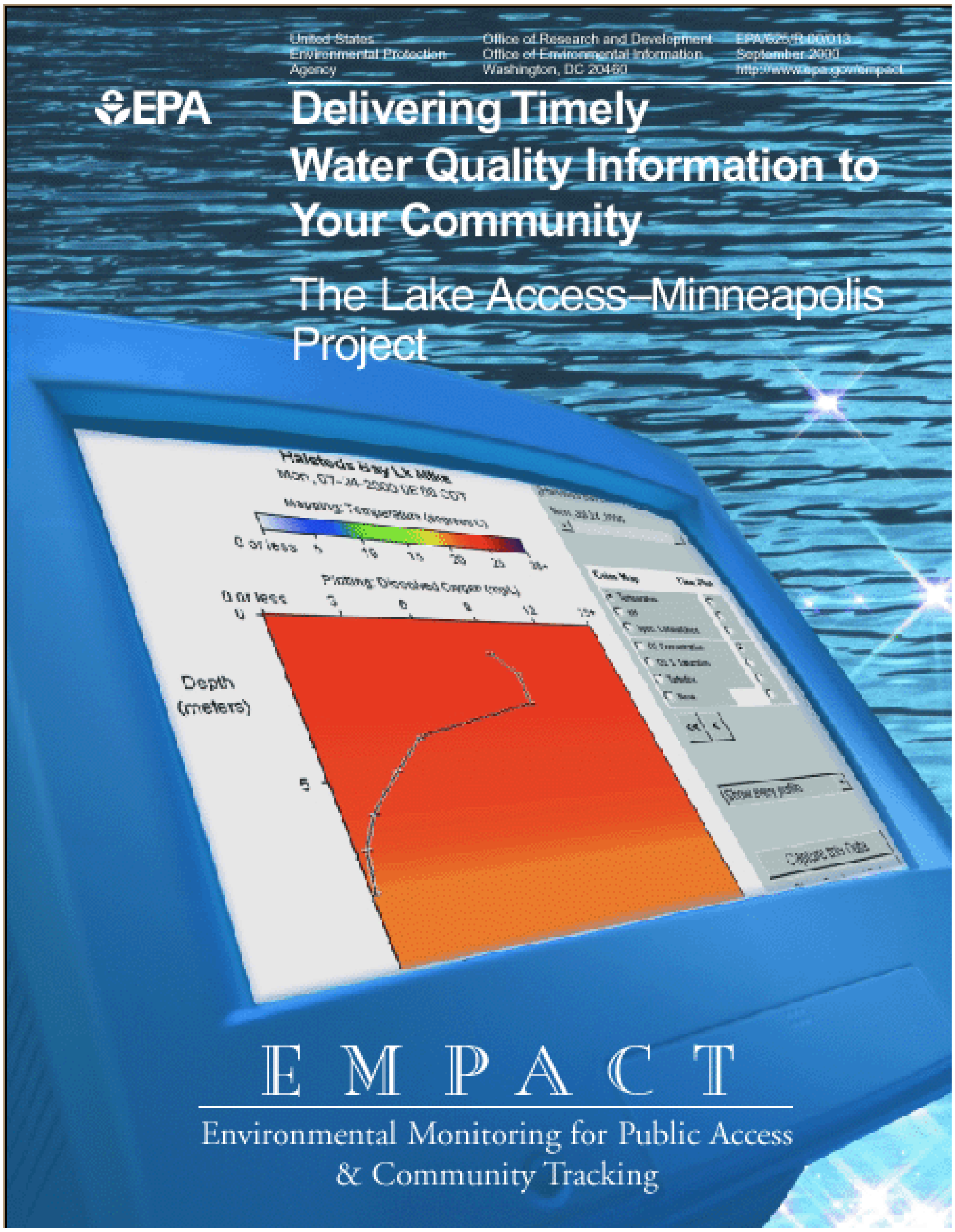

United States
Environmental Protection
Agency

Office of Research and Development
Office of Environmental Information
Washington, DC 20460

EPA/625/R-00/013
September 2000
http://www.epa.gov/empact

EPA

Delivering Timely Water Quality Information to Your Community

The Lake Access–Minneapolis Project

Mapping: Temperature (degrees C)
0 or less
5
10
15
20
25
30+
Plotting: Dissolved Oxygen (mg/L)
0 or less
3
6
9
12
15+
0
Depth
(meters)
5
Show every profile
Capture this Data

E M P A C T

Environmental Monitoring for Public Access
& Community Tracking

1. Introduction

People who spend time in, on, or close to lakes in and near your community can use timely and accurate information about lake water quality to help make day-to-day decisions about lake use and lake issues. For example, swimmers can use information about fecal coliform levels to protect their health when levels of these bacteria near swimming beaches are high. Anglers can use water quality information (e.g., temperature and oxygen levels) to help them decide where and when to go fishing. Time-relevant information can help recreational lake users, businesses, resource managers, lakeshore residents, and other landowners located farther from the lakeshore understand how a lake's water quality is affected by land use practices within its watershed.

This handbook offers step-by-step instructions about how to provide time- relevant water quality data to your community. It was developed by the U.S. Environmental Protection Agency's (EPA's) EMPACT program. EPA created EMPACT (**E**nvironmental **M**onitoring for **P**ublic **A**ccess and **C**ommunity **T**racking) in 1996, at President Clinton's direction. The program takes advantage of new technologies that make it possible to provide time-relevant environmental information to the public.

EMPACT is working with the 86 largest metropolitan areas of the country to help communities in these areas:

- Collect, manage, and distribute time-relevant environmental information.
- Provide residents with easy-to-understand information they can use in making informed, day-to-day decisions.

To make EMPACT more effective, EPA is partnering with the National Oceanic and Atmospheric Administration and the US Geological Survey. EPA will work closely with these federal agencies to help achieve nationwide consistency in measuring environmental data, managing the information, and delivering it to the public.

To date, environmental information projects have been initiated in 84 of the 86 EMPACT-designated metropolitan areas. These projects cover a wide range of environmental issues, including groundwater contamination, water quality, smog, ultraviolet radiation, and overall ecosystem quality. Some of these projects were initiated directly by EPA. Others were launched by EMPACT communities themselves. Local governments from any of the 86 EMPACT metropolitan areas are eligible to apply for EPA-funded Metro Grants to develop their own EMPACT projects. The 86 EMPACT metropolitan areas are listed in the table at the end of this chapter.

Communities selected for Metro Grant awards are responsible for building their own time-relevant environmental monitoring and information delivery systems. To find out how to apply for a Metro Grant, visit the EMPACT Web site at http://www.epa.gov/empact/apply.htm.

One such Metro Grant recipient is the Lake Access–Minneapolis project. The project provides the public with time-relevant and historical water quality data for lakes within the largest, most populated watershed districts in Minnesota.

The Lake Access Project team is using Remote Underwater Sampling System (RUSS) devices to collect time-relevant water quality data from three locations—two in Lake Minnetonka and one in Lake Independence. The Lake Access team has developed an Internet interface for the RUSS units that allows data from the RUSS sensors to be displayed in near-real time on the Lake Access Web site at http://www.lakeaccess.org. The project is a cooperative effort of the Suburban Hennepin Regional Park District, the Minnehaha Creek Watershed District, the University of Minnesota Water on the Web Investigators (i.e., the Natural Resources Research Institute, the University of Minnesota–Duluth Department of Education, and Minnesota Sea Grant), and Apprise Technologies, which holds the license to RUSS technologies. The project team also collects data from monitoring stations established as part of other monitoring programs. The team integrates data supplied by these non-RUSS sites with RUSS-generated data to track conditions in area lakes. Many of the project Web site's key features, such as the Limnology Primer and the Data Visualization Tools, were developed under a grant from The National Science Foundation's Advanced Technology Education Program.

The Technology Transfer and Support Division of the EPA Office of Research and Development's (ORD's) National Risk Management Research Laboratory initiated development of this handbook to help interested communities learn more about the Lake Access Project. The handbook also provides technical information communities need to develop and manage their own time-relevant lake water monitoring, data visualization, and information dissemination programs. ORD, working with the Lake Access Project team, produced this handbook to maximize EMPACT's investment in the project and minimize the resources needed to implement similar projects in other communities.

Both print and CD-ROM versions of the handbook are available for direct on-line ordering from EPA's Office of Research and Development Technology Transfer Web site at http://www.epa.gov/ttbnrmrl. You can also download the handbook from the Lake Access—Minneapolis Web site at http://www.lakeaccess.org. You can also obtain a copy of the handbook by contacting the EMPACT program office at:

EMPACT Program US EPA (2831)
Ariel Rios Building
1200 Pennsylvania Avenue,
NW Washington, DC 20460
Phone: 202 564-6791
Fax: 202 565-1966

We hope you find the handbook worthwhile, informative, and easy to use. We welcome your comments, and you can send them by e-mail from EMPACT's Web site at http://www.epa.gov/empact/comments.htm.

EMPACT Metropolitan Areas

Albany-Schenectady-Troy, NY
Albuquerque, NM
Allentown-Bethlehem-Easton, PA
Anchorage, AK
Atlanta, GA
Austin- San Marcos, TX
Bakersfield, CA
Billings, MT
Birmingham, AL
Boise, ID
Boston, MA-NH
Bridgeport, CT
Buffalo-Niagara Falls, NY
Burlington, VT
Charleston-North Charleston, SC
Charleston, WV
Charlotte-Gastonia-Rock Hill, NC- SC
Cheyenne, WY
Chicago-Gary-Kenosha, IL-IN-WI
Cincinnati-Hamilton, OH-KT-IN
Cleveland-Akron, OH
Columbus, OH
Dallas-Fort Worth, TX
Dayton-Springfield, OH
Denver-Boulder-Greeley, CO
Detroit-Ann Arbor-Flint, MI
El Paso, TX
Fargo-Moorhead, ND-MN
Fresno, CA
Grand Rapids-Muskegon-Holland, MI
Greensboro-Winston Salem-High Point, NC
Greenville-Spartanburg-Anderson, SC
Harrisburg-Lebanon-Carlisle, PA
Hartford, CT
Honolulu, HI
Houston-Galveston-Brazoria, TX
Indianapolis, IN
Jackson, MS
Jacksonville, FL
Kansas City, MO-KS
Knoxville, TN
Las Vegas, NV
Little Rock-North Little Rock, AR
Los Angeles-Riverside-Orange County, CA
Louisville, KY-IN
Memphis, TN-AR-MS
Miami-Fort Lauderdale, FL
Milwaukee-Racine, WI
Minneapolis-St. Paul, MN
Nashville, TN
New Orleans, LA
New York-Northern New Jersey-Long Island, NY-NJ-CT-PA
Norfolk-Virginia Beach-Newport News, VA-NC
Oklahoma City, OH
Omaha, NE-IA
Orlando, FL
Philadelphia- Wilmington-Atlantic City, PA-NJ-DE-MD
Phoenix-Mesa, AZ
Pittsburgh, PA
Portland, ME
Portland-Salem, OR-WA
Providence-Fall River-Warwick, RI-MA
Raleigh-Durham-Chapel Hill, NC
Richmond-Petersburg, VA
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Sacramento-Yolo, CA
Salt Lake City-Ogden, UT
San Antonio, TX
San Diego, CA
San Francisco-Oakland-San Jose, CA
San Juan, PR
Scranton-Wilkes-Barre-Hazleton, PA
Seattle-Tacoma-Bremerton, WA
Sioux Falls, SD
Springfield, MA
St. Louis-E. St. Louis, MO-IL
Stockton-Lodi, CA
Syracuse, NY
Tampa-St. Petersburg-Clearwater, FL
Toledo, OH
Tucson, AZ
Tulsa, OK
Washington-Baltimore, DC-MD-VA- WV
West Palm Beach-Boca Raton, FL
Wichita, KS
Youngstown-Warren, OH

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APPENDIX B Lake Access Brochure
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CONTRIBUTORS

Disclaimer

This document has been reviewed by the U.S. Environmental Protection Agency (EPA) and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation of their use.

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6. COMMUNICATING TIME-RELEVANT WATER QUALITY INFORMATION

As your community develops its time- relevant water quality monitoring and reporting systems, you will want to think about the best ways to communicate the information these systems will yield. This chapter of the handbook is designed to help you do so:

- It outlines the steps involved in developing an outreach plan.
- It profiles the outreach initiatives implemented by the Lake Access Team.
- It also provides guidelines for effectively communicating information and includes resources for water quality monitoring and promoting awareness, which you can incorporate into your own communication and outreach materials.

6.1 Creating an Outreach Plan for Time- Relevant Water Quality Reporting

Outreach will be most effective if you plan it carefully, considering such issues as: Who do you want to reach? What information do you want to disseminate? What are the most effective mechanisms to reach people? Developing a plan ensures that you have considered all important elements of an outreach project before you begin. The plan itself provides a blueprint for action.

An outreach plan does not have to be lengthy or complicated. You can develop a plan simply by documenting your answers to each of the questions discussed below. This will provide you with a solid foundation for launching an outreach effort.

Your outreach plan will be most effective if you involve a variety of people in its development. Where possible, consider involving:

- A communications specialist or someone who has experience developing and implementing an outreach plan.
- Technical experts in the subject matter (both scientific and policy).
- Someone who represents the target audience (i. e., the people or groups you want to reach).
- Key individuals who will be involved in implementing the outreach plan.

As you develop your outreach plan, consider whether you would like to invite any organizations to partner with you in planning or implementing the outreach effort. Potential partners might include shoreline and lakeshore property owner associations, local businesses, environmental organizations, schools, boating associations, local health departments, local planning and zoning authorities, and other local or state agencies. Partners can participate in planning, product development and review, and distribution. Partnerships can be valuable mechanisms for leveraging resources while enhancing the quality, credibility, and success of outreach efforts.

Developing an outreach plan is a creative and iterative process involving a number of interrelated steps, as described below. As you move through each of these steps, you might want to revisit and refine the decisions you made in earlier steps until you have an integrated, comprehensive, and achievable plan.

Whom Are You Trying To Reach?

Identifying Your Audience(s)

The first step in developing an outreach plan is to clearly identify the target audience or audiences for your outreach effort. As illustrated in the sample goals above, outreach goals often define their target audiences. You might want to refine and add to your goals after you have specifically considered which audiences you want to reach.

Target audiences for a water quality outreach program might include, for example, the general public, local decision makers and land management agencies, educators and students (high school and college), special interest groups (e. g., homeowner associations, fishing and boating organizations, gardening clubs, and lawn maintenance/ landscape professionals). Some audiences, such as educators and special interest groups, might serve as conduits to help disseminate information to other audiences you have identified, such as the general public.

Consider whether you should divide the public into two or more audience categories. For example: Will you be providing different information to certain groups, such as citizens and businesses? Does a significant portion of the public you are trying to reach have a different cultural or linguistic background from other members? If so, it likely will be most effective to consider these groups as separate audience categories.

Profiling Your Audience(s)

Outreach will be most effective if the type, content, and distribution of outreach products are specifically tailored to the characteristics of target audiences. Once you have identified your audiences, the next step is to develop a profile of their situations, interests, and concerns. This profile will help you identify the most effective ways of reaching the audience. For each target audience, consider:

- What is their current level of knowledge about water quality?
- What do you want them to know about water quality? What actions would you like them to take regarding water quality?
- What information is likely to be of greatest interest to the audience? What information will they likely want to know once they develop some awareness of water quality issues?
- How much time are they likely to give to receiving and assimilating the information?
- How does this group generally receive information?
- What professional, recreational, and domestic activities does this group typically engage in that might provide avenues for distributing outreach products? Are there any organizations or centers that represent or serve the audience and might be avenues for disseminating your outreach products?

Profiling an audience essentially involves putting yourself "in your audience's shoes." Ways to do this include consulting with individuals or organizations who represent or are members of the audience, consulting with colleagues who have successfully developed other outreach products for the audience, and using your imagination.

What Are Your Outreach Goals?

Defining your outreach goals is the next step in developing an outreach plan. Outreach goals should be clear, simple, action- oriented statements about what you hope to accomplish through outreach. Once you have established your goals, every other element of the plan should relate to those goals (for example, a goal might be to encourage the public to improve its shoreline management practices).

What Do You Want To Communicate?

The next step in planning is to think about what you want to communicate. In particular at this stage, think about the key points, or "messages," you want to communicate. Messages are the "bottom line" information you want your audience to walk away with, even if they forget the details.

A message is usually phrased as a brief (often one- sentence) statement. For example:

- The Lake Access Web site allows you to track daily changes on Lake Minnetonka and Lake Independence.
- You can improve water quality in area lakes by reducing the amount of fertilizer you apply to your lawn.

Outreach products will often have multiple related messages. Consider what messages you want to send to each target audience group. You might have different messages for different audiences.

What Outreach Products Will You Develop?

The next step in developing an outreach plan is to consider what types of outreach products will be most effective for reaching each target audience. There are many different types of outreach: print, audiovisual, electronic, events and novelty items. The table below provides some examples.

Outreach Products		
Print	Brochures Educational curricula Newsletters Posters Question-and-answer sheets	Editorials Fact sheets Newspaper and magazine articles Press releases Utility bill inserts or stuffers
Audiovisual	Cable television programs Exhibits and kiosks	Public service announcements (radio) Videos
Electronic	E-mail messages Web pages	Subscriber list servers
Events	Briefings Fairs and festivals One-on-one meetings Public meetings	Community days Media interviews Press conferences Speeches
Novelty Items	Banners Buttons Floating key chains for boaters Magnets	Bumper stickers Coloring books Frisbee discs Mouse pads

The audience profile information you assembled earlier will be helpful in selecting appropriate products. A communications professional can provide valuable guidance in choosing the most appropriate products to meet your goals within your resource and time constraints. Questions to consider when selecting products include:

- How much information does your audience really need to have? How much does your audience need to know now? The simplest, most effective, most straightforward product generally is most effective.
- Is the product likely to appeal to the target audience? How much time will it take to interact with the product? Is the audience likely to make that time?
- How easy and cost- effective will the product be to distribute or, in the case of an event, organize?
- How many people is this product likely to reach? For an event, how many people are likely to attend?
- What time frame is needed to develop and distribute the product?
- How much will it cost to develop the product? Do you have access to the talent and resources needed for development?
- What other related products are already available? Can you build on existing products?
- When will the material be out of date? (You probably will want to spend fewer resources on products with shorter lifetimes.)
- Would it be effective to have distinct phases of products over time? For example, a first phase of products designed to raise awareness, followed at a later date by a second phase of products to encourage changes in behavior.
- How newsworthy is the information? Information with inherent news value is more likely to be rapidly and widely disseminated by the media.

How Will Your Products Reach Your Audience?

Effective distribution is essential to the success of an outreach strategy. There are many avenues for distribution. The table below lists some examples.

Examples of Distribution Avenues
Your mailing list
Partners' mailing list
Phone/Fax
E-mail

Internet
Journals or newsletters of partner organizations
TV
Radio
Print media
Hotline that distributes products upon request
Meetings, events, or locations (e.g., libraries, schools, marinas, public beaches, tackle shops, and sailing clubs) where products are made available

You need to consider how each product will be distributed and determine who will be responsible for distribution. For some products, your organization might manage distribution. For others, you might rely on intermediaries (such as the media or educators) or organizational partners who are willing to participate in the outreach effort. Consult with an experienced communications professional to obtain information about the resources and time required for the various distribution options. Some points to consider in selecting distribution channels include:

- How does the audience typically receive information?
- What distribution mechanisms has your organization used in the past for this audience? Were these mechanisms effective?
- Can you identify any partner organizations that might be willing to assist in the distribution?
- Can the media play a role in distribution?
- Will the mechanism you are considering really reach the intended audience? For example, the Internet can be an effective distribution mechanism, but certain groups might have limited access to it.
- How many people is the product likely to reach through the distribution mechanism you are considering?
- Are sufficient resources available to fund and implement distribution via the mechanisms of interest?

What Follow-up Mechanisms Will You Establish?

Successful outreach might generate requests for further information or concern about issues you have made the audience aware of. Consider whether and how you will handle this interest. The following questions can help you develop this part of your strategy:

- What types of reactions or concerns are audience members likely to have in response to the outreach information?
- Who will handle requests for additional information?
- Do you want to indicate on the outreach product where people can go for further information (e. g., provide a contact name, number, or address, or establish a hotline)?

What Is the Schedule for Implementation?

Once you have decided on your goals, audiences, messages, products, and distribution channels, you will need to develop an implementation schedule. For each product, consider how much time will be needed for development and distribution. Be sure to factor in sufficient time for product review. Wherever possible, build in time for testing and evaluation by members or representatives of the target audience in focus groups or individual sessions so that you can get feedback on whether you have effectively targeted your material for your audience. Section 6.3 contains suggestions for presenting technical information to the public. It also provides information about online resources that can provide easy to understand background information that you can use in developing your own outreach projects.

6.2 Elements of the Lake Access Project's Outreach Program

The Lake Access team uses a variety of mechanisms to communicate time-relevant water quality information— as well as information about the project itself— to the affected public in Hennepin County and the nearby area. The team uses the project Web site as the primary vehicle for communicating time-relevant information to the public.

Their outreach strategy includes a variety of mechanisms among them, a brochure, kiosks, and teacher training—to provide the public with information about the Lake Access project. Elements of the project's communication program are highlighted below.

Bringing together experts. As a first step, project coordinators brought together a group of naturalists, museum officials, teachers, and other experts to discuss ways to implement the Lake Access Project's outreach efforts. The group identified target audiences, discussed the key points and messages that they felt needed to be communicated, the types of outreach products they thought should be developed, and what mechanisms should be used to distribute the information.

Designing attractive, user- friendly brochures. The team developed an attractive 2- page, 4- color brochure, entitled Seeing Below the Surface, which features basic, easy- to- follow information about the Lake Access project. The target audience is the general public. A reproduction of the brochure is contained in Appendix B.

Survey. Before moving further ahead with project outreach, the Lake Access team needed to know how much general knowledge the public had about water quality and land use issues in the Hennepin County area. To do so, they conducted a survey intended to help the team target its outreach efforts and tailor products to be most useful to lake users and community residents. The survey included a cover page that provided easy- to-understand information about the Lake Access project, and it contained questions about lake use, level of concern about lake water quality, interest in learning more about local lakes, and preferred mechanisms for receiving Lake Access project information. Appendix C contains the entire survey text.

Hennepin County Taxpayer Services provided the team with 450 randomly selected addresses throughout the county. The team sent surveys to these addresses, along with a cover letter, the project brochure, and a postcard that residents returned if they wanted to participate in a focus group. They sent the surveys out again to those who did not initially respond, and in the end, approximately 40 percent of recipients completed the surveys. The survey results revealed a general concern and curiosity about the lake, as well as interest in many aspects of water quality.

Web site. The Lake Access Web site, http://www.lakeaccess.org, is the Project's centerpiece for conveying time-relevant water quality data to the public. The site is organized to present information to four target audiences: swimmers, boaters, anglers, and land owners. Users can retrieve water quality data in various forms, as well as background information on water quality. The site's design includes a rolling banner that presents time-relevant information from the three RUSS unit sites in Lake Minnetonka and Lake Independence. The Web site includes an interactive GIS mapping capability (described in Chapter 5.2) as well as other user- friendly features, such as a "Frequently Asked Questions" page and a "What's New" page.

In addition, one of the project's partners, Water on the Web (WOW), http://wow.nrri.umn.edu, has created an interactive educational Web site with National Science Foundation funding. The site provides teachers with online lessons on water quality issues and provides high school and college students with study guides on various water quality subjects.

Kiosks. The Lake Minnetonka Regional Parks Visitor's Center, the Eastman Nature Center, the Science Museum of Minnesota, and the Great Lakes Aquarium in Duluth have installed touch- screen computer kiosks that feature the same information as the Lake Access project Web site. Kiosk users can access time- relevant water quality data from the three Lake Access Project RUSS units. Kiosks provide a mechanism for people without ready access to the Internet to view the time- relevant data generated by the project.

Training teachers. The project team trained a group of local school teachers on the RUSS unit and the project through a number of workshops, including a two-week summer workshop held at the lake.

Piggybacking on existing events. The team found it simple and efficient to promote the project in conjunction with pre- existing events. The team has found that one of the most effective ways to reach a large number of people is to promote the project at local summer festivals, which attract large crowds.

Developing the Lake Access Web Site

Experience Gained and Lessons Learned

The Lake Access Web site, http://www.lakeaccess.org, is the principal vehicle the Lake Access team uses to disseminate the time- relevant water quality data gathered by the RUSS units. The site's development was initiated through a partnership with Water on the Web, and for the most part, the same people were involved in developing both sites. So by the time the Lake Access Project Web site was designed, many team members had learned valuable lessons from their work on the Water on the Web site (http://wow.nrri.umn.edu).

Team members started from scratch when they developed the Water on the Web site. Using Microsoft FrontPage (a website development and management software tool), they designed and built the site's first release and maintained it for 18 months. Eventually, the team decided to hire a graphic designer to help "spruce up" some of the site's design features. Nine months later, they launched a completely redesigned and rebuilt Water on the Web site. With many individuals working simultaneously to rebuild the structure and content of the site, the team learned that they needed to frequently back up the site to another computer to avoid accidentally overwriting one another's content.

The team followed a very similar process to create the Lake Access Web site. They started with an initial "shell" that has emerged into the full structure and content of the current site. The project team feels that the best features of the site are the time- relevant data it conveys, the solid information base it provides, including the limnological primer, and the data visualization tools it features. (These are described in detail in Chapter 4.) Now that the Web site is fully up and running, the Lake Access Project team plans to add "focused" studies to the site. In other words, the team plans to take portions of time- relevant and manually collected water quality data and, using data visualization tools, explain what lake activity the data are illustrating and what they mean in the context of lake management. The team hopes that these focused studies will help community members become more aware of the factors that affect lake water quality.

The Lake Access Project team recommends having a graphic designer on hand, if your project's resources allow, from the onset of your Web site design and construction process. Using any number of Web- based applications, an experienced Web designer can help you design, develop, and maintain a Web site that most effectively communicates your time- relevant data and the associated messages you want to convey.

6.3 Resources for Presenting Water Quality Information to the Public

As you begin to implement your outreach plan and develop the products selected in the plan, you will want to make sure that these products present your messages and information as clearly and accurately as possible. You also might want to review the available resources on the Internet to help you develop your outreach products, or serve as additional resource materials (e. g., fact sheets).

How Do You Present Technical Information to the Public?

Environmental topics are often technical in nature, and water quality is no exception. Nevertheless, this information can be conveyed in simple, clear terms to nonspecialists, such as the public. Principles of effective writing for the public include avoiding jargon, translating technical terms into everyday language the public can easily understand, using the active voice, keeping sentences short, and using headings and other format devices to provide a very clear, well- organized structure. You can refer to the following Web sites for more ideas about how to write clearly and effectively for a general audience:

- The National Partnership for Reinventing Government has developed a guidance document, *Writing User-Friendly Documents*, that can be found on the Web at http://www.plainlanguage.gov.
- The Web site of the American Bar Association (http://www.abanet.org/lpm/writing/styl.html) has links to important online style manuals, dictionaries, and grammar primers.

As you develop communication materials for a specific audience, remember to consider what the audience members are already likely to know, what you want them to know, and what they are likely to understand. Then tailor your information accordingly. Provide only information that will be valuable and interesting to the target audience. For example, environmentalists in your community might be interested in why dissolved oxygen levels are important to aquatic life. However, it's not likely that school children will be engaged by this level of detail.

When developing outreach products, be sure to consider any special needs of the target audience. For example, if your community has a substantial number of people who speak little or no English, you will need to prepare communication materials in their native language.

The rest of this section contains information about online resources that can provide easy to understand background information that you can use in developing your own outreach projects. Some of the Web sites listed contain products, such as downloadable fact sheets, that you can use to support your education and outreach efforts.

Federal Resources

EPA's Surf Your Watershed
http://www.epa.gov/surf3

EPA provides this service to locate, use, and share environmental information on watersheds. One section of this site, "Locate Your Watershed," allows the user to enter the names of rivers, schools, or their zip code to learn more about the water resources in their local watershed. Users can also access the Index of Watershed Indicators (IWI) from this site. The IWI is a compilation of information on the "health" of aquatic resources in the U. S. The index uses a variety of indicators that point to whether rivers, lakes, streams, wetlands and coastal areas are "well" or "ailing."

EPA's Office of Water Volunteer Lake Monitoring: A Methods Manual
http://www.epa.gov/owow/monitoring/volunteer/lake

EPA developed this manual to present specific information on volunteer lake water quality monitoring methods. It is intended both for the organizers of the volunteer lake monitoring program and for the volunteer who will actually be sampling lake conditions. Its emphasis is on identifying appropriate parameters to monitor and setting forth specific steps for each selected monitoring method. The manual includes quality assurance/ quality control procedures to help ensure that the data collected by volunteers are useful to States and other agencies.

EPA's Non Point Source Pointers
http://www.epa.gov/owow/nps/facts

This Web site features a series of fact sheets on nonpoint source pollution. The series covers topics including: programs and opportunities for public involvement in nonpoint source control, managing urban runoff, and managing nonpoint pollution from various sources (e. g., agriculture, boating, households).

EPA's Great Lakes National Program Office
http://www.epa.gov/glnpo/about.html

EPA's Great Lakes National Program Office Web site includes information about topics such as human health, monitoring, pollution prevention, and visualizing the lakes. One section of this site (http://www.epa.gov/glnpo/gl2000/lamps/index.html) includes the Lakewide Management Plans (LaMPs) for each of the Great Lakes. A LaMP is an action plan to assess, restore, protect and monitor the ecosystem health of a Great Lake. It is used to coordinate the work of all the government, tribal, and non- government partners working to improve the Lake ecosystem. The program uses a public consultation process to ensure that the Lamp is addressing the public's concerns. Lamps could be used as models to assist interested parties in developing similar plans for their lakes.

U. S. Department of Agriculture Natural Resource Conservation Service
http://www.wcc.nrcs.usda.gov/water/quality/frame/wqam

Go to this site and click on "Guidance Documents." The resources there include a simple tool to estimate water body sensitivity to nutrients, a procedure to evaluate the conditions of a stream based on visual characteristics, plus information on how to design a monitoring system to observe changes in water quality associated with agricultural nonpoint source controls.

Education Resources

Project WET (Water Education for Teachers)
http://www.montana.edu/wwwwet

The goal of Project WET is to facilitate and promote awareness, appreciation, knowledge, and stewardship of water resources by developing and disseminating classroom- ready teaching aids and establishing state and internationally sponsored Project WET programs. This site includes a list of all the State Project WET Program Coordinators to help you locate a contact in your area.

Water Science for Schools
http://wwwga.usgs.gov/edu/index.html

The U. S. Geological Survey's (USGS's) Water Science for School Web site offers information on many aspects of water quality, along with pictures, data, maps, and an interactive forum where students can give opinions and test their water knowledge.

Global Rivers Environmental Education Network (GREEN)
http://www.earthforce.org/green

The Global Rivers Environmental Education Network (GREEN) helps young people protect the rivers, streams, and other vital water resources in their communities. This program merges hands- on, scientific learning with civic action. GREEN is working with EcoNet to compile pointers on water- related resources on the Internet. This site (http://www.igc.apc.org/green/resources.html) includes a comprehensive list of water quality projects across the country and around the world.

Adopt- A- Watershed
http://www.adopt-a-watershed.org/about.htm

Adopt- A- Watershed is a K- 12 school- community learning experience. Adopt- A-Watershed uses a local watershed as a living laboratory in which students engage in hands- on activities. The goal is to make science applicable and relevant to students' lives.

National Institutes for Water Resources
http://wrri.nmsu.edu/niwr/niwr.html

The National Institutes for Water Resources (NIWR) is a network of 54 research institutes throughout the U. S. They conduct basic and applied research to solve water problems unique to their area and establish cooperative programs with local governments, state agencies, and industry.

Other Organizations

North American Lake Management Society (NALMS) Guide to Local Resources
http://www.nalms.org/

This is a one- stop resource for local lake- related resources. NALMS's mission is to forge partnerships among citizens, scientists, and professionals to foster the management and protection of lakes and reservoirs. NALMS's Guide to Local Resources contains links to state and provincial agencies, local offices of federal agencies, extension programs, water resources research centers, NALMS chapters, regional directors, and a membership directory.

The Watershed Management Council
http://watershed.org/wmc/aboutwmc.html

The Watershed Management Council is a nonprofit organization whose members represent a broad range of watershed management interests and disciplines. Membership includes professionals, students, teachers, and individuals whose interest is in promoting proper watershed management.

Great Lakes Information Network (GLIN)
http://www.great-lakes.net

The Great Lakes Information Network (GLIN) is a partnership that provides online information about the bi-national Great Lakes- St. Lawrence region of North America. GLIN provides data about the region's environment, including issues related to water quality, diversion of water out of the Great Lakes basin, and the introduction of nonindigenous species and airborne toxins into the basin.

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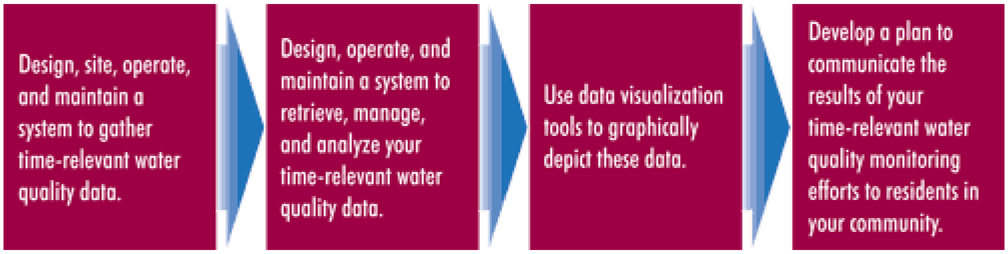
2. HOW TO USE THIS HANDBOOK

This handbook provides you with step-by-step information on how to develop a program to provide time-relevant water quality data to your community, using the Lake Access Project in the Minneapolis-St. Paul, Minnesota, area as a model. It contains detailed guidance on how to:


Design, site, operate, and maintain a system to gather time-relevant water quality data.
Design, operate, and maintain a system to retrieve, manage, and analyze your time-relevant water quality data.
Use data visualization tools to graphically depict these data.
Develop a plan to communicate the results of your time-relevant water quality monitoring efforts to residents in your community.

- Chapter 3 provides information about water quality monitoring—the first step in the process of generating time-relevant information about water quality and making it available to residents in your area. The chapter begins with an overview of water quality monitoring in freshwater systems and then focuses on the remote time-relevant water quality monitoring conducted as part of the Lake Access Project. It also provides step-by-step instructions on how to install, operate, and maintain the Remote Underwater Sampling Station (RUSS) units used by the Lake Access Project team to gather time-relevant water quality data.

- Chapter 4 provides step-by-step instructions on how to operate and maintain an automated system to transmit, store, retrieve, and analyze the water quality data collected from the remote time-relevant water quality monitors. The chapter focuses on the software used by the Lake Access Project team from their RUSS units to their base station, and it also contains information on data quality assurance and control.

- Chapter 5 provides information about using data visualization tools to graphically depict the time-relevant water quality data you have gathered. The chapter begins with a brief overview of data visualization. It then provides a more detailed introduction to selected data visualization tools developed by the Lake Access team. You might want to use these software tools to help analyze your data and in your efforts to provide time-relevant water quality information to your community.

- Chapter 6 outlines the steps involved in developing an outreach plan to communicate information about water quality in your community's lakes. It also provides information about the Lake Access Project's outreach efforts. The chapter includes a list of resources to help you develop easily understandable materials to communicate information about your time relevant water quality monitoring program to a variety of audiences.

This handbook is designed for decision-makers considering whether to implement a time-relevant water quality monitoring program in their communities and for technicians responsible for implementing these programs. Managers and decision-makers likely will find the initial sections of Chapters 3, 4, and 5 most helpful. The latter sections of these chapters are targeted primarily at professionals and technicians and provide detailed "how to" information. Chapter 6 is designed for managers and communication specialists.

The handbook also refers you to supplementary sources of information, such as Web sites and guidance documents, where you can find additional guidance with a greater level of technical detail. Interspersed throughout the handbook are text boxes that describe some of the lessons learned by the Lake Access team in developing and implementing its time-relevant water quality monitoring, data management, and outreach program.

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4.1 | 4.2 | 4.3 | 4.4 | 4.5

4. COLLECTING, TRANSFERRING, AND MANAGING TIME-RELEVANT WATER QUALITY DATA

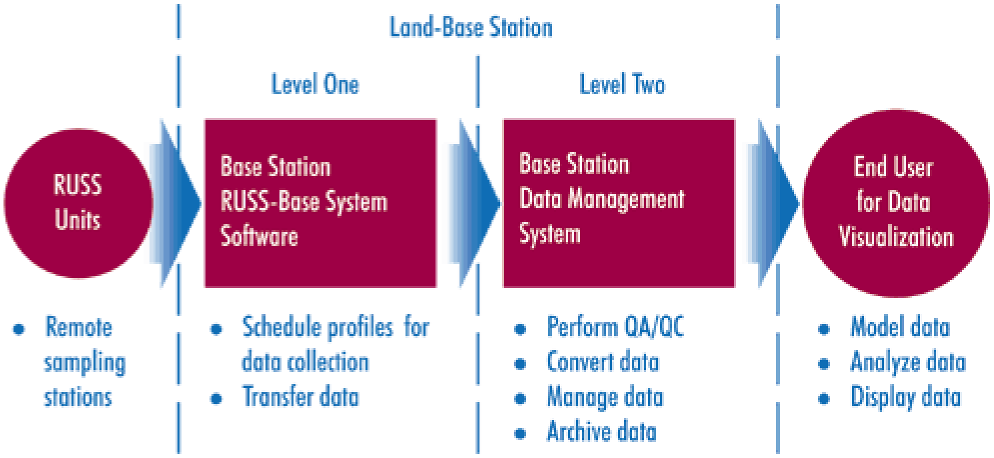
To effectively assess the water quality of a lake or river, it is necessary to collect representative field samples over a time span that takes into account as many influences on the water body as possible. However, conducting a comprehensive manual sampling program that covers different times of the day, as well as different seasons and seasonal events, presents distinct challenges. As a result, many water quality monitoring programs, such as the Lake Access Project, rely on automated systems in which remote water sampling units collect data at programmed intervals and then transmit the data to a land-based station for storage, retrieval, and analysis.

Using the Lake Access Project as a model, this chapter provides you and your community with "how-to" instructions on how to operate and maintain such data collection systems. If you are responsible for or interested in implementing this system, you should carefully read the technical information presented in the sections on setting up and using RUSS-Base software for data collection and transfer, and managing the data at the base station (Sections 4.2 through 4.5). Readers interested in an overview of the system should focus primarily on the introductory information in Section 4.1 below.

4.1 System Overview

A data collection, transfer, and management system can benefit your community in two ways: It enables you to automate the collection of water quality samples, and it enables you to control the resulting data flexibly and easily. By using the system's software, you can program your remote in-water sampling units (in this case, RUSS units) to collect water quality data at specified intervals. Then you can call the sampling units as needed for data transmission or program your system to call for transmissions of data at specified times. Once the data arrive, the information can be formatted and stored or otherwise prepared for export to another database, or it can be analyzed using geographical information system (GIS) or data visualization software.

The data collection, transfer, and management system used in the Lake Access project consists of two main parts (see the figure below):


Land-Base Station
Level One
Level Two
RUSS Units
Base Station RUSS-Base System Software
Base Station Data Management System
End User for Data Visualization
• Remote sampling stations
• Schedule profiles for data collection
• Transfer data
• Perform QA/QC
• Convert data
• Manage data
• Archive data
• Model data
• Analyze data
• Display data

- *Remote Underwater Sampling Station (RUSS) units,* which are deployed in the water and programmed to collect water quality data in the water column at specified depths and intervals.
- *A land-based station*, which is basically a computer equipped with two main parts:
- *RUSS-Base software.* You use this software to create profile schedules of sampling parameters and to communicate with the RUSS units to transmit schedules and receive sampling data.
- *A database management system.* You use this system to format, quality check, and store collected data.

The RUSS units and the base station computer are equipped with communications hardware featuring either a modem/cell phone or modem/radio transceiver. This equipment allows the RUSS units and computer to "talk" to each other over long distances. Because of this communication ability, each RUSS unit becomes part of a remote data acquisition system controlled from the land- base station. At the base station, an operator runs the RUSS-Base software to connect to the RUSS units for data collection and transfer.

The system's flexibility enables you to establish sampling and data transfer protocols based on your specific monitoring needs. For example, you might program your RUSS units to sample every 4 hours, 7 days a week, to monitor general trends. You might also want to conduct sampling specific to certain events, such as storms or heavy rainfalls, during which you might monitor water quality at a single depth on an hourly basis.

The system can collect and store data for future use, or it can retrieve and transmit collected data in near- real time. Each RUSS unit stores collected data in its on- board computer (RePDAR), making the data available for download on demand by the base station. The RUSS unit can hold up to 3 weeks of collected data (assuming average sampling intervals) in its on- board computer. The unit also can serve as a temporary archive by retaining a copy of all transmitted data files. Once the unit runs out of space, it will overwrite data as necessary, beginning with the oldest files.

A single base station can control an array of RUSS units, and an individual RUSS unit can transmit data to more than one base station.

The remainder of this chapter provides information on how to program a data collection and transfer system and how to manage the collected data, using the system used by the Lake Access project as an example.

How often should data be collected?

The Lake Access team generally collects samples every 4 to 6 hours to observe daily changes in water quality parameters (see Chapter 3.1). The RUSS units collect samples at 6: 00 a. m., 12: 00 noon, 6: 00 p. m. and 12: 00 midnight, and the data are transmitted to the land- based station at 7: 30 a. m. the following morning. The team also collects intermittent samples to determine the effect of storm events on lake stratification and nutrient mixing.

4.2 Getting Your Equipment and Software in Place

In addition to deploying your RUSS units for data collection and transfer, you will need to assess whether your base station computer equipment meets minimum technical requirements. Once you have determined that it does, you will be ready to obtain and install the software needed to communicate with your RUSS units. Before you receive the software from Apprise Technologies, you will need to determine which type of telemetry equipment should be used on the RUSS units.

Minimum Requirements

To use a land- based computer as a base station, you will need:

- An IBM- compatible PC with a Pentium II processor (300 megahertz [MHZ])
- Windows 95, 98, or 2000 or Windows NT
- 16 megabytes of RAM
- 10 megabytes of free disk space
- An industry standard internal or external dial- up modem

Telemetry Equipment

As a next step, you will need to determine what kind of data communication or telemetry equipment to install on your RUSS units. Telemetry equipment enables data to be transferred from a remote sampling station (i. e., the RUSS unit) to a receiving station (i. e., the base station). You can choose between a cellular telephone modem (CTM) and a 900- MHz transceiver. To make this choice, you should consider the following factors:

- The initial expense associated with CTM units is relatively low. (They generally cost about $1,000 each.)

However, CTM unit connection costs can be somewhat higher than transceiver unit connection costs. In contrast, the up-front costs for transceiver units is relatively high (generally about $3,000 each), but connection costs are likely to be much lower. In addition, maintenance costs tend to be lower for transceivers.

- Establishing a connection between a CTM unit and RUSS units can be problematic at times if local circuits are overloaded or if tower-switching issues arise.

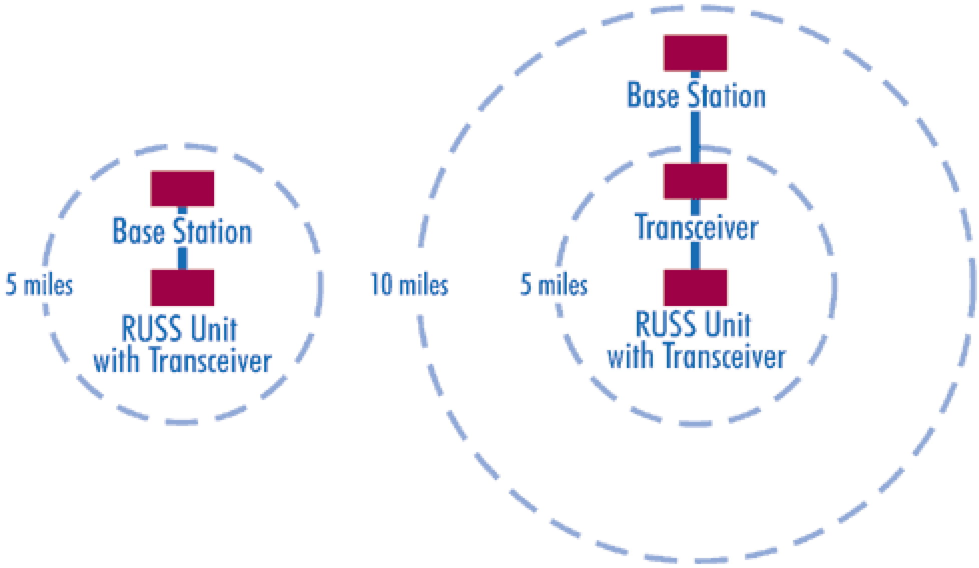
Even when a connection is established, the signal strength might not be strong enough to allow data transmission. A signal strength of less than 50 MHz is usually too weak, while a signal strength between 50 and 60 MHz is marginal.

Tip. To test the connection between a CTM unit and a RUSS unit, you can call the test line maintained by Apprise Technologies, which is usually pre-programmed into the CTM. (Before you dial, be sure to switch the unit to the proper pre-programmed number by using the key pad.) On certain CTMs, you can call the test line by pressing "C" on the key pad. The status of the call will be displayed in the phone's message window, as follows:

- "No service" indicates insufficient signal strength
- "System busy" indicates overloaded local cell capacity
- "No carrier" or "busy" or "dropped call" indicates call interruption
- "Connect" indicates successful connection

(Note: Apprise Technologies does not guarantee the accessibility of its test line.)

- Transceiver unit communications can be affected by radio interference on the transmission channel. The channel's path also can be inadequate to maintain the connection. In such cases, it might be possible to switch to a different channel. Using a dedicated or leased line can help ensure the reliability of data transmission.
- Depending on the distance between the land-based station and a RUSS unit, you may need to deploy a sequence of transceivers. Transceivers can transmit and receive over a distance of no more than 5 miles. The figure below shows different transceiver deployment configurations based on the distance between the land-based station and the RUSS unit.



Installing Level 1 Base Station Software

Once you have determined that your computer meets minimum technical requirements and you have selected and set up your telemetry system, you are ready to obtain and install RUSS-Base, the level 1 base station software. RUSS-Base enables you to create profile schedules with sampling parameters, transmit the schedules to your RUSS units, and receive transmissions of sampling data. Additional software (discussed below) allows you to run RUSS-Base automatically.

RUSS- Base Software

RUSS- Base, a DOS- based software program available from Apprise Technologies, is provided as part of a RUSS unit's data collection and transfer system.

To install RUSS- Base:

1. Copy *R-Base.exe* from the disk or CD- ROM to a directory on your computer.
2. Double click on the executable file. This will load the program onto your computer and create an icon to access RUSS- Base from your desktop. It will also create two directories on your hard drive. One directory, *C:\RUSS*, contains the RUSS- Base program. The other directory, *C:\RUSSdata*, is the default directory in which downloaded data from the RUSS unit will be automatically placed.
3. Verify that the RUSS- Base program is working by double clicking on the desktop icon or navigating to the *C:\RUSS* directory and double clicking on *R-Base.exe*.

Note that Apprise Technology provides customers with update notifications by telephone or e- mail and delivers the actual updates via e- mail, disk, or CD- ROM. We suggest that you implement these updates as you receive them.

Additional Software

ClockerPro and Clocker are personal/ network program schedulers for use on the Windows platform. They are designed to schedule programs (or reminders)— such as the upload and download of data from RUSS units— to run at specified times. Registration for a single copy of these schedules costs $24.95.

To obtain and install ClockerPro or Clocker:

1. Download ClockerPro and Clocker from http://www.winnovation.com/clocker.htm.
2. Click on the file *clkpr311. zip* (for ClockerPro) or *clk2403. Zip* (for Clocker) and save it to a temporary directory on your computer (such as *C:\ tmp*).
3. Navigate to the location of *clkpr311. Zip* or *clk2403. Zip*
4. Run *setup. exe* and follow the instructions provided. For instructions on using ClockerPro or Clocker, select *Help* from the software's main screen.

Anticipating Support Needs

As with any computer system, you will need to ensure the availability of technical support to attend to software, hardware, and security needs. A staff person who is familiar with providing general computer support should be able to maintain your system. You should enlist the services of a technical support person before you deploy the system so that guidance is available when you need it.

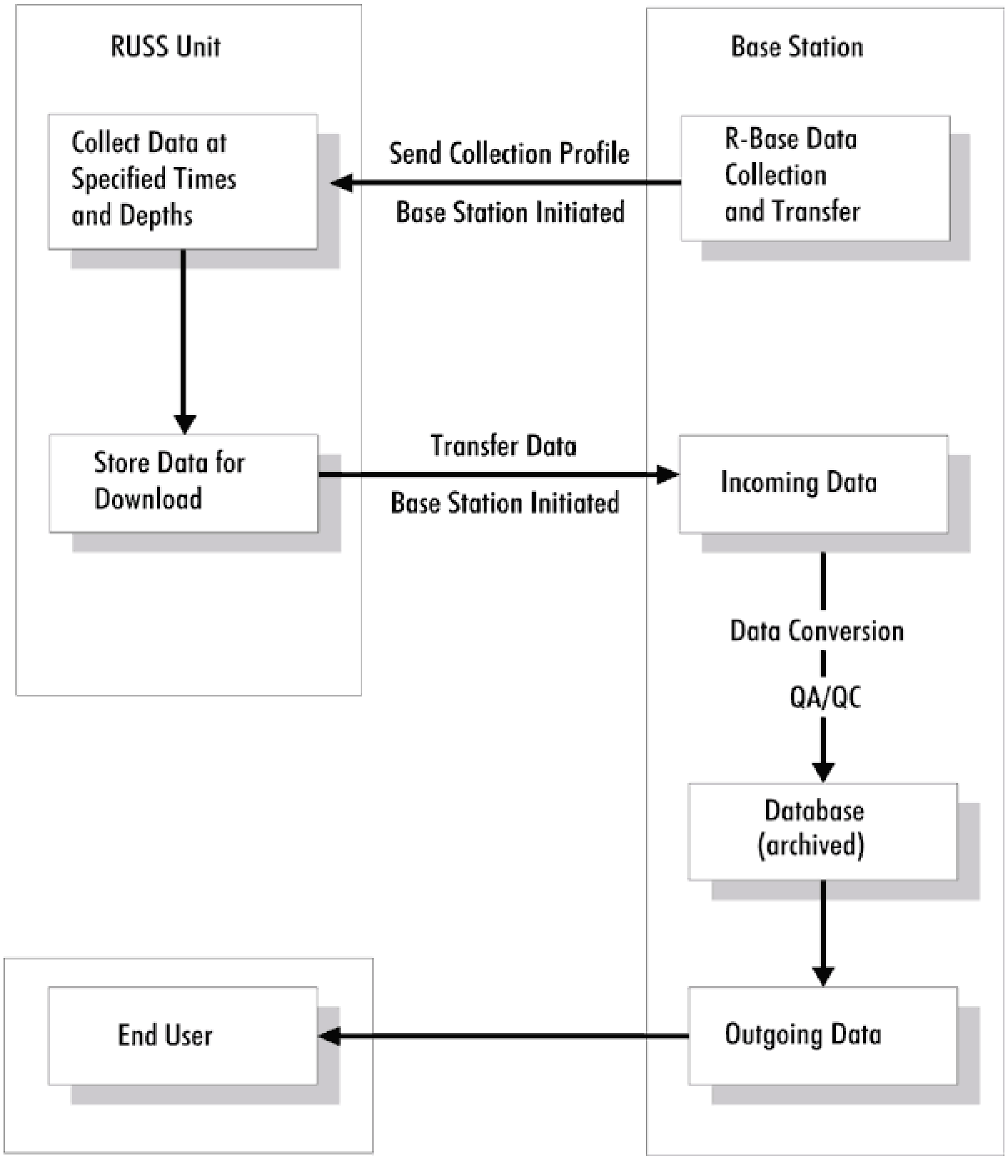
4.3 Programming Your System for Scheduled Transfers of Data

Now that the components of your system are in place, you are ready to program the system components for data collection and transfer using RUSS- Base software and Clocker/ ClockerPro. The RUSS- Base software application is relatively easy to use, particularly if you have some experience with DOS programs and telemetry equipment. This section focuses primarily on:

- Using RUSS- Base to program your RUSS units for sample collection.
- Programming your land- base station to automatically call the RUSS units for scheduled data feeds.

The first time you perform these functions, you will need to be attentive to a variety of details. Once you have established the appropriate protocol, however, implementing these functions should be quick and easy.

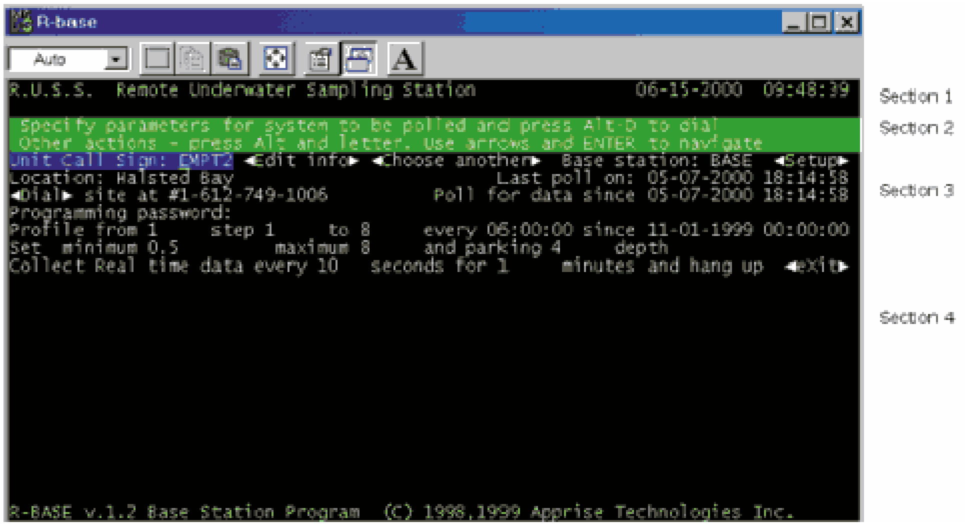
The figure below provides an overview of the data collection and transfer process.


RUSS Unit
Base Station
Collect Data at Specified Times and Depths
Send Collection Profile
Base Station Initiated
R-Base Data Collection and Transfer
Store Data for Download
Transfer Data
Base Station Initiated
Incoming Data
Data Conversion
QA/QC
Database (archived)
End User
Outgoing Data

Getting Familiar with the RUSS- Base Startup Screen

With RUSS- Base installed on your land- based computer, you can launch the program by double clicking on either the desktop icon or the R- base. exe file in the *C:/RUSS directory*. This will open the program to the startup screen, which serves as the gateway to program functions.

The startup screen orients you to the overall format of screens throughout the program. The screen content is organized into four main areas, as shown in the screen below and described in the legend that follows.



```
R.U.S.S.  Remote Underwater Sampling Station                06-15-2000  09:48:39

 Specify parameters for system to be polled and press Alt-D to dial
 Other actions - press Alt and letter. Use arrows and ENTER to navigate
Unit Call Sign: EMPT2 ◄Edit info► ◄Choose another►  Base station: BASE  ◄Setup►
Location: Halsted Bay                            Last poll on: 05-07-2000 18:14:58
◄Dial► site at #1-612-749-1006              Poll for data since 05-07-2000 18:14:58
Programming password:
Profile from 1     step 1     to 8     every 06:00:00 since 11-01-1999 00:00:00
Set  minimum 0.5          maximum 8     and parking 4      depth
Collect Real time data every 10   seconds for 1     minutes and hang up  ◄eXit►

R-BASE v.1.2 Base Station Program  (C) 1998,1999 Apprise Technologies Inc.
```

Legend

Section 1: **Displays the header, date, time, and error messages**

Section 2: **Presents information on navigating the program (highlighted in green)**

Section 3: **Presents the main menu of functions**

Section 4: **Displays component-specific information (e. g., water quality sample values)**

Using the main menu on the startup screen (Section 3 in the screen shown above), you will select and use a variety of RUSS-Base program functions. For reference, these include:

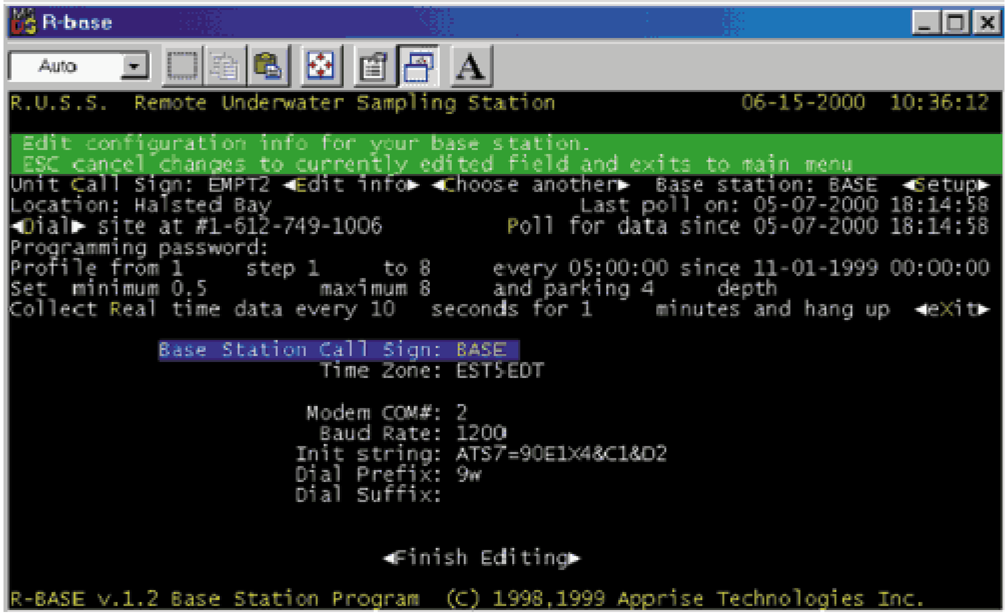
Function	Short Cut Key	Screen Name	Description
Setup	Alt-S	RUSS-Base Setup	Enter base station call sign, time zone, parameters of your modem, and data collection information
Real-time data	Alt-R	RUSS-Base Setup	Enter "real time data" parameters
Poll for data since	Alt-P	RUSS-Base Setup	Enter "poll for data since" parameters
Call sign	Alt-C	RUSS Unit Setup	Enter the call sign
Edit info	Alt-E	RUSS Unit Setup	Enter information for each RUSS unit including call sign, location, modem connection, password, and data folder
Choose another	Alt-C	RUSS Unit Setup	Select one or more RUSS units from a list of RUSS units
Dial	Alt-D	Dialing Status	Dial the RUSS unit for profile upload and data download
Exit	Alt-X		Exit RUSS-Base

Before you proceed, we suggest that you view the startup screen and locate these functions so you will be ready to select them as directed in the section below.

Setting Up Your Base Station

You are now ready to use RUSS-Base to configure your base station to communicate with your RUSS units. In doing so, you will initialize your modem and dial-up specifications and create profile schedules for water quality sampling performed by individual RUSS units. (You will create a configuration file for each RUSS unit in your system.)

To start, select *Setup* from the main menu or press Alt-S on your keyboard. The Setup screen (reproduced below) will appear on your computer screen.



```
R.U.S.S.  Remote Underwater Sampling Station                 06-15-2000  10:36:12

 Edit configuration info for your base station.
 ESC cancel changes to currently edited field and exits to main menu
Unit Call Sign: EMPT2 ◄Edit info► ◄Choose another►  Base station: BASE  ◄Setup►
Location: Halsted Bay                                 Last poll on: 05-07-2000 18:14:58
◄Dial► site at #1-612-749-1006                 Poll for data since 05-07-2000 18:14:58
Programming password:
Profile from 1      step 1      to 8      every 05:00:00 since 11-01-1999 00:00:00
Set  minimum 0.5            maximum 8     and parking 4      depth
Collect Real time data every 10   seconds for 1      minutes and hang up  ◄eXit►

            Base Station Call Sign: BASE
                       Time Zone: EST5EDT

                     Modem COM#: 2
                      Baud Rate: 1200
                    Init string: ATS7=90E1X4&C1&D2
                    Dial Prefix: 9w
                    Dial Suffix:


                          ◄Finish Editing►

R-BASE v.1.2 Base Station Program  (C) 1998,1999 Apprise Technologies Inc.
```

On the Setup screen, enter the information requested for various parameters, explained in the table below:

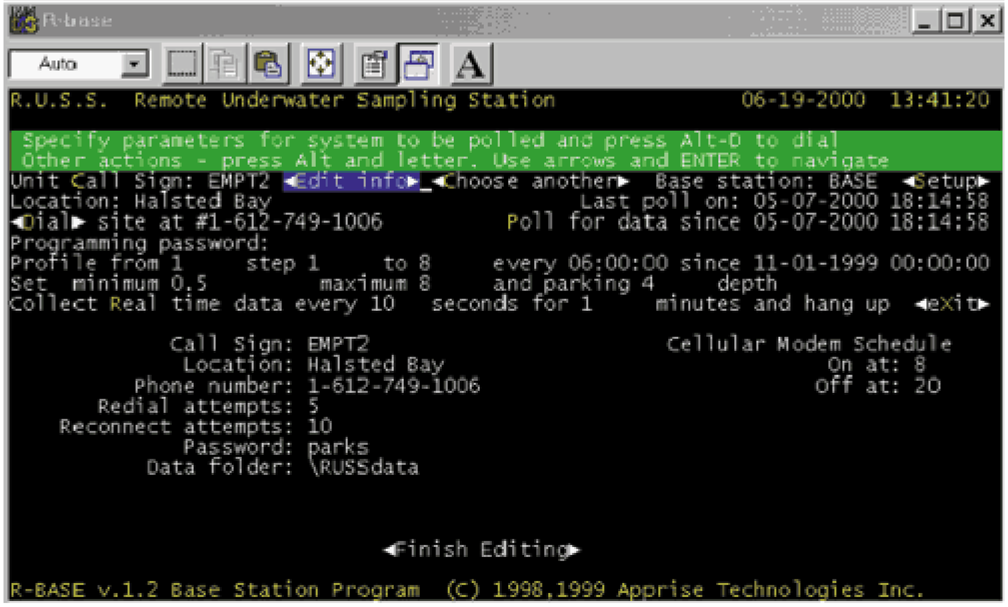
Parameter		Description
Base station call sign		Enter name of the base station computer. This function will track which computer is calling a RUSS unit.
Time zone		Enter in Standard UNIX format: EST5EDT for Eastern time, CST6CDT for Central time, MST7MDT for Mountain time, and PST8PDT for Pacific time.
Modem CDM#		Enter modem CDM#. The default value will work with most modems.
Baud rate		Enter the proper baud rate for your modem: 1200, 2400, 4800, 9600, 19200, or 38400. The default value will work with most modems.
Init string		Enter the initialization string for your modem. The default value will work with most modems.
Dial prefix		Dial prefix If necessary, enter a dial prefix. For example, your organization might require you to dial "9" to reach an outside line.
Dial suffix		If necessary, enter a dial suffix. For example, your organization might require you to enter a project charge code.
Last poll on		This date and time tells you the last time your base station called data from a particular RUSS unit. It also keeps track of the last data point downloaded from the RUSS unit, so only new data will be downloaded.
Profile from...		This sets the depth and time at which the RUSS unit will collect data. The screen shot above shows the following profile: Profile from 1 Step 1 to 8 every 05:00:00 since 11-01-99 00:00:00 This means that data will be collected from 1 to 8 meters at 1-meter intervals. The RUSS unit will collect data every 5 minutes from November 1, 1999, starting at midnight. Note: The more frequently the data are collected, the more battery power is used by the RUSS unit. To conserve battery voltage, you might want to limit sampling frequency.
Collect real time data		This sets the time when real-time data will be downloaded from the RUSS unit to the base station. The screen shot above shows the following parameters: Collect Real Time data every 10 seconds for 1 minute and hang up. In this example, real-time data will be sent by the RUSS unit every 10 seconds for 1 minute. This process provides the base station operator with a sample of real-time data measurements and the ability to QA/QC the data.
Poll for data since		This sets the time when both stored and real-time data will be downloaded from the RUSS unit to the base station. The screen shot above shows the following parameters: Poll for data since 05-07-2000 18:14:58 Data will be downloaded from May 7, 2000 at 6:14 p.m. (and 58 seconds) to the

	present time.
Set minimum... Maximum... and parking depth	This sets the minimum and maximum depths of the profiler in the lake or river. It also sets the parking depth at which maximum... the profiler will remain when inactive. The screen shot above shows the following parameters: and parking depth Set minimum 0.5 maximum 8 and parking 4 depth In this case, the profiler will not ascend above 0.5 meters and will not descend below 8 meters. When inactive, it will hold at 4 meters. The minimum and maximum depths are a fail safe method for preventing potential accidents. For example, suppose you accidentally programmed the profiler to collect data from 1 to 1000 meters. If you had entered 10 meters as the maximum depth that the profiler can descend to, the system will catch this error and the profiler will remain inactive.

Tip. Before sending the profile information to a RUSS unit, you must first enter an authorized programing password in RUSS-Base. The RUSS unit operator will have previously programmed this password into the RUSS unit, and you will enter this same programming password into RUSS-Base. The RUSS unit will reject the profile unless this programming password has been entered in RUSS-Base.

Setting Up Your RUSS Unit

Now that you have set up a configuration file, you need to provide additional information for each deployed RUSS unit. To enter this information, access the RUSS unit setup screen shown below, by selecting *Edit Info*, or by hitting Alt-E.



```
R.U.S.S.  Remote Underwater Sampling Station                06-19-2000  13:41:20

 Specify parameters for system to be polled and press Alt-D to dial
 Other actions - press Alt and letter. Use arrows and ENTER to navigate
Unit Call Sign: EMPT2 ◄Edit info►_◄Choose another►  Base station: BASE  ◄Setup►
Location: Halsted Bay                              Last poll on: 05-07-2000 18:14:58
◄Dial► site at #1-612-749-1006           Poll for data since 05-07-2000 18:14:58
Programming password:
Profile from 1     step 1     to 8     every 06:00:00 since 11-01-1999 00:00:00
Set  minimum 0.5          maximum 8     and parking 4     depth
Collect Real time data every 10   seconds for 1     minutes and hang up  ◄eXit►

            Call Sign: EMPT2                           Cellular Modem Schedule
             Location: Halsted Bay                                  On at: 8
         Phone number: 1-612-749-1006                              Off at: 20
       Redial attempts: 5
    Reconnect attempts: 10
             Password: parks
          Data folder: \RUSSdata


                          ◄Finish Editing►

R-BASE v.1.2 Base Station Program  (C) 1998,1999 Apprise Technologies Inc.
```

Using this RUSS unit Setup screen, enter information about the various RUSS unit parameters:

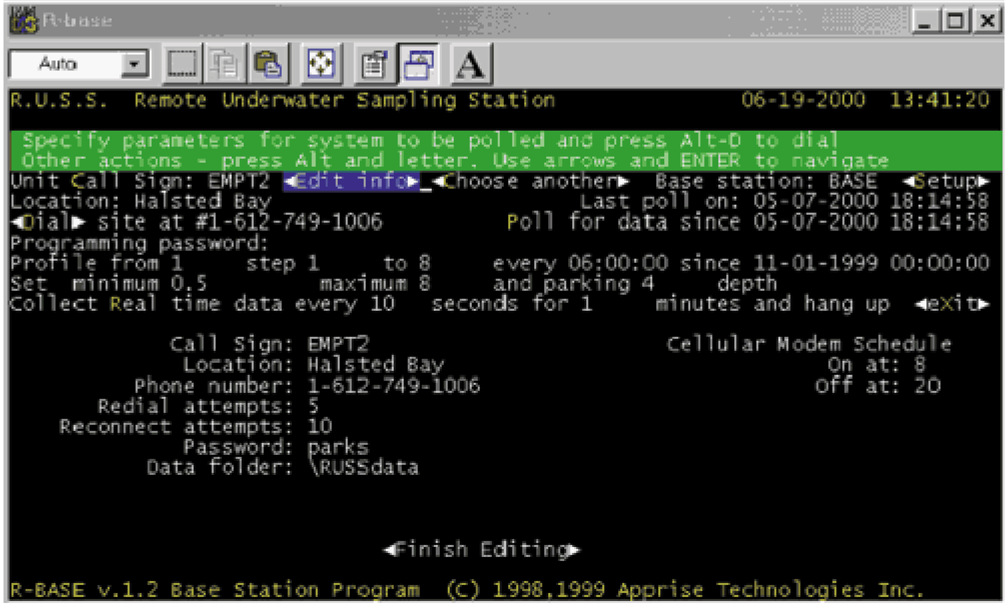
Parameter	Description
Call sign	Name of the RUSS unit.
Location	Location of the RUSS unit.
Phone number	The phone number previously programmed in the RUSS unit cellular phone or transceiver. The base station phone number is not required if your system is not configured for calls initiated by remote stations.
Redial attempts	The maximum number of "Redial attempts." This value specifies how many times the base station will try to redial the programmed phone number until a connection is established.
Reconnect attempts	The maximum number of "Reconnect attempts." If the RUSS unit answers but connection is broken before all stored data are downloaded, the base station will hang up and call the unit again.
Password	This password allows a caller to establish a remote connection with the RUSS unit and download real-time and stored data. (Level 1 access priority.)

Data folder	The name of the folder that the RUSS data will be downloaded to on the base station computer. You can also use the default directory C:\ RUSSdata originally created when you installed RUSS- Base.
Cellular modem schedule	The time when the cellular telemetry is turned on and off. This is to promote power conservation.

You have now set up your system with profile schedules and RUSS unit information— so that you can control your RUSS unit data collection activities. You are now ready to direct your RUSS units to collect data according to the profile schedules and to transfer back the collected data.

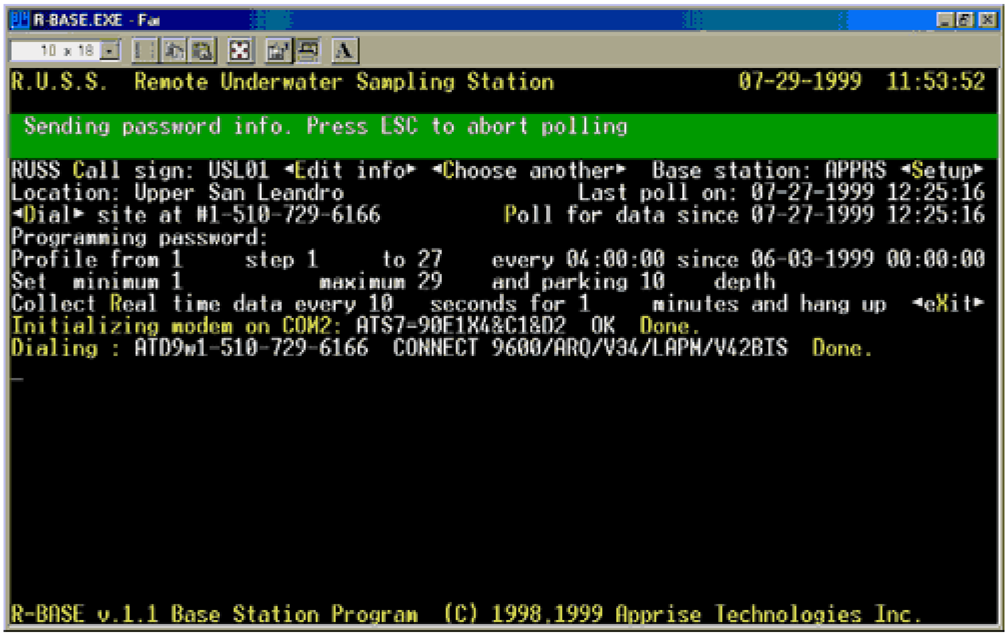
Uploading the Profile Schedule and Downloading Data

To direct your RUSS units to collect data, you must upload your sampling profile schedules to your RUSS units. To do this, use the unit list screen (shown below) to select a unit for profile upload. Access the unit list screen by selecting *choose another* or Alt- C on your keyboard. After selecting a unit from the list, call the unit for profile upload.



```
R.U.S.S.  Remote Underwater Sampling Station              06-19-2000  13:41:20

 Specify parameters for system to be polled and press Alt-D to dial
 Other actions - press Alt and letter. Use arrows and ENTER to navigate
Unit Call Sign: EMPT2 ◄Edit info►_◄Choose another►  Base station: BASE  ◄Setup►
Location: Halsted Bay                          Last poll on: 05-07-2000 18:14:58
◄Dial► site at #1-612-749-1006             Poll for data since 05-07-2000 18:14:58
Programming password:
Profile from 1      step 1     to 8      every 06:00:00 since 11-01-1999 00:00:00
Set  minimum 0.5           maximum 8     and parking 4      depth
Collect Real time data every 10   seconds for 1      minutes and hang up  ◄eXit►

             Call Sign: EMPT2                        Cellular Modem Schedule
              Location: Halsted Bay                                On at: 8
          Phone number: 1-612-749-1006                            Off at: 20
       Redial attempts: 5
    Reconnect attempts: 10
              Password: parks
           Data folder: \RUSSdata


                              ◄Finish Editing►

R-BASE v.1.2 Base Station Program  (C) 1998,1999 Apprise Technologies Inc.
```

To call the unit, select dial (Alt- D), which initiates the call and accesses the screen shown below.



```
R.U.S.S.  Remote Underwater Sampling Station              07-29-1999  11:53:52

 Sending password info. Press ESC to abort polling

RUSS Call sign: USL01 ◄Edit info► ◄Choose another►  Base station: APPRS ◄Setup►
Location: Upper San Leandro                    Last poll on: 07-27-1999 12:25:16
◄Dial► site at #1-510-729-6166            Poll for data since 07-27-1999 12:25:16
Programming password:
Profile from 1      step 1     to 27     every 04:00:00 since 06-03-1999 00:00:00
Set  minimum 1             maximum 29    and parking 10     depth
Collect Real time data every 10   seconds for 1      minutes and hang up  ◄eXit►
Initializing modem on COM2: ATS7=90E1X4&C1&D2  OK  Done.
Dialing : ATD9w1-510-729-6166  CONNECT 9600/ARQ/V34/LAPM/V42BIS  Done.
_

R-BASE v.1.1 Base Station Program  (C) 1998,1999 Apprise Technologies Inc.
```

If the connection established is too weak for transmission, RUSS- Base will disconnect and redial. If the modem initialization fails, terminate the connection attempt by pressing the ESC key and check to see if another program is using the modem.

Tip. Using ClockerPro or Clocker software, you can automatically schedule RUSS- Base to call RUSS units in a predetermined order at different times. These software programs are personal/ network program schedulers for Windows designed to schedule programs (or reminders)— such as the upload and download of data from the RUSS unit(s)— to run at specified times. Use the instructions provided with these programs to run the desired schedules.

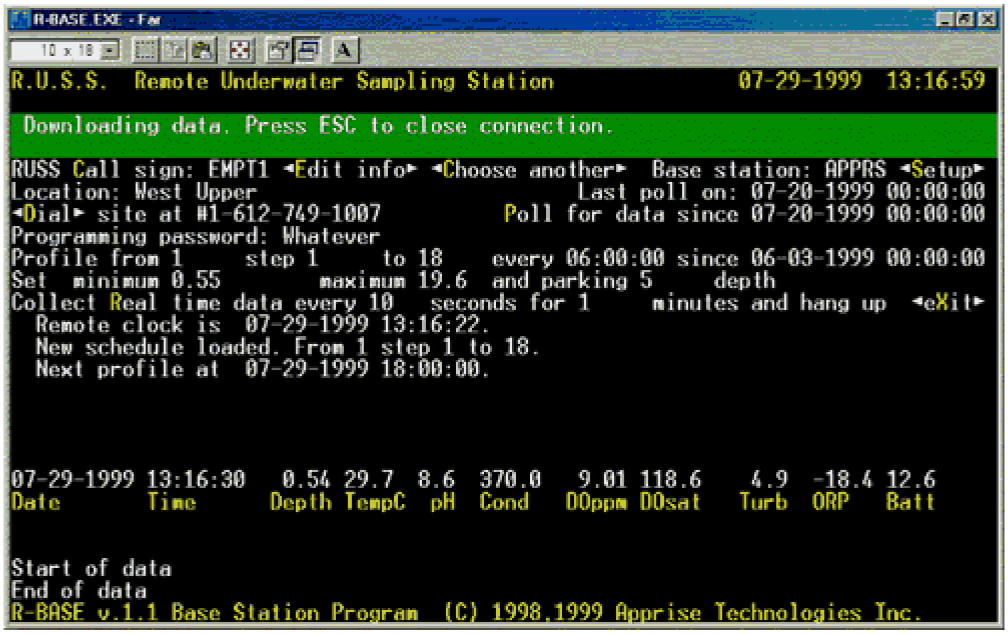
Once a connection is established, the RUSS unit will first validate the programming password if you are loading a new profile schedule. If the programming password is valid, the RUSS unit will report back the time of the next scheduled sample collection and data transmission, as well as profile parameters.

After the unit receives the new profile, its on- board computer will run a validation routine on the profile, checking for logic errors or any conflicts with existing programs. If any questionable data elements are found, the system will prompt you to review and resolve the issue. Once any issues concerning the profile are addressed, the unit will store the profile parameters and implement sampling based on the profile's schedule information. You can then proceed in a similar fashion through the unit list screen to upload profiles to other units in your system.

When collecting a water quality sample, the RUSS unit deploys a device called a Profiler to a specified depth in the water column below the unit. Before data are collected, the sensors will stabilize at the correct depth, which can take 3 to 5 minutes. Collected information is then transmitted to the unit's on- board computer via an underwater cable. The computer has the capacity to store up to 3 weeks of collected data (assuming average sampling intervals).

The collected monitoring information is then automatically transmitted from the RUSS units to the base station at intervals specified in unit- specific profile schedules. After this transmission, you can access the data as needed for analysis.

Even when the system is set up to automatically transmit collected data, you can implement manual downloads using the unit list screen to connect with specific RUSS units (as discussed above). To avoid downloading duplicate data, RUSSBase tracks the last data point for data transmitted from each unit. In addition, you can download near real- time data from a unit at the same time the unit is transmitting data from a scheduled sampling. As information is transmitted, it will display on screen (as shown in the screen shot below). An "End of data" message will be displayed when the transmission is complete.



```
R.U.S.S.  Remote Underwater Sampling Station                07-29-1999  13:16:59

 Downloading data. Press ESC to close connection.

RUSS Call sign: EMPT1 ◄Edit info► ◄Choose another►  Base station: APPRS ◄Setup►
Location: West Upper                              Last poll on: 07-20-1999 00:00:00
◄Dial► site at #1-612-749-1007              Poll for data since 07-20-1999 00:00:00
Programming password: Whatever
Profile from 1      step 1      to 18     every 06:00:00 since 06-03-1999 00:00:00
Set  minimum 0.55          maximum 19.6  and parking 5      depth
Collect Real time data every 10   seconds for 1      minutes and hang up  ◄eXit►
  Remote clock is  07-29-1999 13:16:22.
  New schedule loaded. From 1 step 1 to 18.
  Next profile at  07-29-1999 18:00:00.



07-29-1999 13:16:30   0.54 29.7  8.6  370.0   9.01 118.6    4.9  -18.4 12.6
Date       Time       Depth TempC pH  Cond    DOppm DOsat   Turb  ORP   Batt


Start of data
End of data
R-BASE v.1.1 Base Station Program  (C) 1998,1999 Apprise Technologies Inc.
```

4.4 Managing Data at the Base Station

This section provides you with background information on managing data at the base station. It describes the base station's data functions, including data formatting, QA/ QC, management, retrieval, and storage.

Data Format

As data are automatically transferred from the RUSS units, the data files are automatically downloaded into the C:\ RUSS directory on your base station hard drive. The raw data are formatted as a simple string of comma-delimited ASCII text.

The data format and file name will be slightly different depending on whether you are downloading real- time data or stored data. The following table displays near real- time data obtained from the EMPT2 Russ unit in Halsteds Bay. The file is called EMPT2506. RTD. EMPT2 is the unit call sign, 2506 is the date, and the extension RTD indicates real- time data.

Date	Time	Depth	Temp °C	pH	Cond	DOppm	DOsat	Turb	ORP	Batt
05-06-2000	07:31:19	4.40	15.0	7.8	410.0	7.05	70.0	53.4	48.6	13.0
05-06-2000	07:31:28	4.40	15.0	7.8	410.0	7.08	70.3	51.9	31.4	12.9
05-06-2000	07:31:37	4.40	15.0	7.8	410.0	7.09	70.4	67.3	44.0	12.8
05-06-2000	07:31:49	4.40	15.0	7.8	410.0	7.11	70.6	54.2	48.9	12.8
05-06-2000	07:31:58	4.40	15.0	.8	410.0	7.11	70.6	52.6	48.4	12.8
05-06-2000	07:31:07	4.40	15.0	7.8	410.0	7.11	70.6	45.4	48.9	12.8

The following table displays stored data obtained from the EMPT2 Russ unit in Halsteds Bay. The file is called EMPT2725. DAT where the extension DAT refers to stored data.

Date	Time	Depth	Temp °C	pH	Cond	DOppm	DOsat	Turb	ORP
7/25/00	0:02:13	1.17	24	8.4	382	8.23	97.8	31.2	11.9
7/25/00	0:03:40	1.89	24	8.4	382	8.49	100.9	38.2	9.7
7/25/00	0:05:07	2.83	23.9	8.4	383	8.37	99.4	32.8	11.9
7/25/00	0:06:22	3.86	23.8	8.4	384	7.92	93.8	50.8	13.8
7/25/00	0:08:13	4.97	23.5	8.2	388	6.17	72.7	20.8	20
7/25/00	0:09:40	5.89	22.6	7.6	396	0.83	9.6	27.8	36.8
7/25/00	0:11:31	6.81	22.1	7.4	409	0.11	1.2	23.3	48.2
7/25/00	0:13:34	7.85	20.5	7.2	457	0.11	1.2	57.1	57
7/25/00	6:02:16	1.16	23.8	8.4	383	7.6	90	41.4	13.5
7/25/00	6:03:55	1.92	23.8	8.4	382	8.29	98.2	113.3	8.8
7/25/00	6:05:07	2.88	23.8	8.4	382	8.19	97	96.1	13
7/25/00	6:06:34	3.9	23.7	8.3	384	7.4	87.4	56.5	14.7
7/25/00	6:08:37	4.88	23.5	8.1	387	6.45	75.9	55.5	19.6
7/25/00	6:09:52	5.84	22.9	7.7	393	2.36	27.5	38.2	30
7/25/00	6:11:55	6.86	22.1	7.4	409	0.13	1.5	47.2	43.6
7/25/00	6:13:46	7.84	21	7.3	444	0.11	1.2	64.4	52.6
7/25/00	12:02:40	1.14	23.9	8.4	382	8.01	95	233.5	11.3
7/25/00	12:08:15	2.18	23.8	8.4	382	7.96	94.2	108.3	11.2
7/25/00	12:10:51	2.85	23.7	8.4	383	7.76	91.8	108.3	8.5
7/25/00	12:12:18	3.91	23.5	8.3	384	7.06	83.1	97	16.1
7/25/00	12:13:57	4.82	23.3	8.1	386	6.13	71.9	103.9	21.8
7/25/00	12:15:36	5.89	22.8	7.7	394	2.52	29.3	93.5	36.3
7/25/00	12:17:51	6.9	21.8	7.3	423	0.12	1.4	120.4	46

7/25/00	12:19:18	7.83	20.8	7.2	450	0.12	1.3	111	54.1
7/25/00	18:06:42	0.99	24.5	8.6	380	9.71	116.4	92.4	2.6
7/25/00	18:08:33	1.96	24.5	8.6	380	9.85	118.1	112.4	3.8
7/25/00	18:10:12	2.86	24.4	8.5	381	9.58	114.7	109.3	6.2
7/25/00	18:11:51	3.81	23.7	8.3	386	7.15	84.5	90.9	13.7
7/25/00	18:13:30	4.8	23.3	8	388	5.79	68	113.9	24.4
7/25/00	18:14:57	5.81	22.8	7.5	395	2.81	32.7	96.8	40.9
7/25/00	18:17:00	6.83	21.7	7.3	423	0.15	1.7	123.7	49.6
7/25/00	18:18:51	7.95	20.8	7.2	449	0.12	1.4	113.3	52.3

Checking for Data Quality

After your data have been delivered, you will want to make sure that they meet acceptable quality criteria. The Lake Access team uses both automated and manual data quality checks to ensure accurate and representative measurements of water quality parameters. At all stages of data management, the information is subjected to previously established and documented quality assurance protocols.

Performing quality checks on Lake Access data can take from a few days to weeks or months, depending on the amount of data streaming into the project's base station. The Lake Access team's data quality checks focus on subtle trend differences, data that are out of range, data with unusual rates of change, outliers, data gaps, and the data's consistency with weather patterns and season. An overview of these checks is provided below. For more detailed information, refer to the Lake Access Quality Assurance Protocols document, which is available on the Lake Access Web site at http://www.lakeaccess.org/QAQC.html.

The Lake Access team performs QA/ QC on the data using the methods outlined below:

- The team compares manually collected samples with RUSS unit data prior to recalibrating the RUSS unit. This check provides assurance that the previous period's data are accurate. If the data pass for the previous period, they are considered acceptable. If the data do not pass, team members examine the results in the context of their understanding of the individual lake's limnology and other data (e. g., nutrients, chlorophyll, trends). They then decide to either delete the data from the database and/ or save the information in a different place. The team is especially careful not to delete anomalous data that might reveal actual dynamic changes in lake water quality.

- The team generally performs routine, biweekly maintenance and calibration of the sensors. At the same time, the team also conducts manual sampling with an independent instrument. The following table provides information on quality assurance criteria for the RUSS unit sensors.

Sensor	Relative Percent Difference (RPD)	Delta
Temperature	< 5 percent	< .2°C
Dissolved Oxygen	< 10 percent	< .5 mgO_2/L
EC(25 °C)	< 10 percent	< 5 uS/cm
pH	< 10 percent	< .2 units
Turbidity	< 10 percent	< 5 NTUs

See Chapter 3, Section 3.9 for detailed information on calibration and quality assurance of the RUSS sensors.

- The team has developed sophisticated data visualization programs that allow quick review of the data as they are transmitted from RUSS units. These programs enable the team to identify problems almost immediately. Using the data visualization tools described in Chapter 5, the team can visually inspect the graphical displays to ensure that the data flow in categorical increments and accurately reflect changes in water quality. The team also can visually check for data gaps and outliers. An example of questionable data might be a reading that is inconsistent with the lake's depth. Additionally, the Profile Plotter and Color Mapper tools described in Chapter 5 contain calibration flags that allow the user to keep track of calibration dates as the data stream is being viewed.

- Once the data are transferred to the base station, they are run through an importer program. This program converts the data to a standard format and also checks for errors. (The importer program is described in more detail in the following subsection on converting and managing data.)

The Lake Access team uses data from manual sampling to fill in data gaps and address anomalous data. If the team determines that the anomalies are large and cannot be resolved, or if large amounts of data are missing, the data will not be used or released to the public. If the team determines that the data meet QA/ QC requirements, the data are considered valid and reportable.

Converting and Managing the Data

After you collect data from the RUSS units, you must convert it to the correct format for input into your data management system and visualization tools (described in Chapter 5). The Lake Access team uses an importer program to convert the RUSS unit data to a standard format. This program reads data files that have been created or changed since the last time the program was run. It then converts the data to the format required by the visualization tools and checks the data for integrity.

The importer first tests the RUSS unit's name, site name, and column descriptions to ensure they correspond to the anticipated parameters for that unit. If they do not correspond, the importer generates an error and no further action is taken with the data file. For example, an error will be generated if a data file from Halsteds Bay was accidentally placed in the Lake Independence directory.

The importer then reads each individual data line and converts it to a reading that presents measurements taken at the same depth at the same time. A set of readings is combined to form a "profile" in the database. The importer also flags and rejects data that fall outside a specified range. The following table shows the correlation between water quality parameters and unacceptable data ranges.

Parameter	Unacceptable data range
Temperature	< -1 or > 35 °C
pH	< 5 or > 10
EC at 25 °C	<1 or > 600 Us/cm
Dissolved Oxygen (DO)	<-1 or >20 mgO2/L
DO percent saturation	< -5 or > 200 percent
Turbidity*	< -5 or > 1000 NTU
*Turbidity values between -5 and 0 are set to equal 0.	

After the importer has read the data, it stores the information in an object- oriented storage format. In this format, each line of text represents an object. The conversion method you employ will depend on the type of system you use for data storage or visualization. However, the Lake Access importer program is recommended for ease of use, compatibility with RUSS unit data, and for its ability to conduct quality checks. For additional information on the importer program, please read the Lake Access Quality Assurance Protocols document on the Lake Access Web site at http://www.lakeaccess.org/QAQC.html.

Retrieving the Data

As you set up your system, you can develop your own protocols for retrieving data. To retrieve its data, the Lake Access team directly links its data visualization tools (DVTs) described in the next chapter to its object- oriented database. If you decide to store your data instead in MS Access or another database management system, you can develop simple queries to access data. If you decide to store the data in an Oracle database, you might want to develop a user- friendly interface to retrieve the data. For example, you could make use of drop- down lists to select time periods, check boxes to choose parameters, radio buttons to select output file format, or graphical versus text displays.

Storing and Archiving the Data

It is recommended that you store and archive all sample records, raw data, quality control data, and results. A variety of media are available for archiving data (e. g., CD- ROMs, Zip disks, floppy diskettes, and hard copy). The server storing the data should also be backed up daily to prevent data loss.

4.5 Troubleshooting Q&A

This section contains information about common troubleshooting issues.

Q: Is technical support available for hardware and software installation?

A: Apprise Technologies will work with each client to ensure that the RUSS units and associated software are properly installed. Also, the company can tailor system setup to individual customers. Additionally, Apprise technologies offers telephone and onsite support. Apprise also offers onsite training on topics such as assembling and disassembling RUSS units, deploying the units, installing and operating RUSS- Base software, and system troubleshooting.

Q: Is technical support available for operating the data collection, transfer, and management systems?

A: Apprise Technologies offers telephone and on- site support for its systems. Many communities take advantage of on- site training, which includes sessions focused on data collection, transfer, and management.

Q: What should I do when the data will not download?

A: If you are unable to download data, your communications protocol or RUSS unit battery power might have failed. As a first step, make sure that your RUSS unit has enough battery power to transfer the data. Review the data file you downloaded previously, because this file will contain information about the battery voltage.

Voltage should be in the range of 12.5 to 14.5 Volts during daytime hours. Lower voltages indicate that the RUSS unit solar panel is not recharging the battery due to excessive power drain, loose cables, or a shadowed or damaged panel. A RUSS unit will be fully functional with battery power as low as 11.5 Volts. The more frequently the data are collected, the more battery power is used by the RUSS unit. To conserve battery voltage, you might want to consider limiting sampling frequency.

Q: What should I do when I cannot log in or connect to the RUSS unit from the base station?

A: If you are unable to connect to the RUSS unit, first check that your password entry is correct. For example, be sure not to include leading or trailing spaces. If you cannot determine the cause of the failure, place a test call to Apprise Technology's computer (see Section 4.3) to test the communications system and ensure that it is working properly.

Q: Can I automatically collect data without being present at the base station?

A: Using ClockerPro or Clocker software, you can automatically schedule RUSS- Base to call RUSS units in a predetermined order at different times without anyone being present. (See Section 4.3 for additional information about Clocker and ClockerPro software.)

Q: How can I adjust the time interval that the profiler maintains at each sampling depth?

A: If you would like to adjust the time interval, contact Apprise Technologies and they will program a new time interval for you. Apprise Technologies originally programs the RUSS- Base software to allow for between 3 to 5 minutes at each sampling depth. For example, if your profiler is programmed to collect measurements every meter for 20 meters, it will remain at each meter depth for between 3 and 5 minutes. This interval allows sufficient time for the profiler to stabilize at the given depth. Intervals greater than 6 minutes can drain the RUSS unit battery power too quickly.

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5.1 | 5.2

5. DEPICTING TIME-RELEVANT WATER QUALITY DATA

Now that your water quality monitoring network is in place and you have collected the resulting data, you can turn to the next step in providing your community with time-relevant water quality information: using data visualization tools to graphically depict this information. By using the types of data visualization tools described in this chapter, you can create graphic representations of water quality data that can be used on Web sites, in reports and educational materials, and in other outreach and communication initiatives.

Section 5.1 provides an overview of data visualization. Section 5.2 contains an introduction to selected data visualization tools used by the Lake Access Team. If you are interested in a basic introduction to data visualization, you might only want to read the initial section. If you are responsible for choosing and using data visualization software to model and analyze data, you should also consult Section 5.2.

5.1 What is Data Visualization?

Data visualization is the process of graphically depicting data in ways that are meaningful to you. When data are visualized effectively, the resulting graphical depictions can reveal patterns, trends, and distributions that might otherwise not be apparent from raw data alone. This enables you to "see" and "understand" the data much more easily and meaningfully. The results of your efforts can then be communicated to a broader audience, such as residents in your community.

Data visualization can be accomplished with a variety of software tools, ranging from standard spreadsheet and statistical software to more advanced analytical tools such as:

- Two- and three-dimensional graphic plotters
- Animation techniques
- Geographic Information Systems
- Simulation modeling
- Geostatistical techniques

By applying these tools to water quality data, you can help your community's residents gain a better understanding of factors affecting water quality in area lakes and streams. Once you begin using data visualization tools, you will immediately be impressed with their ability to model and analyze your data for a variety of purposes, from making resource management decisions to supporting public outreach and education efforts. For example, you can use data visualization tools to:

- Explore links between land use patterns within watersheds and the type and magnitude of nonpoint pollutant sources affecting local streams and lakes.
- Calculate acreage of the various land uses within your watershed, and use this information, in conjunction with models, to predict sediment and phosphorous loadings to lakes from inflow streams and nonpoint sources.
- Create daily, monthly, and annual lake water quality profiles.

As explained in Chapter 3 of this handbook, the Lake Access team is using data collected by Remote Underwater Sampling Station (RUSS) units and manual sampling to determine the impact of pollutant loadings on Lake Minnetonka and Lake Independence. The raw data collected from the RUSS units provide information about current water quality conditions and short- and long-term water quality trends. The Lake Access team then uses a number of data visualization tools to analyze and convey information about water quality data. The Lake Access team is using data visualization and interpretation techniques to analyze water quality data and provide information to support resource management and land use planning decisions within the watershed.

A variety of commercially available data visualization tools exist that allow you to graphically represent real-time data, manipulate variables, compare temporal trends, and even depict changes over time. Section 5.2 focuses on the following data visualization tools listed in the table below.

Tool Group	Tools	Primary Uses
DVT Data	Lake Access Live: Near Real-Time Tools Display of Numeric	• Explore lake data as it varies

Visualization Tools	Data; Profile Plotter; Color Mapper; Depth versus Time (DxT) Profiler	with depth and over time • Create animated water quality profiles • Feed real-time data to Internet site • Investigate correlations between water quality variables and trends
Spreadsheet Programs	Microsoft Excel; Lotus 123	• Display raw data • Investigate correlations between water quality variables and trends • Create summary graphs of data
Geographic Information Systems	Several, including ArcInfo; ArcView; GeoMedia; and MapInfo Professional	• Integrate and model spatial data (e. g., water quality and land use) • Develop Internet mapping applications

5.2 Data Visualization Software

This section provides information about the three data visualization software groups described in Section 5.1:

- DVT data visualization tools
- Spreadsheet programs
- Geographic Information Systems

After reviewing this section, you should have a good idea when and why you might want to use these tools and what you need to do to obtain, install, and use them.

DVT Data Visualization Tools

DVT data visualization tools are user- friendly, interactive programs that the Lake Access team uses to depict and manipulate water quality profiles collected by RUSS units and from manual sampling. The four tools listed below were developed originally for the team's Water on the Web project and are designed to work with data sets generated by RUSS technology, but they could also be adapted to work with other data sets from other water quality monitoring systems your community chooses to put in place. These tools are:

- Lake Access Live: Near Real- Time Display of Numeric Data
- Profile plotter
- Color mapper
- Depth versus Time (DxT) Profiler These tools provide the ability to:
- Feed real- time data to the Web for data sharing.
- Compare water quality profiles over time and depth.
- Create animations of profiles to illustrate how water quality parameters change daily, monthly, and annually.

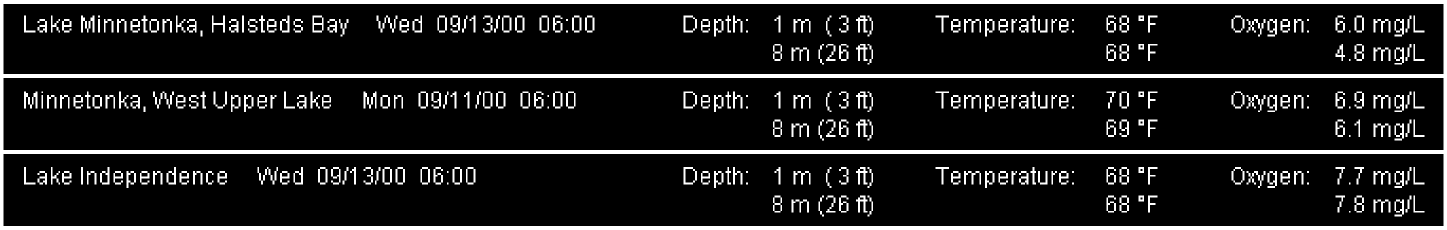
You can obtain the DVT tools by contacting Apprise Technologies at 218- 720- 4341. They are available individually, or as a package called the DVToolkit. The tools are easy to install and are appropriate for a wide variety of platforms, including Windows 95/ 98/ NT, Unix/ Linux, and Macintosh. You can run these applications directly from your computer or over the Web.

For additional information on these tools, consult the Lake Access Web site at http://www.lakeaccess.org and the article *Interactive Technologies for Collecting and Visualizing Water Quality Data*, co- authored by the Water on the Web team and Apprise Technology. This article is published in the journal of the Urban and Regional Information Systems Association (URISA) and is available on the Web at http://www.urisa.org/Journal/accepted/host/interactive_technologies_for_collecting_and_visualizing_water_quality_data.htm (Host et al., 2000, article only viewable to members of the URISA website).

The subsections below present brief overviews of each DVT tool, focusing mainly on what each is used for (i. e., when/ how you might use each tool). This will help you decide if you want to obtain and employ these tools.

Lake Access Live: Near Real- Time Display of Numeric Data

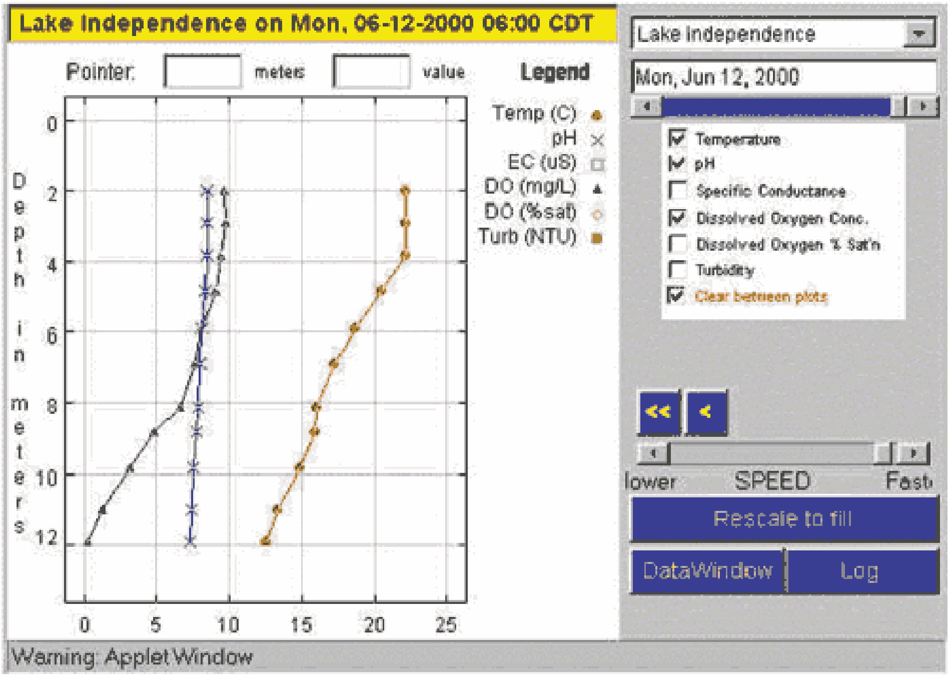
This is a simple program that can be used to provide near real- time data feeds, such as oxygen level and temperature, to Web sites for public access and data sharing. The program automatically retrieves water quality data from your database, embeds the data in a GIF (Graphics Interchange Format) image, and posts the image to a Web site. The screen below, taken from the Lake Access Web site, shows how this program is used to display near real- time data.



Lake Minnetonka, Halsteds Bay	Wed 09/13/00 06:00	Depth:	1 m (3 ft) 8 m (26 ft)	Temperature:	68 °F 68 °F	Oxygen:	6.0 mg/L 4.8 mg/L
Minnetonka, West Upper Lake	Mon 09/11/00 06:00	Depth:	1 m (3 ft) 8 m (26 ft)	Temperature:	70 °F 69 °F	Oxygen:	6.9 mg/L 6.1 mg/L
Lake Independence	Wed 09/13/00 06:00	Depth:	1 m (3 ft) 8 m (26 ft)	Temperature:	68 °F 68 °F	Oxygen:	7.7 mg/L 7.8 mg/L

Profile Plotter

The Profile Plotter program enables users to create static and animated line plots of the profiles of lakes and other water bodies revealing how water quality variables change over time and depth. Animated profiles help users observe how lake profiles change daily, monthly, and annually. Users can choose from a number of different variables to plot. For example, the screen below shows how users can select from a variety of water quality parameters (i. e., temperature, pH, specific conductance, dissolved oxygen, and turbidity) to plot and animate. This particular graph displays temperature, pH, and dissolved oxygen concentrations at various depths in Lake Independence at 6: 00 a. m. on June 12, 2000, in the form of a lake profile line plot. By plotting temperature as a function of depth, you can show how the thermocline location varies with time, and you can illustrate events such as spring and winter turnover.



Lake Independence on Mon, 06-12-2000 06:00 CDT

Lake Independence

Mon, Jun 12, 2000

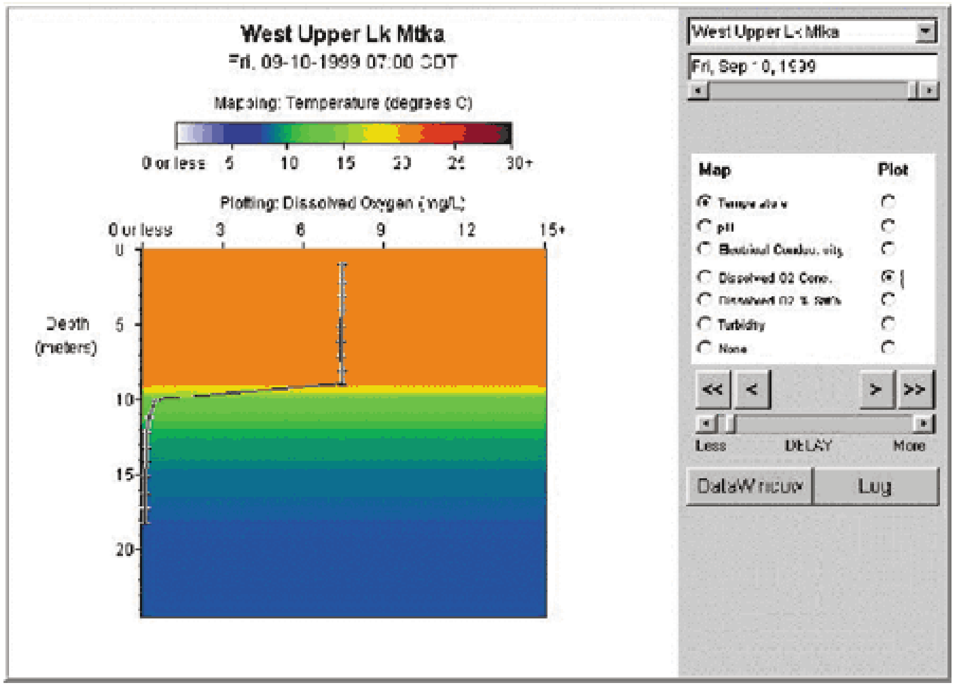
☑ Temperature
☑ pH
☐ Specific Conductance
☑ Dissolved Oxygen Conc.
☐ Dissolved Oxygen % Sat'n
☐ Turbidity
☑ Clear between plots

Profile Plotter

Color Mapper

The Color Mapper is similar to the Profile Plotter, except that it enables you to map two water quality variables simultaneously. A user interested in understanding the correlation between two variables might want to use this tool.

Using Color Mapper, you can map one parameter as color contours and then overlay another variable over the color contours in the form of a line plot. For example, in the graph shown below, the background depicts temperature using color contour, and a superimposed line plot shows oxygen concentrations. This display shows that oxygen is depleted below the thermocline.


