United States
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The EMPACT Collection

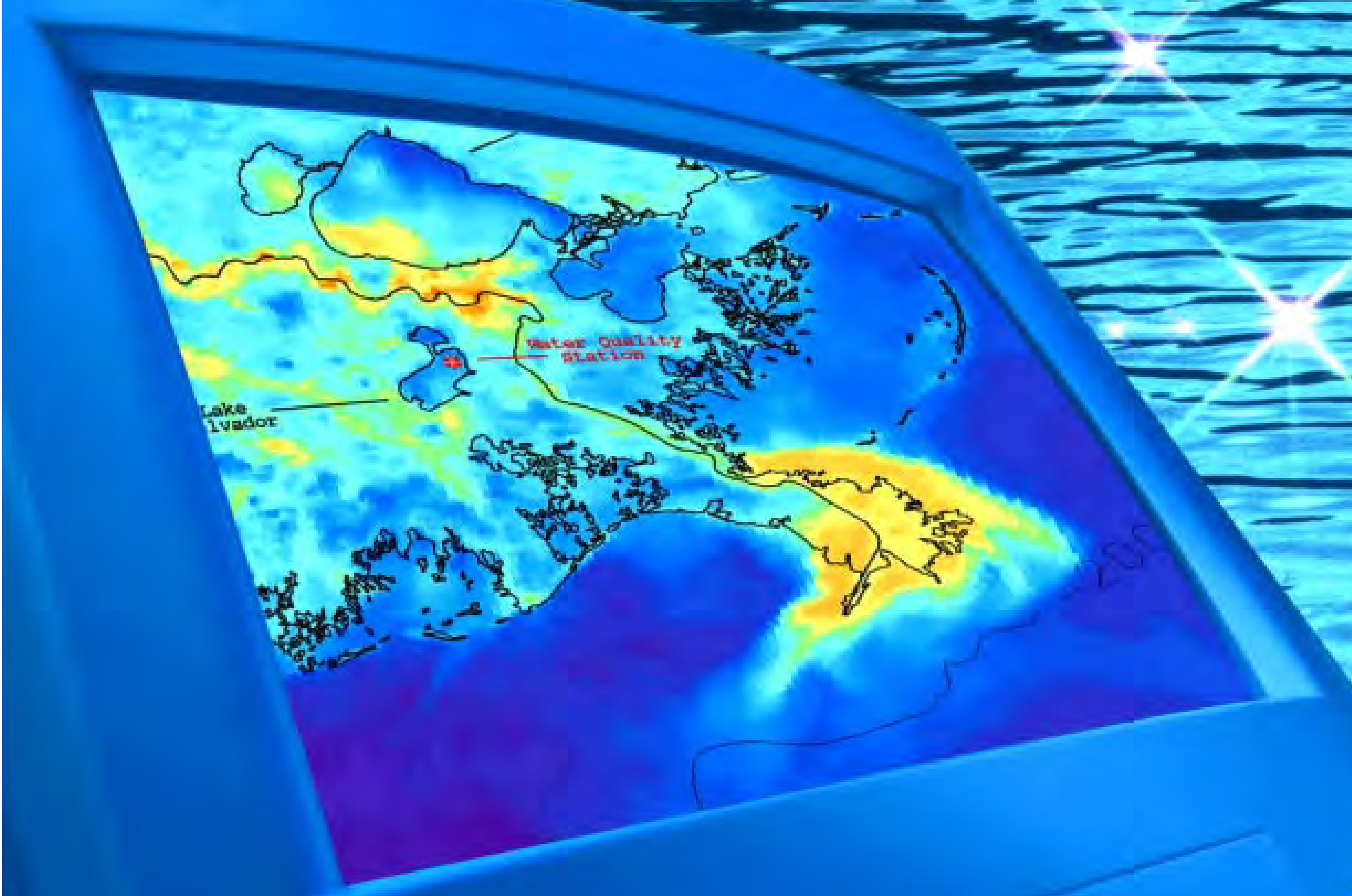
EMPACT

Environmental Monitoring for Public Access & Community Tracking

United States Environmental Protection Agency
Office of Research and Development
Office of Environmental Information
Washington, DC 20460
EPA/625/R-01/005
September 2001
http://www.epa.gov/empact