West Upper Lk Mtka
Fri, 09-10-1999 07:00 CDT
Mapping: Temperature (degrees C)
0 or less
5
10
15
20
25
30+
Plotting: Dissolved Oxygen (mg/L)
0 or less
3
6
9
12
15+
0
5
10
15
20
Depth (meters)
West Upper Lk Mtka
Fri, Sep 10, 1999
Map
Plot
Temperature
pH
Electrical Conductivity
Dissolved O2 Conc.
Dissolved O2 % Sat'n
Turbidity
None
<<
<
>
>>
Less
DELAY
More
DataWindow
Log

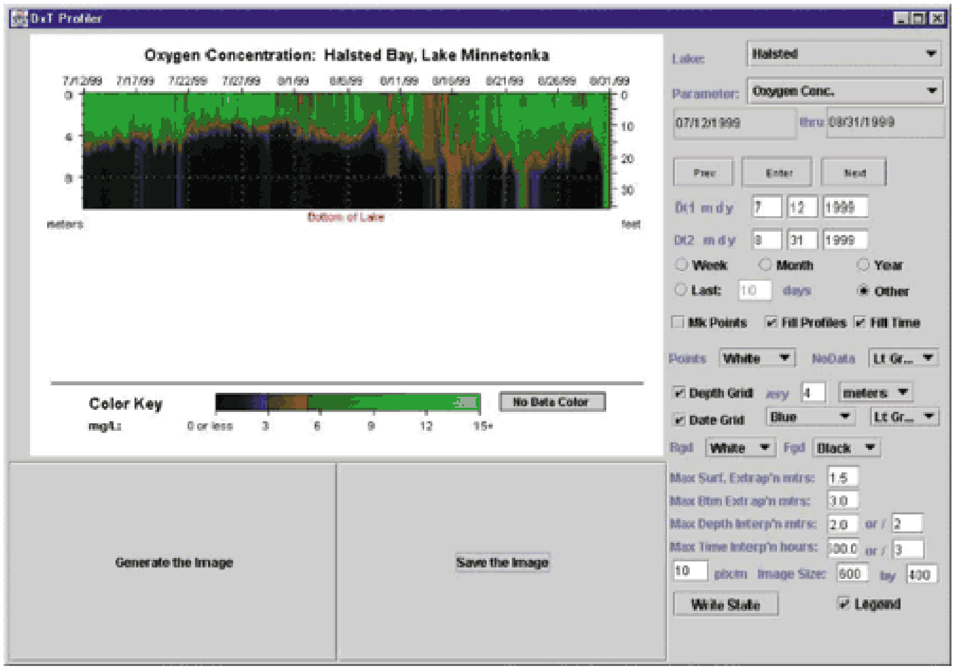
Color Mapper

The temperature data shown in the screen above was originally collected by the RUSS units as point data. To display the data as color contours, the Color Mapper estimates temperatures in areas where there are no measurements (i. e., in the areas between point samples). This process of estimating measurements— in this case, temperature— is called interpolation.

Once the data have been interpolated, the Color Mapper automatically draws color contours representing a range of temperatures. These ranges and colors are chosen based on predetermined break points keyed to changes in temperature. In this case, the red colors represent warmer temperatures and the blue colors represent cooler temperatures.

Depth Versus Time (DxT) Profiler

This program graphically depicts how the lake data collected by RUSS units change over time. The DxT Profiler allows users to display and analyze data in two or three dimensions. As shown in the display below, this program allows you to select the time period for which you want to display data; select the parameter you wish to analyze or illustrate; add grid lines; show the actual data points; and interpolate data by depth and time. You can also output the graphs in GIF format to post to Web sites or incorporate into reports.



Lake: Halsted

Parameter: Oxygen Conc.

07/12/1999 thru 08/31/1999

Dt1 m d y 7 12 1999

Dt2 m d y 8 31 1999

○ Week ○ Month ○ Year

○ Last: 10 days ● Other

☐ Mk Points ☑ Fill Profiles ☑ Fill Time

Points White NoData Lt Gr...

☑ Depth Grid every 4 meters

☑ Date Grid Blue Lt Gr...

Bgd White Fgd Black

Max Surf. Extrap'n mtrs: 1.5

Max Btm Extrap'n mtrs: 3.0

Max Depth Interp'n mtrs: 2.0 or / 2

Max Time Interp'n hours: 300.0 or / 3

10 pix/m Image Size: 600 by 400

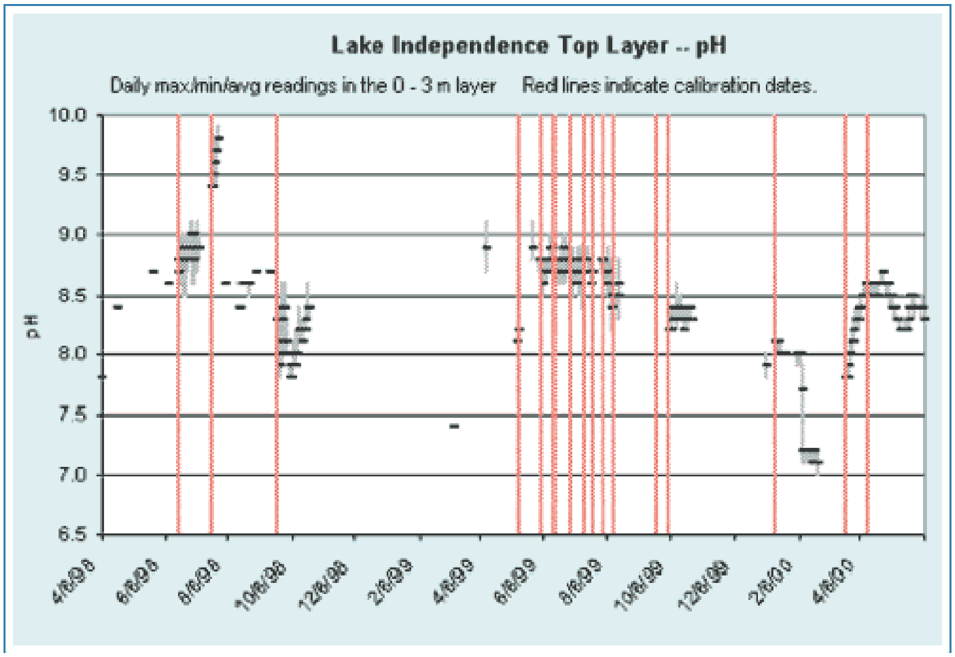
☑ Legend

The screen above shows the changes in oxygen concentrations over time in Halsteds Bay, which is highly eutrophic. The color contours used to display oxygen are based on biological breakpoints that are important to fisheries management. The green colors represent acceptable oxygen levels for fish populations. The change from dark green to brown (at approximately 5 mg/ L oxygen) shows the point at which oxygen levels are too low to support cold- water fish populations. The map's colors change from blue to black (at approximately 1 mg/ L oxygen) to indicate the break point at which oxygen concentrations are too low to support *any* fish populations.

Spreadsheet Programs

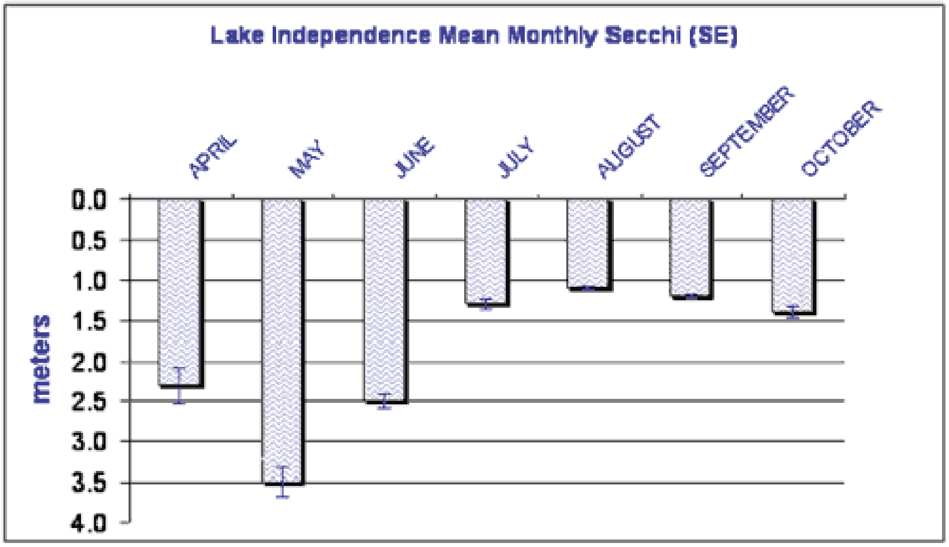
Simple spreadsheet programs such as Microsoft Excel and Lotus 123 can also be used to visually characterize lake data. These programs can be used to create graphs and tabular summaries of various water quality parameters plotted over time or versus depth. The resulting graphs and tables can be used to help analyze surface trends, heat and oxygen budgets, water chemistry, and morphometry. Because these software programs are readily available and easy to use, they can be used effectively in the classroom to introduce students to the basics of modeling and interpreting data. Both Microsoft Excel and Lotus 123 can be purchased at most stores that sell computer equipment and software, and they are easy to install. Both run on a variety of operating systems, including Windows 3.1, 95, 98, 2000, and NT.

For example, the screen below shows how the Lake Access Team uses Microsoft Excel to illustrate the surface trends of lake parameters using RUSS unit data. The screen presents a time course plot that shows the average pH values in Lake Independence's surface layer (the upper 3 meters of the water column), for the period beginning April 6, 1998, and ending April 6, 2000. The vertical bars straddling each data point represent the range of values measured for that particular day.



Note: The pH data shown in the graph above are still undergoing several rounds of quality assessment by the Lake Access team. As a result, some of these data might be subsequently modified.

You can also create other types of graphics using spreadsheet programs. For example in the screen shown below, the Lake Access team has used Microsoft Excel to show the Secchi depth data for Lake Independence over a 7- month period. (See the box in chapter 3 for a detailed explanation of Secchi depth data.)



Geographic Information Systems (GIS)

GIs is a software and hardware system that helps scientists and other technicians capture, store, model, display, and analyze spatial or geographic information. This technology offers powerful tools for analyzing and visualizing spatial patterns and trends in environmental data. (The U. S. Geological Society's (USGS's) Web site contains a user- friendly introduction to GIs at http://info.er.usgs.gov/research/GIs/title.html.

GIs includes a varied range of technologies. To choose, obtain, and use them, you will need to understand the various technologies available and which might be appropriate for your needs and situation. By using GIs technology, you can produce a wide range of graphical outputs, including maps, drawings, animations, and other cartographic products. To create these outputs, you can use GIs to perform a range of powerful functions, including:

- Interactive visualization and manipulation of spatial data
- Integration of spatial analysis and environmental modeling
- Integration of GIs and remote sensing
- Simulations modeling

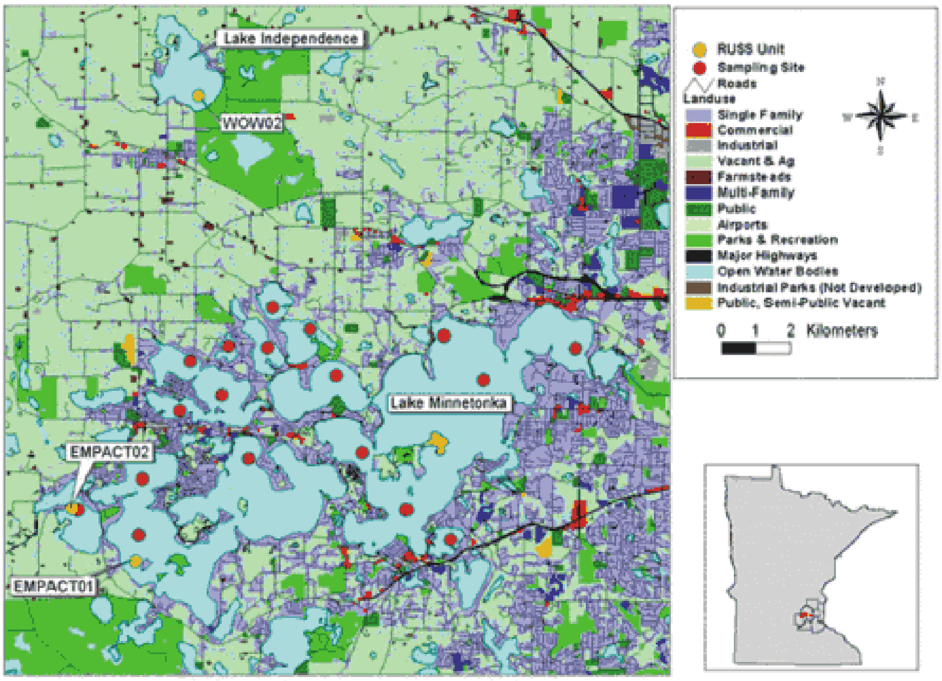
- Creation of two and three- dimensional models
- Internet mapping

To choose, obtain, and use GIs software, you will need to understand the various technologies available and which might be appropriate for your needs and situation. For more information on specific GIs software packages, you can consult manufacturers' Web sites, including:

- ESRI (http://www.esri.com), whose suite of tools includes ArcInfo, ArcView, and ArcIMS Internet mapping software
- Intergraph (http://www.intergraph.com/GIs), whose software includes GeoMedia and GeoMedia Web Map
- MapInfo (http://www.mapinfo.com), whose products include MapInfo and MapInfo Xtreme (an Internet mapping software)

Although GIs is more complex and expensive than other data visualization tools described in this chapter, it also provides more power and flexibility— both in terms of the data you can use and what you can do with the data. You can use GIs technologies from data originating from a variety of sources, including satellite imagery, surveys, hardcopy maps, and environmental readings on variables such as water depth or chemistry. Key data layers in the Lake Access project include RUSS data, manual sampling data, land use data, transportation data, watershed boundaries, elevation, and hydrography. Having these data, you can use GIs to illustrate how land use changes affect water quality. You might also want to use GIs to model the relationships between watershed characteristics and lake water quality. By using GIs, you can combine different types of data layers to predict how quickly sediments or contaminants might move through a stream system.

The following graphic was created by the Lake Access team using ArcInfo software to display land use in the Lake Independence and Lake Minnetonka watersheds. The map is color coded to distinguish the land uses surrounding the lake (e. g., agricultural, residential, commercial, industrial, forest, and wetland).



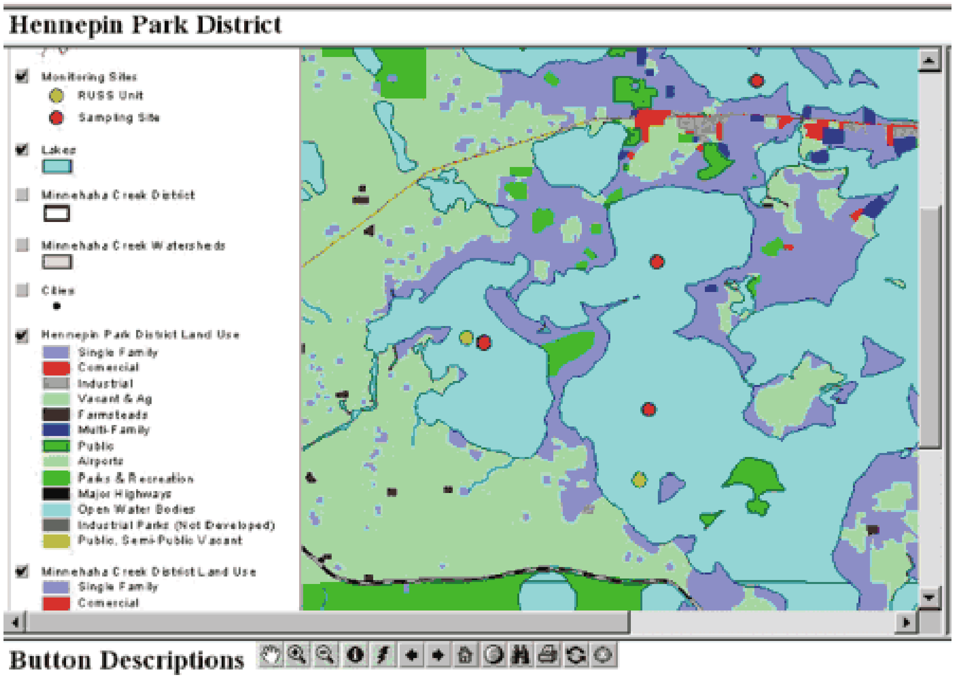
Maps of this type can help inform the public and local officials about connections between local water conditions and current land uses in their communities.

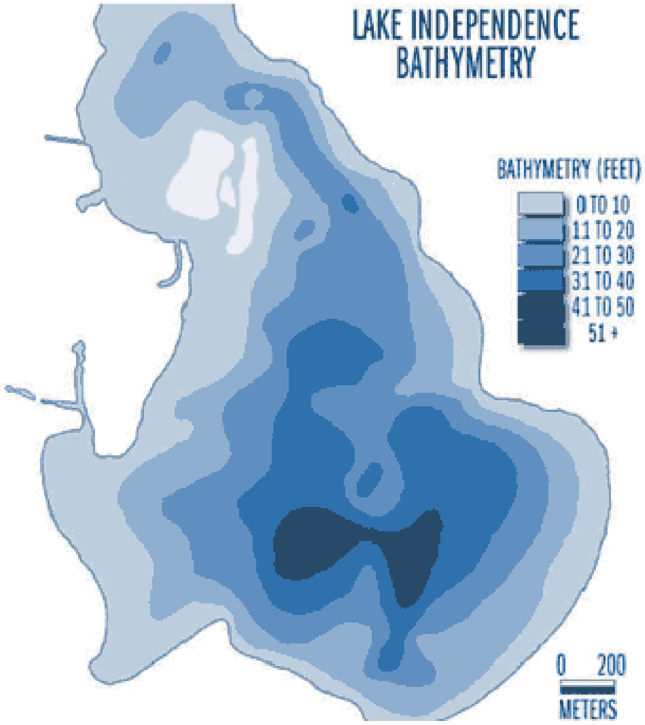
GIs Features on the Lake Access Web site. The Lake Access team has developed a user- friendly and engaging map-based product for the land use page of its Web site at http://www.lakeaccess.org/landuse.html. This Web- based capability is a powerful way to distribute GIs data, allowing thousands of interested parties to simultaneously display and access data. Maps are displayed on the Web site using the ARCVIEW Internet Map Server (IMS) developed by ESRI. Users can zoom in and out of maps and perform queries to gather information about different map elements. Site visitors can generate maps, query data, and retrieve information by simply clicking on the map feature. IMS allows the user to turn different kinds of map layers (e. g., roads, land use, water bodies) on or off to create their own customized maps. For more information on using IMS, visit the ESRI Web site at http://www.esri.com/software/arcview/mapcafe/index.html.

The screen below shows the IMS display for land use in the Lake Independence watershed. The screen has three primary sections:

- A toolbar for performing various map operations
- An interactive legend that allows different layers to be turned on or off
- A map viewing frame that shows the map itself

The status bar at the bottom of the screen provides information about map coordinates, a map scale, a link to a help site, and information on the status of current operations.


Hennepin Park District
☑ Monitoring Sites
RUSS Unit
Sampling Site
☑ Lakes
☐ Minnehaha Creek District
☐ Minnehaha Creek Watersheds
☐ Cities
☑ Hennepin Park District Land Use
Single Family
Comercial
Industrial
Vacant & Ag
Farmsteads
Multi-Family
Public
Airports
Parks & Recreation
Major Highways
Open Water Bodies
Industrial Parks (Not Developed)
Public, Semi-Public Vacant
☑ Minnehaha Creek District Land Use
Single Family
Comercial
Button Descriptions


LAKE INDEPENDENCE
BATHYMETRY
BATHYMETRY (FEET)
0 TO 10
11 TO 20
21 TO 30
31 TO 40
41 TO 50
51 +
0 200
METERS

The Lake Access Project also creates other GIs products, including two- dimensional representations of various lake parameters. For example, depth (i. e. bathymetry) is shown in the graphic above.

GIs and other data visualization tools offer the ability to better support and communicate observations, conclusions, and recommendations to resource managers, the public, students, and regulators. These audiences can then use displays and analyses to help make day- to- day decisions that can affect the quality of their lakes and streams.

NEXT CHAPTER

Table of Contents Chapter: | 1 | 2 | 3 | 4 | 5 | 6 | App: | A | B | C |

3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.8 | 3.9 | 3.10

3. WATER QUALITY MONITORING

This chapter provides information about water quality monitoring—the first step in the process of generating time-relevant information about water quality and making it available to residents in your area.

The chapter begins with a broad overview of water quality monitoring (Section 3.1). It then focuses on the remote time-relevant water quality monitoring conducted as part of the Lake Access Project. It also provides information about installing, operating, and maintaining the equipment used by the Lake Access Project team to gather time-relevant water quality data. Section 3.2 discusses factors to consider when designing a remote time-relevant water quality monitoring project. Sections 3.3, 3.4, and 3.5 explain how to select remote time-relevant monitoring frequencies, parameters, and equipment. Section 3.6 describes how to select the locations of your remote time-relevant water quality monitoring stations. Sections 3.7, 3.8, and 3.9 explain how you can install, operate, and maintain the remote time-relevant water quality monitoring equipment used by the Lake Access Project. The chapter concludes with a brief overview of other water quality monitoring projects conducted in the Twin Cities area (Section 3.10).

Readers primarily interested in an overview of water quality monitoring might want to focus on the introductory information in Sections 3.1 and 3.2. If you are responsible for the actual design and implementation of a monitoring project, you should review Sections 3.3 through 3.9. They provide an introduction to the specific steps involved in developing and operating a remote time-relevant water quality monitoring project and information on where to find additional guidance.

3.1 Water Quality Monitoring: An Overview

Water quality monitoring provides information about the condition of streams, lakes, ponds, estuaries, and coastal waters. It can also tell us if these waters are safe for swimming, fishing, or drinking. The Web site of the U.S. EPA Office of Water (http://www.epa.gov/owow/monitoring) is a good source of background information on water quality monitoring. (The information presented in the following paragraphs is summarized from this Web site.)

Water quality monitoring can consist of the following types of measurements:

- *Chemical* measurements of constituents such as dissolved oxygen, nutrients, metals, and oils in water, sediment, or fish tissue.
- *Physical* measurements of general conditions such as temperature, clarity, flow, and water color.
- *Biological* measurements of the abundance, variety, and growth rates of aquatic plant and animal life in a water body or the ability of aquatic organisms to survive in a water sample.

You can conduct several kinds of water quality monitoring projects, such as those:

- At fixed locations on a continuous basis
- At selected locations on an as-needed basis or to answer specific questions
- On a temporary or seasonal basis (such as during the summer at swimming beaches)
- On an emergency basis (such as after a spill)

Many agencies and organizations conduct water quality monitoring, including state pollution control agencies, Indian tribes, city and county environmental offices, the US EPA and other federal agencies, and private entities, such as universities, watershed organizations, environmental groups, and industries. Volunteer monitors—private citizens who voluntarily collect and analyze water quality samples, conduct visual assessments of physical conditions, and measure the biological health of waters—also provide increasingly important water quality information. The US EPA provides specific information about volunteer monitoring at http://www.epa.gov/owow/monitoring/vol.html.

Water quality monitoring is conducted for many reasons, including:

- Characterizing waters and identifying trends or changes in water quality over time.
- Identifying existing or emerging water quality problems.
- Gathering information for the design of pollution prevention or restoration programs.
- Determining if the goals of specific programs (such as the implementation of pollution prevention strategies) are being met.
- Responding to emergencies such as spills or floods.

EPA helps administer grants for water quality monitoring projects and provides technical guidance on how to monitor and report monitoring results. You can find a number of EPA's water quality monitoring technical guidance documents on the Web at http://www.epa.gov/owow/monitoring/techmon.html.

In addition to the US EPA resources listed above, you can obtain information about lake and reservoir water quality monitoring from the North American Lake Management Society (NALMS). NALMS has published many technical documents, including a guidance manual entitled *Monitoring Lake and Reservoir Restoration*. For more information, visit the NALMS Web site at http://www.nalms.org. State and local agencies also publish and recommend documents to help organizations and communities conduct and understand water quality monitoring. For example, the Minnesota Lakes Association maintains a Web site (http://www.mnlakesassn.org/main/resources/waterquality/index.cfm) that lists resources for water quality monitoring and management. State and local organizations in your community might maintain similar listings. The University of Minnesota–Duluth's Water on the Web site also maintains a list of links for water quality information and resources, including sampling and monitoring methods, at http://wow.nrri.umn.edu/wow/under/links.html. (The Water on the Web project provides on-line, time-relevant lake data as a tool for teaching basic and environmental science.)

In some cases, special water quality monitoring methods, such as remote monitoring, or special types of water quality data, such as time-relevant data, are needed to meet a water quality monitoring program's objectives. *Time-relevant* environmental data are data collected and communicated to the public in a time frame that is useful to their day-to-day decision-making about their health and the environment, and relevant to the temporal variability of the parameter measured. Monitoring is called *remote* when the operator can collect and analyze data from a site other than the monitoring location itself.

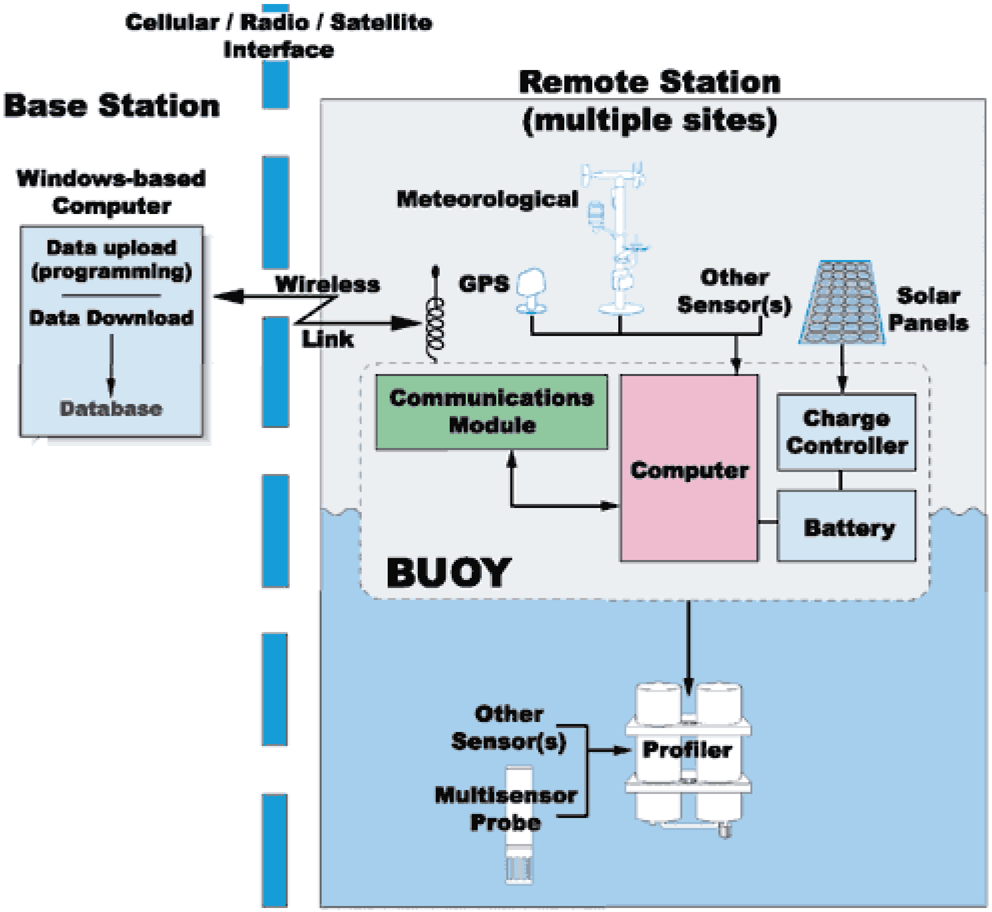
Remote Time-Relevant Water Quality Monitoring: The Lake Access Project

The Lake Access Project helps community lake management and research organizations learn more about the characteristics of lakes in the Minnehaha Creek Watershed District (MCWD) and the Suburban Hennepin Regional Park district (Hennepin Parks) through remote time-relevant monitoring of lake water quality. In turn, the data gathered through the Lake Access Project are used to communicate time-relevant information about lake water quality to the local public.

The Lake Access Project team conducts remote time-relevant monitoring at two locations in Lake Minnetonka and at one location in Lake Independence. At each location, the project team operates a remote underwater sampling station (RUSS^{TM}) unit, manufactured by Apprise Technologies, Inc. The RUSS unit consists of a mobile underwater monitoring sensor tethered to a buoy and featuring an onboard computer, batteries, solar panels, telemetry equipment, and other optional monitoring equipment. Four times daily, each RUSS unit raises and lowers a tethered multiprobe water quality sensor manufactured by Yellow Springs Instruments$^{©}$ (YSI$^{©}$) to collect a profile in 1-meter intervals from the lake surface to the lake bottom. The RUSS unit measures the following parameters:

- Temperature
- pH
- Dissolved oxygen
- Electrical conductivity
- Turbidity
- Depth

The Lake Access Project team uses a land-base station to communicate with the RUSS units via cellular connection. Time-relevant data are remotely downloaded from the RUSS units daily.


Cellular / Radio / Satellite Interface
Base Station
Windows-based Computer
Data upload (programming)
Data Download
Database
Wireless Link
Remote Station (multiple sites)
Meteorological
GPS
Other Sensor(s)
Solar Panels
Communications Module
Computer
Charge Controller
Battery
BUOY
Other Sensor(s)
Profiler
Multisensor Probe

The diagram above illustrates some of the basic RUSS unit components, and it shows how the RUSS unit communicates with the land-base station. This diagram was taken from the RUSS System Manual, which is available from Apprise Technologies. For more information about Apprise Technologies and the RUSS unit, visit http://www.apprisetech.com.

The remainder of this chapter highlights the Lake Access Project. The text box below provides some background information on the characteristics of the lakes studied in the Lake Access Project, and it introduces some important technical terms relevant to the study of these lakes. The information in this text box was taken from the Lake Access Web site, which provides extensive online information about lake ecology. For more information, visit these Web pages at http://www.lakeaccess.org/ecology/lakeecology.html.

3.2 Designing a Time-Relevant Water Quality Monitoring Project

The first step in developing any water quality monitoring project is to define your objectives. Keep in mind that remote time-relevant monitoring might not be the best method for your organization or community. For example, you would not likely require a remote time-relevant monitoring capability to conduct monthly monitoring to comply with a state or federal regulation.

Lake Stratification and Lake Mixing

This text box provides some basic information about the effects of seasonal temperature variations on the types of lakes studied by the Lake Access Project team.

Lakes are directly influenced by fluctuations in seasonal air temperature. The following figure shows the seasonal activities and characteristics of lakes, such as Lake Minnetonka and Lake Independence in the Minneapolis area, with an annual pattern of two seasonal mixing periods. (Lakes with this pattern of mixing are known as *dimictic* lakes.)

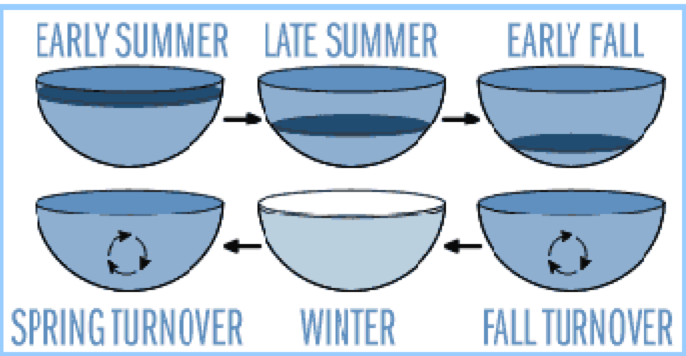


Figure showing the activities and characteristics of the types of lakes studied through the Lake Access Project. (Taken from the Lake Access Web site at http://www.lakeaccess.org/ecology/lakeecologyprim4.html).

Seasonal air temperatures directly affect lake temperatures. Lake temperatures, in turn, affect lake water densities. Water is most dense at about 4°C and becomes less dense at higher and lower temperatures. The typical seasonal lake temperature and density characteristics seen in dimictic lakes are described below:

Summer. During the summer, the lake surface is warmed by the sun, while the lake bottom remains cold. These differing temperatures affect lake water density, causing the water in deeper lakes to separate into layers. This process of separation is called stratification. The figure below shows the following three layers of a typical stratified lake:

- The *epilimnion* is the upper layer. It is warm, well-mixed, and rich in dissolved oxygen.
- The *metalimnion* is also called the thermocline region. The thermocline is the point of maximum temperature change within the metalimnion. In this layer, water temperature declines and density increases rapidly with depth. The drastic density change in this layer prevents the epilimnion and hypolimnion from mixing.
- The *hypolimnion* is the bottom layer of cold water. Because this layer is isolated from the atmosphere and the epilimnion, it becomes anoxic (i.e., the water does not contain any dissolved oxygen). Anoxic conditions can result in many events, including the release of phosphorus, a nutrient, from the lake bottom sediment into the hypolimnion.

Stratified layers develop different physical and chemical characteristics, and support different types of aquatic life. Lake stratification usually persists until the fall.

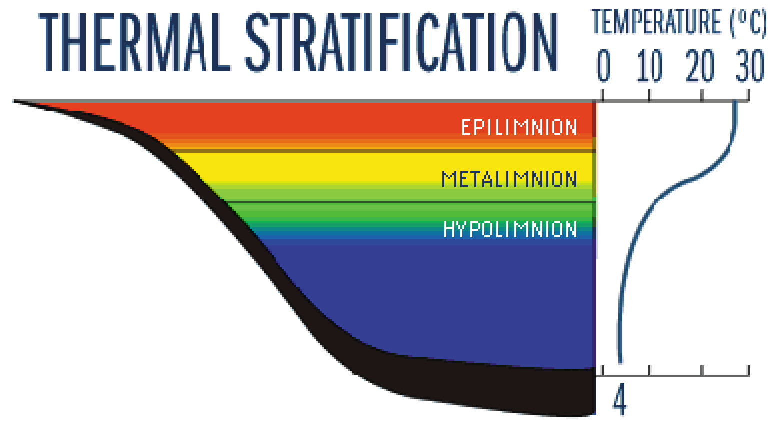


Figure showing the three distinct layers of a typical stratified lake. (Taken from the Lake Access Web site at http://www.lakeaccess.org/ecology/lakeecologyprim4.html).

Fall. As air temperatures cool in the fall, the water temperature in the epilimnion cools and water density increases. Fall winds mix the lake to greater depths, and the thermocline deepens. Then, when the temperature and density of the epilimnion approach the temperature and density of the hypolimnion, fall winds mix the entire lake. This mixing event is called a *turnover*.

Winter. During the winter, the water temperature in the epilimnion cools even further, until a layer of ice forms on the lake surface. Under the ice, the lake again stratifies. Winter stratification differs from summer stratification because the temperature in the epilimnion is lower than that of the hypolimnion, which stays at about 4°C throughout the winter. The stratification is also less stable than in the summer, because the temperature and density differences between the layers is not large. Because the ice isolates the lake from wind mixing, however, stratification usually persists throughout the winter. Anoxia occurs at the bottom of most lakes during the winter.

Spring. During the spring, the water in the epilimnion is heated. As the temperature approaches 4°C, the density increases. When the temperature and density of the epilimnion approach that of the hypolimnion, very little wind energy is needed to mix the lake. After this turnover, the temperature and density of the water in the epilimnion continue to increase until this layer becomes too warm and too buoyant to mix with the lower layers.

Here are some questions to help determine if remote time-relevant monitoring is appropriate to meet your monitoring objectives:

- **What types of questions about water quality would you like to answer, and do you need time-relevant data to answer these questions?** For example, do you want to know more about how rapid events, such as urban or agricultural runoff from rainstorms, might affect water quality in your area by stimulating algal blooms?
- **If you already have other water quality monitoring projects in place, how would the addition of time-relevant data enhance them?** For example, would the frequent review of time-relevant data allow you to tailor your other monitoring projects to yield more representative water quality data or conserve your organization's labor and analytical resources?
- **How would your community or organization benefit from a time-relevant monitoring project?** For example, would time-relevant data provide you with a better opportunity to communicate water quality issues to your community?

Designing the Lake Access Project

The Lake Access Project team's decision to collect time-relevant water quality data using RUSS units grew out of an interest to learn more about rapid, weather-related mixing events in Lake Minnetonka. To do so, Minnehaha Creek Watershed District (MCWD) and Hennepin Parks required time-relevant water quality data and the capability to collect these data remotely. The box below provides more information on the design of the Lake Access Project.

Using Remote Time-Relevant Monitoring to Study Rapid Lake Mixing

The remote time-relevant monitoring conducted using RUSS units has provided the Lake Access Project team with new opportunities for data collection and analysis.

During several years of water quality monitoring, Minnehaha Creek Watershed District (MCWD) and Hennepin Parks personnel learned that water quality conditions in Twin Cities Metropolitan Area (TCMA) lakes varied on an annual basis. Although MCWD and Hennepin Parks personnel weren't particularly surprised by this finding, they were quite surprised that the data showed no correlation between water quality in TCMA lakes and the characteristics of runoff from surrounding watersheds. Instead, the data showed that mixing events occurring within TCMA lakes seemed to have a more significant impact on lake water quality than the effect of watershed runoff.

In addition, water quality data collected from Lake Minnetonka during several summers showed highly variable phosphorus concentrations at the lake bottom. Typically, lake-bottom phosphorus concentrations increase steadily throughout the summer as decreased oxygen levels at the hypolimnion cause phosphorus to be released from bottom sediment. At first, MCWD and Hennepin Parks personnel assumed their highly variable data were caused by sampling error. If they had accidentally hit the lake bottom during manual sampling, they could have inadvertently collected sediment with high phosphorus concentrations. However, several years of highly variable phosphorus data convinced them of the improbability of making the same sampling mistake year after year!

MCWD and Hennepin Parks personnel began to suspect that weather events, such as strong winds or storms, were causing rapid lake mixing events. They suspected these mixing events were similar to seasonal mixing that typically occurs in the spring and fall, but that these events were occurring very rapidly—often in one or two days. As a result, the phosphorous concentration near the lake bottom decreased, and the phosphorous concentration in the upper layer of the lake, where sunlight penetrates, increased, thereby promoting algae growth.

MCWD and Hennepin Parks personnel realized they could not test the validity of their theory using their "traditional" methods for monitoring water quality for the following reasons:

- Rapid lake mixing events typically occur during strong winds or storms. Field personnel could not collect manual water quality samples to document these rapid mixing events because of safety concerns associated with working on lakes during severe weather.

- Lake mixing events can occur rapidly, and algae growth can double in one day under prime conditions. MCWD and Hennepin Parks could not provide the laboratory or analytical resources to conduct water quality monitoring at the short intervals required to fully document these types of rapid events.

As you will read in this chapter, remote time-relevant monitoring has allowed the Lake Access Project team to document and study rapid lake mixing events in Lake Minnetonka.

3.3 Selecting Your Sampling Frequency

The sampling frequency you select for your remote time-relevant water quality monitoring project depends upon your project's objectives. For example:

- If you want to determine the effects of storm-related nonpoint sources on water quality in your area, you could tailor your monitoring frequency to collect data during storm events.
- If you want to study a water body affected by tidal flow, you could tailor your monitoring frequency to collect data during tidal events.

It is appropriate to experiment with different monitoring frequencies to optimize your ability to fulfill your project's objectives.

Lake Access Project Monitoring Frequency

The Lake Access Project team typically programs its RUSS units to collect lake profile samples four times daily. This monitoring frequency enables team members to observe short-term changes in lake stratification and water quality, and to document day-to-night differences for the purpose of teaching basic and environmental science through the Water on the Web curriculum. In order to provide a high-quality data set for understanding and managing the lakes, the data's accuracy needs to be certified. See the box below for more information.

Data Quality Assurance and Quality Control (QA/QC)

QA/QC procedures ensure that data are accurate, precise, and consistent. QA/QC involves following established rules in the field and in the laboratory to ensure that samples are representative of the water you are monitoring, free from contamination, and analyzed following standard procedures. (Chapter 4, section 4.4, provides additional information on standard QA/QC analysis procedures used by the Lake Access Project.)

The Lake Access Project uses two types of water quality data:

1. Time-relevant data collected with a YSI multiprobe water quality sensor controlled by the RUSS unit.
2. "Conventional" data collected by trained field staff, including manual measurements with a YSI multiprobe water quality sensor, as well as the collection of water samples analyzed at a laboratory.

Many state and federal monitoring projects use YSI multiprobe or similar water quality sensors. To ensure the QA/QC of data collected with these sensors, the Lake Access Project team follows manufacturer's instructions for sensor calibration and maintenance. (See Section 3.9 for more information on the calibration and maintenance procedures followed by the team.) To ensure the QA/QC of "conventional" data, the Lake Access Project team follows guidelines set forth by the US EPA and American Public Health Association, in addition to those set forth by the Minnesota Department of Health.

The team also has several years of experience identifying systematic errors associated with sensor deterioration, or biofouling, that occurs when algae, bacteria, and fungi grow on the sensor while it is continually submerged in water beneath the RUSS unit.

The Lake Access Web site provides more information about the team's QA/QC procedures at http://www.lakeaccess.org/QAQC.html. EPA's publication *The Volunteer Monitor's Guide to Quality Assurance Project Plans* provides more information on QA/QC plans for monitoring projects. For more information on this guide, visit http://www.epa.gov/owowwtr1/monitoring/volunteer/qappexec.htm.

The Lake Access Project team can adjust the RUSS unit monitoring frequency from the land-base station. For example, to allow for a more detailed analysis of rapid lake mixing, Lake Access team members can program the RUSS unit to collect samples at a greater frequency during severe storm or wind events.

With frequent review of the time-relevant data, the project team has been able to tailor the frequency of its manual water quality monitoring projects to yield more representative data. For example, the team can conduct manual monitoring in Halsteds Bay immediately after documenting a rapid mixing event with time-relevant data. The team can then use the data collected through manual monitoring to determine the effect of the mixing event on the lake.

Making the Most of Your Time-Relevant Water Quality Data

Currently, your organization will find a limited number of cost-effective time-relevant monitoring technologies available. Also keep in mind that time-relevant data might not be as accurate, precise, or consistent as "conventional" laboratory analytical data. You will want to carefully consider how your project will use time-relevant data and make the most of the time-relevant monitoring parameters you select.

In designing your program, think about how you could use time-relevant measurements of certain parameters as indicators of the phenomena you wish to document. For example, depending on your water body's characteristics and the location of your monitoring equipment, you could use turbidity and dissolved oxygen measurements as indicators of an algae bloom. Then you could learn more about the bloom by conducting manual monitoring of parameters that might not currently be available to you on a cost-effective, time-relevant basis (e.g., chlorophyll-a, phosphorus, nitrogen). Another example might involve using time-relevant measurements of turbidity and electrical conductivity to trace the influx of streams laden with higher loads of particulate (as indicated by turbidity) and dissolved solids (as indicated by electrical conductivity).

3.4 Selecting Water Quality Parameters for Monitoring

Your selection of time-relevant monitoring parameters depends on your project's objectives and on the remote time-relevant technologies available to you. To satisfy the objectives of the Lake Access Project, the project team chose to monitor five basic water quality parameters on a time-relevant basis: temperature, pH, dissolved oxygen, electrical conductivity, and turbidity.

The Lake Access Project team uses time-relevant measurements of temperature, dissolved oxygen, and electrical conductivity as indicators of lake stratification and rapid mixing events. When summer lake stratification is stable, parameter measurements typically show the following:

- Temperature at the lake surface is about 4° to 5° warmer than temperature at the lake bottom, and a thermocline region exists with a temperature gradient of greater than 1° C per meter.
- Dissolved oxygen in the upper mixed layer is nearly saturated. Below the thermocline, dissolved oxygen decreases very rapidly and most of the hypolimnion is completely anoxic until fall overturn.
- Electrical conductivity tends to be higher below the thermocline, and it increases as the summer progresses due to the release of carbon dioxide and other ions from decomposing organic matter.

Immediately after a rapid lake mixing event, time-relevant measurements of temperature, dissolved oxygen, and electrical conductivity are nearly identical at the lake surface and the lake bottom. In addition, the Lake Access Project team usually observes increased turbidity measurements in the lake's upper layer, where sunlight penetrates as algae growth increases because of the additional phosphorus mixed into the upper layer. The project team will often collect manual samples for laboratory analyses of additional parameters immediately after a mixing event to learn more about the effects of the event on the lake.

The Lake Access Web site at http://www.lakeaccess.org/russ/ contains descriptions of time-relevant water quality parameters measured through the Lake Access project and the significance of their measurements. The descriptions are briefly summarized in the box "Lake Access Time-Relevant Water Parameters" below.

Lake Access Time-Relevant Water Quality Parameters

Temperature. Temperature has a direct effect on biological activity and the growth of aquatic organisms because most aquatic organisms are "cold-blooded" (i.e., they cannot regulate their core body temperatures). Temperature also affects biological activity by influencing lake water chemistry. For example, because warm water holds less oxygen than cold water, it might not contain enough oxygen to support some types of aquatic life.

pH. pH is a measure of the acidity of the water. A pH of 7 is neutral. Values lower than 7 are acidic and higher than 7 are basic. Many important chemical and biological reactions are strongly affected by pH. In turn, chemical reactions and biological processes (e.g., photosynthesis and respiration) can affect pH. Lower pH values can increase the amount of dissolved metals in the water, increasing the toxicity of these metals.

Dissolved oxygen. The concentration of dissolved oxygen in water determines the number and type of aquatic organisms that can live in the water. Dissolved oxygen must be present at adequate concentrations to sustain these organisms.

Electrical conductivity. Electrical conductivity is an estimator of the amount of total dissolved salts or total dissolved ions in water. Many factors influence the electrical conductivity of lake water, including the watershed's geology, the watershed's size in relation to lake's size, wastewater from point sources, runoff from nonpoint sources, atmospheric inputs, evaporation rates, and some types of bacterial metabolism. Electrical conductivity is also a function of temperature; therefore, RUSS data are "standardized" to 25° C.

Turbidity. Turbidity describes the clarity of water. Turbidity increases as the amount of total suspended solids in the water increases. Increased turbidity measurements might have several adverse effects on lakes, including the following:

- If light penetration is reduced significantly, growth of aquatic plants and organisms can decrease. Reduced photosynthesis can result in decreased daytime releases of oxygen into the water.
- Particles of silt, clay, and other organic materials can settle to the lake bottom, suffocate eggs and/or newly hatched larvae, and fill in potential areas of habitat for aquatic organisms.
- Turbidity can affect fish populations. Increased turbidity can reduce the ability of predators, such as northern pike and muskellunge, to locate prey—shifting fish populations to species that feed at the lake bottom.
- Fine particulate material can affect aquatic organisms by clogging or damaging their sensitive gill structures, decreasing their resistance to disease, preventing proper egg and larval development, and potentially interfering with particle feeding activities.
- Increased inputs of organic particles, either produced from plant growth in the lake or washed in from the watershed, can deplete oxygen as the organic particles decompose.
- Increased turbidity raises the cost of treating surface water for the drinking water supply.

3.5 Selecting Monitoring Equipment

Your selection of remote time-relevant water quality monitoring equipment depends on your project's objectives. When selecting monitoring equipment, you should also consider equipment lifetime, reliability, and maintenance requirements.

Lake Access Equipment Selection

The Lake Access Team selected the RUSS unit to provide the capability to collect time-relevant water quality data remotely. This capability has provided the Lake Access Project team with new opportunities for data collection and analysis:

- The daily collection of multiple depth profiles enables personnel to view characteristics of lake stratification and metabolism on a daily basis.
- Because the remote equipment can collect and analyze water samples over frequent time intervals and during severe weather conditions, the Lake Access Project team can document lake mixing episodes. In some instances, some bays of Lake Minnetonka can completely mix in a 24-hour period. Scientists had discussed the potential for this type of rapid mixing to occur, and other organizations had attempted to document these events by conducting monitoring on a daily basis, but Lake Access is the first project to successfully measure and document this phenomenon in Lake Minnetonka.

The RUSS unit, developed through a cooperative effort between Apprise Technologies and the University of Minnesota, performs remote water quality monitoring using commercially available monitoring sensors. The sensors transmit time-relevant water quality data to a computer onboard the unit. Using wireless communication, the RUSS unit can both receive programming and transmit data to a land-base station.

The RUSS unit consists of a mobile underwater monitoring sensor tethered to a module that floats on the water surface. The flotation module contains batteries; solar panels; telemetry equipment; and a Remote Programming, Data Acquisition, and Retrieval (RePDAR) unit. A diagram of the RUSS unit is presented below. This diagram, which shows the flotation module, tethered profiler, and three-line unit anchoring system, was taken from the RUSS System Manual. For more information about Apprise Technologies and the RUSS unit, visit http://www.apprisetech.com.

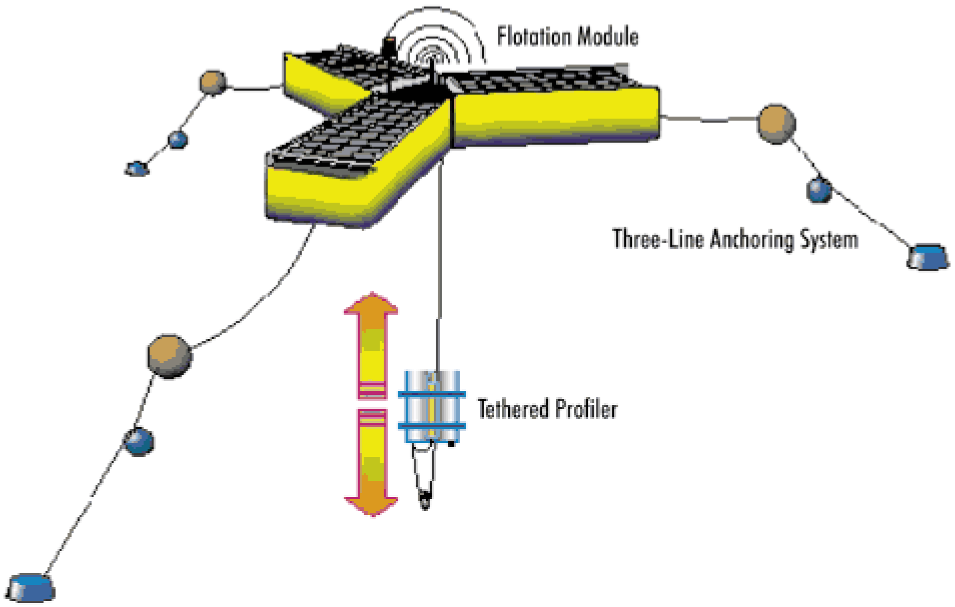


Diagram of RUSS unit, showing the flotation module, tethered profiler, and three-line anchoring system. (Taken from the RUSS System Manual, available from Apprise Technologies at http://www.apprisetech.com.)

The Lake Access Project: A Success Story

Prior to initiation of the Lake Access Project, a feasibility study was conducted to identify methods for improving Halsteds Bay's water quality. The study concluded that a $5.5 million project focusing on watershed restoration and improvement was necessary to accomplish this task. (This restoration project was not implemented.) Since that study, the Lake Access Project has shown that rapid weather-related mixing events cause the release of approximately 10 times more phosphorus to the epilimnion than runoff events from the surrounding watershed. The sediments are providing a reservoir of phosphorus from historical pollution that will take decades to flush out.

The Lake Access Project has provided valuable information—watershed management alone will not improve the water quality of Twin Cities Metropolitan Area lakes in all cases. With a greater understanding of the characteristics and causes of phosphorus concentrations in these lakes, the Lake Access Project team can apply appropriate lake management and water treatment strategies to improve water quality, and apply them with a much higher potential for success.

RePDAR Unit. The RePDAR unit allows for remote water quality monitoring sensor operation, data storage, and data transmission. Each RePDAR unit contains a central processing unit (CPU), power supply charging controls, and telemetry modules enclosed in a watertight resin case. The RePDAR unit enables the user to:

- Collect, process, and store data at user-specified intervals.
- Transmit data to the land-base station via wireless communication systems, including cellular, radio, satellite, or 900 MHz.
- Program the RUSS Unit from the land-base station.
- Operate the RUSS Unit in the field with a portable computer.
- Call the land-base station or an emergency telephone number when a water quality monitoring sensor parameter exceeds a user-specified range.

flotation module. The flotation module is a yellow, three-armed, floating buoy.

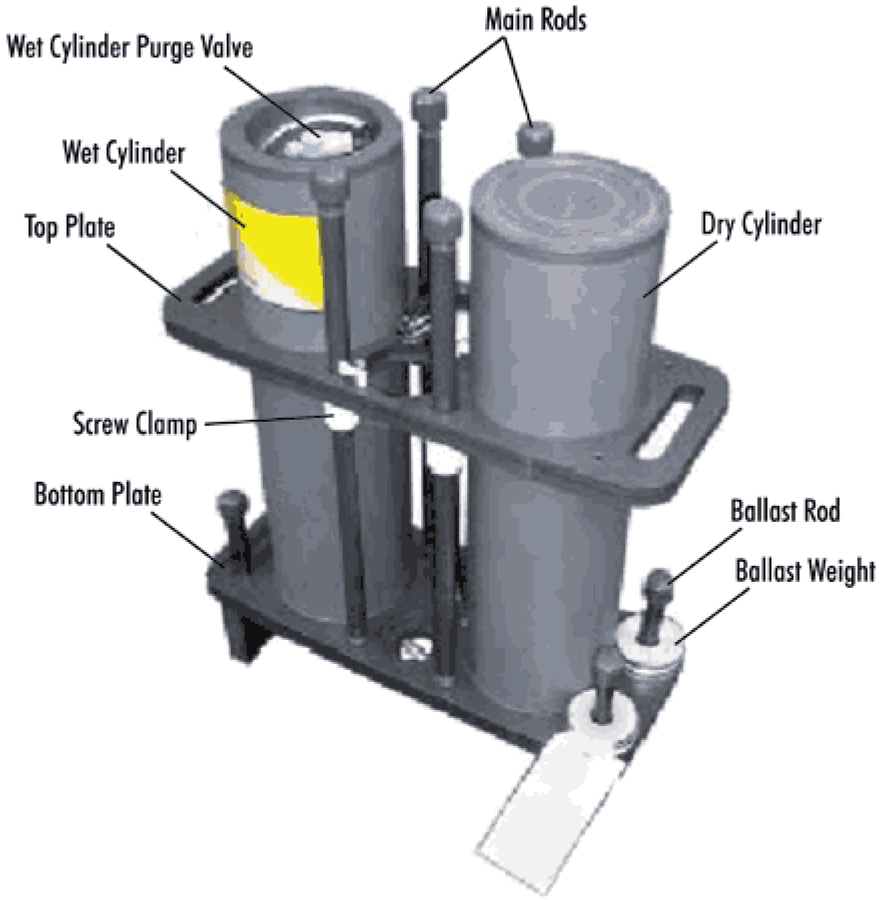
Profiler. The RUSS unit profiler is controlled by the RePDAR unit. The profiler carries the water quality monitoring sensor to multiple depths within the water column beneath the flotation module. A special profiler cable transmits power and buoyancy-control protocols from the RePDAR unit to the profiler and transmits data from the water quality monitoring sensor to the RePDAR unit.

An illustration of the profiler is presented later in this document.

Field controller. The field controller is used during the field service mode of operation. With the field controller, you can manually move the profiler and connect a portable computer to the water quality monitoring sensor and the RePDAR unit without removing the electronics hatch cover. The field controller consists of a small patch box with a receptacle for the profiler cable and a connector plug for the electronics hatch cover.

Software. The RUSS unit can be operated with two Apprise Technologies software programs:

- RUSS-Base, which allows you to operate the RUSS unit remotely using a computer at your land-base station. (See Chapter 4 for information about using RUSS-Base software.)
- CONSOLE, which allows you to operate the RUSS unit using a portable computer in the field.



RUSS unit profiler. (Taken from the RUSS System Manual, available from Apprise Technologies at http://www.apprisetech.com.)

3.6 Siting Monitors

You should select monitoring locations that best fulfill the objectives of your remote time-relevant water quality monitoring project; however, you will need to consider several factors when making your final siting decisions. Consider the checklist of questions below when choosing your location:

Monitoring Site-Selection Checklist

1. Are the time-relevant data you collect at these locations likely to fulfill your project's objectives? Specifically, what questions will you be able to answer with your data, and how will the answers assist you with fulfilling your objectives?

2. Will people in your community support equipment installation and remote time-relevant monitoring at your locations?

3. Will monitoring equipment at your locations pose a potential danger to the people in your community? For example, are your monitoring locations near heavily trafficked areas of the water body?

4. Will monitoring equipment be safe at your locations? In other words, will equipment be especially susceptible to vandalism, tampering, or damage?

5. What local, state, or federal regulations will you need to consider when choosing your locations?

6. Is flexibility important to your project? Would you like the option to move your monitoring equipment to different locations, or would you like to monitor at several locations concurrently?

7. Do you foresee any site-specific problems with installing, operating, and maintaining your monitoring equipment at these locations? Do these locations pose any safety hazards to your personnel?

8. Can you adequately survey and assess your locations? What equipment-specific considerations will you need to make?

Siting the Lake Access Project Monitoring Locations

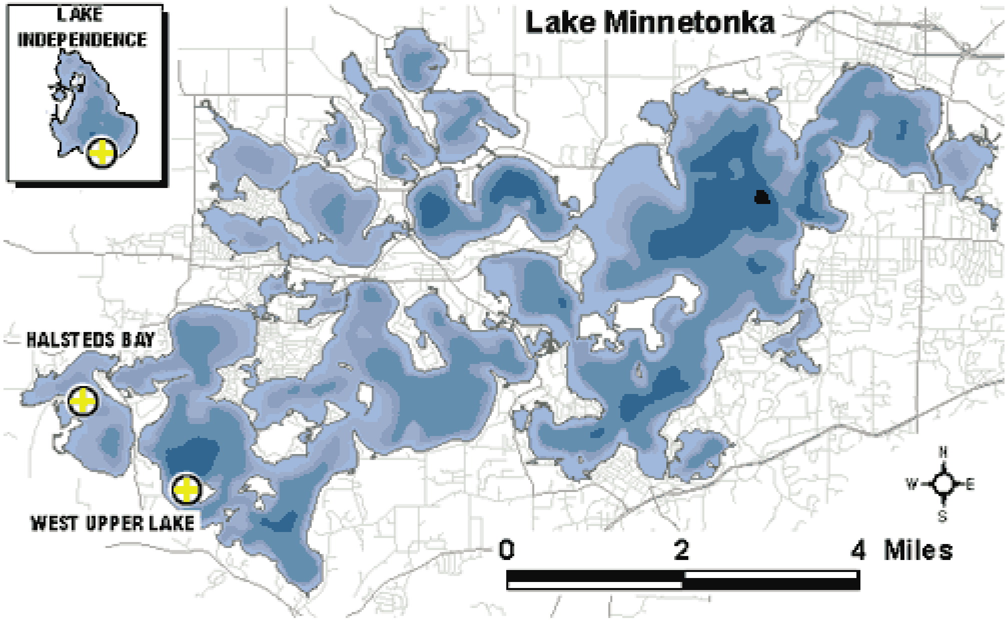
The Lake Access Project team selected three locations for siting RUSS units:

- Halsteds Bay in Lake Minnetonka, which receives runoff from a large watershed of both agricultural and urban residential land use. Because of nutrient loading from the runoff, the water quality in Halsteds Bay is poor. Halsteds Bay is subject to rapid weather-related mixing during the summer because of its relatively shallow depth (about 9-10 meters).

- West Upper Lake in Lake Minnetonka, which is much deeper than Halsteds Bay and has much better water quality. This basin receives runoff only from the area immediately adjacent to its shoreline. Because it is deeper than Halsteds Bay and has lower algal growth, West Upper Lake does not experience the same types of rapid weather-related mixing events.

- Lake Independence, which lies within the metropolitan region but receives primarily agricultural runoff. The water quality conditions in Lake Independence are intermediate to the conditions in Halsteds Bay and West Upper Lake.

The map below shows the locations of these three monitoring stations.



The Lake Access Team selected these three locations for the following reasons:

- The team can study data spanning the range of water quality conditions typically seen in Twin Cities Metropolitan Area (TCMA) lakes.
- MCWD conducts manual monitoring of the runoff to Halsteds Bay. The combination of these data, historical watershed-based land use and cultural data, and the Lake Access time-relevant water quality data from Halsteds Bay allows MCWD to study the link between land use patterns and bay water quality.
- Data from Halsteds Bay allow the Lake Access team to study the rapid weather-related mixing events that transport phosphorus from the lake bottom to the lake's upper layer.
- By comparing data from Halsteds Bay and West Upper Lake, the Lake Access team is able to determine how differences in lake basin shape and depth can produce dramatic differences in lake water quality, which in

turn affect watershed and lake management decisions.

Before making final siting decisions, the Lake Access Project team met with community members to ensure their approval of proposed monitoring locations. The team decided against one proposed location because community members had concerns that monitoring equipment might interfere with lake recreational opportunities or adversely affect the lake's appearance.

The team also met with local agencies to ensure that the proposed monitoring locations complied with local regulations. To comply with boater safety regulations, the Lake Access team could not locate RUSS units in main lake traffic areas. As a result, the locations are closer to shore than the project team would have preferred. The Lake Access Project team was required to obtain navigational buoy permits from the county-level sheriff's office before installing the RUSS units.

The team also considered siting requirements specific to the RUSS units. The RUSS System Manual provides guidance on properly siting these units. Before installation, the manual recommends a site characterization survey consisting of the following:

- ***Maximum depth measurement.*** You will need to make these measurements when installing the RUSS unit profiler. The manual recommends several depth measurements within a 6-meter radius of the deployment location to account for local depth variations. If the water body you are monitoring fluctuates in depth, you must update the maximum depth in the profiler program. The profiler will sustain damage from repeated contact with the bottom of the water body.

- ***Depth contour assessment.*** Depth contour measurements will assist you with deploying the RUSS unit anchoring system. The manual recommends depth measurements in concentric circles surrounding the deployment location to generate a rough contour map of the anchoring site.

- ***Bottom type assessment.*** You might need to assess the material at the bottom of the water body to ensure proper anchoring of the RUSS unit. Different types of anchor designs are available for different bottom types.

- ***Signal strength assessment for the data telemetry device.*** You will need to ensure that cellular signal strength is reliable or radio telemetry is possible at the location.

- ***Temporary site marking.*** You should mark the assessed location to ensure that the RUSS unit is deployed in the proper location.

The Lake Access Project: Looking Ahead

Hennepin Parks would like to conduct future remote time-relevant monitoring with a RUSS unit in a shallow area of Lake Minnetonka where boating occurs. Lake Minnetonka is one of the most heavily used lakes for boating in the United States. Hennepin Parks would use the time-relevant data to study the magnitude at which boat traffic stirs up bottom sediments and the impact these events have on the lake's water quality. If data indicate that boat traffic adversely affects lake water quality, Hennepin Parks would advocate no-wake zones in near-shore areas to maintain ecosystem health.

3.7 Installing RUSS Units

This section summarizes some of the basic RUSS unit installation procedures. These procedures were taken from the RUSS System Manual, available from Apprise Technologies at http://www.apprisetech.com. You will need to consult this manual for detailed step-by-step installation guidance.

Unpacking and inspecting the RUSS unit

The first step to installing a RUSS unit is unpacking and inspecting the unit. You should follow these procedures when receiving the unit:

1. Remove the packing material surrounding the flotation module. Take care when removing the packing material, as some items might have shifted during shipment.
2. Remove the solar panels and solar panel blank (if included) from each arm of the flotation module.
3. Remove the electronics hatch cover to access the dry compartment inside one arm of the flotation module, and remove all items located in the compartment.
4. Using the enclosed packing slip, perform an inventory of all items. If you are missing any items, contact Apprise Technologies.
5. Conduct a thorough visual inspection of all items. If you observe any damage, contact Apprise Technologies and the carrier.

Preparing and assembling the RUSS units

You will need to conduct a series of preparation and assembly activities on land, on shore, and at the RUSS unit deployment location. Complete the following activities on land:

- Ensure your battery(ies) is charged.
- Assemble and connect the arms of the flotation module.
- Install the light and antenna.
- Attach the barrier float anchoring cables.
- Secure an appropriately sized line for towing the unit to the deployment site.
- Calibrate your water quality monitoring sensor according to manufacturer's instructions.
- Install the Apprise Technologies RUSS-Base software program on your land-base station computer.
- Install the Apprise Technologies CONSOLE software program on your field portable computer.

Once you have completed the on-land assembly of the RUSS unit, you will need to transport it to a shore-side location suitable for working on the unit. Complete the following activities on shore:

- Position your battery(ies) and the RePDAR unit within the dry compartment.
- Position and connect the two solar panels.
- Assemble the electrical system.
- Connect the RePDAR unit to the electrical system.
- Connect the profiler.
- Place the unit in the field service mode of operation and perform electrical testing. For more information on the field service mode of operation, see section 3.8.

When you have completed your electrical tests, you should disconnect the profiler and field controller and install your remaining solar panel or solar panel blank on the arm with the dry compartment. You are now ready to tow the RUSS unit to your monitoring location. When you tow the unit, take the water quality monitoring sensor, the profiler (with its ballast weights), and the field controller with you in the boat.

Anchoring the RUSS unit

When you reach the deployment location, you will anchor your RUSS unit. Your anchoring system must meet the following requirements:

- The system must maintain the flotation module in a fixed location and prevent excessive drifting.
- Anchoring lines must maintain proper tension in all water conditions.
- Anchoring lines should not enter the water column below the flotation module (i.e., the working area of the profiler).

Apprise Technologies recommends a three-line anchoring system to provide dynamic control of the flotation module while maintaining proper orientation at the deployment location. A diagram of the recommended anchoring system's components is presented below.

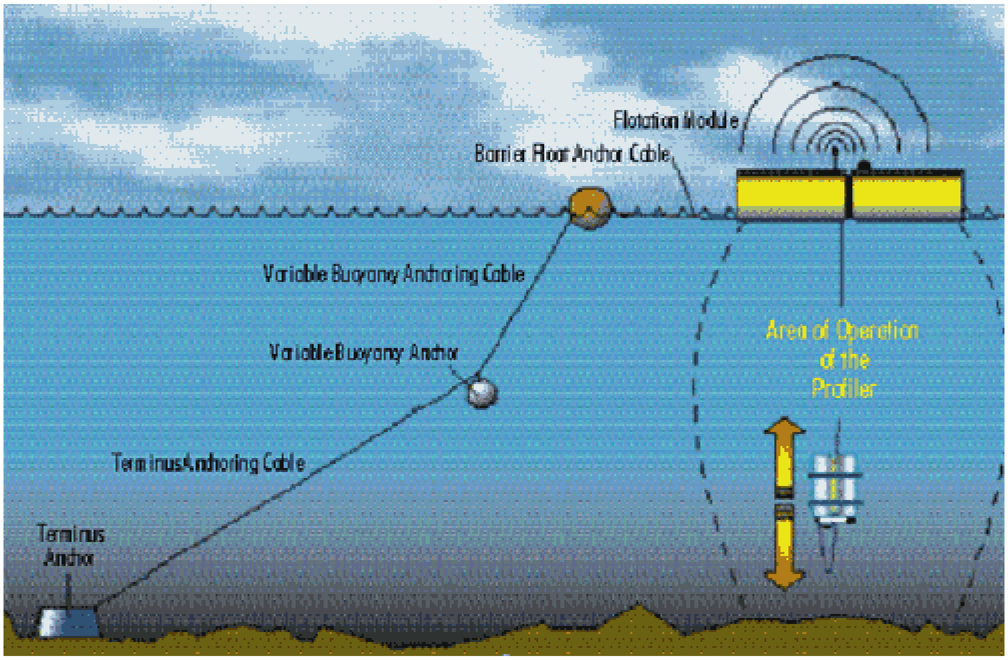

Flotation Module
Barrier Float Anchor Cable
Variable Buoyancy Anchoring Cable
Variable Buoyancy Anchor
Terminus Anchoring Cable
Terminus Anchor
Area of Operation of the Profiler

Diagram of the recommended anchoring system components (only one of the three lines is illustrated). (Taken from the RUSS System Manual, available from Apprise Technologies at http://www.apprisetech.com.)

Each anchoring line of the recommended system contains the following components:

- Barrier float anchoring cable—A 5-foot stainless steel cable of 3/16-inch diameter or greater connecting the flotation module to the barrier float.
- Barrier float—A small flotation buoy connecting the barrier float anchoring cable and the variable buoyancy anchoring cable. The three barrier float buoys (one on each line) can be essential for locating the RUSS unit during rough wave conditions.
- Variable buoyancy anchoring cable—A cable connecting the barrier float to the variable buoyancy anchor.
- Variable buoyancy anchor—Located between the barrier float and the terminus anchor. The variable buoyancy anchor provides tension in both the variable buoyancy anchoring cable and the terminus anchoring cable.
- Terminus anchoring cable—A cable connecting the variable buoyancy anchor to the terminus anchor.
- Terminus anchor—A device used to fix the end of the terminus anchoring cable to the bottom of the water body. The type of terminus anchor you use depends on the type of material at the bottom of the water body. As part of the survey and assessment of the monitoring location you conduct before installation and deployment, you determine this type of material and select a suitable anchor.

Anchoring the Lake Access Project RUSS Units

The Lake Access Project team experienced difficulty with its RUSS unit anchoring system during the first year the units were deployed. The system allowed the RUSS units to drift, and the anchoring lines tangled with one another and with the profiler unit. In addition, the terminus anchors were too heavy to move by hand, so field personnel had to use a barge and crane to move and retrieve them. As a solution, the team installed a three-line anchoring system.

The Lake Access Project team is pleased with the current recommended three-line anchoring system. RUSS unit drifting has been minimized. The anchor lines remain tense and have not tangled with one another or interfered with the profiler operation. In addition, the terminus anchors are sized so team members can move them by hand. The Lake Access Project team has also replaced the steel anchoring cables with suitably sized rope because personnel have cut their hands on the steel cables while moving the anchors.

Deploying the profiler

When your RUSS unit is anchored, you will connect your water quality monitoring sensor to the profiler and deploy the profiler by following these general steps:

1. Measure the length of profiler cable to match the maximum depth of the deployment site plus two meters. As part of your survey and assessment of the monitoring location before installation and deployment, you will have determined the maximum depth. If the water body fluctuates in depth, you must update the maximum depth in the profiler program. The profiler will sustain damage from repeated contact with the bottom of the water body.
2. Connect the profiler cable to the profiler and the electrical system.
3. Fill the profiler's wet cylinder with water and place ballast weights on the ballasting rods to achieve zero profiler buoyancy and vertical suspension.
4. Place the unit in the field service mode of operation and test the profiler movement. For more information on the field service mode of operation, see section 3.8.

Once your profiler testing is complete, your RUSS unit is ready for operation!

3.8 Operating RUSS Units

Although RUSS units are designed for remote operation from a land-base station, you can also operate them in the field. (See Chapter 4, section 4.2, for more information about communicating with your RUSS unit from the land-base station.) This section summarizes the basic procedures for operating your RUSS unit in field service mode. These procedures were taken from the RUSS System Manual, available from Apprise Technologies at http://www.apprisetech.com. You will need to consult this manual for detailed step-by-step field service operation guidance.

Field service operation

The RUSS unit's field service mode of operation allows you to monitor the unit during deployment and in emergency situations. You will need the following equipment to operate your RUSS unit in field service mode:

- The key to the RUSS unit's electronics hatch cover
- The field controller
- A portable computer running Apprise Technologies CONSOLE software
- A null-modem computer cable

Follow these steps to enter the field service mode of operation:

1. Connect the field controller to the RePDAR unit.
2. With the null-modem cable, connect your portable computer to the field controller.
3. Set the field controller rotary switches to enable communication between the RePDAR unit and your portable computer, and to enable automatic movement of the profiler.
4. Turn the electronics hatch cover key to SERVICE to provide power to the RePDAR unit.

Your portable computer, with the CONSOLE software running, will act as your window to the RePDAR unit. Shortly after you provide power to the RePDAR unit, it will initialize. You will notice a 10-second pause after the initialization. You have two options during this pause:

Option 1. If you need to perform an emergency download of data in the RePDAR unit's memory, you can press M during the pause. (You will not need a password for this emergency download, but you will need to send the binary data file to Apprise Technologies or an authorized service site to have the file converted to standard format.)

Option 2. You can press L to log in during the pause. If you do not provide a password, you will be able to perform only deployment and hardware setup functions. If you enter the Level 1 password, you will have access to stored data. If you enter the Level 2 password, you will be able to make changes to the profiler and telemetry setup. If you do not log in during the pause, the software will prompt you for the appropriate password when you try to access any protected information.

After the 10-second pause, the RePDAR unit will enter the Main Setup menu. In this menu, you can access, review, and enter the following information:

- Current time and date
- Profiler schedule and depth
- Water quality monitoring sensor type
- RS-232 baud rate
- Modem baud rate and initialization strings
- RUSS unit call sign and location
- Data access and programming passwords

Under the main menu's *Data Access option*, press *A* to see a screen display of the stored data. As you view this display, the CONSOLE software will automatically capture these data to a file identified by the RUSS unit's call sign.

Under the main menu's *Proceed to Hardware Init* option, you can initialize the RUSS unit hardware according to the configuration you selected. When the initialization is complete, you will see a brief status report for each RUSS unit subsystem (e.g., the profiler, the water quality monitoring sensor, the modem) on your portable computer screen. The status report screen will allow you to do the following:

- View the programmed configuration, including the time, date, and the RUSS unit's call sign and location.
- View the battery voltage.
- View the results of the RePDAR unit's attempts to establish a link with the water quality monitoring sensor.
- Test profiler operation by pressing *(P)ark, (S)tart profile, or (H)alt.*
- View modem information and test commands.
- Test the modem link quality by calling a preprogrammed telephone number. You will be able to view a modem status message of the call's progress.

Setting up the water quality monitoring sensor

In addition to properly calibrating your water quality monitoring sensor according to manufacturer's instructions, you will need to take the following steps to ensure your equipment operates properly:

- In the RUSS unit field mode of operation, confirm the programmed water quality monitoring sensor type and proper units of measurement and ensure that sensor operation is enabled.
- You should set the interval between sampling to a minimum of 3 seconds to ensure reliable profiler operation.
- Water quality monitoring sensors usually have two distinct modes of operation: the menu system is used for calibration and setup, and the data string mode is used during monitoring. You will need to make sure your sensor is in the proper operation mode.

Lake Access Project RUSS unit operation

The Lake Access Project team programs its RUSS units to collect sample profiles at 1-meter intervals four times daily. Profiles begin at the lake surface at 12:00 p.m., 6:00 p.m., 12:00 a.m., and 6:00 a.m. Data are typically transferred to the land-base station each morning.

Apprise Technologies has altered the internal program for the Lake Access Project RUSS units to allow for a 5-minute delay between profiler movement and sample collection. This delay allows the YSI multiprobe water quality sensor to equilibrate to the different water temperature and dissolved oxygen conditions at each depth. Once the sensor has equilibrated, parameter measurement takes about 3 minutes.

When the sampling profile is complete, the profiler parks at a depth programmed by the Lake Access Project team. Parking depth is selected to place the sensor in the area of lowest light without placing it in the anoxic water layer.

3.9 Maintaining RUSS Units

You will likely focus most of your scheduled equipment maintenance on cleaning and calibrating your water quality monitoring sensors to meet your project's QA/QC protocols. The required effort and frequency for this maintenance will depend on the types of sensors you use and the water quality conditions at your monitoring locations. In addition to water quality monitoring sensor cleaning and calibration, you might need to perform scheduled maintenance on your RUSS unit. Required maintenance will depend on factors specific to your project, your community, and your monitoring locations.

Lake Access Project Maintenance Activities

Lake Access Project maintenance activities include cleaning and calibrating the YSI multiprobe water quality sensors, maintaining a RUSS-unit bird deterrent system, removing the RUSS units during lake freezing and thawing conditions, reinstalling the units following these conditions, and repairing damaged or vandalized RUSS units.

Monitoring sensor maintenance and calibration

The Lake Access Project team cleans and calibrates the YSI multiprobe water quality sensors on the three RUSS units every 1 to 4 weeks. The accuracy and precision of data derived from water quality monitoring instruments depend on sound instrument calibration procedures. (Accuracy is the extent to which measurements represent their corresponding actual values, and precision is a measurement of the variability observed upon duplicate collection or repeated analysis.)

Sensor cleaning and calibration is a multistep activity that begins with the following steps:

1. Traveling to the monitoring location.
2. Collecting a manual water quality profile near the unit using a YSI multiprobe water quality sensor identical to the one used on the RUSS unit.
3. Placing the RUSS unit in the field service mode of operation and manually moving the profiler to collect a water quality profile.
4. Manually moving the RUSS profiler to the surface.
5. Removing the sensor from the profiler and manually moving the profiler to its parking depth.
6. Transporting the sensor to the laboratory.

At the laboratory, a set of known parameter standards are measured with the sensor. By comparing these sensor measurements with the known standards and by comparing the two manual water quality measurements taken in the field, the Lake Access Project team can more accurately estimate the amount of error associated with recent sensor measurements and determine the quality of recently collected data.

Lake Access Project personnel clean, calibrate, and inspect the multiprobe sensors according to detailed instructions provided by YSI. The sensors are carefully and thoroughly cleaned to remove algae and other organisms that cause sensor biofouling. The pH, conductivity, and turbidity meters are calibrated against known standard solutions. To ensure accurate calibration, the team selected these standards in ranges at which the parameters are typically detected in the field. The temperature meter is calibrated against the temperature in the laboratory. The dissolved oxygen meter is calibrated using a YSI calibration cup. The depth probe is calibrated out of water to a depth of zero.

Tip. Although cleaning and calibration activities can occur in the field, Lake Access Project personnel prefer to calibrate the monitoring sensors within the laboratory's controlled environment. Because of temperature changes in the field, the sensors can take a long time to equilibrate—even if they are submerged in a bucket of water. Overall, the Lake Access Team has found that the entire cleaning and calibration activity takes longer in the field than in the laboratory.

Lake Access personnel complete the cleaning and calibration activity by:

1. Traveling to the monitoring location.
2. Placing the unit in the field service mode of operation and manually moving the profiler to the surface.
3. Connecting the sensor to the profiler, placing the RePDAR unit in the ON position, and removing the key to the electronics hatch cover. When the key is removed, the RePDAR unit will move the profiler to its parking position and resume normal RUSS unit operation.
4. Lake Access Project personnel are able to complete sensor cleaning and calibration activities on the three RUSS units on Lake Minnetonka and Lake Independence in 1 day, unless a sensor component requires repair or replacement.

Lake Access Project personnel are able to complete sensor cleaning and calibration activities on the three RUSS units on Lake Minnetonka and Lake Independence in 1 day, unless a sensor component requires repair or replacement.

Resolving Calibration Issues

Because of water quality conditions in Lake Minnetonka and Lake Independence, the Lake Access Project team has had some difficulty maintaining the calibration of the units' dissolved oxygen meters. During summer months, the team noticed significant errors in dissolved oxygen measurements. Sometimes the team had to calibrate the dissolved oxygen meters every 7 to 10 days.

The Lake Access Project team had typically parked the RUSS unit profilers at 5 meters deep—below the sunlit layer of the lake—to reduce the rate of algae growth and subsequent biofouling of the sensors. Lake stratification can make Twin Cities Metropolitan Area (TCMA) lakes anoxic below 3 meters deep. In the anoxic area, the level of hydrogen sulfide in the water increases. Lake Access team members began to suspect that the hydrogen sulfide in the anoxic zone was reacting with the potassium chloride in the dissolved oxygen probe, causing the calibration to rapidly decay. The team raised the profiler parking depth to 3 meters—out of the anoxic zone, but still deep enough to reduce the rate of sensor biofouling during the summer months.

During the winter, the Lake Access Project team typically reprograms the profilers to park at 5 meters deep because, during these months, this level of the lake is dark but remains well oxygenated.

Bird deterrence

Some birds love to land on RUSS units! So many birds landed on the Lake Access Project units that guano covered the solar panels, preventing adequate battery charging. Team members sometimes had to clean the solar panels daily.

To prevent this nuisance and ensure adequate battery charging, the Lake Access Project team experimented with bird deterrent systems. First, the team placed coiled wires over the solar panels. Although the wires stopped birds from landing on the solar panels, they prevented field personnel from working comfortably with the RUSS units. The team replaced the coiled wires with chicken-wire covers that fit over the solar panels. The chicken wire is easier to handle and keeps birds off the panels just as well.

Lake freezing and thawing conditions

The Lake Access team temporarily removes its units from the lakes during freezing conditions in the late fall and thawing conditions in the early spring because the units could be severely damaged if left on the ice during these conditions.

Freezing conditions. Just prior to lake freezing conditions, the team removes the RUSS units from the lakes. The team retrieves all portions of each unit (including the buoys, anchors, and anchoring lines), brings the profiler to the surface and detaches it, and tows the unit to shore. The RUSS units are stored intact in a large shed. When the lakes have frozen over, the project team erects an ice house at each monitoring location. The team does not use the RUSS unit flotation module during the winter months. The solar panels are mounted on top of the ice shed, which is oriented to allow for maximum solar exposure and angled to minimize snow accumulation. The RePDAR unit and batteries are stored inside the ice shed, and the profiler is deployed through a hole in the ice.

Thawing conditions. Just prior to lake thawing conditions, the Lake Access Project team removes the icehouses and the RUSS unit components. During winter monitoring, the ice hole cut for the profiler freezes around the cable. Although the ice does not adversely affect the operation of the profiler, personnel have to chip through the ice to remove the cable and the profiler. When the lakes have thawed completely, the project team redeploys the complete RUSS units at the monitoring locations.

3.10 Other Local Monitoring Efforts

This section provides information about additional water quality monitoring efforts being conducted in the Minnehaha Creek Watershed and Hennepin Parks district. Minnesota researchers and natural resource managers are conducting these projects to learn more about the characteristics of Twin Cities Metropolitan Area (TCMA) lakes, detect water quality trends and recreational use impairments, develop lake management strategies and determine their effectiveness, and ensure the safety and health of lake users. Some of these monitoring methods might help satisfy your community's water quality monitoring objectives. For example, there may be times when you are unable to conduct remote time-relevant monitoring (e.g., due to equipment malfunction; during lake freezing and thawing conditions; when remote time-relevant monitoring technology is not available for a particular location or analytical parameter; or when required resources are insufficient). In these instances, you could use the data collection methods described in these projects to supplement time-relevant data.

Specific monitoring efforts conducted by Minneapolis community lake management and research organizations include:

- Monitoring for water quality trends
- Nutrient budget monitoring
- Health and safety monitoring
- Project-specific monitoring

Monitoring for Water Quality Trends

For more than 5 years, MCWD and Hennepin Parks have conducted water quality monitoring on approximately 15 lakes throughout the two districts and on nearly 20 bays in Lake Minnetonka. By measuring four water quality parameters (chlorophyll-a, total and soluble reactive phosphorous, and nitrogen), MCWD and Hennepin Parks personnel can determine how changes in lake nutrient concentrations affect the growth of algae and how the growth of algae affects lake water quality:

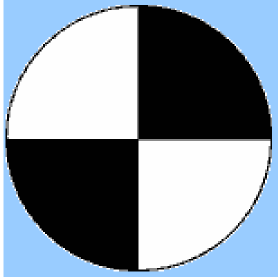
- Chlorophyll-a measurements show how much algae is present in the water.
- Total and soluble reactive (i.e., dissolved) phosphorus measurements indicate the amount of phosphorus available for algae growth. Very little phosphorus is needed to dramatically change lake water quality; one pound of phosphorus entering a lake from the surrounding watershed can grow 300 to 500 pounds of algae in the lake.
- The relationship between the amounts of nitrogen and phosphorus in a lake can help personnel determine whether phosphorous or nitrogen is the limiting nutrient for algae growth.

Collectively, MCWD and Hennepin Parks staff use these data to detect water quality trends. These trends can indicate if impacts such as recreational use or urbanization are impairing water quality, or if management initiatives such as public education or stream, lake, and wetland restoration are leading to improved water quality.

MCWD and Hennepin Parks staff travel to each monitoring location biweekly to collect water quality samples. Before collecting samples, personnel determine Secchi disk depth (see the box below) and use a YSI multiprobe water quality sensor to gather time-relevant data on temperature, pH, dissolved oxygen, electrical conductivity, and depth in a profile of 1-meter intervals from the surface to the bottom of the lake. Personnel use these data in the field to determine the water depth and locate the lake's thermocline.

What is a Secchi Disk?

A Secchi disk is a tool used to measure the water's clarity. It is a weighted, round metal plate about 8 to 12 inches in diameter with an alternating black-and-white pattern like the one shown below.



Field personnel lower the disk into shaded water (because sunlight can affect the measurement) until it is no longer visible. Then they raise the disk until it is barely visible. The average of these two depths is the Secchi disk depth, which provides a measure of the water's clarity or transparency.

(For more information on Secchi disks, see the Lake Access Web site at http://www.lakeaccess.org/russ/index.html.

Staff collect a 2-meter surface composite sample, a grab sample at the thermocline depth, and a grab sample one-half meter from the bottom. The table below summarizes the purposes and techniques for collecting these types of samples.

Nutrient Budget Monitoring

Each year, MCWD and Hennepin Parks conduct nutrient budget monitoring in two to three streams that feed Lake Minnetonka. This type of monitoring includes analyses for the following parameters:

- Total phosphorus
- Total nitrogen
- Total suspended solids
- Total solids
- Soluble reactive phosphorus
- Ammonia
- Nitrate
- Temperature
- pH
- Electrical conductivity

Sample Type	Purpose	Collection Technique
Two-meter surface composite	This type of sample represents the strata of biological activity (e.g., algae growth) in the lake's upper layer, where sunlight penetrates. MCWD and Hennepin Parks collect 2-meter surface columns because sunlight typically penetrates the upper 2 meters of TCMA lakes. This is also the standard surface water sampling protocol used by the Minnesota Pollution Control Agency.	Samples are collected using a PVC pipe 3 inches in diameter and 2 meters long. Field personnel submerge this pipe vertically to collect a column of water from the upper 2 meters of the water body. Each composite sample is brought to the surface, poured into a composite container, mixed, and divided into subsamples for laboratory analyses.
Thermocline grab	A lake thermocline typically deepens during the summer as the upper, wind-mixed layer of the lake (the epilimnion) rises in temperature. The thermocline grab sample indicates how much phosphorus will be available to algae if storms mix the lake below the thermocline depth.	Using a rope, personnel lower a special sampling device (typically a Van Dorn or Kemmerer water bottle) to the thermocline depth. The sampling device consists of a tube with spring-loaded closures on each end. When the device has reached the thermocline depth, personnel send a weight (called a messenger) down the rope. When this weight contacts the sampling device, the spring-loaded closures seal both ends of the tube. The grab sample is brought to the surface and divided into subsamples for laboratory analyses.
Bottom grab	This sample indicates how much phosphorus is located at the lake bottom (and how much phosphorus would be available to algae if the lake were to mix completely).	Field personnel collect the bottom grab by lowering the same type of sampling device used for the thermocline grab to a depth of one-half meter from the bottom. The grab sample is brought to the surface and divided into subsamples for laboratory analyses.

By measuring these parameters, MCWD and Hennepin Parks can characterize total annual nutrient loading from the monitored stream into a lake.

Total phosphorus and total nitrogen measurements indicate the amounts of phosphorus and nitrogen— in particulate and dissolved forms— that enter the lake from the inflow stream.

Measurements of total solids and total suspended solids help MCWD and Hennepin Parks determine the amounts of phosphorus and nitrogen that exist in particulate form. Best management practices (BMPs) such as sediment detention ponds or constructed wetlands are typically designed to remove nutrients in particulate form.

The soluble reactive phosphorus measurement indicates the amount of phosphorus dissolved in the water. The nitrate and ammonia measurements describe the major forms of nitrogen available to algae that are present in the water. These measurements are important because they indicate how much phosphorus and nitrogen are present in the forms most available for algal growth and most difficult to remove by BMPs.

Temperature, pH, and electrical conductivity measurements further describe water quality of the inflow stream. (See Section 3.4 for more information about monitoring for these parameters.)

To conduct nutrient budget monitoring, field personnel install automated flow meters on lake inflow streams to measure and electronically log flow. Automatic samplers are linked to the flow meters to collect flow- weighted composite samples. Composite samples are made up of individual volumes collected over time. At a predetermined stream- flow interval, the flow meter sends a signal to the sampler to collect each volume of the composite sample. At the conclusion of the composite period (which typically spans a storm event, plus one hour), field personnel retrieve, mix, and divide composite samples into subsamples for analysis at the Hennepin Parks water quality laboratory.

Health and Safety Monitoring at Swimming Beaches

Hennepin Parks manages nine swimming beaches. At three of these beaches, Hennepin Parks uses rubber beach curtains that encompass 1 to 1.5 acres of lake area for swimmers and restrict water movement between the swimming area and the lake. These curtains reduce the volume of lake water Hennepin Parks must manage for swimmers. For example, algae blooms can be quite severe on some lakes, but Hennepin Parks has several options for managing blooms within beach curtains. These include pumping fresh water into the swimming area, using fountains to prevent buildup of algae scum on the water surface, and applying aluminum sulfates (alum) to remove phosphorous and algae within the swimming area.

During the swimming season, personnel monitor swimming waters to ensure they are safe for the public. Lifeguards determine the Secchi disk depth of swimming waters three times daily. By comparing Secchi disk depths in water within the beach curtain to water outside the curtain, Hennepin Parks can demonstrate that the beach curtains provide the public a better swimming experience.

Hennepin Parks monitors recreational waters for fecal coliform bacteria weekly. Samples are analyzed at the Hennepin Parks water quality laboratory. Hennepin Parks adheres to national and state guidelines to maintain fecal coliform counts lower than 200 colonies per every 100 mL of water. Studies have shown that the probability of human health risk is minimal if fecal coliform counts are kept below this level. When Hennepin Parks personnel detect coliform levels greater than the guideline level, they immediately analyze a water sample for the bacterium E. coli. This tells personnel what percentage of fecal coliform can actually pose a health risk to swimmers. Fecal coliform bacteria data are posted weekly the Web at http://www.hennepinparks.org.

Making Lake Waters Safe For Swimmers

Hennepin Parks personnel take immediate action to reduce fecal coliform levels when they exceed the guideline level for human health and safety. Typically, high fecal coliform levels in Twin Cities Metropolitan Area lakes can be directly attributed to local goose populations. Each morning, lifeguards patrol the beaches with strainers to remove goose droppings. If a few geese have become particularly fond of a swimming beach, lifeguards attempt to chase the geese away. If a large number of geese descend upon a swimming beach, Hennepin Parks uses a border collie service to herd the geese off the beach.

When fecal coliform sources have been minimized, Hennepin Parks treats the swimming water, if necessary. Personnel have used the following strategies to lower the fecal coliform level in swimming waters:

- Flushing the swimming area within the beach curtain with city drinking water, which contains a small amount of chlorine for disinfection.
- Flushing the swimming area with fresh ground water.
- Raising sections of the beach curtain at deep swimming sites to pull in lake water to flush the swimming area. Lake water is pulled from the bottom to minimize the amount of algae and swimmer's itch organisms pulled into the swimming area.
- Because fecal coliform bacteria are typically associated with solids, using small amounts of aluminum sulfate

to settle any solid material in the swimming area can reduce health risks.

If every available strategy has been used and fecal coliform levels are still above the guideline for 2 to 3 consecutive days, Hennepin Parks closes the beach until the waters reach safe levels again.

Project- Specific Water Quality Monitoring

MCWD and Hennepin Parks also conduct water quality monitoring on project-specific bases. A few examples of these projects are described below.

Monitoring Sediment Detention Pond Effectiveness. When one district lake's water quality began to decline, Hennepin Parks monitored the effectiveness of a sediment detention pond designed to remove nutrients from the lake's inflow stream. Hennepin Parks personnel suspected the sediment detention pond had filled with too much sediment to remain effective. To confirm this suspicion, personnel used the nutrient budget monitoring method to measure flow and collect samples at monitoring locations located upstream and downstream of the sediment detention pond. By comparing the parameters measured at each monitoring location, Hennepin Parks determined that the sediment detention pond was not effectively removing nutrients from the inflow stream. The pond was dredged of excess sediment, and Hennepin Parks conducted additional monitoring to ensure that the dredging increased the pond's effectiveness.

Lawn Fertilizer Runoff Study. Hennepin Parks conducted a series of lawn fertilizer runoff studies. To determine the number of lawns requiring phosphorus fertilizer, Hennepin Parks collected and analyzed soil samples from approximately 200 suburban lawns. Although most suburban home owners use fertilizers with phosphorus, Hennepin Parks found that only about 15 percent of the lawns actually required the addition of phosphorus for healthy turf.

Using sampling devices designed by the U. S. Geological Survey, Hennepin Parks monitored runoff from about 30 suburban lawns, some of which were fertilized and some of which were not. Each sampling device consisted of two 5- foot long, 1- inch diameter PVC pipes with slits cut lengthwise. These pipes were placed horizontally on each lawn to form a "V" pointing down the lawn's slope toward its storm water drainage area. Where the pipes met, personnel attached a cup and placed an 8- inch long, 6- inch diameter PVC pipe (vertically) into the cup. In this pipe, personnel placed a sample bottle. During a rainfall event, runoff water flowed into the slits, through the "V" pipes, and into the sample bottle.

Because most of the monitored lawns were small and because most district rain events are brief, the samplers typically collected all runoff from each rainfall event. By comparing the concentrations of phosphorus measured in the runoff from fertilized and unfertilized lawns, personnel determined that much of the phosphorus fertilizer applied to the lawns not needing additional fertilizer runs off.

Golf Course Runoff Study. To determine the characteristics of runoff that TCMA lakes typically receive from golf courses, Hennepin Parks conducted runoff studies using the nutrient budget monitoring method. In addition to these parameters, personnel also analyzed samples for any pesticides and fungicides used by the golf course.

Hennepin Parks and many community golf courses are cooperating to help improve the quality of local lakes. During the past several years, district golf courses have saved money, maintained suitable turf, and improved the quality of runoff water to TCMA lakes by using the following management strategies:

- Reducing the use of all fertilizers, especially those containing phosphorus.
- Reducing the use of pesticides and fungicides by eliminating preventative treatments. District courses now use these agents to treat only problem areas.

Using Monitoring to Help Meet Lake Water Quality Goals
Minneapolis Park and Recreation Board

The Minneapolis Park and Recreation Board (MPRB) conducts a variety of water quality monitoring projects in Minneapolis lakes. The MPRB undertakes some of this monitoring to measure progress toward meeting water quality goals set by the Minneapolis Chain of Lakes Citizen Committee. In 1993, the Committee developed water quality goals for Lake Calhoun, Lake Harriet, Cedar Lake, and Lake of the Isles. The Committee hopes, over the long term, to restore the water quality of these lakes to conditions as close as possible to those that existed before urbanization. To achieve its goals, the Committee has recommended reducing in-lake phosphorus concentrations and managing influent pollutant loads to each lake with a unique scheme of in-lake manipulations and watershed best management practices (BMPs). The MPRB uses monitoring data to measure changes in water quality and evaluate the effectiveness of the BMPs used. The MPRB also conducts monitoring in other Minneapolis lakes to measure long-term water quality trends, establish water quality goals and lake management plans, and compare the water quality trends in these lakes with trends measured in the Chain of Lakes.

Lake Water Quality Monitoring

The Environmental Operations Section of the MPRB conducts long-term water quality monitoring in Minneapolis lakes. The MPRB plans to conduct this type of monitoring for about three to five years to ensure that water quality changes in city lakes are not masked by annual variations in weather patterns. The long-term monitoring program includes analyses for the following parameters:

- Dissolved oxygen
- pH
- Conductivity
- Temperature
- Total phosphorus
- Total dissolved phosphorus
- Soluble reactive phosphorus
- Total nitrogen
- Silica
- Alkalinity
- Chloride
- Hardness
- Chlorophyll
- Phytoplankton
- Zooplankton

The MPRB selected these parameters to allow for a detailed characterization of the in-lake processes that affect water quality. The MPRB's year-round sampling frequency increases during the lake growing season (May through September), when in-lake conditions are rapidly changing.

Field personnel from the MPRB's Environmental Operations section conduct water quality monitoring at the deepest point of each lake. These points are determined using bathymetric maps and located using shoreline landmarks and depth sounding equipment.

At each monitoring location, field personnel use a Hydrolab© sensor to conduct field measurements of dissolved oxygen, pH, conductivity, and temperature at 1-meter intervals through a vertical column of water. Field crews also collect manual samples for total phosphorus, total dissolved phosphorus, and soluble reactive phosphorus at predetermined intervals in the water column. Personnel collect zooplankton samples by hauling a net vertically through the water column at a rate of 1 meter per second and washing the net with distilled water to remove the contents for preservation and analysis. Surface composite samples for all other parameters are collected in a column of water from the upper two meters of the lake. Personnel also determine Secchi disk depth and perform a survey of vascular plants during sampling.

Storm Water Runoff and Best Management Efficiencies Monitoring

The MPRB conducts monitoring of stormwater runoff and best management efficiencies to determine the actual pollutant removal achieved through the use of structural BMPs (e.g., wetlands, street cleaning, and grit chambers) and to study long-term pollutant loading trends in Minneapolis lakes. These monitoring data are used to determine if changes in BMPs are required. Monitoring locations are selected based on the following requirements:

- The location should be influenced by only one BMP
- No area of the watershed should drain to a sanitary treatment system
- The location should not be affected by a major sewer or street construction project
- The entire watershed should fall within Minneapolis city limits

This type of monitoring includes analyses for the following parameters:

- Total suspended solids
- Total phosphorus
- Dissolved phosphorus
- Total nitrogen

Field personnel use automated flow meters and samplers to conduct stormwater runoff and best management efficiencies monitoring. Automatic flow meters allow personnel to record continuous flow measurements at each monitoring location. Automatic samplers provide the following three sampling options:

- Time-weighted composite sampling, where composite samples are made up of individual volumes collected over a predetermined interval of time.

- Flow-weighted composite sampling, where the automatic sampler is electronically linked to a flow meter. At a predetermined flow interval, the flow meter sends a signal to the sampler to collect each volume of the composite sample.
- Time- or flow-weighted discrete sampling, where the automatic sampler is retrofitted to collect 12 samples in individual bottles at a predetermined time or flow interval.

Because the monitoring equipment cannot be operated in below-freezing conditions, the MPRB installs the equipment as early as possible in the spring and removes the equipment as late as possible in the fall to prolong monitoring time and avoid freezing conditions.

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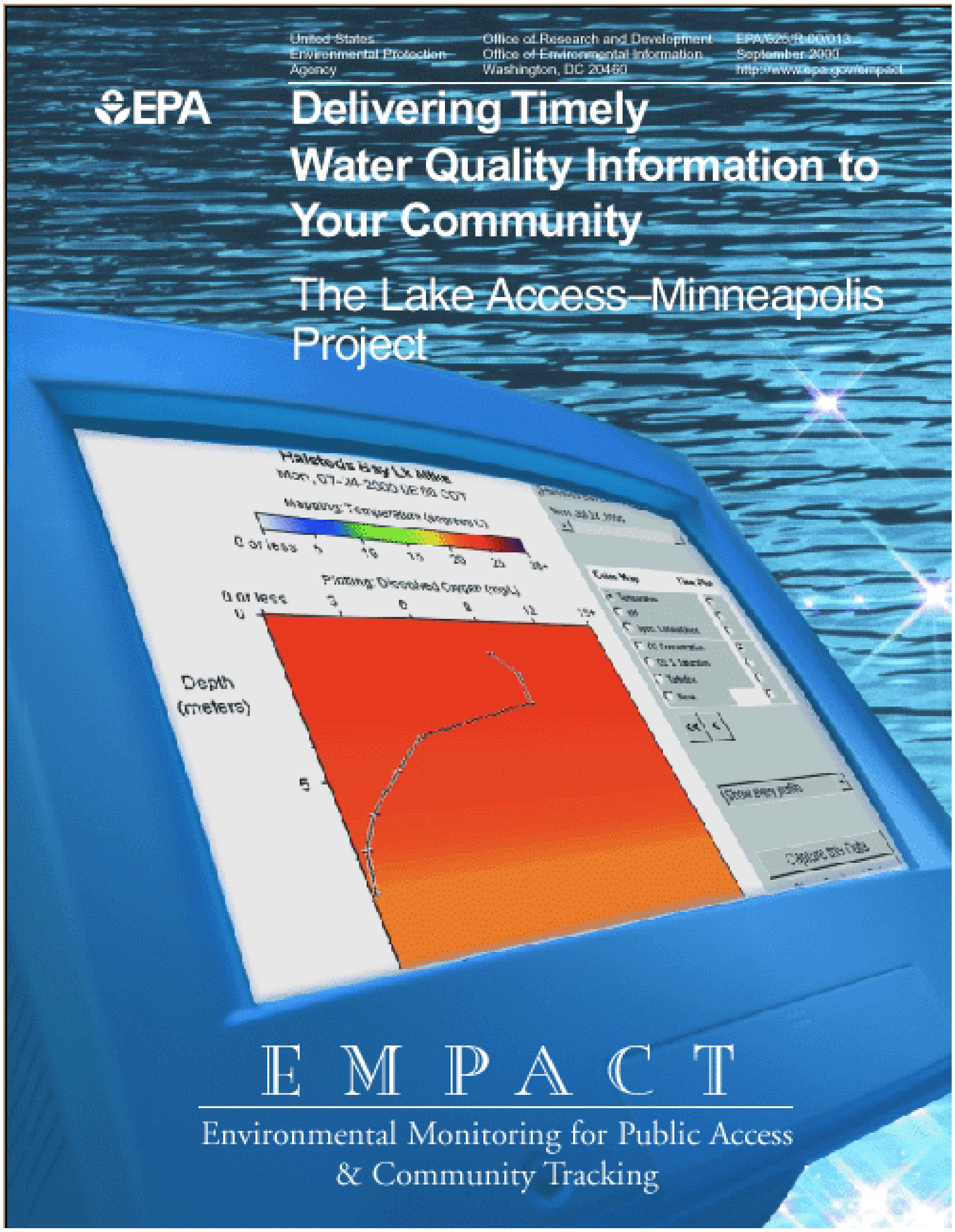
Depth (meters)
5
Plotting: Dissolved Oxygen (mg/L)
Mapping: Temperature (degrees C)
Capture this Data

United States
Environmental Protection
Agency

Office of Research and Development
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Environmental Monitoring for Public Access
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APPENDIX A GLOSSARY OF TERMS

A

Algae: Simple single-celled, colonial, or multi-celled aquatic plants. Aquatic algae are (mostly) microscopic plants that contain chlorophyll and grow by photosynthesis. They absorb nutrients from the water or sediments, add oxygen to the water, and are usually the major source of organic matter at the base of the food web in lakes. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Algal blooms: Referring to excessive growths of algae caused by excessive nutrient loading. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Aluminum sulfate: A compound, $Al_2(SO_4)_3$, used in water purification and sanitation that adsorbs phosphate and small silt and algal particles that settle to the lake bottom.

Anoxia: Condition of being without dissolved oxygen (O_2). (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Anoxic: Completely lacking in oxygen. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

B

Baud: A unit of speed in data transmission equal to one bit per second.

Best Management Practices (BMPs): Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources.

Biofouling: The deterioration of instrumentation when it becomes covered with organisms. For example, biofouling of the RUSS unit sensors occurs when algae, bacteria, and/or fungi grow on the sensor while it is submerged in water beneath the RUSS unit.

C

Chlorophyll: Green pigment in plants that transforms light energy into chemical energy in photosynthesis. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Clarity: Transparency, or light penetration. Clarity is routinely estimated by the depth at which you can no longer see a Secchi disk. The Secchi disk is a weighted metal plate 8 inches in diameter with alternating quadrants painted black and white. The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi depth. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Clocker/ClockerPro: Software designed to schedule programs (or reminders) to run at specified times (e.g., the upload and download of data from the RUSS units).

Color Mapper: A data visualization tool that enables the user to map one parameter as color contours and then overlay another variable over the color contours in the form of a line plot.

CONSOLE: Software that enables operation of a RUSS unit using a portable computer in the field.

CTM: Cellular telephone modem. Can be used to transfer data from the RUSS unit to the land-base station.

D

Depth versus Time (DxT) Profiler: A data visualization program that allows users to display and analyze data in two or three dimensions.

Dimictic: A type of lake that has two mixing periods, typically in spring and fall. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow

Dissolved oxygen (DO): The concentration of oxygen dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation (at the field temperature). Adequate concentrations of dissolved oxygen are necessary to sustain the life of fish and other aquatic organisms and prevent offensive odors. DO levels are considered the most important and commonly employed measurement of water quality and indicator of a water body's ability to support desirable aquatic life. Levels above 5 milligrams per liter (mg O_2/L) are considered optimal and most fish cannot survive for prolonged periods at levels below 3 mg O_2/L. Levels below 1 mg O_2/L are often referred to as hypoxic and when O_2 is totally absent anoxic (often called anaerobic which technically means without air).

(Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Dissolved oxygen profile: A graph of the amount of dissolved oxygen per unit depth, where the depth is on the z (vertical) axis and dissolved oxygen is on the x (horizontal) axis. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

DVT data visualization tools: A suite of four interactive data visualization programs used by the Lake Access team to depict and manipulate water quality profiles collected by RUSS units and from manual sampling, specifically, Lake Access Live: Near Real- Time Display of Numeric Data; Profile Plotter; Color Mapper; and Depth versus Time (DxT) Profiler.

E

E. coli: A bacteria (Escherichia coli) normally found in the gastrointestinal tract and existing as hundreds of strains, some of which can cause diarrheal disease. E. coli can be a water- borne pathogen.

Electrical conductivity: A measure of the water's ability to conduct an electrical current based on its ion content. It is a good estimator of the amount of total dissolved salts or total dissolved ions in water. The electrical conductivity in a lake is influenced by many factors, including the watershed's geology, the watershed's size in relation to lake's size, wastewater from point sources, runoff from nonpoint sources, minor atmospheric inputs, evaporation rates, and some types of bacterial metabolism. Lake Access Project values are standardized to values that would be measured at 25° C to correct for the effect of temperature. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Epilimnion: The upper, wind- mixed layer of a thermally stratified lake. This water is turbulently mixed throughout at least some portion of the day, and because of its exposure, can freely exchange dissolved gases (such as O_2 and CO_2) with the atmosphere. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Eutrophic lake: A very biologically productive type of lake due to relatively high rates of nutrient input that cause high rates of algal and plant growth. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Eutrophication: The process by which lakes and streams are enriched by nutrients (usually phosphorus and nitrogen) which leads to excessive plant growth. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

F G

Geographic Information System (GIS): A computer software and hardware system that helps scientists and other technicians capture, store, model, display, and analyze spatial or geographic information.

GIF (Graphics Interchange Format): A common format for image files, especially suitable for images containing large areas of the same color.

Guano: A substance composed mostly of the dung of sea birds.

H

Hypolimnion: The bottom, and most dense layer of a stratified lake. It is typically the coldest layer in the summer and warmest in the winter. It is isolated from wind mixing and typically too dark for much plant photosynthesis to occur. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

I

Inflow: Water flowing into a lake. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

J K

L

Lake Access Live: Near Real- Time Display of Numeric Data: A data visualization program used to provide near real- time data feeds, such as oxygen level and temperature, to Web sites.

Lake profile: A graph of a lake variable per depth, where the depth is on the z-axis (vertical axis) and the variable is on the x- axis (horizontal axis). Depth is the independent variable and the x- axis is the dependent variable. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Limnology: The study of the life and phenomena of fresh water systems, especially lakes and ponds; freshwater ecology; a limnologist is to lakes as an oceanographer is to oceans.

M

Metalimnion: The middle or transitional zone between the well mixed epilimnion and the colder hypolimnion layers in a stratified lake. This layer contains the thermocline, but is loosely defined depending on the shape of the temperature profile. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Modem: A device that converts data from one form into another (e. g., to a form useable in telephonic transmission).

Morphometry: Relating to the shape of a lake basin; includes parameters needed to describe the shape of the lake such as volume, surface area, mean depth, maximum depth, maximum length and width, shoreline length, shoreline development, depth versus volume, and surface area curves. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

N

Nonpoint source: Diffuse source of pollutant(s); not discharged from a pipe; associated with agricultural or urban runoff, contaminated groundwater flow, atmospheric deposition, or on- site septic systems. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Nutrient loading: The discharge of nutrients from the watershed into a receiving water body (lake, stream, wetland). Expressed usually as mass per unit area per unit time (kg/ ha/ yr or lbs/ acre/ year). (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

O

Organic: Substances that contain carbon atoms and carbon- carbon bonds. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Outflow: Water flowing out of a lake. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Outliers: Data points that lie outside of the normal range of data. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

P

Parameter: Whatever it is you measure— a particular physical, chemical, or biological property that is being measured. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

pH scale: A scale used to determine the alkaline or acidic nature of a substance. The scale ranges from 1 to 14 with 1 being the most acidic and 14 the most basic. Pure water is neutral with a pH of 7. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Phosphorus: Key nutrient influencing plant growth in lakes. Soluble reactive phosphorus (PO_4^{-3}) is the amount of phosphorus in solution that is available to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Photosynthesis: The process by which green plants convert carbon dioxide (CO_2) dissolved in water to sugars and oxygen using sunlight for energy. Photosynthesis is essential in producing a lake's food base and is an important source of oxygen for many lakes. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

ppb: Parts-per-billion; equivalent to a microgram per liter (ug/l). (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

ppm: Parts-per-million; equivalent to a milligram per liter (mg/l). (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Profile: A vertical, depth by depth characterization of a water column, usually at the deepest part of a lake. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Profile Plotter: A data visualization tool that enables users to create static and animated line plots of the profiles of lakes and other water bodies.

Profiler: A component of the RUSS unit that carries the water quality monitoring sensor to multiple depths within the water column beneath the RUSS Unit flotation module. The profiler is controlled by the RePDAR unit.

Q

Quality Assurance/Quality Control (QA/QC). QA/QC procedures are used to ensure that data are accurate, precise, and consistent. QA/QC involves following established rules in the field and in the laboratory to ensure that samples are representative of the water you are monitoring, free from contamination, and analyzed following standard procedures.

R

RUSS-Base: Software that enables the user to remotely operate the RUSS unit using a computer at the land-base station. RUSS-Base creates profile schedules of sampling parameters and communicates with the RUSS unit via telemetry equipment to transmit schedules and receive sampling data.

Remote Underwater Sampling Station (RUSS TM): Monitoring equipment used to remotely collect time-relevant water quality data. The RUSS unit, manufactured by Apprise Technologies, Inc., consists of a mobile underwater monitoring sensor tethered to a a buoy and featuring an onboard computer, batteries, solar panels, telemetry equipment, and other optional monitoring equipment.

RePDAR (Remote Programming, Data Acquisition, and Retrieval) unit.

A component of the RUSS unit that allows for remote water quality monitoring sensor operation, data storage, and data transmission. Each RePDAR unit contains a central processing unit (CPU), power supply charging controls, and telemetry modules.

S

Secchi disk: A disk, typically 8 inches in diameter, divided into 4 equal quadrants of alternating black and white colors. (Some states use totally white Secchis.) It is lowered into a section of shaded water until it can no longer be seen and then lifted back up until it can be seen once again. Averaging the two depths gives a measure of the water's clarity. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Sedimentation: The process of settling inorganic and organic matter on the lake bottom. This matter may have been produced within the lake or washed in from the watershed. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Solubility: The ability of a substance to dissolve into another. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Spring turnover: Period of complete or nearly complete vertical mixing in the spring after ice- out and prior to thermal stratification. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Stormwater discharge: Precipitation and snowmelt runoff from roadways, parking lots, and roof drains that collects in gutters and drains; a major source of nonpoint source pollution to water bodies. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Stratification: An effect where a substance or material is broken into distinct horizontal layers due to different characteristics such as density or temperature. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Stratified: Separated into distinct layers. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Swimmer's itch: An itching inflammation of the skin caused by parasitic larval forms of certain schistosomes that penetrate into the skin, occurring after swimming in infested water.

Substrate: Attachment surface or bottom material in which organisms can attach or live within; such as rock substrate or sand or muck substrate, or woody debris. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Suspended solids: (SS or Total SS [TSS]). Very small particles that remain distributed throughout the water column due to turbulent mixing exceeding gravitational sinking. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

T

Telemetry: The science of automatic measurement and transmission of data by wire, radio, or other methods from remote sources.

Temperature profile: A graph of the temperature per depth; where the depth is on the z- axis (vertical axis) and temperature is on the x- axis (horizontal axis). (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Thermal stratification: Existence of a turbulently mixed layer of warm water (epilimnion) overlying a colder mass of relatively stagnant water (hypolimnion) in a water body due to cold water being denser than warm water coupled with the damping effect of water depth on the intensity of wind mixing. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Thermocline: The depth at which the temperature gradient is steepest during the summer; usually this gradient must be at least 1° C per meter of depth. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Topography: Configuration of physical surface of land; includes relief imprints and locations of all man- made and natural features. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Total dissolved solids (TDS): The amount of dissolved substances, such as salts or minerals, in water remaining after evaporating the water and weighing the residue. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Turbidity: The degree to which light is blocked because water is muddy or cloudy. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Turnover: Fall cooling and spring warming of surface water act to make density uniform throughout the water column. This allows wind and wave action to mix the entire lake. Mixing allows bottom waters to contact the atmosphere, raising the water's oxygen content. However, warming may occur too rapidly in the spring for mixing to be effective, especially in small sheltered kettle lakes. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

U V W

Water column: A conceptual column of water from lake surface to bottom sediments. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

Watershed: All land and water areas that drain toward a river or lake. (Adapted from Water on the Web at http://wow.nrri.umn.edu/wow.)

X Y

YSI multiprobe water quality sensor: The component of the RUSS unit, manufactured by Yellow Springs Instruments (YSI), that is raised and lowered to collect a water quality profile in specified intervals from the lake surface to the lake bottom.

Z

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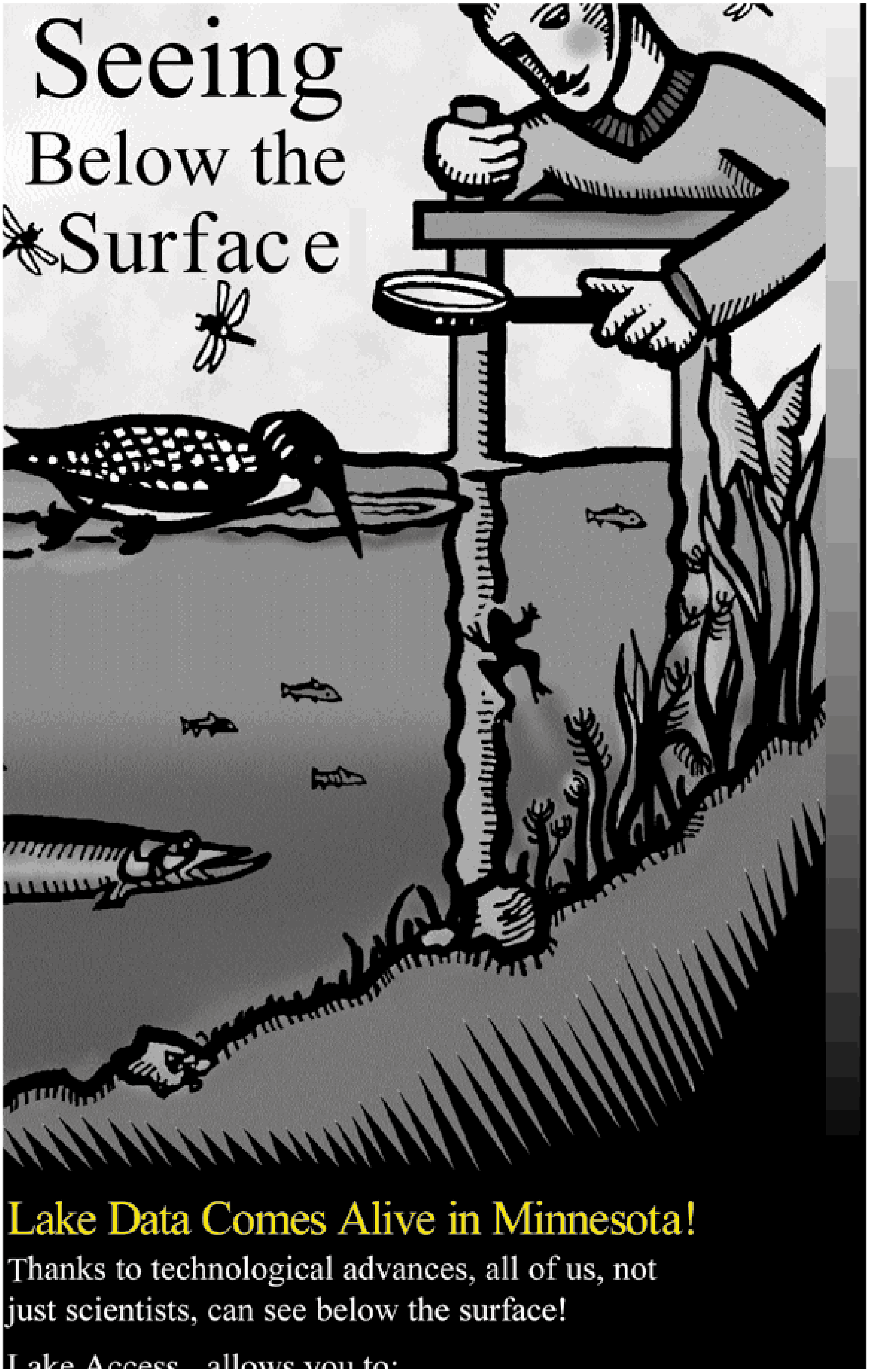
APPENDIX B LAKE ACCESS BROCHURE

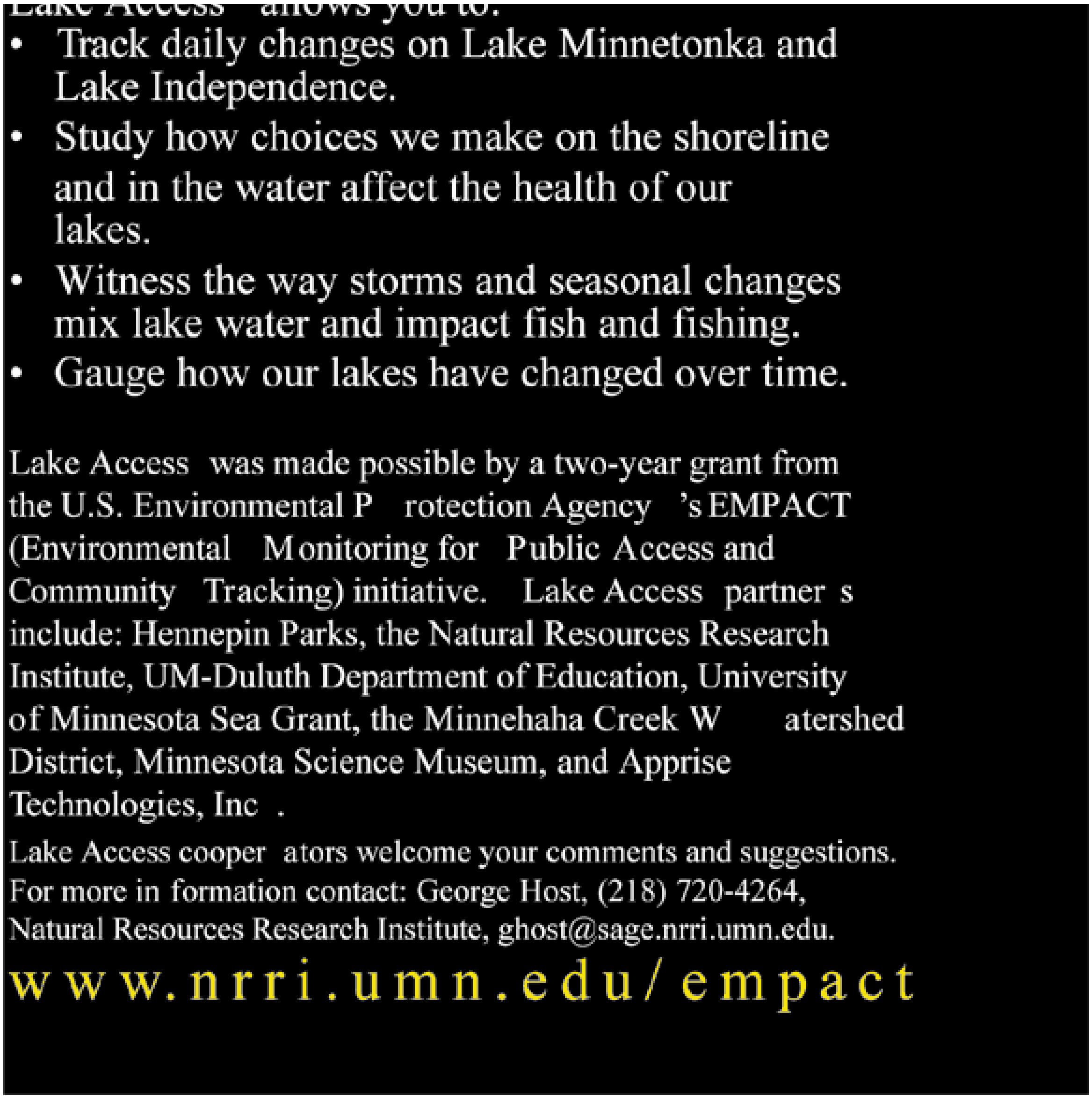


Seeing Below the Surface

Lake Data Comes Alive in Minnesota!

Thanks to technological advances, all of us, not just scientists, can see below the surface!

Lake Access allows you to:



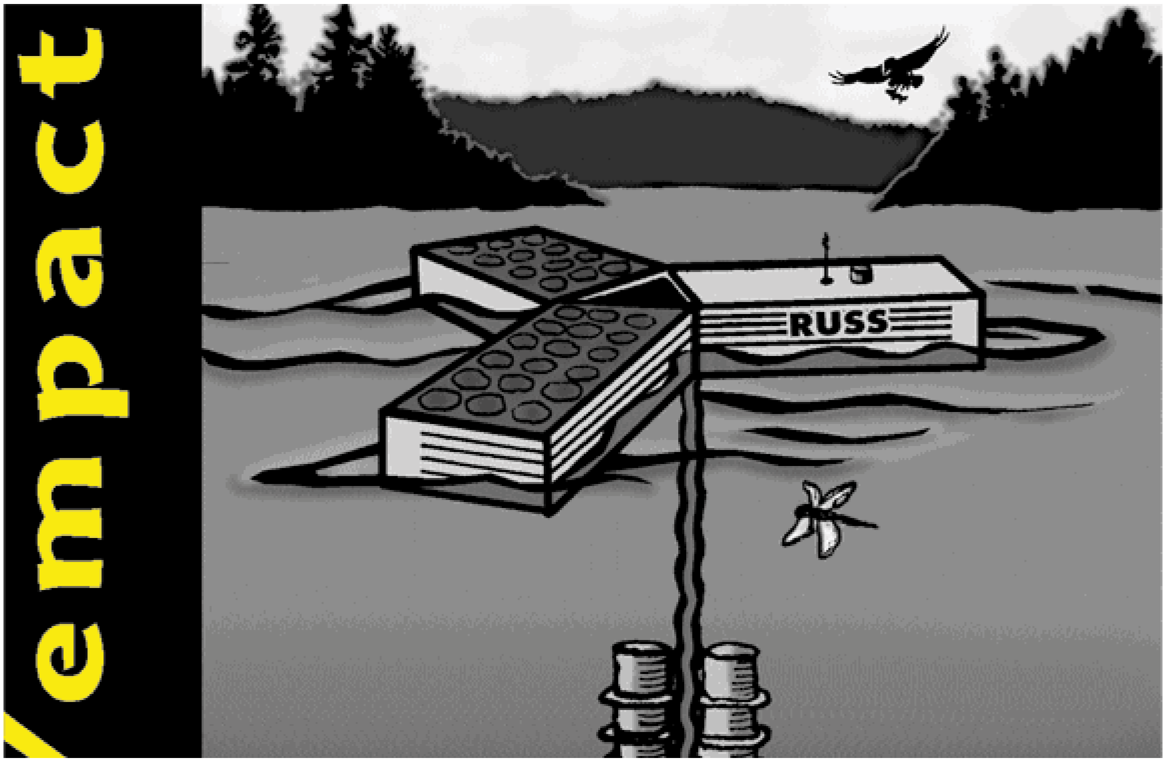
Lake Access allows you to:

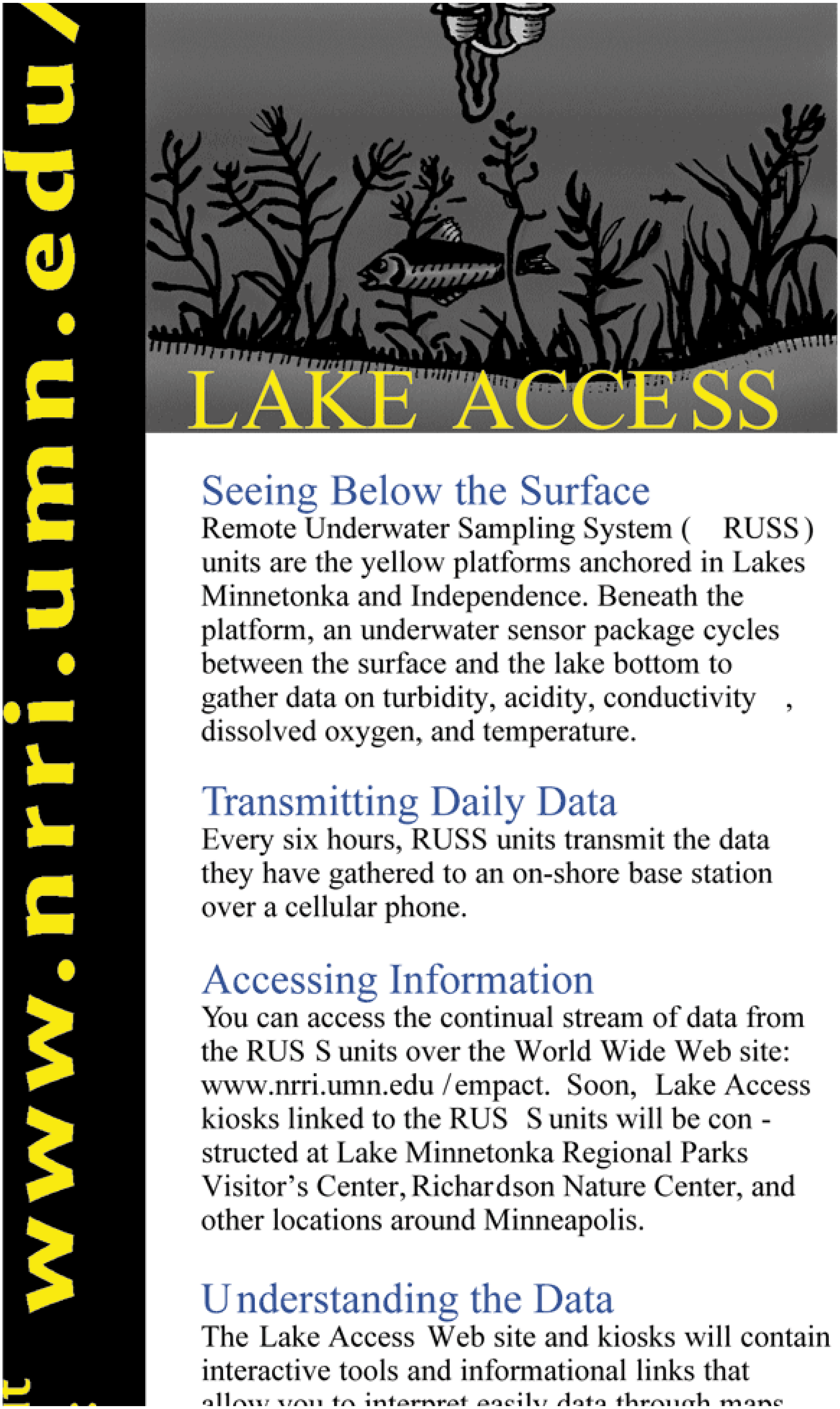
- Track daily changes on Lake Minnetonka and Lake Independence.
- Study how choices we make on the shoreline and in the water affect the health of our lakes.
- Witness the way storms and seasonal changes mix lake water and impact fish and fishing.
- Gauge how our lakes have changed over time.

Lake Access was made possible by a two-year grant from the U.S. Environmental Protection Agency's EMPACT (Environmental Monitoring for Public Access and Community Tracking) initiative. Lake Access partners include: Hennepin Parks, the Natural Resources Research Institute, UM-Duluth Department of Education, University of Minnesota Sea Grant, the Minnehaha Creek Watershed District, Minnesota Science Museum, and Apprise Technologies, Inc.

Lake Access cooperators welcome your comments and suggestions. For more information contact: George Host, (218) 720-4264, Natural Resources Research Institute, ghost@sage.nrri.umn.edu.

www.nrri.umn.edu/empact





www.nrri.umn.edu/

LAKE ACCESS

Seeing Below the Surface

Remote Underwater Sampling System (RUSS) units are the yellow platforms anchored in Lakes Minnetonka and Independence. Beneath the platform, an underwater sensor package cycles between the surface and the lake bottom to gather data on turbidity, acidity, conductivity, dissolved oxygen, and temperature.

Transmitting Daily Data

Every six hours, RUSS units transmit the data they have gathered to an on-shore base station over a cellular phone.

Accessing Information

You can access the continual stream of data from the RUSS units over the World Wide Web site: www.nrri.umn.edu/empact. Soon, Lake Access kiosks linked to the RUSS units will be constructed at Lake Minnetonka Regional Parks Visitor's Center, Richardson Nature Center, and other locations around Minneapolis.

Understanding the Data

The Lake Access Web site and kiosks will contain interactive tools and informational links that allow you to interpret easily data through maps

Please check ou
the Web site at:

allow you to interpret easily data through maps, graphics, and text .

Making a Difference

What you and resource professionals learn from the RUSS units could change the way we manage our shorelines. Lake Access information may encourage lakeshore owners to landscape with more native plants and fewer chemicals. City planners may use RUSS information to develop lake-friendly practices. You may decide how deep to fish or when to swim based on the day’s data.

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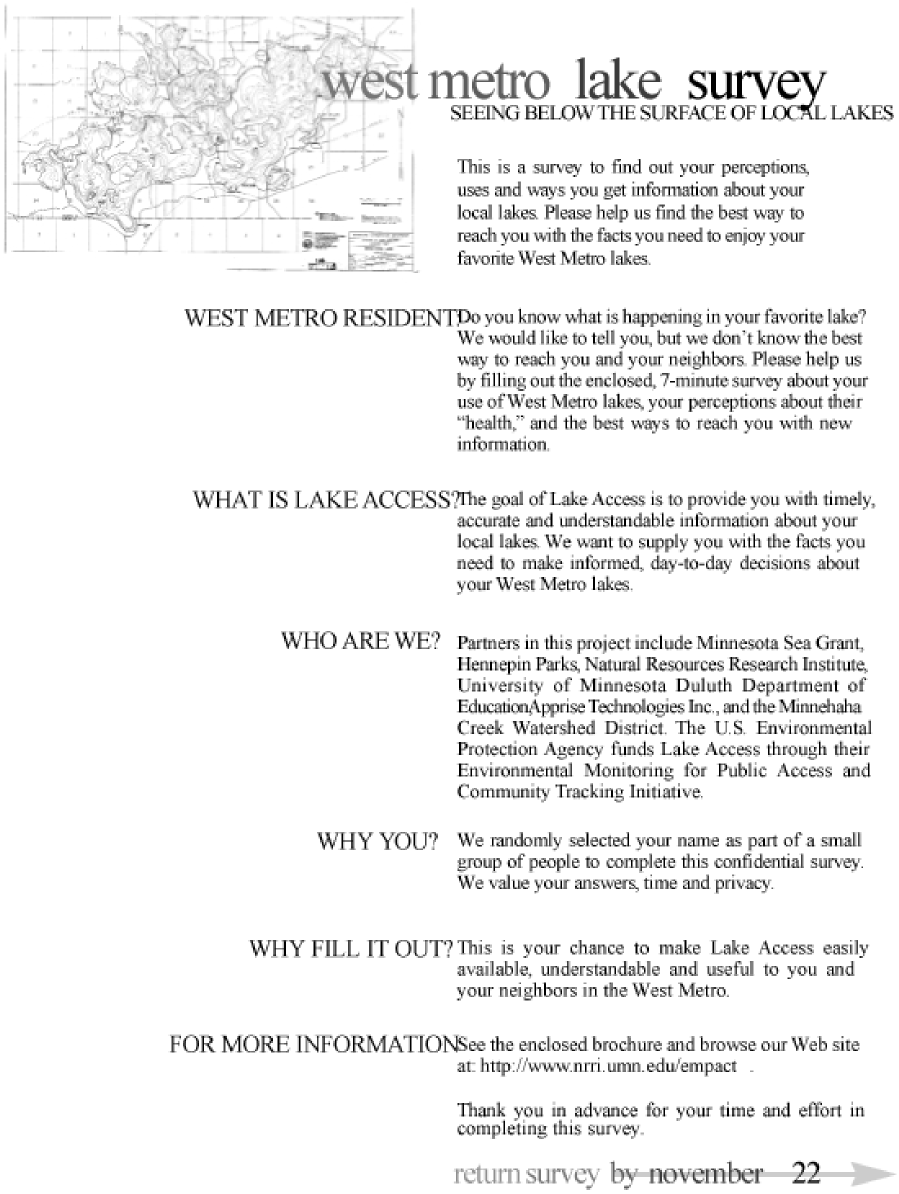
APPENDIX C: LAKE ACCESS SURVEY



west metro lake survey

SEEING BELOW THE SURFACE OF LOCAL LAKES

This is a survey to find out your perceptions, uses and ways you get information about your local lakes. Please help us find the best way to reach you with the facts you need to enjoy your favorite West Metro lakes.

WEST METRO RESIDENT? Do you know what is happening in your favorite lake? We would like to tell you, but we don't know the best way to reach you and your neighbors. Please help us by filling out the enclosed, 7-minute survey about your use of West Metro lakes, your perceptions about their "health," and the best ways to reach you with new information.

WHAT IS LAKE ACCESS? The goal of Lake Access is to provide you with timely, accurate and understandable information about your local lakes. We want to supply you with the facts you need to make informed, day-to-day decisions about your West Metro lakes.

WHO ARE WE? Partners in this project include Minnesota Sea Grant, Hennepin Parks, Natural Resources Research Institute, University of Minnesota Duluth Department of Education, Apprise Technologies Inc., and the Minnehaha Creek Watershed District. The U.S. Environmental Protection Agency funds Lake Access through their Environmental Monitoring for Public Access and Community Tracking Initiative.

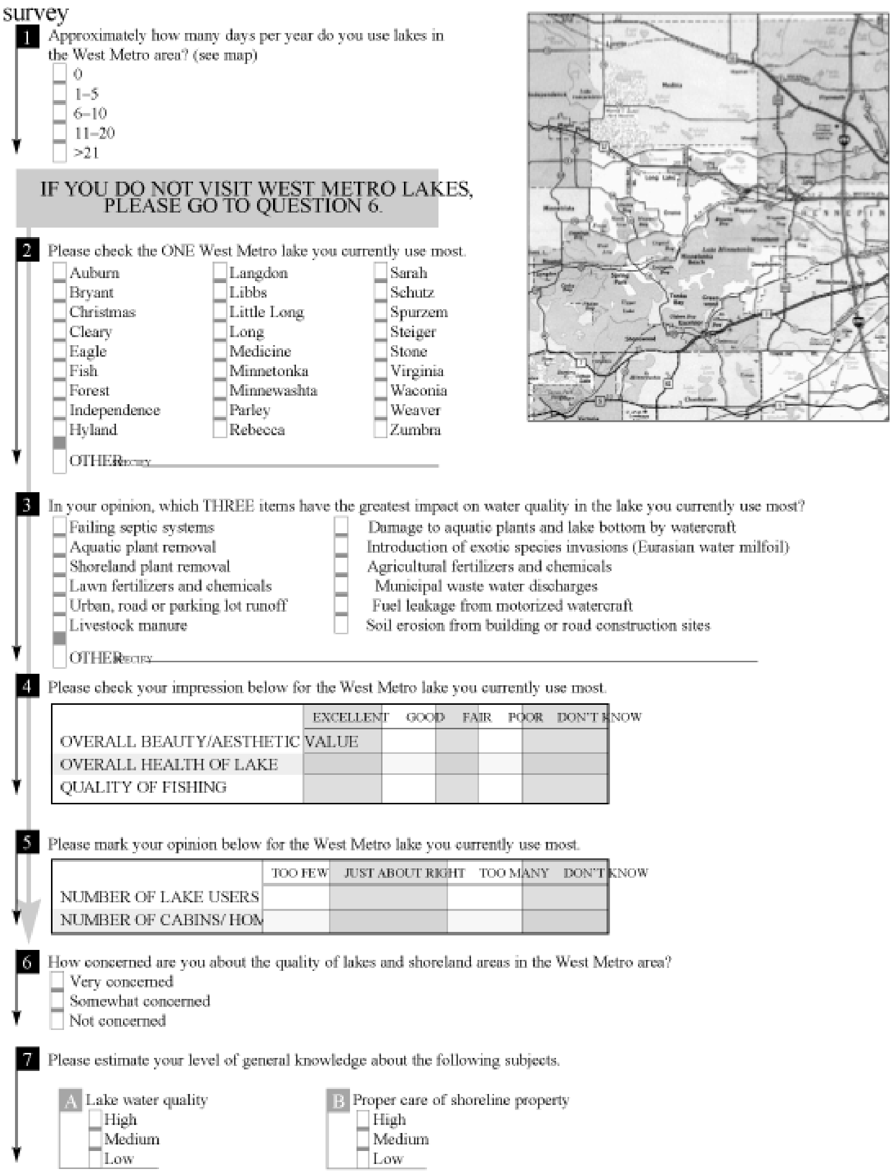
WHY YOU? We randomly selected your name as part of a small group of people to complete this confidential survey. We value your answers, time and privacy.

WHY FILL IT OUT? This is your chance to make Lake Access easily available, understandable and useful to you and your neighbors in the West Metro.

FOR MORE INFORMATION See the enclosed brochure and browse our Web site at: http://www.nrri.umn.edu/empact

Thank you in advance for your time and effort in completing this survey.

return survey by november 22



survey

1 Approximately how many days per year do you use lakes in the West Metro area? (see map)

☐ 0
☐ 1–5
☐ 6–10
☐ 11–20
☐ >21

IF YOU DO NOT VISIT WEST METRO LAKES, PLEASE GO TO QUESTION 6.

2 Please check the ONE West Metro lake you currently use most.

☐ Auburn
☐ Bryant
☐ Christmas
☐ Cleary
☐ Eagle
☐ Fish
☐ Forest
☐ Independence
☐ Hyland
☐ Langdon
☐ Libbs
☐ Little Long
☐ Long
☐ Medicine
☐ Minnetonka
☐ Minnewashta
☐ Parley
☐ Rebecca
☐ Sarah
☐ Schutz
☐ Spurzem
☐ Steiger
☐ Stone
☐ Virginia
☐ Waconia
☐ Weaver
☐ Zumbra
☐ OTHER SPECIFY ______

3 In your opinion, which THREE items have the greatest impact on water quality in the lake you currently use most?

☐ Failing septic systems
☐ Aquatic plant removal
☐ Shoreland plant removal
☐ Lawn fertilizers and chemicals
☐ Urban, road or parking lot runoff
☐ Livestock manure
☐ Damage to aquatic plants and lake bottom by watercraft
☐ Introduction of exotic species invasions (Eurasian water milfoil)
☐ Agricultural fertilizers and chemicals
☐ Municipal waste water discharges
☐ Fuel leakage from motorized watercraft
☐ Soil erosion from building or road construction sites
☐ OTHER SPECIFY ______

4 Please check your impression below for the West Metro lake you currently use most.

	EXCELLENT	GOOD	FAIR	POOR	DON'T KNOW
OVERALL BEAUTY/AESTHETIC VALUE					
OVERALL HEALTH OF LAKE					
QUALITY OF FISHING					

5 Please mark your opinion below for the West Metro lake you currently use most.

	TOO FEW	JUST ABOUT RIGHT	TOO MANY	DON'T KNOW
NUMBER OF LAKE USERS				
NUMBER OF CABINS/ HOM				

6 How concerned are you about the quality of lakes and shoreland areas in the West Metro area?

☐ Very concerned
☐ Somewhat concerned
☐ Not concerned

7 Please estimate your level of general knowledge about the following subjects.

A Lake water quality
☐ High
☐ Medium
☐ Low

B Proper care of shoreline property
☐ High
☐ Medium
☐ Low

8 Are you interested in learning more about lakes in the West Metro area?

☐ Yes
☐ No

9 Please check the item(s) you would like to learn more about West Metro lakes.

☐ Effects of weather on lakes
☐ Fisheries
☐ Control of algae
☐ Control of aquatic plants
☐ User conflict resolutions
☐ Nutrient levels (nitrogen/phosphorus)
☐ Change in water quality over time
☐ Actions that improve lake water quality
☐ Factors that influence lake water quality
☐ Water conditions for swimming
☐ Shoreland restoration with native plants
☐ Basic understanding of how lakes work
☐ Non-native plant control efforts
☐ Real time lake measurements (oxygen profiles, mixing depths, lake temperature)
☐ OTHER SPECIFY ______

THE INTERNET IS AN ELECTRONIC COMMUNICATIONS NETWORK THAT CONNECTS COMPUTER NETWORKS AND FACILITIES A

10 Would you use the Internet to learn more about West Metro lakes?

☐ Yes
☐ No

11 Please check the item(s) below that would make it worth your time to visit our Web site, http://www.nrri.umn.edu/empact.

☐ Live camera coverage of lakeshore conditions
☐ Information about the bacterial contamination of swimming beaches
☐ Current water temperature
☐ Current dissolved oxygen levels
☐ Water clarity measurements
☐ Regional weather
☐ Weekly fishing reports
☐ OTHER SPECIFY ______
☐ I do not have computer access

AN INTERACTIVE KIOSK IS AN INFORMATION BOOTH WITH A COMPUTER TOUCH SCREEN

12 Would you use an interactive kiosk to learn more about lakes in the West Metro area?

☐ Yes
☐ No

13 Please check the THREE most convenient locations for you to use a kiosk?

☐ Beach
☐ Grocery store
☐ Library
☐ Mall
☐ Museum
☐ School
☐ Visitor center
☐ Boat launch
☐ OTHER SPECIFY ______

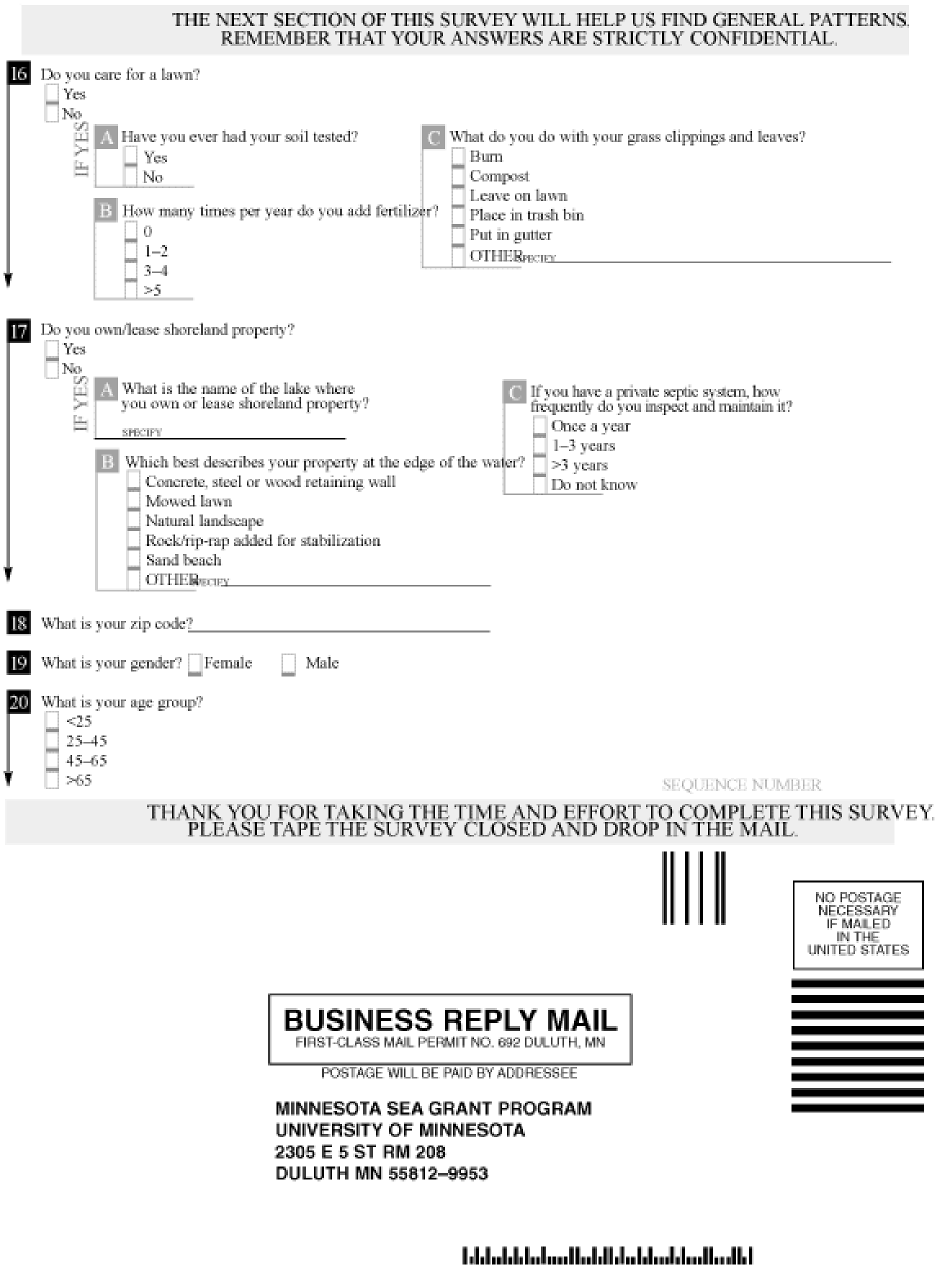
14 As new facts become available about West Metro lakes, which TWO ways would be most convenient for you to access in-depth news and information about your lakes?

☐ Classes/workshops
☐ Interactive kiosk
☐ Organizations
☐ Internet
☐ OTHER SPECIFY ______

15 Please check TWO ways you would most likely notice a brief announcement about West Metro lakes.

☐ Signs
☐ Public radio
☐ Commercial radio
☐ Network television
☐ Cable television
☐ Direct mail
☐ St. Paul Pioneer Press
☐ Minneapolis Star-Tribune
☐ Other newspapers SPECIFY ______
☐ Newsletters SPECIFY ______
☐ Magazines SPECIFY ______

PLEASE CONTINUE



THE NEXT SECTION OF THIS SURVEY WILL HELP US FIND GENERAL PATTERNS.
REMEMBER THAT YOUR ANSWERS ARE STRICTLY CONFIDENTIAL.

16 Do you care for a lawn?
☐ Yes
☐ No

IF YES

A Have you ever had your soil tested?
☐ Yes
☐ No

B How many times per year do you add fertilizer?
☐ 0
☐ 1–2
☐ 3–4
☐ >5

C What do you do with your grass clippings and leaves?
☐ Burn
☐ Compost
☐ Leave on lawn
☐ Place in trash bin
☐ Put in gutter
☐ OTHER SPECIFY ____________

17 Do you own/lease shoreland property?
☐ Yes
☐ No

IF YES

A What is the name of the lake where you own or lease shoreland property?
SPECIFY ____________

B Which best describes your property at the edge of the water?
☐ Concrete, steel or wood retaining wall
☐ Mowed lawn
☐ Natural landscape
☐ Rock/rip-rap added for stabilization
☐ Sand beach
☐ OTHER SPECIFY ____________

C If you have a private septic system, how frequently do you inspect and maintain it?
☐ Once a year
☐ 1–3 years
☐ >3 years
☐ Do not know

18 What is your zip code? ____________

19 What is your gender? ☐ Female ☐ Male

20 What is your age group?
☐ <25
☐ 25–45
☐ 45–65
☐ >65

SEQUENCE NUMBER

THANK YOU FOR TAKING THE TIME AND EFFORT TO COMPLETE THIS SURVEY.
PLEASE TAPE THE SURVEY CLOSED AND DROP IN THE MAIL.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST-CLASS MAIL PERMIT NO. 692 DULUTH, MN

POSTAGE WILL BE PAID BY ADDRESSEE

MINNESOTA SEA GRANT PROGRAM
UNIVERSITY OF MINNESOTA
2305 E 5 ST RM 208
DULUTH MN 55812–9953

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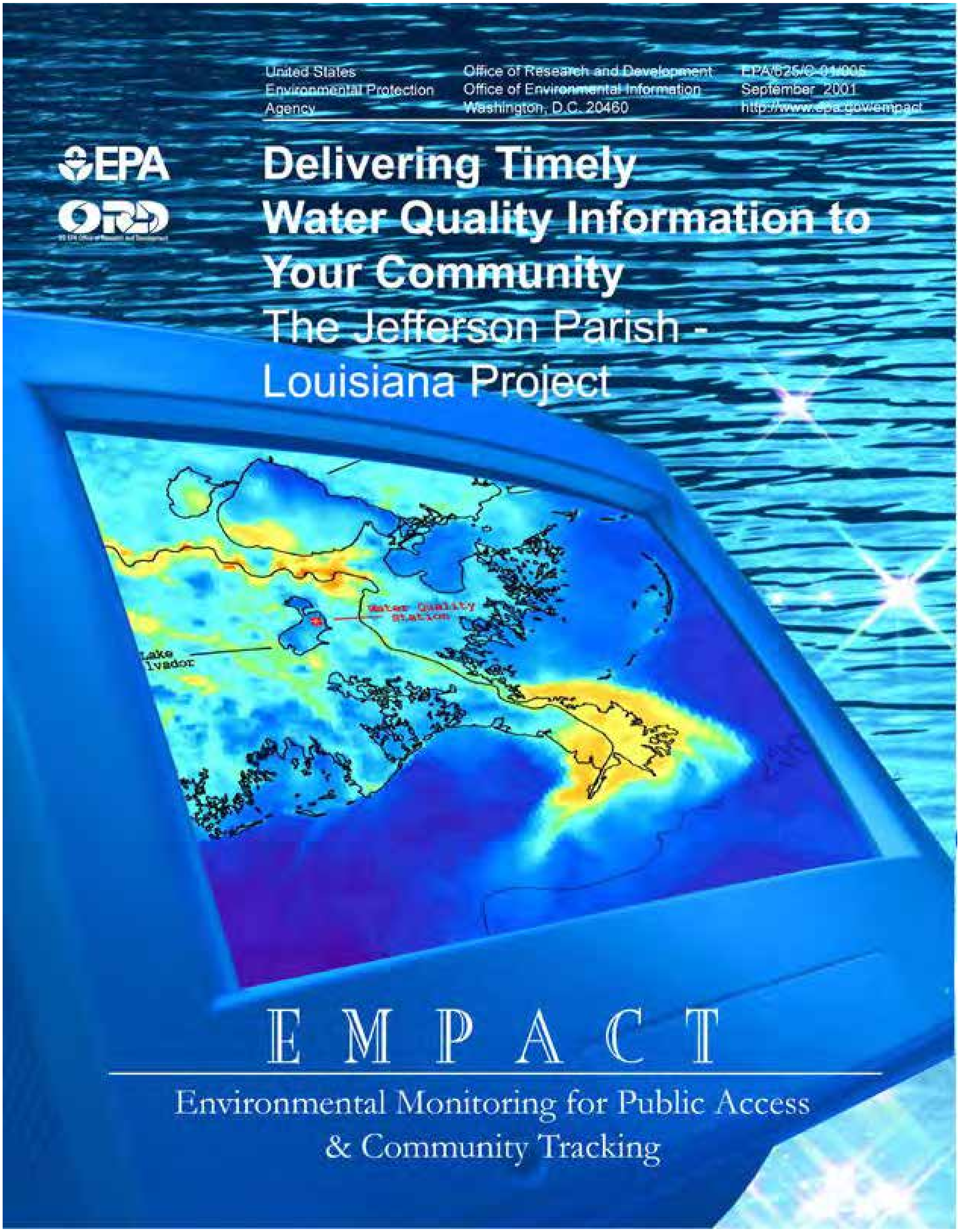


United States
Environmental Protection
Agency

Office of Research and Development
Office of Environmental Information
Washington, D.C. 20460

EPA/625/C-01/005
September 2001
http://www.epa.gov/empact

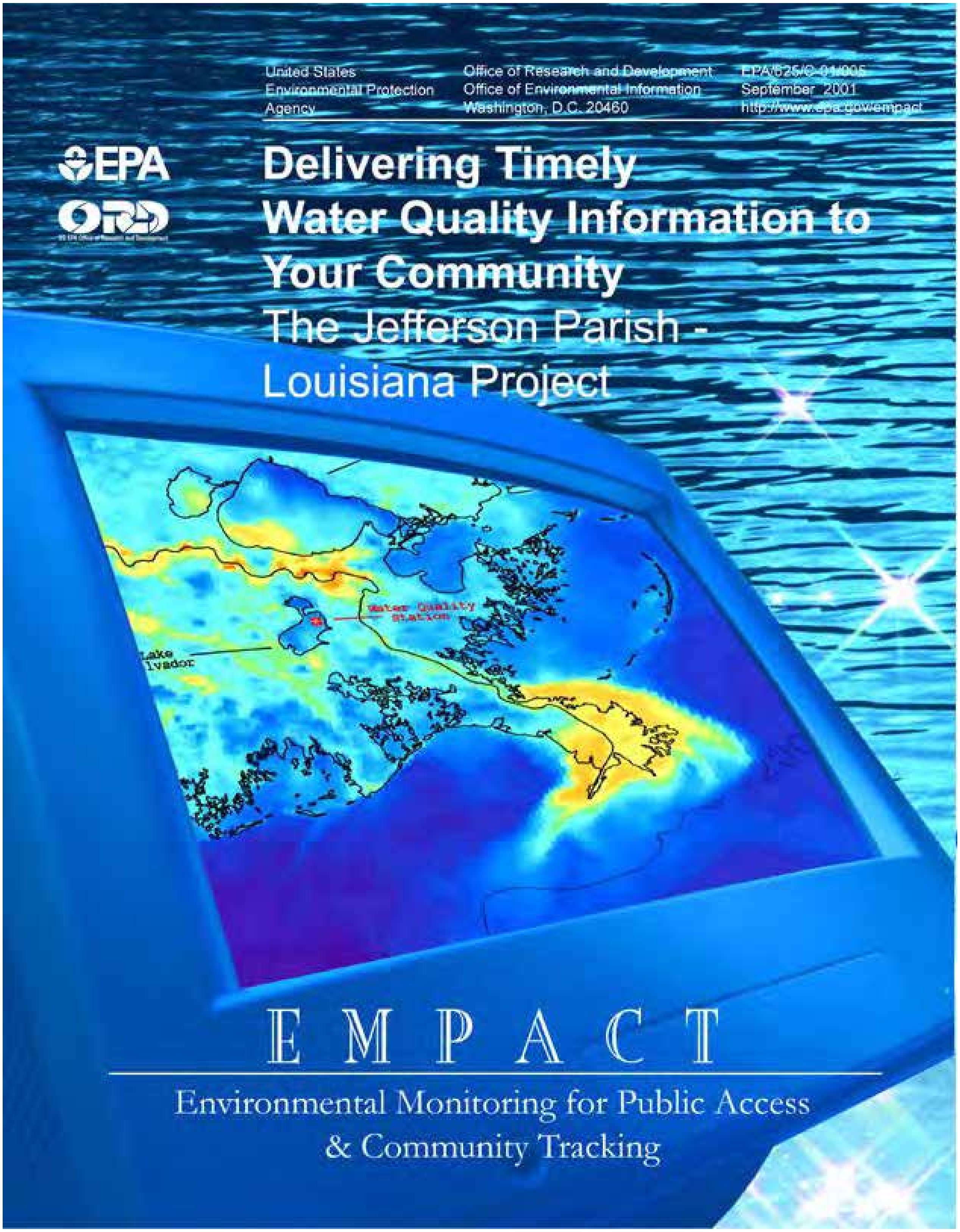
Delivering Timely Water Quality Information to Your Community

The Jefferson Parish - Louisiana Project

EMPACT

Environmental Monitoring for Public Access
& Community Tracking

Click Here or Anywhere on Image to View Contents



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Delivering Timely Water Quality Information to Your Community

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Environmental Monitoring for Public Access
& Community Tracking

Click Here or Anywhere on Image to View Contents

1.1 | 1.2 | 1.3 | 1.4

1. INTRODUCTION

1.1 Background

Wetland loss along the Louisiana coastal zone is one of the state's most pressing environmental problems. Although numerous factors have contributed to this loss, perhaps the leveeing of the Mississippi River for flood control has had the most far-reaching impact. Construction of the levy has blocked the river's historic spring overflows and thus impeded the rush of marsh-supporting fresh water, nutrients, and sediment to the coastal zone. [Source: http://www.mvn.usace.army.mil/pao/dpond/davispond.htm]

Coastal Louisiana is losing, on average, between 25 and 35 square miles of land annually -- that's more than one football field every 30 minutes. Louisiana has 40 percent of the Lower 48 states' coastal wetlands and 80 percent of the nation's total wetland loss. These valuable wetlands are nursery grounds for fisheries, a buffer that protects developed areas from storm surges, and a filtering system for pollutants carried in urban runoff. [Source: Video News Release http://gmpo.gov/pubinfo/empact. html]

One of the strategies for reversing this wetland loss in coastal Louisiana is to partially restore some of the natural flow into the ecosystem. Diversion of freshwater and sediments from the Mississippi River is expected to conserve and restore coastal wetlands. One such project is the Davis Pond Freshwater Diversion Project. The construction for this project began in January 1997. Freshwater diversions to the Barataria Basin are scheduled for 2001. In order to establish a baseline prior to any freshwater diversions, the EMPACT (**E**nvironmental **M**onitoring for **P**ublic **A**ccess and **C**ommunity **T**racking) project team began monitoring the water quality in Lake Salvador and Lake Cataouche (both are downstream of the diversion) in August 1999. After freshwater diversions occur, the water quality monitoring will continue. Analyses of pre- and post diversion water quality data will be used to determine the effects of river water diversion on the estuary.

The Davis Pond Freshwater Diversion into the Barataria Estuary will be the largest freshwater diversion project built to date, capable of diverting up to 10,650 cubic feet (approximately 80,000 gallons) per second of river water. The freshwater diversion will imitate historic spring floods by providing a controlled flow of freshwater and nutrients into the Barataria Bay estuary. It is expected that this diversion will restore former ecological conditions by combating land loss, enhancing vegetation and improving fish and wildlife habitat.

However, there are many concerns that the freshwater diversion will have a negative impact on the estuary. Some citizens are concerned about the impact that nutrient rich river water may have on water quality and growths (blooms) of phytoplankton. Commercial fishermen are concerned that massive amounts of river water may deteriorate the water quality in the lakes and bays where they make their living. Communities south of the diversion site are concerned that water levels will increase and cause flooding during high wind driven tides. Scientists debate the wisdom of introducing more nutrients into an already eutrophic system. Also all stakeholders are interested in the changes that will occur as salinity levels are altered in the upper estuary.

Partners in the project hope that monitoring conducted through the EMPACT project will provide valuable before and after data of the effects of diverting freshwater from Mississippi river into coastal areas encroached by saltwater. These data will assist scientists and coastal managers in making informed decisions on how to best manage freshwater flow from the diversion to diminish the likelihood of algal blooms, which can be toxic, can contaminate seafood, and can have human health impacts.

1.2 EMPACT Overview

This handbook offers step-by-step instructions about how to provide time-relevant water quality data to your community. It was developed by the U.S. Environmental Protection Agency's (EPA's) EMPACT program. The EMPACT program was created by EPA's Office of Research and Development (ORD) to introduce new technologies that make it possible to provide time-relevant environmental information to the public. EMPACT is working with the 150 largest metropolitan areas and Native American Tribes in the country to help communities in these areas:

- Collect, manage, and distribute time-relevant environmental information.
- Provide residents with easy-to-understand information they can use in making informed, day-to-day decisions.

To make this and some other EMPACT projects more effective, partnerships with the National Oceanic and Atmospheric Administration (NOAA) and the United States Geological Survey (USGS) were developed. EPA will work closely with these federal agencies to help achieve nationwide consistency in measuring environmental data, managing the information, and delivering it to the public.

To date, environmental information projects have been initiated in 84 of the 150 EMPACT- designated metropolitan areas and Native American Tribes. These projects cover a wide range of environmental issues, including water quality, groundwater contamination, smog, ultraviolet radiation, and overall ecosystem quality. Some of these projects were initiated directly by EPA.Others were launched by EMPACT communities themselves. Local governments from any of the 150 EMPACT metropolitan areas and Native American Tribes are eligible to apply for EPA-funded Metro Grants to develop their own EMPACT projects. The 150 EMPACT metropolitan areas and Native American Tribes are listed in the table at the end of this chapter.

Communities selected for Metro Grant awards are responsible for building their own time- relevant environmental monitoring and information delivery systems. To find out how to apply for a Metro Grant, visit the EMPACT Web site at http://www.epa.gov/empact/apply.htm.

One such Metro Grant recipient is the Jefferson Parish - New Orleans Project. The project provides the public with time-relevant water quality monitoring data and impacts of water quality management activities (i.e., river water diversions) in the New Orleans Standard Metropolitan Statistical Area (SMSA).

1.3 Jefferson Parish EMPACT Project

1.3.1 Sampling Techniques

The Jefferson Parish - New Orleans Project Team utilizes time-series water sampling data, remote sensing/satellite data, and water quality field sampling data to monitor impacts of freshwater diversions, such as harmful algal blooms, in the New Orleans SMSA. The resulting information is communicated to the community during public meetings and events and by using Internet technology, audiovisual tools, and print media.

The time-series water sampling data are collected by an automated system, in which a sampling unit collects hourly data and then transmits the data via Geostationary Operational Environmental Satellites (GOES) to the USGS District Office every four hours for storage, retrieval, and analysis. Near-real time stream flow data available on the USGS's Louisiana District Home Page are PROVISIONAL data that have not been reviewed or edited. Each station record is considered PROVISIONAL until the data are reviewed, edited, and published. The data are usually published within 6 months of the end of the year, which runs from October through September. Coordinated water temperature, dissolved oxygen, turbidity, salinity, water level, and fluorescence are taken to confirm remote sensing data. The sampling unit is located in Lake Salvador, a key outfall area of the Davis Pond Freshwater Diversion Project.

Satellite data collected by the NOAA Advanced Very High Resolution Radiometer (AVHRR) and the Orbview-2 SeaWiFS ocean color sensor are received and processed at the Earth Scan Lab (ESL), Coastal Studies Institute at Louisiana State University (LSU) using SeaSpace's Terascan^{TM} system. This software package receives the data from the satellites, performs calibration, geometric correction, and more specialized processing for the determination of temperature, reflectance (turbidity), and chlorophyll *a* concentrations. Field water samples, obtained close in time to the satellite data, are used to "surface truth" the satellite measurements for temperature, concentration of suspended solids and chlorophyll *a*. Ground truthing is the process of comparing satellite data to actual field measurements.

Water quality field sampling is conducted weekly from eight stations in Lake Salvador and Lake Cataouche (a smaller lake north of Lake Salvador) to ground-truth remote sensing (satellite) data and validate time-series water sampling data. The LSU-Coastal Ecology Institute (CEI) analyzes the samples for chlorophyll *a*, nutrients, and suspended solids. The Louisiana

University Marine Observatory Consortium (LUMCON) provides data on phytoplankton speciation including identification of harmful algal species. The field sampling data are interpreted and made available via the Internet (http://its2.ocs.lsu.edu/guests/ceilc).

1.3.2 EMPACT Project Team

The Jefferson Parish Project team consists of the following members and key partners:

- Drew Puffer of the Gulf of Mexico Program (GMP) is serving as EPA project manager. His role is to provide technical support and administrative advice, to coordinate communications with the EPA, and to identify potential sources of funding to extend the life of the project.

- Terry Hines-Smith, GMP's public affairs specialist, works with the project partners and stakeholders to identify and maximize their information and public outreach resources.

- Marnie Winter, Director of the Jefferson Parish Environmental and Development Control Department, is the local project manager. Her role is to administer grant funds and to coordinate with parish officials to secure approval of contracts and other legal documents required for the project. She also interacts directly with other partners on the project team, serves as the point of contact for communications, and acts as official parish spokesperson at media and other public outreach events. She has secured additional support for the project through the Jefferson Parish Government and was instrumental in leveraging chlorophyll *a* and silicate monitoring from the U.S. Army Corps of Engineers (USACE).

- Ms. Winter is being assisted by Vickie Duffourc, an environmental specialist for a consulting firm under standing contract with the parish. Ms. Duffourc is responsible for coordinating the various aspects of the project, including project communications, and works under the direct supervision of Ms. Winter.

- The USGS collects water quality field samples and services the time-series sampling unit. Jefferson Parish provides a trained environmental technician and the parish's boat to assist the USGS with collecting water samples and servicing the sampling unit. Dr. Chris Swarzenski and the staff of the USGS District Office in Baton Rouge, Louisiana, provide weekly maintenance and calibration of the data collection station, QA/QC of near-real time data, technical services required to received, transfer, and store the near-real time data set, and scientific interpretation of data received. Jake Peters, at the USGS office in Atlanta, also contributes through his association with the EPA Water Data and Tools Projects. While many persons at the USGS Baton Rouge office contribute to this project, Dr. Swarzenski is the lead investigator and Paul Ensminger is the field service technician.

- Dr. Nan Walker, LSU Coastal Studies Institute and Earth Scan Laboratory, is responsible for acquiring, processing, and interpreting satellite data collected by the NOAA and Orbview-2 satellites. These data are used to assess the regional distribution of water temperature, water quality and chlorophyll *a* content and changes over space and time. She uses field measurements of suspended solids, suspended sediments, chlorophyll *a* and temperature to investigate the relationships between satellite and in-situ data for different regions in the study area. Dr. Walker posts the satellite images and interpretive text on the Earth Scan Laboratory LSU Web page, which is linked to the Jefferson Parish EMPACT home page.

- Dr. Eugene Turner, LSU-CEI, is responsible for analysis of water samples and providing the resulting data in tabular and graphic form. LSU-CEI conducts chlorophyll *a* and nutrient analysis on water samples taken weekly from the project area to ground-truth satellite images. LSU-CEI scientists interpret the water quality data and post it to LSU Web page, which will be linked to the Jefferson Parish EMPACT home page.

- Dr. Quay Dortch, LUMCON, receives weekly water samples from the project area and identifies harmful algal species contained in each sample. She provides the resulting data in tabular and graphic form and coordinates with the Louisiana Department of Health and Hospitals regarding possible threats to human health.

As shown above, this project team consists of several distinguished coastal scientists. The collected and analyzed data are being used to understand the physical and biological conditions of water bodies that may be impacted by the Davis Pond river diversion project in the future.

The project provides near-real time regional physical and biological measurements from satellites and a monitoring station in Lake Salvador to the agencies and organizations involved with public health, fisheries, and habitat related issues. This information allows these entities to respond quickly to adverse environmental conditions, make appropriate decisions to ensure economic and environmental sustainability of the affected environment, and protect the health of commercial and recreational users. During the first year, the chlorophyll *a* measurements (from field and satellite sensors) were not being reported in real time.

The addition of a pressure sensor to detect water level changes in near-real time provides early warning of increased water levels and allows diversion managers to make appropriate decisions to minimize the introduction of more water when flooding is likely.

1.3.3 Project Costs

To keep costs low, Jefferson Parish used nearby existing sampling stations to collect data, used Parish personnel for data collection (when possible), and developed strategic partnerships with members of the project team. Figure 1.1 provides the initial budget for the Jefferson Parish's monitoring project [Source: Water Data and Tools: Tracking Freshwater Diversions & Algal Bloom Impacting the New Orleans Standard Metropolitan Statistical Area Gulf of Mexico, New Orleans, LA].

The costs to conduct a water quality monitoring project similar to the Jefferson Parish Project can vary significantly. Factors affecting the cost include, but are not limited to, the size and location of your study area, the number and types of parameters you want to measure, the number of personnel needed to collect and analyze the data, the number of samples to collect, the amount of new equipment which will need to be purchased, etc. For example, the Parish purchased only one additional sampling station for their study because they were able to obtain data from seven existing sampling stations located nearby. Monitoring costs for a proposed project would be much higher if additional sampling stations are needed.

Figure 1.2 provides some typical costs for equipment and services you could expect to incur when implementing a project similar to that of Jefferson Parish. Please note that these costs can vary significantly for a project depending upon the number of sampling stations required for the project and the types of services contracts that you are able to negotiate.

Figure 1.1. Initial EMPACT Project Budget for Jefferson Parish

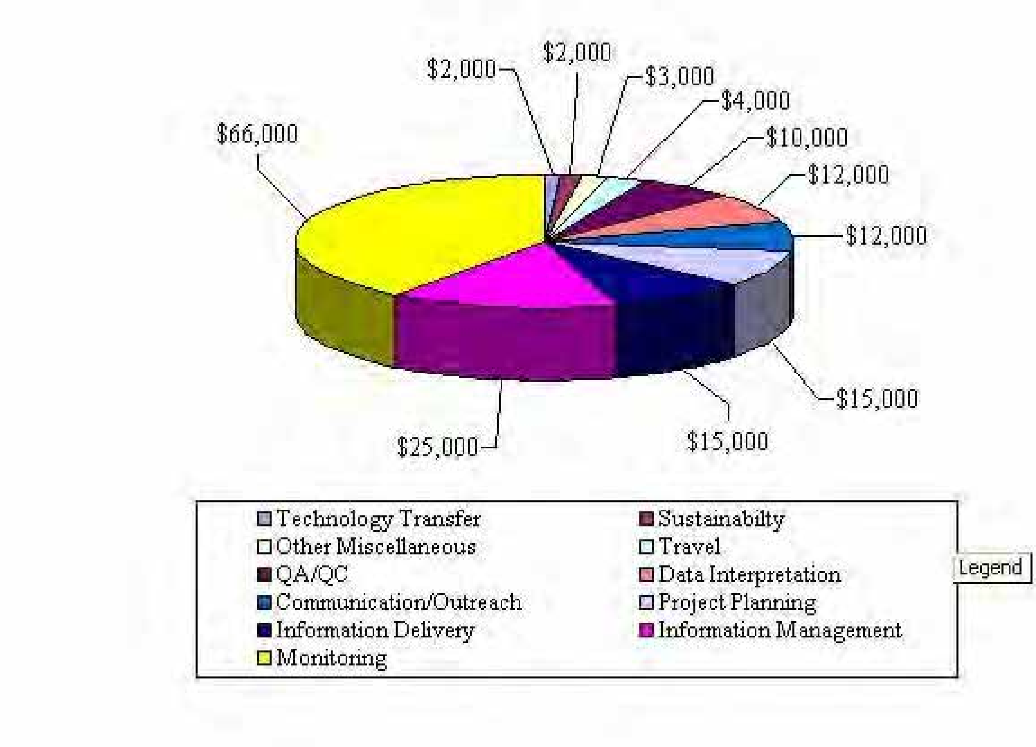
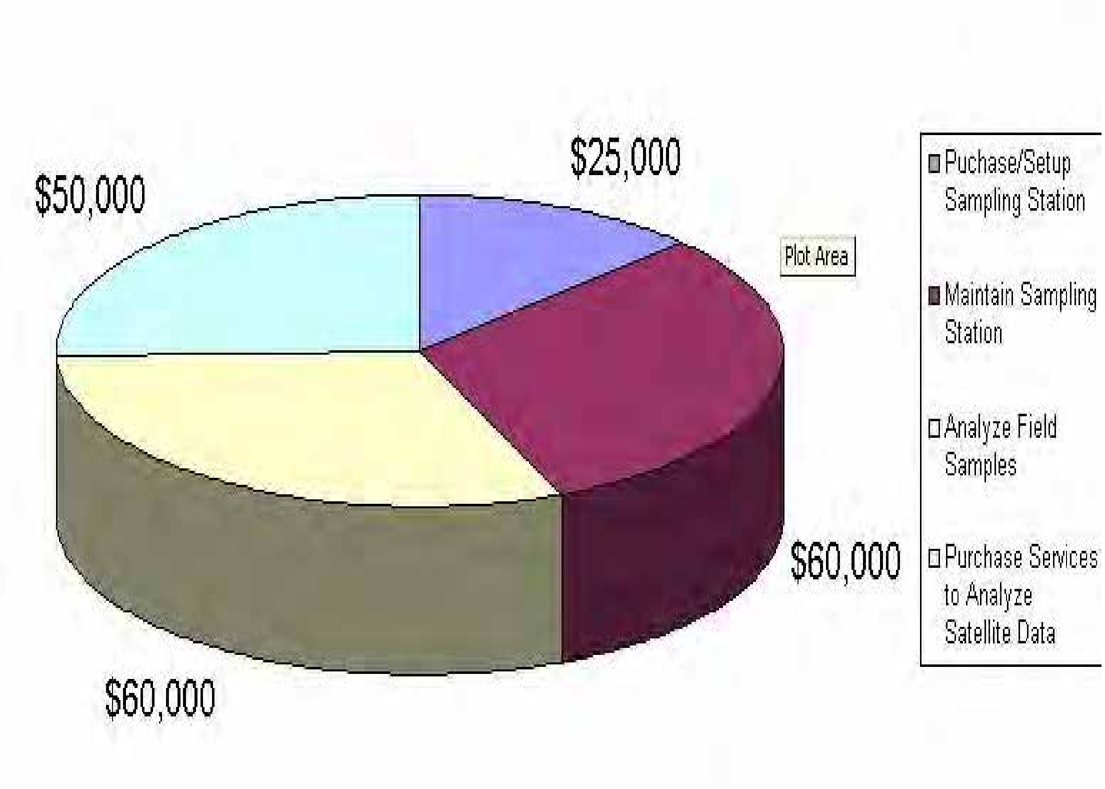


Figure 1.2. Typical Costs For Equipment and Services



1.3.4 Jefferson Parish EMPACT Project Objectives

Overall project objectives include the following:

- To provide the public with information on the physical and biological characteristics and components of Lake Salvador and adjacent regions as close to real time as possible.
- To gather baseline data in the Davis Pond Diversion outfall area to assist coastal scientists and managers in distinguishing the effects of river water from other stressors.
- To use the field data collected to investigate the satellite-derived parameters including water temperature, water reflectance (suspended solids) and chlororphyll *a* .
- To provide reliable data on water quality and phytoplankton blooms to the agencies and organizations involved with public health, fisheries, and habitat related issues.

1.3.5 Technology Transfer Handbook

The Technology Transfer and Support Division of the EPA's ORD National Risk Management Research Laboratory initiated development of this handbook to help interested communities learn more about the Jefferson Parish Project. The handbook also provides technical information communities need to develop and manage their own time-relevant water monitoring, data visualization, and information dissemination programs. ORD, working with the Jefferson Parish Project team, produced this handbook to leverage EMPACT's investment in the project and minimize the resources needed to implement similar projects in other communities.

Both print and CD-ROM versions of the handbook are available for direct on-line ordering from EPA's Office of Research and Development Technology Transfer Web site at http://www.epa.gov/ttbnrmrl. You can also order a copy of the handbook (print or CD-ROM version) by contacting ORD Publications by telephone or mail at:

EPA ORD Publications
US EPA-NCEPI
P.O. Box 42419
Cincinnati, OH 45242
Phone: (800) 490-9198 or (513) 489-8190

Note!

Please make sure you include the title of the handbook and the EPA document number in your request

We hope you find the handbook worthwhile, informative, and easy to use. We welcome your comments, and you can send them by e-mail from EMPACT's Web site at http://www.epa.gov/empact/comment.htm.

1.4 EMPACT Metropolitan Areas

Albany-Schenectady-Troy, NY
Albuquerque, NM
Allentown-Bethlehem-Easton, PA
Anchorage, AK
Appelton-Oshkosh-Neeha, WI
Atlanta, GA
Augusta-Aiken, GA-SC
Austin-San Marcos, TX
Bakersfield, CA
Baton Rouge, LA
Beaumont-Port Arthur, TX
Billings, MT
Biloxi-Gulfport-Pascagoula, MS
Binghamton, NY
Birmingham, AL
Boise City, ID
Boston-Worcester-Lawrence-MA-NH-ME-CT
Brownsville-Harlingen-San Benito, TX
Buffalo-Niagara Falls, NY
Burlington, VT
Canton-Massillon, OH
Charleston-North Charleston, SC

Charleston, WV
Charlotte-Gatsonia-Rock Hill, NC-SC
Chattanooga, TN-GA
Cheyenne, WY
Chicago-Gary-Kenosha, IL-IN-WI

Honolulu, HI
Houston-Galveston-Brazoria, TX
Huntington-Ahsland, WV-KY-OH
Huntsville, AL
Indianapolis, IN
Jackson, MS
Jacksonville, FL
Johnson City-Kingsport-Bristol, TN-VA
Johnston, PA
Kalamazoo-Battle Creek, MI
Kansas City, MO-KS
Killeen-Temple, TX
Knoxville, TN
Lafayette, LA
Lakeland-Winter Haven, FL
Lancaster, PA
Lansing- East Lansing, MI
Las Vegas, NV-AZ
Lexington, KY
Lincoln, NE
Little Rock-North Little Rock, AR
Los Angeles-Riverside-Orange County, CA
Louisville, KY-IN
Lubbock, TX
Macon, GA
Madison, WI
McAllen-Edinburg-Mission, TX
Melbourne-Titusville-Palm Bay, FL
Memphis, TN-AR-MS
Miami-Fort Lauderdale, FL
Milwaukee-Racine, WI
Minneapolis-St. Paul, MN-WI
Mobile, AL

Rochester, NY
Rockford, IL
Sacramento-Yolo, CA
Saginaw-Bay City-Midland, MI
St. Louis, MO-IL
Salinas, CA
Salt Lake City-Ogden, UT
San Antonio, TX
San Diego, CA
San Francisco-Oakland-San Jose, CA
San Juan-Caguas-Arecibo, PR
San Luis Obispo-Atascadero-Paso Robles, CA
Santa Barbara-Santa Maria-Lompoc, CA
Sarasota-Bradenton, FL
Savannah, GA
Scranton-Wilkes Barre-Hazleton, PA
Seattle-Tacoma-Bremerton, WA
Shreveport-Bossier City, LA
Sioux Falls, SD
South Bend, IN
Spokane, WA
Springfield, MA
Springfield, MO
Stockton-Lodi, CA
Syracuse, NY
Tallahassee, FL
Tampa-St. Petersburg-Clearwater, FL
Toledo, OH

Cincinnati-Hamilton, OH-KY-IN
Cleveland, Akron, OH
Colorado Springs, CO
Columbia, SC
Columbus, GA-AL
Columbus, OH
Corpus, Christie, TX
Dallas-Fort Worth, TX
Davenport-Moline-Rock Island, IA-IL
Dayton-Springfield, OH
Daytona Beach, FL
Denver-Boulder-Greeley, CO
Des Moines, IA
Detroit-Ann Arbor-Flint, MI
Duluth-Superior, MN-WI
El Paso, TX
Erie, PA
Eugene-Springfield, OR
Evansville-Henderson, IN-KY
Fargo-Moorhead, ND-MN
Fayetteville, NC
Fayetteville-Springfield-Rogers, AR
Fort Collins-Loveland, CO
Fort Myers-Cape Coral, FL
Fort Pierce-Port St. Lucie, FL
Fort Wayne, IN
Fresno, CA
Grand Rapids-Muskegon-Holland, MI
Greensboro-Winston-Salem-High Point, NC
Greenville-Spartanburg-Anderson, SC
Harrisburg-Lebanon-Carlisle, PA

Hartford, CT
Hickory-Morganton-Lenoir, NC
Modesto, CA
Montgomery, AL
Nashville, TN
New London-Norwich, CT-RI
New Orleans, LA
New York-Northern New Jersey-Long Island, NY-NJ-CT-PA
Norfolk-Virginia Beach-Newport News, VA-NC
Ocala, FL
Odessa-Midland, TX Oklahoma City, OK
Omaha, NE-IA
Orlando, FL
Pensacola, FL
Peoria-Pekin, IL
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD
Phoenix-Mesa, AZ
Pittsburgh, PA
Portland, ME
Portland-Salem, OR-WA
Providence-Fall River-Warwick, RI-MA
Provo-Orem, UT
Raleigh-Durham-Chapel Hill, NC
Reading, PA
Reno, NV
Richmond-Petersburg, VA
Roanoke, VA
Tucson, AZ
Tulsa, OK Visalia-Tulare-Porterville, CA
Utica-Rome, NY
Washington-Baltimore, DC-MD-VA-WV
West Palm Beach-Boca Raton, FL
Wichita, KS
York, PA
Youngstown-Warren, OH

In addition, federally recognized Native American Tribes - regardless of location in the United States - are eligible to apply.

NEXT CHAPTER

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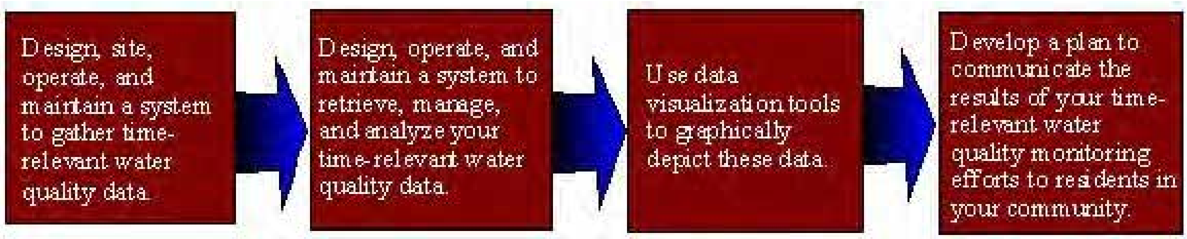
2. HOW TO USE THIS HANDBOOK

This handbook provides you with step-by-step information on how to develop a program to provide time-relevant water quality data to your community, using the Jefferson Parish Project in the New Orleans, Louisiana area as a model. It contains detailed guidance on how to:


Design, site, operate, and maintain a system to gather time-relevant water quality data
Design, operate, and maintain a system to retrieve, manage, and analyze your time-relevant water quality data
Use data visualization tools to graphically depict these data
Develop a plan to communicate the results of your time-relevant water quality monitoring efforts to residents in your community.

- Chapter 3 provides information about water quality monitoring - the first step in the process of generating time-relevant information about water quality and making it available to residents in your area. The chapter begins with an overview of water quality monitoring in estuariane systems and then focuses on the three monitoring components that are part of the Jefferson Parish Project: (1) collection of time-series physical and biological measurements at a fixed location in Lake Salvador; (2) satellite/remote sensing technology; and (3) water quality field sampling. The chapter also provides instructions on how to install, operate, and maintain the time-series sampling system, how to obtain satellite data and use these data for water quality monitoring, and how to set up the field sampling program.

- Chapter 4 provides step-by-step instructions on how to collect, transfer, and manage time-relevant water quality data. This chapter discusses time-series sampling equipment calibration, transferring sampling data to the base station, managing sampling data at the base station, and checking sampling data for quality. This chapter also provides detailed information on satellite data acquisition, processing, interpretation, ground-truthing, and data transfer and management. In addition, this chapter presents details on water quality field sampling including details on sampling, water quality parameter analyses, phytoplankton speciation, and data transfer and management.

- Chapter 5 provides information about using data visualization tools to graphically depict the time-relevant water quality data you have gathered. The chapter begins with a brief overview of data visualization. It then provides a more detailed introduction to selected data visualization tools utilized by the Jefferson Parish team. You might want to use these software tools to help analyze your data and in your efforts to provide time-relevant water quality information to your community.

- Chapter 6 outlines the steps involved in developing an outreach plan to communicate information about water quality in your community. It also provides information about the Jefferson Parish Project's outreach efforts. The chapter includes a list of resources to help you develop easily understandable materials to communicate information about your time-relevant water quality monitoring program to a variety of audiences.

This handbook is designed for decision-makers considering whether to implement a time-relevant water quality monitoring program in their communities and for technicians responsible for implementing these programs. Managers and decision-makers likely will find the initial sections of Chapters 3, 4, and 5 most helpful. The latter sections of these chapters are targeted primarily at professionals and technicians and provide detailed "how to" information. Chapter 6 is designed for managers and communication specialists.

The handbook also refers you to supplementary sources of information, such as Web sites and guidance documents, where you can find additional guidance with a greater level of technical detail. The handbook also describes some of the lessons learned by the Jefferson Parish team in developing and implementing its time-relevant water quality monitoring, data management, and outreach program.

NEXT CHAPTER

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3.1 | 3.2 | 3.3

3. WATER QUALITY MONITORING

This chapter provides information about water quality monitoring - the first step in the process of generating time-relevant information about water quality and making it available to residents in your area.

The chapter begins with a broad overview of water quality monitoring and then focuses on the three monitoring components that are part of the Jefferson Parish Project: (1) time-series water quality sampling (Section 3.1); (2) satellite/remote sensing technology (Section 3.2); and (3) water quality field sampling (Section 3.3). The chapter also provides instructions on how to install, operate, and maintain the sampling equipment, how to obtain satellite data and use these data for water quality monitoring, and how to set up the field sampling program.

Readers primarily interested in an overview of water quality monitoring might want to focus on information presented in this introductory section and the introductory parts of Sections 3.1, 3.2, and 3.3. If you are responsible for the actual design and implementation of a water quality sampling project, you should review Subsections 3.1.1 through 3.1.8. They provide an introduction to the specific steps involved in developing and operating a time-relevant water quality monitoring project and information on where to find additional guidance. If you are responsible for the designing and implementing a water quality monitoring program using satellite/remote sensing technology, you should review Subsections 3.2.1 through 3.2.2. They provide information on available satellite data and information on how to use satellite data for water quality monitoring. If you are responsible for the actual design and implementation of a water quality field sampling project, you should review Subsections 3.3.1 through 3.3.2. They provide information on setting up a field sampling program.

Water Quality Monitoring: An Overview

Water quality monitoring provides information about the condition of streams, lakes, ponds, estuaries, and coastal waters. It can also tell us if these waters are safe for swimming, fishing, or drinking. The Web site of the EPA Office of Water (http://www.epa.gov/owow/monitoring) is a good source of background information on water quality monitoring. (The information presented in the following paragraphs, which is taken from the Lake Access - Minneapolis EMPACT Manual - EPA/625/R-00/012, is summarized from the Web site listed above.)

Water quality monitoring can consist of the following types of measurements:

- Chemical measurements of constituents such as dissolved oxygen, nutrients, metals, and oils in water, sediment, or fish tissue.
- *Physical* measurements of general conditions such as temperature, conductivity/salinity, current speed/direction, water level, water clarity.
- *Biological* measurements of the abundance, variety, and growth rates of aquatic plant and animal life in a water body or the ability of aquatic organisms to survive in a water sample.

You can conduct several kinds of the following water quality monitoring projects:

- At fixed locations on a continuous basis
- At selected locations on an as-needed basis or to answer specific questions
- On a temporary or seasonal basis (such as during the summer at swimming beaches)
- On an emergency basis (such as after a spill)

Many agencies and organizations conduct water quality monitoring, including state pollution control agencies, Indian tribes, city and county environmental offices, the EPA and other federal agencies, and private entities, such as universities, watershed organizations, environmental groups, and industries. Volunteer monitors - private citizens who voluntarily collect and analyze water quality samples, conduct visual assessments of physical conditions, and measure the biological health of waters - also provide increasingly important water quality information. The EPA provides specific information about volunteer monitoring at http://www.epa.gov/owow/monitoring/vol.html.

Water quality monitoring is conducted for many reasons, including:

- Characterizing waters and identifying trends or changes in water quality over time.
- Identifying existing or emerging water quality problems.
- Gathering information for the design of pollution prevention or restoration programs.
- Determining if the goals of specific programs (such as river diversions) are being met.
- Complying with local, state, and Federal regulations.
- Responding to emergencies such as spills or floods.

EPA helps administer grants for water quality monitoring projects and provides technical guidance on how to monitor and report monitoring results. You can find a number of EPA's water quality monitoring technical guidance documents on the Web at: http://www.epa.gov/owow/monitoring/techmon.html.

In addition to the EPA resources listed above, you can obtain information about lake and reservoir water quality monitoring from the North American Lake Management Society (NALMS). NALMS has published many technical documents, including a guidance manual entitled *Monitoring Lake and Reservoir Restoration*. For more information, visit the NALMS Web site at http://www.nalms.org. State and local agencies also publish and recommend documents to help organizations and communities conduct and understand water quality monitoring. For example, the Gulf of Mexico Program maintains a Web site (http://www.gmpo.gov/mmrc/mmrc.html) that lists resources for water quality monitoring and management. State and local organizations in your community might maintain similar listings. The Louisiana State University's Coastal Studies Institute Web site also maintains a list of links for water quality information and resources at http://www.csi.lsu.edu/.

In some cases, special water quality monitoring methods, such as remote monitoring, or special types of water quality data, such as time-relevant data, are needed to meet a water quality monitoring program's objectives. *Time-relevant* environmental data are collected and communicated to the public in a time frame that is useful to their day-to-day decision-making about their health and the environment, and relevant to the temporal variability of the parameter measured. Monitoring is called *remote* when the operator can collect and analyze data from a site other than the monitoring location itself.

3.1 Time-Series Water Quality Sampling

The Jefferson Parish Project provides much needed baseline data on nutrient and chlorophyll levels in the upper Barataria basin. Evaluation of historical data sets indicate a lack of comprehensive water quality data especially in relation to chlorophyll data. It also provides the only data from the Davis Pond Freshwater Diversion outfall that is near-real time and easily assessable to the public via the world wide Web. Diversions, and the possibility of diversion-related algal blooms, are a major concern to communities in the New Orleans area, as is the growing dead zone in the Gulf of Mexico. Using time-relevant monitoring of lake water quality for the early detection of an algal bloom is a useful tool in providing timely environmental information to natural resource and human health protection agencies in Louisiana.

The Jefferson Parish Project team conducts time-relevant monitoring at one location in Lake Salvador. At this location, the project team operates a sampling platform, which performs time-series water quality monitoring using commercially available monitoring sensors. The sensors transmit time-relevant water quality data to a data acquisition system contained on the platform.

Using wireless communication, the sampling system can both receive programming and transmit data to a land-base station.

The time-series sampling system is installed on an existing oil pumping platform. The data collection platform contains batteries; solar panels; telemetry equipment; a data acquisition system (Handar 555A); and a sensor package. The specially designed field computer provides a suite of water quality parameters from the water below the platform. The sensor package, produced by Yellow Springs Instruments© (YSI©), has multisensor probes that can be customized to meet virtually any sensor needs. The sensor package, connected to the data acquisition system, collects data from 4 feet below the water surface at preprogrammed times.

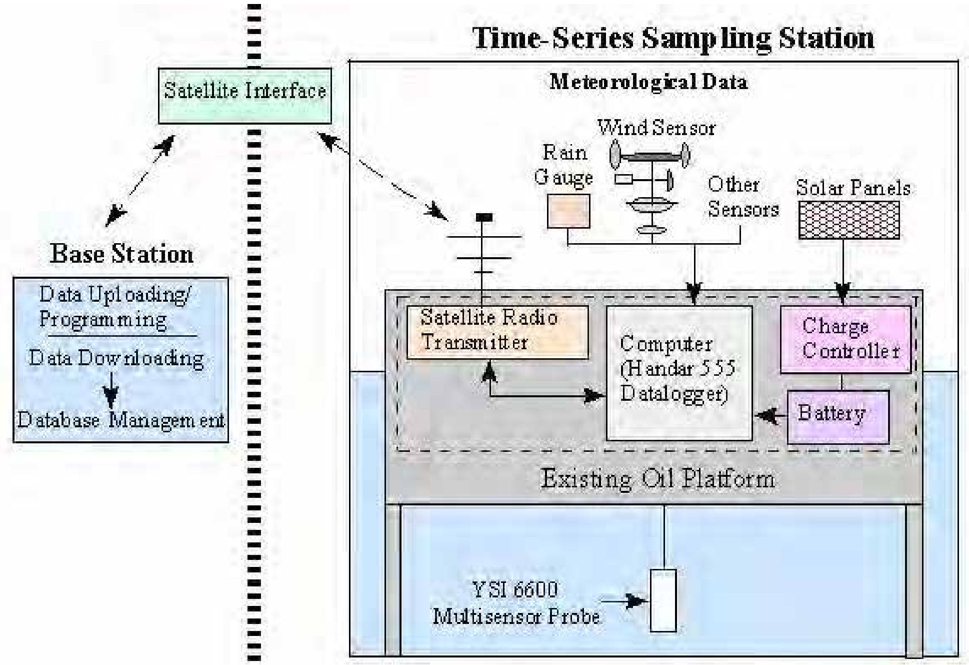
Each hour, the time-series sampling system unit equipped with a multiprobe water quality sensor manufactured by YSI© collects water quality data. The system measures the following parameters:

- Water level
- Precipitation
- Air temperature
- Water temperature
- Wind speed/direction
- Specific conductance/Salinity
- pH
- Dissolved oxygen
- Backscattter/Turbidity
- Chlorophyll *a*

The Jefferson Parish Project team uses a land-base station to communicate with the sampling station via satellite interface. Time-relevant data are remotely downloaded from the station daily. Figure 3.1 illustrates some of the basic sampling station components and shows how the sampling system communicates with the land-base station.

The remainder of this chapter highlights the Jefferson Parish Project. The following subsection provides some background information on river diversion impacts and estuarine ecology and it introduces some important concepts relevant to the study of these topics.

Figure 3.1. Diagram of Basic Sampling Station Components



3.1.1 Designing a Time-Relevant Water Quality Monitoring Project

The first step in developing a water quality monitoring project is to define your objectives. Keep in mind that time-relevant monitoring might not be

the best method for your organization or community. For example, you would not likely need time-relevant monitoring capability to conduct monthly monitoring to comply with a state or federal regulation.

In order to clearly define the objectives of your particular water quality monitoring project, you need to understand the system you are planning to monitor. This means that you need to collect background information about the aquatic system, such as natural occurring processes, system interactions, system ecology, and human impacts on the system.

Since this particular monitoring project involves estuarine ecology and possible impacts of freshwater diversion into estuaries, the following text boxes provides some basic background information about these topics.

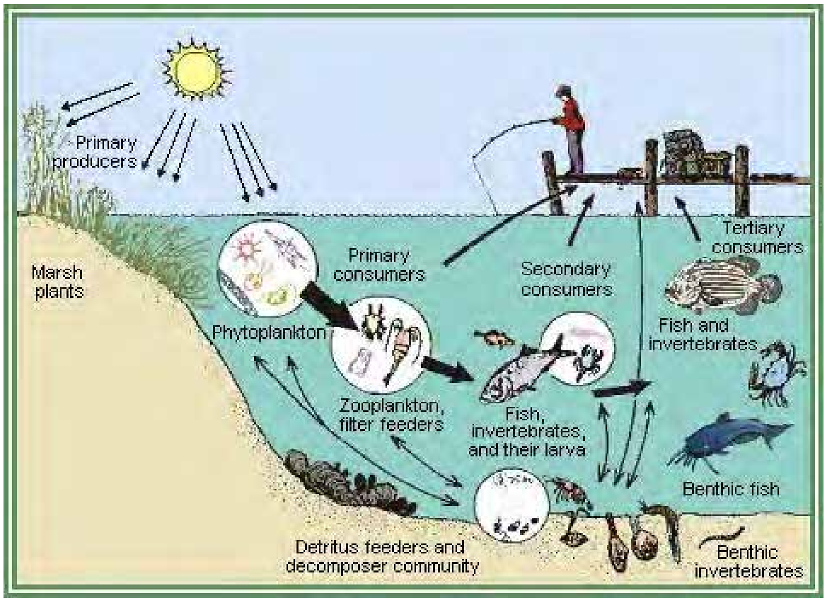
Estuarine Ecology

Estuaries are bodies of water that are balanced by freshwater and sediment influx from rivers and the tidal actions of the oceans, thus providing transition zones between the freshwater of a river and the saline environment of the sea. The result of this interaction is an environment where estuaries, along with their adjacent marshes and seagrasses, provide a highly productive ecosystem, that supports wildlife and fisheries and contributes substantially to the economy of coastal areas. As spawning, nursery, and feeding grounds, estuaries are invaluable to fish and shellfish. Estuarine-dependent species constitute more than 95 percent of the commercial fishery harvests from the Gulf of Mexico, and many important recreational fishery species depend on estuaries during some part of their life cycle. Estuaries are diverse and productive ecosystems that provide a variety of valuable resources, including fish and shellfish, recreation, transportation, and petroleum and minerals.

Estuaries and wetland environments are intertwined. Coastal emergent wetlands border estuaries and the coast and include tidal saltwater and freshwater marshes. Coastal wetlands serve as essential habitat for a diverse range of species. These wetlands are used by shorebirds, migratory waterfowl, fish, invertebrates, reptiles, and mammals. Migrating waterfowl and migratory birds utilize these coastal habitats. Mudflats, salt marshes, mangrove swamps, and barrier island habitats also provide year-round nesting and feeding grounds for abundant populations of gulls, terns, and other shorebirds. Estuaries, marshes and associated watersheds provide habitat for many threatened and endangered species. Estuaries and wetlands support complex food webs that provide an abundant food source for juvenile and adult fishes (see Figure 3.2 below). In addition to providing habitat, wetlands also improve water quality by filtering pollutants and sediment and offer a buffer zone to protect upland areas from flooding and erosion.

Figure 3.2. Conceptual diagram of the food web in estuarine ecosystems

[Source: http://www.epa.gov/ged/gulf.htm].



There are usually three overlapping zones in an estuary: an open connection with the sea where marine water dominates, a middle area where salt water and fresh water mix, and a tidal river zone where fresh water dominates. Tidal forces cause the estuarine characteristics to vary. Also variation in the seasonal discharge of rivers causes the limits of the zones to shift, thus increasing the overall ecological complexity of the estuaries. [Source: http://encarta.msn.com/find/Concise.asp?z=1&pg=2&ti=761570978#s1]

Most of the world's freshwater runoff encounters the oceans in estuaries. Tides or winds help mix the lighter, less dense fresh water from the rivers with the salt water from the ocean to form brackish water. The salinity of brackish water is typically 2 to 10 parts per thousand (ppt), while the salinity of salt water is about 35 ppt. Due mostly to changes in the river flow, the three main estuarine zones - saltwater, brackish, and freshwater - can shift seasonally and vary significantly from one area to another. [Source: http://encarta.msn.com/find/Concise.asp?z=1&pg=2&ti=761570978#s1]

The chemical components of fresh (or river) water can vary greatly and produce significant differences in estuarine nutrient cycles. Typically, the most important compounds for estuarine life that are supplied by river water are nitrogen, phosphorus, silicon, and iron. Seawater, which has fairly uniform chemical components, provides sulfate and bicarbonate. With adequate nutrients and light conditions, estuaries enable the production of phytoplankton which provides the basis for some of the most productive habitats on earth. [Source: http://encarta.msn.com/find/Concise. asp?z=1&pg=2&ti=761570978#s1]

River Diversion Impacts

Leveeing of the rivers for flood control has impacted the estuarine ecology by blocking the rivers' historic spring overflows and thus impeding the rush of marsh-supporting fresh water, nutrients, and sediment to the coastal zone. This resulted in wetland loss along coastal zones and causes pressing environmental problems.

Diversion of freshwater and sediments from rivers is expected to conserve and restore coastal wetlands, but citizens are concerned about the impact that nutrient rich river water may have on water quality and growths (blooms) of phytoplankton. The freshwater diversions imitate historic spring floods by providing a controlled flow of freshwater and nutrients into estuaries. It is expected that this diversion will restore former ecological conditions by combating land loss, enhancing vegetation and improving fish and wildlife habitat.

However, there are concerns that the freshwater diversion may have a negative impact on estuaries. Commercial fishermen are concerned that massive amounts of river water may deteriorate the water quality in the lakes and bays where they make their living. Communities downstream of diversion sites are concerned that water levels will increase and cause flooding during high wind driven tides. Scientists debate the wisdom of introducing more nutrients into already eutrophic systems. Stakeholders are also interested in the changes that will occur as salinity levels are altered in the upper estuaries.

Diverting too much nutrients into estuaries, leads to excessive algae growth and eventually oxygen depletion. In many cases, fish kills are evidence of oxygen depleted water in the estuary. Sewage and other organic wastes that are discharged into rivers and estuaries can overload estuaries with nutrients. These conditions can contribute to the loss of animal and plant life, the decrease of a buffer zone from storm surges, salt water intrusion, and ultimately the decline of the estuary and loss of wetland. [Source: http://encarta.msn.com/find/Concise.asp?z=1&pg=2&ti=761570978#s1]

River water diversions from previously leveed rivers into estuaries have shown three potential impacts: (1) they may increase the water level in the estuary; (2) they may increase nutrient and sediment input into the estuary; and (3) they may decrease the salinity in the estuary. Figure 3.3 shows the possible beneficial and negative impacts of river water diversions.

Designing the Jefferson Parish Project

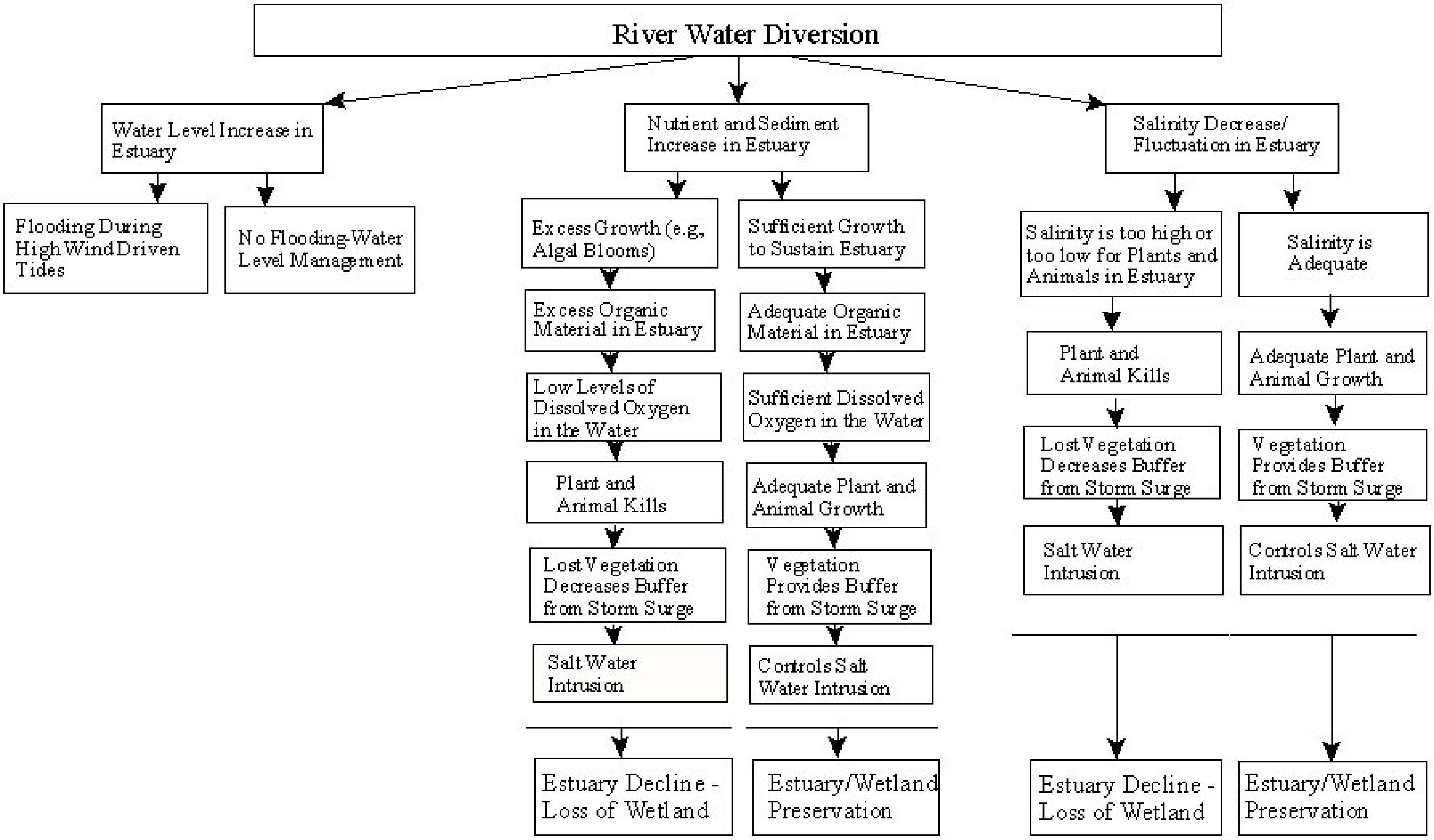
The Jefferson Parish Project team's decision to collect time-relevant water quality data was in response to the public's repeated request for publicly available real time water quality data. Wetland loss and decline of the estuarine ecosystem raised an interest to learn more about impacts of river water diversions from previously leveed rivers into estuaries. The project team determined that pre-and post diversion water quality data have to be collected in order to make assessments of river water diversion impacts.

The project team decided to conduct time-relevant monitoring of lake water quality to be able to detect algal blooms early and to provide timely environmental information to natural resource and human health protection agencies. Having time-relevant data allows entities to respond quickly to adverse environmental conditions, make appropriate decisions to ensure economic and environmental sustainability of the affected environment, and protect the health of commercial and recreational users.

3.1.2 Selecting Your Sampling Frequency

The sampling frequency you select for your time-relevant water quality monitoring project depends on your project's objectives. For example:

Figure 3.3. Possible Beneficial and Negative Impacts of River Water Diversion


River Water Diversion
Water Level Increase in Estuary
Nutrient and Sediment Increase in Estuary
Salinity Decrease/ Fluctuation in Estuary
Flooding During High Wind Driven Tides
No Flooding-Water Level Management
Excess Growth (e.g, Algal Blooms)
Sufficient Growth to Sustain Estuary
Excess Organic Material in Estuary
Adequate Organic Material in Estuary
Low Levels of Dissolved Oxygen in the Water
Sufficient Dissolved Oxygen in the Water
Plant and Animal Kills
Adequate Plant and Animal Growth
Lost Vegetation Decreases Buffer from Storm Surge
Vegetation Provides Buffer from Storm Surge
Salt Water Intrusion
Controls Salt Water Intrusion
Estuary Decline - Loss of Wetland
Estuary/Wetland Preservation
Salinity is too high or too low for Plants and Animals in Estuary
Salinity is Adequate
Plant and Animal Kills
Adequate Plant and Animal Growth
Lost Vegetation Decreases Buffer from Storm Surge
Vegetation Provides Buffer from Storm Surge
Salt Water Intrusion
Controls Salt Water Intrusion
Estuary Decline - Loss of Wetland
Estuary/Wetland Preservation

- If you want to identify existing or emerging water quality problems such as algal blooms, you could tailor your monitoring frequency to collect data often enough to determine problems early to take measures to alleviate the problem and warn the public.
- If you want to study seasonal water quality problems, you may want to increase your monitoring frequency during seasons when water quality problems are more predominant (i.e., low dissolved oxygen levels and associated fish kills during summer months).

It is appropriate to experiment with different monitoring frequencies to optimize your ability to fulfill your project's objectives.

Jefferson Parish Project Monitoring Frequency

The Jefferson Parish Project team programed its time-series sampling system to collect water quality samples every hour. This monitoring frequency allows the team members to see short-term changes in water quality and allows them to detect problems early to respond quickly to adverse environmental conditions, make appropriate decisions to ensure economic and environmental sustainability of the affected environment, and protect the health of commercial and recreational users.

The data from the monitoring station in Lake Salvador are used to assess average conditions and variations from these average conditions. Ancillary measurement, including but not limited to river discharge/stage, are obtained to aid in the determination of the cause of the variability revealed by the time-series data. Previous studies in shallow estuarine systems of coastal Louisiana have shown that the physical and ecological variability is closely related to changes in wind speed/direction and river discharge.

3.1.3 Selecting Water Quality Parameters for Monitoring

The time-relevant monitoring parameters that you select depend on your project's objectives and the time-relevant technologies available to you. The Jefferson Parish project team chose to monitor the following eleven water quality parameters on a time-relevant basis to fulfill the project's objectives: water level, precipitation, air temperature, water temperature, wind speed/direction, specific conductance/salinity, pH, dissolved oxygen, reflectance/turbidity, and chlorophyll *a*.

The Jefferson Parish Project team uses time-relevant measurements of the above listed parameters as indicators for the health of the ecosystem (early detection of algal blooms, seagrass die-offs, and fish kills) and to monitor impacts of freshwater diversions.

Harmful Algal Blooms

Microscopic, single-celled plants (phytoplankton) serve as the primary producers of energy at the base of the estuarine food web. Some species of phytoplankton grow very fast, or "bloom," and accumulate into dense, visible patches near the surface of the water. Although the causes of algal blooms are not entirely known, scientists suspect that blooms occur as a result of a combination of high temperatures, a lack of wind, and, frequently, nutrient enrichment. Some algal blooms are called brown tides, and, while not harmful to humans, they cause serious ecosystem impacts due to decreases in light penetration and dissolved oxygen. Brown tides can cause seagrass die-offs and fish kills. Some algae produce potent neurotoxins that can be transferred through the food web, where they cause damage, even death, to organisms from zooplankton to humans.

The most well-known harmful algal bloom (HAB) events in the Gulf of Mexico involve blooms of *Gymnodinium breve* (also known as red tides). This organism discolors the water red (although other less harmful algae can also discolor the water red) and has been implicated in fish kills and the deaths of manatee and other marine mammals. *G. breve* produces brevetoxins that cause Neurotoxic Shellfish Poisoning (NSP). NSP induces gastrointestinal and neurological symptoms in humans that, although debilitating, are not fatal. In addition, toxic aerosols are formed by wave action and can produce asthma-like symptoms in humans. This often leads to beach closures [Source: http://www.epa.gov/ged/gulf.htm].

Jefferson Parish Time-Relevant Water Quality Monitoring Parameters

Water Level. The water level is monitored to ensure that freshwater diversions do not create or add to any local flooding problems. Early warning of an increased water level allows diversion managers to make appropriate decisions to minimize the introduction of more water when flooding is likely.

Precipitation. Precipitation is monitored because it affects the water level in the estuary. Increased water level may lead to flooding, which adversely impacts coastal communities. Both, the lack or excess, of precipitation can adversely affect vegetation and animal life and stress the ecosystem. In addition, precipitation increases urban runoff, which increases nutrient loads, decreases salinity, and influences dissolved oxygen levels in the estuary.

Air Temperature. Air temperature affects the water temperature and thus air temperature monitoring can be used to predict water temperature trends. Air temperature has a direct effect on biological activity and the growth of terrestrial organisms and vegetation. Extremely high or low air temperatures for extended periods of time can adversely affect vegetation and animal life and stress the ecosystem.

Water Temperature. Water temperature affects metabolic rates and thus has a direct effect on biological activity and the growth of aquatic animal life and aquatic vegetation. Generally, high temperatures (up to a certain limit) increase biological activity and growth, while low temperatures decrease biological activity and growth. For example, high temperatures in nutrient rich environments promote algal growth and may lead to algal blooms. Temperature also affects biological activity by influencing lake water chemistry, such as the oxygen content of the water. Warm water contains less dissolved oxygen than cold water. Low dissolved oxygen levels in the water might not be sufficient to support some types of aquatic life.

Wind speed/direction. Wind speed/direction is important for water mixing. High wind speeds promote mixing of water layers, whereas low wind speeds promote stratification of the water layers. Mixing of bottom and surface water creates relatively uniform temperature, dissolved oxygen, salinity, and reflectance/turbidity profiles. Algal blooms are less likely to occur at high wind speeds because higher turbidity in the surface water layer reduces light penetration and aquatic plant growth. In addition, wind speed and direction influence salinity and water levels through wind-driven tides. For example, a strong southerly wind can increase the water level in the project area by as much as 12 inches. Salinity levels in the project area also increase during periods with strong southernly wind.

Specific Conductance/Salinity or electrical conductivity. Electrical conductivity/salinity is an estimator of the amount of total dissolved salts or total dissolved ions in water. Many factors influence the electrical conductivity/salinity of lake water, including the watershed's geology, the watershed's size, wastewater from point sources, runoff from nonpoint sources, atmospheric inputs, evaporation rates, precipitation, fresh water diversion from rivers, tidal surges, and some types of bacterial metabolism. Electrical conductivity/salinity is also a function of temperature; therefore, time-series data are standardized to 25°C. High amounts of precipitation and fresh water diversion from rivers decreases electrical conductivity/salinity, while tidal surges increase electrical conductivity/salinity in the estuary. Estuaries are characterized by gradients in salinity from near fresh water at the mouths of the tributaries to near marine at the mouth of the estuary. Estuaries in the Gulf of Mexico are predominantly polyhaline (salinity more than 18 ppt) during the summer months. Electrical conductivity/salinity affects the distribution and health of benthic animals, fish, and vegetation. Both, excessively high or low salinities, can negatively impact the estuarine ecosystem.

pH. pH is a measure of the hydrogen ion concentration in the water. A pH of 7 is considered neutral. Values lower than 7 are considered acidic and higher than 7 are basic. Many important chemical and biological reactions are strongly affected by pH. In turn, chemical reactions and biological processes (e.g., photosynthesis and respiration) can affect pH. Lower pH values can increase the amount of dissolved metals in the water,

Dissolved Oxygen. Dissolved oxygen (DO) is an indicator of the habitability of estuarine waters for marine life and it is routinely measured by monitoring programs interested in characterizing the eutrophic state ofestuaries. DO is recognized as an indicator of the extent of eutrophication because wide fluctuations in DO often result from increased primary productivity and may reflect prior nutrient loading. DO concentrations may also vary because of natural processes, such as stratification, depth, wind-induced mixing, and tidal fluxes. DO is necessary for respiration in most aquatic animals but different biota have different requirements for adequate DO. Hypoxia (condition where DO is less than 2 mg/L) increases stress from other factors (e.g., contaminants) on marine organisms, whereas anoxic conditions (DO < 0.1 mg/L) produce toxic hydrogen sulfide which can be lethal to marine biota. Many states require DO concentrations of 4-5 mg/L for estuaries to meet their designated use criteria. Sufficient evidence exists that DO < 2 mg/L is extremely stressful to most aquatic organisms. Low DO is usually observed from June through October and is primarily driven by stratification of the water column [Source: http://www.epa.gov/ged/gulf.htm]. Additional information about hypoxia can also be found on the following USGS Web site: http://wwwrcolka.cr.usgs.gov/midconherb/hypoxia.html .

Turbidity. Turbidity (or backscatter) describes the clarity of the water. Turbidity is a measurement of the amounts of total suspended solids in the water. The particles that make up the turbidity can range from mineral matter to organics. In combination with the chlorophyll measurements, it can be determined if mineral matter or organics dominate. Predominant orgaincs can be an indication of an algal bloom, which could mean that algae below the zone of light penetration are decaying and consuming oxygen, which in turn, can result in hypoxia that effects bottom dwelling organisms. Measurements of turbidity and backscatter are interrelated in that water with high turbidity measurements also yields high reflectance measurements. This is the case because the more particles are present, the more light can be scattered back to the sensor. Increased turbidity measurements might have several adverse effects on water quality, including the following:

- Turbidity reduces light penetration, which deceases the growth of aquatic plants and organisms. The reduced plant growth reduces photosynthesis, which results in decreased daytime releases of oxygen in the water.
- Suspended particles eventually settle to the bottom, suffocating eggs and/or newly hatched larva, and occupy potential areas of habitat for aquatic organisms.
- Turbidity can also negatively impact fish populations by reducing the ability of predators to locate prey - shifting fish populations to species that feed at the lake or ocean bottom.
- Fine particulate material can affect aquatic organisms by clogging or damaging their sensitive gill structures, decreasing their resistance to disease, preventing proper egg and larval development, and potentially interfering with particle feeding activities.
- Increased inputs of organic particles deplete oxygen as the organic particles decompose.
- Increased turbidity raises the cost of treating surface water for the drinking water supply.

Chlorophyll *a*. Nutrient loading is just one indicator of the potential that an estuary has to become eutrophic. Chlorophyll *a* can be an indicator of the first level response to nutrient enrichment. Measurements of chlorophyll *a* (via fluorescence) in the water column represent the standing stock or biomass of phytoplankton. Blooms of phytoplankton often indicate that an estuary is undergoing eutrophication. In some estuaries, there is a good correlation between nitrogen loadings from various sources and concentrations of chlorophyll *a*. In other estuaries, however, the relationship does not hold and it is possible, in fact, for an estuary to receive heavy loads of nitrogen and yet not exhibit increases in phytoplankton biomass. Other factors such as light limitation, depth of the mixing zone, flushing rates, and contaminants may affect the growth of phytoplankton.

3.1.4 Selecting Monitoring Equipment

The time-relevant water quality monitoring equipment that you select depend on your project's objectives. When you select your monitoring equipment, you should carefully consider ease of use, equipment lifetime, reliability, and maintenance requirements. You also might consider to use equipment that has been used successfully for similar types of projects.

Jefferson Parish Equipment Components

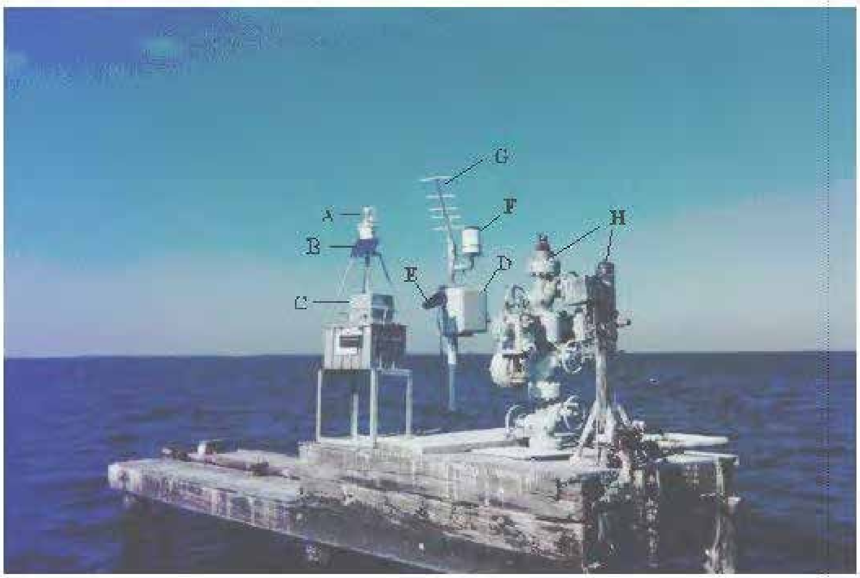
The sampling system consists of a platform; data acquisition system (computer system); a battery; a solar panel; telemetry equipment; and a sensor package. The computer system allows for remote programming, data acquisition, and data retrieval. Information about the equipment components listed below was obtained from User's Manuals available from the Handar (now Vaisala Inc.) Web site at http://www.vaisala.com and from the Yellow Springs Instruments, Inc. (YSI) Web site at http://www.ysi.com. Even though the Jefferson Parish project team uses Handar and YSI instrumentation, other manufactures provide similar equipment. For example, satellite transmitters are also produced by Sutron (http://www.sutron.com) and sensor equipment is also supplied by Hydrolab (http://www.hydrolab.com).

Platform. The platform, which provides the structure for the sampling system, is an existing oil pumping platform in Lake Salvador. A picture of the platform with the sampling system is shown in Figure 3.4. For safety reasons, the platform is equipped with a light that is connected to a battery, which gets charged by a solar panel. The floor of the platform has metal grating to which the equipment on the platform is secured. The grating also allows the Jefferson Parish team members to walk on the platform and access the equipment.

Data Acquisition System (DAS). The Handar Model 555A is a programable DAS that controls the sensors, data storage, telemetry, and data transmission. The 555 software governs all aspects of the DAS operation, which includes reading the sensors, analyzing and processing the data, storage and telemetry. The user creates its own unique program using an MS-DOS compatible computer by selecting commands and sensor parameters from pull down menus. The program is then stored in the nonvolatile memory of the DAS. The unit contains a data acquisition board, serial bus, and power supply enclosed in a corrosion-resistant fiberglass resin case. The Handar 555 unit enables the user to:

- Collect, process, and store data at user-specified intervals.
- Transmit data to the land-base station via wireless communication.
- Program the unit from the land-base station.
- Operate the unit in the field with a portable computer.

Figure 3.4. Picture of the sampling system platform taken during the January 9, 2001 site visit.



The structure on the left of picture is the light (A) below which you see the solar panel (B) and the box containing the battery (C). The structure to the right of the light is the fiberglass case (D) containing the DAS, the satellite radio transmitter, and the battery. The solar panel for the sampling system (E) is to the left of the DAS case. Above the DAS case is the rain gauge (F)and the satellite transmission antenna (G). The wind speed/direction sensor, which is usually mounted above the DAS case, is not shown in the picture because it was damaged prior to the site visit and was in the process of being replaced. The right of the pictures shows pipes and structures (H) of the oil platform, which are not part of the sampling system.

Battery and Solar Panel. The Handar 555A DAS model has an internal lead-acid gel cell battery. This battery is sealed and rechargeable with a solar panel assembly. A variety of solar panels may be used for recharging the battery as long as the charging current is regulated not to exceed 0.3 A. Higher charging currents can damage the battery and even cause a hydrogen gas explosion.

Telemetry Equipment. The Handar Serial Bus allows the data acquisition board to communicate with the communications devices and the Programming Set. A variety of communications options are available for telemetry, including communication via telephone systems, radio, or satellite.

The Jefferson Parish project team uses a satellite radio transmitter for communications via GOES. The GOES are satellites operated by the National Environmental Satellite, Data and Information Service (NESDIS) of NOAA. The GOES Satellite Radio Module consists of a 10-watt transmitter that can be set to any of the allowable 199 domestic GOES and 33 international channels assigned by NESDIS. The normal configuration of GOES consists of the GOES East satellite stationed 21,700 miles above the equator at 75 degrees west longitude and the GOES West satellite is at 135 degrees west longitude.

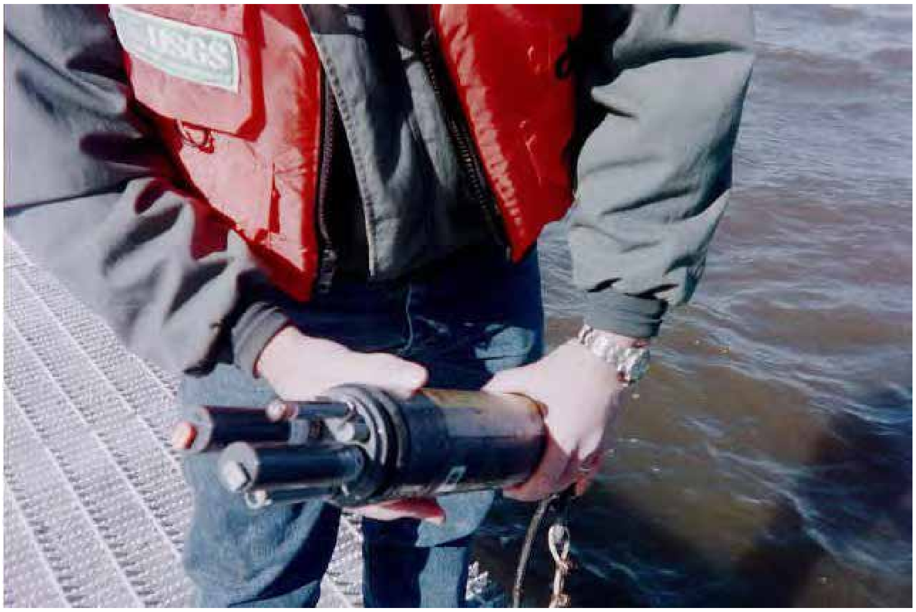
Data are transmitted by the data acquisition system on an assigned ultra high frequency (UHF)-band frequency in the direction of the GOES. The GOES repeats the message in the S-band, which is received at the NESDIS ground station at Wallops Island, Virginia. The data are then re-broadcast to the DOMSAT satellite, which is a low orbiting communications satellite, and then retrieved on an eight-foot dish at the USGS office in Baton Rouge.

Sensor Package. The sensor package, YSI 6600, has multisensor probes to measure the various water quality parameters. A picture of the sensor package and probes is shown in Figure 3.5 below. The YSI 6600 is controlled by the Handar 555 unit. The sensors collect water quality and water level data beneath the platform. A special cable transmits power and protocols from the Handar 555 unit to the sensors and transmits data from the sensors to the Handar 555 unit.

Jefferson Parish Equipment Selection

When selecting the water quality sampling equipment, the Jefferson Parish project team worked with their local USGS office in Baton Rouge to find out which equipment they use. The USGS district office in Baton Rouge already maintains and services a number of water quality sampling stations in that area and has extensive experience with the monitoring equipment used. Since the Jefferson Parish team contracted USGS to operate and maintain their time-series sampling unit, they wanted to use the same equipment the Baton Rouge USGS office is using for their other projects to facilitate the process and reduce costs. Since other USGS offices may be using different water quality monitoring equipment than the Baton Rouge office, you should contact your local USGS office and find out which equipment they use, if you are contracting USGS to operate and maintain your time-series sampling unit. The Jefferson Parish Project team selected the Handar 555A DAS with the YSI 6600 sensor package to collect time-relevant water quality data. This capability has provided the Jefferson Parish Project team with new opportunities for data collection and analysis and helps the project team to meet its objectives as described below:

Figure 3.5. Picture of the YSI 6600 sensor package with multisensor probes taken during the January 9, 2001 site visit.



- Multiple water quality parameters can be collected simultaneously.
- On demand water quality sampling can be conducted during significant environmental events or when humans are physically unable to test on-site.
- Multiple data points may be collected and received daily making water quality testing a more efficient and economical process.
- The frequent collection of water quality data enables personnel to provide timely environmental information to the community and natural resources and human health protection agencies.

The Jefferson Parish Project team also selected the time-series monitoring equipment for its ease of use, warranty and Customer Service, reliability, low maintenance requirements, and successful use for similar types of projects.

Ease of Use. Using the time-series monitoring equipment allows the project team to collect near-real time data without having to travel out into the field to view, upload, and process the data. This eliminates the need for frequent trips to a monitoring site and lets the project team respond to events as they occur.

Equipment Warranty and Customer Service. The Handar 555 DAS with its YSI 6600 multi-parameter monitoring systems is designed for long-term *in situ* monitoring.

The YSI sondes are warranted for two years; all cables are warranted for one year; and depth, dissolved oxygen, temperature/conductivity, pH, chloride, turbidity, and chlorophyll probes are warranted for one year. Handar warrants its data acquisition systems for five years and its telemetry systems for one year. Both YSI and Handar have customer service agreements providing repair services for their equipment.

Reliability. The Handar 555 DAS with its YSI 6600 multi-parameter monitoring systems is designed to work reliably even in extreme weather conditions.

Low Maintenance Requirements. The time-series sampling system has relatively low maintenance requirements. The YSI probes need some regular maintenance, such as periodic cleaning, membrane changes of the dissolved oxygen probe, and replacement of desiccant for the water level sensor. In addition, weekly calibration of the dissolved oxygen sensor is required. Users also need to check the batteries and the charging system of the DAS on a regular basis.

Successful Use in Similar Projects. The Jefferson Parish Project team also selected the time-series sampling system because of its proven track record. Other water quality monitoring projects (e.g., the Louisiana Lake Pontchartrain project and other local monitoring sites maintained by the USGS) use time-series sampling systems successfully for similar types of projects.

3.1.5 Siting Monitors

The time-relevant water quality monitoring location(s) that you select depend on your project's objectives. When you select your monitoring location(s), you should carefully consider the following factors:

- Will the data collected at this location(s) fulfill your project's objectives? For example, if you would like to study the impacts of freshwater diversions on water quality in estuaries, you need to make sure that the monitor to collect pre- and post-diversion data is located in a representative area downstream from the diversion structure.
- Is your community supportive of equipment installation for time-series monitoring in the location(s) you selected?
- Does the monitoring equipment at the selected location(s) present a danger to your community? For example, is the location(s) in an area with heavy boat, swimming, or personal water craft traffic?
- Is your monitoring equipment safe at the selected location(s)? For example, is the equipment protected from vandalism, tampering, or weather related damage?
- Are there any local, state, or federal regulations that you need to consider in siting the monitor(s)?
- Is the access to the monitor location(s) adequate?

Siting the Jefferson Parish Monitoring Location

The Jefferson Parish Project team decided to locate the time-relevant monitoring system on an existing structure, an old oil pumping platform, located in Lake Salvador, a key outfall area of the Davis Pond Diversion. Key project members determined that this site met project locality needs during field reconnaissance.

3.1.6 Installing the Time-Series Sampling System

This section discusses some of the basic installation procedures for the sampling system. The detailed installation procedures for the time-series sampling equipment are available from the user's manuals of the individual pieces of equipment. The user's manual for the YSI 6600 sensor package can be downloaded from the Yellow Springs Instruments, Inc. Web site at http://www.ysi.com. The user's manual for the data acquisition system is can be ordered from the Handar (now Vaisala Inc.) Web site at http://www.vaisala.com. You will need to consult these manuals for detailed step-by-step installation guidance.

Unpacking and Inspecting the Equipment

The first step to install the time-series sampling system is to unpack and inspect the equipment. As soon as you receive the equipment, you should follow the following steps:

1. Remove the packing material surrounding the equipment.
2. Using the enclosed packing slip, perform an inventory of all items. If you are missing any items, contact the manufacturer immediately.

3. Conduct a thorough visual inspection of all items. If you observe any damage, contact the manufacturer and the carrier.

Preparing and Assembling the Equipment

The second step to install the time-series sampling system is to conduct a series of preparation and assembly activities on land and at the sampling location. Complete the following list of preparation and assembly activities:

Installation and preparation on land:

- Calibrate your water quality monitoring sensor according to manufacturer's instructions.
- Install the sampling system base software program on your land-base station computer.
- Ensure your battery to supply power to the sampling system is charged.

Installation at the site:

- Secure Handar unit on the sampling platform.
- Assemble sensor package.
- Install telemetry antennas and correctly point directional antennas.
- Run cables along platform structure and tie cables to the structure with tie-wraps.
- Connect cables (At the lower end of a cable, allow the cable to form a loop with the low point well below the connector on the Handar unit panel. This lets the moisture running down the cable drip to the ground at the low point and keeps it from running into the connectors).
- Assemble the electrical system.
- Connect the Handar unit to the electrical system.
- Connect the sensor package (Connect sensor cables to sensor and data acquisition system).
- Position and connect the solar panel.
- Connect power supply.
- Perform electrical testing to ensure proper operation.
- Initialize data acquisition system.
- Load data acquisition software.
- Test the sensors.
- Set the clock.
- Set start time and interval

3.1.7 Operating the Time-Series Sampling System

This section discusses the basic steps for operating the time-series sampling system. The procedures were summarized from the user's manual for the data acquisition system, which can be ordered from the Handar (now Vaisala Inc.) Web site at http://www.vaisala.com. You will need to refer to this manual, for detailed step-by-step operation guidance.

Viewing and Retrieving Data

In order to examine and collect data from the DAS while it is running in the field, connect your programming set to the DAS and use the *RETRIEVE DATA* command of the ONLINE menu. If you just want to look at the most recent data in memory to see how things are currently going, proceed as follows:

(1) Select *RETRIEVE DATA* command.

(2) Select *ALL DATA STORES*.

(3) To view the most recent items, select *DISPLAY*.

(4) Select either *ALL* data, *LAST MEASUREMENTS*, or *INCLUSIVE PERIOD*, depending on which data you would like to view.

(5) Press *ENTER* for the data to appear on the screen.

Printing Data

If you have a printer connected to your programming set, and you want to have a printed version of the screen display, follow the steps below:

(1) Select *RETRIEVE DATA* command.

(2) Select *ALL DATA STORES*.

(3) To print the most recent items, select *PRINTER*.

(4) Select either *ALL* data, *LAST MEASUREMENTS*, or *INCLUSIVE PERIOD*, depending on which data you would like to print.

(5) Press *ENTER* for the data to print.

Saving Data Files

The procedure for transferring data from the DAS memory to a file on the hard disk or floppy disk in your programming set is nearly the same as for viewing and retrieving data. If you want to save data files, proceed as follows:

(1) Select *RETRIEVE DATA* command.

(2) Select *ALL DATA STORES*.

(3) To save the data, select *DISK*.

(4) Choose either *TEXT* or *BINARY* format

(5) Specify a file name and a path using standard DOS notation to store the data.

Inspecting and Changing Parameters

Parameters are numbers or characters that you provide to control program operation. They include such items as measurement times and intervals to control process schedules, sensor calibration information, and current values and offsets. Initial values of all these items are required during programming, but you can change some of them after loading the program into the data acquisition system. Parameters that you can inspect and change in the data acquisition system are called *field accessible*. To change field accessible parameters, proceed as follows:

(1) Select *ALTER PARAMETERS* in the ONLINE menu.

(2) The screen displays a list of the names of all the field accessible parameters together with their current values. Move the highlight to one you want to change and select it by pressing *ENTER*.

(3) If you see the message *EDITING ACCESS DENIED*, you cannot change the parameter in the present mode of the DAS. Just above this message, there will be a label, for example *ALTERABLE IN STOP MODE ONLY*, that explains the restrictions on the parameter. If the number is displayed, you can change it.

(4) After making your changes, press ENTER and you will see the list of parameters again with the new value for the one you changed. The change will affect all sensors and processes that use that parameter.

3.1.8 Maintaining the Time-Series Sampling System

The scheduled maintenance activities for your time-series sampling system will likely involve cleaning and calibration of your water quality monitoring sensors and replacement of desiccant for the water level sensor. Maintenance frequency is generally governed by the fouling rate of the sensors, and this rate varies by sensor type, hydrologic environment, and season. The performance of temperature and specific conductance sensors tends to be less affected by fouling, whereas the dissolved oxygen, pH, and turbidity sensors are more prone to fouling. The use of wiper or shutter mechanisms on modern turbidity instruments has decreased the fouling problem significantly. For stations with critical data quality objectives, service intervals may be weekly or more often. Monitoring sites with nutrient-enriched waters and moderate to high temperatures may require service intervals as frequently as every third day. In cases of severe environmental fouling, the use of an observer for servicing the water quality monitor should be considered. In addition to fouling problems, physical disruptions (such as recording equipment malfunction, sedimentation, electrical disruption, debris, or vandalism) also may require additional site visits. The service needs of water quality monitoring stations equipped with telemetry can be recognized quickly, and the use of satellite telemetry to verify proper equipment operation is recommended. The USGS Web site (http://water.usgs.gov/pubs/wri/wri004252/#pdf) is a good source for background information on operation and maintenance of near-real time water quality monitoring systems. (The information in this Section is summarized from the USGS document titled "Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting". This document is available from the USGS Web site listed above.)

Jefferson Parish Project Maintenance Activities

Jefferson Parish team services the time-series sampling system at least once per week to conduct routine maintenance activities. In case of physical disruptions (such as recording equipment malfunction, sedimentation, electrical disruption, debris, or vandalism), the Jefferson Parish team conducts additional site visits. Since the Jefferson Parish system is equipped with satellite telemetry, proper equipment operation can be verified at all times allowing quick identification of any service needs of the water quality monitoring station. The following general maintenance functions are conducted on the Jefferson Parish system:

- Daily review of the sensor function by checking the transmitted data
- Weekly inspection of the site for signs of physical disruption
- Weekly inspection of the sensors for fouling, corrosion, or damage
- Weekly change of desiccant used on the "dry" atmospheric side of the differential transducer used for water level measurements
- Check if desiccant for the water level sensor is active (active desiccant is colored blue whereas inactive desiccant is colored pink) and replace it as needed
- Battery/power check
- Routine sensor cleaning and servicing
- Calibration

The Jefferson Parish project team cleans, calibrates, and inspects the monitoring equipment according to detailed instructions provided by the equipment manufactures. The sensors are cleaned carefully and thoroughly to remove algae and any other organisms that foul the sensors. The pH, turbidity, and conductivity sensors are calibrated against known standard solutions. The temperature sensor is generally not calibrated, but the team makes comparisons of the temperature readings by using USGS District-certified thermometers or thermistors. Although field calibration is possible, rough water in Lake Salvador and temperature changes in the field can complicate calibration efforts. Thus, calibration of the dissolved oxygen sensor is conducted in the controlled environment of the USGS laboratory to facilitate the process. The team has two dissolved oxygen sensors, which are being switched between field use and lab calibration on a weekly basis.

The detailed maintenance requirements and procedures for the sampling equipment are available from the user's manuals of the individual pieces of equipment. The user's manual for the YSI 6600 sensor package can be downloaded from the Yellow Springs Instruments, Inc. Web site at http://www.ysi.com. The user's manual for the data acquisition system is can be ordered from the Handar (now Vaisala Inc.) Web site at http://www.vaisala.com.

Figure. 3.6. Picture of the antenna at the LSU Costal Studies Institute taken during the January 9, 2001 site visit.

3.2 Satellite/Remote Sensing Technology

3.2.1 Available Satellite Data

Satellite image data can be used to provide regional maps of the surface or near-surface distribution of physical and biological components/characteristics of water bodies. Data from the NOAA Polar Orbiting Environmental Satellites (POES) can be received directly via antenna, such as is done at the Earth Scan Laboratory, Coastal Studies Institute at LSU. A picture of the antenna used at the LSU Coastal Studies Institute is shown in Figure 3.6 above. The data can be viewed and analyzed close to realtime. The Orbview-2 SeaWiFS (Sea-viewing Wide Field of View Sensor) has a 2-week embargo on research use. A list of SeaWiFS ground stations is provided in Appendix B. The NOAA satellites are equipped with an Advanced Very High Resolution Radiometer (AVHRR). Orbview-2 carries the SeaWiFS ocean color sensor.

Advanced Very High Resolution Radiometer - a broad-band, four or five channel scanner, sensing the visible, near-infrared, and thermal infrared portions of the electromagnetic spectrum. Important functions of the AVHRR include:

- Deriving Sea Surface Temperatures
- Deriving the Normalized Difference Vegetation Index
- Deriving atmospheric aerosols over the oceans
- Monitoring volcanic eruptions and supporting an operational NOAA warning of volcanic ash in the atmosphere during eruption events
- Other applications requiring high temporal resolution of daily coverage, with moderate spectral and spatial resolution, operational stereoscopic coverage, and calibrated thermal sensors.

[Source: http://www.ngdc.noaa.gov/seg/globsys/avhrr3.shtml]

There are four types of AVHRR data:

- High Resolution Picture Transmission (HRPT)
- Global Area Coverage (GAC)
- Local Area Coverage (LAC)
- Automatic Picture Transmission (APT)

HRPT Data are full resolution (1-km) real time data received directly by ground stations. GAC data are sampled onboard to represent a 4.4-km pixel, stored and played back to a NOAA ground stations in Virginia, Alaska, and Lanion, France. LAC data are 1-km recorded onboard and played back to the NOAA ground stations. APT is an analog derivative of HRPT data transmitted at a lower resolution and high power for low-cost very high frequency (VHF) ground stations. For the Jefferson Parish EMPACT document, LSU receives HRPT data. [Source: http://www.ngdc.noaa.gov/seg/globsys/avhrr3.shtml]

Sea-viewing Wide Field-of-view Sensor - a sensor that provides quantitative data on global bio-optical properties to the Earth science community. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications.

The concentration of microscopic marine plants (or phytoplankton) can be derived from satellite observation and quantification of ocean color. This is due to the fact that the color in most of the world's oceans in the visible light region (wavelengths of 400-700 nm) varies with the concentration of chlorophyll and other plant pigments present in the water, i.e., the more phytoplankton present, the greater the concentration of plant pigments and the greener the water.

Since an orbiting sensor can view every square kilometer of cloud-free ocean every 48 hours, satellite-acquired ocean color data constitute a valuable tool for determining the abundance of ocean biota on a global scale.[Source:http://seawifs.gsfc.nasa.gov/SEAWIFS/BACKGROUND/SEAWIFS_BACKGROUND.html]. The SeaWiFS data have an embargo period of at least 14 days and therefore are not available in real time on the Web site [Source: EMPACT 1st Year Report, November 2000, Walker, et al].

The SeaWiFS Project operates a research data system, which gathers, processes, archives, and distributes data received from an ocean color sensor. The data can also be obtained as a "data buy" from a private contractor, Orbital Sciences Corporation (OSC). OSC operates the SeaStar satellite which carries the SeaWiFS sensor. [Source: http://seawifs.gsfc.nasa.gov/SEAWIFS/BACKGROUND/SEAWIFS_970_BROCHURE.html]

3.2.2 Use of Satellite Data - Jefferson Parish Project

The LSU Coastal Studies Institute (CSI) manages the Earth Scan Laboratory (ESL) (http://www.esl.lsu.edu). The ESL is an earth station telemetry site for the capture of NOAA AVHRR, Orbview-2 SeaWiFS and GOES-8 digital satellite image data. The mission of the ESL is to support research, education, and public service/emergency response with near-real time or archived remotely sensed satellite and aircraft data. ESL's mission also includes processing, analysis, interpretation, and dissemination of the remotely sensed data. These satellite data are a valuable asset for environmental management and decision making that involves environmental conditions, such as:

- Monitoring conditions of coastal and estuarine waters, their surface temperature, turbidity (reflectance) levels, and coastal inundation for fisheries management
- Detecting river flooding in local detail for state disaster-related decision makers.

[Source: http://antares.esl.lsu.edu/htmls/intro.html]

The Jefferson Parish project uses satellite data to monitor regional changes in temperature, reflectance (suspended solids) and chlorophyll *a* in Louisiana lakes, bays, and the coastal ocean adjacent to the Davis Pond diversion project.

3.3 Water Quality Field Sampling

The USGS District Office in Baton Rouge, Louisiana, takes weekly and special event field samples to "surface truth" the remote sensing data and to validate the time-series water quality sampling data. "Surface truthing"satellite data involves measuring reflectance and relating the digital measurements of turbidity and fluorescence to suspended solids and chlorophyll *a* measurements taken from field samples.

3.3.1 Water Quality Field Sampling and Analysis Team

The USGS District Office in Baton Rouge, Louisiana, collects water quality field samples. Jefferson Parish provides a trained environmental technician and the parish's boat to assist the USGS with water sample collection.

LSU-CEI is responsible for analysis of water samples and providing the resulting data in tabular and graphic form. The LSU-CEI lab analyzes the field samples for chlorophyll *a*, nutrients, suspended solids, salinity, and pH and provides graphical summaries of each parameter within one week of laboratory analysis. The chlorophyll *a* and nutrient analyses on water samples are used to surface-truth satellite images. LSU-CEI scientists interpret the water quality and remotely sensed data and post it to a Web site. LSU-CEI provides quarterly reports of all data (with allowances for a one month delay in processing and Quality Assurance and Quality Control) to the project manager at Jefferson Parish. Graphical summaries of each parameter are updated within one week of laboratory analysis, but are subject to subsequent QA/QC procedures. Monthly graphics of key parameters are sent to the EMPACT manager for Jefferson Parish. A tabular summary of samples received, status and completion are maintained as part of a routine chain-of-custody procedure. Data are also presented on an LSU Web page, which will be linked to the Jefferson Parish EMPACT home page.

LUMCO identifies harmful algal species contained in each sample, provides the resulting data in tabular and graphic form, and coordinates with the Louisiana Department of Health and hospitals regarding possible threats to human health.

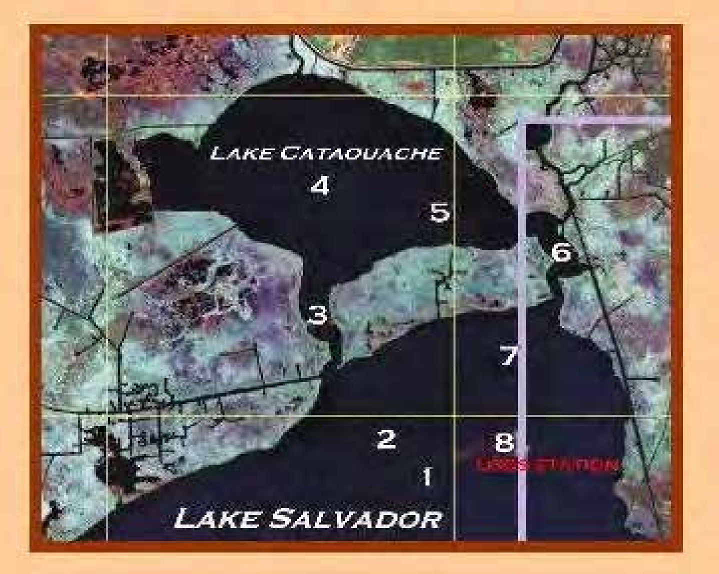
3.3.2 Sampling Locations and Frequency

Water samples for lab analysis are taken weekly from seven stations in Lake Salvador and Lake Cataouche. (Cataouche is a smaller lake to the north of Salvador. Both lie in the direct flow path of the Davis Pond Diversion.) Collection stations were chosen by Dr. Chris Swarzenski, a scientist with the USGS who has been doing marsh grass research in the area for the past 15 years, to compliment and augment monthly monitoring in the area by others (USACE, Louisiana Department of Natural Resources, United States Park

Service, and Turner). The coordinates and a map depicting the location of collection sites is shown in Figure 3.7.

Additionally, samples are taken from the upper Barataria Basin to the Gulf of Mexico during two separate collection dates during the summer months when conditions are most conducive to phytoplankton growth. The relation between surface characteristics from the field samples and satellite data are described in more detail in Section 4.

Figure 3.7. Map and Coordinates (lat/long or UTM) of Water Quality Field Sampling Locations



LC1 (294423, 901254) Southwesterly of platform

LC2 (294549, 901325) West of platform

LC3 (294748, 901405) Northeasterly of No. 2

LC4 (295001, 901426) Northeasterly of No. 3

LC5 (294943, 901207) Easterly of No. 4

LC 6 (294901, 901011) Southeasterly of No. 5 (in channel on east side of Couba Island)

LC 7 (294738, 901043) Northeasterly of platform

LC 8 (294608, 901116) Platform

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4. COLLECTING, TRANSFERRING, AND MANAGING TIME-RELEVANT WATER QUALITY DATA

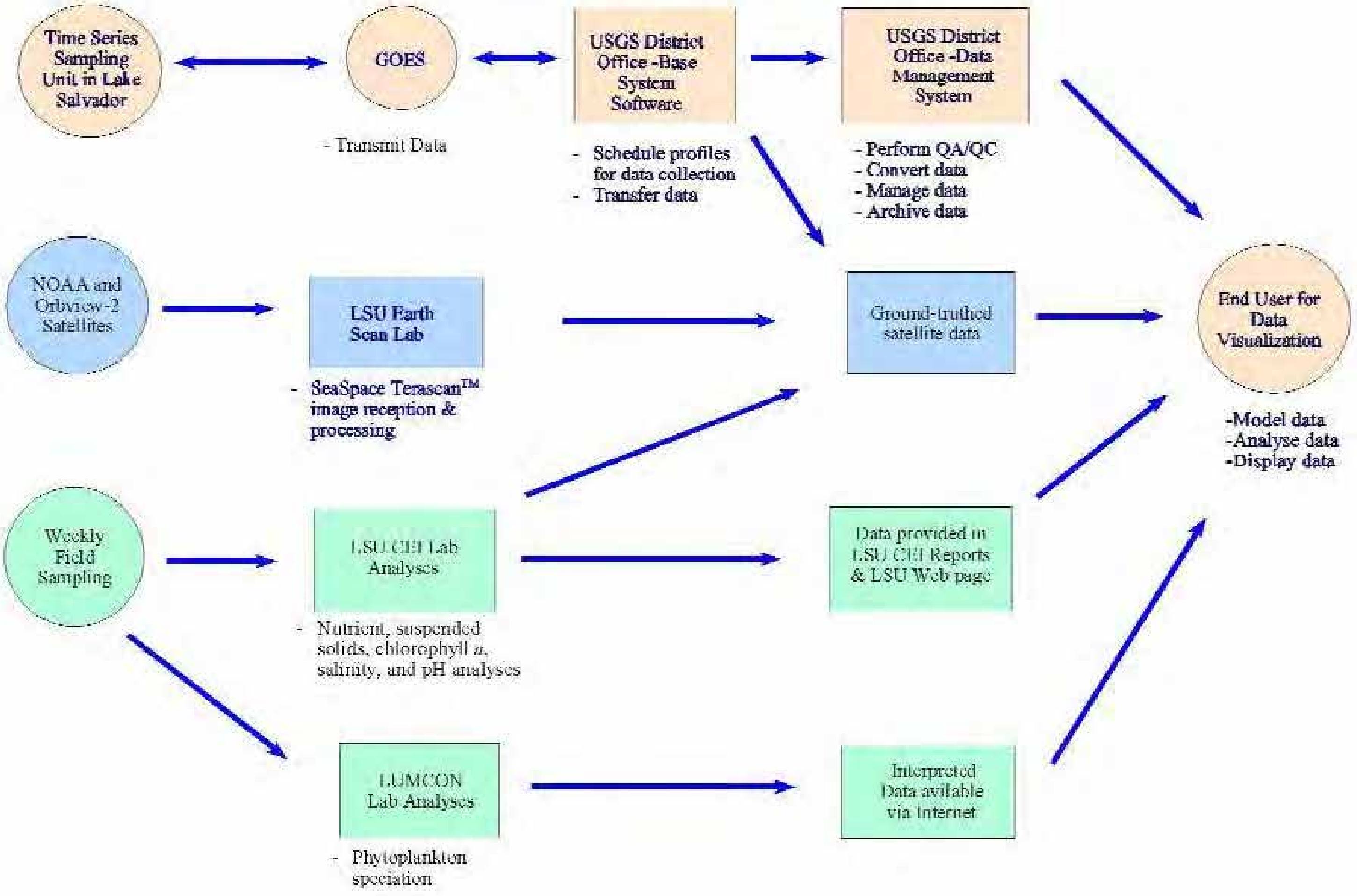
I n order to effectively assess water quality and the impacts of water quality management activities, such as river diversions into estuaries, it is necessary to monitor water quality over time (i.e., monitor pre- and post-diversion water quality). The water quality monitoring should take into account water quality parameters important to the local community. Conducting a comprehensive manual sampling program that covers different times of the day, as well as different seasons and seasonal events, presents distinct challenges. As a result, many water quality monitoring programs, such as the Jefferson Parish Project, rely on automated systems, in which water sampling units collect data at programmed intervals and then transmit the data to a land-based station for storage, retrieval, and analysis. In addition, the Jefferson Parish project relies on remote sensing data to monitor water parameters. However, limited field sampling still has to be conducted to "surface truth" the satellite data.

Using the Jefferson Parish Project as a model, this chapter provides you and your community with "how-to" instructions on how to operate and maintain such data collection systems. If you are responsible for or interested in implementing time-series water sampling, you should carefully read the technical information presented in Section 4.2, which discusses setting up and using a sampling station for data collection and transfer, and managing the data at the base station. If you are interested in using remote sensing technology to monitor water quality parameters, you should read the information presented in the Section 4.3. This section provides detailed information on satellite data acquisition, processing, interpretation, ground-truthing, and data transfer and management. Details on water quality field sampling are discussed in Section 4.4, which provides details on sampling, water quality parameter analyses phytoplankton speciation, and data transfer and management. Readers interested in an overview of the system should focus primarily on the introductory information in Section 4.1 below.

4.1 System Overview

The water quality monitoring program for the Jefferson Parish Project uses three types of data: (1) time-series water sampling data; (2) satellite data; and (3) water quality field sampling data. The data are collected and analyzed by four separate entities. Time-series water sampling data and satellite data can be accessed through links from the Jefferson Parish Web site at http://www.jeffparish.net/pages/index.cfm?DocID=1228.

Figure 4.1. System Overview


Time Series Sampling Unit in Lake Salvador
GOES
- Transmit Data
USGS District Office -Base System Software
- Schedule profiles for data collection
- Transfer data
USGS District Office -Data Management System
- Perform QA/QC
- Convert data
- Manage data
- Archive data
NOAA and Orbview-2 Satellites
LSU Earth Scan Lab
- SeaSpace Terascan™ image reception & processing
Ground-truthed satellite data
End User for Data Visualization
-Model data
-Analyse data
-Display data
Weekly Field Sampling
LSU CEI Lab Analyses
- Nutrient, suspended solids, chlorophyll a, salinity, and pH analyses
Data provided in LSU CEI Reports & LSU Web page
LUMCON Lab Analyses
- Phytoplankton speciation
Interpreted Data avilable via Internet

The field sampling data are available via the Internet at http://its2.ocs.lsu.edu/guests/ceilc/. A schematic of the main components of the data collection, transfer, and management system for the Jefferson Parish project is presented in the figure on the following page.

The time-series water sampling data are collected by an automated system, in which a sampling unit collects hourly data and then transmits the data via GOES to the USGS District Office every four hours for storage, retrieval, and analysis. The sampling unit is located in Lake Salvador, a key outfall area of the Davis Pond Freshwater Diversion Project.

Satellite data collected by NOAA satellites are received and processed using SeaSpace Terascan^{TM} system which operates at the Earth Scan Laboratory, Coastal Studies Institute at LSU. This software package performs calibration, geometric correction, and more specialized processing for the determination of temperature, reflectance (turbidity), and chlorophyll *a* concentrations. Water sampling results are used to "surface truth" satellite reflectance measurements and to relate the digital measurements of turbidity and fluorescence to suspended solids and chlorophyll *a*.

Water quality field sampling is conducted weekly from seven stations in Lake Salvador and Lake Cataouche (a smaller lake north of Lake Salvador) to ground-truth remote sensing data and validate time-series water sampling data. The LSU-CEI analyzes the samples for chlorophyll *a*, nutrients, and suspended solids. The LUMCON provides data on phytoplankton speciation including identification of harmful algal species. The field sampling data are interpreted and made available via the Internet.

4.2 Time-Series Water Quality Sampling

A data collection, transfer, and management system can benefit your community in two ways: It enables you to automate the collection of water quality samples, and it enables you to control the resulting data flexibly and easily. By using the system's software, you can program your time-series water sampling unit to collect water quality data at specified intervals. Then you can call the sampling unit as needed for data transmission or program your system to call for transmissions of data at specified times. Once the data arrive, the information can be formatted and stored or otherwise prepared for export to another database, or it can be analyzed using geographical information system or data visualization software.

The sampling station unit is installed on a platform in the water and programmed to collect water quality data at specified intervals. The sampling unit has a multiprobe water quality sensor manufactured by YSI.

This YSI Model 6600 data collection station is equipped with two optical ports for temperature and conductivity measurements plus a pressure and turbidity probe and dissolved oxygen and pH sensors. The data collected by the sampling station unit is transmitted via GOES to the USGS District Office at set time intervals and displayed on the USGS Internet home page. The data is archived as part of the USGS national hydrologic information system and resides in INGRES, a software developed by the USGS. Data security is managed by established USGS procedures.

The land-based station at the USGS District Office is basically a computer equipped with two main parts: (1) the base system software used to create profile schedules of sampling parameters and to communicate with the sampling station unit to transmit schedules and receive sampling data and (2) the database management system used to format, quality check, and store collected data.

The sampling station unit and the base station computer are equipped with communications hardware featuring a satellite radio transmitter. This equipment allows the sampling station unit and computer to "talk" to each other over long distances. Because of this communication ability, the sampling station unit becomes part of a remote data acquisition system controlled from the land-base station. At the base station, an operator runs the sampling station-base software to connect to the sampling station unit for data collection and transfer.

The system's flexibility enables you to establish sampling and data transfer protocols based on your specific monitoring needs. For example, you might program your sampling station unit to sample every hour, 7 days a week, to monitor general trends. You might also want to conduct sampling specific to certain events, such as conditions conducive to algal blooms, during which you might monitor water quality on a 30-minute basis.

The system can collect and store data for future use, or it can retrieve and transmit collected data in near-real time. Each sampling station unit stores collected data in its on-board computer, making the data available for download on demand by the base station. The unit can also serve as a temporary archive by retaining a copy of all transmitted data files. Once the unit runs out of space, it will overwrite data as necessary, beginning with the oldest data.

The remainder of this section provides information on how the data collected by the sampling system are transferred to the base station, how the data are managed, and which troubleshooting and data quality assurance steps are taken. These steps are illustrated using the Jefferson Parish project as an example.

How often should data be collected?

The Jefferson Parish time-series sampling station collects samples on an hourly basis and transmits the data via GOES to the USGS District Office every four hours. The data is then displayed on the USGS Internet home page.

4.2.1 Data Collection Equipment Calibration

USGS members of the Jefferson Parish team perform routine, weekly maintenance and calibration of the sensors with independent equipment. This independent equipment is tested to ensure accuracy and reliability of the field instrumentation. The USGS district office ensures that adequate testing is carried out and the documented results fully characterize the performance and capabilities of the instruments. The USGS Hydrologic Instrumentation Facility (HIF) conducts testing, evaluation, and documentation of instrument performance. USGS districts purchase instruments through HIF when possible. HIF can also perform independent testing for the district offices. The USGS Web site (http://water.usgs.gov/pubs/wri/wri004252/#pdf) is a good source for background information on calibration and data QA/QC of "real-time" water quality monitoring systems. Table 4.1 shows some USGS sensor calibration requirements. USGS recommends that equipment adjustments be made until the equipment meets their recommended calibration criteria. Otherwise, equipment that cannot meet the calibration criterial should be replaced. The information in this Section is summarized from the USGS document titled "Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting" available from the USGS Web site listed above. The USGS guidelines referred to in this document have evolved based on decades of experience with water-quality monitoring.

4.2.2 Transferring Your Collected Data to the Base Station

As a first step, you will need to determine what kind of data communication or telemetry equipment to install on your sampling station unit. Telemetry equipment enables data to be transferred from a sampling station to a receiving station (i.e., the base station). You can choose between a number of telemetry equipment options including cellular telephone modem, a 900 MHz transceiver, and a satellite radio transmitter.

Jefferson Parish Telemetry Equipment

The USGS, a key partner in the Jefferson Parish EMPACT project, uses automated earth-satellite telemetry for the transmission of data via satellite from the time-series sampling system located in lake Salvador. The data are being collected on an hourly basis and transmitted via GOES. Every four hours a data set that consist of eight hours of monitoring data are being transmitted (one redundant data set from the past four hours and one current four hour data set).

Table 4.1. Sensor Calibration and Accuracy Requirements

Sensor	USGS-Recommended Calibration Accuracy	Calibration
Temperature	+/- 0.2°C	Annual 5-point calibration over temperature range of 0-40°C. Three or more 2-point calibration checks per year for thermistors over the maximum and minimum expected temperature range.
Dissolved Oxygen	+/- 0.3 mg/L	Calibration is conducted weekly at 0.0 mg/L and 100% dissolved oxygen saturation.
Specific Conductance	The greater of +/- 5 uS/cm or +/- 3 % of the measured value	Standards bracketing the expected full range are used to calibrate the specific meter to the appropriate units for particular field conditions. The specific conductance standards are available from the USGS Ocala Quality Water Service Unit (QWSU).
pH	0.2 pH units	Two standard buffers bracketing the expected range of values are used to calibrate the PH electrode, and a third is used to check for linearity. The pH-7 buffer is used to establish the null point, and the pH-4 or pH-10 buffer is used to establish the slope of the calibration line at the temperature of the solution. The temperatures of the buffers should be as close as possible to the samples being measured. Standard buffers are available from QWSU.
Turbidity	The greater of +/- 5 NTU or +/- 5 % of the measured value	Conduct 3 point calibration at values of 0, 10, and 100 NTU using standards based on either Formazin or approved primary standards, such as styrene divinylbenzene polymer standards.

The access to GOES to transmit information is limited to specified users such as governmental agencies like USGS or the Corps of Engineers. Thus, if you want to use satellite telemetry to transmit your data from the sampling system to the base station, you may want to enter into a cooperative agreement with an organization such as USGS.

The GOES are operated by the NESDIS of NOAA. The GOES Satellite Radio Module consists of a 10-watt transmitter that can be set to any of the allowable 199 domestic GOES and 33 international channels assigned by NESDIS. The normal configuration of GOES consists of the GOES East satellite stationed 21,700 miles above the equator at 75 degrees west longitude and the GOES West satellite is at 135 degrees west longitude.

Data are transmitted by the data acquisition system on an assigned UHF-band frequency in the direction of the GOES. The GOES repeats the message in the S-band, which is received at the NESDIS ground station at Wallops Island, Virginia. The data are then re-broadcast to the DOMSAT satellite, which is a low orbiting communications satellite, and then retrieved on an eight-foot dish at the USGS office in Baton Rouge. A schematic of the data transfer process is shown in Figure 4.2.

4.2.3 Managing Data at the Base Station

This section provides you with background information on managing data at the base station. It discusses the basic data management steps conducted at the base station including processing, QA/QC, distribution, and storage.

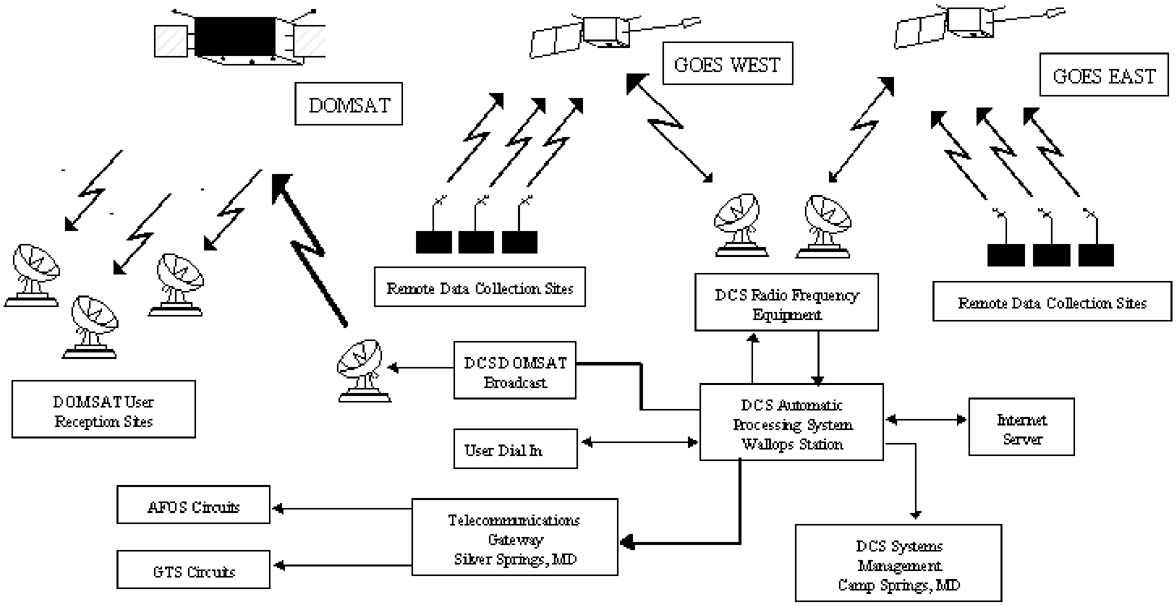
The base station software used by USGS is called ILEX, which is a specialized software that was developed specifically for USGS by an outside contractor. The Local Readout Ground Station (LRGS) at the USGS district office in Baton Rouge receives data from all USGS data collection sites. By entering specific site codes, data from specific USGS monitoring sites can be filtered out and kept for processing.

The data received by the LRGS are processed, checked to assure they do not fall outside the range of set thresholds, and distributed. The data are stored/archived as part of the USGS national hydrologic information system and resides in INGRES, a software developed by USGS. Data security is managed by established USGS procedures. USGS is currently coordinating with the EPA to make the archived data available in STORET, a software used by the EPA. The data are displayed near-real time on the USGS Hydrowatch Web site, from where they can be accessed by anyone who has access to the Internet including Federal, State, and local agencies, academia, industry, the public, policy-makers, and managers. Figure 4.3 shows the data transfer to the base station and the basic data management steps taken at the base station.

Data-Processing Procedures

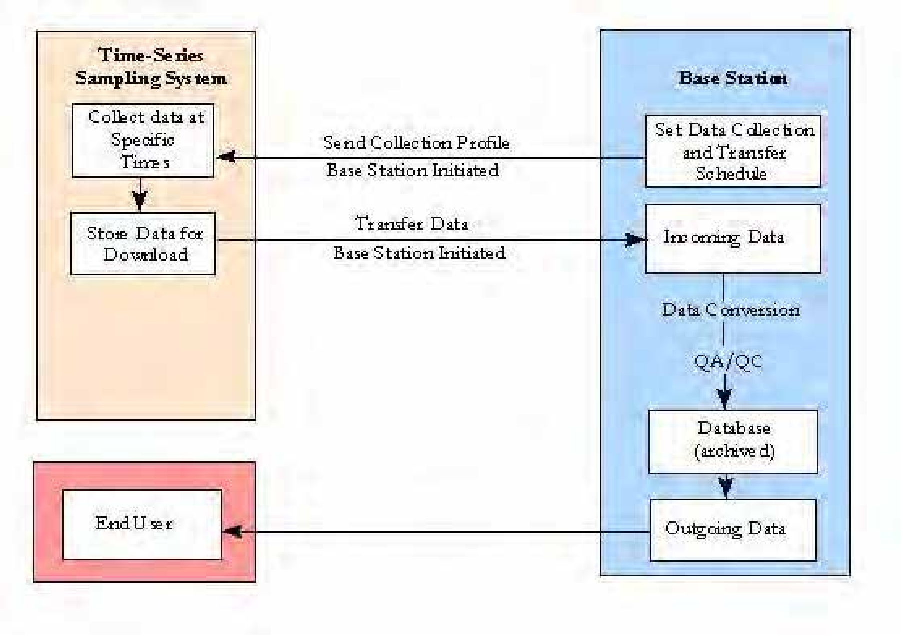
To ensure time-relevant access to the data and to avoid data management problems, the water quality monitoring data should be processed soon after data collection and retrieval. When processing the data, no corrections should be made unless they can be validated or explained with information or observations in the field notes or by comparison to information from other data sources. The USGS data processing procedures consist of six major steps: (1) initial data evaluation, (2) application of corrections and shifts, (3) application and evaluation of cross-section corrections, (4) final data evaluation, (5) record checking, and (6) record review. These processing procedures, which are described in detail in the sections below, are summarized from the USGS document titled "Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting" available from the USGS Web site at http://water.usgs.gov/pubs/wri/wri004252/#pdf.

Figure 4.2. Schematic of the GOES Data Collection System (DCS) and Data Transfer Process


DOMSAT
GOES WEST
GOES EAST
Remote Data Collection Sites
DCS Radio Frequency Equipment
Remote Data Collection Sites
DOMSAT User Reception Sites
DCSD OMSAT Broadcast
DCS Automatic Processing System Wallops Station
Internet Server
User Dial In
AFOS Circuits
GTS Circuits
Telecommunications Gateway Silver Springs, MD
DCS Systems Management Camp Springs, MD

[[Source: http://www.osd.noaa.gov/sats/dcs-figure.htm]](http://www.osd.noaa.gov/sats/dcs-figure.htm)

Figure 4.3. Data Transfer and Management Diagram



Initial Data Evaluation

In the initial data evaluation step, USGS checks the success of the raw field data transfer to the office database. This provides an opportunity for initial checks to evaluate and correct erroneous data. The raw field data may be stored in a variety of formats, depending on the recording equipment and the means of downloading data from the recording equipment. The conversion of raw data from the sampling system into a standard entry format to the USGS district database, or Automated Data-Processing System (ADAPS), is accomplished by using an on-line computer program, or Device Conversion and Delivery System (DECODES). After entry into ADAPS, primary data tables and plots can be produced for review.

Application of Corrections and Shifts

The application of corrections and shifts allows USGS to adjust data to compensate for errors that occurred during the service interval as a result of environmental or instrumental effects. There are three types of measurement-error corrections: (1) fouling, (2) drift, and (3) cross-section correction. USGS only make corrections to measurements when the type and degree of correction is known. If the deviation between the actual value and sensor reading exceed the criterion for water quality data shifts, as shown in Table 4.2, a correction is required. The correction is a linear interpolation over time between sensor inspections.

Table 4.2. Criteria for Water-Quality Data Shifts

Measured Physical Property	USGS-Recommended Shift Criteria (Apply Shift when Deviation Exceeds this Value))
Temperature	+/- 0.2°C
Dissolved Oxygen	+/- 0.3 mg/L
Specific Conductance	The greater of +/- 5 uS/cm or +/- 3 % of the measured value
pH	0.2 pH units
Turbidity	The greater of +/- 5 NTU or +/- 5 % of the measured value

Evaluation and Application of Cross-Section Corrections

Cross-section corrections allow USGS to adjust measurements of the monitoring equipment to reflect conditions more accurately in the entire cross section of the monitoring area (e.g., from bank to bank of the water body that you are monitoring). The application of cross-section corrections is intended to improve the accuracy and representativeness of monitoring measurements. However, USGS only makes cross section corrections, if the variability in the cross section exceeds the shift criteria. Corrections to the cross section are based on field measurements taken both horizontally and vertically in the water body cross section.

Final Data Evaluation

Final data evaluations consist of reviewing the data record, checking shifts, and making any needed final corrections. When completed, USGS verifies the data for publication and rates the data for quality. The data that USGS cannot verify or that are rated as unacceptable are retained for record-checking and review purposes but are not published in ADAPS. However, USGS archives unacceptable or unverified data following established USGS district policies.

Many USGS district offices have established quality-control limits for shifting data, which are commonly referred to as "maximum allowable limits." This means that data are not published, if the recorded values differ from the field-measured values by more than the maximum allowable limits. For the purpose of consistency within the USGS the limits are established

at 10 times the calibration criteria for all standard continuous-monitoring data-gathering activities, except for more stringent requirements for DO and turbidity. Table 4.3 below shows the maximum allowable limits for continuous water quality monitoring sensors.

Table 4.3. USGS Recommended Maximum Allowable Limits for Continuous Water-Quality Monitoring Sensors

Measured Physical Property	Maximum Allowable Limits for Water Quality Sensor Values
Temperature	+/- 2.0°C
Dissolved Oxygen	The greater of +/- 2.0 mg/L or 20 %
Specific Conductance	+/- 30 %
pH	2.0 pH units
Turbidity	+/- 30 %

After evaluating each record for maximum allowable limits, USGS applies one of four accuracy classifications to each measured physical property on a scale ranging from poor to excellent. The accuracy ratings are based on data values recorded before any shifts or corrections are made and depend on how much the recorded values differ from the field-measured values. For more details on the USGS data publication criteria guidelines refer to the USGS document titled "Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting" available from the USGS Web site at http://water.usgs.gov/pubs/wri/wri004252/#pdf.

Record Checking and Record Review

In the record checking process, USGS thoroughly checks all data used in producing the final water quality record for completeness and accuracy before final review and publication. The hydrographer who is responsible for computing the water quality record first reviews the record, followed by a second check for completeness and accuracy by an experienced hydrographer. Finally, the USGS district water quality specialist or district-designated reviewer inspects the water quality record. In addition, all field data are verified for accuracy and transcription from field sheets, all shifts are checked to assure that the correct values are used for a shift, and all dates and numbers in the station manuscript are checked for accuracy.

Near-Real Time Data QA/QC versus Non-Real Time Data QA/QC

Depending on the type of data (near-real time versus non-real time data) you are providing to the public, you can spend different amounts of time and effort on quality control checks. If your goal is to provide near-real time data, there is no time for extensive manual QA/QC checks. On the other hand, if you are providing non-real time data, you have time to perform extensive quality checks, as described in the sections above. Performing quality checks on Jefferson Parish non-real time data can take from a few days to weeks or months, depending on the amount of data streaming into the project's base station.

When you are providing near-real time data, such as the data found on the USGS Hydrowatch Web site, time for QA/QC checks is limited. The checks that can be conducted must either be automated or can only focus on obvious data problems, if they are done manually. The near-real time data undergo two very basic QA/QC steps during the data management process.

The first QA/QC step is done while the data are processed by the DECODES software program at the USGS base station. USGS can enter set thresholds in the DECODES software for each water quality parameter. If the value for any given parameter falls outside the acceptable range entered for that parameter, the data point will be removed. For example, if a pH reading exceeding a pH of 10 is recorded, the data point will be removed because if falls in an unacceptable range for that particular parameter.

The second QA/QC step is taken at the base station when the data are imported into Microsoft Access. At this point, the data undergo a brief manual QA/QC step, at which outliers or obvious erroneous data points are deleted manually from the database.

Storing and Archiving the Data

It is recommended that you store and archive all sample records, raw data, quality control data, and results. A variety of media are available for archiving data (e. g., CD- ROMs, Zip disks, floppy diskettes, and hard copy). The server storing the data should also be backed up daily to prevent data loss.

4.2.4 Troubleshooting

This section contains information about common troubleshooting issues. Table 4.4 below can be used to identify the causes of some common difficulties that may occur while operating the YSI 6600 sensor package. The "symptom" column describes the type of difficulty that you might experience, the "possible cause" column describes the condition that might cause the stated symptom, and the "action" column provides simple steps that can be followed to correct the problem. [Source: The user's manual for the YSI 6600 sensor package, which can be downloaded from the Yellow Springs Instruments, Inc. Web site at http://www.ysi.com.]

Table 4.4. Common Troubleshooting Issues and Actions

Symptoms	Possible Cause	Action
Dissolved Oxygen reading unstable or inaccurate	Probe not properly calibrated	Follow DO calibration procedures
	Membrane not properly installed or punctured	Follow setup procedure
	DO probe electrodes require cleaning	Follow DO cleaning procedure
	Water in probe connector	Dry connector; reinstall probe
	Algae or other contaminant clinging to probe	Rinse DO probe with clean water
	Barometric pressure is incorrect	Repeat DO calibration procedure
	Calibrated at extreme temperature	Recalibrate at/near sample temperature
	DO charge to high (>100): (1) Anode polarized (tarnished) (2) Probe left on continuously	Enable DO charge parameter in sonde report menu. Run sonde, if charge is over 100, recondition probe. Follow DO cleaning procedure.
	DO charge too low (<25); insufficient electrolyte.	Replace electrolyte and membrane
	DO probe has been damaged	Replace probe
	Internal failure	Return sonde for service
pH, chloride, ammonium, or nitrate readings are unstable or inaccurate. Error messages appear during calibration.	Probe requires cleaning	Follow probe cleaning procedure
	Probe requires calibration	Follow calibration procedures
	pH probe reference junction has dried out from improper storage	Soak probe in tap water or buffer until readings become stable
	Water in probe connector	Dry connector; reinstall probe
	Probe has been damaged	Replace probe
	Calibration solutions out of spec or contaminated	Use new calibration solutions
	Internal failure	Return sonde for service
Level Sensor unstable or inaccurate	Desiccant is spent	Replace desiccant
	Level sensor hole is obstructed	Follow level sensor cleaning procedure
	Level sensor has been damaged	Return sonde for service
	Internal failure	Return sonde for service
Conductivity unstable or inaccurate. Error messages appear during calibration	Conductivity improperly calibrated	Follow recalibration procedure
	Conductivity probe requires cleaning	Follow cleaning procedure
	Conductivity probe damaged	Replace probe
	Calibration solution out of spec or contaminated	Use new calibration solution
	Internal failure	Return sonde for service
	Calibration solution or sample does not cover entire sensor	Immerse sensor fully
Installed probe has no reading	Sensor has been disabled	Enable sensor
	Water in probe connector	Dry connector; reinstall probe
	Probe has been damaged	Replace probe
	Report output improperly set	Set up report output
	Internal failure	Return sonde for service
Temperature unstable or inaccurate	Water in connector	Dry connector; reinstall probe
	Probe has been damaged	Replace probe
	Probe requires cleaning	Follow probe cleaning procedure

Turbidity probe unstable or inaccurate. Error messages appear during calibration	Probe requires calibration	Follow calibration procedure
	Probe has been damaged	Replace probe
	Water in probe connector	Dry connector; reinstall probe
	Calibration solutions out of spec	Use new calibration solutions
	Wiper is not turning or is not synchronized	Activate wiper. Assure rotation. Make sure set screw is tight.
	Wiper is fouled or damaged	Clean or replace wiper
	Internal failure	Return probe for service

4.3 Satellite/Remote Sensing Technology

4.3.1 Data Acquisition

As mentioned earlier, LSU receives two different satellite data streams; NOAA AVHRR and Orbview-2 SeaWiFS. AVHRR satellite data are available to anyone who has the capability to receive it. NOAA does not charge any fee for an entity to establish and operate a station to receive AVHRR data nor does NOAA require station operators to make themselves known to NOAA. However, NOAA recommends that operators subscribe to NOAA's mail outs and make use of its on-line bulletin board. NOAA maintains an office to support potential operators of HRPT at the following address:

Coordinator, Direct Readout Services
NOAA/NESDIS
Washington, DC 20233

HRPT ground stations can be constructed using commercial equipment for under $100,000. However, some radio amateurs have constructed systems for $100s using personal computers, surplus antennas, and circuit boards. [Source: http://www.ngdc.noaa.gov/seg/globsys/avhrr3.shtml]

If your project is not considered "research," the SeaWiFS data can be purchased from Orbimage, since they own the commercial rights to SeaWiFS. Note that Orbimage refers to SeaWiFS data as OrbView-2. If your project is considered research, you may apply to become a NASA-Authorized SeaWiFS user. To become an Authorized SeaWiFS data user, you must read the *SeaWiFS Dear Colleague Letter* and *Appendices* to gain an understanding of the terms of the user agreement. The applicant must then submit a short proposal, which includes the title of the project, a scientific rationale for the request, the processing level of the data required, and plans for the publication/dissemination of the results or data access. The applicant must print, sign, and complete a hard copy of the *Research Data Use Terms and Conditions Agreement*. The applicant must mail the proposal and original hard copy of the form to:

Dr. Charles R. McClain
SeaWiFS Project
NASA/GSFC Code 970.2
Building 28, Room W108
Greenbelt, MD 20771

Additional procedures for requesting data should be followed if the applicant desires to become an authorized SeaWiFS Direct Readout Ground Station or an authorized SeaWiFS Temporary Real-Time User or Station. There are not any specific deadlines for receipt of proposals to obtain SeaWiFS data. [Source: http://seawifs.gsfc.nasa.gov/SEAWIFS/ LICENSE/checklist.html]

Once approved as an authorized user, you can receive data for free from the Goddard Distributed Active Archive Center (DAAC) after the data is at least two weeks old. If your project is considered research and your organization wants to receive HRPT SeaWiFS data, you can apply to become an authorized SeaWiFS Ground Station. Current SeaWiFS users who want to get data in real-time from an existing SeaWiFS Ground Station, can apply to become an authorized SeaWiFS Temporary Real-Time User. [Source: http://seawifs.gsfc.nasa.gov./SEAWIFS/ANNOUNCEMENTS/getting_data.html]

LSU is an authorized SeaWiFS Direct Readout Ground Station and has applied for and received authorization to become a Temporary Real-Time User Station. However, since the data must be held for two weeks prior to publication, the SeaWiFS data are not placed on the LSU Web site.

If a new user wants a turnkey operation to obtain SeaWiFS data, SeaSpace TeraScan SeaWiFS systems can be purchased. [Note that you must still obtain a decryption device and decryption key from NASA to read the data.] The TeraScan SeaWiFS system can be configured to support land-based, shipboard, or portable applications and is comprised of the following components:

- Polar Orbiting Tracking Antenna (1.2 m and 1.5 m)
- Global Positioning System (GPS) Antenna/Receiver
- Telemetry Receiver
- SGP Interface Unit (SGPI)
- Workstation

- Uninterruptible Power Supply (UPS)
- TeraScan Software

The specifications for the TeraScan SeaWiFS system are described below.

Antenna

Specifications	1.2 m Antenna	1.5 m Antenna
Reflector Diameter	1.2 m (4 ft)	1.5 m (5 ft)
Input Frequency	1691 - 1714 MHz	1691 - 1714 MHz
Acquisition Elevation	8 degrees	5 degrees
LNA Gain	30 dB minimum LNA Gain	30 dB minimum LNA Gain
LNA Noise Figure	<0.8 dB	<0.8 dB
Input Bandwidth	15 MHz	15 MHz
Downconverter Gain	22 dB minimum	22 dB minimum
Elevation Range	0 to 90 degrees	0 to 180 degrees
Azimuth Range	± 265 degrees	± 265 degrees
Elevation/Azimuth Tracking Rate	6 degrees per second	6 degrees per second
Position Accuracy	0.5 degrees	0.5 degrees
Temperature Range	-30C (-22F) - without heater to 70C (158F)	-30C (-22F) - without heater to 60C (140F)
Humidity	0 to 100%	0 to 100%
Maximum Wind Force	161 km/hr (100 mph)	161 km/hr (100 mph)
Radome Dimension	1.55 m (61") diameter by 1.67 m (65.90") high	1.88 m (73.88") diameter by 1.82 m (71.94") high
Antenna/Radome Weight	95 kg (210 lbs)	131 kg (290 lbs)
Antenna Shipping Weight	227 kg (500 lbs)	273 kg (600 lbs)

GPS

- Satellites tracked: 8
- Satellites used in a solution: 4
- Positional Accuracy: ±100 m (330 ft)
- System Time Accuracy: ± 0.1 second

Receiver

- Model: HR-250
- IF input frequency range: 128 - 145 MHz
- Demodulator Type: PSK-PLL
- Bit rate: 665.4 Kbps
- Bit error rate: Within 1 db of theoretical
- Programmable IF input frequency selection

Workstation

- Type: Sun ULTRA-10
- Processor: 440 MHz
- Memory: 128 MB RAM
- Internal Hard Drive Capacity: 18 GB
- Internal CD-ROM Capacity: 644 MB

- Monitor Size: 21"
- Display Resolution: 1280 x 1024 x 24 bit
- LAN Types: 10/100 BaseT
- External DAT 4 mm Tape Storage: 24 GB compressed
- Modem: 56 Kbps
- Operating System: Solaris 7
- Keyboard and mouse
- PCI Frame Synchronizer
- PCI SCSI Controller
- PCI Serial Multiplexer

UPS

- Output Power Capacity 1400 VA
- Dimensions: 0.18 m (7") W x 0.23 m (9") H x 0.42 m (18") D

Options

- Antenna Pedestal
- Antenna Heater
- Color Printer
- 100 m (330 ft) Antenna Control and Signal Cable

For more information about the TeraScan SeaWiFS system refer to their Web site, the source of this information, at http://www.seaspace.com/main/product_line/seawifs/seawifs.html.

4.3.2 Data Processing

Acquisition and processing of the satellite data are performed using the SeaSpace TeraScan™ image reception and processing system operated at the LSU Earth Scan Laboratory (http://www.esl.lsu.edu). This software performs calibration, geometric correction, and additional specialized processing for the determination of temperature, reflectance (turbidity), and chlorophyll *a*.

AVHRR - Dr. Nan Walker and Adele Hammack (LSU-CSI) view satellite imagery from the NOAA satellites daily (at least 8 times per day) and processes these images with specialized software to produce color- enhancedimagery of water temperature and turbidity (reflectance). At the end of each month, Dr. Walker provides a written description of the more interesting images taken during the month to assist the public in interpreting the turbidity and temperature changes that are visible in the satellite images.

For the EMPACT project, sea surface temperatures (SST) are computed, in either Celsius or Fahrenheit, with NOAA AVHRR satellite data using a modification of the MCSST technique described by McClain et al (1985). Surface reflectance is computed in percent albedo with NOAA AVHRR satellite data using a modification (Walker and Hammack, 2000) of the Stumpf atmospheric correction technique (1992). The technique corrects for incoming solar irradiance, aerosols, sunlight and Rayleigh scattering.

Dr. Walker uses a commercial software package suite called TeraScan^{TM}, which is produced by SeaSpace. You can find SeaSpace's Web site at http://www.seaspace.com. The TeraScan^{TM} software suite includes software for data acquisition and scheduling called TeraCapCon and TeraTrack. TeraMaster & TeraPGS are used for product generation. TeraVision is used for developing images to visualize satellite data. TeraPGS is used to distribute data images according to user specifications. The image processing of temperature and reflectance is a multi-step process and is outlined below.

- Calibrate visible and thermal infrared data from count values to science units.
- Screen the data for image quality.
- Calculate temperatures and reflectances.
- Navigation/registration images to project on a rectangular map.

- Scale temperatures and reflectances.
- Produce GIF images of temperatures and reflectances.
- Post images on LSU Web site (http://www.esl.lsu.edu/research/empact.html).

[Source: EMPACT 1st Year Report, Satellite Remote Sensing of Surface Water Temperature, Surface Reflectance, and Chlorophyll a Concentrations: Southeastern Louisiana, Nan D. Walker, Adele Hammack, and Soe Myint, November 2000.]

SeaWiFS - The Orbview-2 satellite broadcasts SeaWiFS data in real time to the GSFC HRPT Station as well as other stations. LSU receives the SeaWiFS data in real-time via their satellite. LSU uses the SeaSpace TeraScan^{TM} software suite to process (calibrate and atmospherically correct) and visualize the SeaWiFS data. The software is based upon the SeaDAS software used by NASA. The NASA OC2 algorithm is used to estimate chlorophyll *a* concentrations with the 490 and 555 nm bands (O'Reilly et al., 1998).

[Source: EMPACT 1st Year Report, Satellite Remote Sensing of Surface Water Temperature, Surface Reflectance, and Chlorophyll a Concentrations: Southeastern Louisiana, Nan D. Walker, Adele Hammack, and Soe Myint, November 2000.]

4.3.3 Data Interpretation

Wind measurements from monitoring stations are used to interpret the image patterns and to write the monthly text that is provided on the LSU Web site. The hourly time-series measurements at the Lake Salvador monitoring station are obtained from the USGS and used to interpret the satellite data.

[Source: EMPACT 1st Year Report, Satellite Remote Sensing of Surface Water Temperature, Surface Reflectance, and Chlorophyll a Concentrations: Southeastern Louisiana, Nan D. Walker, Adele Hammack, and Soe Myint, November 2000.]

4.3.4 Ground Truthing

Ground truthing is a process of comparing and correlating satellite data to actual field measurements. Ground truthing of sea temperatures in the Jefferson Parish project showed very similar results when comparing satellite and field measurements of surface sea temperatures taken at the eight sampling points shown in Figure 3.7. The linear regression of the temperature data-sets using 173 data points show a strong statistical linear correlation with an R^2 of 0.951. However, the satellite reflectance values, when compared to YSI turbidity field measurements, were not very similar ($R^2 = 0.43$). The differences are thought to result from several factors. For example, the satellite reflectance measurements were made at 580-680 nm and are related to light reflected from near the water surface by suspended material in the water column. The YSI probe measures backscatter from particles suspended in the water column (4 feet below the surface) in the 830-890 nm region. Other factors, which affect the satellite reflectances and YSI backscatter results, include the concentration of inorganic and organic material, type of inorganic sediment (clay, silt, and sand), and additional pigments (e.g., from other chlorophyll and colored dissolved organic matter).

[Source: EMPACT 1st Year Report, Satellite Remote Sensing of Surface Water Temperature, Surface Reflectance, and Chlorophyll a Concentrations: Southeastern Louisiana, Nan D. Walker, Adele Hammack, and Soe Myint, November 2000.]

The mapping of chlorophyll *a* with SeaWiFS in coastal regions requires extensive collection of water samples to validate the technique and develop regional algorithms if necessary. The SeaWiFS radiance data is collected in 6 visible channels which can be used to map suspended solids, suspended sediments and chlorophyll *a*. On April 26, 2000, a SeaWiFS ground truth experiment was conducted in Barataria Bay and the coastal ocean, seaward of the bay. The satellite-derived chlorophyll *a* estimates using SeaWiFS were very similar to the chlorophyll *a* concentrations of the field samples.

A cubic regression model yielded the best relationships between field and satellite data, with a an R^2 of 0.92. However, the correlation was not as strong for chlorophyll values measured in Lakes Cataouche and Salvador, probably due to higher concentration of colored dissolved organic matter.

Turbidity was estimated from two SeaWiFS channels (555 nm and 670 nm). Regression analysis revealed that the 670 nm channel yielded the highest statistical relationship between the satellite and field measurements. (R^2 of 0.84 - nonlinear power relationship).

[Source: EMPACT 1st Year Report, Satellite Remote Sensing of Surface Water Temperature, Surface Reflectance, and Chlorophyll a Concentrations: Southeastern Louisiana, Nan D. Walker, Adele Hammack, and Soe Myint, November 2000.]

4.3.5 Data Transfer

As discussed earlier, the LSU ESL receives the NOAA AVHRR and SeaWiFS satellite data. Through a sequence of processing steps computations are made of surface temperature, surface reflecance and chlorphyll a. GIF images are posted on the LSU Web site in quasi real-time.

The GSFC EOS DAAC is responsible for the distribution of SeaWiFS data to all approved SeaWiFS data users.

4.3.6 Data Management

The NOAA AVHRR temperature and reflective imagery is provided on the LSU Web site usually the same day the data are received (i.e., almost real-time). Dr. Walker provides interpretive text with the imagery to assist the public in understanding the image pattern.

The GSFC EOS DAAC is responsible for permanently archiving and distributing the SeaWiFS data. LSU processes the SeaWiFS data as they are received; however because the data have a 14 day embargo period, they are not available in real-time nor are they posted on the LSU Web site.

4.4 Water Quality Field Sampling

Water samples for lab analysis are taken weekly from eight stations in Lake Salvador and Lake Cataouche. (Cataouche is a smaller lake to the north of Salvador (Figure 3.7). Both lie in the direct flow path of the Davis Pond Diversion.) Collection stations were chosen by Dr. Chris Swarzenski, a scientist with USGS, who has been doing marsh grass research in the area for the past 15 years to compliment and augment monthly monitoring in the area by others (USACE, Louisiana Department of Natural Resources, United States Park Service, and Turner).

Additionally samples are taken from the upper Barataria Basin to the Gulf of Mexico during two separate collection dates during the summer months when conditions are most conducive to phytoplankton growth. These weekly and special event samples are to "surface truth" the satellite reflectance measurements and to relate the digital measurements of turbidity and fluorescence to suspended solids and chlorophyll *a*. These water samples provide baseline information on variations in water quality in the study region before the opening of the Davis Pond Diversion.

4.4.1 Water Quality Analyses

The LSU-CEI laboratory analyzes the field water samples for the following parameters: (1) water salinity; (2) pigments (chlorophyll *a* and phaeophytin a); (3) suspended load (sediment and organic); (4) carbon (total, inorganic, and total organic carbon); and (5) nutrients (Ammonium, Nitrate, Nitrite, Phosphate, and Silicate). The analytical techniques used to conduct the water quality analyses are described below.

Salinity/Conductivity

Salinity or conductivity of each sample is measured upon return to the laboratory using a Haake-Buchler Digital Chloridimeter® [http://www.analyticon.com/manurefv.html]. This device measures the amount of chloride in the sample by titrating it with silver. Salinity measurements are necessary to interpret the circulation and bulk impacts of the freshwater diversion.

pH

A Corning Model pH-30 waterproof pH meter is used to measure pH of the samples upon return to the laboratory [http://www.scienceproducts.corning.com]. The pH measurements are necessary to convert the total carbon dioxide measurements to alkalinity.

Chlorophyl *a* and Pheo-Pigments

Chlorophyll *a* containing plankton are concentrated from a volume of water by filtering at a low vacuum through a glass fiber filter (GFF). The pigments are extracted from the phytoplankton using a solution of 60% Acetone and 40% dimethyl sulfoxide (DMSO). The samples are allowed to steep for 2 to 24 hours (maximum) to extract the chlorophyll *a*. The samples are then centrifuged to clarify the solution. The fluorescence is then measured before and after acidification with 0.1 N HCl. The fluorescence readings are then used to calculate the concentration (in ug/l) of chlorophyll *a* and pheophytin *a* in the sample extract. This procedure is a modification of EPA method 445.0 (Arar and Collins 1992) in which DMSO is used in lieu of grinding for extraction of the pigments.

Suspended Load

The suspended load is determined by filtering a known volume of water through a combusted (550C) and pre-weighed glass fiber filter (Whatman Type GF/F or equivalent). The filters are dried (at 60C) then re-weighed to determine total suspended load in mg/l. The filters are then combusted at 550C, cooled, then re-weighed to determine organic suspended load (APHA, 1992). The sediment or non-organic suspended load is determined by subtracting the organic suspended load from the total suspended load.

Carbon

Total carbon (TC) is measured by employing High Temperature Catalytic Oxidation (HTCO) using a Shimadzu® TOC-5000A analyzer [http://www.ssi.shimadzu.com]. The machine operates by combusting the water sample (at 680 centigrade) in a combustion tube filled with a platinum-alumina catalyst. The carbon in the sample is combusted to CO_2, which is detected by a non-dispersive infrared gas analyzer (NDIR) that measures the total amount of carbon in the sample. Inorganic carbon (IC) is analyzed by first treating the sample with phosphoric acid (to remove organic carbon) and then performing the above analysis to obtain the total amount if inorganic carbon in the sample. Total organic carbon (TOC) is obtained by subtracting the IC value from the TC value.

Nutrients

The water samples are analyzed for nutrients with a Technicon Auto-Analyzer II [http://www.labequip.com] using the methods listed in Table 4.5 for each nutrient:

Table 4.5. Methods and Detection Limits for Nutrient Analyses

Nutrient Limit	Method	Detection
Nitrate-Nitrite	EPA Method 353.2	0.05 mg/l
Nitrite	EPA Method 353.2	0.05 mg/l

Ammonia	EPA Method 350.1	0.01 mg/l
Silicate	Technicon Method 186-72W/B	0.03 mg/l
Phosphorus	EPA Method 365.2	0.01 mg/l

4.4.2 Phytoplankton Identification

Water samples are also sent to Louisiana University Marine Observatory Consortium (LUMCON) where the harmful algal species present in the sample are identified by Dr. Quay Dortch. The Gulf of Mexico Program is currently providing funds to support this research.

Prior experience in counting phytoplankton in Louisiana coastal waters shows that the phytoplankton range in size from 1 µ to greater than 100 µ with the tiny phytoplankton often dominating the biomass. Traditional methods of counting phytoplankton have missed or underestimated these small phytoplankton, whereas the more recently developed epifluroescence methods can be used to count both small and large phytoplankton. Table 4.6 shows common phytoplankton groups counted in each size fraction. Methods other than the epifluroescence method, such as differential interference contrast (DIC) or scanning electron microscope (SEM), can also be used for identification when necessary.

The method for preserving and counting phytoplankton is adapted from Murphy and Haugen (1985), Shapiro and Haugen (1988), and Shapiro et al. (1989). In this method, one hundred milliliters of seawater are preserved with 50% glutaraldehyde to a final concentration of 0.5% (by volume) and refrigerated until samples are processed. One aliquot of sample is filtered through a 3 µm polycarbonate filter and onto a 0.2 µm polycarbonate filter without prior staining. The 3 µm filter is discarded and the 0.2 µm filter retained (0.2 to 3 µm size fraction). Another aliquot of sample is filtered through an 8 µm polycarbonate filter and then a 3 µm filter; both filters are retained (3 to 8 and >8 µm size fractions). Before filtration this aliquot is made up to 25 ml with filtered water of approximately the same salinity and stained with 0.05 ml proflavine monohydrochloride (Sigma P-4646, 1.5 g/liter in distilled, de-ionized water). If possible, all samples are filtered without vacuum, but if necessary, <100 mm vacuum is applied. All filters are transferred to slides and mounted with low fluorescence, low RFA epi-fluorescence microscope [http://www.olympus.co.jp] with blue and green excitation (excitation filters BP-490 and BP-545, barrier filters O-515 and O-590, and dichromatic mirrors DM500 and DM580, respectively). The 0.2 and 3 µm pore size filters are counted immediately at 1000x. The 8 µm pore size filters are stored frozen and counted as soon as possible. Three different counts are made on the 8 µm filters, using different magnification and counting different areas of the filter, in order to adequately count small, abundant organisms, as well as large, rarer organisms. To avoid counting an organism more than once they are separated according to length. Phytoplankton is identified to the nearest possible taxon and the previous table describes the types of organisms usually observed in each size fraction. It is possible for some groupings of taxa and even individual species, to be present in more than one size fraction, if the size of colonies or individuals varies considerably or if they occurred both singly and in aggregates of sediment, organic matter and cells. The 0.2 and 3 µm filters are discarded after counting, because they quickly become uncountable; 8 µm filters are archived frozen

Table 4.6. Common Phytoplankton Groups Counted in each Size Fraction

Size	Phytoplankton Groups
0.2-3 µm	Coccoid cyanobacteria -- mostly Synechococcus Autotrophic eukaryotes Heterotrophic eukaryotes
3-8 µm	Photosynthetic flagellates and non-flagellates Heterotrophic flagellates and non-flagellates Cryptomonads Athecate dinoflagellates Diatoms Coccoid cyanobacteria
> 8 µm Diatoms	Dinoflagellates Ciliates Cryptomonads Colonial cyanobacteria Colonial, freshwater chlorophytes Coccoid cyanobacteria [1]

[1] Many coccoid cyanobacteria occur in aggregates, especially when suspended particulate matter concentrations are high, which do not break up during size fractionation.

at Louisiana Universities Marine Consortium.

4.4.3 Data Transfer and Management

The personnel collecting the water samples complete a field documentation form, of which one copy is kept on file by Jefferson Parish and one copy accompanies the samples to the lab. These water samples are delivered to the LSU-CEI laboratory within 6 hours of collection and are stored on ice or in a refrigerator until analyzed for corruptible analytes. The LSU-CEI laboratory has existing QA/QC plan approved under EPA project X-9996097-01. The processing for Chlorophyll *a* begins within 12 hours of sample delivery, and usually within 1 hour. The dissolved nutrient samples are stored frozen until analysis, usually within 2-4 weeks (sample analysis is more economical if done in batches of >50 samples).

Sub-samples of the water samples are sent to LUMCON immediately after sample collection for identification of harmful algal species. The Gulf of Mexico Program is currently providing funds to support this research. Project funds are used to interpret this data set and make it available to the public via the Internet; interpretive text is written or reviewed by Dr. Dortch.

LSU-CEI provides quarterly reports of all data (with allowances for a one month delay in processing and QA and QC) to the project manager at Jefferson Parish. Graphical summaries of each parameter, averaged for each lake, are updated within one week of laboratory analysis, but are subject to subsequent QA/QC procedures. Monthly graphics of key parameters are sent to the EMPACT manager for Jefferson Parish. A tabular summary of samples received, status and completion are maintained as part of a routine chain-of-custody procedure. Data are also presented on an LSU Web page linked to the Jefferson Parish EMPACT home page.

Jefferson Parish disseminates the monthly graphics of key parameters to the Jefferson Parish Marine Fisheries Advisory Board, the Davis Pond Freshwater Diversion Advisory Committee, Louisiana Department of Health and Hospitals and other stakeholders as requested, for their review and feedback.

Plots of the weekly field water sampling data from August 19, 1999 through August 17, 2000 are available on the LSU-CEI Web site at [http://its2.ocs.lsu.edu/guests/ceilc/].

The EPA is in the planning stages to make such data available through their EMPACT website [http://www.epa.gov/empact]. Currently, the EMPACT website has a link to the Jefferson Parish website.

NEXT CHAPTER

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5.1 | 5.2

5. DEVELOPING IMAGES TO PRESENT WATER QUALITY MONITORING DATA

Once your water quality monitoring network is in place and you have collected or received the resulting data, you can provide your community with time-relevant water quality information using data visualization tools to graphically depict this information. Using data visualization tools, you can create graphical representations of water quality data that can be downloaded on Web sites and/or included in reports and educational/outreach materials for the community. The types of data visualization software used by the Jefferson Parish EMPACT team are Microsoft Excel and SeaSpace's TeraScan^{TM} satellite imagery software.

Section 5.1 provides a basic introduction and overview to data visualization and is useful if you are interested in gaining a general understanding of data visualization. Section 5.2 contains an introduction to the software data visualization tools used on the Jefferson Parish EMPACT project. You should consult Section 5.2 if you are responsible for choosing and using data visualization software to model and analyze your data.

5.1 What is Data Visualization?

Data visualization is the process of converting raw data to images or graphs so that the data are easier to comprehend and understand. A common example of data visualization can be seen when you watch the weather report on television. The electronic pictures of cloud cover over an area or the location and path of an impending hurricane are examples of satellite data that have been visualized with computer software. Displaying data visually enables you to communicate results to a broader audience, such as residents in your community. A variety of software tools can be used to convert data to images. Such tools range from standard spreadsheet and statistical software to more advanced analytical tools such as:

- Satellite imaging software products
- Geographic Information Systems (GIS)
- Computer Models
- Statistical techniques

By applying such tools to water quality data, you can help residents in your community gain a better understanding of factors affecting the water quality in area lakes or nearby estuaries (e.g., chlorophyll *a* or turbidity). Once you begin using satellite data visualization tools, you will be impressed with their ability to model and analyze your data. You can then use the visualized data for a variety of purposes such as:

- Exploring trends in lake elevation, chlorophyll concentration, pH, dissolved oxygen concentration, salinity, specific conductance, turbidity, and water temperature.
- Studying spatial patterns of sea-surface temperature.
- Studying spatial patterns of near-surface reflectance.
- Making resource management decisions.
- Supporting public outreach and education programs.

There are a number of commercially available data visualization tools that allow you to graphically represent real-time satellite data. Section 5.2 focuses on the software tools which were used to visualize the satellite data in the Jefferson Parish EMPACT project. These software tools are listed in Table 5.1 below.

Table 5.1. Software Tools to Visualize Satellite Data

Tool Group	Tools	Primary Uses
SeaSpace's TeraScan^{TM} Software Suite http://www.seaspace.com	TeraCapCon	Enables the user to program the system for automatic capture, archiving, and processing of the satellite data.
	TeraTrack	Reports the information related to a satellite pass capture; reports information that can be used for diagnosing reception problems;

		insures quality control performance.
	TeraMaster	Views, creates, or modifies a data set that defines an area of the earth's surface in terms of map projection (shape), extends, and pixel resolution.
	TeraScan^{TM} Product Generation System (TeraPGS)	Automatically generates and distributes products according to user specifications.
	TeraVision	Displays and manipulates data images and overlays.
Database and Spreadsheet Software	Microsoft Access Microsoft Excel	Displays raw data (parameters) from Lake Salvador in tables. Creates 1- to 7-day summary hydrographs of various Lake Salvador data. Allows to Investigate correlations or trends in water quality variables.

Many computer users are familiar with Microsoft Access (a database software) and Excel (a spreadsheet software). For this reason, the remainder of this chapter will only focus on the satellite imagery software.

5.2 Satellite Acquisition, Processing, and Visualization Software

There are various vendors which offer satellite data visualization software. The USGS also posts visualized satellite data on their Web site. This section discusses only the satellite data acquisition, processing, and visualization software used for the Jefferson Parish EMPACT project.

As mentioned earlier, the Jefferson Parish Project utilized the SeaSpace's TeraScan^{TM} software suite. This software can be used to acquire, process, visualize and disseminate the AVHRR and SeaWiFS satellite data. Provided below is a description of the TeraScan^{TM} software suite. More information about this software can be found on SeaSpace's Web site (http://www.seaspace.com).

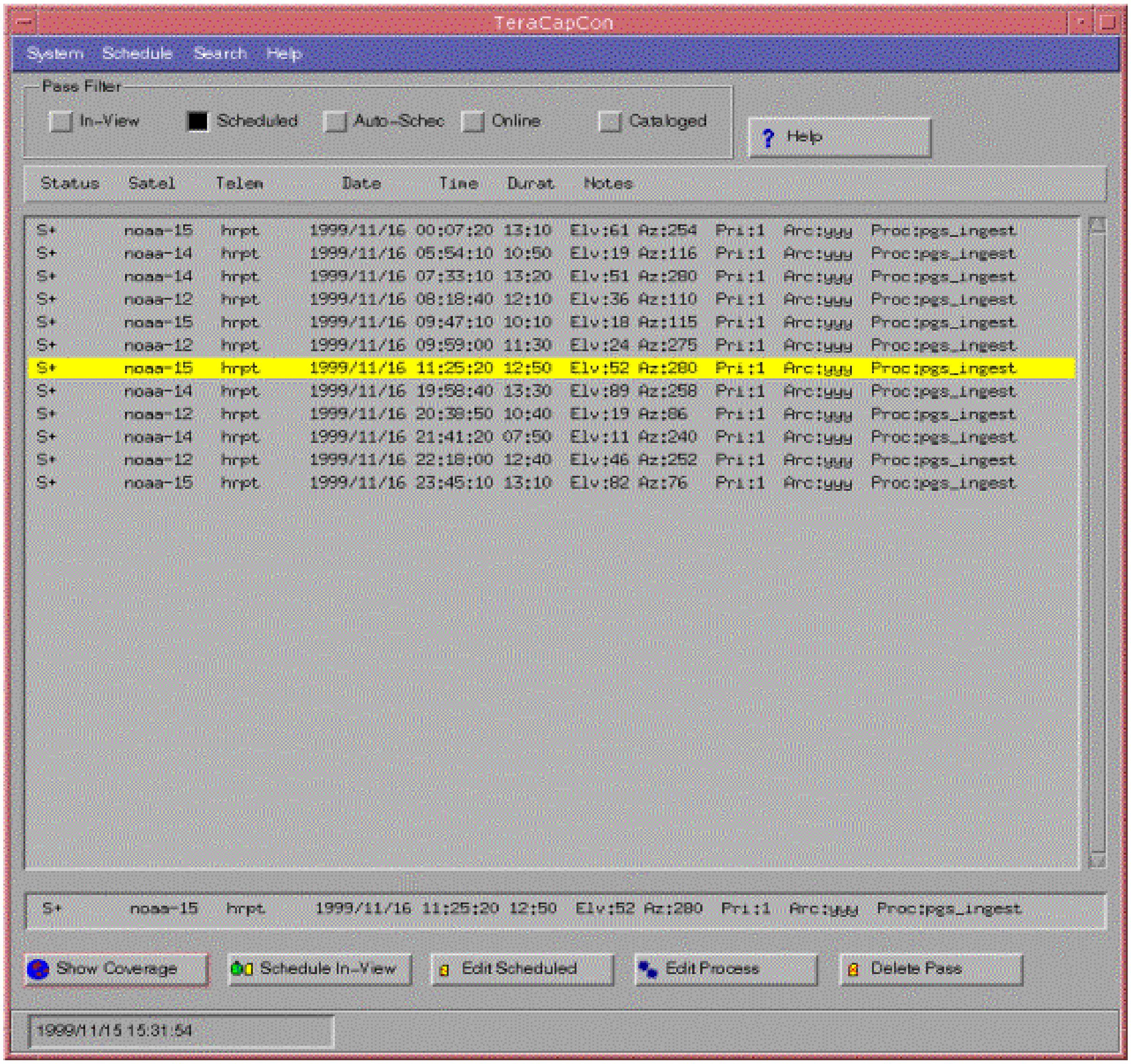
TeraCapCon

TeraCapCon is the graphical user interface (GUI) that provides automatic, "hands-off" scheduling and archiving of satellite data. With TeraCapCon, the user can define the autoscheduling parameters that govern the daily acquisition (or capture) of the satellite data. Such parameters include the following:

- Which satellites to select for data collection,
- The minimum satellite elevation at the satellite's highest point relative to the receiver,
- The minimum sun elevation,
- The time of day when the data are to be collected,
- The number of days of passes to be obtained,
- Whether or not the data should be archived on tape,
- Specify which processing script to run on the data.

These autoscheduling parameters can be easily edited. In addition, the user can view the upcoming swath of the pass from a polar orbiting satellite. Figure 5.1 is a screen shot from the TeraCapCon software.

Figure 5.1. TeraCapCon Screen Shot



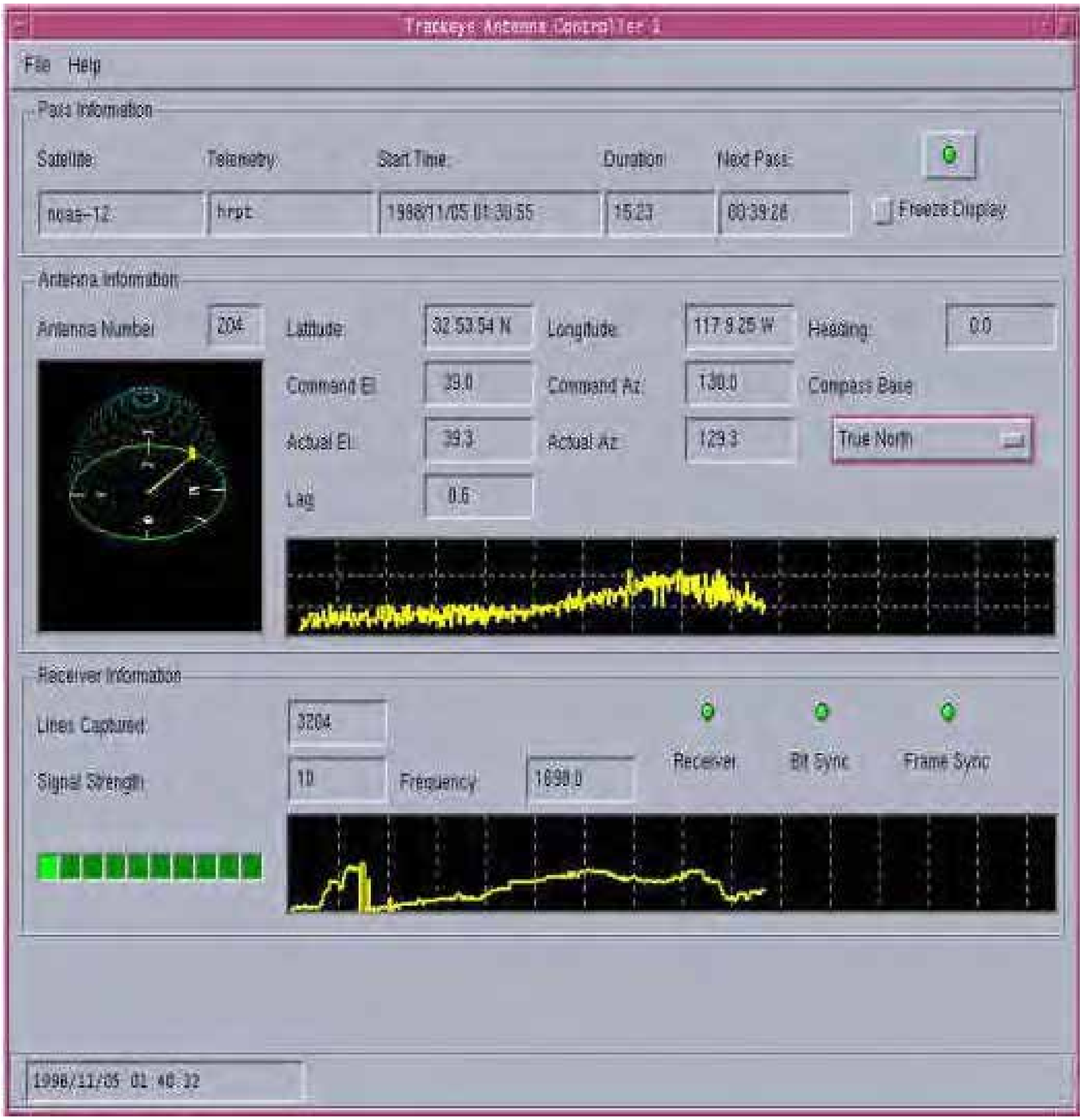
```
Status   Satel     Telem        Date       Time     Durat   Notes
S+       noaa-15   hrpt     1999/11/16 00:07:20 13:10  Elv:61 Az:254  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-14   hrpt     1999/11/16 05:54:10 10:50  Elv:19 Az:116  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-14   hrpt     1999/11/16 07:33:10 13:20  Elv:51 Az:280  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-12   hrpt     1999/11/16 08:18:40 12:10  Elv:36 Az:110  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-15   hrpt     1999/11/16 09:47:10 10:10  Elv:18 Az:115  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-12   hrpt     1999/11/16 09:59:00 11:30  Elv:24 Az:275  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-15   hrpt     1999/11/16 11:25:20 12:50  Elv:52 Az:280  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-14   hrpt     1999/11/16 19:58:40 13:30  Elv:89 Az:258  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-12   hrpt     1999/11/16 20:38:50 10:40  Elv:19 Az:86   Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-14   hrpt     1999/11/16 21:41:20 07:50  Elv:11 Az:240  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-12   hrpt     1999/11/16 22:18:00 12:40  Elv:46 Az:252  Pri:1  Arc:yyy  Proc:pgs_ingest
S+       noaa-15   hrpt     1999/11/16 23:45:10 13:10  Elv:82 Az:76   Pri:1  Arc:yyy  Proc:pgs_ingest

S+       noaa-15   hrpt     1999/11/16 11:25:20 12:50  Elv:52 Az:280  Pri:1  Arc:yyy  Proc:pgs_ingest

1999/11/15 15:31:54
```

[**Image Courtesy of SeaSpace Corporation**].

TeraTrack

TeraTrack is the GUI that reports information used for diagnosing reception problems and insuring quality control performance. Such information related to the satellite pass capture includes signal strength, lag time between the actual pointing direction of the antenna and the commanded pointed direction. The software also displays the functionality of the receiver, synchronizer, and frame synchronizer. Figure 5.2 is a screen shot from the TeraTrack software, which provides satellite pass information, antenna information, and receiver information.