Delivering Timely Water Quality Information to Your Community

The Jefferson Parish - Louisiana Project



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Disclaimer

CONTRIBUTORS

Dr. Dan Petersen of the U.S. Environmental Protection Agency (EPA), National Risk Management Laboratory served as principal author of this handbook, and managed its development with support of Pacific Environmental Services, Inc., an EPA contractor. The authors of this handbook are grateful for the involvement and contributions of individuals involved in this project. The following contributing authors provided valuable assistance for the development of the handbook:

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Dr. Chris Swarzenski, United States Geologic Survey District Office in Baton Rouge, Louisiana

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Dr. Nan Walker, LSU Coastal Studies Institute and Earth Scan Laboratory, Baton Rouge, Louisiana

Marnie Winter, Director of the Jefferson Parish Environmental and Development Control Department

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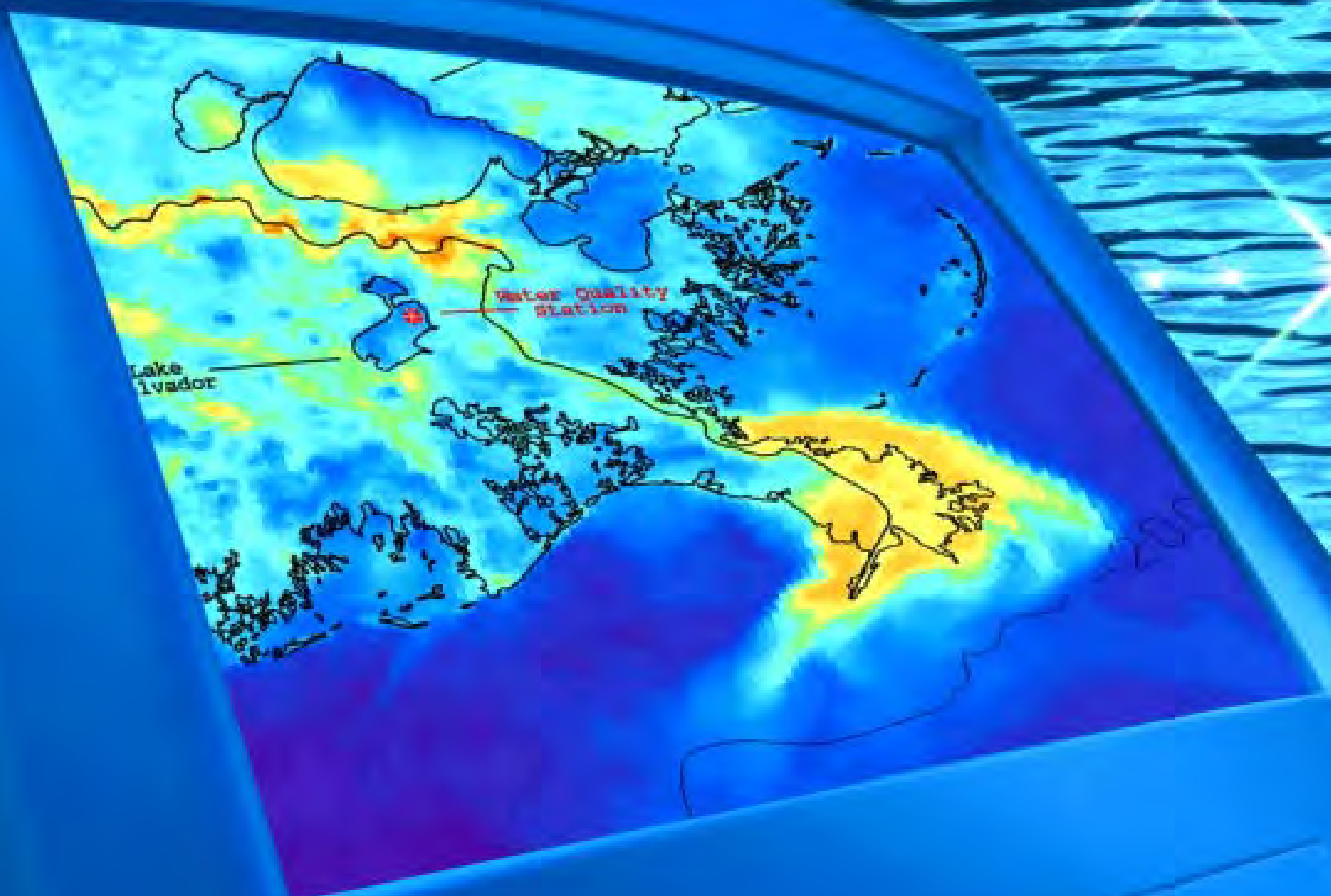

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1. INTRODUCTION

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™ 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

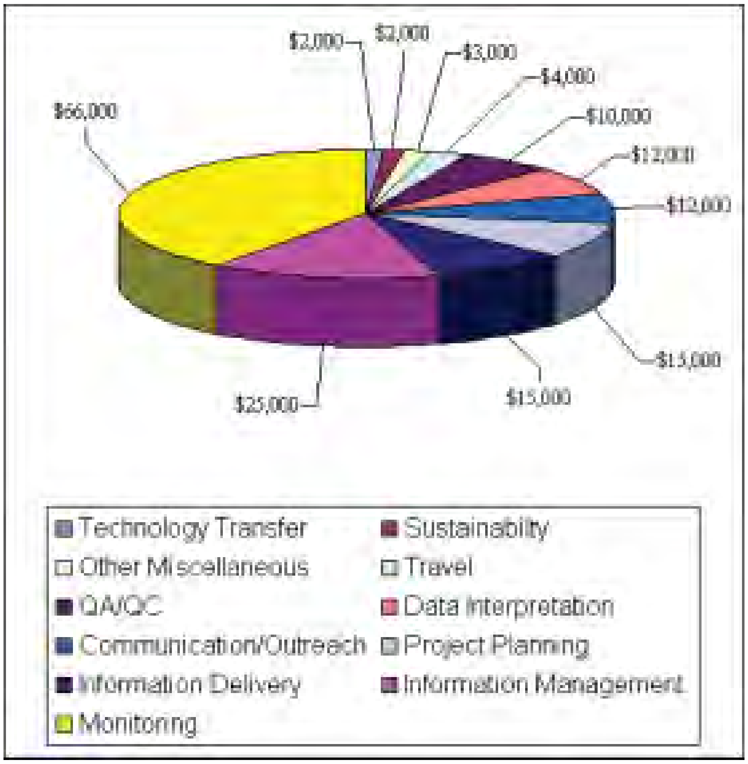
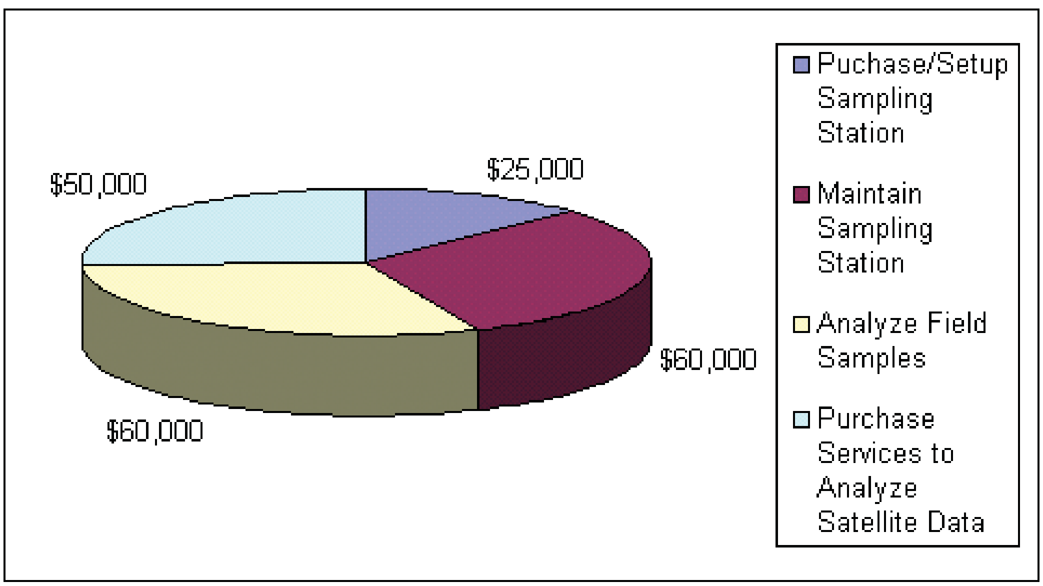


Figure 1.2. Typical Costs For Equipment and Services



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**.