Figure 5.2. TeraTrack Screen Shot


Trackeye Antenna Controller 1
File
Help
Pass Information
Freeze Display
Antenna Information
Compass Base
Receiver Information
Receiver
Bit Sync
Frame Sync

Satellite: noaa-12
Telemetry: hrpt
Start Time: 1998/11/05 01:30:55
Duration: 15:23
Next Pass: 00:39:28

Antenna Number: 204
Latitude: 32 53 54 N
Longitude: 117 8 25 W
Heading: 0.0
Command El: 39.0
Command Az: 130.0
Compass Base: True North
Actual El: 39.3
Actual Az: 129.3
Lag: 0.6

Lines Captured: 3204
Signal Strength: 10
Frequency: 1698.0

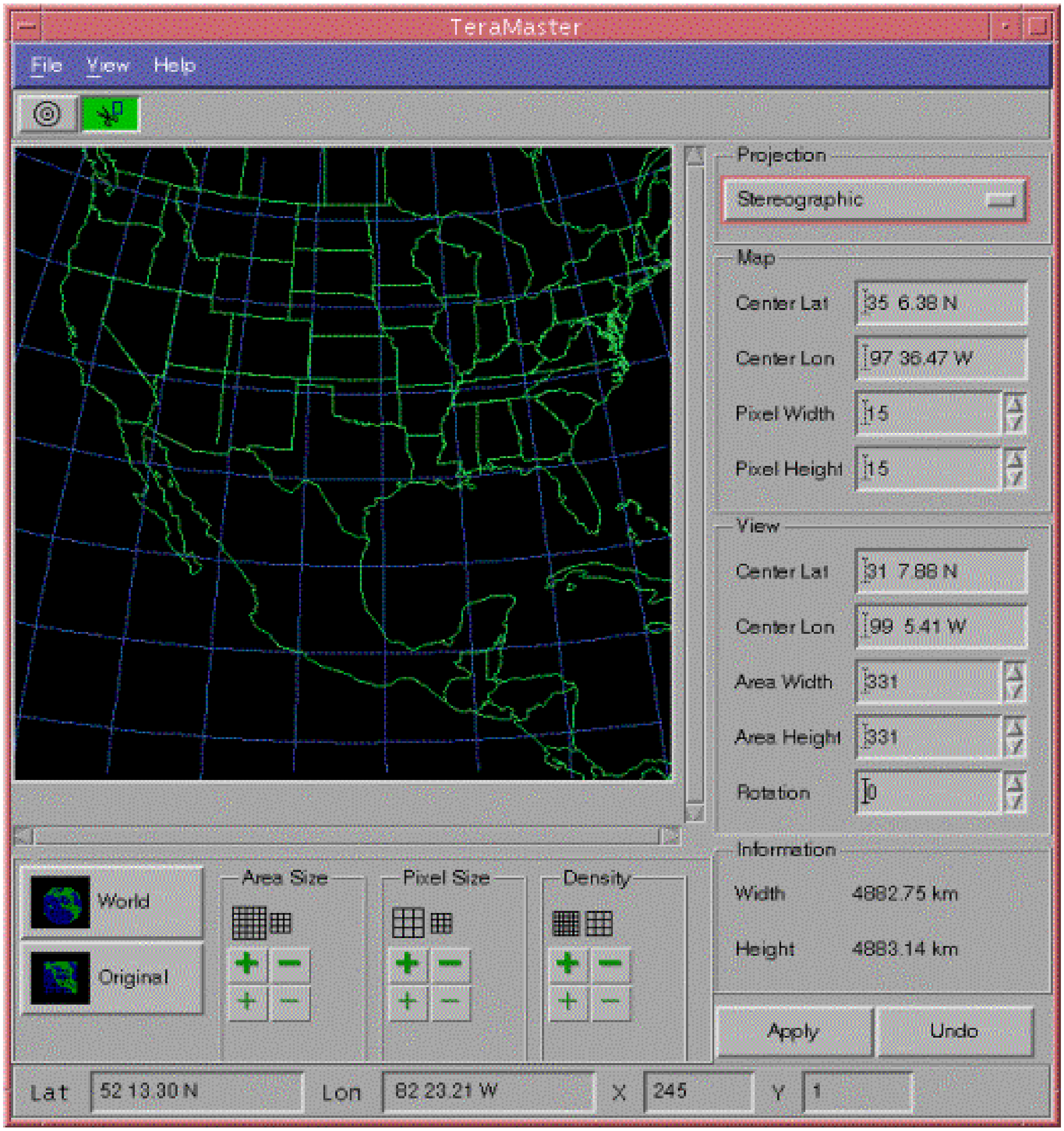
1998/11/05 01 40 32

[**Image Courtesy of SeaSpace Corporation].**

TeraMaster

TeraMaster is a GUI for viewing, creating, or modifying a data set that defines an area of the earth's surface in terms of map projection (shape), extents, and resolution. This data set is referred to as a master. The user can specify a master area anywhere in the world by using the computer mouse or entering latitudes and longitudes into the data fields. Figure 5.3 is a screen shot of the TeraMaster software.

Figure 5.3. TeraMaster Screen Shot


TeraMaster
File
View
Help
Projection
Map
View
Information
World
Original
Area Size
Pixel Size
Density
Apply
Undo

Projection: Stereographic

Map

Center Lat: 35 6.38 N
Center Lon: 97 36.47 W
Pixel Width: 15
Pixel Height: 15

View

Center Lat: 31 7.88 N
Center Lon: 99 5.41 W
Area Width: 331
Area Height: 331
Rotation: 0

Information

Width: 4882.75 km
Height: 4883.14 km

Lat: 52 13.30 N
Lon: 82 23.21 W
X: 245
Y: 1

[**Image Courtesy of SeaSpace Corporation**].

TeraScan^{TM} Product Generation System (TeraPGS)

TeraPGS automatically generates and distributes products (TeraScan^{TM} data sets and picture products) according to the specifications provided by the user. The picture products can be produced in any of the following formats:

- JPEG
- TIFF
- MARTA-PCX
- GIF
- PNG
- PostScript

TeraPGS has three primary components: (1) the GUI, (2) the product-generation (processing) scripts, and (3) the distributor.

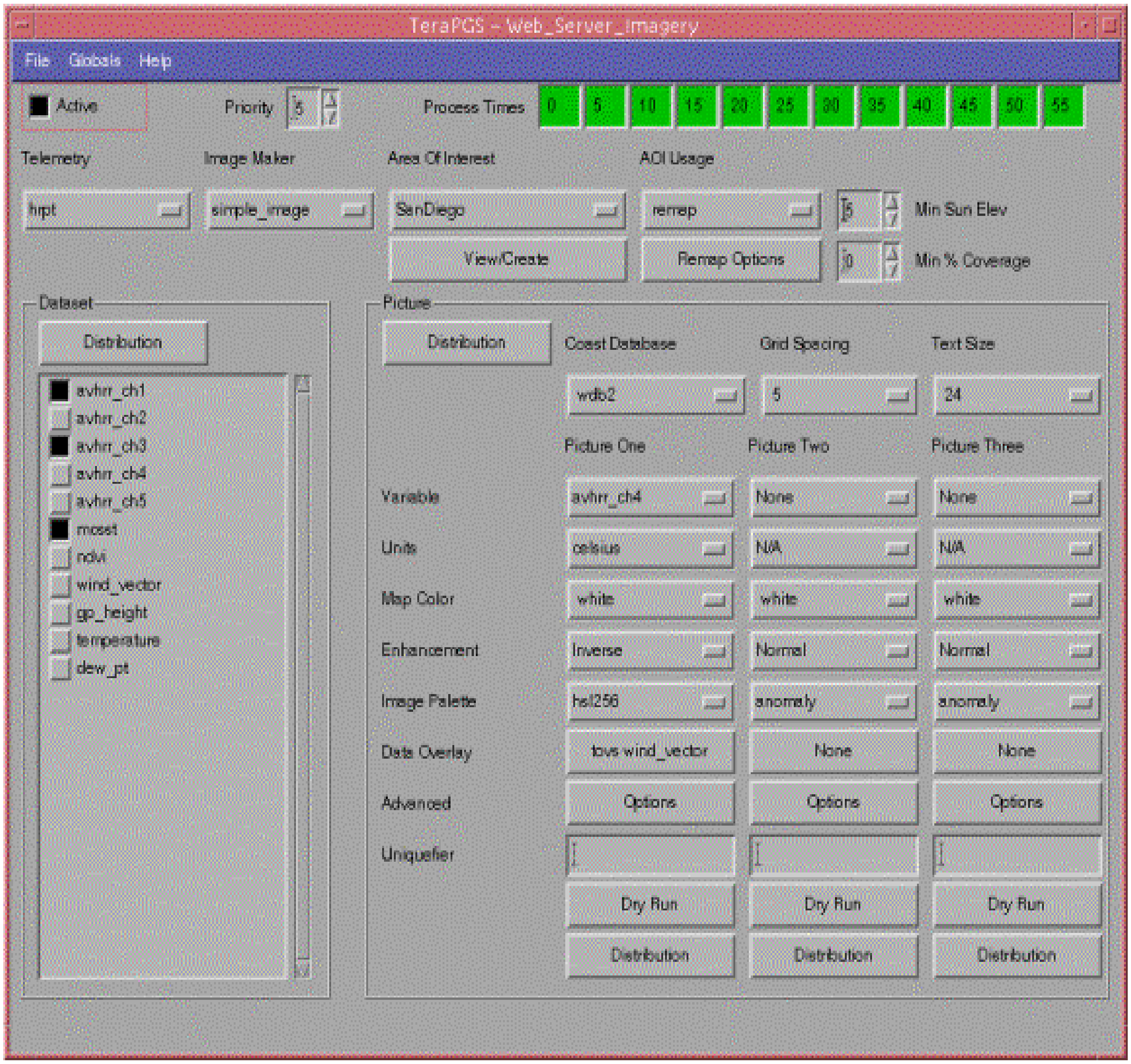
TeraPGS - GUI: The GUI allows the user to create, edit and store product definitions. These product definitions can dictate which TeraScan^{TM} data set to use and the type of picture representations to be generated from the data. The software has a "dry run" feature, which allows the user to test product definitions by generating and displaying the product locally prior to being sent to a delivery destination (e.g., Web site, database, or archive). The types of definition parameters include the following:

- Data selection by telemetry and variable, by time window, by geographic coverage, and by minimum sun elevation.
- Options for picture products.
- Data unit, palette, and enhancement selection.
- Delivery destinations and times.
- Notification of delivery success and/or failure.

Figure 5.4 is a screen shot of the TeraPGA - GUI.

TeraPGS - Product Generation (Processing) Scripts: The processing script generates either data sets or picture products according to the product definitions prescribed via the GUI. The software automatically logs the processing progress and notifies the user (via e-mail) in the event of a failure.

Figure 5.4. TeraPGS - GUI Screen Shot



■ Active

Priority: 5

Process Times: 0 5 10 15 20 25 30 35 40 45 50 55

Telemetry: hrpt

Image Maker: simple_image

Area Of Interest: SanDiego

AOI Usage: remap

Min Sun Elev: 5

Min % Coverage: 0

Dataset

■ avhrr_ch1
☐ avhrr_ch2
■ avhrr_ch3
☐ avhrr_ch4
☐ avhrr_ch5
■ mcsst
☐ ndvi
☐ wind_vector
☐ gp_height
☐ temperature
☐ dew_pt

Picture

Coast Database: wdb2

Grid Spacing: 5

Text Size: 24

	Picture One	Picture Two	Picture Three
Variable	avhrr_ch4	None	None
Units	celsius	N/A	N/A
Map Color	white	white	white
Enhancement	Inverse	Normal	Normal
Image Palette	hsl256	anomaly	anomaly
Data Overlay	tovs wind_vector	None	None
Advanced	Options	Options	Options
Uniquefier			

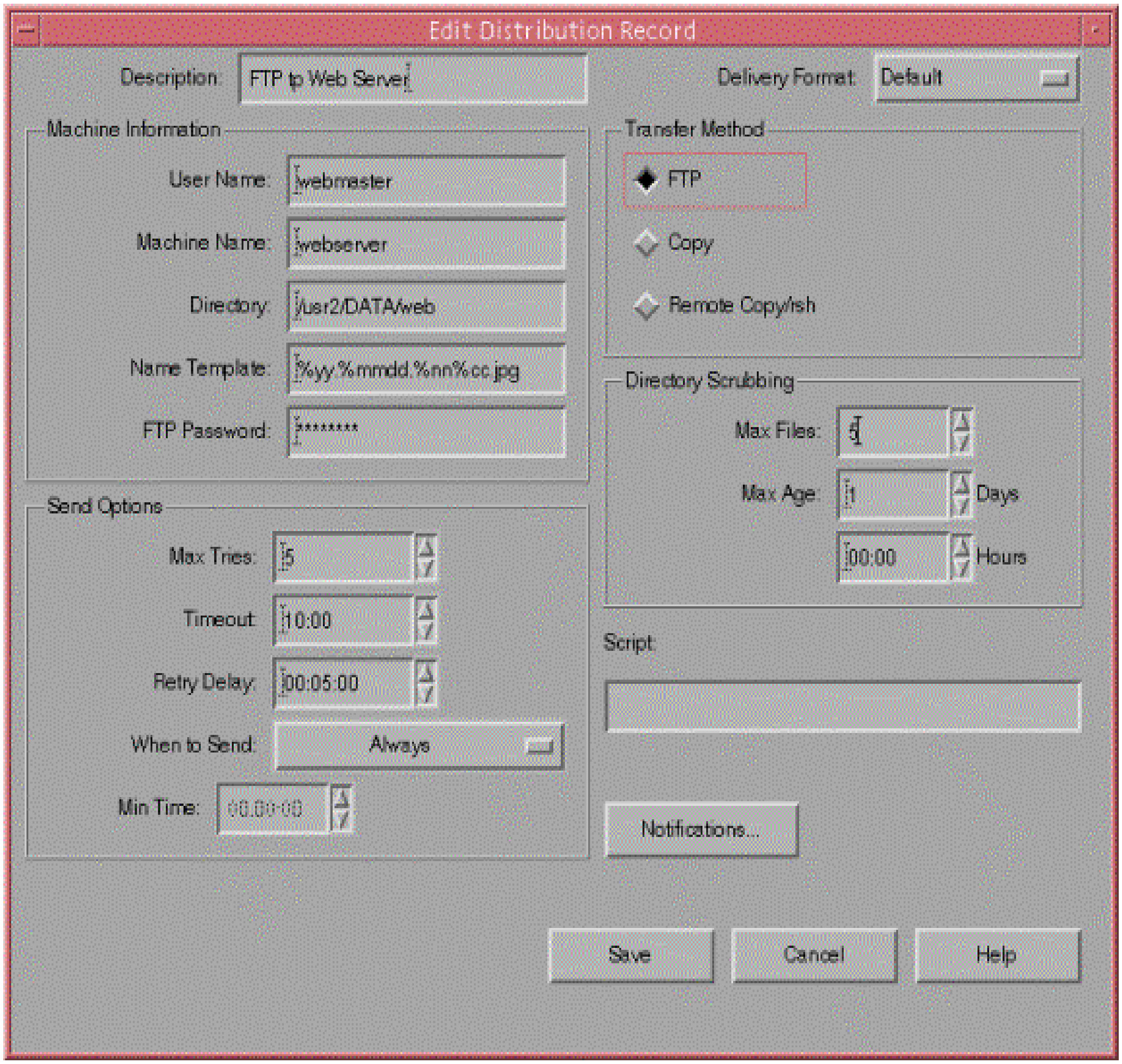
[Image Courtesy of SeaSpace Corporation]

TeraPGS - Distributor: The distributor is a server that manages the delivery of the products (e.g., data sets or pictures). The distributor's features include:

- Delivery of up to 50 products simultaneously to multiple users.
- Delivery of both data sets and picture products via FTP, copy, or remote copy.
- Data delivery retry options.

Figure 5.5 is a screen shot from the TeraPGS' Distributor software.

Figure 5.5. TeraPGS - Distributor Screen Shot



Description: FTP to Web Server
Delivery Format: Default

User Name: webmaster
Machine Name: webserver
Directory: /usr2/DATA/web
Name Template: %yy%mmdd.%nn%cc.jpg
FTP Password: ********

◆ FTP
◇ Copy
◇ Remote Copy/rsh

Max Files: 5
Max Age: 1 Days
00:00 Hours

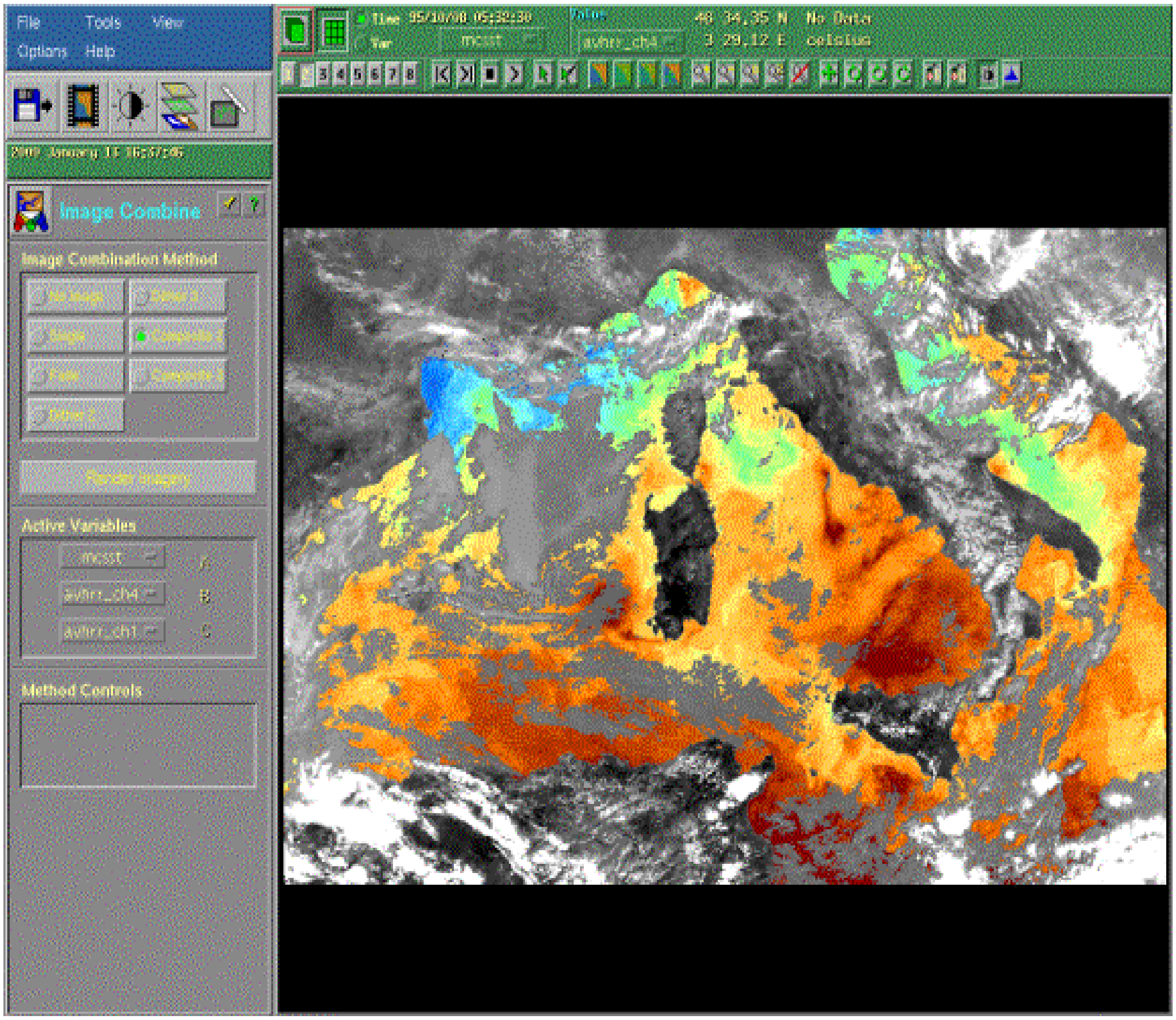
Max Tries: 5
Timeout: 10:00
Retry Delay: 00:05:00
When to Send: Always
Min Time: 00:00:00

[Image Courtesy of SeaSpace Corporation]

TeraVision

TeraVision displays and manipulates data as images and overlays. Data can be presented as overlay images such as coast lines, contours, vectors, and stream plots. To enhance the user's understanding of the data, the software allows them to add a legend or to label areas of interest (e.g., sampling stations and lakes.) The software also has data analysis tools for generating and displaying histogram plots, profile plots, Skew-T diagrams, and scatter plots. To look for trends, LSU uses TeraVision to sequence visualized data of the same area at different times. Such trend analyses assist LSU when interpreting the data. Images can be enhanced via color palettes, convolution filters, and histogram equalization and printed to any color or black-and-white PostScript Level 2 printer. Figure 5.6 is a screen shot of the TeraVision software.

Figure 5.6. TeraVision Screen Shot


File
Tools
View
Options
Help
Time 95/10/08 05:32:30
Var
mcsst
Value
avhrr_ch4
48 34.35 N
3 29.12 E
No Data
celsius
Image Combine
Image Combination Method
Composite 2
Composite 3
Render Imagery
Active Variables
mcsst
A
avhrr_ch4
B
avhrr_ch1
C
Method Controls

[**Image Courtesy of SeaSpace Corporation**]

Training

SeaSpace offers basic hands-on, instructor-led training courses for its TeraScan^{TM} software. Such courses include a 4-day Scientific Training Program, a 3-day Operational/Forecasting Training Program, and an Operational program consisting of 2 half day sections. SeaSpace also offers customized training upon request. For more information about TeraScan^{TM} training see the following Web site: http://www.seaspace.com/service/ support/training.shtml.

NEXT CHAPTER

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6.1 | 6.2 | 6.3

6. COMMUNICATING TIME-RELEVANT WATER QUALITY INFORMATION

In addition to designing and implementing a time-relevant water quality monitoring system, you will also want to consider how and what types of data to communicate to the community. This chapter is designed to help you develop an approach for communicating pertinent water quality information to people in your community, or more specifically, your target audience. This chapter provides the following:

- The steps involved in developing an outreach plan.
- Guidelines for effectively communicating information.
- Resources to assist in promoting community awareness.
- The outreach initiatives implemented by the Jefferson Parish Team.

6.1 Developing an Outreach Plan for Time-Relevant Water Quality Reporting

Your outreach program will be most effective if you ask yourself the following questions:

- Who do you want to reach? (i.e., Who is your target audience?)
- What information do you want to distribute or communicate?
- What are the most effective mechanisms to reach my target audience?

Developing an outreach plan ensures that you have considered all important elements of an outreach project before you begin. The plan itself provides a blueprint for action. An outreach plan does not have to be lengthy or complicated. You can develop a plan simply by documenting your answers to each of the questions discussed below. This will provide you with a solid foundation for launching an outreach effort.

Your outreach plan will be most effective if you involve a variety of people in its development. Where possible, consider involving:

- A communications specialist or someone who has experience developing and implementing an outreach plan.
- Technical experts in the subject matter (both scientific and policy).
- Someone who represents the target audience (i.e., the people or groups you want to reach).
- Key individuals who will be involved in implementing the outreach plan.

As you develop your outreach plan, consider whether you would like to invite any organizations to partner with you in planning or implementing the outreach effort. Potential partners might include shoreline and lakeshore property owner associations, local businesses, environmental organizations, schools, boating associations, local health departments, local planning and zoning authorities, and other local or state agencies. Partners can participate in planning, product development and review, and distribution. Partnerships can be valuable mechanisms for leveraging resources while enhancing the quality, credibility, and success of outreach efforts. Developing an outreach plan is a creative and iterative process involving a number of interrelated steps, as described below. As you move through each of these steps, you might want to revisit and refine the decisions you made in earlier steps until you have an integrated, comprehensive, and achievable plan.

What Are Your Outreach Goals?

Defining your outreach goals is the initial step in developing an outreach plan. Outreach goals should be clear, simple, action-oriented statements about what you hope to accomplish through outreach. Once you have established your goals, every other element of the plan should relate to those goals. Here were some project goals for the Jefferson Parish EMPACT project:

- To provide the public with a weekly, or more frequent "weather report" on freshwater diversions and their impact on water quality and algal blooms in area water bodies.
- To gather baseline data in the Davis Pond Diversion outfall area to assist coastal scientist and managers in distinguishing the effects of river water from other ecosystem stressors.
- To use the data collected to confirm remote sensing data and calibrate the predictive ability of remote sensing data.
- To provide ground-truthed remotely sensed data on water quality and phytoplankton blooms to the agencies and organizations involved with public health, fisheries, and habitat related issues.

Whom Are You Trying To Reach?

Identifying Your Audience(s)

The next step in developing an outreach plan is to clearly identify the target audience or audiences for your outreach effort. As illustrated in the Jefferson Parish project goals above, outreach goals often define their target audiences (e.g., the public, coastal scientists, fisheries, etc.). You might want to refine and add to your goals after you have defined your target audience(s).

Target audiences for a water quality outreach program might include, for example, the general public, local decision makers and land management agencies, educators and students (high school and college), special interest groups (e. g., homeowner associations, fishing and boating organizations, gardening clubs, and lawn maintenance/landscape professionals). Some audiences, such as educators and special interest groups, might serve as conduits to help disseminate information to other audiences you have identified, such as the general public.

Consider whether you should divide the public into two or more audience categories. For example: Will you be providing different information to certain groups, such as citizens and businesses? Does a significant portion of the public you are trying to reach have a different cultural or linguistic background from other members? If so, it likely will be most effective to consider these groups as separate audience categories.

Profiling Your Audience(s)

Once you have identified your audiences, the next step is to develop a profile of their situations, interests, and concerns. Outreach will be most effective if the type, content, and distribution of outreach products are specifically tailored to the characteristics of your target audiences. Developing a profile will help you identify the most effective ways of reaching the audience. For each target audience, consider:

- What is their current level of knowledge about water quality?
- What do you want them to know about water quality? What actions would you like them to take regarding water quality?
- What information is likely to be of greatest interest to the audience? What information will they likely want to know once they develop some awareness of water quality issues?
- How much time are they likely to give to receiving and assimilating the information?
- How does this group generally receive information?
- What professional, recreational, and domestic activities does this group typically engage in that might provide

avenues for distributing outreach products? Are there any organizations or centers that represent or serve the audience and might be avenues for disseminating your outreach products?

Profiling an audience essentially involves putting yourself "in your audience's shoes." Ways to do this include consulting with individuals or organizations who represent or are members of the audience, consulting with colleagues who have successfully developed other outreach products for the audience, and using your imagination.

What Do You Want To Communicate?

The next step in planning an outreach program is to think about what you want to communicate. In particular at this stage, think about the key points, or "messages," you want to communicate. Messages are the "bottom line" information you want your audience to walk away with, even if they forget the details.

A message is usually phrased as a brief (often one-sentence) statement. For example:

- The freshwater diversion this week had a ______ effect on Lake Salvador.
- Salinity levels at the sampling station in Lake Salvador are dropped below ___ppt.
- The Hydrowatch site allows you to track daily changes on Lake Salvador.

Outreach products will often have multiple related messages. Consider what messages you want to send to each target audience group. You may have different messages for different audiences.

What Outreach Products Will You Develop?

The next step in developing an outreach plan is to consider what types of outreach products will be most effective for reaching each target audience. There are many different types of outreach: print, audiovisual, electronic, events, and novelty items. The table below provides some examples of each type of outreach product.

The audience profile information you assembled earlier will be helpful in selecting appropriate products. A communications professional can provide valuable guidance in choosing the most appropriate products to meet your goals within your resource and time constraints. Questions to consider when selecting products include:

- How much information does your audience really need? How much does your audience need to know now? The simplest, most effective, most straightforward product generally is most effective.
- Is the product likely to appeal to the target audience? How much time will it take to interact with the product? Is the audience likely to make that time?

Print	Audiovisual	Electronic	Events	Novelty Items
◦ Brochures ◦ Educational curricula ◦ Newsletters ◦ Posters ◦ Question-and-answer sheets ◦ Editorials ◦ Fact sheets ◦ Newspaper and magazine articles ◦ Press releases ◦ Utility bill inserts or stuffers	• Cable television programs • Exhibits • Kiosks • Public service announcements (radio) • Videos	• E-mail messages • Web pages • Subscriber list servers	• Briefings • Fairs and festivals • One-on-one meetings • Public meetings • Community days • Media interviews • Press conferences • Speeches	• Banners • Buttons • Floating key chains for boaters • Magnets • Bumper stickers • Coloring books • Frisbee discs • Mouse pads • Golf tees

- How easy and cost-effective will the product be to distribute or, in the case of an event, organize?
- How many people is this product likely to reach? For an event, how many people are likely to attend?
- What time frame is needed to develop and distribute the product?
- How much will it cost to develop the product? Do you have access to the talent and resources needed for development?
- What other related products are already available? Can you build on existing products?
- When will the material be out of date? (You probably will want to spend fewer resources on products with shorter lifetimes.)
- Would it be effective to have distinct phases of products over time? For example, an initial phase of products designed to raise awareness,followed by later phases of products to increase understanding.
- How newsworthy is the information? Information with inherent news value is more likely to be rapidly and widely disseminated by the media.

How Will Your Products Reach Your Audience?

Effective distribution is essential to the success of an outreach strategy. There are many avenues for distribution. The table below lists some examples.

EXAMPLES OF DISTRIBUTION AVENUES	
• Your mailing list • Partners' mailing list • Phone/Fax • E-mail • Internet • TV • Radio • Print media	• Hotline that distributes products upon request • Journals or newsletters of partner organizations • Meetings, events, or locations (e.g., libraries, schools, marinas, public beaches, tackle shops, and sailing clubs) where products are made available

You need to consider how each product will be distributed and determine who will be responsible for distribution. For some products, your organization might manage distribution. For others, you might rely on intermediaries (such as the media or educators) or organizational partners who are willing to participate in the outreach effort. Consult with an experienced communications professional to obtain information about the resources and time required for the various distribution options. Some points to consider in selecting distribution channels include:

- How does the audience typically receive information?
- What distribution mechanisms has your organization used in the past for this audience? Were these mechanisms effective?
- Can you identify any partner organizations that might be willing to assist in the distribution?
- Can the media play a role in distribution?
- Will the mechanism you are considering really reach the intended audience? For example, the Internet can be an effective distribution mechanism, but certain groups might have limited access to it.

- How many people is the product likely to reach through the distribution mechanism you are considering?
- Are sufficient resources available to fund and implement distribution via the mechanisms of interest?

What Follow-up Mechanisms Will You Establish?

Successful outreach may cause people to contact you with requests for more information or expressing concern about issues you have addressed. Consider whether and how you will handle this interest. The following questions can help you develop this part of your strategy:

- What types of reactions or concerns are audience members likely to have in response to the outreach information?
- Who will handle requests for additional information?
- Do you want to indicate on the outreach product where people can go for further information (e. g., provide a contact name, number, or address, or establish a hotline)?

What Is the Schedule for Implementation?

Once you have decided on your goals, audiences, messages, products, and distribution channels, you will need to develop an implementation schedule. For each product, consider how much time will be needed for development and distribution. Be sure to factor in sufficient time for product review. Wherever possible, build in time for testing and evaluation by members or representatives of the target audience in focus groups or individual sessions so that you can get feedback on whether you have effectively targeted your material for your audience. Section 6.3 contains suggestions for presenting technical information to the public. It also provides information about online resources that can provide easy to understand background information that you can use in developing your own outreach projects.

6.2 Elements of the Jefferson Parish Project's Outreach Program

The Jefferson Parish team uses a variety of mechanisms to communicate time-relevant water quality information - as well as information about the project itself - to the affected commercial and recreational users of Lake Salvador and other nearby water bodies. The team uses the Parish Web site as the primary vehicle for communicating time-relevant information to the public. Their outreach strategy includes a variety of mechanisms (e.g.,Internet, brochures, presentations at events, and television) to provide the public with information about the Jefferson Parish project. Each element of the project's communication program are discussed below.

Bringing together experts. The EMPACT project stakeholders are made up of a variety of organizations that provide input on the information generated from the project and how it is communicated. These stakeholders are identified below.

- Jefferson Parish Marine Fisheries Advisory Board
- Davis Pond Freshwater Diversion Advisory Committee
- Barataria-Terrebonne National Estuary Program (BTNEP)
- Lake Pontchartrain Basin Foundation
- SMSA Parishes
- Nearby State Agencies
- Local academic community

Brochure. The Jefferson Parish Environmental & Development Control Department published a brochure highlighting current projects overseen by the Coastal Zone Management (CZM) Program. The EMPACT project was announced in the brochure. The team distributed the CZM brochures through local libraries and during community events. Appendix C contains a reproduction of the brochure.

Newspaper. Shortly after the time-series sampling system became operational, two newspaper articles were run announcing the monitoring effort. The articles described the types of data to be collected, how the data were relevant to the community, how the data would be used, and where the public could access the data.

Survey. To determine specific issues of concern in the surrounding communities, the Jefferson Parish team used information already collected by BTNEP, one of the team members. To increase public awareness for the estuary's importance and problems, and to encourage residents, users, and decision makers to become more involved in the promotion and protection of the estuary, BTNEP held a series of eight public workshops in 1998. These workshops provided citizens with information about the program and allowed them to address any specific issues of concern. The Jefferson Parish team used this information to find out what was important to the communities regarding their wetlands. Also the team was able to determine their target audience:

- Commercial and recreational users of Lake Salvador.
- Residents of communities that could be impacted by diversion related to flooding.
- Louisiana citizens concerned about coastal erosion, hypoxia in the Gulf, eutrophication, and algal blooms.

Web site. The Jefferson Parish Web site can be accessed at http://www.jeffparish.net. The EMPACT project is discussed at http://www.jeffparish.net/pages/index.cfm?DOCID=1228. The Web site is the main avenue used by the team for disseminating the water quality information. The site has a static page which describes the Jefferson Parish EMPACT project. On the left side of the site, there are links to the USGS Hydrowatch site, which displays near-real time data from the time-series sampling system at Lake Salvador. An example of the results measured by the time-series sampling system is provided in Appendix D. The Web site also has a link to the Earth Scan Laboratory's Web site. An example of the reflectance results taken from satellite data is provided in Appendix E. The site also has links to learn more about the Davis Pond Diversion Project and the EPA's EMPACT program.

Piggybacking on existing events. The Jefferson Parish team has found some opportunities to promote the EMPACT project at other events. For example, BTNEP hosted a one-day Forum to discuss their Estuary Program. The team had the opportunity to give a power point presentation concerning the EMPACT project. The team also provided a poster presentation and handed out an information sheet about the project.

Developing the Lake Access Web Site

Experience Gained and Lessons Learned

The Jefferson Parish team uses a private contractor to manage their EMPACT Web site (http://www.jeffparish.net/pages/index.cfm? DOCID=1228). The team is considering ways to make the Web site more effective. Currently the site has only information about the EMPACT project and links to the data via Earth Scan and Hydrowatch. Because the information on the Jefferson Parish Web site is not routinely revised or changed, the team is concerned that individuals interested in the near-real time water quality data are going directly to the Earth Scan and/or Hydrowatch Web sites. As a result, the team does not know how many people are accessing data generated by the Jefferson Parish EMPACT project. The team is considering revising the Jefferson Parish site to store "live" data to attract users back to the Web site.

The Jefferson Parish Project team recommends that you design your Web site to include live changing data (e.g., daily) so that users will always find something new and different when they visit your site. The team also recommends that you set up procedures for notifying the project team when changes are made to your site. Such procedures could include providing your Web Master with a list of individuals (and their e-mail addresses) to contact when the site is modified (e.g., site has moved to a new address or new features are available).

Some of the local entities interested in the Lake Salvador data do not have Internet connectivity. As a result they do not have access to any of the near-real time data. At present, the team encourages them to visit their local library so they can access the Web site. The team is considering other avenues to relay the information to interested parties who do not have Internet access.

6.3 Resources for Presenting Water Quality Information to the Public

As you develop your various forms of communication materials and begin to implement your outreach plan, you will want to make sure that these materials present your information as clearly and accurately as possible. There are resources on the Internet to help you develop your outreach materials. Some of these are discussed below.

How Do You Present Technical Information to the Public?

Environmental topics are often technical in nature and full of jargon, and water quality information is no exception. Nonetheless, technical information can be conveyed in simple, clear terms to those in the general public not familiar with water quality. The following principles should be used when conveying technical information to the public:

- Avoid using jargon,
- Translate technical terms (e.g., reflectance) into everyday language the public can easily understand,
- Use active voice,
- Write short sentences,
- Use headings and other formatting techniques to provide a clear and organized structure.

The following Web sites provide guidance regarding how to write clearly and effectively for a general audience:

- The National Partnership for Reinventing Government has a guidance document, *Writing User-Friendly Documents*, that can be found on the Web at http://www.plainlanguage.gov.
- The American Bar Association has a Web site that provides links to on-line writing labs(http://www.abanet.org/lpm/bparticle11463_front. shtml). The Web site discusses topics such as handouts and grammar.

As you develop communication materials for your audience, remember to tailor your information to consider what they are already likely to know, what you want them to know, and what they are likely to understand. The most effective approach is to provide information that is valuable and interesting to the target audience. For example, the local fishers in the Lake Salvador area are concerned about some of the potential effects (e.g., changes in salinity and algae blooms) of the Davis Pond freshwater diversion. Also when developing outreach products, be sure to consider special needs of the target audience. For example, ask yourself if your target audience has a large number of people who speak little or no English. If so, you should prepare communication materials in their native language.

The rest of this section contains information about resources available on the Internet that can assist you as you develop your own outreach projects. Some of the Web sites discussed below contain products, such as downloadable documents or fact sheets, which you can use to develop and tailor your education and outreach efforts.

Federal Resources

EPA's Surf Your Watershed
http://www.epa.gov/surf3

This Web site can be used to locate, use, and share environmental information on watersheds. One section of this site, "Locate Your Watershed," allows the user to enter the names of rivers, schools, or zip codes to learn more about watersheds in their local area or in other parts of the country. The EPA's Index of Watershed Indicators (IWI) can also be accessed from this site. The IWI is a numerical grade (1 to 6), which is compiled and calculated based on a variety of indicators that point to whether rivers, lakes, streams, wetlands, and coastal areas are "well" or "ailing."

EPA's Office of Water Volunteer Lake Monitoring: A Methods Manual
http://www.epa.gov/owow/monitoring/volunteer/lake

EPA developed this manual to present specific information on volunteer lake water quality monitoring methods. It is intended both for the organizers of the volunteer lake monitoring program and for the volunteer(s) who will actually be sampling lake conditions. Its emphasis is on identifying appropriate parameters to monitor and listing specific steps for each selected monitoring method. The manual also includes quality assurance/quality control procedures to ensure that the data collected by volunteers are useful to States and other agencies.

EPA's Non Point Source Pointers (Fact sheets)
http://www.epa.gov/owow/nps/facts

This Web site features a series of fact sheets (referred to as "pointers) on nonpoint source pollution (e.g., pollution occurring from storm water runoff). The pointers covers topics including: programs and opportunities for public involvement in nonpoint source control, managing wetlands to control nonpoint source pollution, and managing urban runoff.

EPA's Great Lakes National Program Office
http://www.epa.gov/glnpo/about.html

EPA's Great Lakes National Program Office Web site includes information about topics such as human health, visualizing the lakes, monitoring, and pollution prevention. One section of this site (http://www.epa.gov/glnpo/gl2000/lamps/index.html) has links to Lakewide Management Plans (LaMP) documents for each of the Great Lakes. A LaMP is a plan of action developed by the United States and Canada to assess, restore, protect and monitor the ecosystem health of a Great Lake. The LaMP has a section dedicated to public involvement or outreach and education. The program utilizes a public review process to ensure that the LaMP is addressing their concerns. You could use the LaMP as a model in developing similar plans for your water monitoring program.

U. S. Department of Agriculture Natural Resource Conservation Service
http://www.wcc.nrcs.usda.gov/water/quality/frame/wqam

Under "Guidance Documents," there are several documents pertaining to water quality that can be downloaded or ordered. These documents are listed below.

- A Procedure to Estimate the Response of Aquatic Systems to Changes in Phosphorus and Nitrogen Inputs
- Stream Visual Assessment Protocol
- National Handbook of Water Quality Monitoring
- Water Quality Indicators Guide
- Water Quality Field Guide

Education Resources

Project WET (Water Education for Teachers)
http://www.montana.edu/wwwwet

One goal of Project WET is to promote awareness, appreciation, knowledge, and good stewardship of water resources by developing and making available classroom-ready teaching aids. Another goal of WET is to establish state- and internationally-sponsored Project WET programs. The WET site has a list of all the State Project WET Program

Coordinators.

Water Science for Schools
http://wwwga.usgs.gov/edu/index.html

The USGS's Water Science for School Web site offers information on many aspects of water and water quality. The Web site has pictures, data, maps, and an interactive forum where you can provide opinions and test your water knowledge. Water quality is discussed under "Special Topics."

Global Rivers Environmental Education Network (GREEN)
http://www.earthforce.org/green

The GREEN provides opportunities for middle and high school-aged youth to understand, improve and sustain watersheds in their community. This site (http://www.igc.apc.org/green/resources.html) also includes a list of water quality projects being conducted across the country and around the world.

Adopt- A-Watershed
http://www.adopt-a-watershed.org/about.htm

Adopt- A- Watershed is a school-community learning experience for students from kindergarten through high school. Their goal is to make science applicable and relevant to the students. Adopt-A-Watershed has many products and services available to teachers wishing to start an Adopt-A-Watershed project. Although not active in every state, the Web site has a list of contacts in 25 States if you are interested in beginning a project in your area.

National Institutes for Water Resources
http://wrri.nmsu.edu/niwr/niwr.html

The National Institutes for Water Resources (NIWR) is a network of 54 research institutes throughout each of the 50 States, District of Columbia, the Virgin Islands, Puerto Rico, and Guam/Federated States of Micronesia. Each institute conducts research to solve water problems unique to their area and establish cooperative programs with local governments, state agencies, and industry.

Other Organizations

North American Lake Management Society (NALMS) Guide to Local Resources
http://www.nalms.org/

This Web site provides resources for those dealing with local lake-related issues. NALMS's mission is to forge partnerships among citizens, scientists, and professionals to promote the management and protection of lakes and reservoirs. NALMS's Guide to Local Resources (http://www.nalms.org/resource/lnkagenc/links.htm) contains various links to regulatory agencies, extension programs, research centers, NALMS chapters, regional directors, and a membership directory.

The Watershed Management Council
http://watershed.org/wmc/aboutwmc.html

The Watershed Management Council (WMC) is a nonprofit organization whose members represent a variety of watershed management interests and disciplines. WMC membership includes professionals, students, teachers, and individuals whose interest is in promoting proper watershed management.

Gulf of Mexico Program
http://gmpo.gov

The EPA established the Gulf of Mexico Program (GMP). Their mission is to provide information and resources to facilitate the protection and restoration of the coastal marine waters of the Gulf of Mexico and its coastal natural habitats. The GMP's Web site has links to existing coastal projects, has links to educator and student resources, and provides near-real time oceanic data.

The Barataria - Terrebonne National Estuary Program (BTNEP)
http://www.btnep.org

BTNEP is the result of a cooperative agreement between the EPA and the State of Louisiana under the National Estuary Program. The program's charter was to develop a coalition of government, private, and commercial interests to identify problems, assess trends, design pollution control, develop resource management strategies, recommend corrective actions, and seek implementation commitments for the preservation of Louisiana's Barataria and Terrebonne basins.

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Disclaimer

This document has been reviewed by the U. S. Environmental Protection Agency (EPA) and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation of their use.

EPA/625/R-01/005

September 2001

Delivering Timely Water Quality Information to Your Community

The Jefferson Parish-Louisiana Project

United States Environmental Protection Agency
National Risk Management Research Laboratory
Office of Research and Development
Cincinnati, OH 45268

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APPENDIX A

GLOSSARY OF TERMS & ACRONYM LIST

A

ADAPS: Automated Data - Processing System.

Algae: Simple single-celled, colonial, or multi-celled aquatic plants. Aquatic algae are (mostly) microscopic plants that contain chlorophyll and grow by photosynthesis. They absorb nutrients from the water or sediments, add oxygen to the water, and are usually the major source of organic matter at the base of the food web.

Algal blooms: Referring to excessive growths of algae caused by excessive nutrient loading.

Anoxia: Absence of oxygen in water**.**

APT: Automatic picture transmission.

AVHRR: Advanced very high resolution radiometer.

B

BTNEP: Barataria-Terrebonne National Estuary Program.

C

CEI: Coastal Ecology Institute.

Chlorophyll: Green pigment in plants that transforms light energy into chemical energy by photosynthesis.

CO_2: carbon dioxide.

CSI: Coastal Studies Institute.

CZM: Coastal Zone Management.

D

DAAC: Distributed Active Archive Center.

DAS: Data acquisition system.

dB: decibel

DECODES: Device Conversion and Delivery System

DIC: Differential interference contrast.

Dissolved oxygen (DO): The concentration of oxygen (O_2) dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation (at the field temperature). Adequate concentrations of dissolved oxygen are necessary to sustain the life of fish and other aquatic organisms and prevent offensive odors. DO levels are considered a very important and commonly employed measurement of water quality and indicator of a water body's ability to support desirable aquatic life. Levels above 5 milligrams per liter (mg O_2/L) are considered optimal and fish cannot survive for prolonged periods at levels below 3 mg O_2/L. Levels below 2 mg O_2/L are often referred to as hypoxic and when O_2 is less than 0.1 mg/, conditions are considered to be anoxic.

DMSO: Dimethyl sulfoxide.

DO: Dissolved oxygen.

DOMSAT: Domestic satellite. A DOMSAT system utilizes a geosynchronous satellite to re-broadcast satellite data received at a central reception and preprocessing center.

DVT(s): Data visualization tools.

E

EMPACT: Environmental Monitoring for Public Access and Community Tracking.

EPA: U.S Environmental Protection Agency.

ESL: Earth Scan Laboratory

Estuary: A semi-enclosed coastal area, where seawater mixes with fresh water from rivers.

Eutrophication: The process by which surface water is enriched by nutrients (usually phosphorus and nitrogen) which leads to excessive plant growth.

F

ft: feet.

FTP: File transfer protocol.

G

GAC: Global area coverage.

GFF: Glass fiber filter.

GIS: Geographic information systems.

GMP: Gulf of Mexico Program.

GOES: Geostationary operational environmental satellites.

GPS: Global positioning system.

GREEN: Global Rivers Environmental Education Network

GUI: Graphical user interface.

*u***g/l:** micrograms (10^{-6} grams)/liter.

*u***S/cm:** microsiemens per centimeter.

H

HAB: Harmful algal bloom.

HCl: hydrochloric acid.

HRPT: High resolution picture transmission.

HTCO: High temperature catalytic oxidation.

Hypoxia: Physical condition caused by low amounts of dissolved oxygen in water (i.e., less than 2 mg/l.)

I

IC: Inorganic carbon.

IWI: Index of Watershed Indicators

J

K

Kbps: kilobytes per second.

kg: kilogram.

km: kilometer.

km/hr: kilometers per hour.

L

lbs: pounds.

L: liter

LAC: Local area coverage.

LaMP: Lakewide Management Plans

LNA: Low noise amplifier.

LRGS: Local readout ground station

LSU: Louisiana State University

LSU-CEI: Louisiana State University Coastal Ecology Institute.

LUMCON: Louisiana University Marine Observatory Consortium.

M

m: meters.

mg: milligrams

mg/L: milligrams/liter

mph: miles per hour.

MHz: Megahertz.

N

NALMS: North American Lake Management Society.

NASA: National Aeronautics and Space Administration.

NDIR: Non-dispersive infrared gas analyzer.

Near-real time: Refers to data current enough to be used in day-to-day decision-making. These data are collected and distributed as close to real time as possible. Reasons for some small time delays in distributing the collected data include the following: (1) the time it takes to physically transmit and process the data, (2) delays due to the data transmission schedule (i.e., some collected data are only transmitted in set time intervals as opposed to transmitting the data continuously), and (3) the time it takes for automated and preliminary manual QA/QC.

NESDIS: National Environmental Satellite, Data and Information Service.

NIWR: National Institute for Water Resources.

NOAA: National Oceanic and Atmospheric Administration.

nm: Nanometer, 10^{-9} meter.

NSP: Neurotoxic shellfish poisoning.

NTU: Nephelometric turbidity unit.

Nutrient loading: The discharge of nutrients from the watershed into a receiving water body (e.g., wetland). Expressed usually as mass per unit area per unit time (kg/ hectare/ yr or lbs/acre/year).

O

ORD: Office of Research and Development.

Organic: Refers to substances that contain carbon atoms and carbon-carbon bonds.

OSC: Orbital Sciences Corporation.

P

PC: Personal computer.

PCI: Peripheral component interconnect.

pH scale: A scale used to determine the alkaline or acidic nature of a substance. The scale ranges from 1 to 14 with 1 being the most acidic and 14 the most basic. Pure water is neutral with a ph of 7.

Parameter: Whatever it is you measure - a particular physical, chemical, or biological property that is being measured.

Photosynthesis: The process by which green plants convert carbon dioxide to sugars and oxygen using sunlight for energy.

POES: Polar orbiting environmental satellites.

ppt: parts per thousand.

Q

Quality Assurance/Quality Control (QA/QC): QA/QC procedures are used to ensure that data are accurate, precise, and consistent. QA/QC involves established rules in the field and in the laboratory to ensure thatsamples are representative of the water you are monitoring, free from contamination, and analyzed following standard procedures.

QWSU: Quality Water Service Unit.

R

Remote Monitoring: Monitoring is called *remote* when the operator can collect and analyze data from a site other than the monitoring location itself.

S

Salinity: Measurement of the mass of dissolved salts in water. Salinity is usually expressed in ppt.

SeaWiFS: Sea-viewing Wide Field-of-view Sensor. The SeaWiFS is an Earth-orbiting ocean color sensor flown on the Orbview-2 satellite that provides quantitative data on global ocean bio-opticals properties to the science community.

[Source: http://seawifs.gsfc.nasa.gov/SEAWIFS/BACKGROUND/ SEAWIFS_BACKGROUND.html]

SCSI: Small Computer System Interface (pronounced "scuzzy")

SEM: Scanning electron microscope.

SMSA: Standard metropolitan statistical area.

Specific Conductance: The measure of how well water can conduct an electrical current. Specific conductance indirectly measures the presence of compounds such as sulfates, nitrates, and phosphates. As a result, specific conductance can be used as an indicator of water pollution. Specific conductivity is usually expressed in *u*S/cm.

SST: Sea surface temperatures.

Surface Truthing: Relating the digital measurements of a parameter (e.g., turbidity and fluorescence) to field sample measurements for the same or a similar parameter.

Suspended solids: (SS or Total SS [TSS]). Organic and inorganic particles in suspension in a water mass.

T

TC: Total carbon.

Time-relevant environmental data: Data that are collected and communicated to the public in a time frame that is useful to their day-to-day decision-making about their health and the environment, and relevant to the temporal variability of the parameter measured.

TOC: Total organic carbon.

Turbidity: The degree to which light is scattered in water because of suspended organic and inorganic particles. Turbidity is commonly measured in NTU's.

U

UHF: Ultra high frequency, 300 to 3000 megahertz.

UPS: Uninterruptible power supply.

USGS: United States Geologic Survey.

USACE: United States Army Corps of Engineers.

V

VHF: Very high frequency, 88 to 216 megahertz.

W

WET: Water Education for Teachers.

WMC: Watershed Management Council.

X

Y

YSI©: Yellow Springs Instruments©.

Z

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APPENDIX B

LIST OF AUTHORIZED SEAWIFS GROUND STATIONS/USERS

Name/Telephone No.	Affiliation	Address
Andrew B. Archer 303.790.8606, ext. 3136	Antarctic Support Association	61 Inverness Dr. East, Suite 300 Englewood, CO 80112
Dr. Robert Arnone 601.688.5268	Naval Research Lab/Stennis Space Center	Code 7243 Building 1105 Stennis Space Center, MS 39529
Mr. B. Edward Arthur Jr. 228.688.5265	Naval Research Lab/Stennis Space Center	Code 7340 Stennis Space Center, MS 39529-5004
Dr. Max P. Bleiweiss 505.678.3504	US Army Research Laboratory	AMSRL-IS-EW White Sands Missile Range, NM 88002-5501
Robert A. Kamphaus 757.441.6206	NOAA Ship Ron Brown	NOAA Ship Ron Brown Atlantic Marine Center 439 W. York Street Norfolk, VA 23510-1114
Dr. Francisco Chavez 831.775.1709	Monterey Bay Aquarium Research Institute	P.O. Box 628 7700 Sandholdt Rd. Moss Landing, CA 95039-0628
Prof. Duane E. Waliser 631.632.8647	Institute for Terrestrial And Planetary Atmosphere	MSRC/Endeavor Hall #205 State University of New York Stony Brook, NY 11794-5000

Dr. Kevin Engle 907.474.5569	Institute of Marine Science	University of Alaska Fairbanks Fairbanks, AK 99775-7220
Rafael Fernandez-Sein 787.834.7620, ext. 2263	University of Puerto Rico	NASA-URC Tropical Center for Earth and Space Studies University of Puerto Rico at Mayaguez Road 108, Km 1.0 Miradero PO Box 9001 Mayaguez, PR 00680-9001
Dr. Pierre Flament 808.956.6663	University of Hawaii at Manoa	1000 Pope Road Honolulu, HI 96822
Mr. Scott M. Glenn 908.932.6555, ext. 544	Institute of Marine and Coastal Sciences	Marine Science Building Rutgers, The State University 71 Dudley Road New Brunswick, NJ 08901-8521
Dr. Frank E. Hoge 757.824.1567	NASA/GSFC Wallops Flight Facility	Code 972 Building N-159 Wallops Island, VA 23337
Dr. Michael Laurs 808.942.1279	Hawaii Regional Coastwatch Node	National Marine Fisheries Service Honolulu Laboratory 2570 Dole Street Honolulu, HI 96882
Mr. Ronald J. Lynn 619.546.7084	NOAA/La Jolla	National Marine Fisheries Service PO Box 271 La Jolla, CA 92007
John M. Morrison 919.515.7449	Department of Marine Earth and Atmospheric Science	North Carolina State University 1125 Jordan Hall Box 8208 Raleigh, NC 27695-8208
Thomas L. Mote 701.777.3164	Department of Space Studies	University of North Dakota Grand Forks, ND 58202-9008
Dr. Frank E Muller-Karger	Department of Marine Science	University of South Florida 140 7th Avenue S.

813.553.3335		St. Petersburg, FL 33701
Dr. Norman B. Nelson 805.893.5303	University of California, Santa Barbara	ICESS, Ellison Hall Santa Barbara, CA 93106
Dr. Torben N. Nielsen 808.956.5896	University of Hawaii/HIGP	1680 East-West Road Post 619E Honolulu, HI 96816
Albert J. Peters 402.472.4893	University of Nebraska	113 Nebraska Hall Lincoln, NE 68588-0517
Dr. John N. Porter 808.956.6483	University of Hawaii	Hawaii Institute of Geophysics and Planetology 2525 Correa Rd. Honolulu, HI 96822
Mr. Raymond C. Smith	University of California, Santa Barbara	University of California Santa Barbara Ellison Hall, 6th Floor Santa Barbara, CA 93106
Greg Stossmeister 303.497.8692	University Corporation for Atmospheric Research	PO Box 3000, UCAR Boulder, CO 80307-3000
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Dr. Andrew Thomas 207.581.4335	University of Maine	School of Marine Sciences University of Maine 5741 Libby Hall, Room 218 Orono, ME 04469-5741
Nan D. Walker 225-388-2395	Louisiana State University	Coastal Studies Institute Howe-Russell Geoscience Complex Louisiana State University Baton Rouge, LA 70803
Dr. Kirk Waters 843.740.1227	NOAA Coastal Service Center	2234 South Hobson Ave. Charleston, SC 29405-2314

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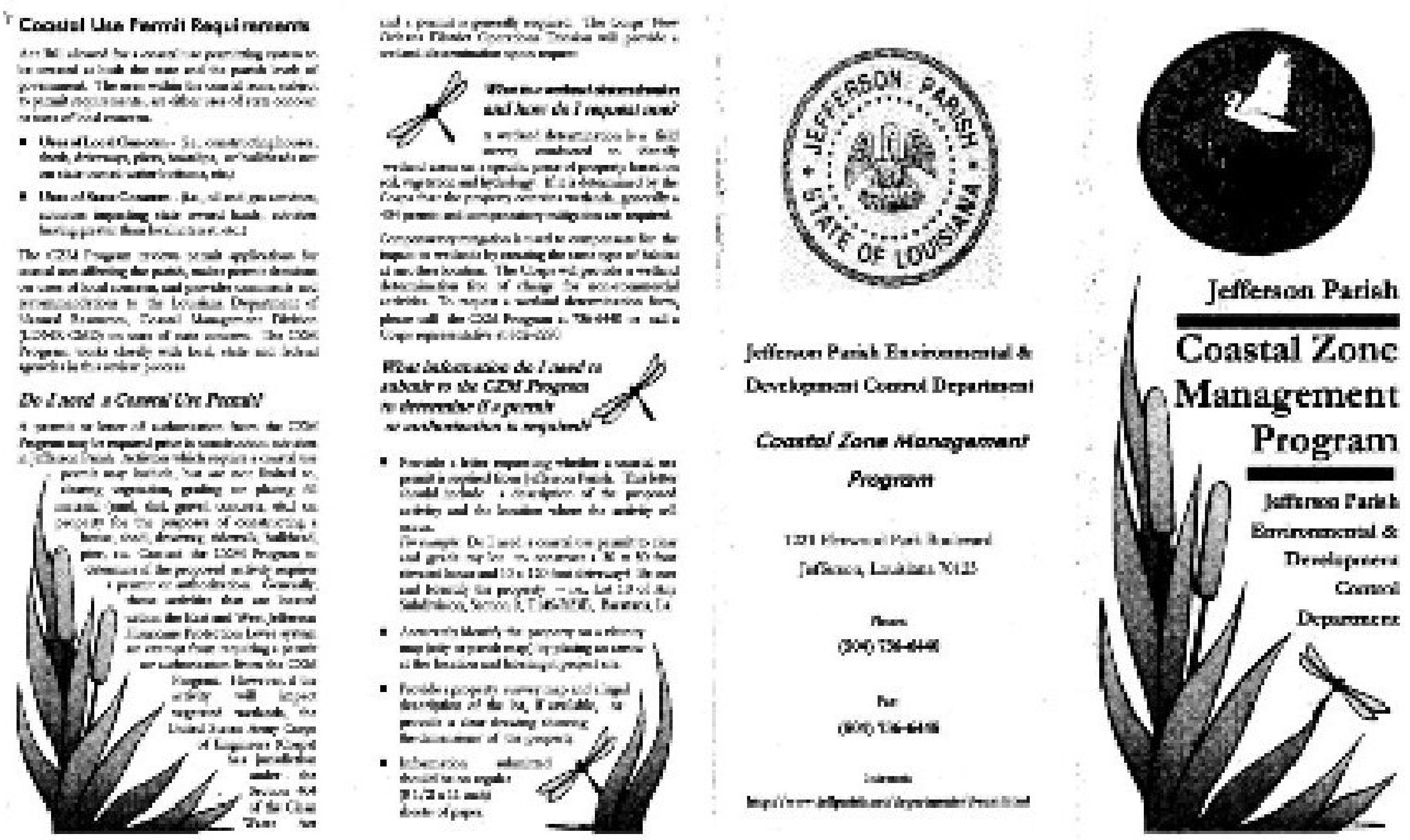
APPENDIX C

JEFFERSON PARISH

BROCHURE



Coastal Use Permit Requirements

Do I need a Coastal Use Permit?

What information do I need to submit to the CZM Program to determine if a permit or authorization is required?

Jefferson Parish Environmental & Development Control Department

Coastal Zone Management Program

Jefferson Parish

Coastal Zone Management Program

Jefferson Parish Environmental & Development Control Department

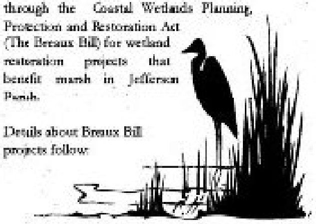
Jefferson Parish Coastal Zone Management Program

The Jefferson Parish Coastal Zone Management (CZM) Program was approved by the state on January 4, 1985 in accordance with the the State and Local Coastal Resources Management Act of 1978 (Act 361). The CZM Program established major goals and policies for managing the parish's coastal resources and created guidelines for the issuance of local coastal use permits.

Louisiana has 40% of the nations remaining coastal wetlands and is experiencing 80% of coastal wetland loss. The Barataria Basin is the fastest-eroding area of Louisiana's coast. Jefferson Parish once had 50 miles of near-solid, healthy wetlands between it and the Gulf of Mexico. The wetlands protect developed areas against hurricane surges, provide natural treatment for stormwater runoff and provide a rich nursery ground for fisheries. Louisiana contains wetland habitats that have been estimated to produce over 30% of the nation's seafood harvest and to support up to 60% of the Mississippi Flyway's wintering waterfowl.

In addition to regulating development activities that impact the coastal zone, the CZM Program also designs, seeks funding for, and implements projects to combat coastal erosion and promote marsh restoration. A comprehensive Coastal Wetland Conservation and Restoration Plan was developed for the parish in 1993 in an effort to provide a long-term solution to coastal erosion and wetland loss. The CZM Program has secured over $41 million in state and federal funding through the Coastal Wetlands Planning, Protection and Restoration Act (The Breaux Bill) for wetland restoration projects that benefit marsh in Jefferson Parish.

Details about Breaux Bill projects follow.



Breaux Bill Projects in Jefferson Parish

Barataria Bay Marsh Creation
Priority List 1 - $1,676,424

The project involves using maintenance-dredged sediments to create marsh in shallow water areas adjacent to the channel. Queen Bess Island and Pelican Rookery restoration was completed for $945,678. Remaining funds will be used to purchase oyster leases for beneficial dredge material disposal.

Lake Salvador Shoreline Protection at Jean Lafitte National Historic Park
Priority List 1 - $60,000

The project is to restore the shoreline/marsh area at the northeast corner of Lake Salvador, specifically where the lake broke through the Bayou Segnette Waterway.

Jonathan Davis Wetland Protection
Priority List 2 - $4,200,063

The project will reduce the marsh loss rate, maintain and improve fish and wildlife habitat quality, and lower rates of water exchange, erosion and salt water intrusion in an area of wetlands west of Barataria, La.

Barataria Waterway "Dupre Cut" - West
Priority List 4 - $2,275,892

The project objective is to rebuild the west bank of the Dupre Cut to protect the adjacent marsh from unnatural water exchange and subsequent erosion. A rock dike will be constructed along 9,400 linear feet of the west bank of the Barataria Waterway.

Myrtle Grove Siphon
Priority List 5 - $15,525,925

The project is intended to convey up to 2,000 cfs of fresh and sediments from the Mississippi River to deteriorating tidal marshes in the vicinity of Bayou Dupont, east of Lafitte, Louisiana.

Naomi Outfall Management
Priority List 5 - $1,778,927

The project will manage the outfall of the existing eight siphons by controlling the movement of the diverted waters. The siphons divert sediment-laden water from the Mississippi River into the west bank wetlands to retard saltwater intrusion and enhance wetland productivity.

Barataria Waterway "Dupre Cut" - East
Priority List 6 - $3,027,621

The objective of this project is to rebuild the banks of the Barataria Waterway to protect the adjacent marsh from excessive tidal action and saltwater intrusion. The project consists of 3.3 miles of levee constructed with dredged material from the waterway, and 3.3 miles of rock armor.

Barataria Basin Landbridge - Phase I
Priority List 7 - $10,352,340

The objective of the project is to construct a cost-effective erosion control technique to stop the erosion on the southwestern shoreline of Bayou Perot and the southeastern shoreline of Bayou Rigolettes. The length of protection is estimated to be ± 8,000 feet.

Grand Terre Island Vegetative Plantings
Priority List 7 - $538,420

Grand Terre is a barrier island located adjacent to , and east of Grand Isle, Louisiana. In 1996, a 180 acre section on the east side of the island was filled with material dredged from the Barataria Waterway bar channel. This project will implement a planting protocol to re-vegetate the dredged material site and will include strategic degrading of retention dikes to enhance the ingress and egress of marine fisheries.

Barataria Basin Landbridge - Phase II
Priority List 8 - $7,161,749

This phase is a continuation of the original project authorized for Priority List 7. The project would protect the eastern shoreline of Bayou Rigolettes and the western shoreline of Bayou Perot. Phase II represents about 22% of the total length of the initially proposed shoreline protection.

Your Project Could Be Listed Here!

The Coastal Zone Management Program welcomes input from fishermen and other coastal users regarding ideas for future restoration projects in Jefferson Parish.

Jefferson Parish Christmas Tree/Marsh Restoration Project

The Jefferson Parish Christmas Tree/Marsh Restoration Project has saved valuable landfill space by recycling over 500,000 Christmas trees to construct approximately 15500 linear feet of shoreline fences and to fill abandoned, dead-end canals. Hundreds of acres of wetlands have been created or protected by this project. The idea of using brush fences to trap sediments and build land originated in Holland and was first adapted to Louisiana using Christmas trees in 1987. In 1991, the Louisiana State Wetland Trust Fund awarded small grants to coastal Parishes to develop Christmas Tree projects. Each year since the inception of the program, Jefferson Parish has had the largest project in the state, in number of trees recycled, amount of wetlands restored, and number of volunteers.

This project could not take place without a huge volunteer effort and strong corporate sponsorship. Each year, approximately 500 volunteers help in this hands-on project. Please call 736-6440 to volunteer.

Jefferson Parish EMPACT Project

The EPA Environmental Monitoring for Public Access and Community Tracking Program has awarded a $100,000 grant to Jefferson Parish to provide data that will enable citizens to track impacts of the Davis Pond Freshwater Diversion. Real-time water quality data from Lake Salvador and remote sensed images of the impact area will be available on the Environmental Department's web page.

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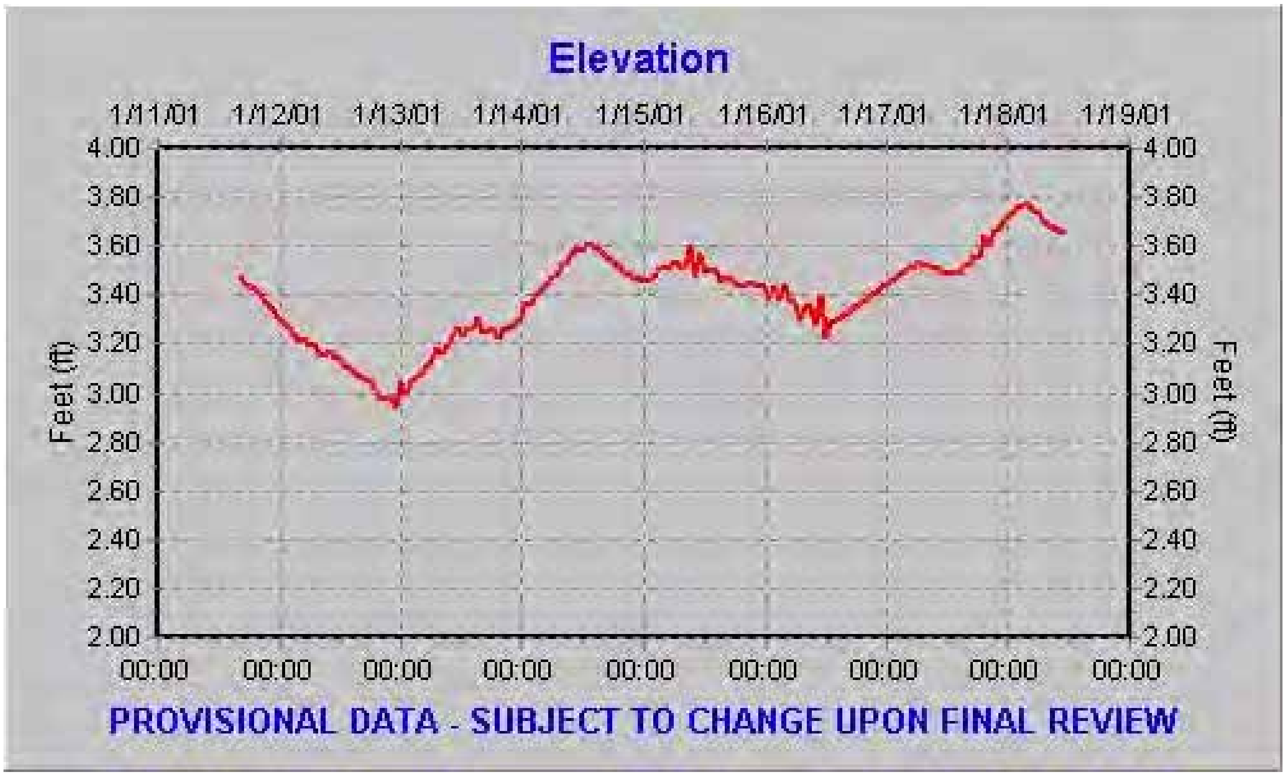
APPENDIX D

EXAMPLE DATA FROM USGS HYDROWATCH



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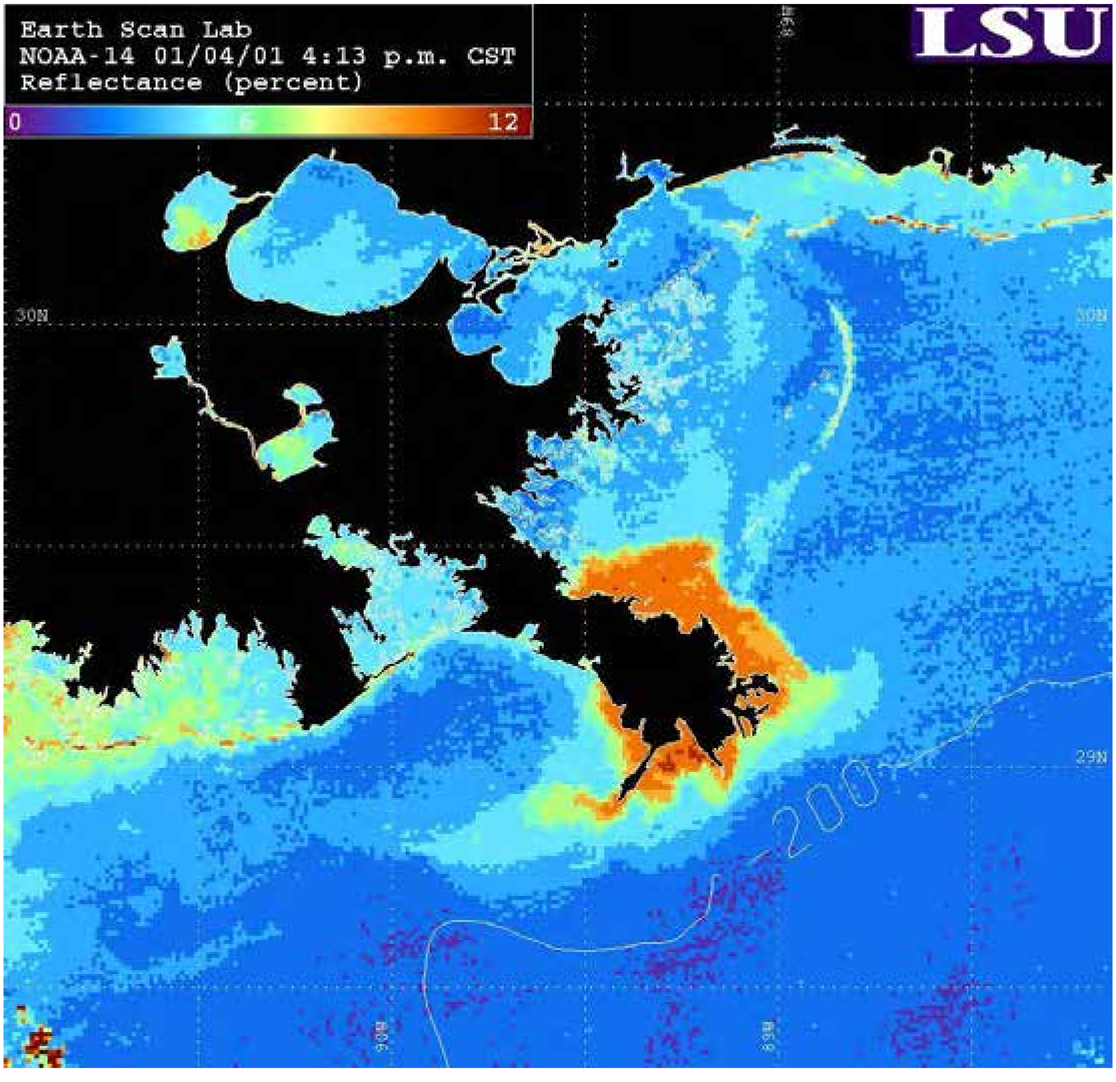
EXAMPLE DATA FROM EARTH SCAN LABORATORIES

(Satellite Data - Reflectance)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30N
30N
29N
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90W
89W

United States
Environmental Protection
Agency

Office of Research
and Development
Washington, DC 20460

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Developing and Implementing a Bird Migration Monitoring, Assessment, and Public Outreach Program for Your Community

The BirdCast Project

EMPACT

Environmental Monitoring for Public Access
& Community Tracking

US EPA Office of Research and Development

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The BirdCast Project

National Risk Management Research Laboratory
Office of Research and Development
U. S. Environmental Protection Agency
Cincinnati, Ohio 45268

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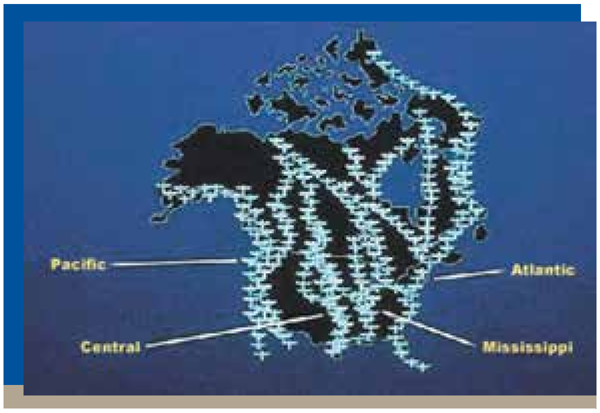
1 INTRODUCTION

Every year, several billion birds undertake seasonal migrations in pursuit of food, shelter, and nesting grounds. North America is the site of some of the world's most spectacular bird migration, and millions of American "birders" enjoy spending time in the field identifying the birds passing through their area. Migratory birds are delightful not only for birders, but also for countless other Americans who casually observe their comings and goings, particularly in the spring and fall. These birds also have a distinct economic value (nearly $3 billion in the mid-Atlantic states alone) to the tourist and outfitting industries of the regions located along their flight path.

of North America, the sight of migrating

Aside from any immediate benefits they provide, migratory birds are valuable for the role they play in our ecosystems—in particular, for eating insects and thereby keeping pest populations under control. We also have reason to be concerned about the well-being of migratory birds that extends beyond any inherent value these birds may possess. As naturalist Roger Tory Peterson noted, birds are an "ecological litmus paper"—because of their rapid metabolism and wide geographic range, they often provide an early warning of environmental deterioration. Migratory birds depend on many different kinds of open space, such as swamps, marshes, meadows, and suburban parkland. Therefore, research and conservation aimed at keeping a particular bird population healthy may lead to the broader goal of restoring these threatened habitats.



migration routes in North America

When migrating, a bird may travel hundreds or even thousands of miles without stopping. The exertion of flying such long distances leaves birds exhausted and vulnerable. Many birds, particularly those that encounter adverse weather conditions, do not survive their journeys. Unfortunately, human activities can further increase the levels of stress and danger that a migratory bird faces. For example:

- Inopportune application of pesticides to lawns, gardens, and parks may poison a bird's food supply at just the moment when it is weakest and most in need of nourishment. In the United States, migratory birds are particularly vulnerable to pesticide application as they migrate northward in the spring.
- Lights on tall structures (such as skyscrapers and communication towers) may confuse and disorient birds, causing them to become exhausted and crash into objects. Similarly, birds injure or kill themselves by flying into panes of glass. These problems appear to be particularly severe on overcast nights when birds may circle a light source.

- The development of land for human purposes such as agriculture, housing, and commerce often renders it unsuitable for use by birds. Birds may be challenged not only by the loss of habitat in their breeding and wintering ranges, but also by loss of habitat at key stop-over points where they need to rest and regain strength over the course of migration.
- Humans have imported animals to North America that prey upon migratory birds (e.g., cats) or compete with them (e.g., starlings). These new biological threats, combined with decreasing quantities of suitable habitat, may reduce the population and range of a particular migratory bird species.

There is much that property managers and the general public can do to mitigate these problems if they are aware of them, interested in solving them, and educated about bird conservation. During a period of peak bird migration, pesticide applications can be delayed, bright building lights can be turned off, and cats can be kept indoors. Therefore, outreach programs designed to inform these audiences about the status of seasonal bird migration are a promising route to improving the conservation of migratory birds.

EPA has developed this technology transfer handbook primarily for community organizers, non-profit groups, local government officials, and other decision-makers who will implement, or are considering implementing, bird migration monitoring and public outreach programs. The handbook is designed with two main goals in mind. The first goal is to present a case study showing how one regional outreach program—EMPACT's BirdCast project for the mid-Atlantic coast of the United States—provides information that allows property managers and the general public to assist migratory birds. The second—and perhaps more important—goal is to provide you with guidance for developing a similar program in your own region. The guidance in the handbook is based on the experience of the EMPACT BirdCast project, as well as that of other experts in the fields of ornithology and public outreach.

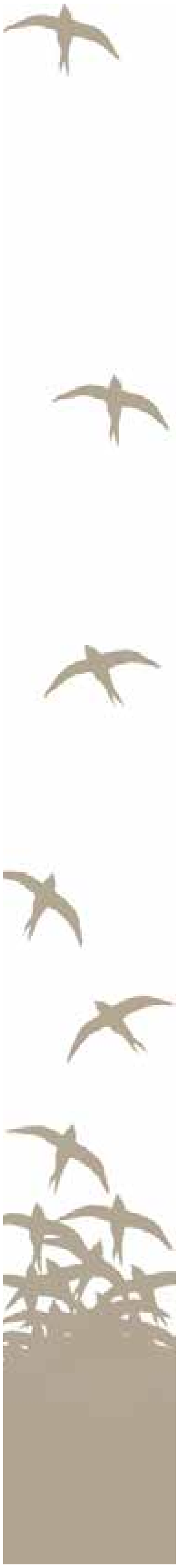
1.1 About the EMPACT Program

This handbook was developed by the U.S. Environmental Protection Agency's (EPA's) EMPACT Program (*http://www.epa.gov/empact*). EPA created EMPACT (Environmental Monitoring for Public Access and Community Tracking) in 1997. It is now one of the programs within EPA's Office of Environmental Information. EMPACT is a new approach to providing timely environmental information to communities across the nation, helping people to make informed, day-to-day decisions. Residents in 156 of the largest metropolitan areas in the United States have or will soon have an easy way to answer questions such as:

- What is the ozone level in my city this morning?
- What is the water quality at my beach today?
- How high is the ultraviolet radiation in my city today?
- What is the level of contamination at the hazardous waste site in my community?
- What are the levels of lead in the soil in yards in my neighborhood?

To help make EMPACT more effective, EPA is partnering with the National Oceanic and Atmospheric Administration and the U.S. Geological Survey. EPA is working closely with these federal entities to help achieve nationwide consistency in measuring environmental data, managing information, and delivering that information to the public.

EMPACT projects cover a wide range of environmental issues, such as groundwater contamination, ocean pollution, smog, drinking water quality, ultraviolet radiation, and ecosystem quality. Some of these projects have been initiated directly by EPA. Others have been launched by the EMPACT communities themselves.



1.2 About the EMPACT BirdCast Project

EPA's EMPACT program started funding the BirdCast project (*http://www.birdcast.org*) in 1999, and the project started public operation on April 1, 2000. The project began as a collaboration among EMPACT, EPA Region 3, EPA's Office of Pesticide Programs, the National Audubon Society, Cornell University's Laboratory of Ornithology, Clemson University's Radar Ornithology Laboratory, the Academy of Natural Sciences in Philadelphia, and GeoMarine, Inc. The four primary objectives of the project are:

1) To maintain an Internet Web site that posts educational information about bird migration and the steps that property managers can take to mitigate the danger and stress that migrating birds face when passing through an area.

2) To predict and monitor bird migrations on a daily basis using weather radar. The data gathered by radar are continually interpreted by trained scientists and presented using text summaries, charts, and radar maps. During its first year, BirdCast also experimented with using microphones to perform bioacoustic monitoring of bird migrations.

3) To collect and disseminate volunteers' reports of bird sightings. This information collection, known as "groundtruthing," is coordinated through the BirdCast Web site. Groundtruthing information is stored on an Web-accessible database called "BirdSource" that Cornell maintains. Visitors to the BirdCast Web site can query this database and display reports in chart or graph form.

4) To raise public awareness about the sensitivity of migratory bird populations. This public relations campaign, coordinated by National Audubon, involves generating press releases, working with local land managers, distributing promotional materials, and making presentations at conferences and conventions.

1.2.1 BirdCast's Regional Focus

To date, the BirdCast program has primarily covered bird migration along a portion of the "mid-Atlantic flyway," a coastal area between North Carolina and New England that experiences significant migratory bird activity each spring and fall. The initial focus of BirdCast's attention has been the city of Philadelphia. BirdCast established a local partnership with Philadelphia's local PBS station (WHYY) and the Academy of Natural Sciences to develop a public relations focus on the region surrounding this city. The BirdCast project's efforts to collaborate with land managers so far have consisted primarily of work with Philadelphia's Fairmont Park Commission. It is hoped that eventually BirdCast can be expanded to cover the entire Atlantic flyway. Birds could be tracked coming across the Gulf of Mexico and at their first landfall. Birdwatchers up the coast could be alerted to the status of the migrating birds and provided with additional early warning of their arrival.

Despite its current regional focus, BirdCast also hopes to expand to cover the entire United States by forming new partnerships with local governments and birding organizations. So far, BirdCast has succeeded at drawing both widespread media attention (it was discussed in more than over 100 news articles by spring 2000) and attention in venues of national importance (it has been covered by news reporters from both the New York Times and the Wall Street Journal).

1.2.2 BirdCast in Context

The BirdCast project is a collaboration among individuals and organizations that made significant contributions to the field of bird monitoring both before and after receiving EMPACT funding. A brief history of these bird monitoring activities (and of radar ornithology in particular) will help to place BirdCast in its full context.

At the outset of World War II, almost immediately after the invention of tracking radar, British radar operators noticed that birds flying over the English channel would sometimes appear on their screens. At the time, this fact was noteworthy primarily because it was possible to mistake a bird for a fast-moving-ship—significant ornithological use of this phenomenon did not begin until the 1960s. Sidney Gauthreaux, now Director of the Clemson University Radar Ornithology Laboratory, began studying the radar detection of birds at that time and has accumulated over 35 years of experience with the method. In the 1970s, the United States Air Force also began studying bird migration as a serious hazard to the operation of military aircraft, which often fly at high speeds and low altitudes. The Bird Aircraft Strike Hazard (BASH) team organized by the Air Force began exploring radar's potential to provide early warning of potential bird collisions. Their efforts were significantly aided by the emergence of "Next Generation Radar" (NEXRAD) in the early 1990s. NEXRAD is a network of highly sensitive weather radar stations located throughout the United States. In 1995, Sidney Gauthreaux also began using NEXRAD in his ornithological studies.

Meanwhile, in the mid-1990s, the National Audubon Society and Cornell University's Laboratory of Ornithology began applying a very different emerging technology to the field of bird conservation. These two groups collaborated to develop BirdSource, a sophisticated computer database that uses the Internet to allow birders from across North America to send their observations to a central repository. With financial assistance from the Packard Foundation, these two groups spent more than $2.5 million developing the BirdSource database as a nation-wide information technology resource for birders.

The idea of the BirdCast program emerged at a 1997 biodiversity meeting attended by personnel from both EPA Region 3 and the Department of Defense. EPA and DoD discussed the possibility of providing the public with near real-time information about bird migration using radar technology. BirdCast combined the capabilities of Clemson's Radar Ornithology Lab with the information technology capabilities of BirdSource so that members of the public would be able to not only view radar images but also submit data that might verify (i.e., "groundtruth") those images. EMPACT began funding the project through EPA's Office of Pesticide Programs and Region 3 in 1999, and BirdCast began its public operations in 2000.

1.2.3 Related Bird Monitoring Programs

BirdCast is not the only program that is currently using radar technology to track bird migration. Additional groups, such as the ones listed below, either have pursued or plan to pursue radar tracking technologies:

- BASH, the U.S. Air Force's program to guard against collisions between wildlife and aircraft, has developed an Avian Hazard Advisory System (AHAS). AHAS can be accessed on the Web at *http://www.ahas.com*. This system uses radar to predict the risk of a bird-aircraft collision along various flight paths at various times.
- The Illinois Natural History Survey, the University of Illinois (*http://www.inhs.uiuc.edu*), and EPA Region 5 (*http://www.epa.gov/region5*) have pro-

posed setting up a project analogous to BirdCast for the Chicago region. The organizers hope to draw Chicago residents' attention to the unique role that their urban and suburban open spaces play in the migration of birds, thereby encouraging interest in the conservation of those open spaces.

1.3 About This Handbook

A number of bird observatories throughout the United States have expressed interest in beginning projects similar to BirdCast. The Technology Transfer and Support Division of the EPA Office of Research and Development's (ORD's) National Risk Management Research Laboratory initiated the development of this handbook to help interested organizations learn more about BirdCast and to provide them with the technical information they need to develop their own programs. ORD, working with BirdCast, produced the handbook to leverage EMPACT's investment in the project and minimize the resources needed to implement similar projects in new areas.

Both print and CD-ROM versions of the handbook are available for direct online ordering from ORD's Technology Transfer Web site at *http://www.epa.gov/ttbnrmrl*. A PDF version of the handbook can also be downloaded from that site. In addition, you can order a copy of the handbook (print or CD-ROM version) by contacting ORD Publications by telephone or by mail at:

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Please make sure you include the title of the handbook and the EPA document number in your request.

We hope that you find the handbook worthwhile, informative, and easy to use.
We welcome your comments; you can send them by e-mail from EMPACT's Web site at *http://www.epa.gov/empact/comment.htm.*

1.4 For More Information

Try the following resources for more on the issues and programs this handbook discusses:

The EMPACT Program
http://www.epa.gov/empact

BirdSource
http://www.BirdSource.org

Cornell University Laboratory of Ornithology
http://birds.cornell.edu

National Audubon Society
http://www.audubon.org

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EPA Office of Pesticide Programs
(703) 308-3273

Ronald Landy
EPA Region 3
(410) 305-2757

Sally Conyne
National Audubon Society
(215) 297-9040

Steve Kelling
Cornell University Laboratory of Ornithology
(607) 254-2478

2 HOW TO USE THIS HANDBOOK

This handbook provides information your organization can use to create and implement a Web-based bird monitoring program. It presents detailed guidance, based on the experience of the EMPACT BirdCast Project, on how to:

1. Identify target communities that would be interested in reporting on and following the progress of bird migration.
2. Record and present real-time information about bird migration using radar, weather information, and acoustic monitoring.
3. Collect groundtruthing information from volunteer birders and present it to the public.
4. Provide education and outreach to members of the public about what to do when migratory birds pass through their area.

This handbook provides simple "how to" instructions on each facet of planning and implementing a bird monitoring program, along with additional information about bird migration:

- **Chapter 3** discusses bird migration as a general conservation issue and how the different members of a bird migration monitoring organization work with each other to help birds as they migrate.
- **Chapter 4** discusses instrument-based observations of birds.
- **Chapter 5** covers a variety of issues relevant to volunteer groundtruthing, including a detailed description of BirdCast's policies and experiences working with volunteer birders.
- **Chapter 6** treats the methods and strategies a bird monitoring organization may make use of to conduct public outreach and education.
- **Appendix A** presents examples of education and outreach materials from the BirdCast project.

Interspersed throughout the handbook are success stories and lessons learned in the course of the EMPACT BirdCast project.

3 BEGINNING A NEW BIRD MIGRATION MONITORING PROGRAM

This chapter provides guidance on important first steps that you will need to take as you start your bird migration monitoring program. Section 3.1 provides a brief overview of the structure of a bird migration monitoring program and outlines the roles and responsibilities of program partners, based on the EMPACT BirdCast Project model. Section 3.2 discusses the critical process of selecting program partners who can best help you meet your program's objectives within your target community.

The information in this chapter is designed primarily for managers and decision-makers who may be considering whether to implement bird migration monitoring programs in their communities, as well as for organizers who are implementing such programs.

3.1 PROGRAM STRUCTURE: OVERVIEW OF A BIRD MIGRATION MONITORING PROGRAM

The EMPACT BirdCast project is a multifaceted project that engages a variety of activities—everything from distributing posters to counting birds. These activities can be grouped into four main categories, which make up the main components of the project: administration and public outreach, radar analysis, database management, and volunteer groundtruthing.

The following paragraphs summarize these activities to provide an overview of how the EMPACT BirdCast program works. These activities are described in greater detail in Chapters 4 through 6.

General Administration and Public Outreach. The administrator and staff of BirdCast are responsible for the primary public relations and outreach efforts of the project. This includes managing the distribution of posters about pesticide use, maintaining contacts with news media organizations to ensure that BirdCast stays in the public eye, issuing periodic press releases, and working with local land managers to encourage bird-friendly gardening practices. The administrator also provides a broad range of support tasks related to the project's birdwatching volunteer program. These tasks include providing advice about making bird identifications, making quality control checks of data submitted by volunteers, and networking to recruit new volunteers. The BirdCast administrator also serves a central liaison with the other BirdCast staff, including the radar analyst and the chief database base manager.

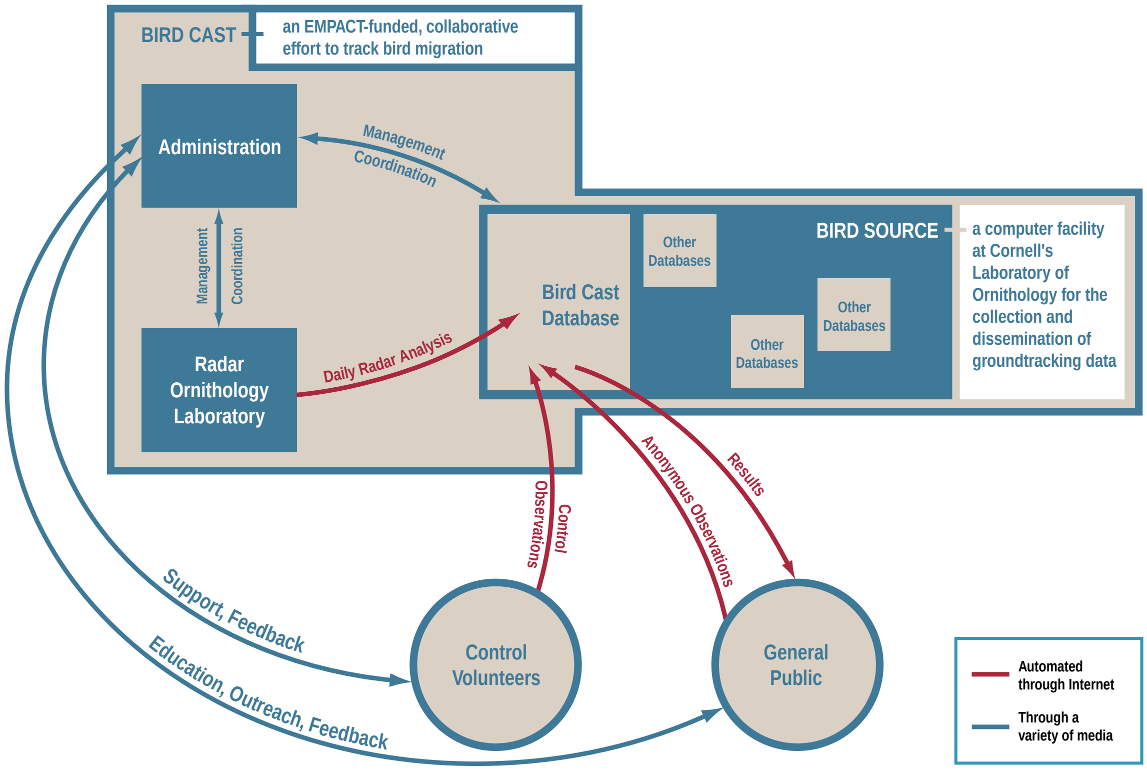
Radar Analysis. The chief radar analyst and his assistant are responsible for predicting the degree of bird migration activity in upcoming evenings and for measuring the actual amount of bird migration using radar data. The radar analyst (and/or his assistant) must make daily reports of predicted and observed migration during the periods of bird migration (in the spring and the fall) but have fewer regular duties during the “off season.” They seek out and contract information service providers to ensure a constant supply of radar data during the periods of migration. Once per day, the radar analysts submit their predictions and observations to the database administrator via the Internet.

Database Administration. BirdCast’s database administrator and his staff ensure that the public has access (via the Internet) to the information submitted by the radar analyst. In the case of BirdCast, the database is actually maintained as a separate organization called

BirdSource. BirdSource is an entity distinct from BirdCast and it maintains a variety of other Web-enabled birding databases. The BirdCast database administrator issues user identifications to new volunteers, implements backups and system security measures, and coordinates the programming of changes to the database system. Also, while BirdCast's bioaccoustic monitoring was being conducted, the project was coordinated by the database administrator.

Volunteer Birdwatching. BirdCast's volunteers provide the "groundtruthing" information necessary to verify the observations made using radar instrumentation. Volunteers are recruited by the project administrator and contact her with any questions or comments they may have about their participation in the program. Registered volunteers make observations several times a week and record their findings directly to the BirdCast database (using the Internet).

The flow chart below summarizes the basic structure of the BirdCast project. The chart identifies the main activities of the project, the team members responsible for these activities, and the flow of work among team members. It also indicates where in this handbook you can go for more information about specific activities.


BIRD CAST
an EMPACT-funded, collaborative effort to track bird migration
Administration
Management
Coordination
Management
Coordination
Radar Ornithology Laboratory
Daily Radar Analysis
Bird Cast Database
Other Databases
Other Databases
Other Databases
BIRD SOURCE
a computer facility at Cornell's Laboratory of Ornithology for the collection and dissemination of groundtracking data
Control Observations
Anonymous Observations
Results
Support, Feedback
Education, Outreach, Feedback
Control Volunteers
General Public
Automated through Internet
Through a variety of media

3.2 Selecting Program Partners

As described in Chapter 1, BirdCast is a partnership of several public and non-profit organizations. These have included university laboratories, a wildlife conservation society, a park management authority, and a natural history organization. The reason BirdCast is composed of such a wide range of partners is that its goals require the use of a wide range range of skills and community connections. None of the individual organizations, working by themselves, would have been as effective as the collaboration of many different organizations, each possessing complementary skills and abilities.

For example, the staff of Clemson University's Radar Ornithology Lab have specialized skills in forecasting and analyzing bird migration patterns using radar images and other weather data. The National Audubon Society, on the other hand, has an extensive media infrastructure for presenting bird conservation information to the public and can easily enlist the support of birding communities. Cornell's Laboratory of Ornithology, in conjunction with the National Audubon Society, has invested in the development of BirdSource, a sophisticated Web-enabled database for the collection and distribution of bird monitoring data.

In starting your own bird monitoring program, you'll need to assemble a team of individuals or organizations who offer a similar range of skills and qualifications. To select partners or team members, you should think about how each will fit into the overall program structure, and how different partners can work together to create a successful program. You will also need to consider their relationship to the region where you will be monitoring bird activity. For example:

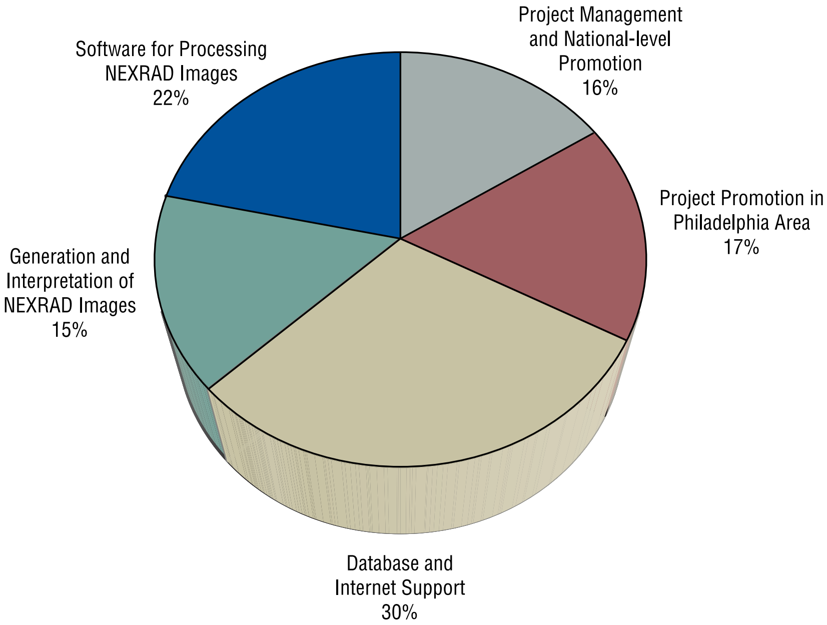
- A small, grass-roots organization that already has strong ties to the community can be ideal for providing public outreach and obtaining volunteer birdwatchers. Local chapters of birding clubs, natural history associations, or conservation groups can all be good choices. (For a directory of birding clubs in the United States, see: (*http://birding.about.com/hobbies/birding/library/blalphausclub.htm*.)
- A university with an ornithology laboratory would make a good partner for identifying and interpreting radar images of birds. A professor or graduate student working in such a lab might either already have the necessary skills or be able to acquire them for the benefit of the bird monitoring project.
- A government agency, university, or private company that employs persons with a range of programming and "new media" skills would make a good partner for the purposes of establishing a Web site where the public can access up-to-date radar images and submit and retrieve groundtruthing observations. Building such a Web site from the ground up may require access to staff trained in JAVA programming, Web page design, network administration, and database building.

3.3 Figuring Costs

One of the important first steps for your organization to take when it is considering setting up a bird monitoring program is to estimate how much your planned activities will cost. Although your program need not be as large or ambitious as BirdCast's, you may find it helpful to know how much money BirdCast spent in its first year of operation.

In its initial year (between December of 1999 and November of 2000) EMPACT provided BirdCast with $449,500 for operations and set-up. As shown above, these expenses break down into five categories, each of which was handled by a separate entity:

- **Project management and national level promotion** was handled by National Audubon Society. This cost $71,000 or 16% of the overall EMPACT budget for BirdCast. This category covers all the public promotion of BirdCast that went on during the year, excepting a local media campaign in Philadelphia.



- **Project promotion in the Philadelphia area** was handled by the Academy of Natural Sciences. This cost $76,500 or 17% of the overall EMPACT budget for BirdCast. The Academy was responsible for encouraging local news media to discuss BirdCast and reporting its findings.
- **Database and Internet support** was provided by the staff of the BirdSource project at Cornell University. This support cost $136,000, or 30% of the overall EMPACT budget. BirdSource staff maintained the BirdCast Web site, set up and managed a database for groundtruthing observations, and coordinated BirdCast's bioacoustic monitoring program.
- **Generation and interpretation of NEXRAD images** was performed by Clemson University's Radar Ornithology Laboratory (CUROL) for a fee of $68,000, or 15% of the overall EMPACT budget. As described elsewhere in this report, CUROL submitted daily radar information about bird migration to the BirdCast Web site.
- **Software for Processing NEXRAD images** was developed by GeoMarine Software for $98,000, or 22% of the overall EMPACT budget. GeoMarine developed software algorithms for distinguishing radar signals reflected from birds from those reflected from clouds.

This cost breakdown represents the first-year of a cutting-edge program and should not be taken as completely representative of the ongoing costs of other bird monitoring programs, particularly those that are smaller in scale. For example, BirdCast organizers learned that it was neither necessary nor feasible at present to automatically distinguish birds from precipitation with software algorithms. The expense associated with this component of the program, therefore, was not carried forward into future years and need not be incurred by newer monitoring programs.

4 INSTRUMENT-BASED OBSERVATION OF BIRD MIGRATION

Flying takes a lot of work. While larger birds (such as raptors, cranes, and waterfowl) will migrate during daylight hours, most songbirds migrate on clear, calm nights when weather conditions are most favorable to powered flight. Unless there is a full moon out, lack of light can make it almost impossible to visually observe migrating songbirds. Birders can take note of where such birds land in the morning, but actual songbird migration is typically recorded using special instruments.

The primary foundation of BirdCast's predictions and observations of bird migration is the information provided by a network of WSR-88D weather stations located throughout the United States. These weather stations (and the data they produce) are collectively referred to as Next Generation Radar (NEXRAD). BirdCast has also experimented with bioacoustic monitoring of nocturnal bird migration. Although this technique has proved promising, it is not currently in widespread use due to cost considerations.

4.1 WHAT IS NEXRAD AND WHAT CAN IT DO?

Like all radar systems, NEXRAD identifies the location of distant objects by transmitting radio signals and analyzing the returning signals that have been reflected off of those distant objects. Unlike previous radar networks, which were composed of WSR-57 and/or WSR-74C radar stations, NEXRAD radar is also able to measure the radial velocity of objects by recording the Doppler shift of the reflected radar. (The Doppler shift is the difference between the frequency of the transmitted radar signal and the reflected signal—if the reflected signal is higher frequency than the transmitted signal, it is an indication that the reflecting object is moving toward the radar station; conversely, if the reflected signal is at a lower frequency, it is an indication that the object is moving away from the radar station).

National Weather Service

NEXRAD Radar Station in Mount Holly, New Jersey

In addition to this new ability to detect object velocity, NEXRAD is also distinguished by increased object detection sensitivity. This is particularly important for ornithologists because birds are relatively weak reflectors (compared to the objects usually detected with radar, such as clouds, airplanes, and ships). NEXRAD is capable of detecting birds flying at a range of heights and can provide a rough idea of the altitude at which a particular group of birds is flying. NEXRAD is so sensitive that radar ornithologists need to learn how to differentiate birds and insects—both can be detected.

Finally, NEXRAD provides information about the reflectivity of a particular object (i.e., how effective a particular object is at reflecting radio waves). Reflectivity can be determined by a number of different factors but in the case of migrating birds, it provides indirect information about the number of birds traveling in a particular area.

In summary, then, NEXRAD can help determine:

- The **location** of a group of migrating birds, including general altitude information.
- The **speed** with which the group birds are moving towards and away from a particular radar station.
- The **approximate quantity** of migrating birds in a particular area. Quantitative NEXRAD estimates are calibrated by "moonwatching" (counting the number of birds that fly across a visible full moon) and by making next-morning ground observations.

4.2 What is Bioacoustic Monitoring And What Can It Do?

BirdCast staff have been experimenting with bioacoustic monitoring as a way of keeping track of nighttime bird migrations. Bioacoustic monitoring is the process of recording bird calls and matching them to a library of the bird calls of different species. When birds fly at night, they typically make frequent 50- to 100-millisecond vocalizations. Some birders can make fine distinctions between certain kinds of birds simply on the basis of these calls (e.g., the distinction between the Veery Thrush, the Gray-Cheeked Thrush, and the Hermit Thrush). Although birders can perform something like bioacoustic monitoring right in their heads, BirdCast staff are developing a computerized system to automate and standardize the process of recording, filtering, and identifying bird calls.

A bioacoustic monitoring station, typically located on the property of a volunteer birder, consists of a computer with a sound processing card and a specially designed outdoor microphone. The microphones used in bioacoustic monitoring can detect noises made by birds that fly up to 1,500 above the ground. Throughout an entire evening, the computer automatically analyzes the sounds picked up on the microphone and digitally records those sounds that appear to be made by birds. In the morning, a volunteer uploads this "filtered" recording to the Cornell Laboratory of Ornithology, where more sophisticated computer software enters the information into a database and attempts to determine which species are represented in the recording.

The BirdCast program has recently found it necessary to curtail its bioaccoustic monitoring program—only a very few stations are currently in use and there are no current plans to establish new ones. The greatest barrier to the more extensive use of bioacoustic monitoring has been the cost of manufacturing the special microphones for the monitoring stations. The basic materials for the microphones are quite inexpensive, but because production quantities were extremely low, the microphones were being hand-built by laboratory staff at Cornell. The microphones currently cost about $2,500 apiece, but BirdCast staff imagine that the microphones could be dramatically reduced in price if some way were found to mass produce them.

Additional limitations of bioacoustic monitoring include the following:

- Weather conditions can affect both the likelihood that birds will make noises and the ease with which those noises can be picked up with a microphone. Thus, it is difficult to disentangle weather variability from variability in the numbers of migrating birds.
- Many species of birds do not make noises while flying. Therefore, it is difficult to gauge overall numbers of migrating birds solely using this method.

- Bioacoustic technology is in an early stage of development. The software that is used to quantify and identify birds on the basis of sound recordings is still quite experimental and there has not been enough time for scientific literature to accumulate on this topic.

4.3 How Do NEXRAD, Bioacoustic Monitoring, and Volunteer Groundtruthing Fit Together?

It is noteworthy that the altitude detection range for bioacoustic monitoring (0-1,500 feet) does not overlap with the detection range for NEXRAD radar (generally between 3,000 to 6,000 feet). The non-overlap of these two ranges complicates the correlation of bioacoustic results and NEXRAD results, as it is possible for certain bird species to picked up by one kind of instrument and not the other. Due to the influence of variable weather conditions and a lack of complete information about the altitude at which different bird species fly when they migrate, it is not possible to precisely predict which species will fly within the altitude range of which instruments on any given evening.

Groundtruthing data collection, covered in greater detail in Chapter 5, is an essential complement to both NEXRAD radar interpretation and bioacoustic monitoring. One reason for this is the fact that it is difficult to ascertain what kinds of birds are migrating through an area solely from NEXRAD data. In combination with coordinated groundtruthing data, however, it is sometimes possible to associate particular clusters of reflectivity with particular species of birds. Groundtruthing also helps to calibrate the quantitative estimates of birds made from radar and it serves as a quality control check of the basic reporting information provided by radar and bioacoustic monitoring.

Until recently, the BirdCast Web site combined the daily results of NEXRAD observations, bioaccoustic monitoring, and groundtruthing in a single display. The purpose of this display was to show how each of these methods produced results that were similar to those of the other methods. Under ideal circumstances, for example, all three methods would predict the same degree of migration activity. This display has been recently discontinued on the grounds that some viewers may have found it too complicated.

4.4 How Can A Bird Monitoring Organization Begin Using NEXRAD To Observe and Predict Bird Migrations?

The essential first step in setting up a radar component for your migration monitoring program is to contact an organization that is already experienced in this work, such as the Clemson University Radar Ornithology Laboratory or the Illinois Natural History Survey. Such contact is essential for obtaining advice about the feasibility of your project and about the best way to obtain the expertise necessary to accomplish your project. Depending on the training and availability of your organization's staff, you will probably need to either delegate your actual NEXRAD analysis to an experienced laboratory or send a staff member for training at such a laboratory. Both of these plans would require negotiating a working partnership with an organization possessing expertise in radar ornithology.

The use of NEXRAD to forecast bird migration, in the words of one practitioner, "is a difficult task that requires laboratory and field experience as well as an appreciation for meteorological phenomena." The interpretation of NEXRAD radar to observe current migration is a similarly complex task. At present, it is an undertaking suitable for a graduate level or post-doctoral ornithologist who has received hands-on training with an expert.

4.5 How Did BirdCast Implement the NEXRAD Component of Its Bird Monitoring Program?

In July 1998, Dr. Sidney Gauthreaux of the Clemson University Radar Ornithology Laboratory (CUROL) helped propose the BirdCast project to EPA's EMPACT Program. His proposed task involved forecasting bird migration twice a day (mid-morning and mid-evening) over the Delaware Valley and then using Doppler weather surveillance radar (i.e., the NEXRAD network of WSR-88D stations) to validate the forecast and measure the actual amount of bird migration that occurred over the area. The text files and graphic radar files were to be sent to the BirdCast Web server at the Laboratory of Ornithology at Cornell University and posted on the BirdCast Web site. GeoMarine, another partner in the project, was to supply hourly WSR-88D imagery that had been processed to eliminate echoes from weather and other non-bird targets. The hourly images would also be posted on the BirdCast Web site. A proposal was developed in August 1998 and work began after Clemson University signed a subcontract with National Audubon Society in mid-March 2000.

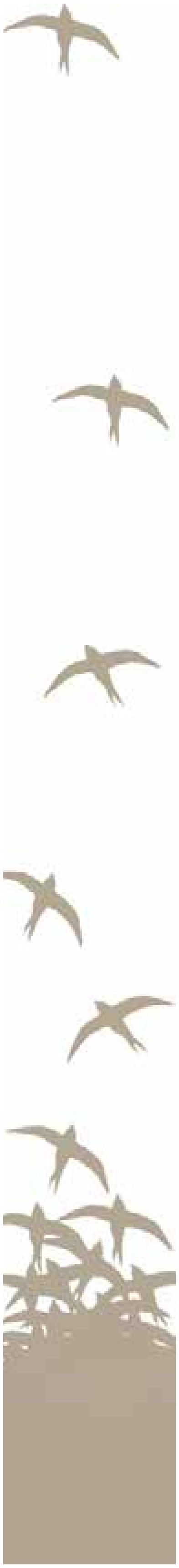
4.5.1 Activities in Spring 2000

The first task was to purchase a host computer (Dell Dimension XPS T600MHz, Dell Computer Corporation) that could be used to download the WSR-88D images from the NEXRAD Information Distribution Service (NIDS) provider, download the weather data necessary for generating a migration forecast, and serve as host computer where Cornell could electronically "capture" forecast text files, analysis text files, and the mosaic radar image files. CUROL used Marta Systems, Inc. as the NIDS provider. CUROL was familiar with Marta Systems' software, so it could easily make the mosaic images of the radar displays from the Delaware Valley. In order to work from remote locations, CUROL also purchased a Gateway Solo 9300 CX laptop computer. This allowed laboratory staff to work on forecasts and analysis while at home or traveling by communicating with the Dell host computer over the Internet. CUROL believes that laptops are essential for producing consistent and timely results for display on the BirdCast Web site.

During a previous research project in the middle 1970s, Dr. Gauthreaux developed a multivariate forecasting model to predict the amount of bird migration in the Athens, Georgia, area. The input variables for this model were the weather predictions for the period in question. Dr. Gauthreaux generated this model by step-wise regression analysis, choosing an array of weather variables that best explained the variation of nightly bird migration amounts. No existing forecasting models of bird migration were available for the Delaware Valley area and time constraints prohibited the development of a model for the region. Given this situation, CUROL used the Athens forecast model for the spring 2000 BirdCast effort.

From 31 March through 30 May, Dr. Gauthreaux or graduate students Andrew Farnsworth or Jonathan Ariail gathered weather data via the Internet from weather stations in the Delaware Valley for input to the Athens model. The model generated a forecast of the amount of migration expected over the Delaware Valley. The model was run before noon to forecast the amount of migration expected that evening at 10 PM, and it was run before midnight to forecast the amount of migration expected the following morning at 10 AM. In addition, to verify the accuracy of their forecasts, CUROL downloaded radar imagery from five WSR-88D stations (KAKQ in Norfolk, VA; KLWX in Sterling, VA.; KDOX at Dover Air Force Base, DE; KDIX at Ft. Dix near Philadelphia, PA; and KCCX at State College, PA) and made mosaic images showing the amount of bird migration over the Delaware Valley at the forecast times. The laboratory analyzed and interpreted the mosaics so that the viewer of BirdCast would be able to discriminate birds from weather and insects.

Each morning before noon and each evening before midnight, CUROL staff placed the text file of the forecast, the text file of the analysis, the graphic file of the radar reflectivity mosaic, and the graphic file of the radar velocity mosaic in separate folders on the Dell host computer. The BirdCast server at Cornell automatically downloaded the files and posted the materials on the BirdCast Web site. Except for a few glitches near the beginning of the project, the CUROL efforts proceeded with no problems.



4.5.2 Later Seasons (Fall 2000 and Spring 2001)

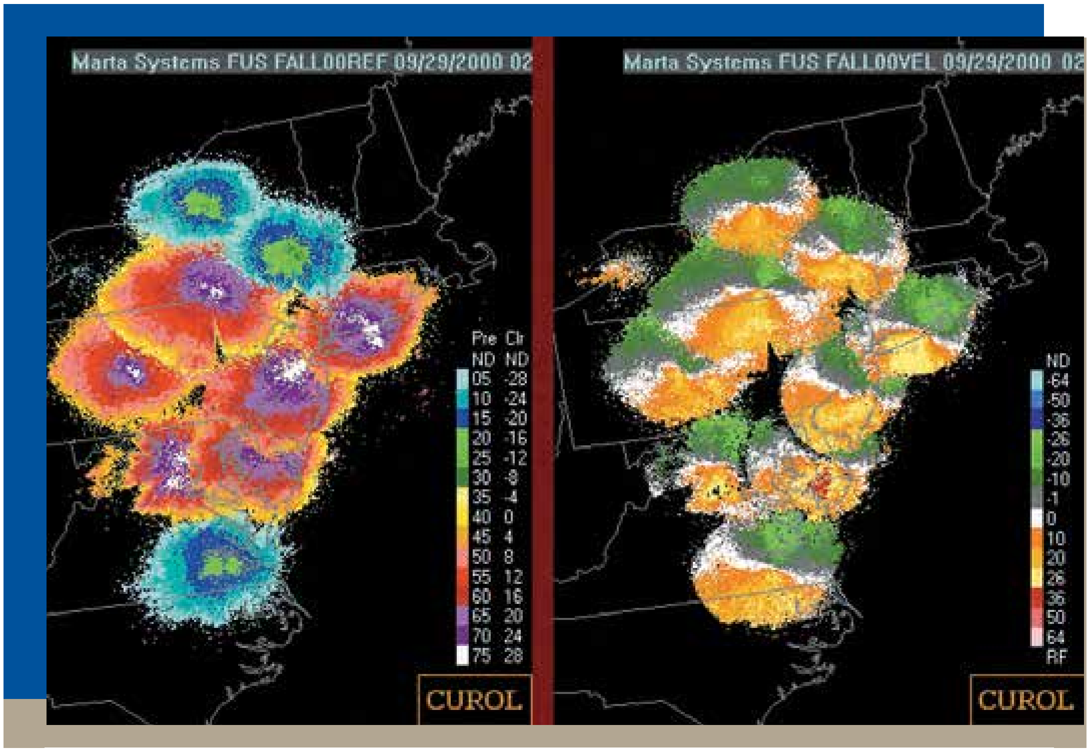
CUROL was encouraged to continue with the BirdCast program because of its success in forecasting the amount of bird migration during the initial BirdCast effort. There were a number of changes between the second season of BirdCast and the first. For example, BirdCast coverage was expanded in this season to include the state of New York. Also, because only a very small amount of bird movement had been found in the mid-morning hours, CUROL discontinued forecasts and analyses of daytime bird migration.

CUROL learned from the spring 2000 effort that using a single model to forecast migration amount over the entire BirdCast area resulted in inaccurate forecasts for some areas. In an effort to overcome the geographical limitations of the spring 2000 model, CUROL developed two models specifically for the BirdCast area using a step-wise regression analysis of forecast weather variables and the amount of bird migration measured (i.e., the relative reflectivity of targets [dBZ] displayed in WSR-88D images). CUROL used WSR-88D data collected during the fall migration of 1999 for another CUROL project and Local Climatic Data (LCD) for September and October 1999 that it purchased from the National Climatic Data Center (NCDC) for two stations: Albany, New York, and Washington, D.C. By the spring of 2001, CUROL had developed more than 30 regional models.

As in the spring of 2000, at 2 PM every day CUROL placed a text file containing the evening forecast, a text file containing the analysis of the previous evening, the graphic file of the radar reflectivity mosaic, and the graphic file of the radar velocity mosaic in separate folders on CUROL's BirdCast host computer. As in the spring the Cornell BirdCast server collected these files and posted them to the CUROL portions of the BirdCast Web site. The ability to generate a forecast each day, including days on which both forecasters were traveling or away from the CUROL host computer, was greatly enhanced by a laptop computer with an FTP program that allowed the forecasters to upload text and graphics remotely. With the exception of some initial glitches that were quickly corrected, CUROL's models worked well. A sample of the Web page products for an afternoon posting (in this case for the afternoons of 28 and 29 September 2000) can be found in Figure 1.

4.5.3 Feedback and Conclusions

CUROL received overwhelmingly positive feedback from the public with regard to its forecasting and the radar ornithology tutorial that it developed for the BirdCast Web site. Although the forecasting and analysis portion of the BirdCast project is complete, CUROL seeks to develop better forecast models. As it refines its methodology for building models and its understanding of the interactions and correlations between specific weather variables and the amount of bird migration, the accuracy of its forecasting will continue to improve. Models are an absolute necessity for any attempt to track bird migration over large spatial scales (such as the entire eastern seaboard), and improved accuracy will improve scientists' ability to understand where and when large movements of migrating birds will occur.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75 28
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RF
CUROL

Figure 1. NEXRAD radar images of bird migration on September 28: reflectivity (l) and velocity (r).

Analysis 28 September evening:

Weather conditions over the BirdCast area were favorable for bird migration. Northerly winds, clear skies, and cool temperatures associated with a strong ridge of high pressure over the area facilitated southward movements of migrants across the region. The reflectivity image (above left) shows extensive moderate to high densities (15-28 dBZ) of non-precipitation reflectors over the coverage area. The velocity image (above right) shows most of these reflectors are moving S and SSW at 20-50 knots on N and NW winds at 5-10 knots. These are likely birds. Migration amount was moderate to high across the region, with bird densities reaching 600-1150 birds per cubic kilometers (25-28 dBZ) in many areas.

—Andrew Farnsworth, Clemson University Radar Ornithology Laboratory

Forecast 29 September evening:

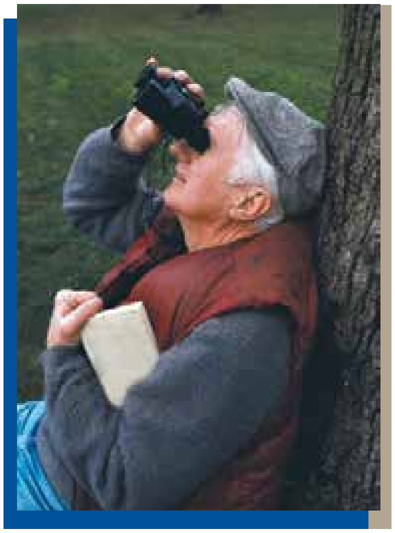
Weather conditions over the BirdCast area will not be favorable for bird migration. E and S winds and warming temperatures associated with high pressure off the coast of New England will keep most birds on the ground. Migration amount will be low to moderate, reaching densities of 80-120 birds per cubic kilometer (12-16 dBZ).

—Andrew Farnsworth, Clemson University Radar Ornithology Laboratory.

5 GROUNDTRUTHING OBSERVATIONS

The ornithological community uses the term "groundtruthing" to refer to a particular process of corroborating and supplementing instrument-based observations of birds (such as NEXRAD signals). This procedure is straightforward: one recruits birders in the area in question to count and identify birds there. A collective groundtruthing program serves a variety of purposes:

- It complements the radar data provided by NEXRAD.
- As a form of "citizen science" it encourages birders to become increasingly engaged in environmental science and conservation.
- It makes birding more fun by organizing an audience for the observations of individual birders.



Dedicated birdwatchers are often eager to contribute their observations to groundtruthing programs.

This chapter is oriented toward helping the administrators of bird monitoring organizations develop and manage groundtruthing programs. It describes BirdCast's sophisticatedInternet-based groundtruthing database (BirdSource). However, a groundtruthing program need not use precisely this kind of tool to manage its information. Regardless of a particular program's data distribution/collection needs, the experiences of the BirdCast program may provide valuable insights.

5.1 HOW DOES GROUNDTRUTHING COMPLEMENT RADAR ANALYSIS?

The eyes and ears of a careful observer offer the most direct indication of the number and type of birds in a particular area. Therefore, such observations can serve as a means of calibrating, validating, and supplementing NEXRAD images of bird migration. As described in Chapter 4, NEXRAD does not provide a direct sampling of the number of birds traveling through a particular area and provides very little information about what kind of birds are being detected. All it can do is record the radio reflectivity at a particular distance and angle from the station. During spring migration in particular, there appears to be a high correlation between nights when radar shows bird-like signals and mornings when birders see a lot of new birds on the ground in nearby areas. Radar ornithologists are still in the process of developing relationships between radar activity at a particular place and time and groundtruthing results at other places and times. Therefore, there is heightened value in a coordinated program of groundtruthing and radar imaging—the connection between the two data sets is as valuable as the sets themselves. In the future, for example, it may be possible to track the migration of individual species of birds using a combination of radar and extensive groundtruthing.

5.2 How Does BirdCast Conduct its Groundtruthing Program?

Over an average week of operation, the BirdCast Web site receives more than 300 reports of bird activity from its volunteers. The project then presents this information (in the form of charts and graphs) to the Web site's visitors, who number over 80,000 in a 2-month migratory season. As these figures indicate, BirdCast's groundtruthing program requires significant information technology infrastructure and program administration. Whether your organization is planning a groundtruthing program of similar scope or one that will be smaller scale, a knowledge of the methods and experiences of BirdCast in this endeavor is likely to be helpful.

5.2.1 BirdCast's Information Management Infrastructure

As described in Chapter 3, BirdCast's operation relies on a substantial prior investment of time, money, and labor in the establishment of BirdSource's information technology infrastructure. This infrastructure consists of:

- **Software:** an Oracle database customized to handle groundtruthing data, JAVA applications to process the information requests of users of the BirdSource Web site, and a GIS tool that allows users to specify the latitude and longitude of their observation site by zooming in from a map of the mid-Atlantic United States.
- **Hardware:** A four-processor server computer to maintain the BirdSource web site, an uninterruptable power supply and tape backup system, and Internet connection service for the computer.
- **Support Staff:** one full-time network administrator and five JAVA programmers.

This infrastructure, which cost $2.5 million to establish, is larger and more robust than what is necessary to simply record and present groundtruthing information. One proposed bird monitoring program, based in the Chicago area, expects to meet its information technology needs for 2 years at a cost of $100,000 per year. A potentially economical option for supporting groundtruthing programs may be to collaborate with BirdSource staff at Cornell's Laboratory of Ornithology. BirdSource staff expect that they could provide complete information technology support for an initial outlay of $35,000-50,000 and a maintenance fee of $5,000-10,000 per year. Depending on the goals and needs of your organization's groundtruthing program, it may not even be necessary to spend this much. One group planning to set up a groundtruthing program in the Chicago area has estimated that they could store their data using spreadsheet software and would not even need to dedicate an entire Windows workstation to the task.

5.3 BirdCast's Administrative Procedures

BirdCast records the birding observations of both registered and unregistered visitors to its Web site. The former are called "control" observations and the latter are called "anonymous" observations.

5.3.1 Collecting Control Observations

Control observations are repeated visual inventories of birds obtained by regularly visiting a particular site during a bird migration season. They are made by committed, experienced birders known by or referred to the site's administrator. It is one of the primary tasks of the administrator to identify these individuals, provide them with support and guidance, and monitor and edit their contributions to the database.

The site administrator actively recruits individuals to serve as control observers through several avenues:

- ◆ Personal networking within the local birding community.
- ◆ Appeals to local conservation groups, such as chapters of the Audubon Society and the Nature Conservancy.
- ◆ Postings to e-mail distribution lists dedicated to birding.

A control observer needs be reasonably experienced at quantifying and identifying birds in his or her area. He or she must also have enough free time, energy, and commitment to make frequent visits to an observation site. Ideally, a volunteer should be able to make these visits during the early morning hours (between sunrise and roughly 9 AM) when migratory birds are most active. It is also very helpful for a volunteer to be able to recognize birds by their songs as this is the most rapid way of identifying the presence of a particular species of bird. (The Cornell ornithological laboratory makes recordings of bird songs that volunteers can use for training purposes.)

At present, BirdCast has not established a formal procedure for screening observers or checking their qualifications, as most control observers are friends or colleagues of the project organizers. Some control observers, however, are individuals unknown to BirdCast staff who have spontaneously approached the project about participating. It is assumed that an inexperienced birdwatcher would tend to be discouraged by the time commitment required in making regular observations over a prolonged period, so there is a process of “self-screening” inherent in signing up volunteers.

Lessons Learned: How frequently should control observers go into the field?

In the experience of BirdCast organizers, control observers should ideally make five visits to a single observation site during each week of a data collection period. A typical observation session takes between 1 and 2 hours, depending on the observer's time constraints and the abundance of birds at the observation site. This schedule of frequent observations increases the likelihood of “catching” the migration of different species of birds through an area. The goal is to have the observation record reflect the variability of the birds' presence or absence at a particular location rather than the variability of the observer's presence or absence.

In the mid-Atlantic region of the United States, spring migration period takes place over a relatively short period of time: roughly from April 15 to May 15. Fall migration, however, is more difficult to observe completely because it takes place over a more extended period of time. In the fall of 2000, BirdCast experienced significant difficulties with volunteer burn-out when it asked control observers to work from September 1 to November 1. In the future, BirdCast is planning to implement a staggered observation schedule that will keep observers' commitment limited to approximately 1 month. Volunteers living at higher latitudes will begin and end their observing earlier than will volunteers living at lower latitudes.

Once the site administrator has identified a new control observer, she briefs him or her about the standard observation protocols used by the project and issues that person a new User ID for logging into the site. Also, new control observers need to be shown how to use BirdSource's interactive map to estimate the latitude and longitude of their observation site.

The interactive map is a software component of the BirdSource Web site in which users "zoom in" to their observation site by clicking on a map of the United States. Once a user has selected a particular location, the software calculates that location's latitude and longitude.

Once they have registered and determined the location of their observation site, control observers use their User ID to access data entry pages on the BirdCast Web site where they can enter:

- The date and time of their observations.
- Whether or not they recorded every species that they saw.
- The birders' estimation of their own skill at identification.
- The physical environment and weather at the place of observation.
- The numbers and kinds of different birds counted.
- Any additional information not provided elsewhere in the form.

The administrator has ongoing responsibilities for answering any questions the control observer may have and for editing the data provided by the observer. The purpose of this editing process is to ensure that the data provided by the control observers is of a high quality. Editing requires some local birding expertise—one must review the submitted observations and make judgment calls about whether they are reasonable, questionable, or obviously erroneous. The administrator flags control observations that appear problematic and follows up with the observer to resolve her concerns. The following signs, when they appear repeatedly or in combination with each other, may cast doubt on an observer's results:

- Species that are extremely rare for the area, particularly in large numbers.
- Species that are extremely rare for a particular time of year (particularly record-setting early sightings of a species).
- The omission of migratory species that are quite common for the particular area and time.

None of these signs is a certain indication that a set of observations is invalid, but they may prompt the BirdCast administrator to request additional information from the observer, such as sketches, notes, photographs, and the names of co-observers. Following is a sample letter from BirdCast that requests additional information in a non-confrontational manner:

May 10, 2001

Dear Mr./Ms ___________________

I'm interested in learning more about the birds you've reported to our project and the site from which you're reporting. As you probably know, you've had some extraordinary sightings during the two days for which you've reported. Standard procedure for our BirdSource projects is that we request verification for unusual reports before the data is entered in the database.

Several of these would be all time early records for your immediate area and the numbers you report for some species are unusually large. On the other hand, your report for a species like Yellow-rumped Warbler is very low.

We are making a great effort to report only species and numbers that were well seen and absolutely identified. Only sightings of this type will give our project credibility and, in the long run, benefit bird conservation efforts. With this in mind, would you review your reports that I have listed below and answer the following questions?

> Was the bird well-seen? for how long?
> Is this a positive identification? Which of the field marks were observed?
> Was the bird photographed? Was it seen by additional observers?
> Were notes taken? Sketches made?

American Black Duck - Wild bird? late
Yellow-bellied Flycatcher - early
Golden-crowned Kinglet - late
Philadelphia Vireo - 1 unusual, 2 extremely rare
Bay-breasted Warbler - early, 2
Cerulean Warbler - early, 2
Mourning Warbler - early
Yellow-breasted Chat - early, 2
Rusty Blackbird - late, unusual, 10 birds

I would also like to have more information about the site where you observed these species. Is this land named? Is it public or private?

Thanks very much for providing us with this information and thanks for your patience.

Sally Conyne

Audubon

BirdCast also has a number of proactive strategies for limiting the amount of potentially unreliable observations that it receives. These strategies include:

- Putting caps on the number of individual birds of a particular species that can be reported.
- Phrasing data entry questions clearly to avoid misunderstanding.
- Offering assistance in the identification of birds to volunteers.
- Creating area-specific checklists of birds for volunteers to use in data entry. This prevents the reporting of obviously erroneous reports (e.g., roadrunners in upstate New York)

Lessons Learned: Data Entry Burdens

One of the lessons that BirdCast organizers learned when they established their volunteer groundtruthing program was that they needed to minimize the data entry requirements for their volunteers. Some of the first volunteer observers complained that the observation protocols took too long to key into the computer. BirdCast has reduced the length of its protocol since then to make volunteers' jobs easier.

5.3.2 Collecting Anonymous Observations

Visitors to the BirdCast Web site do not need to register or commit to making a schedule of repeated observations in order to submit data to the BirdSource database. Any birder visiting the site may submit information as an "anonymous" observer. Strictly speaking, these observers are not always anonymous because they are encouraged to submit their e-mail address along with their observations. The term is meant in distinction to the control observers, who are either known by or referred to the BirdCast staff.

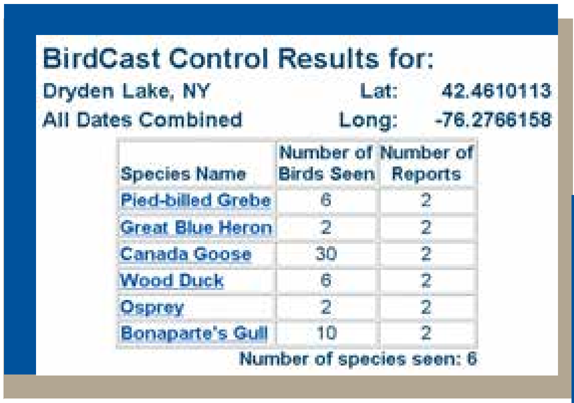
The data entry form used by anonymous observers and the data they submit are very similar to those of control observers. There are number of differences, however, between how control and anonymous observations are handled. Unlike control observations, anonymous observations do not include information about the latitude and longitude of the observation site. Instead, observers simply list the postal code of their area. Also, BirdCast does not (at present) conduct any quality control editing of anonymous observations. BirdCast staff currently do not have enough time to manually edit the anonymous observations, which are of somewhat less value than the control observations because they are not made regularly. BirdCast hopes, however, that in the future they will be able to institute computer-based "filters" that will provide automated quality control of anonymous data.

5.3.3 Displaying Groundtruthing Information

Visitors to the BirdCast Web site have two options for displaying observation data. They may either:

- **Select a single observation location.** The user then views a table (such as Figure 2 and Figure 3) of different kinds of birds counted at that single observation location (either an anonymous observation postal code or a specific control site). The table also lists the numbers of each kind of bird, and the numbers of reports of each kind of bird. The user may select whether this table lists results for the entire migration period or for a specific date.

- **Select a single species of bird.** The user then views a graph (such as Figure 4 and Figure 5) of how many times that bird was sighted during each day of the migration period. The graph includes combined information from all the control sites but excludes anonymous observations. This is because anonymous observations are not edited for accuracy and are not likely to be made regularly at any single location.



BirdCast Control Results for:

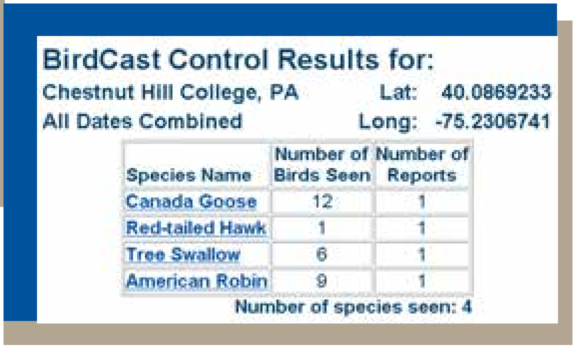
Dryden Lake, NY — Lat: 42.4610113

All Dates Combined — Long: -76.2766158

Species Name	Number of Birds Seen	Number of Reports
Pied-billed Grebe	6	2
Great Blue Heron	2	2
Canada Goose	30	2
Wood Duck	6	2
Osprey	2	2
Bonaparte's Gull	10	2

Number of species seen: 6

Fig 2. Single observation location: Dryden Lake, NY.



BirdCast Control Results for:

Chestnut Hill College, PA — Lat: 40.0869233

All Dates Combined — Long: -75.2306741

Species Name	Number of Birds Seen	Number of Reports
Canada Goose	12	1
Red-tailed Hawk	1	1
Tree Swallow	6	1
American Robin	9	1

Number of species seen: 4

Fig 3. Single observation location: Chestnut Hill College, PA.

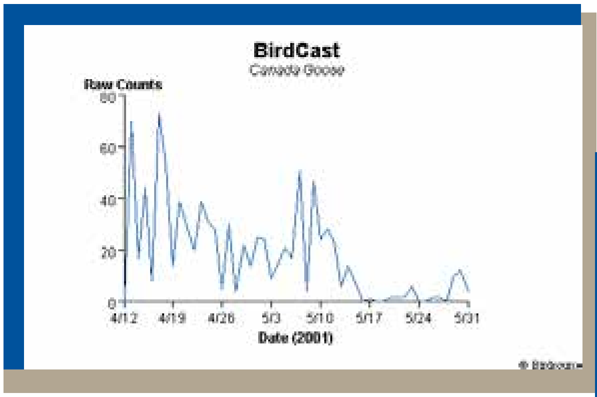


Fig 4. Single species count: Canada Goose

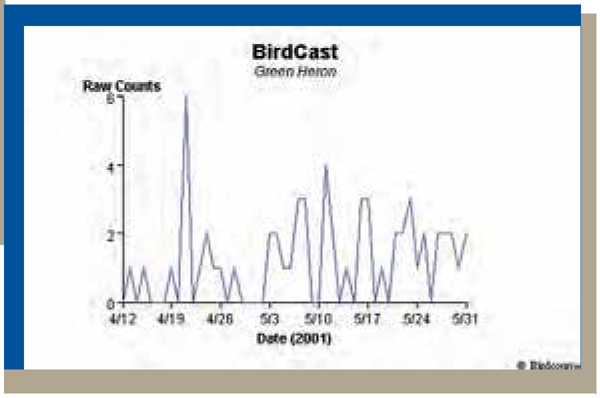
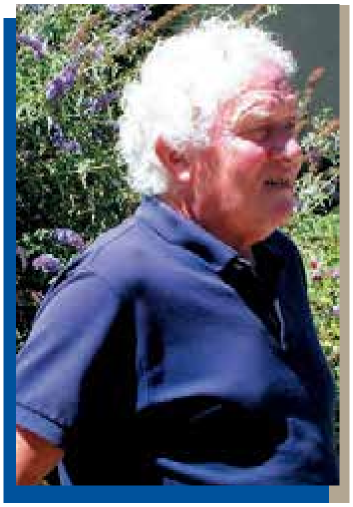


Fig 5: Single species count: Green Heron



Chuck Hetzel

MEET TWO BIRDCAST VOLUNTEERS

Chuck Hetzel, one of BirdCast's control observers, doesn't have to go any farther than his back yard to collect data for the project. That's because he's fortunate enough to live at the edge of the Schuylkill Valley Nature Center near Philadelphia. Mr. Hetzel first heard about BirdCast through his local bird club—the Cornell Laboratory of Ornithology was looking for volunteers in his area to host bioacoustic monitoring stations in their homes. Through this introduction to Cornell's research program, he became involved in making regular control observations for BirdCast. It usually takes him between 1 and 2 hours to record the birds in his backyard, which he does nearly every day of the migration period around 7 AM. With more than 50 years of birding experience, he doesn't need to take an identification guide into the field with him; all he needs is a notepad or a tape recorder for keeping track of the types and numbers of birds that he sees (or hears). Mr. Hetzel enjoys the extra motivation to go birdwatching that BirdCast provides—in sharing his observations through the BirdCast database he enjoys an extra feeling of accomplishment and satisfaction about birdwatching.

Hannah Suthers

Hannah Suthers makes her control observations at an abandoned 108-acre farm in central New Jersey. The farm, which has recently been converted into a wildlife sanctuary, is slowly reverting back to forest. This makes it a fascinating birding site because the land's habitat is undergoing continual transformation. Ms. Suthers has more than 50 years of experience as a bird bander and for more than 20 years has been studying how the farm's changing habitat has affected the population of resident birds in the area. Now in her retirement, she continues to publish articles related to avian population biology and trains graduate students from nearby Princeton and Rutgers Universities in bird banding. After a friend referred her to the BirdCast project, Ms. Suthers started working as a volunteer for it, tallying migratory birds at the sanctuary. During the BirdCast observation period, she aims to be in the field on a daily basis, tallying birds by sight and sound. She carries a small notebook with her and jots down her tally in alpha codes. A counting session can take anywhere between 1.5 to 4 hours, depending on the time of season and how many different species are present. It can be tiring getting up so early in the morning on a regular basis, she admits. Though she does not need to go out as frequently to spot-map the singing males on their breeding territory, she feels that to get an accurate picture of migratory movements one needs to go into the field daily. One of the most pleasant aspects of the work is the opportunity to greet all her "old friends" as they fly through her area each migration season.

6 EDUCATION AND OUTREACH

This chapter provides guidance on setting up and maintaining an education and outreach component of a bird migration monitoring program. Section 6.1 provides tips on developing an outreach plan for your program, with a focus on defining goals, key messages, and target audiences. Section 6.2 describes a variety of outreach tools that can be used, and provides examples of outreach materials developed by the BirdCast project. Section 6.3 describes the challenge of evaluating the success of your education and outreach program, and Section 6.4 lists some additional sources of information for education and outreach.

The information in this chapter is designed primarily for managers who are implementing bird migration monitoring programs, as well as for education and outreach workers who are responsible for communicating about these programs.

6.1 DEVELOPING AN OUTREACH PLAN

BirdCast represents a milestone for radar ornithology, a field that has evolved slowly for more than 30 years, advanced by a handful of scientists working mostly in isolation. BirdCast's breakthrough is that it is the first program to bridge the gap between these scientists, collecting and interpreting radar images in their labs using highly specialized technologies and techniques, and the general public. The founders of BirdCast also recognized that "a picture is worth a thousand words"— a live visual image, such as a radar image of birds migrating, or digital photos or videos from groundtruthers, would more likely stimulate action than just a verbal description of migration.

Communication is at the heart of the BirdCast mission: to provide the public with timely information on the status of bird migrations, and to educate land managers and the broader public about actions they can take to assist birds during their migration and reduce the number of birds that die while passing through. An effective education and outreach program, therefore, is key to the project's success.

BirdCast's education and outreach program is run primarily by the National Audubon Society. Staff from Audubon's Citizen Science Program work together with Audubon's public relations department to create educational materials, write and distribute press releases, develop and deliver presentations, and conduct direct outreach to land managers. Other BirdCast partners (including staff from EPA's Office of Pesticide Programs, EPA Region 3, Cornell University's Laboratory of Ornithology, and Clemson University's Radar Ornithology Laboratory) contribute to the outreach effort as well, mostly by delivering presentations. In addition, Philadelphia's Academy of Natural Sciences, a founding partner of BirdCast, developed many of the project's original outreach materials.

The first step to creating an effective education and outreach program of your own is to develop an outreach plan. This plan will provide a blueprint for action. It does not have to be lengthy or complicated, but it should define four things: What are your outreach goals? Who are the target audiences? What are the key messages and types of information that you want to deliver? And what outreach tools will you use to reach these audiences? Let's look at each of these questions in turn.

6.1.1 What Are Your Outreach Goals?

Defining your outreach goals is the first step in developing an education and outreach plan. Outreach goals should be clear, simple, action-oriented statements about what you hope to accomplish through outreach. Here are some sample goal statements that a BirdCast-type program might develop for its outreach effort:

- Convince all local television stations in the region to give a brief report on bird migration after the weather forecast, or to run at least one report on bird migration per migratory season.
- Place a story on bird migration in the major newspaper of each state in the region.
- Deliver a presentation to each bird club or Audubon chapter in the region.
- Conduct direct outreach (e.g., via letter or phone call) to the managers of all public parks in your region.
- Attract 100,000 visitors per year to your Web site.

Where possible, outreach goals should be measureable. This will help you when it comes time to evaluate the success of your program (see Section 6.3). Abstract statements of good intention (e.g., "increase the public's appreciation of the wonders of bird migration") do not make effective outreach goals, even if such statements accurately describe one of your main motivations for starting a BirdCast-type program.

6.1.2 Who Are Your Target Audiences?

The second step in developing an outreach plan is to clearly identify the target audience or audiences for your outreach effort. As illustrated in the sample goals above, outreach goals often define their target audiences. You might want to refine and add to your goals after you have specifically considered which audiences you want to reach.

The target audience for the BirdCast project is broadly defined as land managers and the general public. Yet within these groups there are a number of sub-audiences, each with specialized interests. For example, among the general public there are (according to a 1998 report of the U.S. Fish and Wildlife Service) roughly 55 million people who consider themselves bird enthusiasts, and within that number there is a smaller pool of deeply committed birders. Your goals for conducting outreach to these committed birders may be different than your goals for the general public. Likewise, the category of "land managers" includes park managers, city officials, utility land managers, building managers, golf course managers, and others. Here again, you will want to tailor your message for the specific audience.

Before you can begin tailoring messages for your different audiences, however, you will need to develop a profile of their situations, interests, and concerns. This profile will help you identify the most effective ways of reaching the audience. For each target audience, consider:

- What is their current level of knowledge about bird migration and birds in general?
- What do you want them to know about birds and migration? What actions would you like them to take?
- What information is likely to be of greatest interest to the audience? What information will they likely want to know once they develop some awareness of bird migration issues?
- How much time are they likely to give to receiving and assimilating the information?

- How does this group generally receive information?
- What professional, recreational, and domestic activities does this group typically engage in that might provide avenues for distributing outreach products? Are there any organizations or centers that represent or serve the audience and might be avenues for disseminating your outreach products?

Profiling an audience essentially involves putting yourself "in your audience's shoes." Ways to do this include consulting with individuals or organizations who represent or are members of the audience, consulting with colleagues who have successfully developed other outreach products for the audience, and using your imagination.

6.1.3 WHAT ARE THE KEY MESSAGES AND TYPES OF INFORMATION THAT YOU WANT TO DELIVER?

The next step in planning is to think about what you want to communicate. In particular at this stage, think about the key points, or "messages," you want to communicate. Messages are the "bottom line" information you want your audience to walk away with, even if they forget the details.

A message is usually phrased as a brief (often one-sentence) statement. For example:

- Populations of migratory birds are declining and vulnerable.
- The BirdCast Web site provides you with real-time information about the status of bird migrations.
- You can take steps to help protect migrating birds.

Outreach products often will have multiple related messages. Consider what messages you want to deliver to each target audience group, and in what level of detail. As stated above, you will want to tailor different messages for different audiences.

Let's look at how this can be done. For instance, let's say that you are writing a press release for distribution to newspapers and other general interest publications. Your audience, the average reader of these publications, has relatively little interest in birds. What should be the focus of your press release? Probably you will want to concentrate on a few simple messages: that bird migration is a fascinating and magnificent phenomena; that populations of migratory birds are declining and vulnerable; and that individuals can help protect migratory birds through simple steps such as keeping cats indoors, providing food and water, and avoiding pesticide use during the peak of migration (you would probably time your release for distribution just prior to peak migration).

On the other hand, if you were composing a press release for placement in bird club newsletters, you would probably spend less time preaching the wonders of migration (after all, here you would be preaching to the converted) and more time addressing complex issues of special interest to birders: how the technical aspects of radar ornithology work, how birders can attract birds to residential yards by creating a landscape of native plants, how to choose pesticides that cause less ecological harm. Your press release could also provide detailed information on how birders can participate as citizen scientists in BirdCast's groundtruthing efforts. (See Appendix A, pages 49 to 50, for an example of a press release for bird club newsletter.) Alternatively, you could choose to deliver all of this information through a presentation at a bird club meeting.

Here's another scenario: Let's say you are targeting the managers of a number of large buildings in a downtown area. In this case, your message might be very focused and simple: that tall, brightly lit buildings threaten migratory birds by disrupting their ability to navigate, and that building managers can prevent bird deaths by turning off lights during peak migrations. But the real challenge here would be reaching these building managers with your message. Could you issue a press release or media advisory? Possibly, but even if the local newspapers picked up the story, there's no guarantee that the target audience would read it. No, in this case, the only way to ensure that your message reaches the target is to contact the building managers directly through a letter or phone call. In fact, you might have to follow up with repeated letters or phone calls. This type of direct outreach is time-consuming and can be a drain on resources, but in some circumstances it is absolutely necessary.

Tall, brightly lit buildings threaten migratory birds by disrupting their ability to navigate.

6.1.4 WHAT OUTREACH TOOLS WILL YOU USE?

As the above examples illustrate, one of the challenges of conducting outreach and education, besides tailoring your message for the intended audience, is choosing the best outreach tool or approach for delivering your message. There are many different types of outreach products in print, audiovisual, electronic, and event formats (outreach tools used by the BirdCast project are described in the next section). It's up to you to select the most appropriate products to meet your goals within your resource and time constraints. Questions to consider when selecting products include:

- How much information does your audience really need to have? How much does your audience need to know now? The simplest, most effective, most straightforward product generally is most effective.
- Is the product likely to appeal to the target audience? How much time will it take to interact with the product? Is the audience likely to make that time?
- How easy and cost-effective will the product be to distribute or, in the case of an event, organize?
- How many people is this product likely to reach? For an event, how many people are likely to attend?
- What time frame is needed to develop and distribute the product?
- How much will it cost to develop the product? Do you have access to the talent and resources needed for development?
- What other related products are already available? Can you build on existing products?
- When will the material be out of date? (You probably will want to spend fewer resources on products with shorter lifetimes.)
- Would it be effective to have distinct phases of products over time? For example, a first phase of products could be designed to raise awareness, followed at a later date by a second phase of products to encourage changes in behavior.

- How newsworthy is the information? Information with inherent news value may be rapidly and widely disseminated by the media.

The key here is to make good use of the resources available to you. In the best of all worlds, you would have the time and budget to personally contact every land manager in your region and to craft customized press releases for every type of publication and every audience. But it is unlikely that you will have the resources to do everything you'd like to do. The goal, then, is to pick your spots wisely. Reach as many people as you can, but also focus on those audiences that are most receptive to your message. If you have only limited time for direct outreach, concentrate on land managers who control critical habitat.

6.2 Education and Outreach Tools

This section describes a variety of outreach tools used by the BirdCast project. Examples of specific outreach materials developed by BirdCast can be found in Appendix A.

6.2.1 BirdCast Web site

In addition to hosting radar images, daily migration forecasts, and groundtruthing data, the BirdCast Web site (*http://www.BirdCast.org*) also contains an array of outreach and educational information designed to assist the public in the protection of migrating birds. Major educational pieces on the site include:

- Guidance on appropriate timing and application of pesticides to minimize birds' exposure.
- Tips on preventing bird deaths caused by collisions with household windows.
- Advice on controlling domestic cats to prevent predation on migratory birds.
- Information on how tall buildings and radio towers can disorient birds, causing them to crash or drop from exhaustion.
- Tips on bird feeding and watering, and on providing habitat for migratory birds during stopovers.

Many of these educational pieces are provided in hard copy in Appendix A of this handbook. Others can be found online (go to *http://www.birdcast.org/ucanhelp.html*). If you are developing a BirdCast-type program of your own, you can use these pieces as a model to stimulate ideas for your own outreach language. If you are a member of the public interested in birds and migration, you can read these materials to learn about steps that you can take to protects migrants.

One of BirdCast's mottos is: "Engage, educate, activate." The BirdCast Web site is a key tool for accomplishing each of these goals. The site is designed to be both attractive and interactive. The homepage, for example, features a colorful poster by Charley Harper, entitled "Mystery of the Missing Migrants," along with a species key to help visitors identify the birds depicted in the poster. Any birder visiting the site is welcome to submit data on his or her bird observations (see Section 5.3.2, Collecting Anonymous Observations), and visitors can also search the database of groundtruthing observations to view tables and summary graphs. In addition, throughout the site there are numerous links that visitors can follow to gather additional information and access other resources.

The goal of all this interactivity is to engage visitors, interest them in the plight of migratory birds, and give them a chance to participate in protecting and researching the lives of migrants. The outreach materials are there to educate them. The site also features several text pieces on the aesthetic and economic values of migrating birds, along with the beautifully written preface to Scott Weidensaul's book, *Living on the Wind: Across the Hemisphere with Migratory Birds,* which BirdCast was able to use with the permission of the author.

6.2.2 POSTERS AND OTHER PRINT MATERIALS

Because BirdCast is a Web-based project, it has developed relatively few educational and outreach materials for distribution in hard copy. When the project was first launched, a press packet was created for distribution to reporters and other media outlets, containing news clippings and other outreach materials. But this is no longer in use.

The main item that BirdCast partners distribute in hard-copy format is a poster entitled "Audubon Guide for Healthy Yard and Beyond," which was developed by the National Audubon Society. The poster lists actions that home owners can take to limit pesticide use and create healthy habitats for birds and wildlife. It also includes a guide to home pesticides, with information on chemicals, their uses, their toxicity to wildlife, and alternatives to the chemicals. Altogether, over 1 million copies of the poster have been distributed through Audubon chapter offices, bird-oriented stores, parks departments, and other groups.

To request copies of the poster, e-mail healthyhabitats@audubon.org. A version of the poster can also be found online at:
http://www.audubon.org/bird/pesticides/10%20COMs%20boxes.html.

Lessons Learned: Conducting Outreach Via Television Stations

When BirdCast was first launched, one of the original goals was to encourage television coverage of bird migrations. BirdCast's founders envisioned that there would come a day when weather forecasters would routinely include migration updates as part of their nightly reports. But that day has unfortunately not yet arrived.

As part of its education and outreach program, BirdCast has made a concerted effort to conduct outreach to newscasters and weather forecasters. The idea has been to combine radar images with photographs and educational information on protecting migrants, creating a package that will appeal to television stations. But so far the results have been discouraging. Though several stations have produced short news pieces on BirdCast, the general response has been that the BirdCast outreach materials are inappropriate for television in that they lack visual appeal. Newscasters have stated that the radar images are too esoteric and difficult to interpret.

In the future, the BirdCast project will continue to look for creative ways to package its outreach materials for television. The Illinois Natural History Survey, another organization that has succeeded at getting a local television station to make use of NEXRAD images of bird migration, has some ideas for getting television stations interested. The Survey suggested pointing out to television weather forecasters that significant bird migration usually coincides with "meteorologically boring periods" when they might lack weather-related material to discuss. The Survey also suggested developing simplified visual displays that convey basic information (e.g., presence/absence of birds, relative abundance of birds, general direction of bird movement) in a manner that parallels the other displays on the weather forecast.

6.2.3 Press Releases

Press releases are a key tool in BirdCast's education and outreach efforts. Writing a single press release and distributing it to dozens of publications simultaneously is a cost-effective way of reaching a large and varied audience.

The National Audubon Society's public relations department leads BirdCast's efforts to conduct outreach through the media. A PR department is an ideal choice for this job for two reasons: 1) PR staff have the writing, editing, and outreach skills needed for developing stories that will appeal to various news outlets, and 2) PR staff already have contacts and working relationships with individual journalists, editors, and newscasters. An experienced PR worker knows how to work with people in the media, feeding them the information they need to get stories into print and on the air.

For BirdCast, the Audubon PR staff have done several rounds of outreach to the media, each timed to coincide with a major migration (spring or fall). Their technique, which has produced excellent results so far, has been to write a single, in-depth press release and distribute it to a list of roughly 500 reporters whom Audubon has worked with in the past. (Examples of these press releases can be found on pages 45 to 48.) In some cases, Audubon staff precede the press release with a phone call or e-mail to the reporter, meant to kindle interest in the story. In other cases, Audubon sends the press release first, then follows up with an e-mail or phone call.

Once a reporter has expressed interest in BirdCast, the PR staff work with him or her as necessary to get the story into print. Some reporters (maybe half) request additional interviews with BirdCast partners or want help identifying a local angle for the story (for example, a reporter from a small city newspaper may want to interview members of a local bird club). Other reporters will develop a story using little more than the information and quotes found in the press release and other materials found online.

This type of personal contact with members of the press is crucial, as is the strategy of targeting individual reporters or newscasters. The odds of placing a story fall drastically if you just send a press release to a news desk or editorial department, since most publications are inundated with dozens (if not hundreds) of press releases daily. Audubon's PR staff always send press releases directly to a particular reporter, and virtually every story they've placed has been written by a reporter whom Audubon had worked with in the past.

What if you don't have a contact at a particular publication? One thing you can do is to read some back issues of the publication, looking for a reporter who has demonstrated some interest in topics related to your project. If the publication is a daily newspaper, it will likely have a beat reporter who focuses primarily on science and/or the environment. Outdoors writers often have an interest in bird migration, especially if their columns cover hunting and waterfowl migration. BirdCast has placed several stories with gardening columnists, and numerous technology reporters have also written about the project, focusing on the BirdCast Web site or on the project's use of advanced radar technology.

Once you have targeted a particular reporter, write him or her a personal e-mail or call directly. Pitch the story, keeping your presentation short and to the point. Ask the reporter if he or she would be interested in reading your press release (or, better yet, simply attach the release to an e-mail as an electronic file). Also, it never hurts to demonstrate that you are familiar with a reporter's work by complimenting or mentioning some article that he or she wrote in the past.

How many publications or news outlets should you target? The simple answer is, as many as possible. However, there are different ways to use the resources available to you. One approach would be to identify a limited number of publications that you view as critical, and then to spend extra time and resources doing everything you can to place a story with them (this might involve customizing your press release or following up repeatedly with a reporter). If you don't have existing contacts with the news outlets in your area, this type of intensive, focused effort might be necessary.

Audubon's PR staff have taken the approach of writing one major press release for each migratory season (spring and fall) and distributing it to hundreds of media outlets throughout the mid-Atlantic flyway, from New York to Maryland and the Washington, D.C. area. Audubon's staff spend virtually no time customizing press releases for particular publications, though they have issued press releases for particular occasions. For example, in September 2000, Audubon issued a spur-of-the-moment press release urging health officials not to spray for West Nile Virus on a weekend when BirdCast was predicting that a large wave of migratory birds would pass through the area. (See pages 47 to 48 for a copy of this release.)

Audubon's primary goal each migratory season has been to place a story in the major paper of each state in the region, with the idea that smaller papers will pick up the story after seeing it in a major paper (this has turned out to be true). The results of this PR effort have been excellent. More than 100 articles on BirdCast appeared in spring 2000, including prominent articles in the Philadelphia Inquirer, New York Times, Wall Street Journal, USA Today, and other major publications. Articles also appeared in virtually every Audubon chapter and independent bird club newsletter from northern Virginia to southern New York. Additionally, BirdCast was the subject of stories in Scientific American and National Audubon magazines, and the project was also featured on National Public Radio.

Lessons Learned: Dealing with the Redundancy Issue

Audubon's PR staff have found that one of the main challenges associated with conducting BirdCast outreach through the media is the issue of redundancy. Birds migrate through the mid-Atlantic flyway twice each year, in spring and fall. Ideally, BirdCast would like to have the media cover both migrations, every year. However, once a publication has covered the story once or twice, reporters and editors no longer consider it newsworthy.

Audubon's PR staff constantly search for creative ways to work around this problem. One strategy is to look for a "news peg" or tie-in, some newsworthy happening that can provide the basis for an article. For example, you might craft a press release about International Migratory Bird Day (an annual event set on the second Saturday in May), and slip in some information about your program within the body of the text. Audubon staff used a similar approach when they sent copies of the poster "Audubon Guide for Healthy Yard and Beyond," to all of the reporters in their database; the idea was to generate articles about the effects of pesticides on migrating birds and other wildlife, with BirdCast as a subtext.

The key point here is that your program doesn't have to be the main focus of every press release you send out. Look again at the press release on pages 47 to 48. The main message of this release was an urgent recommendation that health officials not spray for West Nile Virus on a weekend of intensive bird migration. Yet the press release also managed to provide a thorough description of the BirdCast project, and it also touched on a number of other important messages: the decline in numbers of migrating birds; their vulnerability to pesticides and other man-made threats; and steps individuals can take to protect migrants.

6.2.4 DIRECT OUTREACH TO LAND MANAGERS, BUILDING MANAGERS, AND OTHERS

Property managers (including park managers, city officials, utility land managers, building managers, golf course managers, and others) are a key target for BirdCast's outreach and education efforts. Many property managers, especially in urban areas, control large chunks of open or undeveloped land that provide important habitat for migrating birds. These managers can help protect migrants by avoiding pesticide applications during migratory stopovers and by considering the birds' needs when making other management decisions.

Large areas of open or undeveloped land, such as city parks, provide important habitat for migrating birds.

BirdCast relies on direct communication when conducting outreach to property managers. This typically involves calling or writing property managers a few times a year to update them on the status of bird migrations and to remind them of the need for environmentally responsible management practices. In general, BirdCast has found direct outreach to be a relatively time-consuming process (especially in comparison to outreach through the media, where a much larger audience can be reached with a single press release). In the future, the project may attempt to make more use of volunteers in its direct outreach efforts.

Following are a few examples of effective direct outreach, taken from the work of BirdCast and other groups:

- In Philadelphia, BirdCast has worked closely with the Fairmount Park Commission to encourage environmentally responsible land management and to raise awareness of the plight of migrating birds. The Commission oversees a system of parks, golf courses, and baseball fields in the city, and works with other land and utilities managers in the Philadelphia area. BirdCast wrote to alert the Commission about the value of the parks' habitat to migrating birds and the timing of migration. BirdCast provided copies of the poster "Audubon Guide for Healthy Yard and Beyond," for the commission to distribute, and provided all facility managers under their jurisdiction with guidance on environmentally responsible pesticide application (e.g., how to alter the use of specific chemicals and minimize the impacts on migrants).
- The City of Chicago and the U.S. Fish and Wildlife Service have signed an innovative "Treaty for Birds," which features an effort by downtown building owners to turn off their lights during migration periods. Members of the mayor's Wildlife and Nature Committee worked with Chicago's Building Owners and Managers Association to spread the word to owners of downtown skyscrapers. Members of the Bird Conservation Network assembled the information needed to convince building owners that this action was warranted, and helped to identify buildings that were known for their high bird mortality.

- ◆ In the Chicago area, a partnership of researchers, government scientists, city officials, and conservationists is proposing to use radar ornithology to identify key stopover habitat for migrating birds. The partners will then use direct outreach to educate land managers about the habitat needs of migrating birds, and to ask them to take steps to protect and enhance bird habitat (e.g., by controlling the spread of buckthorn, an invasive plant that impacts biodiversity).

6.2.5 Presentations

BirdCast partners regularly deliver presentations on the project to school groups, bird clubs, American Birding Association meetings, Audubon chapters, and other groups. The partners have developed several PowerPoint presentations for this purpose. These include:

- ◆ An overview of the project.
- ◆ A more detailed presentation on how BirdCast integrates multiple monitoring techniques (radar, groundtruthing, acoustic monitoring) to achieve a unified analysis of bird migration.
- ◆ A presentation focusing on the radar ornithology component.

All of these presentations make use of screen captures from the BirdCast Web site, sample radar images, and graphs from the groundtruthing database to give the audience a genuine feel for how BirdCast works.

6.2.6 ListServs

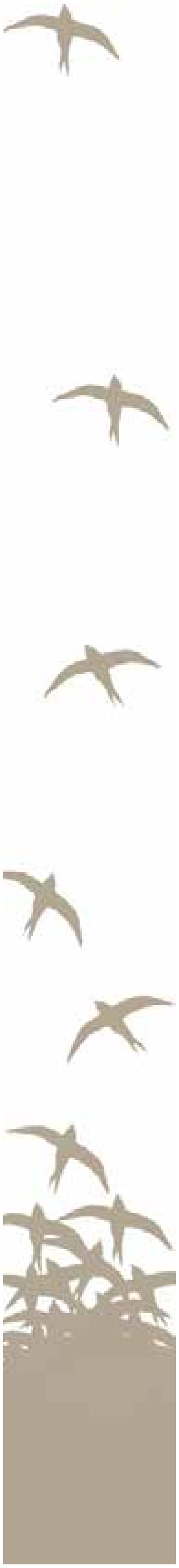
A ListServ is an automated system that automatically redistributes e-mail to names on a mailing list. Users can subscribe to a mailing list by sending an e-mail note to a mailing list they learn about; the ListServ will automatically add the name and distribute future e-mail postings to every subscriber.

There are numerous bird-oriented ListServs around the country. Some of these have a regional focus, and are used by birders to compare field notes and share notable sightings. Others are devoted to bird conservation, activism, and other topics of general interest. For an index of ListServs administered by the National Audubon Society, go to *http://list.audubon.org/archives/*. The American Birding Association also maintains a state-by-state list of birding ListServs, available at *http://www.americanbirding.org/resources/reschat.htm*.

BirdCast's education and outreach program utilizes ListServs as a medium for distributing information about the program, such as press releases and announcements. ListServs make an ideal tool for targeting an audience of committed birders. They are also cost effective, since there is no charge for subscribing to (or posting messages on) most ListServs.

BirdCast has also occasionally used ListServs as a tool for recruiting birders for the project's groundtruthing efforts. By monitoring the discussions at particular regional ListServs, BirdCast staff have been able to identify birders who are both committed and skilled and then contact them directly via e-mail. For more information on recruiting birders for groundtruthing, see Section 5.3.1.

6.3 EVALUATING THE EFFECTIVENESS OF OUTREACH EFFORTS



BirdCast has found no easy or cost-effective way of measuring the success of its education and outreach program. Since the ultimate goal of the program is to encourage behavior changes (e.g., changes in the way people use pesticides), the only true measure of success would be to document behavior changes on a large scale. Doing this is beyond the scope and means of the project.

Due to these limitations, BirdCast's partners have been forced to rely on other indicators as a measure of the program's effectiveness. For example:

- Between September 1 and October 21, 2000, the BirdCast Web site received 1,867,163 "hits" and 147,423 visitors. These numbers show, among other things, that many people are returning to the site multiple times.
- In the spring of 2001, roughly 100 to 150 people per week were submitting "anonymous" bird observations to the BirdCast database. (See Section 5.3.2 for more information on collecting anonymous observations.)
- More than 100 articles on BirdCast appeared in the spring of 2000, including prominent articles in major publications such as the Philadelphia Inquirer, New York Times, Wall Street Journal, and USA Today. The combined readership of these publications is in the many millions.

If nothing else, these numbers indicate that BirdCast has reached thousands (if not millions) of people, raising their awareness about the plight of migratory birds and things they can do to help. The numbers also seem to show that thousands of people are engaged in the project and are participating on some level (for example, by returning to the BirdCast Web site repeatedly, or by submitting their own bird observations). Overall, it appears that BirdCast is succeeding in its mission: to engage, to educate, and to activate.

6.4 FOR MORE INFORMATION

The BirdCast Web site: *http://www.birdcast.org/*

To access BirdCast's educational pieces online, go to: *http://www.birdcast.org/ucanhelp.html*

Scott Weidensaul's *Living on the Wind: Across the Hemisphere with Migratory Birds* (Northpoint Press, 1999) has been called "a nimble summation of current thinking on bird migration and attendant environmental themes" (Kirkus Reviews).

To request copies of the poster "Audubon Guide for Healthy Yard and Beyond", developed by the National Audubon Society, e-mail healthyhabitats@audubon.org. A version of the poster can also be found online at:
http://www.audubon.org/bird/pesticides/10%20COMs%20boxes.html

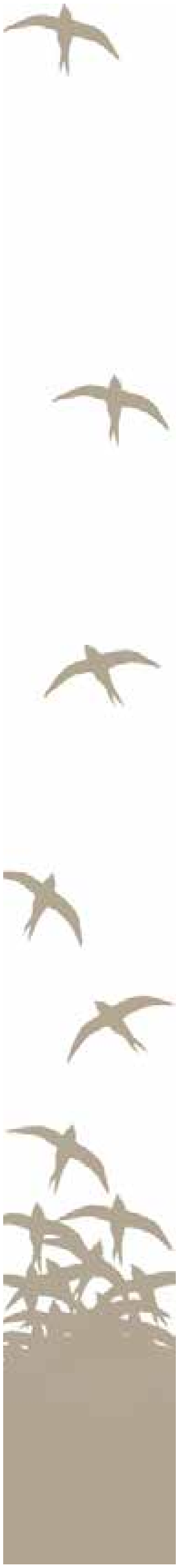
For an index of birding ListServs administered by the National Audubon Society, go to *http://list.audubon.org/archives*

The American Birding Association maintains a state-by-state list of birding ListServs, available at *http://www.americanbirding.org/resources/reschat.htm*

Chapter 6

APPENDIX A

BIRDCAST EDUCATION AND OUTREACH MATERIALS



PESTICIDES: IS YOUR BACKYARD SAFE FOR BIRDS?

Our lawns and gardens are like other environments. Plants, insects and other animals all interact and affect one another. Altering a part of that system can have unintended effects on other components of it. This is an important thing to keep in mind when considering whether or not to apply pesticides around the home. Pesticides are not only lethal to pests, but to other wildlife as well. Here are three important rules to consider before applying any pesticides:

1. Make sure you actually have a pest problem. Learn to identify pests and to determine at what stage they actually become a problem. Many times people treat for pests that are either not present, or not present in large enough numbers to cause problems.

2. Know your pesticides. Read the labels on your pesticides CAREFULLY. Learn to identify what active ingredients are contained in the product. Read about the potential effects these pesticides can have on the other organisms in your yard and community.

3. Check for alternative treatments. Make it a priority to use the least toxic method to control any pests or diseases. Many simple, non-toxic solutions are as easy to employ and as effective as chemical solutions. Contact your local garden center and Cooperative Extension for advice.

Making your garden or lawn more community friendly isn't difficult and may actually save you time and money. Plus a little bit of education and a few changes around your home can have a lasting effect on migratory bird populations and other wildlife.

To learn more about the pesticides commonly used around the home, refer to Audubon's pesticide summary at *http://birdsource.cornell.edu/birdcast/pestsum.html.*

Other useful pesticide web sites:

EPA's Office of Pesticide Programs: *http://www.epa.gov/pesticides*

The National Pesticides Telecommunication Network:
http://ace.orst.edu/info/nptn/index.html

Toxicology and Environmental Health Information: *http://sis.nlm.nih.gov/tehip.htm*

Look up all the registered pesticide products containing certain active ingredients:
http://www.cdpr.ca.gov/docs/epa/epachem.htm

The American Bird Conservancy's Pesticide Pages:
http://www.abcbirds.org/pesticideindex.htm

Windows: An Invisible Threat to Migrating Birds

Fact: Every year millions of birds die when they crash into windows in homes, schools, skyscrapers, factories, office buildings, and other sites.

Why: The transparent quality of windows makes them virtually invisible to birds, often until it is too late to stop short. It is difficult for a bird in flight to distinguish between glass and open space. It may see reflected vegetation in the window, but not the glass itself.

What You Can Do: There are different steps you can take in your home to prevent needless bird deaths caused by invisible windows.

- **Move your bird feeder.** Make sure your bird feeder is either a minimum of 3 meters away from windows, or less than 1 meter away. Birds may still fly into the window if you move the feeder closer, but they will not have enough momentum to injure themselves.
- **Reduce transparency and reflectivity.** Change the angle or surface of the window to lessen the transparency and reflectivity. Cover the window's external surface with a film, change the lighting, and keep all curtains closed or add external blinds.
- **Mark the window.** You can etch the surface of the glass or streak it with a bar of soap. Hang strips of newspaper or ribbons, place strips of masking tape on the window. (These are more temporary measures in case there is a severe problem. However, most of these solutions are inconvenient or unsightly.)
- **Apply netting.** Perhaps the best and most permanent solution is to stretch netting across the windows. Fine black netting that is used to protect berry bushes and fruit trees is available at many garden shops, home centers, and feed mills. Stretch the netting across the window or across a frame that can be installed outside the window. Be sure it is stretched with adequate tension to hold it several inches from the window's surface. Birds may continue to fly towards the window, but they will bounce off the mesh unhurt.
- **Hang hawk silhouettes.** Attach hawk silhouettes to the window's surface. These shapes probably decrease collisions because they break up the smooth reflective surface and make the glass more "visible" rather than because they are shaped like hawks; but, in any case, they seem to help. The silhouettes are most effective if used in multiples. It is helpful also to attach the silhouettes by a suction cup or a hanging device from the outside so that movement caused by wind will catch the birds' attention. Most people think that the graceful shapes are interesting rather than unsightly. They're available commercially but they're also easy to make. (See the below instructions.)

Materials:

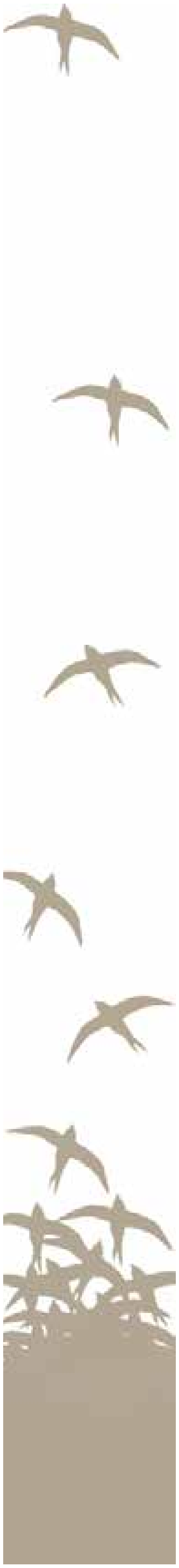
- black, light-weight plastic
- clear, outdoor tape
- scissors
- a template or model of the shape (approximately 8 inches from bill to tail and 12 inches from wing tip to wing tip)—go to *http://birdsource.cornell.edu/birdcast/images/hawk.gif* for print-ready template

Simply trace or carefully draw the shape on the plastic, cut out the silhouette, and tape it to the outside of the window. Be sure to place several on any large expanse of glass. One word of caution: you should check with the manufacturers of thermopane windows before you place anything on the glass surface. If this presents a problem, hang the silhouette from the sash around the window.

Not only can you make your house safer for birds, but by making several silhouettes and giving them as gifts to friends, neighbors, and even that office building with the big glass windows down the street, you can also encourage others to make their houses bird-safe.

Other Useful Window Web Sites:

National Audubon Society: *http://www.audubon.org/educate/expert/window.html*



BIRDCAST

Domestic Cats: A Cause for Concern

Fact: Every year hundreds of thousands of birds are killed in the United States by free-roaming domestic cats.

Why: Cats are natural hunters. Even your cute house pet is innately a predator. But while hunting is an instinctual behavior, cats are not a natural link in local food chains. Cats were introduced to North America by humans towards the end of the 19th century as a method of pest control. Since then feline populations have exploded out of control. Their predatory activities are an unnatural burden on birds. Keeping your cat well fed does not deter it from attacking birds; hunting birds is a natural behavior unrelated to a cat's hunger. You may not see your cat in action, but if you routinely let it outside it is likely to be killing up to 10 birds every year. With nearly 60 million pet cats in America today, that is a significant number of bird kills. Combined with many other threats birds face, this adds significantly to their struggle to survive. When you allow your cat to roam free outside, you are risking the lives of countless birds. You are also risking the life of your cat; those that are kept indoors live happier, healthier, and longer lives.

What You Can Do: A cat is only responding to a natural instinct. Ultimately you are responsible for your cat and its behavior.

- Keep your cat indoors, especially during the peak migratory seasons in fall and spring.
- Put an alarm collar on your cat. Many collars exist which will hamper the cats' stalk and attack. These collars will not harm the cat, but will give an unsuspecting bird ample warning to escape before a cat strikes. Bells alone will not stop a cat from attacking.
- Spay your cat. Make sure you spay or neuter your cat to help keep the cat population in check.
- Help stray cats. In addition to house pets, there are millions of stray cats in the United States, all a potential threat to native wildlife. You can take in some of these cats or call a local animal shelter.
- Keep birdfeeders out of reach. Make sure the birdfeeder in your yard is not cat accessible. Keep it high and away from windows and vegetation.
- Join the Indoor Cat Campaign. Encourage others to keep their cats indoors. Check out the American Bird Conservancy "Cats Indoors" at *http://www.abcbirds.org/catindoo.htm*

Other Useful Web Sites:

American Bird Conservancy: *http://www.abcbirds.org*

May 13, 2000 is National "Keep Your Cat Indoors" Day

Man-made Obstacles Pose Problems for Migrating Birds

Fact: Millions of birds die every year in building collisions.

Why: Tall buildings and their lights pose a serious threat to migrating birds. The feat of migration is already a dangerous one with the natural hazards due to weather, predators, and food scarcity. Birds are exhausted and hungry and yet humans have created tall obstacles to complicate an already difficult journey.

Birds use a variety of different cues to navigate their migration route, including the pattern of the stars, topographic features, earth's magnetic fields, and the location of the setting sun. If any of these cues are disrupted or unclear, for example during cloudy weather, the birds will have difficulty staying on their path. The lights of tall buildings and radio towers only contribute to this confusion. The lights will often overwhelm natural cues and disorient the birds. These confused birds will then circle the lighted structures, not because they are attracted to the light, but because they are following an erroneous and obscure cue. Blinking lights, which often adorn radio towers, and bad weather only further contribute to the problem. Eventually many of these birds will collide with the building, with each other, or will drop from exhaustion.

This problem is increasing as more and more highrise buildings are constructed. The now popular glass skyscrapers, found brilliantly lit at night, are augmenting the dangers.

Not all birds die from the collisions. Some will only be stunned with minor injuries, but often these dazed birds will fall prey to predators, cats and other birds, lurking on city streets. Many will panic upon finding themselves in the midst of a busy, morning, urban setting.

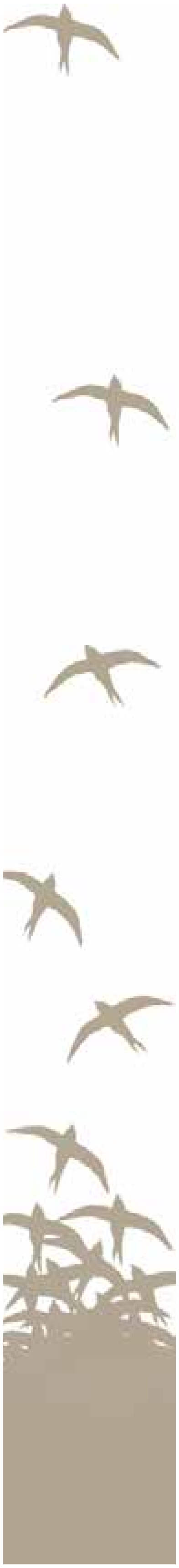
Another related danger to nightflying migrants are the broadcast radio towers which may stand 200-2000 feet into the night sky. There are around 75,000 towers currently built in the United States and with the current progress of Internet and satellite technology another 5000 to be added every year. Each of these towers may kill hundreds to thousands of birds in a single migratory season. Add lights and bad weather to the scenario and the death rate grows even higher.

What You Can Do:

- Turn off all lights during the peak migration seasons in fall and spring.
- Write letters to the owners of tall skyscrapers requesting that lights be turned off at night during peak migration periods.
- If you find a stunned bird, carefully place it upright inside a brown paper bag and transport it to a safe area where it can recover before resuming its journey.

Other Useful Web Sites:

Fatal Light Awareness Program: *http://www.flap.org*
Towerkills: *http://www.towerkill.com*



Native Plants and Biodiversity

We have peppered our continent with new houses, sidewalks, lawns, and regimented landscapes that are relatively devoid of seedpods, berries or other natural food sources. Imagine a different type of “yarden”: birds chirping, butterflies flitting, bees busily transporting pollen, and wildlife drinking and bathing in the rainwater you collected in your yarden. You can create this scene, and in so doing, you’ll find that you’ll have to replace plants less often and use less pesticide, time, money, and water.

To begin the transformation from traditional landscape to nativescape:

- Identify your existing plants, then explore forests and other natural areas to examine differences. Never remove plants from the wild.
- For a gradual transition, retain high maintenance areas close to the house while establishing a natural garden toward the edges and back of your property.
- Consider neighboring property. Cooperate with your neighbors and extend existing plantings to create larger joint habitat.
- Reduce lawn by breaking it up with curved borders around gardens, trees, shrubs and groundcovers to create an “edge effect.”
- Select native plants to attract birds through all seasons and allow space for natural growth patterns (less pruning).
- Consider tall native grasses (quail and other grassland species are declining), flowering annuals and perennials, and shrubs for shelter and food.
- Consider removal of overgrown, unattractive plants that offer little wildlife value.
- Add to your plan a little at a time. Enjoy a work in progress while reducing the area of lawn.
- Plant more than one of a plant, as larger patches are more visible to birds. Plant them in an irregular pattern so that it looks more natural.

AVOID TOXIC CHEMICALS. Birds eat the treated insects and berries.

Remember, numerous plant species attract a greater variety of birds and other wildlife. Check links below to find out more and where you can find native plants.

Learn more about how to reduce the use of pesticides, find alternatives, and create a healthy backyard by region

- Pesticide and garden tips: Ten Commandments for a Healthy Yard: *http://www.audubon.org/bird/pesticides/10%20COMs%20boxes.html*
- The Environmental Protection Agency’s Biopesticides site: *http://www.epa.gov/pesticides/biopesticides/*

- Backyard Conservation: 1-888-LANDCARE, *http://www.nhq.nrcs.usda.gov/CCS/Backyard.html*
- Native plants and gardening links: *http://plants.usda.gov/plants/links.html*
- Native plant societies by region: *http://www.nanps.org/associations/frame.shtml*
- Green Landscaping with Native Plants: *http://www.epa.gov/greenacres/*
- Audubon Habitat Collection from Monrovia: 1-888-PLANT IT

Further Reading:

The Bird Garden by Steve Kress

Bird Gardening Book by Donald and Lillian Stokes

The Chemical Free Lawn by Warren Schultz

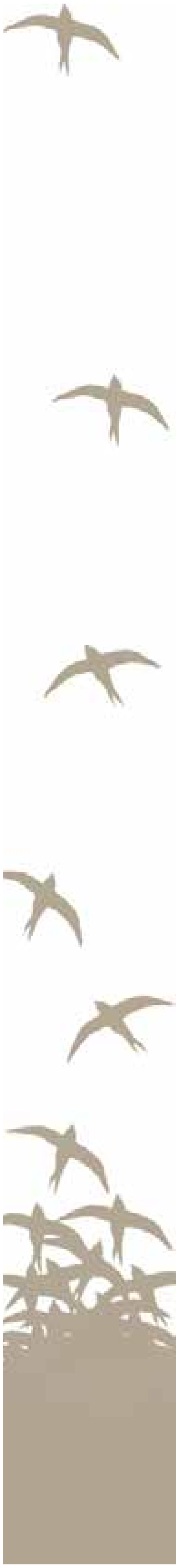
Going Native by Brooklyn Botanic Garden

Landscaping for Wildlife by Carrol L. Henderson

Redesigning the American Lawn - A Search for Environmental Harmony by Bormann, Balmori & Geballe

For additional information contact:

Director, Pesticide Initiative & Healthy Habitats
National Audubon Society
HealthyYards@Audubon.org



CITIZEN SCIENTISTS LEND A HAND TO BIRDS THIS FALL

Award-Winning Web Site Combines Technology and Bird Science to Help Birds Get Home Safely

New York, NY August 28, 2000 – This fall, migratory birds will face a number of life threatening challenges in their journey south. In addition to predators, difficult weather, and long distances, birds this year must contend with man made threats including potential poisoning from the pesticides employed to combat the West Nile Virus. With the help of citizen scientists and state-of-the-art forecasting technology, birds migrating through the Mid-Atlantic may get a break.

“Using the most advanced migration monitoring techniques, in combination with the efforts of the public, BirdCast *www.BirdCast.org* will become one of the most effective ways to track bird movement, and protect bird species,” said Audubon’s Senior Vice President for Science, Frank Gill. “From September 1st through November 15th, National Audubon Society urges citizens from New York to Washington, D.C. to report bird sightings to BirdCast and to take action to aid birds.”

As birds migrate, major factors contributing to their demise include pesticide use; loss of feeding and watering opportunities; impact with radio, television, and cellular towers, and brightly lit office buildings which disorient birds, causing them to crash. Scientists recognize that migrating birds are in decline—down by nearly 50% since the 1960’s.

BirdCast, enabling scientists to predict bird migration through a specific region, offers practical uses for homeowners and public officials. Using BirdCast, homeowners will be advised as to when to avoid spraying pesticides in their gardens, provide seed and water, and when to keep their cats indoors, in order to keep bird populations alive and well. Building owners can use BirdCast to determine when to turn off disorienting lights that often cause birds to crash into windows and die.

Public Health officials are also urged to make use of BirdCast. “This fall, BirdCast has an unintended and immediate use for county health officers,” continued Audubon’s Gill. “BirdCast will provide guidelines on when to suspend spray operations, helping officials avoid unnecessary bird deaths and violations of federal Migratory Bird Laws.”

BirdCast, a project of National Audubon Society, Cornell Lab of Ornithology, and Clemson University Radar Ornithology Lab, made its debut this past spring and was a resounding success. Funded by the Environmental Protection Agency’s Office of Research and Development and the Office of Pesticide Programs, the project was granted the “Dr. Copernicus Award" by the Copernicus Education Gateway, a Web site that features the best educational sites for students and teachers. Using radar pictures, audio samples and most importantly, personal observations (or “groundtruthing,”) scientists were able to make predictions and draw conclusions about songbird migratory behavior.

Participants from the mid-Atlantic region watched the skies, reported their findings to the BirdCast site and were then advised when to keep their cats indoors, to refrain from pesticide use, and to provide food and water in order to protect migrating birds in their region. Of particular interest to the thousands who visited BirdCast were the “10 Commandments to a Healthy Yard” and “The Audubon Guide to Home Pesticides," still available at the site *http://magazine.audubon.org/backyard/backyard0005.html.*

“By encouraging the public to report bird sightings in their region, BirdCast has and will continue to enable scientists to gather valuable information on migratory movements,” said Gill. “The project will not only increase scientific knowledge but also encourages people to make informed decisions about when to apply pesticides, let their cats out or undertake other activities that might cause birds harm.”

This fall, with additional support from the EPA’s Office of Pesticide Programs, BirdCast will expand into the states of New York and New Jersey. Scientists will generate morning and evening pictures of warbler, waterfowl, and hawk migration through the region using NEXRAD (Next Generation Radar). These snapshots of bird migration and weather events will be accompanied by interpretation and predictions from the Clemson Lab so that the general public and city officials can both observe and assist migratory birds.

“BirdCast has already inspired the general public to use this new technology to observe birds and ultimately become partners in conservation,” said Sally Conyne, Director of Citizen Science for Audubon. “This fall we are eager to track bird movement once again. Web users will be able to obtain daily forecasts of bird movements, learn about the best bird-viewing spots and find out how human activity impacts birds. In addition, the site now includes general information about migration, some late-breaking pesticide news, and a variety of tips for the fall gardener.”

Aside from adding color and music to our lives, birds serve as important environmental indicators, helping scientists assess the health of an ecosystem. Evidence of a declining bird species in a particular region may indicate another problem such as the loss of food or water sources, the destruction of specific habitats, or contamination by a toxic element. Despite the significant role birds play in local ecosystems, every year the numbers of migratory birds that return to the Mid-Atlantic region, and other parts of the country, decreases. These decreases may indicate problems with broad environmental implications, problems that can impact us in many ways.

Founded in 1905 and with over a 550,000 members and supporters in 530 chapters throughout the Americas, the National Audubon Society conserves and restores natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth’s biological diversity.

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NATIONAL AUDUBON SOCIETY URGES NY, NJ & CT HEALTH OFFICIALS NOT TO SPRAY PESTICIDES THIS WEEKEND

Largest Wave of Bird Migration This Fall Predicted to Pass Through Tri-State Area

New York, NY September 15, 2000- Using the latest technology in bird tracking techniques and the efforts of citizen scientists through BirdCast.org, National Audubon Society predicts the largest wave of migration will occur this weekend- and strongly urges county officials to suspend pesticide spraying operations in the tri-state area.

“This weekend will be one of the best opportunities for people to see a wide variety of species of migrating songbirds and hawks, and to contribute their sightings to BirdCast,” said Sally Conyne, Director of Citizen Science for Audubon. “On the other hand, this weekend will be one of the worst times for pesticide sprayings to occur, due to the unknown effects of the use of Scourge and Anvil on birds and the consequent reduction of their food source. By not spraying pesticides in the tri-state area this weekend, county and city officials will avoid unnecessary bird deaths and violations of federal Migratory Bird Laws.”

Migratory birds usually face a number of life threatening challenges in their journey south. This weekend, in addition to predators, difficult weather, and long distances, birds must contend with man made threats, especially potential poisoning from the pesticides employed to combat the West Nile Virus. With the cooperation of health officials, help of citizen scientists and state-of-the-art BirdCast technology, birds migrating through the Mid-Atlantic may get a break.

“In combination with the efforts of the public, BirdCast *www.BirdCast.org* will become one of the most effective ways to track bird movement, and protect bird species,” said Audubon’s Senior Vice President for Science, Frank Gill. “From September 1st through November 15th, National Audubon Society urges citizens from New York to Washington, D.C. to report bird sightings to BirdCast and to take action to aid birds.”

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BirdCast, enabling scientists to predict bird migration through a specific region, offers practical information for homeowners and public officials. Using BirdCast, homeowners will learn when to avoid spraying pesticides in their gardens, when to provide seed and water, and when to keep their cats indoors, in order to keep bird populations alive and well. Building owners can use BirdCast to determine when to turn off disorienting lights that often cause birds to crash into windows and die.

BirdCast, a project of National Audubon Society, Cornell Lab of Ornithology, Clemson University Radar Ornithology Lab, and Academy of Natural Sciences made its debut this past spring and was a resounding success. Supported by the Environmental Protection Office of Pesticide Programs and Mid-Atlantic Office (Region III), the project was granted the "Dr. Copernicus Award" by the Copernicus Education Gateway, an educational Web site for students and teachers. Using radar pictures, audio samples and personal observations (or "ground truthing,") scientists were able to make predictions and draw conclusions about songbird migratory behavior.

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"By encouraging the public to report bird sightings in their region, BirdCast has and will continue to enable scientists to gather valuable information on migratory movements," said Gill. "The project will not only increase scientific knowledge but also encourages people to make informed decisions about when to apply pesticides, let their cats out or undertake other activities that might cause birds harm."

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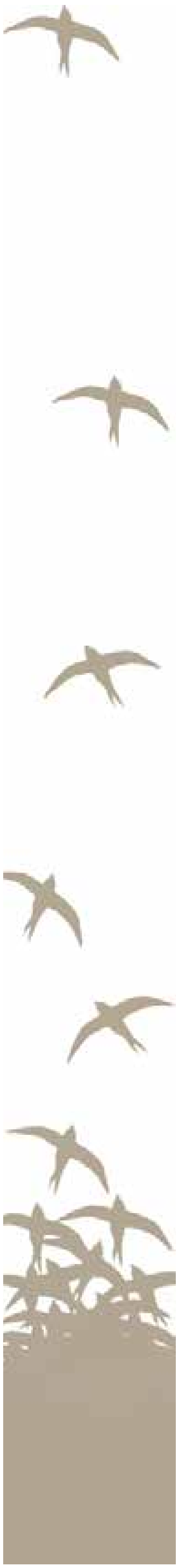

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BirdCast & NEXRAD

In the early days of World War II, British radar operators noticed mysterious, ethereal shadows drifting across their screens. Those apparitions, so wonderfully dubbed angels by pioneering radar technicians, heralded the beginnings of radar ornithology. Radar's first major contribution to ornithology took form only a few years later when in 1958 Sidney Gauthreaux, then a high school student in New Orleans, postulated that if radar can see planes and weather, why not birds? Only a few years later, as a Louisiana State graduate student, he found his proof. His radar images definitively proved the existence of massive trans-Gulf migrations. Prior to these observations, there was a continuing belief that the majority of migrants held to a more land bound, clockwise pattern; arriving in North America via Mexico.

Through the 60's, 70's, and 80's, however, radar's promise failed to fully evolve. There were a few notable discoveries, such as in 1989 when Gauthreaux, working from archival images, awakened the ornithological world to the precipitous decline in migrating flocks—down by nearly half when compared to the 1960's. The existing radar of the day, however, was proving largely inadequate. It lacked not only the necessary resolution, but it also failed to provide a three dimensional view.

In the early 1990s, however, change was coming. The new, highly efficient NEXRAD Doppler radar (Next Generation Radar) began to be placed in service. The Air Force started investigating NEXRAD's utility in their Bird Aircraft Strike Hazard Program (BASH). During this period, portable NEXRAD units were teamed with vertically mounted thermal imaging units so that the images captured by the radar could be visually verified. Elsewhere, graduate students under Sid Gauthreaux were making their own exciting discoveries. Their breath-taking images of giant expanding aerial doughnuts were found to be thousands of Purple Martin radiating from critical roosting sites each morning.

Radar ornithology work is now taking place in many parts of the country and it is soon to come to the Mid-Atlantic. With the support of the Environmental Protection Agency's Office of Research and Development and the Office of Pesticide Programs, a coalition consisting of National Audubon, Cornell's Laboratory of Ornithology, and Clemson's Radar Ornithology Laboratory, "BirdCast" will be coming soon to a computer near you on September 1, 2000. To access BirdCast you will go to the existing Audubon/Cornell Web site—BirdSource *http://www.BirdSource.org.* Throughout periods of peak migration, BirdCast will provide a morning and evening, unfiltered snapshot of the eastern region of the US from New York through Virginia. The birds and weather shown in theseimages will be accompanied by interpretation and a migration prediction provided by the Clemson Lab.

Is this work being done just as a special favor for birders? Well, not exactly. You can think of BirdCast as an early alert and an environmental billboard on the Internet. Linked to BirdCast will be messages such as admonitions against the use of certain pesticides as well as a number of other migrant-friendly changes that people can make in their backyards. We'll advise the residents of the region about the pests that actually pose local threats and the safest management strategies. Included at the site are two charts of special interest—"10 Commandments for a Healthy Yard" and "The Audubon Guide to Home Pesticides." With the completion of data collection this migration season, we hope to use the interpreted and ground-truthed images in pinpointing critical habitat in need of protection.

While all of this seems reasonably simple and employs proven technology, its not simple at all. In fact, it's really research in the development stage. What has been sorely lacking in the past is you. Most earlier radar work has been lacking a critical component—ground-truthing. Dozens, hundreds, and, indeed, thousands of sets of eyes are needed to verify what the radar images are capturing and to that end, BirdCast will have an interactive component and will allow you to log on and enter your daily sightings. These will feed directly into our database and be available to everyone in real-time.

So, BirdCast needs you. Dust off those bins and get ready to head to your favorite haunts. While we encourage all of you to post each and every sighting, of greatest value will be sightings coming from those who can afford the time to make regular observations. Those of you who would like to participate on a daily or regular basis or if you would like additional information please contact Sally Conyne **sconyne@audubon.org.** These data you collect will greatly enhance our overall understanding of migration patterns and movements. And this project will educate a multitude of people about how their backyards can be made friendlier and healthier for our angels. So, please, help us help the birds.

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Printed on paper containing at least
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Developing and Implementing a Bird Migration Monitoring, Assessment, and Public Outreach Program for Your Community

The BirdCast Project

National Risk Management Research Laboratory
Office of Research and Development
U. S. Environmental Protection Agency
Cincinnati, Ohio 45268

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Duane Heaton, EPA Region 5
Steve Kelling, Cornell University Laboratory of Ornithology
Ronald Landy, EPA Region 3
Ron Larkin, Illinois Natural History Survey
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BIRDCAST EDUCATION AND OUTREACH MATERIALS

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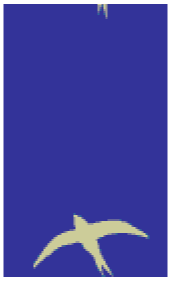

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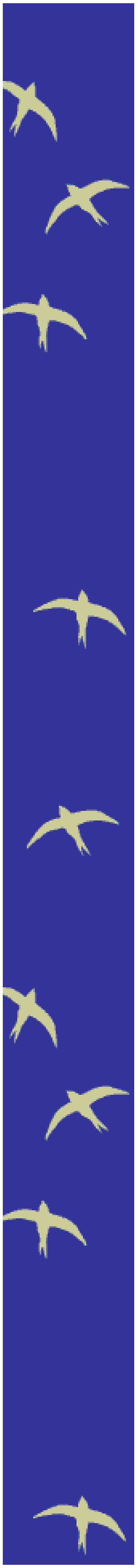

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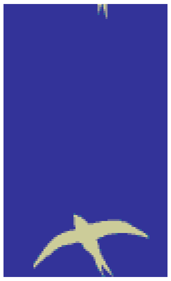

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Developing and Implementing a Bird Migration Monitoring, Assessment, and Public

Outreach Program for Your Community

The BirdCast Project

National Risk Management Research Laboratory Office of Research and Development U. S. Environmental Protection Agency

Cincinnati, Ohio 45268

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11 1 1 Introduction

Introduction 1

E very year, several billion birds undertake seasonal migrations in pursuit of food, shelter, and nesting

grounds. North America is the site of some of the world’s most spectacular bird migration, and millions of American “birders” enjoy spending time in the field identifying the birds passing through their area. Migratory birds are delightful not only for birders, but also for countless other Americans who casually observe their comings and goings, particularly in the spring and fall. These birds also have a distinct economic value (nearly $3 billion in the mid-Atlantic states alone) to the tourist and outfitting industries of the regions located along their flight path.

Aside from any immediate benefits they provide, migratory birds are valuable for the role they play in our ecosystems — in particular, for eating insects and thereby keeping pest populations under control. We also have reason to be concerned about the well- being of migratory birds that extends beyond any inherent value these birds may possess. As naturalist Roger Tory Peterson noted, birds are an “ecological litmus paper”— because of their rapid metabolism and wide geographic range, they often provide an early warning of environmental deterioration. Migratory birds depend on many different kinds of open space, such as swamps, marshes, meadows, and suburban parkland. Therefore, research and conservation aimed at keeping a particular bird population healthy may lead to the broader goal of restoring these threatened habitats.

When migrating, a bird may travel hundreds or even thousands of miles without stopping. The exertion of flying such long distances leaves birds exhausted and vulnerable. Many birds, particularly those that encounter adverse weather conditions, do not survive their journeys. Unfortunately, human activities can further increase the levels of stress and danger that a migratory bird faces. For example:

Inopportune application of pesticides to lawns, gardens, and parks may poison a bird’s food supply at just the moment when it is weakest and most in need of nourishment. In the United States, migratory birds are particularly vulnerable to pesticide application as they migrate northward in the spring.

Lights on tall structures (such as skyscrapers and communication towers) may confuse and disorient birds, causing them to become exhausted and crash into objects. Similarly, birds injure or kill themselves by flying into panes of glass. These problems appear to be particularly severe on overcast nights when birds may circle a light source.

Throughout much of North America, the sight of migrating birds marks the spring and fall seasons.

Major migration routes in North America

The development of land for human purposes such as agriculture, housing, and commerce often renders it unsuitable for use by birds. Birds may be challenged not only by the loss of habitat in their breeding and wintering ranges, but also by loss of habitat at key stop- over points where they need to rest and regain strength over the course of migration.

Humans have imported animals to North America that prey upon migratory birds (e. g., cats) or compete with them (e. g., starlings). These new biological threats, combined with decreasing quantities of suitable habitat, may reduce the population and range of a particular migratory bird species.

There is much that property managers and the general public can do to mitigate these problems if they are aware of them, interested in solving them, and educated about bird conservation. During a period of peak bird migration, pesticide applications can be delayed, bright building lights can be turned off, and cats can be kept indoors. Therefore, outreach programs designed to inform these audiences about the status of seasonal bird migration are a promising route to improving the conservation of migratory birds.

EPA has developed this technology transfer handbook primarily for community organizers, non- profit groups, local government officials, and other decision- makers who will implement, or are considering implementing, bird migration monitoring and public outreach programs. The handbook is designed with two main goals in mind. The first goal is to present a case study showing how one regional outreach program— EMPACT's BirdCast project for the mid- Atlantic coast of the United States— provides information that allows property managers and the general public to assist migratory birds. The second— and perhaps more important— goal is to provide you with guidance for developing a similar program in your own region. The guidance in the handbook is based on the experience of the EMPACT BirdCast project, as well as that of other experts in the fields of ornithology and public outreach.

1.1 About the EMPACT Program

This handbook was developed by the U. S. Environmental Protection Agency's (EPA's) EMPACT Program (http:// www. epa. gov/ empact). EPA created EMPACT (Environmental Monitoring for Public Access and Community Tracking) in 1997. It is now one of the programs within EPA's Office of Environmental Information. EMPACT is a new approach to providing timely environmental information to communities across the nation, helping people to make informed, day- to- day decisions. Residents in 156 of the largest metropolitan areas in the United States have or will soon have an easy way to answer questions such as:

What is the ozone level in my city this morning?

What is the water quality at my beach today?

How high is the ultraviolet radiation in my city today?

What is the level of contamination at the hazardous waste site in my community?

What are the levels of lead in the soil in yards in my neighborhood? To help make EMPACT more effective, EPA is partnering with the National Oceanic and Atmospheric Administration and the U. S. Geological Survey. EPA is working closely with these federal entities to help achieve nationwide consistency in measuring environmental data, managing information, and delivering that information to the public.

EMPACT projects cover a wide range of environmental issues, such as groundwater contamination, ocean pollution, smog, drinking water quality, ultraviolet radiation, and ecosystem quality. Some of these projects have been initiated directly by EPA. Others have been launched by the EMPACT communities themselves.

1.2 About the EMPACT BirdCast Project

EPA’s EMPACT program started funding the BirdCast project (http:// www. birdcast. org) in 1999, and the project started public operation on April 1, 2000. The project began as a collaboration among EMPACT, EPA Region 3, EPA’s Office of Pesticide Programs, the National Audubon Society, Cornell University’s Laboratory of Ornithology, Clemson University’s Radar Ornithology Laboratory, the Academy of Natural Sciences in Philadelphia, and GeoMarine, Inc. The four primary objectives of the project are:

1) To maintain an Internet Web site that posts educational information about bird migration and the steps that property managers can take to mitigate the danger and stress that migrating birds face when passing through an area.

2) To predict and monitor bird migrations on a daily basis using weather radar. The data gathered by radar are continually interpreted by trained scientists and presented using text summaries, charts, and radar maps. During its first year, BirdCast also experimented with using microphones to perform bioacoustic monitoring of bird migrations.

3) To collect and disseminate volunteers’ reports of bird sightings. This information collection, known as “groundtruthing,” is coordinated through the BirdCast Web site. Groundtruthing information is stored on an Web-accessible database called “BirdSource” that Cornell maintains. Visitors to the BirdCast Web site can query this database and display reports in chart or graph form.

4) To raise public awareness about the sensitivity of migratory bird populations. This public relations campaign, coordinated by National Audubon, involves generating press releases, working with local land managers, distributing promotional materials, and making presentations at conferences and conventions.

1.2.1 BirdCast’s Regional Focus

To date, the BirdCast program has primarily covered bird migration along a portion of the “mid- Atlantic flyway,” a coastal area between North Carolina and New England that experiences significant migratory bird activity each spring and fall. The initial focus of BirdCast’s attention has been the city of Philadelphia. BirdCast established a local partnership with Philadelphia’s local PBS station (WHYY) and the Academy of Natural Sciences to develop a public relations focus on the region surrounding this city. The BirdCast project’s efforts to collaborate with land managers so far have consisted primarily of work with Philadelphia’s Fairmont Park Commission. It is hoped that eventually BirdCast can be expanded to cover the entire Atlantic flyway. Birds could be tracked coming across the Gulf of Mexico and at their first landfall. Birdwatchers up the coast could be alerted to the status of the migrating birds and provided with additional early warning of their arrival.

Despite its current regional focus, BirdCast also hopes to expand to cover the entire United States by forming new partnerships with local governments and birding organizations. So far, BirdCast has succeeded at drawing both widespread media attention (it was discussed in more than over 100 news articles by spring 2000) and attention in venues of national importance (it has been covered by news reporters from both the New York Times and the Wall Street Journal).

1.2.2 BirdCast in Context

The BirdCast project is a collaboration among individuals and organizations that made significant contributions to the field of bird monitoring both before and after receiving EMPACT funding. A brief history of these bird monitoring activities (and of radar ornithology in particular) will help to place BirdCast in its full context.

At the outset of World War II, almost immediately after the invention of tracking radar, British radar operators noticed that birds flying over the English channel would sometimes appear on their screens. At the time, this fact was noteworthy primarily because it was possible to mistake a bird for a fast- moving- ship— significant ornithological use of this phenomenon did not begin until the 1960s. Sidney Gauthreaux, now Director of the Clemson University Radar Ornithology Laboratory, began studying the radar detection of birds at that time and has accumulated over 35 years of experience with the method. In the 1970s, the United States Air Force also began studying bird migration as a serious hazard to the operation of military aircraft, which often fly at high speeds and low altitudes. The Bird Aircraft Strike Hazard (BASH) team organized by the Air Force began exploring radar's potential to provide early warning of potential bird collisions. Their efforts were significantly aided by the emergence of "Next Generation Radar" (NEXRAD) in the early 1990s. NEXRAD is a network of highly sensitive weather radar stations located throughout the United States. In 1995, Sidney Gauthreaux also began using NEXRAD in his ornithological studies.

Meanwhile, in the mid- 1990s, the National Audubon Society and Cornell University's Laboratory of Ornithology began applying a very different emerging technology to the field of bird conservation. These two groups collaborated to develop BirdSource, a sophisticated computer database that uses the Internet to allow birders from across North America to send their observations to a central repository. With financial assistance from the Packard Foundation, these two groups spent more than $2.5 million developing the BirdSource database as a nation- wide information technology resource for birders.

The idea of the BirdCast program emerged at a 1997 biodiversity meeting attended by personnel from both EPA Region 3 and the Department of Defense. EPA and DoD discussed the possibility of providing the public with near real- time information about bird migration using radar technology. BirdCast combined the capabilities of Clemson's Radar Ornithology Lab with the information technology capabilities of BirdSource so that members of the public would be able to not only view radar images but also submit data that might verify (i. e., "groundtruth") those images. EMPACT began funding the project through EPA's Office of Pesticide Programs and Region 3 in 1999, and BirdCast began its public operations in 2000.

1.2.3 Related Bird Monitoring Programs

BirdCast is not the only program that is currently using radar technology to track bird migration. Additional groups, such as the ones listed below, either have pursued or plan to pursue radar tracking technologies:

BASH, the U. S. Air Force's program to guard against collisions between wildlife and aircraft, has developed an Avian Hazard Advisory System (AHAS). AHAS can be accessed on the Web at http:// www. ahas. com. This system uses radar to predict the risk of a bird- aircraft collision along various flight paths at various times.

The Illinois Natural History Survey, the University of Illinois (http:// www. inhs. uiuc. edu), and EPA Region 5 (http:// www. epa. gov/ region5) have pro4

posed setting up a project analogous to BirdCast for the Chicago region. The organizers hope to draw Chicago residents' attention to the unique role that their urban and suburban open spaces play in the migration of birds, thereby encouraging interest in the conservation of those open spaces.

1.3 About This Handbook

A number of bird observatories throughout the United States have expressed interest in beginning projects similar to BirdCast. The Technology Transfer and Support Division of the EPA Office of Research and Development's (ORD's) National Risk Management Research Laboratory initiated the development of this handbook to help interested organizations learn more about BirdCast and to provide them with the technical information they need to develop their own programs. ORD, working with BirdCast, produced the handbook to leverage EMPACT's investment in the project and minimize the resources needed to implement similar projects in new areas.

Both print and CD- ROM versions of the handbook are available for direct online ordering from ORD's Technology Transfer Web site at http:// www. epa. gov/ ttbnrmrl. A PDF version of the handbook can also be downloaded from that site. In addition, you can order a copy of the handbook (print or CD- ROM version) by contacting ORD Publications by telephone or by mail at:

EPA ORD Publications USEPA- NCEPI P. O. Box 42419 Cincinnati, OH 45242 Phone: (800) 490- 9198 or (513) 489-

8190

Please make sure you include the title of the handbook and the EPA document number in your request.

We hope that you find the handbook worthwhile, informative, and easy to use. We welcome your comments; you can send them by e- mail from EMPACT's Web site at

http:// www. epa. gov/ empact/ comment. htm.

1.4 For More Information

Try the following resources for more on the issues and programs this handbook discusses:

The EMPACT Program

http:// www. epa. gov/ empact

BirdSource

http:// www. BirdSource. org

Cornell University Laboratory of Ornithology

http:// birds. cornell. edu

National Audubon Society

http:// www. audubon. org

Ralph Wright EPA Office of Pesticide Programs (703) 308- 3273

Ronald Landy EPA Region 3 (410) 305- 2757

Sally Conyne National Audubon Society (215) 297- 9040

Steve Kelling Cornell University Laboratory of Ornithology (607) 254- 2478

T his handbook provides information your organization can use to create and implement a Web- based bird monitoring program. It presents detailed guidance, based on

the experience of the EMPACT BirdCast Project, on how to: 1. Identify target communities that would be interested in reporting on and following

the progress of bird migration. 2. Record and present real- time information about bird migration using radar, weather

information, and acoustic monitoring. 3. Collect groundtruthing information from volunteer birders and present it to the public. 4. Provide education and outreach to members of the public about what to do when

migratory birds pass through their area. This handbook provides simple "how to" instructions on each facet of planning and implementing a bird monitoring program, along with additional information about bird migration:

Chapter 3 discusses bird migration as a general conservation issue and how the different members of a bird migration monitoring organization work with each other to help birds as they migrate.

Chapter 4 discusses instrument- based observations of birds.

Chapter 5 covers a variety of issues relevant to volunteer groundtruthing, including a detailed description of BirdCast's policies and experiences working with volunteer birders.

Chapter 6 treats the methods and strategies a bird monitoring organization may make use of to conduct public outreach and education.

Appendix A presents examples of education and outreach materials from the BirdCast project.

Interspersed throughout the handbook are success stories and lessons learned in the course of the EMPACT BirdCast project.

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8 Chapter 2

T his chapter provides guidance on important first steps that you will need to take as you start your bird migration monitoring program. Section 3.1 provides a brief

overview of the structure of a bird migration monitoring program and outlines the roles and responsibilities of program partners, based on the EMPACT BirdCast Project model. Section 3.2 discusses the critical process of selecting program partners who can best help you meet your program's objectives within your target community.

The information in this chapter is designed primarily for managers and decision- makers who may be considering whether to implement bird migration monitoring programs in their communities, as well as for organizers who are implementing such programs.

3.1 Program Structure: Overview of a Bird Migration Monitoring Program

The EMPACT BirdCast project is a multifaceted project that engages a variety of activities— everything from distributing posters to counting birds. These activities can be grouped into four main categories, which make up the main components of the project: administration and public outreach, radar analysis, database management, and volunteer groundtruthing.

The following paragraphs summarize these activities to provide an overview of how the EMPACT BirdCast program works. These activities are described in greater detail in Chapters 4 through 6.

General Administration and Public Outreach. The administrator and staff of BirdCast are responsible for the primary public relations and outreach efforts of the project. This includes managing the distribution of posters about pesticide use, maintaining contacts with news media organizations to ensure that BirdCast stays in the public eye, issuing periodic press releases, and working with local land managers to encourage bird- friendly gardening practices. The administrator also provides a broad range of support tasks related to the project's birdwatching volunteer program. These tasks include providing advice about making bird identifications, making quality control checks of data submitted by volunteers, and networking to recruit new volunteers. The BirdCast administrator also serves a central liaison with the other BirdCast staff, including the radar analyst and the chief database base manager.

Radar Analysis. The chief radar analyst and his assistant are responsible for predicting the degree of bird migration activity in upcoming evenings and for measuring the actual amount of bird migration using radar data. The radar analyst (and/ or his assistant) must make daily reports of predicted and observed migration during the periods of bird migration (in the spring and the fall) but have fewer regular duties during the “off season.” They seek out and contract information service providers to ensure a constant supply of radar data during the periods of migration. Once per day, the radar analysts submit their predictions and observations to the database administrator via the Internet.

Database Administration. BirdCast's database administrator and his staff ensure that the public has access (via the Internet) to the information submitted by the radar analyst. In the case of BirdCast, the database is actually maintained as a separate organization called

33 3 3 Beginning a New Bird Migration Monitoring Program

BirdSource. BirdSource is an entity distinct from BirdCast and it maintains a variety of other Web- enabled birding databases. The BirdCast database administrator issues user identifications to new volunteers, implements backups and system security measures, and coordinates the programming of changes to the database system. Also, while BirdCast's bioaccoustic monitoring was being conducted, the project was coordinated by the database administrator.

Volunteer Birdwatching. BirdCast's volunteers provide the “groundtruthing” information necessary to verify the observations made using radar instrumentation. Volunteers are recruited by the project administrator and contact her with any questions or comments they may have about their participation in the program. Registered volunteers make observations several times a week and record their findings directly to the BirdCast database (using the Internet).

The flow chart below summarizes the basic structure of the BirdCast project. The chart identifies the main activities of the project, the team members responsible for these activities, and the flow of work among team members. It also indicates where in this handbook you can go for more information about specific activities.

3.2 Selecting Program Partners

As described in Chapter 1, BirdCast is a partnership of several public and non- profit organizations. These have included university laboratories, a wildlife conservation society, a park management authority, and a natural history organization. The reason BirdCast is composed of such a wide range of partners is that its goals require the use of a wide range range

Management Coordination

Bird Cast Database

BIRD SOURCE BIRD CAST

Other Databases

Other Databases

Other Databases Administration

Management Coordination

Control Observations

Anonymous Observations

Results Education,

Outreach, Feedback Support,

Feedback Control

Volunteers General

Public Radar

Ornithology Laboratory

Automated through Internet

Through a variety of media an EMPACT- funded, collaborative

effort to track bird migration a computer facility at Cornell's Laboratory of Ornithology for the collection and dissemination of groundtracking data Daily

Radar Analysis

of skills and community connections. None of the individual organizations, working by themselves, would have been as effective as the collaboration of many different organizations, each possessing complementary skills and abilities.