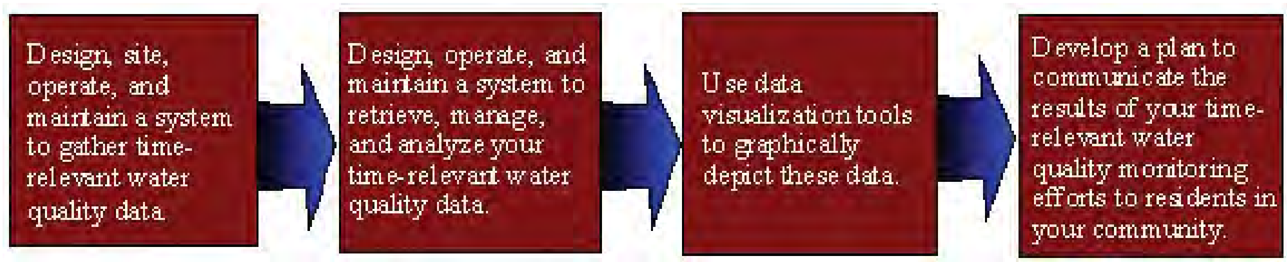
1.4 EMPACT Metropolitan Areas

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
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
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
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, TXOklahoma 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
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
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.

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:



- **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.

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*

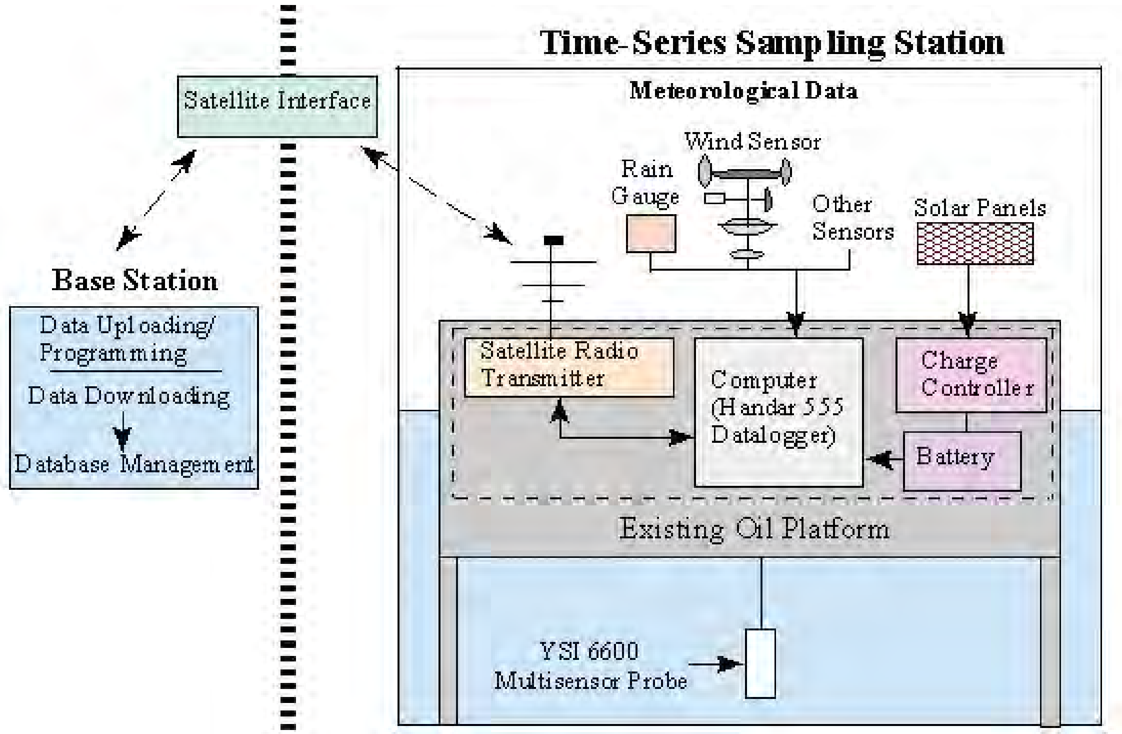
The Jefferson Parish Project team uses a land-base station to communicate with the sampling station via satellite interface. Time-relevant data are remotely downloaded from the station daily. Figure 3.1 illustrates some of the basic sampling station components and shows how the sampling system communicates 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.

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

Figure 3.1 Diagram of Basic Sampling Station Components



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.

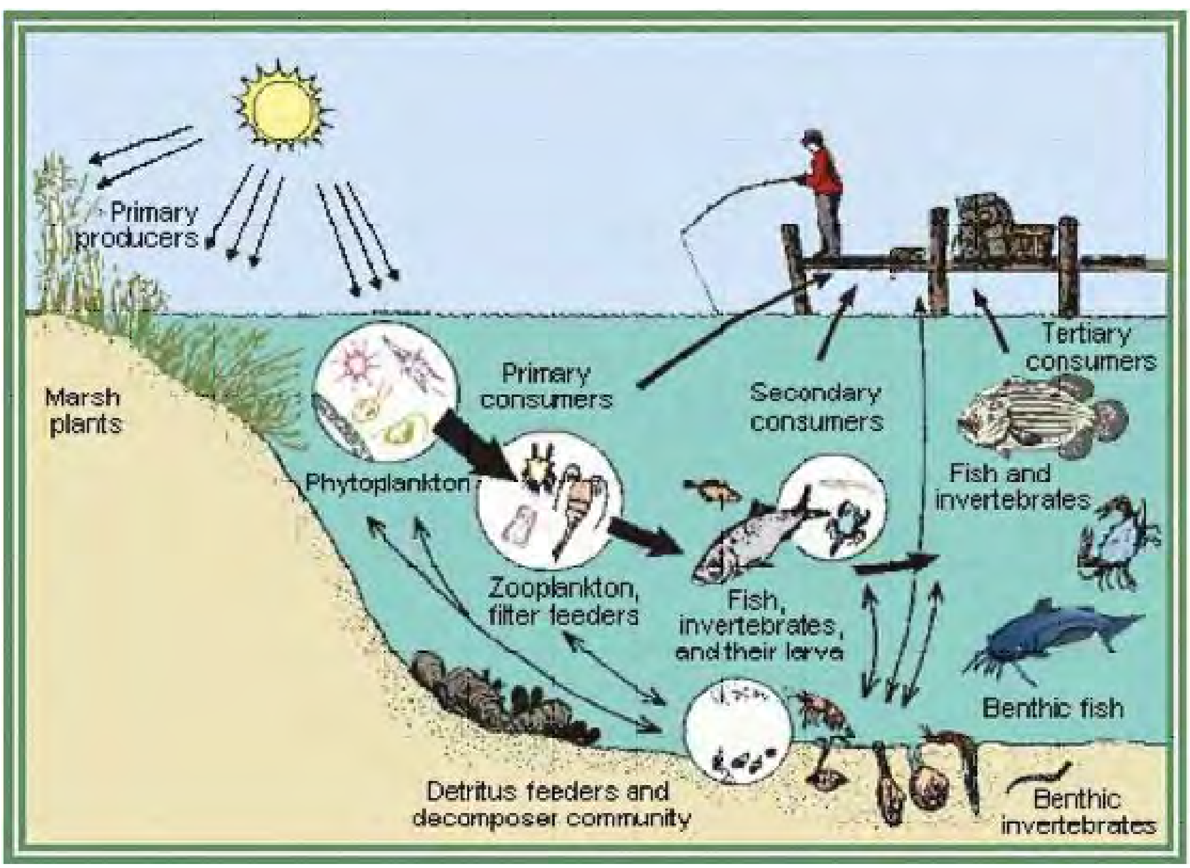
Since this particular monitoring project involves estuarine ecology and possible impacts of freshwater diversion into estuaries, the following text boxes provides some basic background information about these topics.

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.