For example, the staff of Clemson University's Radar Ornithology Lab have specialized skills in forecasting and analyzing bird migration patterns using radar images and other weather data. The National Audubon Society, on the other hand, has an extensive media infrastructure for presenting bird conservation information to the public and can easily enlist the support of birding communities. Cornell's Laboratory of Ornithology, in conjunction with the National Audubon Society, has invested in the development of BirdSource, a sophisticated Web- enabled database for the collection and distribution of bird monitoring data.

In starting your own bird monitoring program, you'll need to assemble a team of individuals or organizations who offer a similar range of skills and qualifications. To select partners or team members, you should think about how each will fit into the overall program structure, and how different partners can work together to create a successful program. You will also need to consider their relationship to the region where you will be monitoring bird activity. For example:

A small, grass- roots organization that already has strong ties to the community can be ideal for providing public outreach and obtaining volunteer birdwatchers. Local chapters of birding clubs, natural history associations, or conservation groups can all be good choices. (For a directory of birding clubs in the United States, see: (http:// birding. about. com/ hobbies/ birding/ library/ blalphausclub. htm.)

A university with an ornithology laboratory would make a good partner for identifying and interpreting radar images of birds. A professor or graduate student working in such a lab might either already have the necessary skills or be able to acquire them for the benefit of the bird monitoring project.

A government agency, university, or private company that employs persons with a range of programming and "new media" skills would make a good partner for the purposes of establishing a Web site where the public can access up- to- date radar images and submit and retrieve groundtruthing observations. Building such a Web site from the ground up may require access to staff trained in JAVA programming, Web page design, network administration, and database building.

3.3 Figuring Costs

One of the important first steps for your organization to take when it is considering setting up a bird monitoring program is to estimate how much your planned activities will cost. Although your program need not be as large or ambitious as BirdCast's, you may find it helpful to know how much money BirdCast spent in its first year of operation.

In its initial year (between December of 1999 and November of 2000) EMPACT provided BirdCast with $449,500 for operations and set- up. As shown above, these expenses break down into five categories, each of which was handled by a separate entity:

Project management and national level promotion was handled by National Audubon Society. This cost $71,000 or 16% of the overall EMPACT budget for BirdCast. This category covers all the public promotion of BirdCast that went on during the year, excepting a local media campaign in Philadelphia.

Project promotion in the Philadelphia area was handled by the Academy of Natural Sciences. This cost $76,500 or 17% of the overall EMPACT budget for BirdCast. The Academy was responsible for encouraging local news media to discuss BirdCast and reporting its findings.

Database and Internet support was provided by the staff of the BirdSource project at Cornell University. This support cost $136,000, or 30% of the overall EMPACT budget. BirdSource staff maintained the BirdCast Web site, set up and managed a database for groundtruthing observations, and coordinated BirdCast's bioacoustic monitoring program.

Generation and interpretation of NEXRAD images was performed by Clemson University's Radar Ornithology Laboratory (CUROL) for a fee of $68,000, or 15% of the overall EMPACT budget. As described elsewhere in this report, CUROL submitted daily radar information about bird migration to the BirdCast Web site.

Software for Processing NEXRAD images was developed by GeoMarine Software for $98,000, or 22% of the overall EMPACT budget. GeoMarine developed software algorithms for distinguishing radar signals reflected from birds from those reflected from clouds.

This cost breakdown represents the first- year of a cutting- edge program and should not be taken as completely representative of the ongoing costs of other bird monitoring programs, particularly those that are smaller in scale. For example, BirdCast organizers learned that it was neither necessary nor feasible at present to automatically distinguish birds from precipitation with software algorithms. The expense associated with this component of the program, therefore, was not carried forward into future years and need not be incurred by newer monitoring programs.

Flying takes a lot of work. While larger birds (such as raptors, cranes, and waterfowl) will migrate during daylight hours, most songbirds migrate on clear, calm nights when

weather conditions are most favorable to powered flight. Unless there is a full moon out, lack of light can make it almost impossible to visually observe migrating songbirds. Birders can take note of where such birds land in the morning, but actual songbird migration is typically recorded using special instruments.

The primary foundation of BirdCast’s predictions and observations of bird migration is the information provided by a network of WSR- 88D weather stations located throughout the United States. These weather stations (and the data they produce) are collectively referred to as Next Generation Radar (NEXRAD). BirdCast has also experimented with bioacoustic monitoring of nocturnal bird migration. Although this technique has proved promising, it is not currently in widespread use due to cost considerations.

4.1 What is NEXRAD And What Can It Do?

Like all radar systems, NEXRAD identifies the location of distant objects by transmitting radio signals and analyzing the returning signals that have been reflected off of those distant objects. Unlike previous radar networks, which were composed of WSR- 57 and/ or WSR- 74C radar stations, NEXRAD radar is also able to measure the radial velocity of objects by recording the Doppler shift of the reflected radar. (The Doppler shift is the difference between the frequency of the transmitted radar signal and the reflected signal— if

the reflected signal is higher frequency than the transmitted signal, it is an indication that the reflecting object is moving toward the radar station; conversely, if the reflected signal is at a lower frequency, it is an indication that the object is moving away from the radar station).

In addition to this new ability to detect object velocity, NEXRAD is also distinguished by increased object detection sensitivity. This is particularly important for ornithologists because birds are relatively weak reflectors (compared to the objects usually detected with radar, such as clouds, airplanes, and ships). NEXRAD is capable of detecting birds flying at a range of heights and can provide a rough idea of the altitude at which a particular group of birds is flying. NEXRAD is so sensitive that radar ornithologists need to learn how to differentiate birds and insects— both can be detected.

Finally, NEXRAD provides information about the reflectivity of a particular object (i. e., how effective a particular object is at reflecting radio waves). Reflectivity can be determined by a number of different factors but in the case of migrating birds, it provides indirect information about the number of birds traveling in a particular area.

NEXRAD Radar Station in Mount Holly, New Jersey

National Weather Service

In summary, then, NEXRAD can help determine:

The location of a group of migrating birds, including general altitude information.

The speed with which the group birds are moving towards and away from a particular radar station.

The approximate quantity of migrating birds in a particular area. Quantitative NEXRAD estimates are calibrated by “moonwatching” (counting the number of birds that fly across a visible full moon) and by making next- morning ground observations.

4.2 What is Bioacoustic Monitoring And What Can It Do?

BirdCast staff have been experimenting with bioacoustic monitoring as a way of keeping track of nighttime bird migrations. Bioacoustic monitoring is the process of recording bird calls and matching them to a library of the bird calls of different species. When birds fly at night, they typically make frequent 50- to 100- millisecond vocalizations. Some birders can make fine distinctions between certain kinds of birds simply on the basis of these calls (e. g., the distinction between the Veery Thrush, the Gray- Cheeked Thrush, and the Hermit Thrush). Although birders can perform something like bioacoustic monitoring right in their heads, BirdCast staff are developing a computerized system to automate and standardize the process of recording, filtering, and identifying bird calls.

A bioacoustic monitoring station, typically located on the property of a volunteer birder, consists of a computer with a sound processing card and a specially designed outdoor microphone. The microphones used in bioacoustic monitoring can detect noises made by birds that fly up to 1,500 above the ground. Throughout an entire evening, the computer automatically analyzes the sounds picked up on the microphone and digitally records those sounds that appear to be made by birds. In the morning, a volunteer uploads this “filtered” recording to the Cornell Laboratory of Ornithology, where more sophisticated computer software enters the information into a database and attempts to determine which species are represented in the recording.

The BirdCast program has recently found it necessary to curtail its bioaccoustic monitoring program— only a very few stations are currently in use and there are no current plans to establish new ones. The greatest barrier to the more extensive use of bioacoustic monitoring has been the cost of manufacturing the special microphones for the monitoring stations. The basic materials for the microphones are quite inexpensive, but because production quantities were extremely low, the microphones were being hand- built by laboratory staff at Cornell. The microphones currently cost about $2,500 apiece, but BirdCast staff imagine that the microphones could be dramatically reduced in price if some way were found to mass produce them.

Additional limitations of bioacoustic monitoring include the following:

Weather conditions can affect both the likelihood that birds will make noises and the ease with which those noises can be picked up with a microphone. Thus, it is difficult to disentangle weather variability from variability in the numbers of migrating birds.

Many species of birds do not make noises while flying. Therefore, it is difficult to gauge overall numbers of migrating birds solely using this method.

Bioacoustic technology is in an early stage of development. The software that is used to quantify and identify birds on the basis of sound recordings is still quite experimental and there has not been enough time for scientific literature to accumulate on this topic.

4.3 How Do NEXRAD, Bioacoustic Monitoring, and Volunteer Groundtruthing Fit Together?

It is noteworthy that the altitude detection range for bioacoustic monitoring (0- 1,500 feet) does not overlap with the detection range for NEXRAD radar (generally between 3,000 to 6,000 feet). The non- overlap of these two ranges complicates the correlation of bioacoustic results and NEXRAD results, as it is possible for certain bird species to picked up by one kind of instrument and not the other. Due to the influence of variable weather conditions and a lack of complete information about the altitude at which different bird species fly when they migrate, it is not possible to precisely predict which species will fly within the altitude range of which instruments on any given evening.

Groundtruthing data collection, covered in greater detail in Chapter 5, is an essential complement to both NEXRAD radar interpretation and bioacoustic monitoring. One reason for this is the fact that it is difficult to ascertain what kinds of birds are migrating through an area solely from NEXRAD data. In combination with coordinated groundtruthing data, however, it is sometimes possible to associate particular clusters of reflectivity with particular species of birds. Groundtruthing also helps to calibrate the quantitative estimates of birds made from radar and it serves as a quality control check of the basic reporting information provided by radar and bioacoustic monitoring.

Until recently, the BirdCast Web site combined the daily results of NEXRAD observations, bioaccoustic monitoring, and groundtruthing in a single display. The purpose of this display was to show how each of these methods produced results that were similar to those of the other methods. Under ideal circumstances, for example, all three methods would predict the same degree of migration activity. This display has been recently discontinued on the grounds that some viewers may have found it too complicated.

4.4 How Can A Bird Monitoring Organization Begin Using NEXRAD To Observe and Predict Bird Migrations?

The essential first step in setting up a radar component for your migration monitoring program is to contact an organization that is already experienced in this work, such as the Clemson University Radar Ornithology Laboratory or the Illinois Natural History Survey. Such contact is essential for obtaining advice about the feasibility of your project and about the best way to obtain the expertise necessary to accomplish your project. Depending on the training and availability of your organization’s staff, you will probably need to either delegate your actual NEXRAD analysis to an experienced laboratory or send a staff member for training at such a laboratory. Both of these plans would require negotiating a working partnership with an organization possessing expertise in radar ornithology.

The use of NEXRAD to forecast bird migration, in the words of one practitioner, “is a difficult task that requires laboratory and field experience as well as an appreciation for meteorological phenomena.” The interpretation of NEXRAD radar to observe current migration is a similarly complex task. At present, it is an undertaking suitable for a graduate level or post- doctoral ornithologist who has received hands- on training with an expert.

4.5 How Did BirdCast Implement the NEXRAD Component of Its Bird Monitoring Program?

In July 1998, Dr. Sidney Gauthreaux of the Clemson University Radar Ornithology Laboratory (CUROL) helped propose the BirdCast project to EPA’s EMPACT Program. His proposed task involved forecasting bird migration twice a day (mid- morning and midevening) over the Delaware Valley and then using Doppler weather surveillance radar (i. e., the NEXRAD network of WSR- 88D stations) to validate the forecast and measure the actual amount of bird migration that occurred over the area. The text files and graphic radar files were to be sent to the BirdCast Web server at the Laboratory of Ornithology at Cornell University and posted on the BirdCast Web site. GeoMarine, another partner in the project, was to supply hourly WSR- 88D imagery that had been processed to eliminate echoes from weather and other non- bird targets. The hourly images would also be posted on the BirdCast Web site. A proposal was developed in August 1998 and work began after Clemson University signed a subcontract with National Audubon Society in mid- March 2000.

4.5.1 Activities in Spring 2000

The first task was to purchase a host computer (Dell Dimension XPS T600MHz, Dell Computer Corporation) that could be used to download the WSR- 88D images from the NEXRAD Information Distribution Service (NIDS) provider, download the weather data necessary for generating a migration forecast, and serve as host computer where Cornell could electronically "capture" forecast text files, analysis text files, and the mosaic radar image files. CUROL used Marta Systems, Inc. as the NIDS provider. CUROL was familiar with Marta Systems’ software, so it could easily make the mosaic images of the radar displays from the Delaware Valley. In order to work from remote locations, CUROL also purchased a Gateway Solo 9300 CX laptop computer. This allowed laboratory staff to work on forecasts and analysis while at home or traveling by communicating with the Dell host computer over the Internet. CUROL believes that laptops are essential for producing consistent and timely results for display on the BirdCast Web site.

During a previous research project in the middle 1970s, Dr. Gauthreaux developed a multivariate forecasting model to predict the amount of bird migration in the Athens, Georgia, area. The input variables for this model were the weather predictions for the period in question. Dr. Gauthreaux generated this model by step- wise regression analysis, choosing an array of weather variables that best explained the variation of nightly bird migration amounts. No existing forecasting models of bird migration were available for the Delaware Valley area and time constraints prohibited the development of a model for the region. Given this situation, CUROL used the Athens forecast model for the spring 2000 BirdCast effort.

From 31 March through 30 May, Dr. Gauthreaux or graduate students Andrew Farnsworth or Jonathan Ariail gathered weather data via the Internet from weather stations in the Delaware Valley for input to the Athens model. The model generated a forecast of the amount of migration expected over the Delaware Valley. The model was run before noon to forecast the amount of migration expected that evening at 10 PM, and it was run before midnight to forecast the amount of migration expected the following morning at 10 AM. In addition, to verify the accuracy of their forecasts, CUROL downloaded radar imagery from five WSR- 88D stations (KAKQ in Norfolk, VA; KLWX in Sterling, VA.; KDOX at Dover Air Force Base, DE; KDIX at Ft. Dix near Philadelphia, PA; and KCCX at State College, PA) and made mosaic images showing the amount of bird migration over the Delaware Valley at the forecast times. The laboratory analyzed and interpreted the mosaics so that the viewer of BirdCast would be able to discriminate birds from weather and insects.

Each morning before noon and each evening before midnight, CUROL staff placed the text file of the forecast, the text file of the analysis, the graphic file of the radar reflectivity mosaic, and the graphic file of the radar velocity mosaic in separate folders on the Dell host computer. The BirdCast server at Cornell automatically downloaded the files and posted the materials on the BirdCast Web site. Except for a few glitches near the beginning of the project, the CUROL efforts proceeded with no problems.

4.5.2 Later Seasons (Fall 2000 and Spring 2001)

CUROL was encouraged to continue with the BirdCast program because of its success in forecasting the amount of bird migration during the initial BirdCast effort. There were a number of changes between the second season of BirdCast and the first. For example, BirdCast coverage was expanded in this season to include the state of New York. Also, because only a very small amount of bird movement had been found in the mid- morning hours, CUROL discontinued forecasts and analyses of daytime bird migration.

CUROL learned from the spring 2000 effort that using a single model to forecast migration amount over the entire BirdCast area resulted in inaccurate forecasts for some areas. In an effort to overcome the geographical limitations of the spring 2000 model, CUROL developed two models specifically for the BirdCast area using a step- wise regression analysis of forecast weather variables and the amount of bird migration measured (i. e., the relative reflectivity of targets [dBZ] displayed in WSR- 88D images). CUROL used WSR- 88D data collected during the fall migration of 1999 for another CUROL project and Local Climatic Data (LCD) for September and October 1999 that it purchased from the National Climatic Data Center (NCDC) for two stations: Albany, New York, and Washington, D. C. By the spring of 2001, CUROL had developed more than 30 regional models.

As in the spring of 2000, at 2 PM every day CUROL placed a text file containing the evening forecast, a text file containing the analysis of the previous evening, the graphic file of the radar reflectivity mosaic, and the graphic file of the radar velocity mosaic in separate folders on CUROL’s BirdCast host computer. As in the spring the Cornell BirdCast server collected these files and posted them to the CUROL portions of the BirdCast Web site. The ability to generate a forecast each day, including days on which both forecasters were traveling or away from the CUROL host computer, was greatly enhanced by a laptop computer with an FTP program that allowed the forecasters to upload text and graphics remotely. With the exception of some initial glitches that were quickly corrected, CUROL’s models worked well. A sample of the Web page products for an afternoon posting (in this case for the afternoons of 28 and 29 September 2000) can be found in Figure 1.

4.5.3 Feedback and Conclusions

CUROL received overwhelmingly positive feedback from the public with regard to its forecasting and the radar ornithology tutorial that it developed for the BirdCast Web site. Although the forecasting and analysis portion of the BirdCast project is complete, CUROL seeks to develop better forecast models. As it refines its methodology for building models and its understanding of the interactions and correlations between specific weather variables and the amount of bird migration, the accuracy of its forecasting will continue to improve. Models are an absolute necessity for any attempt to track bird migration over large spatial scales (such as the entire eastern seaboard), and improved accuracy will improve scientists’ ability to understand where and when large movements of migrating birds will occur.

Analysis 28 September evening:

Weather conditions over the BirdCast area were favorable for bird migration. Northerly winds, clear skies, and cool temperatures associated with a strong ridge of high pressure over the area facilitated southward movements of migrants across the region. The reflectivity image (above left) shows extensive moderate to high densities (15- 28 dBZ) of non-precipitation reflectors over the coverage area. The velocity image (above right) shows most of these reflectors are moving S and SSW at 20- 50 knots on N and NW winds at 5- 10 knots. These are likely birds. Migration amount was moderate to high across the region, with bird densities reaching 600- 1150 birds per cubic kilometers (25- 28 dBZ) in many areas.

—Andrew Farnsworth, Clemson University Radar Ornithology Laboratory

Forecast 29 September evening:

Weather conditions over the BirdCast area will not be favorable for bird migration. E and S winds and warming temperatures associated with high pressure off the coast of New England will keep most birds on the ground. Migration amount will be low to moderate, reaching densities of 80- 120 birds per cubic kilometer (12- 16 dBZ).

—Andrew Farnsworth, Clemson University Radar Ornithology Laboratory.

Figure 1. NEXRAD radar images of bird migration on September 28: reflectivity (l) and velocity (r).

T he ornithological community uses the term “groundtruthing” to refer to a particular process of corroborating and supplementing instrument- based observations of birds

(such as NEXRAD signals). This procedure is straightforward: one recruits birders in the area in question to count and identify birds there. A collective groundtruthing program serves a variety of purposes:

It complements the radar data provided by NEXRAD.

As a form of “citizen science” it encourages birders to become increasingly engaged in environmental science and conservation.

It makes birding more fun by organizing an audience for the observations of individual birders.

This chapter is oriented toward helping the administrators of bird monitoring organizations develop and manage groundtruthing programs. It describes BirdCast’s sophisticatedInternet- based groundtruthing database (BirdSource). However, a groundtruthing program need not use precisely this kind of tool to manage its information. Regardless of a particular program’s data distribution/ collection needs, the experiences of the BirdCast program may provide valuable insights.

5.1 How Does Groundtruthing Complement Radar Analysis?

The eyes and ears of a careful observer offer the most direct indication of the number and type of birds in a particular area. Therefore, such observations can serve as a means of calibrating, validating, and supplementing NEXRAD images of bird migration. As described in Chapter 4, NEXRAD does not provide a direct sampling of the number of birds traveling through a particular area and provides very little information about what kind of birds are being detected. All it can do is record the radio reflectivity at a particular distance and angle from the station. During spring migration in particular, there appears to be a high correlation between nights when radar shows bird- like signals and mornings when birders see a lot of new birds on the ground in nearby areas. Radar ornithologists are still in the process of developing relationships between radar activity at a particular place and time and groundtruthing results at other places and times. Therefore, there is heightened value in a coordinated program of groundtruthing and radar imaging— the connection between the two data sets is as valuable as the sets themselves. In the future, for example, it may be possible to track the migration of individual species of birds using a combination of radar and extensive groundtruthing.

55 5 5 Groundtruthing Observations

Dedicated birdwatchers are often eager to contribute their observations to groundtruthing programs.

5.2 How Does BirdCast Conduct its Groundtruthing Program?

Over an average week of operation, the BirdCast Web site receives more than 300 reports of bird activity from its volunteers. The project then presents this information (in the form of charts and graphs) to the Web site’s visitors, who number over 80,000 in a 2- month migratory season. As these figures indicate, BirdCast’s groundtruthing program requires significant information technology infrastructure and program administration. Whether your organization is planning a groundtruthing program of similar scope or one that will be smaller scale, a knowledge of the methods and experiences of BirdCast in this endeavor is likely to be helpful.

5.2.1 BirdCast's Information Management Infrastructure

As described in Chapter 3, BirdCast's operation relies on a substantial prior investment of time, money, and labor in the establishment of BirdSource's information technology infrastructure. This infrastructure consists of:

Software: an Oracle database customized to handle groundtruthing data, JAVA applications to process the information requests of users of the BirdSource Web site, and a GIS tool that allows users to specify the latitude and longitude of their observation site by zooming in from a map of the mid- Atlantic United States.

Hardware: A four- processor server computer to maintain the BirdSource web site, an uninterruptable power supply and tape backup system, and Internet connection service for the computer.

Support Staff: one full- time network administrator and five JAVA programmers. This infrastructure, which cost $2.5 million to establish, is larger and more robust than what is necessary to simply record and present groundtruthing information. One proposed bird monitoring program, based in the Chicago area, expects to meet its information technology needs for 2 years at a cost of $100,000 per year. A potentially economical option for supporting groundtruthing programs may be to collaborate with BirdSource staff at Cornell's Laboratory of Ornithology. BirdSource staff expect that they could provide complete information technology support for an initial outlay of $35,000- 50,000 and a maintenance fee of $5,000- 10,000 per year. Depending on the goals and needs of your organization's groundtruthing program, it may not even be necessary to spend this much. One group planning to set up a groundtruthing program in the Chicago area has estimated that they could store their data using spreadsheet software and would not even need to dedicate an entire Windows workstation to the task.

5.3 BirdCast's Administrative Procedures

BirdCast records the birding observations of both registered and unregistered visitors to its Web site. The former are called "control" observations and the latter are called "anonymous" observations.

5.3.1 Collecting Control Observations

Control observations are repeated visual inventories of birds obtained by regularly visiting a particular site during a bird migration season. They are made by committed, experienced birders known by or referred to the site's administrator. It is one of the primary tasks of the administrator to identify these individuals, provide them with support and guidance, and monitor and edit their contributions to the database.

The site administrator actively recruits individuals to serve as control observers through several avenues:

Personal networking within the local birding community.

Appeals to local conservation groups, such as chapters of the Audubon Society and the Nature Conservancy.

Postings to e- mail distribution lists dedicated to birding. A control observer needs be reasonably experienced at quantifying and identifying birds in his or her area. He or she must also have enough free time, energy, and commitment to make frequent visits to an observation site. Ideally, a volunteer should be able to make these visits during the early morning hours (between sunrise and roughly 9 AM) when migratory birds are most active. It is also very helpful for a volunteer to be able to recognize birds by their songs as this is the most rapid way of identifying the presence of a particular species of bird. (The Cornell ornithological laboratory makes recordings of bird songs that volunteers can use for training purposes.)

At present, BirdCast has not established a formal procedure for screening observers or checking their qualifications, as most control observers are friends or colleagues of the project organizers. Some control observers, however, are individuals unknown to BirdCast staff who have spontaneously approached the project about participating. It is assumed that an inexperienced birdwatcher would tend to be discouraged by the time commitment required in making regular observations over a prolonged period, so there is a process of "self- screening" inherent in signing up volunteers.

Lessons Learned: How frequently should control observers go into the field?

In the experience of BirdCast organizers, control observers should ideally make five visits to a single observation site during each week of a data collection period. A typical observation session takes between 1 and 2 hours, depending on the observer's time constraints and the abundance of birds at the observation site. This schedule of frequent observations increases the likelihood of "catching" the migration of different species of birds through an area. The goal is to have the observation record reflect the variability of the birds' presence or absence at a particular location rather than the variability of the observer's presence or absence.

In the mid- Atlantic region of the United States, spring migration period takes place over a relatively short period of time: roughly from April 15 to May 15. Fall migration, however, is more difficult to observe completely because it takes place over a more extended period of time. In the fall of 2000, BirdCast experienced significant difficulties with volunteer burn- out when it asked control observers to work from September 1 to November 1. In the future, BirdCast is planning to implement a staggered observation schedule that will keep observers' commitment limited to approximately 1 month. Volunteers living at higher latitudes will begin and end their observing earlier than will volunteers living at lower latitudes.

Once the site administrator has identified a new control observer, she briefs him or her about the standard observation protocols used by the project and issues that person a new User ID for logging into the site. Also, new control observers need to be shown how to use BirdSource's interactive map to estimate the latitude and longitude of their observation site.

The interactive map is a software component of the BirdSource Web site in which users "zoom in" to their observation site by clicking on a map of the United States. Once a user has selected a particular location, the software calculates that location's latitude and longitude.

Once they have registered and determined the location of their observation site, control observers use their User ID to access data entry pages on the BirdCast Web site where they can enter:

The date and time of their observations.

Whether or not they recorded every species that they saw.

The birders' estimation of their own skill at identification.

The physical environment and weather at the place of observation.

The numbers and kinds of different birds counted.

Any additional information not provided elsewhere in the form. The administrator has ongoing responsibilities for answering any questions the control observer may have and for editing the data provided by the observer. The purpose of this editing process is to ensure that the data provided by the control observers is of a high quality. Editing requires some local birding expertise— one must review the submitted observations and make judgment calls about whether they are reasonable, questionable, or obviously erroneous. The administrator flags control observations that appear problematic and follows up with the observer to resolve her concerns. The following signs, when they appear repeatedly or in combination with each other, may cast doubt on an observer's results:

Species that are extremely rare for the area, particularly in large numbers.

Species that are extremely rare for a particular time of year (particularly record- setting early sightings of a species).

The omission of migratory species that are quite common for the particular area and time.

None of these signs is a certain indication that a set of observations is invalid, but they may prompt the BirdCast administrator to request additional information from the observer, such as sketches, notes, photographs, and the names of co- observers. Following is a sample letter from BirdCast that requests additional information in a non- confrontational manner:

May 10, 2001 Dear Mr./ Ms __________________ I'm interested in learning more about the birds you've reported to our project and the site from which you're reporting. As you probably know, you've had some extraordinary sightings during the two days for which you've reported. Standard procedure for our BirdSource projects is that we request verification for unusual reports before the data is entered in the database.

Several of these would be all time early records for your immediate area and the numbers you report for some species are unusually large. On the other hand, your report for a species like Yellow- rumped Warbler is very low.

We are making a great effort to report only species and numbers that were well seen and absolutely identified. Only sightings of this type will give our project credibility and, in the long run, benefit bird conservation efforts. With this in mind, would you review your reports that I have listed below and answer the following questions?

Was the bird well- seen? for how long? Is this a positive identification? Which of the field marks were observed? Was the bird photographed? Was it seen by additional observers? Were notes taken? Sketches made?

American Black Duck - Wild bird? late Yellow- bellied Flycatcher - early Golden- crowned Kinglet - late Philadelphia Vireo - 1 unusual, 2 extremely rare Bay- breasted Warbler - early, 2 Cerulean Warbler - early, 2 Mourning Warbler - early Yellow- breasted Chat - early, 2 Rusty Blackbird - late, unusual, 10 birds

I would also like to have more information about the site where you observed these species. Is this land named? Is it public or private?

Thanks very much for providing us with this information and thanks for your patience. Sally Conyne Audubon

BirdCast also has a number of proactive strategies for limiting the amount of potentially unreliable observations that it receives. These strategies include:

Putting caps on the number of individual birds of a particular species that can be reported.

Phrasing data entry questions clearly to avoid misunderstanding.

Offering assistance in the identification of birds to volunteers.

Creating area- specific checklists of birds for volunteers to use in data entry. This prevents the reporting of obviously erroneous reports (e. g., roadrunners in upstate New York)

5.3.2 Collecting Anonymous Observations

Visitors to the BirdCast Web site do not need to register or commit to making a schedule of repeated observations in order to submit data to the BirdSource database. Any birder visiting the site may submit information as an "anonymous" observer. Strictly speaking, these observers are not always anonymous because they are encouraged to submit their e- mail address along with their observations. The term is meant in distinction to the control observers, who are either known by or referred to the BirdCast staff.

The data entry form used by anonymous observers and the data they submit are very similar to those of control observers. There are number of differences, however, between how control and anonymous observations are handled. Unlike control observations, anonymous observations do not include information about the latitude and longitude of the observation site. Instead, observers simply list the postal code of their area. Also, BirdCast does not (at present) conduct any quality control editing of anonymous observations. BirdCast staff currently do not have enough time to manually edit the anonymous observations, which are of somewhat less value than the control observations because they are not made regularly. BirdCast hopes, however, that in the future they will be able to institute computer- based "filters" that will provide automated quality control of anonymous data.

5.3.3 Displaying Groundtruthing Information

Visitors to the BirdCast Web site have two options for displaying observation data. They may either:

Select a single observation location. The user then views a table (such as Figure 2 and Figure 3) of different kinds of birds counted at that single observation location (either an anonymous observation postal code or a specific control site). The table also lists the numbers of each kind of bird, and the numbers of reports of each kind of bird. The user may select whether this table lists results for the entire migration period or for a specific date.

Lessons Learned: Data Entry Burdens

One of the lessons that BirdCast organizers learned when they established their volunteer groundtruthing program was that they needed to minimize the data entry requirements for their volunteers. Some of the first volunteer observers complained that the observation protocols took too long to key into the computer. BirdCast has reduced the length of its protocol since then to make volunteers' jobs easier.

Select a single species of bird. The user then views a graph (such as Figure 4 and Figure 5) of how many times that bird was sighted during each day of the migration period. The graph includes combined information from all the control sites but excludes anonymous observations. This is because anonymous observations are not edited for accuracy and are not likely to be made regularly at any single location.

Fig 4. Single species count: Canada Goose Fig 5: Single species count: Green Heron Fig 2. Single observation location: Dryden Lake, NY.

Fig 3. Single observation location: Chestnut Hill College, PA.

Meet Two BirdCast Volunteers

Chuck Hetzel, one of BirdCast's control observers, doesn't have to go any farther than his back yard to collect data for the project. That's because he's fortunate enough to live at the edge of the Schuylkill Valley Nature Center near Philadelphia. Mr. Hetzel first heard about BirdCast through his local bird club— the Cornell Laboratory of Ornithology was looking for volunteers in his area to host bioacoustic monitoring stations in their homes. Through this introduction to Cornell's research program, he became involved in making regular control observations for BirdCast. It usually takes him between 1 and 2 hours to record the birds in his backyard, which he does nearly every day of the migration period around 7 AM. With more than 50 years of birding experience, he doesn't need to take an identification guide into the field with him; all he needs is a notepad or a tape recorder for keeping track of the types and numbers of birds that he sees (or hears). Mr. Hetzel enjoys the extra motivation to go birdwatching that BirdCast provides— in sharing his observations through the BirdCast database he enjoys an extra feeling of accomplishment and satisfaction about birdwatching.

Hannah Suthers makes her control observations at an abandoned 108- acre farm in central New Jersey. The farm, which has recently been converted into a wildlife sanctuary, is slowly reverting back to forest. This makes it a fascinating birding site because the land's habitat is undergoing continual transformation. Ms. Suthers has more than 50 years of experience as a bird bander and for more than 20 years has been studying how the farm's changing habitat has affected the population of resident birds in the area. Now in her retirement, she continues to publish articles related to avian population biology and trains graduate students from nearby Princeton and Rutgers Universities in bird banding. After a friend referred her to the BirdCast project, Ms. Suthers started working as a volunteer for it, tallying migratory birds at the sanctuary. During the BirdCast observation period, she aims to be in the field on a daily basis, tallying birds by sight and sound. She carries a small notebook with her and jots down her tally in alpha codes. A counting session can take anywhere between 1.5 to 4 hours, depending on the time of season and how many different species are present. It can be tiring getting up so early in the morning on a regular basis, she admits. Though she does not need to go out as frequently to spot- map the singing males on their breeding territory, she feels that to get an accurate picture of migratory movements one needs to go into the field daily. One of the most pleasant aspects of the work is the opportunity to greet all her "old friends" as they fly through her area each migration season.

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Hannah Suthers Chuck Hetzel

T his chapter provides guidance on setting up and maintaining an education and outreach component of a bird migration monitoring program. Section 6.1 provides tips

on developing an outreach plan for your program, with a focus on defining goals, key messages, and target audiences. Section 6.2 describes a variety of outreach tools that can be used, and provides examples of outreach materials developed by the BirdCast project. Section 6.3 describes the challenge of evaluating the success of your education and outreach program, and Section 6.4 lists some additional sources of information for education and outreach.

The information in this chapter is designed primarily for managers who are implementing bird migration monitoring programs, as well as for education and outreach workers who are responsible for communicating about these programs.

6.1 Developing an Outreach Plan

BirdCast represents a milestone for radar ornithology, a field that has evolved slowly for more than 30 years, advanced by a handful of scientists working mostly in isolation. BirdCast’s breakthrough is that it is the first program to bridge the gap between these scientists, collecting and interpreting radar images in their labs using highly specialized technologies and techniques, and the general public. The founders of BirdCast also recognized that “a picture is worth a thousand words”— a live visual image, such as a radar image of birds migrating, or digital photos or videos from groundtruthers, would more likely stimulate action than just a verbal description of migration.

Communication is at the heart of the BirdCast mission: to provide the public with timely information on the status of bird migrations, and to educate land managers and the broader public about actions they can take to assist birds during their migration and reduce the number of birds that die while passing through. An effective education and outreach program, therefore, is key to the project’s success.

BirdCast’s education and outreach program is run primarily by the National Audubon Society. Staff from Audubon’s Citizen Science Program work together with Audubon’s public relations department to create educational materials, write and distribute press releases, develop and deliver presentations, and conduct direct outreach to land managers. Other BirdCast partners (including staff from EPA’s Office of Pesticide Programs, EPA Region 3, Cornell University’s Laboratory of Ornithology, and Clemson University’s Radar Ornithology Laboratory) contribute to the outreach effort as well, mostly by delivering presentations. In addition, Philadelphia’s Academy of Natural Sciences, a founding partner of BirdCast, developed many of the project’s original outreach materials.

The first step to creating an effective education and outreach program of your own is to develop an outreach plan. This plan will provide a blueprint for action. It does not have to be lengthy or complicated, but it should define four things: What are your outreach goals? Who are the target audiences? What are the key messages and types of information that you want to deliver? And what outreach tools will you use to reach these audiences? Let’s look at each of these questions in turn.

6 Education and Outreach

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6.1.1 What Are Your Outreach Goals?

Defining your outreach goals is the first step in developing an education and outreach plan. Outreach goals should be clear, simple, action- oriented statements about what you hope to accomplish through outreach. Here are some sample goal statements that a BirdCast- type program might develop for its outreach effort:

Convince all local television stations in the region to give a brief report on bird migration after the weather forecast, or to run at least one report on bird migration per migratory season.

Place a story on bird migration in the major newspaper of each state in the region.

Deliver a presentation to each bird club or Audubon chapter in the region.

Conduct direct outreach (e. g., via letter or phone call) to the managers of all public parks in your region.

Attract 100,000 visitors per year to your Web site. Where possible, outreach goals should be measureable. This will help you when it comes time to evaluate the success of your program (see Section 6.3). Abstract statements of good intention (e. g., “increase the public’s appreciation of the wonders of bird migration”) do not make effective outreach goals, even if such statements accurately describe one of your main motivations for starting a BirdCast- type program.

6.1.2 Who Are Your Target Audiences?

The second step in developing an outreach plan is to clearly identify the target audience or audiences for your outreach effort. As illustrated in the sample goals above, outreach goals often define their target audiences. You might want to refine and add to your goals after you have specifically considered which audiences you want to reach.

The target audience for the BirdCast project is broadly defined as land managers and the general public. Yet within these groups there are a number of sub- audiences, each with specialized interests. For example, among the general public there are (according to a 1998 report of the U. S. Fish and Wildlife Service) roughly 55 million people who consider themselves bird enthusiasts, and within that number there is a smaller pool of deeply committed birders. Your goals for conducting outreach to these committed birders may be different than your goals for the general public. Likewise, the category of “land managers” includes park managers, city officials, utility land managers, building managers, golf course managers, and others. Here again, you will want to tailor your message for the specific audience.

Before you can begin tailoring messages for your different audiences, however, you will need to develop a profile of their situations, interests, and concerns. This profile will help you identify the most effective ways of reaching the audience. For each target audience, consider:

What is their current level of knowledge about bird migration and birds in general?

What do you want them to know about birds and migration? What actions would you like them to take?

What information is likely to be of greatest interest to the audience? What information will they likely want to know once they develop some awareness of bird migration issues?

How much time are they likely to give to receiving and assimilating the information?

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How does this group generally receive information?

What professional, recreational, and domestic activities does this group typically engage in that might provide avenues for distributing outreach products? Are there any organizations or centers that represent or serve the audience and might be avenues for disseminating your outreach products?

Profiling an audience essentially involves putting yourself “in your audience’s shoes.” Ways to do this include consulting with individuals or organizations who represent or are members of the audience, consulting with colleagues who have successfully developed other outreach products for the audience, and using your imagination.

6.1.3 What Are the Key Messages and Types of Information That You Want to Deliver?

The next step in planning is to think about what you want to communicate. In particular at this stage, think about the key points, or “messages,” you want to communicate. Messages are the “bottom line” information you want your audience to walk away with, even if they forget the details.

A message is usually phrased as a brief (often one- sentence) statement. For example:

Populations of migratory birds are declining and vulnerable.

The BirdCast Web site provides you with real- time information about the status of bird migrations.

You can take steps to help protect migrating birds. Outreach products often will have multiple related messages. Consider what messages you want to deliver to each target audience group, and in what level of detail. As stated above, you will want to tailor different messages for different audiences.

Let’s look at how this can be done. For instance, let’s say that you are writing a press release for distribution to newspapers and other general interest publications. Your audience, the average reader of these publications, has relatively little interest in birds. What should be the focus of your press release? Probably you will want to concentrate on a few simple messages: that bird migration is a fascinating and magnificent phenomena; that populations of migratory birds are declining and vulnerable; and that individuals can help protect migratory birds through simple steps such as keeping cats indoors, providing food and water, and avoiding pesticide use during the peak of migration (you would probably time your release for distribution just prior to peak migration).

On the other hand, if you were composing a press release for placement in bird club newsletters, you would probably spend less time preaching the wonders of migration (after all, here you would be preaching to the converted) and more time addressing complex issues of special interest to birders: how the technical aspects of radar ornithology work, how birders can attract birds to residential yards by creating a landscape of native plants, how to choose pesticides that cause less ecological harm. Your press release could also provide detailed information on how birders can participate as citizen scientists in BirdCast’s groundtruthing efforts. (See Appendix A, pages 49 to 50, for an example of a press release for bird club newsletter.) Alternatively, you could choose to deliver all of this information through a presentation at a bird club meeting.

Here’s another scenario: Let’s say you are targeting the managers of a number of large buildings in a downtown area. In this case, your message might be very focused and simple: that tall, brightly lit buildings threaten migratory birds by disrupting their ability to navigate, and that building managers can prevent bird deaths by turning off lights during peak migrations. But the real challenge here would be reaching these building managers with your message. Could you issue a press release or media advisory? Possibly, but even if the local newspapers picked up the story, there’s no guarantee that the target audience would read it. No, in this case, the only way to ensure that your message reaches the target is to contact the building managers directly through a letter or phone call. In fact, you might have to follow up with repeated letters or phone calls. This type of direct outreach is time- consuming and can be a drain on resources, but in some circumstances it is absolutely necessary.

6.1.4 What Outreach Tools Will You Use?

As the above examples illustrate, one of the challenges of conducting outreach and education, besides tailoring your message for the intended audience, is choosing the best outreach tool or approach for delivering your message. There are many different types of outreach products in print, audiovisual, electronic, and event formats (outreach tools used by the BirdCast project are described in the next section). It's up to you to select the most appropriate products to meet your goals within your resource and time constraints. Questions to consider when selecting products include:

How much information does your audience really need to have? How much does your audience need to know now? The simplest, most effective, most straightforward product generally is most effective.

Is the product likely to appeal to the target audience? How much time will it take to interact with the product? Is the audience likely to make that time?

How easy and cost- effective will the product be to distribute or, in the case of an event, organize?

How many people is this product likely to reach? For an event, how many people are likely to attend?

What time frame is needed to develop and distribute the product?

How much will it cost to develop the product? Do you have access to the talent and resources needed for development?

What other related products are already available? Can you build on existing products?

When will the material be out of date? (You probably will want to spend fewer resources on products with shorter lifetimes.)

Would it be effective to have distinct phases of products over time? For example, a first phase of products could be designed to raise awareness, followed at a later date by a second phase of products to encourage changes in behavior.

Tall, brightly lit buildings threaten migratory birds by disrupting their ability to navigate.

How newsworthy is the information? Information with inherent news value may be rapidly and widely disseminated by the media.

The key here is to make good use of the resources available to you. In the best of all worlds, you would have the time and budget to personally contact every land manager in your region and to craft customized press releases for every type of publication and every audience. But it is unlikely that you will have the resources to do everything you'd like to do. The goal, then, is to pick your spots wisely. Reach as many people as you can, but also focus on those audiences that are most receptive to your message. If you have only limited time for direct outreach, concentrate on land managers who control critical habitat.

6.2 Education and Outreach Tools

This section describes a variety of outreach tools used by the BirdCast project. Examples of specific outreach materials developed by BirdCast can be found in Appendix A.

6.2.1 BirdCast Web site

In addition to hosting radar images, daily migration forecasts, and groundtruthing data, the BirdCast Web site (http:// www. BirdCast. org) also contains an array of outreach and educational information designed to assist the public in the protection of migrating birds. Major educational pieces on the site include:

Guidance on appropriate timing and application of pesticides to minimize birds' exposure.

Tips on preventing bird deaths caused by collisions with household windows.

Advice on controlling domestic cats to prevent predation on migratory birds.

Information on how tall buildings and radio towers can disorient birds, causing them to crash or drop from exhaustion.

Tips on bird feeding and watering, and on providing habitat for migratory birds during stopovers.

Many of these educational pieces are provided in hard copy in Appendix A of this handbook. Others can be found online (go to http:// www. birdcast. org/ ucanhelp. html). If you are developing a BirdCast- type program of your own, you can use these pieces as a model to stimulate ideas for your own outreach language. If you are a member of the public interested in birds and migration, you can read these materials to learn about steps that you can take to protects migrants.

One of BirdCast's mottos is: "Engage, educate, activate." The BirdCast Web site is a key tool for accomplishing each of these goals. The site is designed to be both attractive and interactive. The homepage, for example, features a colorful poster by Charley Harper, entitled "Mystery of the Missing Migrants," along with a species key to help visitors identify the birds depicted in the poster. Any birder visiting the site is welcome to submit data on his or her bird observations (see Section 5.3.2, Collecting Anonymous Observations), and visitors can also search the database of groundtruthing observations to view tables and summary graphs. In addition, throughout the site there are numerous links that visitors can follow to gather additional information and access other resources.

The goal of all this interactivity is to engage visitors, interest them in the plight of migratory birds, and give them a chance to participate in protecting and researching the lives of migrants. The outreach materials are there to educate them. The site also features several text pieces on the aesthetic and economic values of migrating birds, along with the beautifully written preface to Scott Weidensaul's book, Living on the Wind: Across the Hemisphere with Migratory Birds, which BirdCast was able to use with the permission of the author.

6.2.2 Posters and Other Print Materials

Because BirdCast is a Web- based project, it has developed relatively few educational and outreach materials for distribution in hard copy. When the project was first launched, a press packet was created for distribution to reporters and other media outlets, containing news clippings and other outreach materials. But this is no longer in use.

The main item that BirdCast partners distribute in hard- copy format is a poster entitled "Audubon Guide for Healthy Yard and Beyond," which was developed by the National Audubon Society. The poster lists actions that home owners can take to limit pesticide use and create healthy habitats for birds and wildlife. It also includes a guide to home pesticides, with information on chemicals, their uses, their toxicity to wildlife, and alternatives to the chemicals. Altogether, over 1 million copies of the poster have been distributed through Audubon chapter offices, bird- oriented stores, parks departments, and other groups.

To request copies of the poster, e- mail healthyhabitats@ audubon. org. A version of the poster can also be found online at:

http:// www. audubon. org/ bird/ pesticides/ 10% 20COMs% 20boxes. html.

Lessons Learned: Conducting Outreach Via Television Stations

When BirdCast was first launched, one of the original goals was to encourage television coverage of bird migrations. BirdCast's founders envisioned that there would come a day when weather forecasters would routinely include migration updates as part of their nightly reports. But that day has unfortunately not yet arrived.

As part of its education and outreach program, BirdCast has made a concerted effort to conduct outreach to newscasters and weather forecasters. The idea has been to combine radar images with photographs and educational information on protecting migrants, creating a package that will appeal to television stations. But so far the results have been discouraging. Though several stations have produced short news pieces on BirdCast, the general response has been that the BirdCast outreach materials are inappropriate for television in that they lack visual appeal. Newscasters have stated that the radar images are too esoteric and difficult to interpret.

In the future, the BirdCast project will continue to look for creative ways to package its outreach materials for television. The Illinois Natural History Survey, another organization that has succeeded at getting a local television station to make use of NEXRAD images of bird migration, has some ideas for getting television stations interested. The Survey suggested pointing out to television weather forecasters that significant bird migration usually coincides with “meteorologically boring periods” when they might lack weather- related material to discuss. The Survey also suggested developing simplified visual displays that convey basic information (e. g., presence/ absence of birds, relative abundance of birds, general direction of bird movement) in a manner that parallels the other displays on the weather forecast.

6.2.3 Press Releases

Press releases are a key tool in BirdCast’s education and outreach efforts. Writing a single press release and distributing it to dozens of publications simultaneously is a cost- effective way of reaching a large and varied audience.

The National Audubon Society’s public relations department leads BirdCast’s efforts to conduct outreach through the media. A PR department is an ideal choice for this job for two reasons: 1) PR staff have the writing, editing, and outreach skills needed for developing stories that will appeal to various news outlets, and 2) PR staff already have contacts and working relationships with individual journalists, editors, and newscasters. An experienced PR worker knows how to work with people in the media, feeding them the information they need to get stories into print and on the air.

For BirdCast, the Audubon PR staff have done several rounds of outreach to the media, each timed to coincide with a major migration (spring or fall). Their technique, which has produced excellent results so far, has been to write a single, in- depth press release and distribute it to a list of roughly 500 reporters whom Audubon has worked with in the past. (Examples of these press releases can be found on pages 45 to 48.) In some cases, Audubon staff precede the press release with a phone call or e- mail to the reporter, meant to kindle interest in the story. In other cases, Audubon sends the press release first, then follows up with an e- mail or phone call.

Once a reporter has expressed interest in BirdCast, the PR staff work with him or her as necessary to get the story into print. Some reporters (maybe half) request additional interviews with BirdCast partners or want help identifying a local angle for the story (for example, a reporter from a small city newspaper may want to interview members of a local bird club). Other reporters will develop a story using little more than the information and quotes found in the press release and other materials found online.

This type of personal contact with members of the press is crucial, as is the strategy of targeting individual reporters or newscasters. The odds of placing a story fall drastically if you just send a press release to a news desk or editorial department, since most publications are inundated with dozens (if not hundreds) of press releases daily. Audubon’s PR staff always send press releases directly to a particular reporter, and virtually every story they’ve placed has been written by a reporter whom Audubon had worked with in the past.

What if you don’t have a contact at a particular publication? One thing you can do is to read some back issues of the publication, looking for a reporter who has demonstrated some interest in topics related to your project. If the publication is a daily newspaper, it will likely have a beat reporter who focuses primarily on science and/ or the environment. Outdoors writers often have an interest in bird migration, especially if their columns cover hunting and waterfowl migration. BirdCast has placed several stories with gardening columnists, and numerous technology reporters have also written about the project, focusing on the BirdCast Web site or on the project’s use of advanced radar technology.

Once you have targeted a particular reporter, write him or her a personal e- mail or call directly. Pitch the story, keeping your presentation short and to the point. Ask the reporter if he or she would be interested in reading your press release (or, better yet, simply attach the release to an e- mail as an electronic file). Also, it never hurts to demonstrate that you are familiar with a reporter's work by complimenting or mentioning some article that he or she wrote in the past.

How many publications or news outlets should you target? The simple answer is, as many as possible. However, there are different ways to use the resources available to you. One approach would be to identify a limited number of publications that you view as critical, and then to spend extra time and resources doing everything you can to place a story with them (this might involve customizing your press release or following up repeatedly with a reporter). If you don't have existing contacts with the news outlets in your area, this type of intensive, focused effort might be necessary.

Audubon's PR staff have taken the approach of writing one major press release for each migratory season (spring and fall) and distributing it to hundreds of media outlets throughout the mid- Atlantic flyway, from New York to Maryland and the Washington, D. C. area. Audubon's staff spend virtually no time customizing press releases for particular publications, though they have issued press releases for particular occasions. For example, in September 2000, Audubon issued a spur- of- the- moment press release urging health officials not to spray for West Nile Virus on a weekend when BirdCast was predicting that a large wave of migratory birds would pass through the area. (See pages 47 to 48 for a copy of this release.)

Audubon's primary goal each migratory season has been to place a story in the major paper of each state in the region, with the idea that smaller papers will pick up the story after seeing it in a major paper (this has turned out to be true). The results of this PR effort have been excellent. More than 100 articles on BirdCast appeared in spring 2000, including prominent articles in the Philadelphia Inquirer, New York Times, Wall Street Journal, USA Today, and other major publications. Articles also appeared in virtually every Audubon chapter and independent bird club newsletter from northern Virginia to southern New York. Additionally, BirdCast was the subject of stories in Scientific American and National Audubon magazines, and the project was also featured on National Public Radio.

Lessons Learned: Dealing with the Redundancy Issue

Audubon's PR staff have found that one of the main challenges associated with conducting BirdCast outreach through the media is the issue of redundancy. Birds migrate through the mid- Atlantic flyway twice each year, in spring and fall. Ideally, BirdCast would like to have the media cover both migrations, every year. However, once a publication has covered the story once or twice, reporters and editors no longer consider it newsworthy.

Audubon's PR staff constantly search for creative ways to work around this problem. One strategy is to look for a "news peg" or tie- in, some newsworthy happening that can provide the basis for an article. For example, you might craft a press release about International Migratory Bird Day (an annual event set on the second Saturday in May), and slip in some information about your program within the body of the text. Audubon staff used a similar approach when they sent copies of the poster "Audubon Guide for Healthy Yard and Beyond," to all of the reporters in their database; the idea was to generate articles about the effects of pesticides on migrating birds and other wildlife, with BirdCast as a subtext.

The key point here is that your program doesn't have to be the main focus of every press release you send out. Look again at the press release on pages 47 to 48. The main message of this release was an urgent recommendation that health officials not spray for West Nile Virus on a weekend of intensive bird migration. Yet the press release also managed to provide a thorough description of the BirdCast project, and it also touched on a number of other important messages: the decline in numbers of migrating birds; their vulnerability to pesticides and other man- made threats; and steps individuals can take to protect migrants.

6.2.4 Direct Outreach to Land Managers, Building Managers, and Others

Property managers (including park managers, city officials, utility land managers, building managers, golf course managers, and others) are a key target for BirdCast's outreach and education efforts. Many property managers, especially in urban areas, control large chunks of open or undeveloped land that provide important habitat for migrating birds. These managers can help protect migrants by avoiding pesticide applications during migratory stopovers and by considering the birds' needs when making other management decisions.

BirdCast relies on direct communication when conducting outreach to property managers. This typically involves calling or writing property managers a few times a year to update them on the status of bird migrations and to remind them of the need for environmentally responsible management practices. In general, BirdCast has found direct outreach to be a relatively time- consuming process (especially in comparison to outreach through the media, where a much larger audience can be reached with a single press release). In the future, the project may attempt to make more use of volunteers in its direct outreach efforts.

Following are a few examples of effective direct outreach, taken from the work of BirdCast and other groups:

In Philadelphia, BirdCast has worked closely with the Fairmount Park Commission to encourage environmentally responsible land management and to raise awareness of the plight of migrating birds. The Commission oversees a system of parks, golf courses, and baseball fields in the city, and works with other land and utilities managers in the Philadelphia area. BirdCast wrote to alert the Commission about the value of the parks' habitat to migrating birds and the timing of migration. BirdCast provided copies of the poster "Audubon Guide for Healthy Yard and Beyond," for the commission to distribute, and provided all facility managers under their jurisdiction with guidance on environmentally responsible pesticide application (e. g., how to alter the use of specific chemicals and minimize the impacts on migrants).

The City of Chicago and the U. S. Fish and Wildlife Service have signed an innovative "Treaty for Birds," which features an effort by downtown building owners to turn off their lights during migration periods. Members of the mayor's Wildlife and Nature Committee worked with Chicago's Building Owners and Managers Association to spread the word to owners of downtown skyscrapers. Members of the Bird Conservation Network assembled the information needed to convince building owners that this action was warranted, and helped to identify buildings that were known for their high bird mortality.

Large areas of open or undeveloped land, such as city parks, provide important habitat for migrating birds.

In the Chicago area, a partnership of researchers, government scientists, city officials, and conservationists is proposing to use radar ornithology to identify key stopover habitat for migrating birds. The partners will then use direct outreach to educate land managers about the habitat needs of migrating birds, and to ask them to take steps to protect and enhance bird habitat (e. g., by controlling the spread of buckthorn, an invasive plant that impacts biodiversity).

6.2.5 Presentations

BirdCast partners regularly deliver presentations on the project to school groups, bird clubs, American Birding Association meetings, Audubon chapters, and other groups. The partners have developed several PowerPoint presentations for this purpose. These include:

An overview of the project.

A more detailed presentation on how BirdCast integrates multiple monitoring techniques (radar, groundtruthing, acoustic monitoring) to achieve a unified analysis of bird migration.

A presentation focusing on the radar ornithology component. All of these presentations make use of screen captures from the BirdCast Web site, sample radar images, and graphs from the groundtruthing database to give the audience a genuine feel for how BirdCast works.

6.2.6 ListServs

A ListServ is an automated system that automatically redistributes e- mail to names on a mailing list. Users can subscribe to a mailing list by sending an e- mail note to a mailing list they learn about; the ListServ will automatically add the name and distribute future e- mail postings to every subscriber.

There are numerous bird- oriented ListServs around the country. Some of these have a regional focus, and are used by birders to compare field notes and share notable sightings. Others are devoted to bird conservation, activism, and other topics of general interest. For an index of ListServs administered by the National Audubon Society, go to http:// list. audubon. org/ archives/.

The American Birding Association also maintains a state- by- state list of birding ListServs, available at http:// www. americanbirding. org/ resources/ reschat. htm.

BirdCast's education and outreach program utilizes ListServs as a medium for distributing information about the program, such as press releases and announcements. ListServs make an ideal tool for targeting an audience of committed birders. They are also cost effective, since there is no charge for subscribing to (or posting messages on) most ListServs.

BirdCast has also occasionally used ListServs as a tool for recruiting birders for the project's groundtruthing efforts. By monitoring the discussions at particular regional ListServs, BirdCast staff have been able to identify birders who are both committed and skilled and then contact them directly via e- mail. For more information on recruiting birders for groundtruthing, see Section 5. 3.1.

6.3 Evaluating the Effectiveness of Outreach Efforts

BirdCast has found no easy or cost- effective way of measuring the success of its education and outreach program. Since the ultimate goal of the program is to encourage behavior changes (e. g., changes in the way people use pesticides), the only true measure of success would be to document behavior changes on a large scale. Doing this is beyond the scope and means of the project.

Due to these limitations, BirdCast's partners have been forced to rely on other indicators as a measure of the program's effectiveness. For example:

Between September 1 and October 21, 2000, the BirdCast Web site received 1,867,163 "hits" and 147,423 visitors. These numbers show, among other things, that many people are returning to the site multiple times.

In the spring of 2001, roughly 100 to 150 people per week were submitting "anonymous" bird observations to the BirdCast database. (See Section 5.3.2 for more information on collecting anonymous observations.)

More than 100 articles on BirdCast appeared in the spring of 2000, including prominent articles in major publications such as the Philadelphia Inquirer, New York Times, Wall Street Journal, and USA Today. The combined readership of these publications is in the many millions.

If nothing else, these numbers indicate that BirdCast has reached thousands (if not millions) of people, raising their awareness about the plight of migratory birds and things they can do to help. The numbers also seem to show that thousands of people are engaged in the project and are participating on some level (for example, by returning to the BirdCast Web site repeatedly, or by submitting their own bird observations). Overall, it appears that BirdCast is succeeding in its mission: to engage, to educate, and to activate.

6.4 For More Information

The BirdCast Web site: http:// www. birdcast. org/

To access BirdCast's educational pieces online, go to: http:// www. birdcast. org/ ucanhelp. html

Scott Weidensaul's Living on the Wind: Across the Hemisphere with Migratory Birds

(Northpoint Press, 1999) has been called "a nimble summation of current thinking on bird migration and attendant environmental themes" (Kirkus Reviews).

To request copies of the poster "Audubon Guide for Healthy Yard and Beyond", developed by the National Audubon Society, e- mail healthyhabitats@ audubon. org. A version of the poster can also be found online at:

http:// www. audubon. org/ bird/ pesticides/ 10% 20COMs% 20boxes. html

For an index of birding ListServs administered by the National Audubon Society, go to

http:// list. audubon. org/ archives

The American Birding Association maintains a state- by- state list of birding ListServs, available at http:// www. americanbirding. org/ resources/ reschat. htm

Chapter 6

Pesticides: Is Your Backyard Safe for Birds?

Our lawns and gardens are like other environments. Plants, insects and other animals all interact and affect one another. Altering a part of that system can have unintended effects on other components of it. This is an important thing to keep in mind when considering whether or not to apply pesticides around the home. Pesticides are not only lethal to pests, but to other wildlife as well. Here are three important rules to consider before applying any pesticides:

1. Make sure you actually have a pest problem. Learn to identify pests and to determine at what stage they actually become a problem. Many times people treat for pests that are either not present, or not present in large enough numbers to cause problems.

2. Know your pesticides. Read the labels on your pesticides CAREFULLY. Learn to identify what active ingredients are contained in the product. Read about the potential effects these pesticides can have on the other organisms in your yard and community.

3. Check for alternative treatments. Make it a priority to use the least toxic method to control any pests or diseases. Many simple, non- toxic solutions are as easy to employ and as effective as chemical solutions. Contact your local garden center and Cooperative Extension for advice.

Making your garden or lawn more community friendly isn't difficult and may actually save you time and money. Plus a little bit of education and a few changes around your home can have a lasting effect on migratory bird populations and other wildlife.

To learn more about the pesticides commonly used around the home, refer to Audubon's pesticide summary at http:// birdsource. cornell. edu/ birdcast/ pestsum. html.

Other useful pesticide web sites:

EPA's Office of Pesticide Programs: http:// www. epa. gov/ pesticides

The National Pesticides Telecommunication Network:

http:// ace. orst. edu/ info/ nptn/ index. html

Toxicology and Environmental Health Information: http:// sis. nlm. nih. gov/ tehip. htm

Look up all the registered pesticide products containing certain active ingredients:

http:// www. cdpr. ca. gov/ docs/ epa/ epachem. htm

The American Bird Conservancy's Pesticide Pages:

http:// www. abcbirds. org/ pesticideindex. htm

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Appendix A BirdCast Education and Outreach Materials

40 Appendix A Windows: An Invisible Threat to Migrating Birds

Fact: Every year millions of birds die when they crash into windows in homes, schools, skyscrapers, factories, office buildings, and other sites.

Why: The transparent quality of windows makes them virtually invisible to birds, often until it is too late to stop short. It is difficult for a bird in flight to distinguish between glass and open space. It may see reflected vegetation in the window, but not the glass itself.

What You Can Do: There are different steps you can take in your home to prevent needless bird deaths caused by invisible windows.

Move your bird feeder. Make sure your bird feeder is either a minimum of 3 meters away from windows, or less than 1 meter away. Birds may still fly into the window if you move the feeder closer, but they will not have enough momentum to injure themselves.

Reduce transparency and reflectivity. Change the angle or surface of the window to lessen the transparency and reflectivity. Cover the window's external surface with a film, change the lighting, and keep all curtains closed or add external blinds.

Mark the window. You can etch the surface of the glass or streak it with a bar of soap. Hang strips of newspaper or ribbons, place strips of masking tape on the window. (These are more temporary measures in case there is a severe problem. However, most of these solutions are inconvenient or unsightly.)

Apply netting. Perhaps the best and most permanent solution is to stretch netting across the windows. Fine black netting that is used to protect berry bushes and fruit trees is available at many garden shops, home centers, and feed mills. Stretch the netting across the window or across a frame that can be installed outside the window. Be sure it is stretched with adequate tension to hold it several inches from the window's surface. Birds may continue to fly towards the window, but they will bounce off the mesh unhurt.

Hang hawk silhouettes. Attach hawk silhouettes to the window's surface. These shapes probably decrease collisions because they break up the smooth reflective surface and make the glass more "visible" rather than because they are shaped like hawks; but, in any case, they seem to help. The silhouettes are most effective if used in multiples. It is helpful also to attach the silhouettes by a suction cup or a hanging device from the outside so that movement caused by wind will catch the birds' attention. Most people think that the graceful shapes are interesting rather than unsightly. They're available commercially but they're also easy to make. (See the below instructions.)

Materials:

black, light- weight plastic

clear, outdoor tape

scissors

a template or model of the shape (approximately 8 inches from bill to tail and 12 inches from wing tip to wing tip)— go to

http:// birdsource. cornell. edu/ birdcast/ images/ hawk. gif for print- ready template Simply trace or carefully draw the shape on the plastic, cut out the silhouette, and tape it to the outside of the window. Be sure to place several on any large expanse of glass. One word of caution: you should check with the manufacturers of thermopane windows before you place anything on the glass surface. If this presents a problem, hang the silhouette from the sash around the window.

Not only can you make your house safer for birds, but by making several silhouettes and giving them as gifts to friends, neighbors, and even that office building with the big glass windows down the street, you can also encourage others to make their houses bird- safe.

Other Useful Window Web Sites:

National Audubon Society: http:// www. audubon. org/ educate/ expert/ window. html

Domestic Cats: A Cause for Concern

Fact: Every year hundreds of thousands of birds are killed in the United States by freeroaming domestic cats.

Why: Cats are natural hunters. Even your cute house pet is innately a predator. But while hunting is an instinctual behavior, cats are not a natural link in local food chains. Cats were introduced to North America by humans towards the end of the 19th century as a method of pest control. Since then feline populations have exploded out of control. Their predatory activities are an unnatural burden on birds. Keeping your cat well fed does not deter it from attacking birds; hunting birds is a natural behavior unrelated to a cat's hunger. You may not see your cat in action, but if you routinely let it outside it is likely to be killing up to 10 birds every year. With nearly 60 million pet cats in America today, that is a significant number of bird kills. Combined with many other threats birds face, this adds significantly to their struggle to survive. When you allow your cat to roam free outside, you are risking the lives of countless birds. You are also risking the life of your cat; those that are kept indoors live happier, healthier, and longer lives.

What You Can Do: A cat is only responding to a natural instinct. Ultimately you are responsible for your cat and its behavior.

Keep your cat indoors, especially during the peak migratory seasons in fall and spring.

Put an alarm collar on your cat. Many collars exist which will hamper the cats' stalk and attack. These collars will not harm the cat, but will give an unsuspecting bird ample warning to escape before a cat strikes. Bells alone will not stop a cat from attacking.

Spay your cat. Make sure you spay or neuter your cat to help keep the cat population in check.

Help stray cats. In addition to house pets, there are millions of stray cats in the United States, all a potential threat to native wildlife. You can take in some of these cats or call a local animal shelter.

Keep birdfeeders out of reach. Make sure the birdfeeder in your yard is not cat accessible. Keep it high and away from windows and vegetation.

Join the Indoor Cat Campaign. Encourage others to keep their cats indoors. Check out the American Bird Conservancy "Cats Indoors" at

http:// www. abcbirds. org/ catindoo. htm

Other Useful Web Sites:

American Bird Conservancy: http:// www. abcbirds. org

May 13, 2000 is National “Keep Your Cat Indoors” Day

Man- made Obstacles Pose Problems for Migrating Birds

Fact: Millions of birds die every year in building collisions.

Why: Tall buildings and their lights pose a serious threat to migrating birds. The feat of migration is already a dangerous one with the natural hazards due to weather, predators, and food scarcity. Birds are exhausted and hungry and yet humans have created tall obstacles to complicate an already difficult journey.

Birds use a variety of different cues to navigate their migration route, including the pattern of the stars, topographic features, earth’s magnetic fields, and the location of the setting sun. If any of these cues are disrupted or unclear, for example during cloudy weather, the birds will have difficulty staying on their path. The lights of tall buildings and radio towers only contribute to this confusion. The lights will often overwhelm natural cues and disorient the birds. These confused birds will then circle the lighted structures, not because they are attracted to the light, but because they are following an erroneous and obscure cue. Blinking lights, which often adorn radio towers, and bad weather only further contribute to the problem. Eventually many of these birds will collide with the building, with each other, or will drop from exhaustion.

This problem is increasing as more and more highrise buildings are constructed. The now popular glass skyscrapers, found brilliantly lit at night, are augmenting the dangers.

Not all birds die from the collisions. Some will only be stunned with minor injuries, but often these dazed birds will fall prey to predators, cats and other birds, lurking on city streets. Many will panic upon finding themselves in the midst of a busy, morning, urban setting.

Another related danger to nightflying migrants are the broadcast radio towers which may stand 200- 2000 feet into the night sky. There are around 75,000 towers currently built in the United States and with the current progress of Internet and satellite technology another 5000 to be added every year. Each of these towers may kill hundreds to thousands of birds in a single migratory season. Add lights and bad weather to the scenario and the death rate grows even higher.

What You Can Do:

Turn off all lights during the peak migration seasons in fall and spring.

Write letters to the owners of tall skyscrapers requesting that lights be turned off at night during peak migration periods.

If you find a stunned bird, carefully place it upright inside a brown paper bag and transport it to a safe area where it can recover before resuming its journey.

Other Useful Web Sites:

Fatal Light Awareness Program: http:// www. flap. org

Towerkills: http:// www. towerkill. com

44 Appendix A Native Plants and Biodiversity

We have peppered our continent with new houses, sidewalks, lawns, and regimented landscapes that are relatively devoid of seedpods, berries or other natural food sources. Imagine a different type of “yarden”: birds chirping, butterflies flitting, bees busily transporting pollen, and wildlife drinking and bathing in the rainwater you collected in your yarden. You can create this scene, and in so doing, you’ll find that you’ll have to replace plants less often and use less pesticide, time, money, and water.

To begin the transformation from traditional landscape to nativescape:

Identify your existing plants, then explore forests and other natural areas to examine differences. Never remove plants from the wild.

For a gradual transition, retain high maintenance areas close to the house while establishing a natural garden toward the edges and back of your property.

Consider neighboring property. Cooperate with your neighbors and extend existing plantings to create larger joint habitat.

Reduce lawn by breaking it up with curved borders around gardens, trees, shrubs and groundcovers to create an “edge effect.”

Select native plants to attract birds through all seasons and allow space for natural growth patterns (less pruning).

Consider tall native grasses (quail and other grassland species are declining), flowering annuals and perennials, and shrubs for shelter and food.

Consider removal of overgrown, unattractive plants that offer little wildlife value.

Add to your plan a little at a time. Enjoy a work in progress while reducing the area of lawn.

Plant more than one of a plant, as larger patches are more visible to birds. Plant them in an irregular pattern so that it looks more natural.

AVOID TOXIC CHEMICALS. Birds eat the treated insects and berries.

Remember, numerous plant species attract a greater variety of birds and other wildlife. Check links below to find out more and where you can find native plants.

Learn more about how to reduce the use of pesticides, find alternatives, and create a healthy backyard by region

Pesticide and garden tips: Ten Commandments for a Healthy Yard:

http:// www. audubon. org/ bird/ pesticides/ 10% 20COMs% 20boxes. html

The Environmental Protection Agency’s Biopesticides site:

http:// www. epa. gov/ pesticides/ biopesticides/

Backyard Conservation: 1- 888- LANDCARE,

http:// www. nhq. nrcs. usda. gov/ CCS/ Backyard. html

Native plants and gardening links: http:// plants. usda. gov/ plants/ links. html

Native plant societies by region: http:// www. nanps. org/ associations/ frame. shtml

Green Landscaping with Native Plants: http:// www. epa. gov/ greenacres/

Audubon Habitat Collection from Monrovia: 1- 888- PLANT IT

Further Reading:

The Bird GardenbySteve Kress Bird Gardening Book by Donald and Lillian Stokes The Chemical Free Lawn by Warren Schultz Going Native by Brooklyn Botanic Garden Landscaping for Wildlife by Carrol L. Henderson Redesigning the American Lawn -A SearchforEnvironmental Harmony by Bormann, Balmori & Geballe

For additional information contact:

Director, Pesticide Initiative & Healthy Habitats National Audubon Society HealthyYards@ Audubon. org

CITIZEN SCIENTISTS LEND A HAND TO BIRDS THIS FALL Award- Winning Web Site Combines Technology and Bird Science

to Help Birds Get Home Safely

New York, NY August 28, 2000 – This fall, migratory birds will face a number of life threatening challenges in their journey south. In addition to predators, difficult weather, and long distances, birds this year must contend with man made threats including potential poisoning from the pesticides employed to combat the West Nile Virus. With the help of citizen scientists and state- of- the- art forecasting technology, birds migrating through the Mid- Atlantic may get a break.

“Using the most advanced migration monitoring techniques, in combination with the efforts of the public, BirdCast www. BirdCast. org will become one of the most effective ways to track bird movement, and protect bird species,” said Audubon’s Senior Vice President for Science, Frank Gill. “From September 1st through November 15th, National Audubon Society urges citizens from New York to Washington, D. C. to report bird sightings to BirdCast and to take action to aid birds.”

As birds migrate, major factors contributing to their demise include pesticide use; loss of feeding and watering opportunities; impact with radio, television, and cellular towers, and brightly lit office buildings which disorient birds, causing them to crash. Scientists recognize that migrating birds are in decline— down by nearly 50% since the 1960’s.

BirdCast, enabling scientists to predict bird migration through a specific region, offers practical uses for homeowners and public officials. Using BirdCast, homeowners will be advised as to when to avoid spraying pesticides in their gardens, provide seed and water, and when to keep their cats indoors, in order to keep bird populations alive and well. Building owners can use BirdCast to determine when to turn off disorienting lights that often cause birds to crash into windows and die.

Public Health officials are also urged to make use of BirdCast. “This fall, BirdCast has an unintended and immediate use for county health officers,” continued Audubon’s Gill. “BirdCast will provide guidelines on when to suspend spray operations, helping officials avoid unnecessary bird deaths and violations of federal Migratory Bird Laws.”

BirdCast, a project of National Audubon Society, Cornell Lab of Ornithology, and Clemson University Radar Ornithology Lab, made its debut this past spring and was a resounding success. Funded by the Environmental Protection Agency’s Office of Research and Development and the Office of Pesticide Programs, the project was granted the “Dr. Copernicus Award" by the Copernicus Education Gateway, a Web site that features the best educational sites for students and teachers. Using radar pictures, audio samples and most importantly, personal observations (or “groundtruthing,”) scientists were able to make predictions and draw conclusions about songbird migratory behavior.

Participants from the mid- Atlantic region watched the skies, reported their findings to the BirdCast site and were then advised when to keep their cats indoors, to refrain from pesticide use, and to provide food and water in order to protect migrating birds in their region. Of particular interest to the thousands who visited BirdCast were the “10 Commandments to a Healthy Yard” and “The Audubon Guide to Home Pesticides," still available at the site

http:// magazine. audubon. org/ backyard/ backyard0005. html.

“By encouraging the public to report bird sightings in their region, BirdCast has and will continue to enable scientists to gather valuable information on migratory movements,” said Gill. “The project will not only increase scientific knowledge but also encourages people to make informed decisions about when to apply pesticides, let their cats out or undertake other activities that might cause birds harm.”

This fall, with additional support from the EPA’s Office of Pesticide Programs, BirdCast will expand into the states of New York and New Jersey. Scientists will generate morning and evening pictures of warbler, waterfowl, and hawk migration through the region using NEXRAD (Next Generation Radar). These snapshots of bird migration and weather events will be accompanied by interpretation and predictions from the Clemson Lab so that the general public and city officials can both observe and assist migratory birds.

“BirdCast has already inspired the general public to use this new technology to observe birds and ultimately become partners in conservation,” said Sally Conyne, Director of Citizen Science for Audubon. “This fall we are eager to track bird movement once again. Web users will be able to obtain daily forecasts of bird movements, learn about the best bird- viewing spots and find out how human activity impacts birds. In addition, the site now includes general information about migration, some late- breaking pesticide news, and a variety of tips for the fall gardener.”

Aside from adding color and music to our lives, birds serve as important environmental indicators, helping scientists assess the health of an ecosystem. Evidence of a declining bird species in a particular region may indicate another problem such as the loss of food or water sources, the destruction of specific habitats, or contamination by a toxic element. Despite the significant role birds play in local ecosystems, every year the numbers of migratory birds that return to the Mid- Atlantic region, and other parts of the country, decreases. These decreases may indicate problems with broad environmental implications, problems that can impact us in many ways.

Founded in 1905 and with over a 550,000 members and supporters in 530 chapters throughout the Americas, the National Audubon Society conserves and restores natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth’s biological diversity.

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John Bianchi jbianchi@ audubon. org 212/ 979- 3026 Kara Grobert kgrobert@ audubon. org 212/ 979- 3027

NATIONAL AUDUBON SOCIETY URGES NY, NJ & CT HEALTH OFFICIALS NOT TO SPRAY PESTICIDES THIS WEEKEND

Largest Wave of Bird Migration This Fall Predicted to Pass Through Tri- State Area

New York, NY September 15, 2000- Using the latest technology in bird tracking techniques and the efforts of citizen scientists through BirdCast. org, National Audubon Society predicts the largest wave of migration will occur this weekend- and strongly urges county officials to suspend pesticide spraying operations in the tri- state area.

“This weekend will be one of the best opportunities for people to see a wide variety of species of migrating songbirds and hawks, and to contribute their sightings to BirdCast,” said Sally Conyne, Director of Citizen Science for Audubon. “On the other hand, this weekend will be one of the worst times for pesticide sprayings to occur, due to the unknown effects of the use of Scourge and Anvil on birds and the consequent reduction of their food source. By not spraying pesticides in the tri- state area this weekend, county and city officials will avoid unnecessary bird deaths and violations of federal Migratory Bird Laws.”

Migratory birds usually face a number of life threatening challenges in their journey south. This weekend, in addition to predators, difficult weather, and long distances, birds must contend with man made threats, especially potential poisoning from the pesticides employed to combat the West Nile Virus. With the cooperation of health officials, help of citizen scientists and state- of- the- art BirdCast technology, birds migrating through the MidAtlantic may get a break.

“In combination with the efforts of the public, BirdCast www. BirdCast. org will become one of the most effective ways to track bird movement, and protect bird species,” said Audubon’s Senior Vice President for Science, Frank Gill. “From September 1st through November 15th, National Audubon Society urges citizens from New York to Washington, D. C. to report bird sightings to BirdCast and to take action to aid birds.”

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BirdCast, a project of National Audubon Society, Cornell Lab of Ornithology, Clemson University Radar Ornithology Lab, and Academy of Natural Sciences made its debut this past spring and was a resounding success. Supported by the Environmental Protection Office of Pesticide Programs and Mid- Atlantic Office (Region III), the project was granted the "Dr. Copernicus Award" by the Copernicus Education Gateway, an educational Web site for students and teachers. Using radar pictures, audio samples and personal observations (or "ground truthing,") scientists were able to make predictions and draw conclusions about songbird migratory behavior.

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http:// www. birdsource. org/ birdcast/ pestsum. html.

“By encouraging the public to report bird sightings in their region, BirdCast has and will continue to enable scientists to gather valuable information on migratory movements,” said Gill. “The project will not only increase scientific knowledge but also encourages people to make informed decisions about when to apply pesticides, let their cats out or undertake other activities that might cause birds harm.”

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BirdCast & NEXRAD

In the early days of World War II, British radar operators noticed mysterious, ethereal shadows drifting across their screens. Those apparitions, so wonderfully dubbed angels by pioneering radar technicians, heralded the beginnings of radar ornithology. Radar's first major contribution to ornithology took form only a few years later when in 1958 Sidney Gauthreaux, then a high school student in New Orleans, postulated that if radar can see planes and weather, why not birds? Only a few years later, as a Louisiana State graduate student, he found his proof. His radar images definitively proved the existence of massive trans- Gulf migrations. Prior to these observations, there was a continuing belief that the majority of migrants held to a more land bound, clockwise pattern; arriving in North America via Mexico.

Through the 60's, 70's, and 80's, however, radar's promise failed to fully evolve. There were a few notable discoveries, such as in 1989 when Gauthreaux, working from archival images, awakened the ornithological world to the precipitous decline in migrating flocks— down by nearly half when compared to the 1960's. The existing radar of the day, however, was proving largely inadequate. It lacked not only the necessary resolution, but it also failed to provide a three dimensional view.

In the early 1990s, however, change was coming. The new, highly efficient NEXRAD Doppler radar (Next Generation Radar) began to be placed in service. The Air Force started investigating NEXRAD's utility in their Bird Aircraft Strike Hazard Program (BASH). During this period, portable NEXRAD units were teamed with vertically mounted thermal imaging units so that the images captured by the radar could be visually verified. Elsewhere, graduate students under Sid Gauthreaux were making their own exciting discoveries. Their breath- taking images of giant expanding aerial doughnuts were found to be thousands of Purple Martin radiating from critical roosting sites each morning.

Radar ornithology work is now taking place in many parts of the country and it is soon to come to the Mid- Atlantic. With the support of the Environmental Protection Agency's Office of Research and Development and the Office of Pesticide Programs, a coalition consisting of National Audubon, Cornell's Laboratory of Ornithology, and Clemson's Radar Ornithology Laboratory, "BirdCast" will be coming soon to a computer near you on September 1, 2000. To access BirdCast you will go to the existing Audubon/ Cornell Web site— BirdSource

http:// www. BirdSource. org. Throughout periods of peak migration, BirdCast will provide a morning and evening, unfiltered snapshot of the eastern region of the US from New York through Virginia. The birds and weather shown in theseimages will be accompanied by interpretation and a migration prediction provided by the Clemson Lab.

Is this work being done just as a special favor for birders? Well, not exactly. You can think of BirdCast as an early alert and an environmental billboard on the Internet. Linked to BirdCast will be messages such as admonitions against the use of certain pesticides as well as a number of other migrant- friendly changes that people can make in their backyards. We'll advise the residents of the region about the pests that actually pose local threats and the safest management strategies. Included at the site are two charts of special interest— "10 Commandments for a Healthy Yard" and "The Audubon Guide to Home Pesticides." With the completion of data collection this migration season, we hope to use the interpreted and ground- truthed images in pinpointing critical habitat in need of protection.

While all of this seems reasonably simple and employs proven technology, its not simple at all. In fact, it's really research in the development stage. What has been sorely lacking in the past is you. Most earlier radar work has been lacking a critical component— groundtruthing. Dozens, hundreds, and, indeed, thousands of sets of eyes are needed to verify what the radar images are capturing and to that end, BirdCast will have an interactive component and will allow you to log on and enter your daily sightings. These will feed directly into our database and be available to everyone in real- time.

So, BirdCast needs you. Dust off those bins and get ready to head to your favorite haunts. While we encourage all of you to post each and every sighting, of greatest value will be sightings coming from those who can afford the time to make regular observations. Those of you who would like to participate on a daily or regular basis or if you would like additional information please contact Sally Conyne sconyne@ audubon. org. These data you collect will greatly enhance our overall understanding of migration patterns and movements. And this project will educate a multitude of people about how their backyards can be made friendlier and healthier for our angels. So, please, help us help the birds.

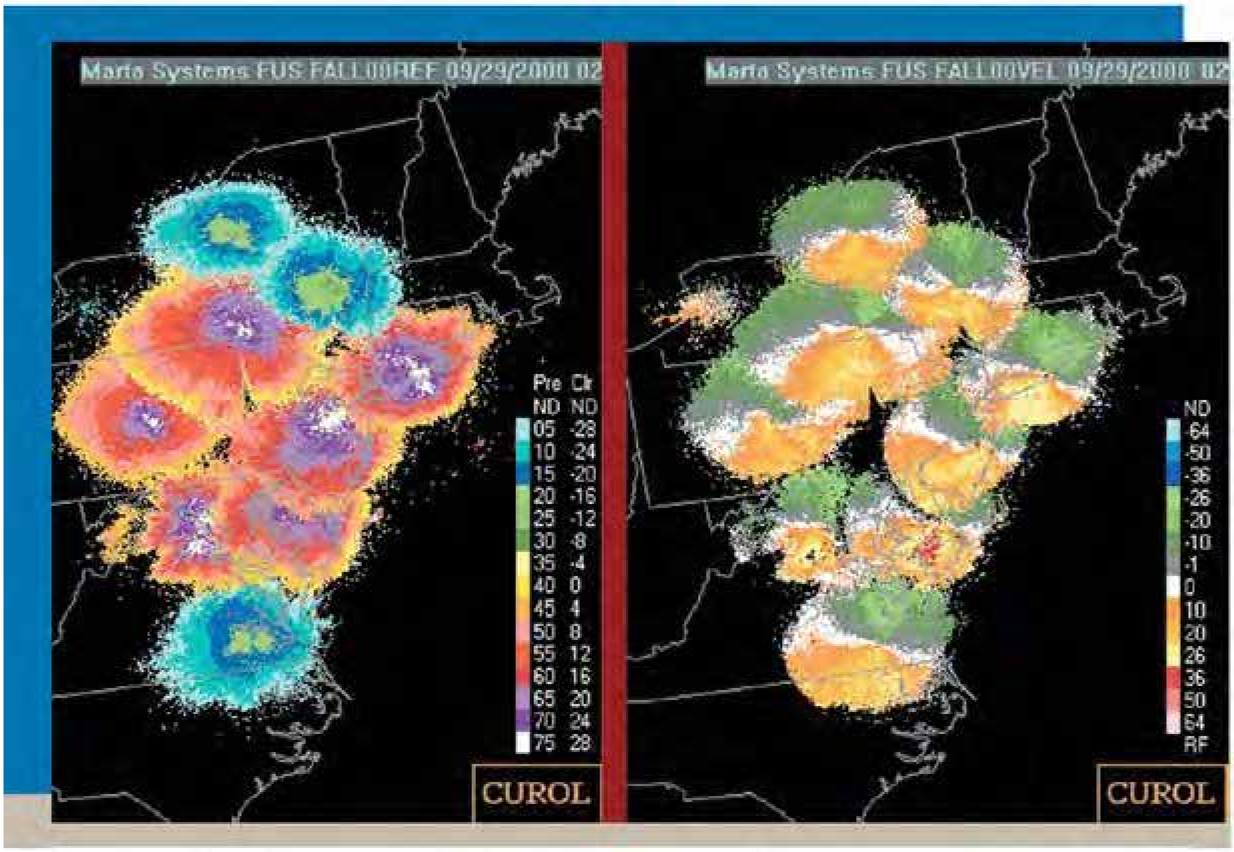
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Figure 1. NEXRAD radar images of bird migration on September 28: reflectivity (l) and velocity (r).

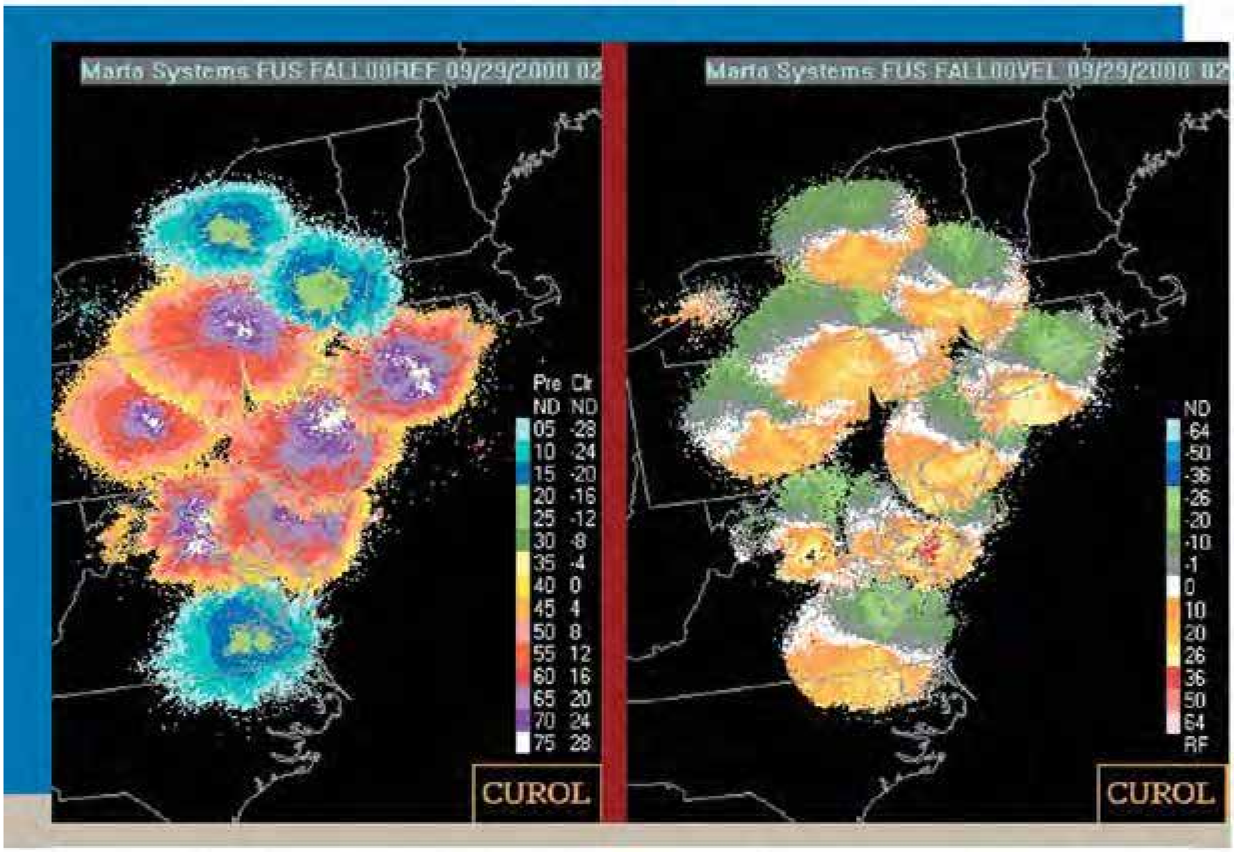
Analysis 28 September evening:

Weather conditions over the BirdCast area were favorable for bird migration. Northerly winds, clear skies, and cool temperatures associated with a strong ridge of high pressure over the area facilitated southward movements of migrants across the region. The reflectivity image (above left) shows extensive moderate to high densities (15-28 dBZ) of non-precipitation reflectors over the coverage area. The velocity image (above right) shows most of these reflectors are moving S and SSW
at 20-50 knots on N and NW winds at 5-10 knots. These are likely birds. Migration amount was moderate to high across the region, with bird densities reaching 600-1150 birds per cubic kilometers (25-28 dBZ) in many areas.
—Andrew Farnsworth, Clemson University Radar Ornithology Laboratory.

Forecast 29 September evening:

Weather conditions over the BirdCast area will not be favorable for bird migration.
E and S winds and warming temperatures associated with high pressure off the coast
of New England will keep most birds on the ground. Migration amount will be low
to moderate, reaching densities of 80-120 birds per cubic kilometer (12-16 dBZ).
—Andrew Farnsworth, Clemson University Radar Ornithology Laboratory.

Figure 1 NEXRAD Radar images of bird migration on September 28: reflectivity (1) and velocity (r).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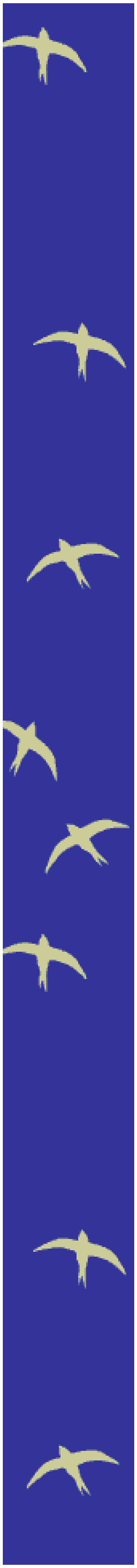

United States Environmental Protection Agency

EPA/625/R-01/007
September 2001

Developing and Implementing a Bird Migration Monitoring, Assessment, and Public Outreach Program for Your Community

The BirdCast Project

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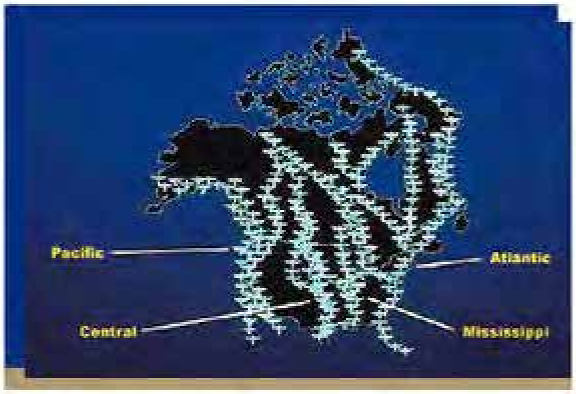
1. Introduction

Throughout much of North America, the sight of migrating birds marks the spring and fall seasons.

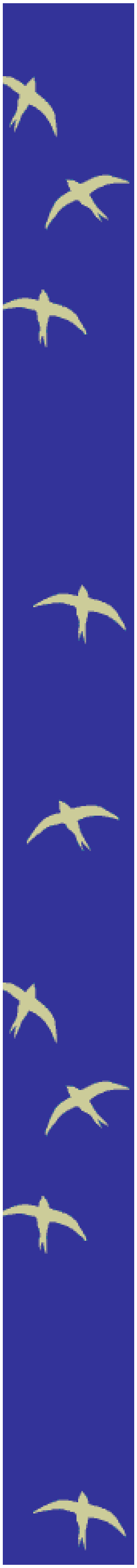
Every year, several billion birds undertake seasonal migrations in pursuit of food, shelter, and nesting grounds. North America is the site of some of the world’s most spectacular bird migration, and millions of American “birders” enjoy spending time in the field identifying the birds passing through their area. Migratory birds are delightful not only for birders, but also for countless other Americans who casually observe their comings and goings, particularly in the spring and fall. These birds also have a distinct economic value (nearly $3 billion in the mid-Atlantic states alone) to the tourist and outfitting industries of the regions located along their flight path.



Major migration routes in North America

Aside from any immediate benefits they provide, migratory birds are valuable for the role they play in our ecosystems— in particular, for eating insects and thereby keeping pest populations under control. We also have reason to be concerned about the well- being of migratory birds that extends beyond any inherent value these birds may possess. As naturalist Roger Tory Peterson noted, birds are an “ecological litmus paper”— because of their rapid metabolism and wide geographic range, they often provide an early warning of environmental deterioration. Migratory birds depend on many different kinds of open space, such as swamps, marshes, meadows, and suburban parkland. Therefore, research and conservation aimed at keeping a particular bird population healthy may lead to the broader goal of restoring these threatened habitats.

When migrating, a bird may travel hundreds or even thousands of miles without stopping. The exertion of flying such long distances leaves birds

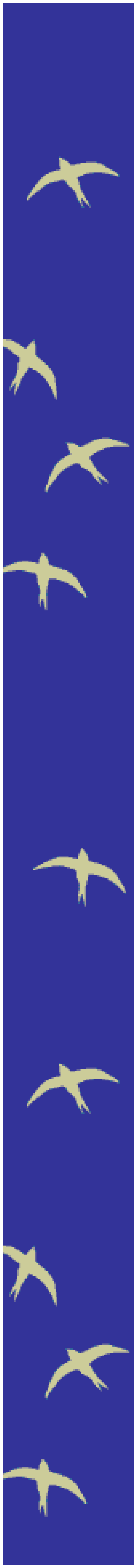


exhausted and vulnerable. Many birds, particularly those that encounter adverse weather conditions, do not survive their journeys. Unfortunately, human activities can further increase the levels of stress and danger that a migratory bird faces. For example:

- Inopportune application of pesticides to lawns, gardens, and parks may poison a bird's food supply at just the moment when it is weakest and most in need of nourishment. In the United States, migratory birds are particularly vulnerable to pesticide application as they migrate northward in the spring.
- Lights on tall structures (such as skyscrapers and communication towers) may confuse and disorient birds, causing them to become exhausted and crash into objects. Similarly, birds injure or kill themselves by flying into panes of glass. These problems appear to be particularly severe on overcast nights when birds may circle a light source.
- The development of land for human purposes such as agriculture, housing, and commerce often renders it unsuitable for use by birds. Birds may be challenged not only by the loss of habitat in their breeding and wintering ranges, but also by loss of habitat at key stop-over points where they need to rest and regain strength over the course of migration.
- Humans have imported animals to North America that prey upon migratory birds (e.g., cats) or compete with them (e.g., starlings). These new biological threats, combined with decreasing quantities of suitable habitat, may reduce the population and range of a particular migratory bird species.

There is much that property managers and the general public can do to mitigate these problems if they are aware of them, interested in solving them, and educated about bird conservation. During a period of peak bird migration, pesticide applications can be delayed, bright building lights can be turned off, and cats can be kept indoors. Therefore, outreach programs designed to inform these audiences about the status of seasonal bird migration are a promising route to improving the conservation of migratory birds.

EPA has developed this technology transfer handbook primarily for community organizers, non-profit groups, local government officials, and other decision- makers who will implement, or are considering implementing, bird migration monitoring and public outreach programs. The handbook is designed with two main goals in mind. The first goal is to present a case study showing how one regional outreach program—EMPACT's BirdCast project for the mid-Atlantic coast of the United States — provides information that allows property managers and the general public to assist migratory birds. The second— and perhaps more important — goal is to provide you with guidance for developing a similar program in your own region. The guidance in the handbook is based on the experience of the EMPACT BirdCast project, as well as that of other experts in the fields of ornithology and public outreach.



1.1 About the EMPACT Program

This handbook was developed by the U.S. Environmental Protection Agency's (EPA's) EMPACT Program (http://www.epa.gov/empact). EPA created EMPACT (Environmental Monitoring for Public Access and Community Tracking) in 1997. It is now one of the programs within EPA's Office of Environmental Information. EMPACT is a new approach to providing timely environmental information to communities across the nation, helping people to make informed, day-to-day decisions. Residents in 156 of the largest metropolitan areas in the United States have or will soon have an easy way to answer questions such as:

- What is the ozone level in my city this morning?
- What is the water quality at my beach today?
- How high is the ultraviolet radiation in my city today?
- What is the level of contamination at the hazardous waste site in my community?
- What are the levels of lead in the soil in yards in my neighborhood?

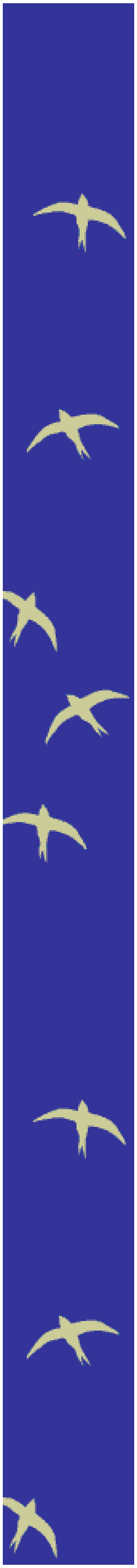
To help make EMPACT more effective, EPA is partnering with the National Oceanic and Atmospheric Administration and the U.S. Geological Survey. EPA is working closely with these federal entities to help achieve nationwide consistency in measuring environmental data, managing information, and delivering that information to the public.

EMPACT projects cover a wide range of environmental issues, such as groundwater contamination, ocean pollution, smog, drinking water quality, ultraviolet radiation, and ecosystem quality. Some of these projects have been initiated directly by EPA. Others have been launched by the EMPACT communities themselves.

1.2 About the EMPACT BirdCast Project

EPA's EMPACT program started funding the BirdCast project (http://www.birdcast.org) exit epa in 1999, and the project started public operation on April 1, 2000. The project began as a collaboration among EMPACT, EPA Region 3, EPA's Office of Pesticide Programs, the National Audubon Society, Cornell University's Laboratory of Ornithology, Clemson University's Radar Ornithology Laboratory, the Academy of Natural Sciences in Philadelphia, and GeoMarine, Inc. The four primary objectives of the project are:

1. To maintain an Internet Web site that posts educational information about bird migration and the steps that property managers can take to mitigate the danger and stress that migrating birds face when passing through an area.
2. To predict and monitor bird migrations on a daily basis using weather radar. The data gathered by radar are continually interpreted by trained scientists and presented using text summaries, charts, and



radar maps. During its first year, BirdCast also experimented with using microphones to perform bioacoustic monitoring of bird migrations.

3. To collect and disseminate volunteers' reports of bird sightings. This information collection, known as "groundtruthing," is coordinated through the BirdCast Web site. Groundtruthing information is stored on an Web-accessible database called "BirdSource" that Cornell maintains. Visitors to the BirdCast Web site can query this database and display reports in chart or graph form.

4. To raise public awareness about the sensitivity of migratory bird populations. This pub-lic relations campaign, coordinated by National Audubon, involves generating press releases, working with local land managers, distributing promotional materials, and making presentations at conferences and conventions.

1.2.1 BirdCast Regional Focus

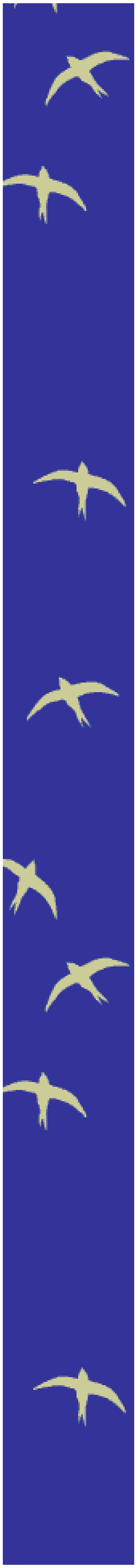
To date, the BirdCast program has primarily covered bird migration along a portion of the "mid-Atlantic flyway," a coastal area between North Carolina and New England that experiences significant migratory bird activity each spring and fall. The initial focus of BirdCast's attention has been the city of Philadelphia. BirdCast established a local partnership with Philadelphia's local PBS station (WHYY) and the Academy of Natural Sciences to develop a public relations focus on the region surrounding this city. The BirdCast project's efforts to collaborate with land managers so far have consisted primarily of work with Philadelphia's Fairmont Park Commission. It is hoped that eventually BirdCast can be expanded to cover the entire Atlantic flyway. Birds could be tracked coming across the Gulf of Mexico and at their first landfall. Birdwatchers up the coast could be alerted to the status of the migrating birds and provided with additional early warning of their arrival.

Despite its current regional focus, BirdCast also hopes to expand to cover the entire United States by forming new partnerships with local governments and birding organizations. So far, BirdCast has succeeded at drawing both widespread media attention (it was discussed in more than over 100 news articles by spring 2000) and attention in venues of national importance (it has been covered by news reporters from both the New York Times and the Wall Street Journal).

1.2.2 BirdCast in Context

The BirdCast project is a collaboration among individuals and organizations that made significant contributions to the field of bird monitoring both before and after receiving EMPACT funding. A brief history of these bird monitoring activities (and of radar ornithology in particular) will help to place BirdCast in its full context.

At the outset of World War II, almost immediately after the invention of tracking radar, British radar operators noticed that birds flying over the English channel would sometimes appear on their screens. At the time, this



fact was noteworthy primarily because it was possible to mistake a bird for a fast-moving-ship—significant ornithological use of this phenomenon did not begin until the 1960s. Sidney Gauthreaux, now Director of the Clemson University Radar Ornithology Laboratory, began studying the radar detection of birds at that time and has accumulated over 35 years of experience with the method. In the 1970s, the United States Air Force also began studying bird migration as a serious hazard to the operation of military aircraft, which often fly at high speeds and low altitudes. The Bird Aircraft Strike Hazard (BASH) team organized by the Air Force began exploring radar's potential to provide early warning of potential bird collisions. Their efforts were significantly aided by the emergence of "Next Generation Radar" (NEXRAD) in the early 1990s. NEXRAD is a network of highly sensitive weather radar stations located throughout the United States. In 1995, Sidney Gauthreaux also began using NEXRAD in his ornithological studies.

Meanwhile, in the mid-1990s, the National Audubon Society and Cornell University's Laboratory of Ornithology began applying a very different emerging technology to the field of bird conservation. These two groups collaborated to develop BirdSource, a sophisticated computer database that uses the Internet to allow birders from across North America to send their observations to a central repository. With financial assistance from the Packard Foundation, these two groups spent more than $2.5 million developing the BirdSource database as a nation-wide information technology resource for birders.

The idea of the BirdCast program emerged at a 1997 biodiversity meeting attended by personnel from both EPA Region 3 and the Department of Defense. EPA and DoD discussed the possibility of providing the public with near real-time information about bird migration using radar technology. BirdCast combined the capabilities of Clemson's Radar Ornithology Lab with the information technology capabilities of BirdSource so that members of the public would be able to not only view radar images but also submit data that might verify (i.e., "groundtruth") those images. EMPACT began funding the project through EPA's Office of Pesticide Programs and Region 3 in 1999, and BirdCast began its public operations in 2000.

1.2.3 Related Bird Monitoring Programs

BirdCast is not the only program that is currently using radar technology to track bird migration. Additional groups, such as the ones listed below, either have pursued or plan to pursue radar tracking technologies:

- BASH, the U.S. Air Force's program to guard against collisions between wildlife and aircraft, has developed an Avian Hazard Advisory System (AHAS). AHAS can be accessed on the Web at http://www.ahas.com. This system uses radar to predict the risk of a bird-aircraft collision along various flight paths at various times.

- The Illinois Natural History Survey, the University of Illinois (http://www.inhs.uiuc.edu), and EPA Region 5 (http://www.epa.gov/region5) have pro-posed setting up a project analogous to BirdCast for the Chicago region. The organizers hope to draw Chicago residents’ attention to the unique role that their urban and suburban open spaces play in the migration of birds, thereby encouraging interest in the conservation of those open spaces.

1.3 About this Handbook

A number of bird observatories throughout the United States have expressed interest in beginning projects similar to BirdCast. The Technology Transfer and Support Division of the EPA Office of Research and Development’s (ORD’s) National Risk Management Research Laboratory initiated the development of this handbook to help interested organizations learn more about BirdCast and to provide them with the technical information they need to develop their own programs. ORD, working with BirdCast, produced the handbook to leverage EMPACT’s investment in the project and minimize the resources needed to implement similar projects in new areas.

Both print and CD-ROM versions of the handbook are available for direct online ordering from ORD’s Technology Transfer Web site at http://www.epa.gov/ttbnrmrl. A PDF version of the handbook can also be downloaded from that site. In addition, you can order a copy of the handbook (print or CD-ROM version) by contacting ORD Publications by telephone or by mail at:

EPA ORD Publications
USEPA-NCEPI
P.O. Box 42419
Cincinnati, OH 45242
Phone: (800) 490-9198 or (513) 489-8190

Please make sure you include the title of the handbook and the EPA document number in your request.

We hope that you find the handbook worthwhile, informative, and easy to use.
We welcome your comments; you can send them by e-mail from EMPACT’s Web site at http://www.epa.gov/empact/comment.htm.

1.4 For More Information

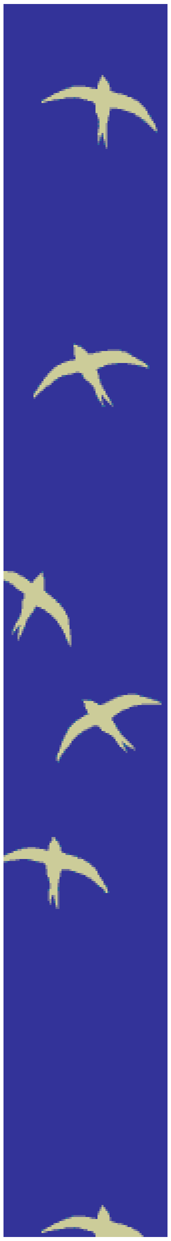
Try the following resources for more on the issues and programs this handbook discusses:

The EMPACT Program
http://www.epa.gov/empact

BirdSource
http://www.BirdSource.org exit epa

Cornell University Laboratory of Ornithology
http://birds.cornell.edu exit epa

National Audubon Society
http://www.audubon.org exit epa



Ralph Wright
EPA Office of Pesticide Programs
(703) 308-3273

Ronald Landy
EPA Region 3
(410) 305-2757

Sally Conyne
National Audubon Society
(215) 297-9040

Steve Kelling
Cornell University Laboratory of Ornithology
(607) 254-2478

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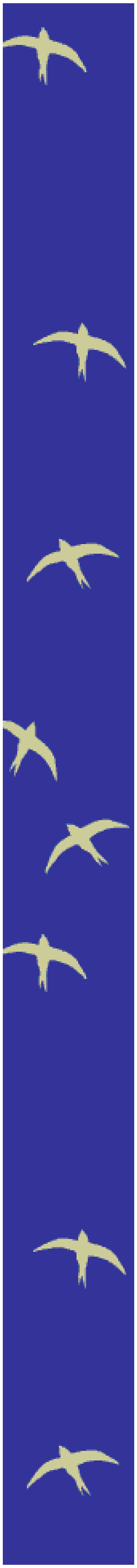

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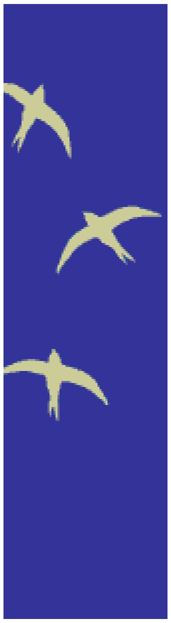
2. How to Use This Handbook

This handbook provides information your organization can use to create and implement aWeb-based bird monitoring program. It presents detailed guidance, based on the experience of the EMPACT BirdCast Project, on how to:

1. Identify target communities that would be interested in reporting on and following the progress of bird migration.
2. Record and present real-time information about bird migration using radar, weather information, and acoustic monitoring.
3. Collect groundtruthing information from volunteer birders and present it to the public.
4. Provide education and outreach to members of the public about what to do when migratory birds pass through their area.

This handbook provides simple “how to” instructions on each facet of planning and implementing a bird monitoring program, along with additional information about bird migration:

- **Chapter 3** discusses bird migration as a general conservation issue and how the different members of a bird migration monitoring organization work with each other to help birds as they migrate.
- **Chapter 4** discusses instrument-based observations of birds.
- **Chapter 5** covers a variety of issues relevant to volunteer groundtruthing, including a detailed description of BirdCast's policies and experiences working with volunteer birders.
- **Chapter 6** treats the methods and strategies a bird monitoring organization may make use of to conduct public outreach and education.
- **Appendix A** presents examples of education and outreach materials from the BirdCast project. Interspersed throughout the handbook are success stories and lessons learned in the course of the EMPACT BirdCast project.



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3. Beginning a New Bird Migration Monitoring Program

This chapter provides guidance on important first steps that you will need to take as you start your bird migration monitoring program. Section 3.1 provides a brief overview of the structure of a bird migration monitoring program and outlines the roles and responsibilities of program partners, based on the EMPACT BirdCast Project model. Section 3.2 discusses the critical process of selecting program partners who can best help you meet your program's objectives within your target community.

The information in this chapter is designed primarily for managers and decision-makers who may be considering whether to implement bird migration monitoring programs in their communities, as well as for organizers who are implementing such programs.

3.1 Program Structure: Overview of a Bird Migration Monitoring Program

The EMPACT BirdCast project is a multifaceted project that engages a variety of activities —everything from distributing posters to counting birds. These activities can be grouped into four main categories, which make up the main components of the project: administration and public outreach, radar analysis, database management, and volunteer groundtruthing.

The following paragraphs summarize these activities to provide an overview of how the EMPACT BirdCast program works. These activities are described in greater detail in Chapters 4 through 6.

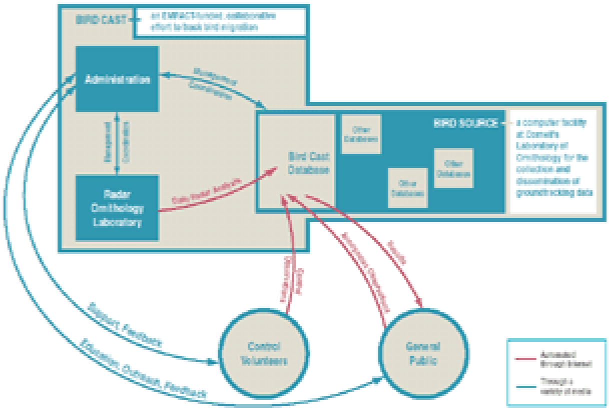
General Administration and Public Outreach. The administrator and staff of BirdCast are responsible for the primary public relations and outreach efforts of the project. This includes managing the distribution of posters about pesticide use, maintaining contacts with news media organizations to ensure that BirdCast stays in the public eye, issuing periodic press releases, and working with local land managers to encourage bird-friendly gardening practices. The administrator also provides a broad range of support tasks related to the project's birdwatching volunteer program. These tasks include providing advice about making bird identifications, making quality control checks of data submitted by volunteers, and networking to recruit new volunteers. The BirdCast administrator also serves a central liaison with the other BirdCast staff, including the radar analyst and the chief database base manager.

Radar Analysis. The chief radar analyst and his assistant are responsible for predicting the degree of bird migration activity in upcoming evenings and for measuring the actual amount of bird migration using radar data. The radar analyst (and/or his assistant) must make daily reports of predicted and observed migration during the periods of bird migration (in the spring and the fall) but have fewer regular duties during the “off season.” They seek out and contract information service providers to ensure a constant supply of radar data during the periods of migration. Once per day, the radar analysts submit their predictions and observations to the database administrator via the Internet.

Database Administration. BirdCast’s database administrator and his staff ensure that the public has access (via the Internet) to the information submitted by the radar analyst. In the case of BirdCast, the database is actually maintained as a separate organization called BirdSource. BirdSource is an entity distinct from BirdCast and it maintains a variety of other Web-enabled birding databases. The BirdCast database administrator issues user identifications to new volunteers, implements backups and system security measures, and coordinates the programming of changes to the database system. Also, while BirdCast’s bioaccoustic monitoring was being conducted, the project was coordinated by the database administrator.

Volunteer Birdwatching. BirdCast's volunteers provide the “groundtruthing” information necessary to verify the observations made using radar instrumentation. Volunteers are recruited by the project administrator and contact her with any questions or comments they may have about their participation in the program. Registered volunteers make observations several times a week and record their findings directly to the BirdCast database (using the Internet).

The flow chart below summarizes the basic structure of the BirdCast project. The chart identifies the main activities of the project, the team members responsible for these activities, and the flow of work among team members. It also indicates where in this handbook you can go for more information about specific activities.


BIRD CAST
an EMPACT-funded, collaborative effort to track bird migration
Administration
Management Coordination
Radar Ornithology Laboratory
Daily Radar Analysis
Bird Cast Database
Other Databases
Other Databases
Other Databases
BIRD SOURCE
a computer facility at Cornell's Laboratory of Ornithology for the collection and dissemination of groundtracking data
Support, Feedback
Education, Outreach, Feedback
Control Volunteers
General Public
Automated through Internet
Through a variety of media

View Full Chart

3.2 Selecting Program Partners

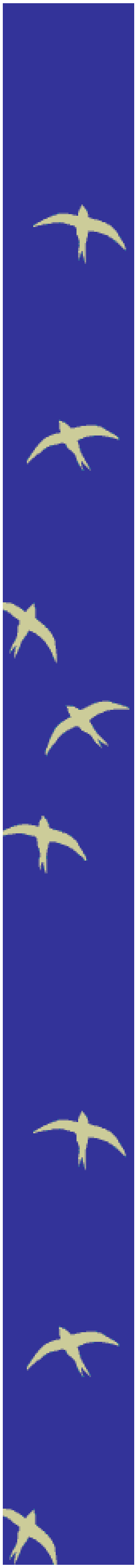
As described in Chapter 1, BirdCast is a partnership of several public and non-profit organizations. These have included university laboratories, a wildlife conservation society, a park management authority, and a natural history organization. The reason BirdCast is composed of such a wide range of partners is that its goals require the use of a wide range of skills and community connections. None of the individual organizations, working by themselves, would have been as effective as the collaboration of many different organizations, each possessing complementary skills and abilities.

For example, the staff of Clemson University's Radar Ornithology Lab have specialized skills in forecasting and analyzing bird migration patterns using radar images and other weather data. The National Audubon Society, on the other hand, has an extensive media infrastructure for presenting bird conservation information to the public and can easily enlist the support of birding communities. Cornell's Laboratory of Ornithology, in conjunction with the National Audubon Society, has invested in the development of BirdSource, a sophisticated Web-enabled database for the collection and distribution of bird monitoring data.

In starting your own bird monitoring program, you'll need to assemble a team of individuals or organizations who offer a similar range of skills and qualifications. To select partners or team members, you should think about how each will fit into the overall program structure, and how different partners can work together to create a successful program. You will also need to consider their relationship to the region where you will be monitoring bird activity. For example:

- A small, grass-roots organization that already has strong ties to the community can be ideal for providing public outreach and obtaining volunteer birdwatchers. Local chapters of birding clubs, natural history associations, or conservation groups can all be good choices. (For a directory of birding clubs in the United States, see (http://birding.about.com/hobbies/birding/library/blalphausclub.htm. exit epa)
- A university with an ornithology laboratory would make a good partner for identifying and interpreting radar images of birds. A professor or graduate student working in such a lab might either already have the necessary skills or be able to acquire them for the benefit of the bird monitoring project.
- A government agency, university, or private company that employs persons with a range of programming and "new media" skills would make a good partner for the purposes of establishing a Web site where the public can access up-to-date radar images and submit and retrieve groundtruthing observations. Building such a Web site from the ground up may require access to staff trained in JAVA programming, Web page design, network administration, and database building.

3.3 Figuring Costs



One of the important first steps for your organization to take when it is considering setting up a bird monitoring program is to estimate how much your planned activities will cost. Although your program need not be as large or ambitious as BirdCast's, you may find it helpful to know how much money BirdCast spent in its first year of operation.

In its initial year (between December of 1999 and November of 2000) EMPACT provided BirdCast with $449,500 for operations and set-up. As shown above, these expenses break down into five categories, each of which was handled by a separate entity:

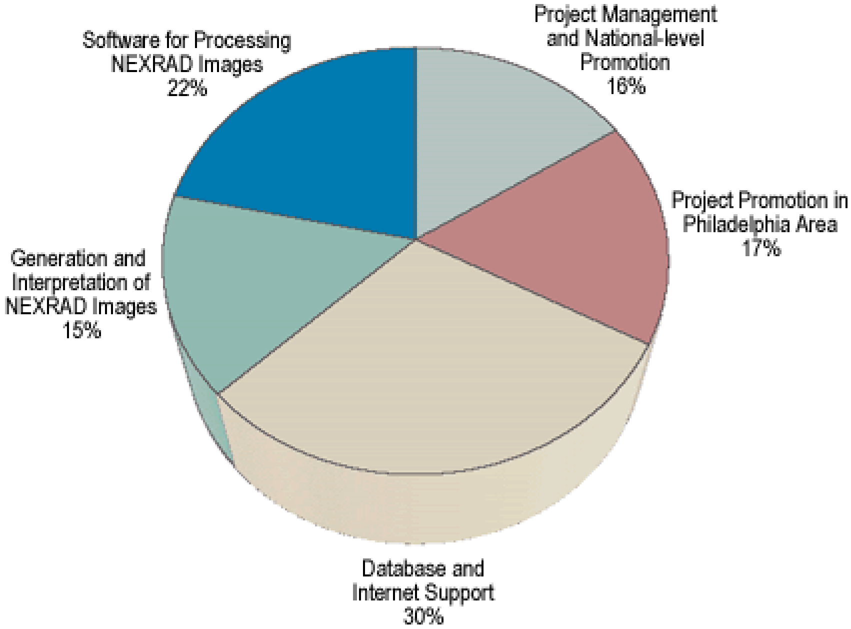
- **Project management and national level promotion** was handled by National Audubon Society. This cost $71,000 or 16% of the overall EMPACT budget for BirdCast. This category covers all the public promotion of BirdCast that went on during the year, excepting a local media campaign in Philadelphia.

- **Project promotion in the Philadelphia area** was handled by the Academy of Natural Sciences. This cost $76,500 or 17% of the overall EMPACT budget for BirdCast. The Academy was responsible for encouraging local news media to discuss BirdCast and reporting its findings.

- **Database and Internet support** was provided by the staff of the BirdSource project at Cornell University. This support cost $136,000, or 30% of the overall EMPACT budget. BirdSource staff maintained the BirdCast Web site, set up and managed a database for groundtruthing observations, and coordinated BirdCast's bioacoustic monitoring program.

- **Generation and interpretation of NEXRAD images** was performed by Clemson University's Radar Ornithology Laboratory (CUROL) for a fee of $68,000, or 15% of the overall EMPACT budget. As described elsewhere in this report, CUROL submitted daily radar information about bird migration to the BirdCast Web site.

- **Software for Processing NEXRAD images** was developed by GeoMarine Software for $98,000, or 22% of the overall EMPACT budget. GeoMarine developed software algorithms for distinguishing radar signals reflected from birds from those reflected from clouds.



This cost breakdown represents the first-year of a cutting-edge program and should not be taken as completely representative of the ongoing costs of other bird monitoring programs, particularly those that are smaller in scale. For example, BirdCast organizers learned that it was neither necessary nor feasible at present to automatically distinguish birds from precipitation with software algorithms. The expense associated with this component of the program, therefore, was not carried forward into future years and need not be incurred by newer monitoring programs.

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4. Instrument Based Observation of Bird Migration

Flying takes a lot of work. While larger birds (such as raptors, cranes, and waterfowl) will migrate during daylight hours, most songbirds migrate on clear, calm nights when weather conditions are most favorable to powered flight. Unless there is a full moon out, lack of light can make it almost impossible to visually observe migrating songbirds. Birders can take note of where such birds land in the morning, but actual songbird migration is typically recorded using special instruments.

The primary foundation of BirdCast's predictions and observations of bird migration is the information provided by a network of WSR-88D weather stations located throughout the United States. These weather stations (and the data they produce) are collectively referred to as Next Generation Radar (NEXRAD). BirdCast has also experimented with bioacoustic monitoring of nocturnal bird migration. Although this technique has proved promising, it is not currently in widespread use due to cost considerations.

4.1 What is NEXRAD And What Can It Do?

National Weather Service

NEXRAD Radar Station in Mount Holly, New Jersey

Like all radar systems, NEXRAD identifies the location of distant objects by transmitting radio signals and analyzing the returning signals that have been reflected off of those distant objects. Unlike previous radar networks, which were composed of WSR-57 and/or WSR-74C radar stations, NEXRAD radar is also able to measure the radial velocity of objects by recording the Doppler shift of the reflected radar. (The Doppler shift is the difference between the frequency of the transmitted radar signal and the reflected signal—if the reflected signal is higher frequency than the transmitted signal, it is an indication that the reflecting object is moving toward the radar station; conversely, if the reflected signal is at a lower frequency, it is an indication that the object is moving away from the radar station)

In addition to this new ability to detect object velocity, NEXRAD is also distinguished by increased object detection sensitivity. This is particularly important for ornithologists because birds are relatively weak reflectors (compared to the objects usually detected with radar, such as clouds, airplanes, and ships). NEXRAD is capable of detecting birds flying at a range of heights and can provide a rough idea of the altitude at which a particular group of birds is flying. NEXRAD is so sensitive that radar ornithologists need to learn how to differentiate birds and insects—both can be detected. NEXRAD Radar Station in Mount Holly, New Jersey.

Finally, NEXRAD provides information about the reflectivity of a particular object (i.e., how effective a particular object is at reflecting radio waves). Reflectivity can be determined by a number of different factors but in the case of migrating birds, it provides indirect information about the number of birds traveling in a particular area.

In summary, then, NEXRAD can help determine:

- The **location** of a group of migrating birds, including general altitude information.
- The **speed** with which the group birds are moving towards and away from a particular radar station.
- The **approximate quantity** of migrating birds in a particular area. Quantitative NEXRAD estimates are calibrated by “moonwatching” (counting the number of birds that fly across a visible full moon) and by making next-morning ground observations.

4.2 What is Bioacoustic Monitoring And What Can It Do?

BirdCast staff have been experimenting with bioacoustic monitoring as a way of keeping track of nighttime bird migrations. Bioacoustic monitoring is the process of recording bird calls and matching them to a library of the bird calls of different species. When birds fly at night, they typically make frequent 50- to 100-millisecond vocalizations. Some birders can make fine distinctions between certain kinds of birds simply on the basis of these calls (e.g., the distinction between the Veery Thrush, the Gray-Cheeked Thrush, and the Hermit Thrush). Although birders can perform something like bioacoustic monitoring right in their heads, BirdCast staff are developing a computerized system to automate and standardize the process of recording, filtering, and identifying bird calls.

A bioacoustic monitoring station, typically located on the property of a volunteer birder, consists of a computer with a sound processing card and a specially designed outdoor microphone. The microphones used in bioacoustic monitoring can detect noises made by birds that fly up to 1,500 above the ground. Throughout an entire evening, the computer automatically analyzes the sounds picked up on the microphone and digitally records those sounds that appear to be made by birds. In the morning, a volunteer uploads this “filtered” recording to the Cornell Laboratory of Ornithology, where more sophisticated computer software enters the information into a database and attempts to determine which species are represented in the recording.

The BirdCast program has recently found it necessary to curtail its bioaccoustic monitoring program—only a very few stations are currently in use and there are no current plans to establish new ones. The greatest barrier to the more extensive use of bioacoustic monitoring has been the cost of manufacturing the special microphones for the monitoring stations. The basic materials for the microphones are quite inexpensive, but because production quantities were extremely low, the microphones were being hand-built by laboratory staff at Cornell. The microphones currently cost about $2,500 apiece, but BirdCast staff imagine that the microphones could be dramatically reduced in price if some way were found to mass produce them.

Additional limitations of bioacoustic monitoring include the following:

- Weather conditions can affect both the likelihood that birds will make noises and the ease with which those noises can be picked up with a microphone. Thus, it is difficult to disentangle weather variability from variability in the numbers of migrating birds.
- Many species of birds do not make noises while flying. Therefore, it is difficult to gauge overall numbers of migrating birds solely using this method.
- Bioacoustic technology is in an early stage of development. The software that is used to quantify and identify birds on the basis of sound recordings is still quite experimental and there has not been enough time for scientific literature to accumulate on this topic.

4.3 How Do NEXRAD, Bioacoustic Monitoring, and Volunteer Groundtruthing Fit Together?

It is noteworthy that the altitude detection range for bioacoustic monitoring (0-1,500 feet) does not overlap with the detection range for NEXRAD radar (generally between 3,000 to 6,000 feet). The non-overlap of these two ranges complicates the correlation of bioacoustic results and NEXRAD results, as it is possible for certain bird species to picked up by one kind of instrument and not the other. Due to the influence of variable weather conditions and a lack of complete information about the altitude at which different bird species fly when they migrate, it is not possible to precisely predict which species will fly within the altitude range of which instruments on any given evening.

Groundtruthing data collection, covered in greater detail in Chapter 5, is an essential complement to both NEXRAD radar interpretation and bioacoustic monitoring. One reason for this is the fact that it is difficult to ascertain what kinds of birds are migrating through an area solely from NEXRAD data. In combination with coordinated groundtruthing data, however, it is sometimes possible to associate particular clusters of reflectivity with particular species of birds. Groundtruthing also helps to calibrate the quantitative estimates of birds made from radar and it serves as a quality control check of the basic reporting information provided by radar and bioacoustic monitoring.

Until recently, the BirdCastWeb site combined the daily results of NEXRAD observations, bioaccoustic monitoring, and groundtruthing in a single display. The purpose of this display was to show how each of these methods produced results that were similar to those of the other methods. Under ideal circumstances, for example, all three methods would predict the same degree of migration activity. This display has been recently discontinued on the grounds that some viewers may have found it too complicated.

4.4 How Can A Bird Monitoring Organization Begin Using NEXRAD To Observe and Predict Bird Migrations?

The essential first step in setting up a radar component for your migration monitoring program is to contact an organization that is already experienced in this work, such as the Clemson University Radar Ornithology Laboratory or the Illinois Natural History Survey. Such contact is essential for obtaining advice about the feasibility of your project and about the best way to obtain the expertise necessary to accomplish your project. Depending on the training and availability of your organization’s staff, you will probably need to either delegate your actual NEXRAD analysis to an experienced laboratory or send a staff member for training at such a laboratory. Both of these plans would require negotiating a working partnership with an organization possessing expertise in radar ornithology.

The use of NEXRAD to forecast bird migration, in the words of one practitioner, “is a difficult task that requires laboratory and field experience as well as an appreciation for meteorological phenomena.” The interpretation of NEXRAD radar to observe current migration is a similarly complex task. At present, it is an undertaking suitable for a graduate level or post-doctoral ornithologist who has received hands-on training with an expert.

4.5 How Did BirdCast Implement the NEXRAD Component of Its Bird Monitoring Program?

In July 1998, Dr. Sidney Gauthreaux of the Clemson University Radar Ornithology Laboratory (CUROL) helped propose the BirdCast project to EPA’s EMPACT Program. His proposed task involved forecasting bird migration twice a day (mid-morning and midevening) over the Delaware Valley and then using Doppler weather surveillance radar (i.e., the NEXRAD network of WSR-88D stations) to validate the forecast and measure the actual amount of bird migration that occurred over the area. The text files and graphic radar files were to be sent to the BirdCast Web server at the Laboratory of Ornithology at Cornell University and posted on the BirdCast Web site. GeoMarine, another partner in the project, was to supply hourly WSR-88D imagery that had been processed to eliminate echoes from weather and other non-bird targets. The hourly images would also be posted on the BirdCastWeb site. A proposal was developed in August 1998 and work began after Clemson University signed a subcontract withNational Audubon Society in mid-March 2000.

4.5.1 Activities in Spring 2000

The first task was to purchase a host computer (Dell Dimension XPS T600MHz, Dell Computer Corporation) that could be used to download the WSR-88D images from the NEXRAD Information Distribution Service (NIDS) provider, download the weather data necessary for generating a migration forecast, and serve as host computer where Cornell could electronically "capture" forecast text files, analysis text files, and the mosaic radar image files. CUROL used Marta Systems, Inc. as the NIDS provider. CUROL was familiar with Marta Systems’ software, so it could easily make the mosaic images of the radar displays from the Delaware Valley. In order to work from remote locations, CUROL also purchased a Gateway Solo 9300 CX laptop computer. This allowed laboratory staff to work on forecasts and analysis while at home or traveling by communicating with the Dell host computer over the Internet. CUROL believes that laptops are essential for producing consistent and timely results for display on the BirdCast Web site.

During a previous research project in the middle 1970s, Dr. Gauthreaux developed a multivariate forecasting model to predict the amount of bird migration in the Athens, Georgia, area. The input variables for this model were the weather predictions for the period in question. Dr. Gauthreaux generated this model by step-wise regression analysis, choosing an array of weather variables that best explained the variation of nightly bird migration amounts. No existing forecasting models of bird migration were available for the Delaware Valley area and time constraints prohibited the development of a model for the region. Given this situation, CUROL used the Athens forecast model for the spring 2000 BirdCast effort.

From 31 March through 30 May, Dr. Gauthreaux or graduate students Andrew Farnsworth or Jonathan Ariail gathered weather data via the Internet from weather stations in the Delaware Valley for input to the Athens model. The model generated a forecast of the amount of migration expected over the Delaware Valley. The model was run before noon to forecast the amount of migration expected that evening at 10 PM, and it was run before midnight to forecast the amount of migration expected the following morning at 10 AM. In addition, to verify the accuracy of their forecasts, CUROL downloaded radar imagery from five WSR-88D stations (KAKQ in Norfolk, VA; KLWX in Sterling, VA.; KDOX at Dover Air Force Base, DE; KDIX at Ft. Dix near Philadelphia, PA; and KCCX at State College, PA) and made mosaic images showing the amount of bird migration over the Delaware Valley at the forecast times. The laboratory analyzed and interpreted the mosaics so that the viewer of BirdCast would be able to discriminate birds from weather and insects.

Each morning before noon and each evening before midnight, CUROL staff placed the text file of the forecast, the text file of the analysis, the graphic file of the radar reflectivity mosaic, and the graphic file of the radar velocity mosaic in separate folders on the Dell host computer. The BirdCast server at Cornell automatically downloaded the files and posted the materials on the BirdCast Web site. Except for a few glitches near the beginning of the project, the CUROL efforts proceeded with no problems.

4.5.2 Later Seasons (Fall 2000 and Spring 2001)

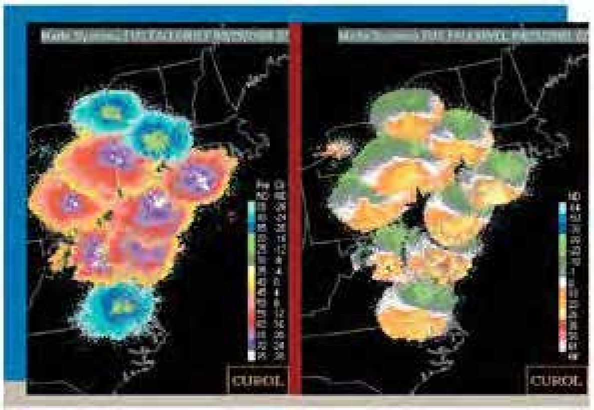
CUROL was encouraged to continue with the BirdCast program because of its success in forecasting the amount of bird migration during the initial BirdCast effort. There were a number of changes between the second season of BirdCast and the first. For example, BirdCast coverage was expanded in this season to include the state of New York. Also, because only a very small amount of bird movement had been found in the mid-morning hours, CUROL discontinued forecasts and analyses of daytime bird migration.

CUROL learned from the spring 2000 effort that using a single model to forecast migration amount over the entire BirdCast area resulted in inaccurate forecasts for some areas. In an effort to overcome the geographical limitations of the spring 2000 model, CUROL developed two models specifically for the BirdCast area using a step-wise regression analysis of forecast weather variables and the amount of bird migration measured (i.e., the relative reflectivity of targets [dBZ] displayed in WSR-88D images). CUROL used WSR-88D data collected during the fall migration of 1999 for another CUROL project and Local Climatic Data (LCD) for September and October 1999 that it purchased from the National Climatic Data Center (NCDC) for two stations: Albany, New York, and Washington, D.C. By the spring of 2001, CUROL had developed more than 30 regional models.

As in the spring of 2000, at 2 PM every day CUROL placed a text file containing the evening forecast, a text file containing the analysis of the previous evening, the graphic file of the radar reflectivity mosaic, and the graphic file of the radar velocity mosaic in separate folders on CUROL’s BirdCast host computer. As in the spring the Cornell BirdCast server collected these files and posted them to the CUROL portions of the BirdCast Web site. The ability to generate a forecast each day, including days on which both forecasters were traveling or away from the CUROL host computer, was greatly enhanced by a laptop computer with an FTP program that allowed the forecasters to upload text and graphics remotely.With the exception of some initial glitches that were quickly corrected, CUROL’s models worked well. A sample of the Web page products for an afternoon posting (in this case for the afternoons of 28 and 29 September 2000) can be found in Figure 1.

4.5.3 Feedback and Conclusions

CUROL received overwhelmingly positive feedback from the public with regard to its forecasting and the radar ornithology tutorial that it developed for the BirdCast Web site. Although the forecasting and analysis portion of the BirdCast project is complete, CUROL seeks to develop better forecast models. As it refines its methodology for building models and its understanding of the interactions and correlations between specific weather variables and the amount of bird migration, the accuracy of its forecasting will continue to improve. Models are an absolute necessity for any attempt to track bird migration over large spatial scales (such as the entire eastern seaboard), and improved accuracy will improve scientists’ ability to understand where and when large movements of migrating birds will occur.



View Figure 1

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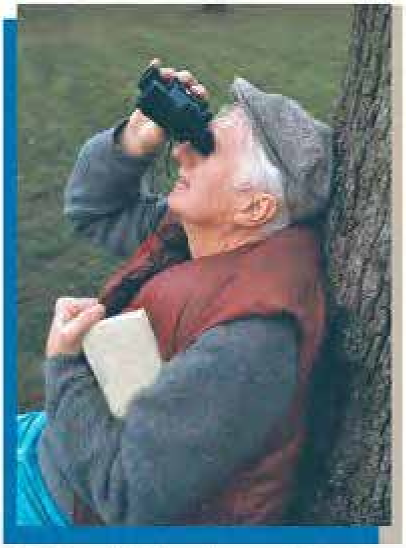
5. Groundtruthing Observations

The ornithological community uses the term “groundtruthing” to refer to a particular process of corroborating and supplementing instrument-based observations of birds (such as NEXRAD signals). This procedure is straightforward: one recruits birders in the area in question to count and identify birds there. A collective groundtruthing program serves a variety of purposes:

- It complements the radar data provided by NEXRAD.
- As a form of “citizen science” it encourages birders to become increasingly engaged in environmental science and conservation.
- It makes birding more fun by organizing an audience for the observations of individual birders.



Dedicated birdwatchers are often eager to contribute their observations to groundtruthing programs.

This chapter is oriented toward helping the administrators of bird monitoring organizations develop and manage groundtruthing programs. It describes BirdCast’s sophisticatedInternet-based groundtruthing database (BirdSource). However, a groundtruthing program need not use precisely this kind of tool to manage its information. Regardless of a particular program’s data distribution/collection needs, the experiences of the BirdCast program may provide valuable insights.

5.1 How Does Groundtruthing Complement Radar Analysis?

The eyes and ears of a careful observer offer the most direct indication of the number and type of birds in a particular area. Therefore, such observations can serve as a means of calibrating, validating, and supplementing NEXRAD images of bird migration. As described in Chapter 4, NEXRAD does not provide a direct sampling of the number of birds traveling through a particular area and provides very little information about what kind of birds are being detected. All it can do is record the radio reflectivity at a particular distance and angle from the station. During spring migration in particular, there appears to be a high correlation between nights when radar shows bird-like signals and mornings when birders see a lot of new birds on the ground in nearby areas. Radar ornithologists are still in the process of developing relationships between radar activity at a particular place and time and groundtruthing results at other places and times. Therefore, there is heightened value in a coordinated program of groundtruthing and radar imaging—the connection between the two data sets is as valuable as the sets themselves. In the future, for example, it may be possible to track the migration of individual species of birds using a combination of radar and extensive groundtruthing.

5.2 How Does BirdCast Conduct its Groundtruthing Program?

Over an average week of operation, the BirdCast Web site receives more than 300 reports of bird activity from its volunteers. The project then presents this information (in the form of charts and graphs) to the Web site's visitors, who number over 80,000 in a 2-month migratory season. As these figures indicate, BirdCast's groundtruthing program requires significant information technology infrastructure and program administration. Whether your organization is planning a groundtruthing program of similar scope or one that will be smaller scale, a knowledge of the methods and experiences of BirdCast in this endeavor is likely to be helpful.

5.2.1 BirdCast's Information Management Infrastructure

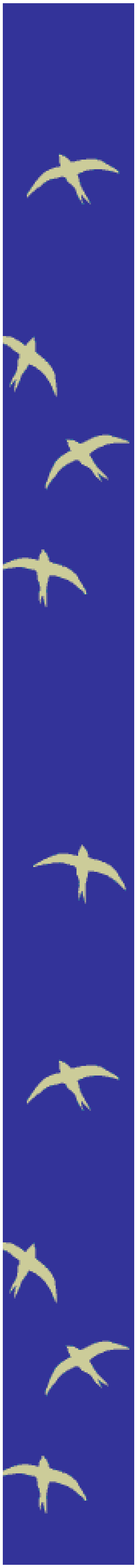
As described in Chapter 3, BirdCast's operation relies on a substantial prior investment of time, money, and labor in the establishment of BirdSource's information technology infrastructure. This infrastructure consists of:

- **Software:** an Oracle database customized to handle groundtruthing data, JAVA applications to process the information requests of users of the BirdSource Web site, and a GIS tool that allows users to specify the latitude and longitude of their observation site by zooming in from a map of the mid-Atlantic United States.

- **Hardware:** A four-processor server computer to maintain the BirdSource web site, an uninterruptable power supply and tape backup system, and Internet connection service for the computer.

- **Support Staff:** one full-time network administrator and five JAVA programmers.

This infrastructure, which cost $2.5 million to establish, is larger and more robust than what is necessary to simply record and present groundtruthing information. One proposed bird monitoring program, based in the Chicago area, expects to meet its information technology needs for 2 years at a cost of $100,000 per year. A potentially economical option for supporting groundtruthing programs may be to collaborate with BirdSource staff at Cornell's Laboratory of Ornithology. BirdSource staff expect that they could provide complete information technology support for an initial outlay



of $35,000-50,000 and a maintenance fee of $5,000-10,000 per year. Depending on the goals and needs of your organization's groundtruthing program, it may not even be necessary to spend this much. One group planning to set up a groundtruthing program in the Chicago area has estimated that they could store their data using spreadsheet software and would not even need to dedicate an entire Windows workstation to the task.

5.3 BirdCast's Administrative Procedures

BirdCast records the birding observations of both registered and unregistered visitors to its Web site. The former are called "control" observations and the latter are called "anonymous" observations.

5.3.1 Collecting Control Observations

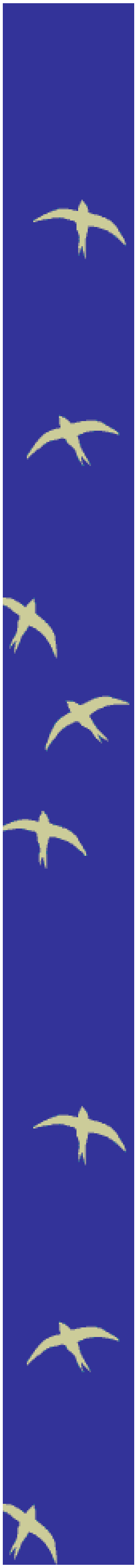
Control observations are repeated visual inventories of birds obtained by regularly visiting a particular site during a bird migration season. They are made by committed, experienced birders known by or referred to the site's administrator. It is one of the primary tasks of the administrator to identify these individuals, provide them with support and guidance, and monitor and edit their contributions to the database.

The site administrator actively recruits individuals to serve as control observers through several avenues:

- Personal networking within the local birding community.
- Appeals to local conservation groups, such as chapters of the Audubon Society and the Nature Conservancy.
- Postings to e-mail distribution lists dedicated to birding.

A control observer needs be reasonably experienced at quantifying and identifying birds in his or her area. He or she must also have enough free time, energy, and commitment to make frequent visits to an observation site. Ideally, a volunteer should be able to make these visits during the early morning hours (between sunrise and roughly 9 AM) when migratory birds are most active. It is also very helpful for a volunteer to be able to recognize birds by their songs as this is the most rapid way of identifying the presence of a particular species of bird. (The Cornell ornithological laboratory makes recordings of bird songs that volunteers can use for training purposes.)

At present, BirdCast has not established a formal procedure for screening observers or checking their qualifications, as most control observers are friends or colleagues of the project organizers. Some control observers, however, are individuals unknown to BirdCast staff who have spontaneously approached the project about participating. It is assumed that an inexperienced birdwatcher would tend to be discouraged by the time commitment required in making regular observations over a prolonged period, so there is a process of "self-screening" inherent in signing up volunteers.



Lessons Learned: How frequently should control observers go into the field?

In the experience of BirdCast organizers, control observers should ideally make five visits to a single observation site during each week of a data collection period. A typical observation session takes between 1 and 2 hours, depending on the observer's time constraints and the abundance of birds at the observation site. This schedule of frequent observations increases the likelihood of “catching” the migration of different species of birds through an area. The goal is to have the observation record reflect the variability of the birds' presence or absence at a particular location rather than the variability of the observer's presence or absence.

In the mid-Atlantic region of the United States, spring migration period takes place over a relatively short period of time: roughly from April 15 to May 15. Fall migration, however, is more difficult to observe completely because it takes place over a more extended period of time. In the fall of 2000, BirdCast experienced significant difficulties with volunteer burn-out when it asked control observers to work from September 1 to November 1. In the future, BirdCast is planning to implement a staggered observation schedule that will keep observers' commitment limited to approximately 1 month. Volunteers living at higher latitudes will begin and end their observing earlier than will volunteers living at lower latitudes.

Once the site administrator has identified a new control observer, she briefs him or her about the standard observation protocols used by the project and issues that person a new User ID for logging into the site. Also, new control observers need to be shown how to use BirdSource’s interactive map to estimate the latitude and longitude of their observation site.

The interactive map is a software component of the BirdSource Web site in which users “zoom in” to their observation site by clicking on a map of the United States. Once a user has selected a particular location, the software calculates that location’s latitude and longitude.

Once they have registered and determined the location of their observation site, control observers use their User ID to access data entry pages on the BirdCastWeb site where they can enter:

- The date and time of their observations.
- Whether or not they recorded every species that they saw.
- The birders’ estimation of their own skill at identification.
- The physical environment and weather at the place of observation.
- The numbers and kinds of different birds counted.
- Any additional information not provided elsewhere in the form.

The administrator has ongoing responsibilities for answering any questions the control observer may have and for editing the data provided by the observer. The purpose of this editing process is to ensure that the data provided by the control observers is of a high quality. Editing requires some local birding expertise—one must review the submitted observations and make judgment calls about whether they are reasonable, questionable, or obviously erroneous. The administrator flags control observations that appear problematic and follows up with the observer to resolve her concerns. The following signs, when they appear repeatedly or in combination with each other, may cast doubt on an observer's results:

- Species that are extremely rare for the area, particularly in large numbers.
- Species that are extremely rare for a particular time of year (particularly record-setting early sightings of a species).
- The omission of migratory species that are quite common for the particular area and time.

None of these signs is a certain indication that a set of observations is invalid, but they may prompt the BirdCast administrator to request additional information from the observer, such as sketches, notes, photographs, and the names of co-observers. Following is a sample letter from BirdCast that requests additional information in a non-confrontational manner:

May 10, 2001

Dear Mr./Ms ___________________

I'm interested in learning more about the birds you've reported to our project and the site from which you're reporting. As you probably know, you've had some extraordinary sightings during the two days for which you've reported. Standard procedure for our BirdSource projects is that we request verification for unusual reports before the data is entered in the database.

Several of these would be all time early records for your immediate area and the numbers you report for some species are unusually large. On the other hand, your report for a species like Yellow-rumped Warbler is very low.

We are making a great effort to report only species and numbers that were well seen and absolutely identified. Only sightings of this type will give our project credibility and, in the long run, benefit bird conservation efforts. With this in mind, would you review your reports that I have listed below and answer the following questions?

> Was the bird well-seen? for how long?
> Is this a positive identification? Which of the field marks were observed?
> Was the bird photographed? Was it seen by additional observers?
> Were notes taken? Sketches made?

American Black Duck - Wild bird? late
Yellow-bellied Flycatcher - early
Golden-crowned Kinglet - late
Philadelphia Vireo - 1 unusual, 2 extremely rare
Bay-breasted Warbler - early, 2
Cerulean Warbler - early, 2
Mourning Warbler - early
Yellow-breasted Chat - early, 2
Rusty Blackbird - late, unusual, 10 birds

I would also like to have more information about the site where you observed these species. Is this land named? Is it public or private?

Thanks very much for providing us with this information and thanks for your patience.

Sally Conyne
Audubon

BirdCast also has a number of proactive strategies for limiting the amount of potentially unreliable observations that it receives. These strategies include:

- Putting caps on the number of individual birds of a particular species that can be reported.
- Phrasing data entry questions clearly to avoid misunderstanding.
- Offering assistance in the identification of birds to volunteers.
- Creating area-specific checklists of birds for volunteers to use in data entry. This prevents the reporting of obviously erroneous reports (e.g., roadrunners in upstate New York)

Lessons Learned: Data Entry Burdens

One of the lessons that BirdCast organizers learned when they established their volunteer groundtruthing program was that they needed to minimize the data entry requirements for their volunteers. Some of the first volunteer observers complained that the observation protocols took too long to key into the computer. BirdCast has reduced the length of its protocol since then to make volunteers’ jobs easier.

5.3.2 Collecting Anonymous Observations

Visitors to the BirdCast Web site do not need to register or commit to making a schedule of repeated observations in order to submit data to the BirdSource database. Any birder visiting the site may submit information as an “anonymous” observer. Strictly speaking, these observers are not always anonymous because they are encouraged to submit their e-mail address along with their observations. The term is meant in distinction to the control observers, who are either known by or referred to the BirdCast staff.

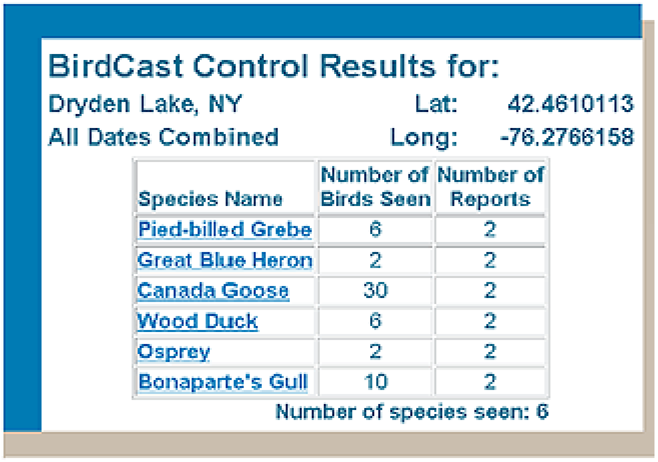
The data entry form used by anonymous observers and the data they submit are very similar to those of control observers. There are number of differences, however, between how control and anonymous observations are handled. Unlike control observations, anonymous observations do not include information about the latitude and longitude of the observation site. Instead, observers simply list the postal code of their area. Also, BirdCast does not (at present) conduct any quality control editing of anonymous observations. BirdCast staff currently do not have enough time to manually edit the anonymous observations, which are of somewhat less value than the control observations because they are not made regularly. BirdCast hopes, however, that in the future they will be able to institute computer-based “filters” that will provide automated quality control of anonymous data.

5.3.3 Displaying Groundtruthing Information

Visitors to the BirdCast Web site have two options for displaying observation data. They may either:

- **Select a single observation location.** The user then views a table (such as Figure 2 and Figure 3) of different kinds of birds counted at that single observation location (either an anonymous observation postal code or a specific control site). The table also lists the numbers of each kind of bird, and the numbers of reports of each kind of bird. The user may select whether this table lists results for the entire migration period or for a specific date.

- **Select a single species of bird.** The user then views a graph (such as Figure 4 and Figure 5) of how many times that bird was sighted during each day of the migration period. The graph includes combined information from all the control sites but excludes anonymous observations. This is because anonymous observations are not edited for accuracy and are not likely to be made regularly at any single location.



BirdCast Control Results for:

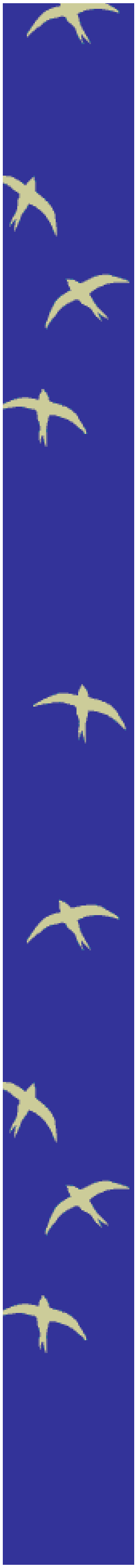
Dryden Lake, NY Lat: 42.4610113

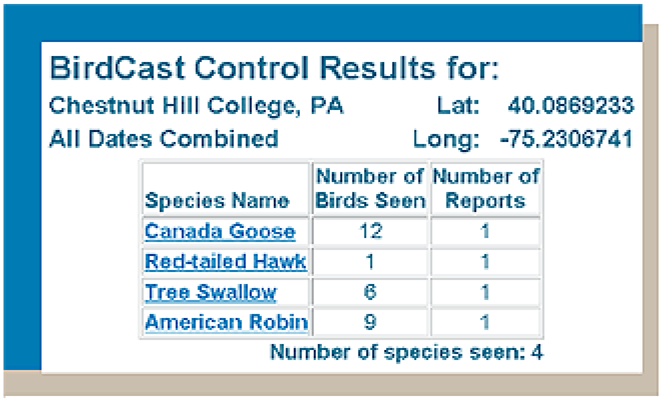
All Dates Combined Long: -76.2766158

Species Name	Number of Birds Seen	Number of Reports
Pied-billed Grebe	6	2
Great Blue Heron	2	2
Canada Goose	30	2
Wood Duck	6	2
Osprey	2	2
Bonaparte's Gull	10	2

Number of species seen: 6

Fig 2. Single observation location: Dryden Lake, NY.





BirdCast Control Results for:

Chestnut Hill College, PA Lat: 40.0869233

All Dates Combined Long: -75.2306741

Species Name	Number of Birds Seen	Number of Reports
Canada Goose	12	1
Red-tailed Hawk	1	1
Tree Swallow	6	1
American Robin	9	1

Number of species seen: 4

Fig 3. Single observation location: Chestnut Hill College, PA.

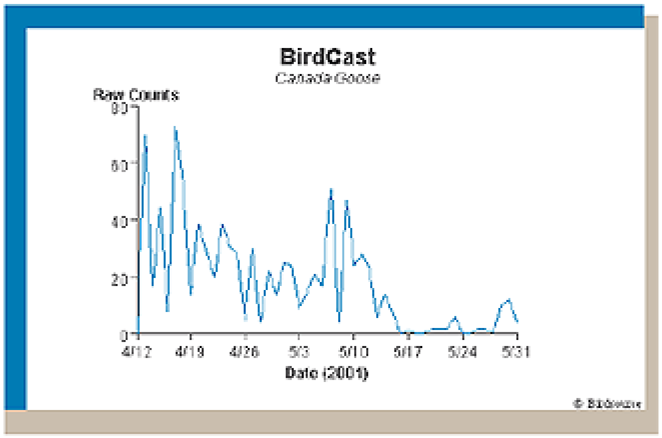


Fig 4. Single species count: Canada Goose

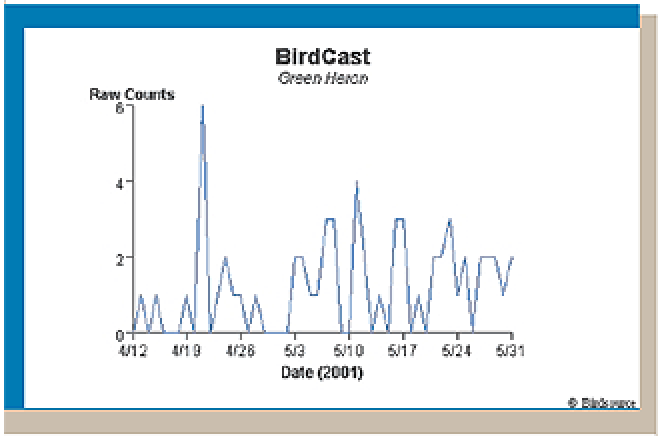


Fig 5: Single species count: Green Heron

Meet Two BirdCast Volunteers

Chuck Hetzel, one of BirdCast’s control observers, doesn’t have to go any farther than his back yard to collect data for the project. That’s because he’s fortunate enough to live at the edge of the Schuylkill Valley Nature Center near Philadelphia. Mr. Hetzel first heard about BirdCast through his local bird club—the Cornell Laboratory of Ornithology was

Chuck Hetzel

looking for volunteers in his area to host bioacoustic monitoring stations in their homes. Through this introduction to Cornell’s research program, he became involved in making regular control observations for BirdCast. It usually takes him between 1 and 2 hours to record the birds in his backyard, which he does nearly every day of the migration period around 7 AM. With more than 50 years of birding experience, he doesn’t need to take an identification guide into the field with him; all he needs is a notepad or a tape recorder for keeping track of the types and numbers of birds that he sees (or hears). Mr. Hetzel enjoys the extra motivation to go birdwatching that BirdCast provides—in sharing his observations through the BirdCast database he enjoys an extra feeling of accomplishment and satisfaction about birdwatching.

Hannah Suthers

Hannah Suthers makes her control observations at an abandoned 108-acre farm in central New Jersey. The farm, which has recently been converted into a wildlife sanctuary, is slowly reverting back to forest. This makes it a fascinating birding site because the land's habitat is undergoing continual transformation. Ms. Suthers has more than 50 years of experience as a bird bander and for more than 20 years has been studying how the farm's changing habitat has affected the population of resident birds in the area. Now in her retirement, she continues to publish articles related to avian population biology and trains graduate students from nearby Princeton and Rutgers Universities in bird banding. After a friend referred her to the BirdCast project, Ms. Suthers started working as a volunteer for it, tallying migratory birds at the sanctuary. During the BirdCast observation period, she aims to be in the field on a daily basis, tallying birds by sight and sound. She carries a small notebook with her and jots down her tally in alpha codes. A counting session can take anywhere between 1.5 to 4 hours, depending on the time of season and how many different species are present. It can be tiring getting up so early in the morning on a regular basis, she admits. Though she does not need to go out as frequently to spot-map the singing males on their breeding territory, she

feels that to get an accurate picture of migratory movements one needs to go into the field daily. One of the most pleasant aspects of the work is the opportunity to greet all her "old friends" as they fly through her area each migration season.

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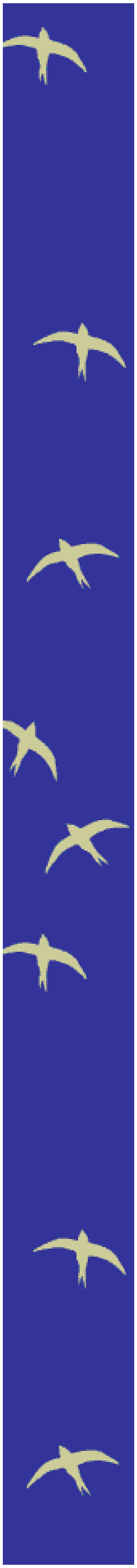

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6. Education and Outreach

This chapter provides guidance on setting up and maintaining an education and outreach component of a bird migration monitoring program. Section 6.1 provides tips on developing an outreach plan for your program, with a focus on defining goals, key messages, and target audiences. Section 6.2 describes a variety of outreach tools that can be used, and provides examples of outreach materials developed by the BirdCast project. Section 6.3 describes the challenge of evaluating the success of your education and outreach program, and Section 6.4 lists some additional sources of information for education and outreach.

The information in this chapter is designed primarily for managers who are implementing bird migration monitoring programs, as well as for education and outreach workers who are responsible for communicating about these programs.

6.1 Developing an Outreach Plan

BirdCast represents a milestone for radar ornithology, a field that has evolved slowly for more than 30 years, advanced by a handful of scientists working mostly in isolation. BirdCast's breakthrough is that it is the first program to bridge the gap between these scientists, collecting and interpreting radar images in their labs using highly specialized technologies and techniques, and the general public. The founders of BirdCast also recognized that "a picture is worth a thousand words"— a live visual image, such as a radar image of birds migrating, or digital photos or videos from groundtruthers, would more likely stimulate action than just a verbal description of migration.

Communication is at the heart of the BirdCast mission: to provide the public with timely information on the status of bird migrations, and to educate land managers and the broader public about actions they can take to assist birds during their migration and reduce the number of birds that die while passing through. An effective education and outreach program, therefore, is key to the project's success.

BirdCast's education and outreach program is run primarily by the National Audubon Society. Staff from Audubon's Citizen Science Program work together with Audubon's public relations department to create educational materials, write and distribute press releases, develop and deliver presentations, and conduct direct outreach to land managers. Other BirdCast partners (including staff from EPA’s Office of Pesticide Programs, EPA Region 3, Cornell University’s Laboratory of Ornithology, and Clemson University’s Radar Ornithology Laboratory) contribute to the outreach effort as well, mostly by delivering presentations. In addition, Philadelphia’s Academy of Natural Sciences, a founding partner of BirdCast, developed many of the project’s original outreach materials.

The first step to creating an effective education and outreach program of your own is to develop an outreach plan. This plan will provide a blueprint for action. It does not have to be lengthy or complicated, but it should define four things: What are your outreach goals? Who are the target audiences? What are the key messages and types of information that you want to deliver? And what outreach tools will you use to reach these audiences? Let’s look at each of these questions in turn.

6.1.1 What Are Your Outreach Goals?

Defining your outreach goals is the first step in developing an education and outreach plan. Outreach goals should be clear, simple, action-oriented statements about what you hope to accomplish through outreach. Here are some sample goal statements that a BirdCast-type program might develop for its outreach effort:

- Convince all local television stations in the region to give a brief report on bird migration after the weather forecast, or to run at least one report on bird migration per migratory season.
- Place a story on bird migration in the major newspaper of each state in the region.
- Deliver a presentation to each bird club or Audubon chapter in the region.
- Conduct direct outreach (e.g., via letter or phone call) to the managers of all public parks in your region.
- Attract 100,000 visitors per year to your Web site.

Where possible, outreach goals should be measureable. This will help you when it comes time to evaluate the success of your program (see Section 6.3). Abstract statements of good intention (e.g., “increase the public’s appreciation of the wonders of bird migration”) do not make effective outreach goals, even if such statements accurately describe one of your main motivations for starting a BirdCast-type program.

6.1.2 Who Are Your Target Audiences?

The second step in developing an outreach plan is to clearly identify the target audience or audiences for your outreach effort. As illustrated in the sample goals above, outreach goals often define their target audiences. You might want to refine and add to your goals after you have specifically considered which audiences you want to reach.

The target audience for the BirdCast project is broadly defined as land managers and the general public. Yet within these groups there are a number of sub-audiences, each with specialized interests. For example, among the general public there are (according to a 1998 report of the U.S. Fish and Wildlife Service) roughly 55 million people who consider themselves bird enthusiasts, and within that number there is a smaller pool of deeply committed birders. Your goals for conducting outreach to these committed birders may be different than your goals for the general public. Likewise, the category of “land managers” includes park managers, city officials, utility land managers, building managers, golf course managers, and others. Here again, you will want to tailor your message for the specific audience.

Before you can begin tailoring messages for your different audiences, however, you will need to develop a profile of their situations, interests, and concerns. This profile will help you identify the most effective ways of reaching the audience. For each target audience, consider:

- What is their current level of knowledge about bird migration and birds in general?
- What do you want them to know about birds and migration? What actions would you like them to take?
- What information is likely to be of greatest interest to the audience? What information will they likely want to know once they develop some awareness of bird migration issues?
- How much time are they likely to give to receiving and assimilating the information?
- How does this group generally receive information?
- What professional, recreational, and domestic activities does this group typically engage in that might provide avenues for distributing outreach products? Are there any organizations or centers that represent or serve the audience and might be avenues for disseminating your outreach products?

Profiling an audience essentially involves putting yourself “in your audience’s shoes.” Ways to do this include consulting with individuals or organizations who represent or are members of the audience, consulting with colleagues who have successfully developed other outreach products for the audience, and using your imagination.

6.1.3 What Are the Key Messages and Types of Information That You Want to Deliver?

The next step in planning is to think about what you want to communicate. In particular at this stage, think about the key points, or “messages,” you want to communicate. Messages are the “bottom line” information you want your audience to walk away with, even if they forget the details. A message is usually phrased as a brief (often one-sentence) statement. For example:

]

- Populations of migratory birds are declining and vulnerable.
- The BirdCast Web site provides you with real-time information about the status of bird migrations.
- You can take steps to help protect migrating birds.

Outreach products often will have multiple related messages. Consider what messages you want to deliver to each target audience group, and in what level of detail. As stated above, you will want to tailor different messages for different audiences.

Let's look at how this can be done. For instance, let's say that you are writing a press release for distribution to newspapers and other general interest publications. Your audience, the average reader of these publications, has relatively little interest in birds. What should be the focus of your press release? Probably you will want to concentrate on a few simple messages: that bird migration is a fascinating and magnificent phenomena; that populations of migratory birds are declining and vulnerable; and that individuals can help protect migratory birds through simple steps such as keeping cats indoors, providing food and water, and avoiding pesticide use during the peak of migration (you would probably time your release for distribution just prior to peak migration).

On the other hand, if you were composing a press release for placement in bird club newsletters, you would probably spend less time preaching the wonders of migration (after all, here you would be preaching to the converted) and more time addressing complex issues of special interest to birders: how the technical aspects of radar ornithology work, how birders can attract birds to residential yards by creating a landscape of native plants, how to choose pesticides that cause less ecological harm. Your press release could also provide detailed information on how birders can participate as citizen scientists in BirdCast's groundtruthing efforts. (See Appendix A, for an example of a press release for bird club newsletter.) Alternatively, you could choose to deliver all of this information through a presentation at a bird club meeting.

Here's another scenario: Let's say you are targeting the managers of a number of large buildings in a downtown area. In this case, your message might be very focused and simple: that tall, brightly lit buildings threaten migratory birds by disrupting their ability to navigate, and that building managers can prevent bird deaths by turning off lights during peak migrations. But the real challenge here would be reaching these building managers with your message. Could you issue a press release or media advisory? Possibly, but even if the local newspapers picked up the story, there's no guarantee that the target audience would read it. No, in this case,

Tall, brightly lit buildings threaten migratory birds by disrupting their ability to navigate.

the only way to ensure that your message reaches the target is to contact the building managers directly through a letter or phone call. In fact, you might have to follow up with repeated letters or phone calls. This type of direct outreach is time-consuming and can be a drain on resources, but in some circumstances it is absolutely necessary.

6.1.4 What Outreach Tools Will You Use?

As the above examples illustrate, one of the challenges of conducting outreach and education, besides tailoring your message for the intended audience, is choosing the best outreach tool or approach for delivering your message. There are many different types of outreach products in print, audiovisual, electronic, and event formats (outreach tools used by the BirdCast project are described in the next section). It's up to you to select the most appropriate products to meet your goals within your resource and time constraints. Questions to consider when selecting products include

- How much information does your audience really need to have? How much does your audience need to know now? The simplest, most effective, most straightforward product generally is most effective.
- Is the product likely to appeal to the target audience? How much time will it take to interact with the product? Is the audience likely to make that time?
- How easy and cost-effective will the product be to distribute or, in the case of an event, organize?
- How many people is this product likely to reach? For an event, how many people are likely to attend?
- What time frame is needed to develop and distribute the product?
- How much will it cost to develop the product? Do you have access to the talent and resources needed for development?
- What other related products are already available? Can you build on existing products?
- When will the material be out of date? (You probably will want to spend fewer resources on products with shorter lifetimes.)
- Would it be effective to have distinct phases of products over time? For example, a first phase of products could be designed to raise awareness, followed at a later date by a second phase of products to encourage changes in behavior.
- How newsworthy is the information? Information with inherent news value may be rapidly and widely disseminated by the media.

The key here is to make good use of the resources available to you. In the best of all worlds, you would have the time and budget to personally contact every land manager in your region and to craft customized press releases for every type of publication and every audience. But it is unlikely that you will have the resources to do everything you'd like to do. The goal, then, is to pick your spots wisely. Reach as many people as you can, but also focus on those audiences that are most receptive to your message. If you have only limited time for direct outreach, concentrate on land managers who control critical habitat.

6.2 Education and Outreach Tools

This section describes a variety of outreach tools used by the BirdCast project. Examples of specific outreach materials developed by BirdCast can be found in Appendix A.

6.2.1 BirdCast Web site

In addition to hosting radar images, daily migration forecasts, and groundtruthing data, the BirdCastWeb site (http://www.BirdCast.org) also contains an array of outreach and educational information designed to assist the public in the protection of migrating birds. Major educational pieces on the site include:

- Guidance on appropriate timing and application of pesticides to minimize birds' exposure.
- Tips on preventing bird deaths caused by collisions with household windows.
- Advice on controlling domestic cats to prevent predation on migratory birds.
- Information on how tall buildings and radio towers can disorient birds, causing them to crash or drop from exhaustion.
- Tips on bird feeding and watering, and on providing habitat for migratory birds during stopovers.

Many of these educational pieces are provided in hard copy in Appendix A of this handbook. Others can be found online (go to http://www.birdcast.org/ucanhelp.html). If you are developing a BirdCast-type program of your own, you can use these pieces as a model to stimulate ideas for your own outreach language. If you are a member of the public interested in birds and migration, you can read these materials to learn about steps that you can take to protects migrants.

One of BirdCast's mottos is: "Engage, educate, activate." The BirdCast Web site is a key tool for accomplishing each of these goals. The site is designed to be both attractive and interactive. The homepage, for example, features a colorful poster by Charley Harper, entitled "Mystery of the Missing Migrants," along with a species key to help visitors identify the birds depicted in the poster. Any birder visiting the site is welcome to submit data on his or her bird observations (see Section 5.3.2, Collecting Anonymous Observations), and visitors can also search the database of groundtruthing observations to view tables and summary graphs. In addition, throughout the site there are numerous links that visitors can follow to gather additional information and access other resources.

The goal of all this interactivity is to engage visitors, interest them in the plight of migratory birds, and give them a chance to participate in protecting and researching the lives of migrants. The outreach materials are there to educate them. The site also features several text pieces on the aesthetic and economic values of migrating birds, along with the beautifully written preface to Scott Weidensaul's book, Living on theWind: Across the Hemisphere with Migratory Birds, which BirdCast was able to use with the permission of the author.

6.2.2 Posters and Other Print Material

Because BirdCast is a Web-based project, it has developed relatively few educational and outreach materials for distribution in hard copy. When the project was first launched, press packet was created for distribution to reporters and other media outlets, containing news clippings and other outreach materials. But this is no longer in use.

The main item that BirdCast partners distribute in hard-copy format is a poster entitled "Audubon Guide for Healthy Yard and Beyond," which was developed by the National Audubon Society. The poster lists actions that home owners can take to limit pesticide use and create healthy habitats for birds and wildlife. It also includes a guide to home pesticides, with information on chemicals, their uses, their toxicity to wildlife, and alternatives to the chemicals. Altogether, over 1 million copies of the poster have been distributed through Audubon chapter offices, bird-oriented stores, parks departments, and other groups.

To request copies of the poster, e-mail healthyhabitats@audubon.org. A version of the poster can also be found online at: http://www.audubon.org/bird/pesticides/10%20COMs%20boxes.html.

Lessons Learned: Conducting Outreach Via Television Stations

When BirdCast was first launched, one of the original goals was to encourage television coverage of bird migrations. BirdCast's founders envisioned that there would come a day when weather forecasters would routinely include migration updates as part of their nightly reports. But that day has unfortunately not yet arrived.

As part of its education and outreach program, BirdCast has made a concerted effort to conduct outreach to newscasters and weather forecasters. The idea has been to combine radar images with photographs and educational information on protecting migrants, creating a package that will appeal to television stations. But so far the results have been discouraging. Though several stations have produced short news pieces on BirdCast, the general response has been that the BirdCast outreach materials are inappropriate for television in that they lack visual appeal. Newscasters have stated that the radar images are too esoteric and difficult to interpret.

In the future, the BirdCast project will continue to look for creative ways to package its outreach materials for television. The Illinois Natural History

Survey, another organization that has succeeded at getting a local television station to make use of NEXRAD images of bird migration, has some ideas for getting television stations interested. The Survey suggested pointing out to television weather forecasters that significant bird migration usually coincides with “meteorologically boring periods” when they might lack weather-related material to discuss. The Survey also suggested developing simplified visual displays that convey basic information (e.g., presence/absence of birds, relative abundance of birds, general direction of bird movement) in a manner that parallels the other displays on the weather forecast.

6.2.3 Press Releases

Press releases are a key tool in BirdCast’s education and outreach efforts. Writing a single press release and distributing it to dozens of publications simultaneously is a cost-effective way of reaching a large and varied audience.

The National Audubon Society’s public relations department leads BirdCast’s efforts to conduct outreach through the media. A PR department is an ideal choice for this job for two reasons: 1) PR staff have the writing, editing, and outreach skills needed for developing stories that will appeal to various news outlets, and 2) PR staff already have contacts and working relationships with individual journalists, editors, and newscasters. An experienced PR worker knows how to work with people in the media, feeding them the information they need to get stories into print and on the air.

For BirdCast, the Audubon PR staff have done several rounds of outreach to the media, each timed to coincide with a major migration (spring or fall). Their technique, which has produced excellent results so far, has been to write a single, in-depth press release and distribute it to a list of roughly 500 reporters whom Audubon has worked with in the past. (Examples of these press releases can be found in Appendix A) In some cases, Audubon staff precede the press release with a phone call or e-mail to the reporter, meant to kindle interest in the story. In other cases, Audubon sends the press release first, then follows up with an e-mail or phone call.

Once a reporter has expressed interest in BirdCast, the PR staff work with him or her as necessary to get the story into print. Some reporters (maybe half) request additional interviews with BirdCast partners or want help identifying a local angle for the story (for example, a reporter from a small city newspaper may want to interview members of a local bird club). Other reporters will develop a story using little more than the information and quotes found in the press release and other materials found online.

This type of personal contact with members of the press is crucial, as is the strategy of targeting individual reporters or newscasters. The odds of placing a story fall drastically if you just send a press release to a news desk or editorial department, since most publications are inundated with dozens (if not hundreds) of press releases daily. Audubon’s PR staff always send press releases directly to a particular reporter, and virtually every story they’ve placed has been written by a reporter whom Audubon had worked with in the past.

What if you don't have a contact at a particular publication? One thing you can do is to read some back issues of the publication, looking for a reporter who has demonstrated some interest in topics related to your project. If the publication is a daily newspaper, it will likely have a beat reporter who focuses primarily on science and/or the environment. Outdoors writers often have an interest in bird migration, especially if their columns cover hunting and waterfowl migration. BirdCast has placed several stories with gardening columnists, and numerous technology reporters have also written about the project, focusing on the BirdCast Web site or on the project's use of advanced radar technology.

Once you have targeted a particular reporter, write him or her a personal e-mail or call directly. Pitch the story, keeping your presentation short and to the point. Ask the reporter if he or she would be interested in reading your press release (or, better yet, simply attach the release to an e-mail as an electronic file). Also, it never hurts to demonstrate that you are familiar with a reporter's work by complimenting or mentioning some article that he or she wrote in the past.

How many publications or news outlets should you target? The simple answer is, as many as possible. However, there are different ways to use the resources available to you. One approach would be to identify a limited number of publications that you view as critical, and then to spend extra time and resources doing everything you can to place a story with them (this might involve customizing your press release or following up repeatedly with a reporter). If you don't have existing contacts with the news outlets in your area, this type of intensive, focused effort might be necessary.

Audubon's PR staff have taken the approach of writing one major press release for each migratory season (spring and fall) and distributing it to hundreds of media outlets throughout the mid-Atlantic flyway, from New York to Maryland and theWashington, D.C. area. Audubon's staff spend virtually no time customizing press releases for particular publications, though they have issued press releases for particular occasions. For example, in September 2000, Audubon issued a spur-of-the-moment press release urging health officials not to spray for West Nile Virus on a weekend when BirdCast was predicting that a large wave of migratory birds would pass through the area. (See Appendix A for a copy of this release.)

Audubon's primary goal each migratory season has been to place a story in the major paper of each state in the region, with the idea that smaller papers will pick up the story after seeing it in a major paper (this has turned out to be true). The results of this PR effort have been excellent. More than 100 articles on BirdCast appeared in spring 2000, including prominent articles in the Philadelphia Inquirer, New York Times, Wall Street Journal, USA Today, and other major publications. Articles also appeared in virtually every Audubon chapter and independent bird club newsletter from northern Virginia to southern New York. Additionally, BirdCast was the subject of stories in Scientific American and National Audubon magazines, and the project was also featured on National Public Radio.

Lessons Learned: Dealing with the Redundancy Issue

Audubon’s PR staff have found that one of the main challenges associated with conducting BirdCast outreach through the media is the issue of redundancy. Birds migrate through the mid-Atlantic flyway twice each year, in spring and fall. Ideally, BirdCast would like to have the media cover both migrations, every year. However, once a publication has covered the story once or twice, reporters and editors no longer consider it newsworthy.

Audubon's PR staff constantly search for creative ways to work around this problem. One strategy is to look for a “news peg” or tie-in, some newsworthy happening that can provide the basis for an article. For example, you might craft a press release about International Migratory Bird Day (an annual event set on the second Saturday in May), and slip in some information about your program within the body of the text. Audubon staff used a similar approach when they sent copies of the poster “Audubon Guide for Healthy Yard and Beyond,” to all of the reporters in their database; the idea was to generate articles about the effects of pesticides on migrating birds and other wildlife, with BirdCast as a subtext.

The key point here is that your program doesn't have to be the main focus of every press release you send out. Look again at the press release on Appendix A. The main message of this release was an urgent recommendation that health officials not spray for West Nile Virus on a weekend of intensive bird migration. Yet the press release also managed to provide a thorough description of the BirdCast project, and it also touched on a number of other important messages: the decline in numbers of migrating birds; their vulnerability to pesticides and other man-made threats; and steps individuals can take to protect migrants.

6.2.4 Direct Outreach to Land Managers, Building managers, and Others

Large areas of open or undeveloped land, such as city parks, provide important habitat for migrating birds.

Property managers (including park managers, city officials, utility land managers, building managers, golf course managers, and others) are a key target for BirdCast’s outreach and education efforts. Many property managers, especially in urban areas, control large chunks of open or undeveloped land that provide important habitat for migrating birds. These managers can help protect migrants by avoiding pesticide applications during migratory stopovers and by considering the birds’ needs when making other management decisions.

BirdCast relies on direct communication when conducting outreach to property managers. This typically involves calling or writing property managers a few times a year to update them on the status of bird migrations and to remind them of the need for environmentally responsible management practices. In general, BirdCast has found direct outreach to be a relatively time-consuming process (especially in comparison to outreach through the media, where a much larger audience can be reached with a single press release). In the future, the project may attempt to make more use of volunteers in its direct outreach efforts. Large areas of open or undeveloped land, such as city parks, provide important habitat for migrating birds.

Following are a few examples of effective direct outreach, taken from the work of BirdCast and other groups:

- In Philadelphia, BirdCast has worked closely with the Fairmount Park Commission to encourage environmentally responsible land management and to raise awareness of the plight of migrating birds. The Commission oversees a system of parks, golf courses, and baseball fields in the city, and works with other land and utilities managers in the Philadelphia area. BirdCast wrote to alert the Commission about the value of the parks' habitat to migrating birds and the timing of migration. BirdCast provided copies of the poster "Audubon Guide for Healthy Yard and Beyond," for the commission to distribute, and provided all facility managers under their jurisdiction with guidance on environmentally responsible pesticide application (e.g., how to alter the use of specific chemicals and minimize the impacts on migrants).

- The City of Chicago and the U.S. Fish and Wildlife Service have signed an innovative "Treaty for Birds," which features an effort by downtown building owners to turn off their lights during migration periods. Members of the mayor's Wildlife and Nature Committee worked with Chicago's Building Owners and Managers Association to spread the word to owners of downtown skyscrapers. Members of the Bird Conservation Network assembled the information needed to convince building owners that this action was warranted, and helped to identify buildings that were known for their high bird mortality.

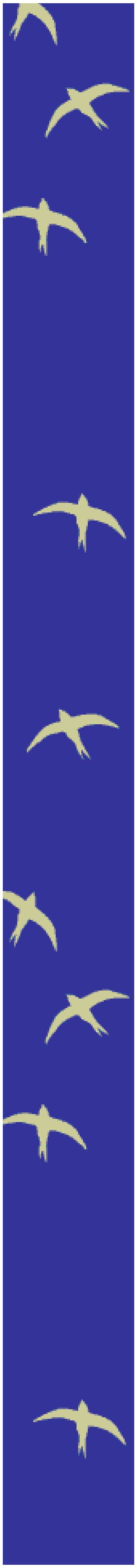
- In the Chicago area, a partnership of researchers, government scientists, city officials, and conservationists is proposing to use radar ornithology to identify key stopover habitat for migrating birds. The partners will then use direct outreach to educate land managers about the habitat needs of migrating birds, and to ask them to take steps to protect and enhance bird habitat (e.g., by controlling the spread of buckthorn, an invasive plant that impacts biodiversity).

6.2.5 Presentations

BirdCast partners regularly deliver presentations on the project to school groups, bird clubs, American Birding Association meetings, Audubon chapters, and other groups. The partners have developed several PowerPoint presentations for this purpose. These include:

- An overview of the project.

- A more detailed presentation on how BirdCast integrates multiple monitoring techniques (radar, groundtruthing, acoustic monitoring) to achieve a unified analysis of bird migration.



- A presentation focusing on the radar ornithology component.

All of these presentations make use of screen captures from the BirdCast Web site, sample radar images, and graphs from the groundtruthing database to give the audience a genuine feel for how BirdCast works.

6.2.6 ListServs

A ListServ is an automated system that automatically redistributes e-mail to names on a mailing list. Users can subscribe to a mailing list by sending an e-mail note to a mailing list they learn about; the ListServ will automatically add the name and distribute future e-mail postings to every subscriber.

There are numerous bird-oriented ListServs around the country. Some of these have a regional focus, and are used by birders to compare field notes and share notable sightings. Others are devoted to bird conservation, activism, and other topics of general interest. For an index of ListServs administered by the National Audubon Society, go to http://list.audubon.org/archives/. The American Birding Association also maintains a state-by-state list of birding ListServs, available at http://www.americanbirding.org/resources/reschat.htm.

BirdCast's education and outreach program utilizes ListServs as a medium for distributing information about the program, such as press releases and announcements. ListServs make an ideal tool for targeting an audience of committed birders. They are also cost effective, since there is no charge for subscribing to (or posting messages on) most ListServs.

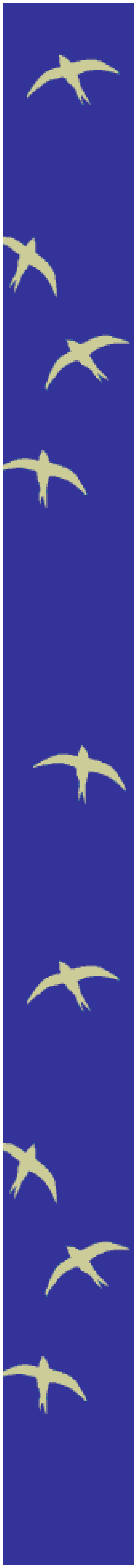
BirdCast has also occasionally used ListServs as a tool for recruiting birders for the project's groundtruthing efforts. By monitoring the discussions at particular regional ListServs, BirdCast staff have been able to identify birders who are both committed and skilled and then contact them directly via e-mail. For more information on recruiting birders for groundtruthing, see Section 5.3.1.

6.3 Evaluating the Effectiveness of Outreach Efforts

BirdCast has found no easy or cost-effective way of measuring the success of its education and outreach program. Since the ultimate goal of the program is to encourage behavior changes (e.g., changes in the way people use pesticides), the only true measure of success would be to document behavior changes on a large scale. Doing this is beyond the scope and means of the project. Due to these limitations, BirdCast's partners have been forced to rely on other indicators as a measure of the program's effectiveness. For example:

- Between September 1 and October 21, 2000, the BirdCast Web site received 1,867,163 "hits" and 147,423 visitors. These numbers show, among other things, that many people are returning to the site multiple times.

- In the spring of 2001, roughly 100 to 150 people per week were submitting "anonymous" bird observations to the BirdCast database.



(See Section 5.3.2 for more information on collecting anonymous observations.)

- More than 100 articles on BirdCast appeared in the spring of 2000, including prominent articles in major publications such as the Philadelphia Inquirer, New York Times,Wall Street Journal, and USA Today. The combined readership of these publications is in the many millions.

If nothing else, these numbers indicate that BirdCast has reached thousands (if not millions) of people, raising their awareness about the plight of migratory birds and things they can do to help. The numbers also seem to show that thousands of people are engaged in the project and are participating on some level (for example, by returning to the BirdCast Web site repeatedly, or by submitting their own bird observations). Overall, it appears that BirdCast is succeeding in its mission: to engage, to educate, and to activate.

6.4 For More Information

The BirdCast Web site: http://www.birdcast.org/ exit epa

To access BirdCast’s educational pieces online, go to: http://www.birdcast.org/ucanhelp.html exit epa

Scott Weidensaul’s Living on the Wind: Across the Hemisphere with Migratory Birds (Northpoint Press, 1999) has been called “a nimble summation of current thinking on bird migration and attendant environmental themes” (Kirkus Reviews).

To request copies of the poster “Audubon Guide for Healthy Yard and Beyond”, developed by the National Audubon Society, e-mail healthyhabitats@audubon.org. exit epa A version of the poster can also be found online at: http://www.audubon.org/bird/pesticides/10%20COMs%20boxes.html

For an index of birding ListServs administered by the National Audubon Society, go to http://list.audubon.org/archives exit epa

The American Birding Association maintains a state-by-state list of birding ListServs, available at http://www.americanbirding.org/resources/reschat.htm exit epa

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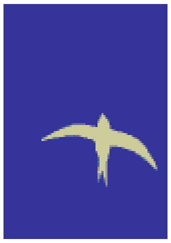

EPA/625/R-01/007
September 2001

Developing and Implementing a Bird Migration Monitoring, Assessment, and Public Outreach Program for Your Community

The BirdCast Project

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4. How to Use This Handbook

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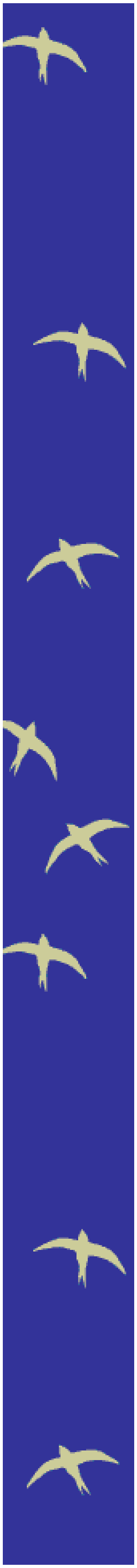

EPA/625/R-01/007
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Developing and Implementing a Bird Migration Monitoring, Assessment, and Public Outreach Program for Your Community

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Appendix A
Birdcast Education and Outreach Materials

- Pesticides: Is Your Backyard Safe for Birds?
- Windows: An Invisible Threat to Migrating Birds
- Domestic Cats: A Cause for Concern
- Man-made Obstacles Pose Problems for Migrating Birds
- Native Plants and Biodiversity
- CITIZEN SCIENTISTS LEND A HAND TO BIRDS THIS FALL
- NATIONAL AUDUBON SOCIETY URGES NY, NJ & CT HEALTH OFFICIALS NOT TO SPRAY PESTICIDES THIS WEEKEND
- BirdCast & NEXRAD

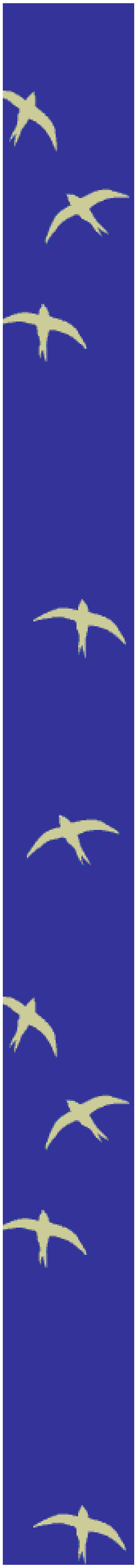
Pesticides: Is Your Backyard Safe for Birds?

Our lawns and gardens are like other environments. Plants, insects and other animals all interact and affect one another. Altering a part of that system can have unintended effects on other components of it. This is an important thing to keep in mind when considering whether or not to apply pesticides around the home. Pesticides are not only lethal to pests, but to other wildlife as well. Here are three important rules to consider before applying any pesticides:

1. **Make sure you actually have a pest problem.** Learn to identify pests and to determine at what stage they actually become a problem. Many times people treat for pests that are either not present, or not present in large enough numbers to cause problems.

2. **Know your pesticides.** Read the labels on your pesticides CAREFULLY. Learn to identify what active ingredients are contained in the product. Read about the potential effects these pesticides can have on the other organisms in your yard and community.

3. **Check for alternative treatments.** Make it a priority to use the least toxic method to control any pests or diseases. Many simple, non-toxic solutions are as easy to employ and as effective as chemical solutions. Contact your local garden center and Cooperative Extension for



advice.

Making your garden or lawn more community friendly isn’t difficult and may actually save you time and money. Plus a little bit of education and a few changes around your home can have a lasting effect on migratory bird populations and other wildlife.

To learn more about the pesticides commonly used around the home, refer to Audubon’s pesticide summary at http://birdsource.cornell.edu/birdcast/pestsum.html.

Other useful pesticide web sites:

EPA’s Office of Pesticide Programs: http://www.epa.gov/pesticides

The National Pesticides Telecommunication Network: http://ace.orst.edu/info/nptn/index.html

Toxicology and Environmental Health Information: http://sis.nlm.nih.gov/tehip.htm

Look up all the registered pesticide products containing certain active ingredients: http://www.cdpr.ca.gov/docs/epa/epachem.htm

The American Bird Conservancy’s Pesticide Pages: http://www.abcbirds.org/pesticideindex.htm

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Windows: An Invisible Threat to Migrating Birds

Fact: Every year millions of birds die when they crash into windows in homes, schools, skyscrapers, factories, office buildings, and other sites.

Why: The transparent quality of windows makes them virtually invisible to birds, often until it is too late to stop short. It is difficult for a bird in flight to distinguish between glass and open space. It may see reflected vegetation in the window, but not the glass itself.

What You Can Do: There are different steps you can take in your home to prevent needless bird deaths caused by invisible windows.

- **Move your bird feeder.** Make sure your bird feeder is either a minimum of 3 meters away from windows, or less than 1 meter away. Birds may still fly into the window if you move the feeder closer, but they will not have enough momentum to injure themselves.
- **Reduce transparency and reflectivity.** Change the angle or surface of the window to lessen the transparency and reflectivity. Cover the window’s external surface with a film, change the lighting, and keep all curtains closed or add external blinds.
- **Mark the window.** You can etch the surface of the glass or streak it

with a bar of soap. Hang strips of newspaper or ribbons, place strips of masking tape on the window. (These are more temporary measures in case there is a severe problem. However, most of these solutions are inconvenient or unsightly.)

- **Apply netting.** Perhaps the best and most permanent solution is to stretch netting across the windows. Fine black netting that is used to protect berry bushes and fruit trees is available at many garden shops, home centers, and feed mills. Stretch the netting across the window or across a frame that can be installed outside the window. Be sure it is stretched with adequate tension to hold it several inches from the window's surface. Birds may continue to fly towards the window, but they will bounce off the mesh unhurt.

- **Hang hawk silhouettes.** Attach hawk silhouettes to the window's surface. These shapes probably decrease collisions because they break up the smooth reflective surface and make the glass more "visible" rather than because they are shaped like hawks; but, in any case, they seem to help. The silhouettes are most effective if used in multiples. It is helpful also to attach the silhouettes by a suction cup or a hanging device from the outside so that movement caused by wind will catch the birds' attention. Most people think that the graceful shapes are interesting rather than unsightly. They're available commercially but they're also easy to make. (See the below instructions.)

Materials:

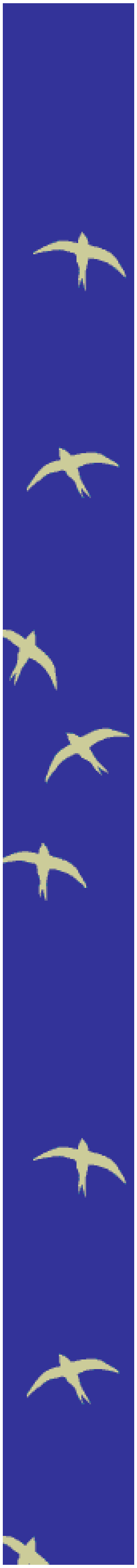
- black, light-weight plastic
- clear, outdoor tape
- scissors
- a template or model of the shape (approximately 8 inches from bill to tail and 12 inches from wing tip to wing tip)—go to http://birdsource.cornell.edu/birdcast/images/hawk.gif exit epa for print-ready template

Simply trace or carefully draw the shape on the plastic, cut out the silhouette, and tape it to the outside of the window. Be sure to place several on any large expanse of glass. One word of caution: you should check with the manufacturers of thermopane windows before you place anything on the glass surface. If this presents a problem, hang the silhouette from the sash around the window.

Not only can you make your house safer for birds, but by making several silhouettes and giving them as gifts to friends, neighbors, and even that office building with the big glass windows down the street, you can also encourage others to make their houses bird-safe.

Other Useful Window Web Sites:
National Audubon Society:
http://www.audubon.org/educate/expert/window.html exit epa

Domestic Cats: A Cause for Concern



Fact: Every year hundreds of thousands of birds are killed in the United States by freeroaming domestic cats.

Why: Cats are natural hunters. Even your cute house pet is innately a predator. But while hunting is an instinctual behavior, cats are not a natural link in local food chains. Cats were introduced to North America by humans towards the end of the 19th century as a method of pest control. Since then feline populations have exploded out of control. Their predatory activities are an unnatural burden on birds. Keeping your cat well fed does not deter it from attacking birds; hunting birds is a natural behavior unrelated to a cat’s hunger. You may not see your cat in action, but if you routinely let it outside it is likely to be killing up to 10 birds every year. With nearly 60 million pet cats in America today, that is a significant number of bird kills. Combined with many other threats birds face, this adds significantly to their struggle to survive. When you allow your cat to roam free outside, you are risking the lives of countless birds. You are also risking the life of your cat; those that are kept indoors live happier, healthier, and longer lives.

What You Can Do: A cat is only responding to a natural instinct. Ultimately you are responsible for your cat and its behavior.

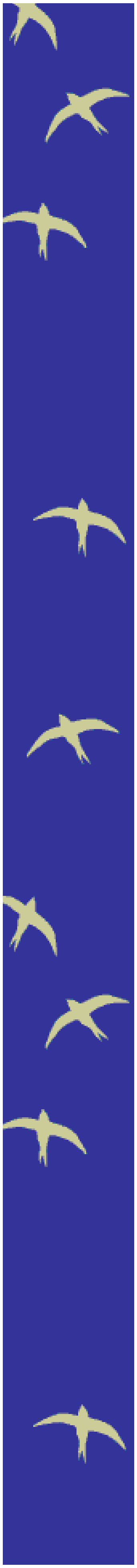
- Keep your cat indoors, especially during the peak migratory seasons in fall and spring.
- Put an alarm collar on your cat. Many collars exist which will hamper the cats’ stalk and attack. These collars will not harm the cat, but will give an unsuspecting bird ample warning to escape before a cat strikes. Bells alone will not stop a cat from attacking.
- Spay your cat. Make sure you spay or neuter your cat to help keep the cat population in check.
- Help stray cats. In addition to house pets, there are millions of stray cats in the United States, all a potential threat to native wildlife. You can take in some of these cats or call a local animal shelter.
- Keep birdfeeders out of reach. Make sure the birdfeeder in your yard is not cat accessible. Keep it high and away from windows and vegetation.
- Join the Indoor Cat Campaign. Encourage others to keep their cats indoors. Check out the American Bird Conservancy "Cats Indoors" at http://www.abcbirds.org/catindoo.htm exit epa

Other Useful Web Sites:
American Bird Conservancy: http://www.abcbirds.org exit epa

May 13, 2000 is National “Keep Your Cat Indoors” Day

Man-made Obstacles Pose Problems for Migrating Birds

Fact: Millions of birds die every year in building collisions.



Why: Tall buildings and their lights pose a serious threat to migrating birds. The feat of migration is already a dangerous one with the natural hazards due to weather, predators, and food scarcity. Birds are exhausted and hungry and yet humans have created tall obstacles to complicate an already difficult journey.

Birds use a variety of different cues to navigate their migration route, including the pattern of the stars, topographic features, earth's magnetic fields, and the location of the setting sun. If any of these cues are disrupted or unclear, for example during cloudy weather, the birds will have difficulty staying on their path. The lights of tall buildings and radio towers only contribute to this confusion. The lights will often overwhelm natural cues and disorient the birds. These confused birds will then circle the lighted structures, not because they are attracted to the light, but because they are following an erroneous and obscure cue. Blinking lights, which often adorn radio towers, and bad weather only further contribute to the problem. Eventually many of these birds will collide with the building, with each other, or will drop from exhaustion.

This problem is increasing as more and more highrise buildings are constructed. The now popular glass skyscrapers, found brilliantly lit at night, are augmenting the dangers.

Not all birds die from the collisions. Some will only be stunned with minor injuries, but often these dazed birds will fall prey to predators, cats and other birds, lurking on city streets. Many will panic upon finding themselves in the midst of a busy, morning, urban setting.

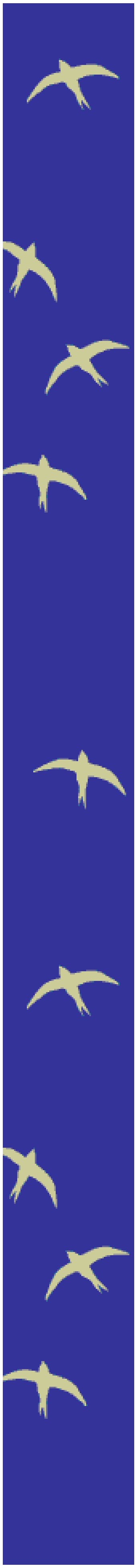
Another related danger to nightflying migrants are the broadcast radio towers which may stand 200-2000 feet into the night sky. There are around 75,000 towers currently built in the United States and with the current progress of Internet and satellite technology another 5000 to be added every year. Each of these towers may kill hundreds to thousands of birds in a single migratory season. Add lights and bad weather to the scenario and the death rate grows even higher.

What You Can Do:

- Turn off all lights during the peak migration seasons in fall and spring.
- Write letters to the owners of tall skyscrapers requesting that lights be turned off at night during peak migration periods.
- If you find a stunned bird, carefully place it upright inside a brown paper bag and transport it to a safe area where it can recover before resuming its journey.

Other Useful Web Sites:
Fatal Light Awareness Program: http://www.flap.org exit epa
Towerkills: http://www.towerkill.com exit epa

Native Plants and Biodiversity



We have peppered our continent with new houses, sidewalks, lawns, and regimented landscapes that are relatively devoid of seedpods, berries or other natural food sources. Imagine a different type of “yarden”: birds chirping, butterflies flitting, bees busily transporting pollen, and wildlife drinking and bathing in the rainwater you collected in your yarden. You can create this scene, and in so doing, you’ll find that you’ll have to replace plants less often and use less pesticide, time, money, and water.

To begin the transformation from traditional landscape to nativescape:

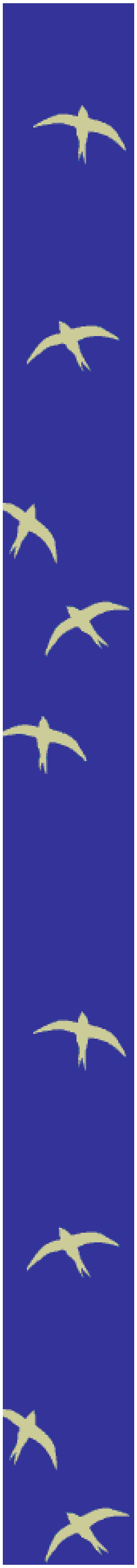
- Identify your existing plants, then explore forests and other natural areas to examine differences. Never remove plants from the wild.
- For a gradual transition, retain high maintenance areas close to the house while establishing a natural garden toward the edges and back of your property.
- Consider neighboring property. Cooperate with your neighbors and extend existing plantings to create larger joint habitat.
- Reduce lawn by breaking it up with curved borders around gardens, trees, shrubs and groundcovers to create an “edge effect.”
- Select native plants to attract birds through all seasons and allow space for natural growth patterns (less pruning).
- Consider tall native grasses (quail and other grassland species are declining), flowering annuals and perennials, and shrubs for shelter and food.
- Consider removal of overgrown, unattractive plants that offer little wildlife value.
- Add to your plan a little at a time. Enjoy a work in progress while reducing the area of lawn.
- Plant more than one of a plant, as larger patches are more visible to birds. Plant them in an irregular pattern so that it looks more natural.

AVOID TOXIC CHEMICALS. Birds eat the treated insects and berries.

Remember, numerous plant species attract a greater variety of birds and other wildlife. Check links below to find out more and where you can find native plants.

Learn more about how to reduce the use of pesticides, find alternatives, and create a healthy backyard by region

- Pesticide and garden tips: Ten Commandments for a Healthy Yard: http://www.audubon.org/bird/pesticides/10%20COMs%20boxes.html
- The Environmental Protection Agency’s Biopesticides site: http://www.epa.gov/pesticides/biopesticides/



- Backyard Conservation: 1-888-LANDCARE, http://www.nhq.nrcs.usda.gov/CCS/Backyard.html
- Native plants and gardening links: http://plants.usda.gov/plants/links.html
- Native plant societies by region: http://www.nanps.org/associations/frame.shtml
- Green Landscaping with Native Plants: http://www.epa.gov/greenacres/
- Audubon Habitat Collection from Monrovia: 1-888-PLANT IT

Further Reading:
The Bird Garden by Steve Kress

Bird Gardening Book by Donald and Lillian Stokes

The Chemical Free Lawn byWarren Schultz

Going Native by Brooklyn Botanic Garden

Landscaping forWildlife by Carrol L. Henderson

Redesigning the American Lawn - A Search for Environmental Harmony by Bormann, Balmori & Geballe

For additional information contact:
Director, Pesticide Initiative & Healthy Habitats National Audubon Society
HealthyYards@Audubon.org

CITIZEN SCIENTISTS LEND A HAND TO BIRDS THIS FALL

Award-Winning Web Site Combines Technology and Bird Science to Help Birds Get Home Safely

New York, NY August 28, 2000 – This fall, migratory birds will face a number of life threatening challenges in their journey south. In addition to predators, difficult weather, and long distances, birds this year must contend with man made threats including potential poisoning from the pesticides employed to combat the West Nile Virus. With the help of citizen scientists and state-of-the-art forecasting technology, birds migrating through the Mid-Atlantic may get a break.

“Using the most advanced migration monitoring techniques, in combination with the efforts of the public, BirdCast www.BirdCast.org will become one of the most effective ways to track bird movement, and protect bird species,” said Audubon’s Senior Vice President for Science, Frank Gill. “From September 1st through November 15th, National Audubon Society urges citizens from New York to Washington, D.C. to report bird sightings

to BirdCast and to take action to aid birds."

As birds migrate, major factors contributing to their demise include pesticide use; loss of feeding and watering opportunities; impact with radio, television, and cellular towers, and brightly lit office buildings which disorient birds, causing them to crash. Scientists recognize that migrating birds are in decline—down by nearly 50% since the 1960's.

BirdCast, enabling scientists to predict bird migration through a specific region, offers practical uses for homeowners and public officials. Using BirdCast, homeowners will be advised as to when to avoid spraying pesticides in their gardens, provide seed and water, and when to keep their cats indoors, in order to keep bird populations alive and well. Building owners can use BirdCast to determine when to turn off disorienting lights that often cause birds to crash into windows and die.

Public Health officials are also urged to make use of BirdCast. "This fall, BirdCast has an unintended and immediate use for county health officers," continued Audubon's Gill. "BirdCast will provide guidelines on when to suspend spray operations, helping officials avoid unnecessary bird deaths and violations of federal Migratory Bird Laws."

BirdCast, a project of National Audubon Society, Cornell Lab of Ornithology, and Clemson University Radar Ornithology Lab, made its debut this past spring and was a resounding success. Funded by the Environmental Protection Agency's Office of Research and Development and the Office of Pesticide Programs, the project was granted the "Dr. Copernicus Award" by the Copernicus Education Gateway, a Web site that features the best educational sites for students and teachers. Using radar pictures, audio samples and most importantly, personal observations (or "groundtruthing,") scientists were able to make predictions and draw conclusions about songbird migratory behavior.

Participants from the mid-Atlantic region watched the skies, reported their findings to the BirdCast site and were then advised when to keep their cats indoors, to refrain from pesticide use, and to provide food and water in order to protect migrating birds in their region. Of particular interest to the thousands who visited BirdCast were the "10 Commandments to a Healthy Yard" and "The Audubon Guide to Home Pesticides," still available at the site http://magazine.audubon.org/backyard/backyard0005.html.

"By encouraging the public to report bird sightings in their region, BirdCast has and will continue to enable scientists to gather valuable information on migratory movements," said Gill. "The project will not only increase scientific knowledge but also encourages people to make informed decisions about when to apply pesticides, let their cats out or undertake other activities that might cause birds harm."

This fall, with additional support from the EPA's Office of Pesticide Programs, BirdCast will expand into the states of New York and New Jersey. Scientists will generate morning and evening pictures of warbler, waterfowl, and hawk migration through the region using NEXRAD (Next Generation Radar). These snapshots of bird migration and weather events will be accompanied by interpretation and predictions from the Clemson

Lab so that the general public and city officials can both observe and assist migratory birds.

“BirdCast has already inspired the general public to use this new technology to observe birds and ultimately become partners in conservation,” said Sally Conyne, Director of Citizen Science for Audubon. “This fall we are eager to track bird movement once again. Web users will be able to obtain daily forecasts of bird movements, learn about the best bird-viewing spots and find out how human activity impacts birds. In addition, the site now includes general information about migration, some late-breaking pesticide news, and a variety of tips for the fall gardener.”

Aside from adding color and music to our lives, birds serve as important environmental indicators, helping scientists assess the health of an ecosystem. Evidence of a declining bird species in a particular region may indicate another problem such as the loss of food or water sources, the destruction of specific habitats, or contamination by a toxic element. Despite the significant role birds play in local ecosystems, every year the numbers of migratory birds that return to the Mid-Atlantic region, and other parts of the country, decreases. These decreases may indicate problems with broad environmental implications, problems that can impact us in many ways.

Founded in 1905 and with over a 550,000 members and supporters in 530 chapters throughout the Americas, the National Audubon Society conserves and restores natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth’s biological diversity.

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NATIONAL AUDUBON SOCIETY URGES NY, NJ & CT HEALTH OFFICIALS NOT TO SPRAY PESTICIDES THIS WEEKEND

Largest Wave of Bird Migration This Fall Predicted to Pass Through Tri-State Area

New York, NY September 15, 2000- Using the latest technology in bird tracking techniques and the efforts of citizen scientists through BirdCast.org, National Audubon Society predicts the largest wave of migration will occur this weekend- and strongly urges county officials to suspend pesticide spraying operations in the tri-state area.

“This weekend will be one of the best opportunities for people to see a wide variety of species of migrating songbirds and hawks, and to contribute their sightings to BirdCast,” said Sally Conyne, Director of Citizen Science for

Audubon. “On the other hand, this weekend will be one of the worst times for pesticide sprayings to occur, due to the unknown effects of the use of Scourge and Anvil on birds and the consequent reduction of their food source. By not spraying pesticides in the tri-state area this weekend, county and city officials will avoid unnecessary bird deaths and violations of federal Migratory Bird Laws.”

Migratory birds usually face a number of life threatening challenges in their journey south. This weekend, in addition to predators, difficult weather, and long distances, birds must contend with man made threats, especially potential poisoning from the pesticides employed to combat the West Nile Virus. With the cooperation of health officials, help of citizen scientists and state-of-the-art BirdCast technology, birds migrating through the Mid-Atlantic may get a break.

“In combination with the efforts of the public, BirdCast www.BirdCast.org will become one of the most effective ways to track bird movement, and protect bird species,” said Audubon’s Senior Vice President for Science, Frank Gill. “From September 1st through November 15th, National Audubon Society urges citizens from New York to Washington, D.C. to report bird sightings to BirdCast and to take action to aid birds.”

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BirdCast, a project of National Audubon Society, Cornell Lab of Ornithology, Clemson University Radar Ornithology Lab, and Academy of Natural Sciences made its debut this past spring and was a resounding success. Supported by the Environmental Protection Office of Pesticide Programs and Mid-Atlantic Office (Region III), the project was granted the "Dr. Copernicus Award" by the Copernicus Education Gateway, an educational Web site for students and teachers. Using radar pictures, audio samples and personal observations (or "ground truthing,") scientists were able to make predictions and draw conclusions about songbird migratory behavior.

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“By encouraging the public to report bird sightings in their region, BirdCast has and will continue to enable scientists to gather valuable information on migratory movements,” said Gill. “The project will not only increase scientific knowledge but also encourages people to make informed decisions about when to apply pesticides, let their cats out or undertake other activities that might cause birds harm.”

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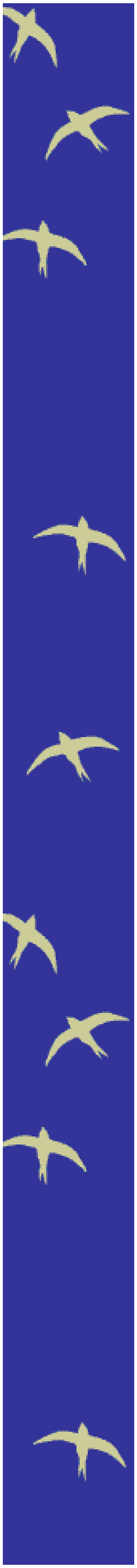
BirdCast & NEXRAD

In the early days of World War II, British radar operators noticed mysterious, ethereal shadows drifting across their screens. Those apparitions, so wonderfully dubbed angels by pioneering radar technicians, heralded the beginnings of radar ornithology. Radar’s first major contribution to ornithology took form only a few years later when in 1958 Sidney Gauthreaux, then a high school student in New Orleans, postulated that if radar can see planes and weather, why not birds? Only a few years



later, as a Louisiana State graduate student, he found his proof. His radar images definitively proved the existence of massive trans-Gulf migrations. Prior to these observations, there was a continuing belief that the majority of migrants held to a more land bound, clockwise pattern; arriving in North America via Mexico.

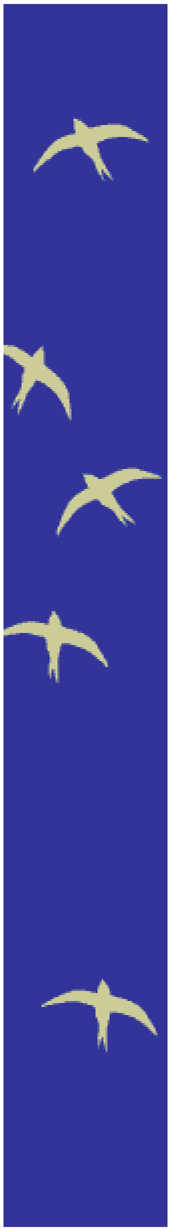
Through the 60's, 70's, and 80's, however, radar's promise failed to fully evolve. There were a few notable discoveries, such as in 1989 when Gauthreaux, working from archival images, awakened the ornithological world to the precipitous decline in migrating flocks—down by nearly half when compared to the 1960's. The existing radar of the day, however, was proving largely inadequate. It lacked not only the necessary resolution, but it also failed to provide a three dimensional view.

In the early 1990s, however, change was coming. The new, highly efficient NEXRAD Doppler radar (Next Generation Radar) began to be placed in service. The Air Force started investigating NEXRAD's utility in their Bird Aircraft Strike Hazard Program (BASH). During this period, portable NEXRAD units were teamed with vertically mounted thermal imaging units so that the images captured by the radar could be visually verified. Elsewhere, graduate students under Sid Gauthreaux were making their own exciting discoveries. Their breath-taking images of giant expanding aerial doughnuts were found to be thousands of Purple Martin radiating from critical roosting sites each morning.

Radar ornithology work is now taking place in many parts of the country and it is soon to come to the Mid-Atlantic.With the support of the Environmental Protection Agency's Office of Research and Development and the Office of Pesticide Programs, a coalition consisting of National Audubon, Cornell's Laboratory of Ornithology, and Clemson's Radar Ornithology Laboratory, "BirdCast" will be coming soon to a computer near you on September 1, 2000. To access BirdCast you will go to the existing Audubon/Cornell Web site—BirdSource http://www.BirdSource.org. exit epa Throughout periods of peak migration, BirdCast will provide a morning and evening, unfiltered snapshot of the eastern region of the US from New York through Virginia. The birds and weather shown in theseimages will be accompanied by interpretation and a migration prediction provided by the Clemson Lab.

Is this work being done just as a special favor for birders? Well, not exactly. You can think of BirdCast as an early alert and an environmental billboard on the Internet. Linked to BirdCast will be messages such as admonitions against the use of certain pesticides as well as a number of other migrant-friendly changes that people can make in their backyards. We'll advise the residents of the region about the pests that actually pose local threats and the safest management strategies. Included at the site are two charts of special interest— "10 Commandments for a Healthy Yard" and "The Audubon Guide to Home Pesticides." With the completion of data collection this migration season, we hope to use the interpreted and ground-truthed images in pinpointing critical habitat in need of protection.

While all of this seems reasonably simple and employs proven technology, its not simple at all. In fact, it's really research in the development stage. What has been sorely lacking in the past is you. Most earlier radar work has



been lacking a critical component—groundtruthing. Dozens, hundreds, and, indeed, thousands of sets of eyes are needed to verify what the radar images are capturing and to that end, BirdCast will have an interactive component and will allow you to log on and enter your daily sightings. These will feed directly into our database and be available to everyone in real-time.

So, BirdCast needs you. Dust off those bins and get ready to head to your favorite haunts. While we encourage all of you to post each and every sighting, of greatest value will be sightings coming from those who can afford the time to make regular observations. Those of you who would like to participate on a daily or regular basis or if you would like additional information please contact Sally Conyne sconyne@audubon.org. exit epa These data you collect will greatly enhance our overall understanding of migration patterns and movements. And this project will educate a multitude of people about how their backyards can be made friendlier and healthier for our angels. So, please, help us help the birds.

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