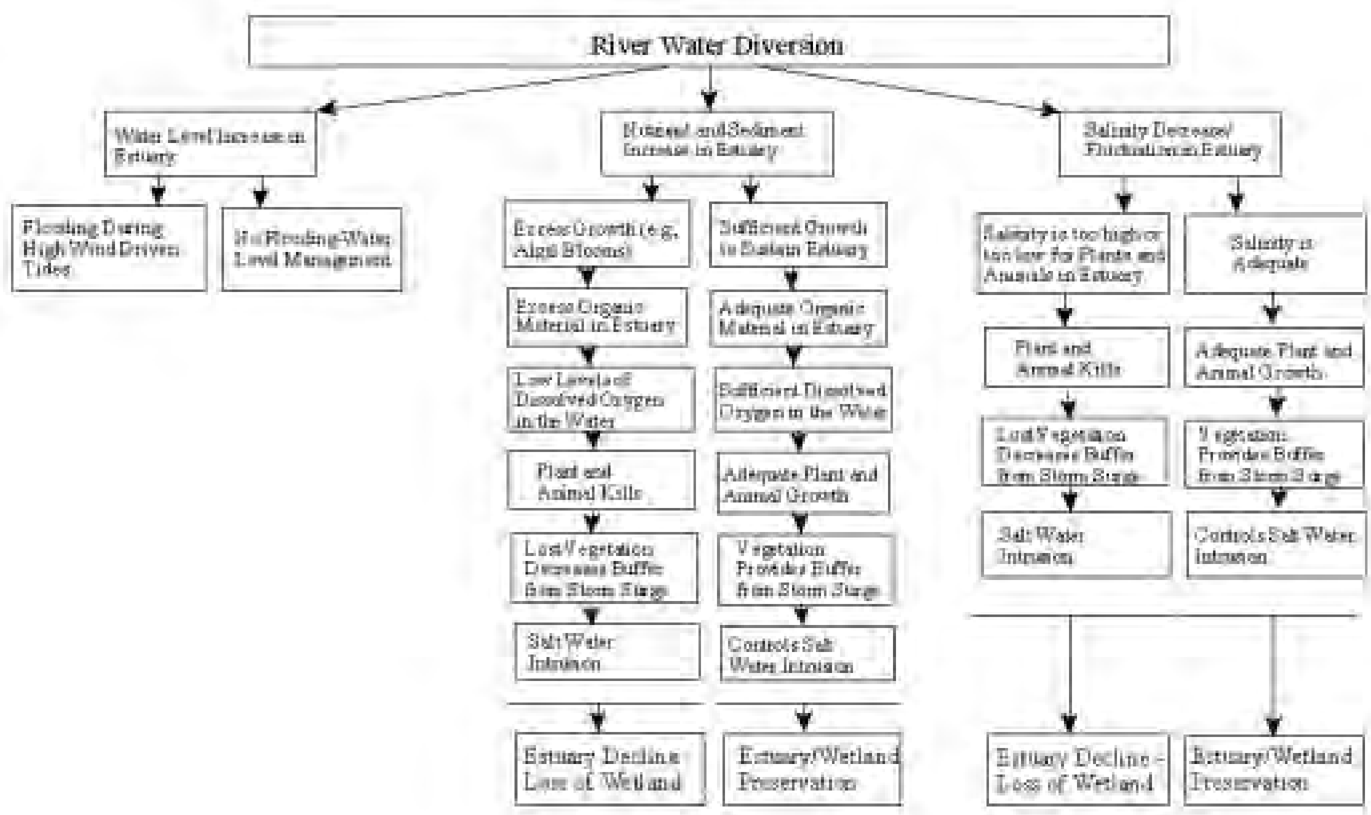
The project team decided to conduct time-relevant monitoring of lake water quality to be able to detect algal blooms early and to provide timely environmental information to natural resource and human health protection agencies. Having time-relevant data allows entities to respond quickly to adverse 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:

- If you want to identify existing or emerging water quality problems such as algal blooms, you could tailor your monitoring frequency to

Figure 3.3. Possible Beneficial and Negative Impacts of River Water Diversion



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, increasing the toxicity of these metals. [Source: Lake Access - Minneapolis EMPACT Manual - EPA/625/R-00/012]

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 of estuaries. 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 thedrinking 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

Figure 3.5. Picture of the YSI 6600 sensor package with multisensor probes taken during the January 9, 2001 site visit.

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:

- 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

4. COLLECTING, TRANSFERRING, AND MANAGING TIME-RELEVANT WATER QUALITY DATA

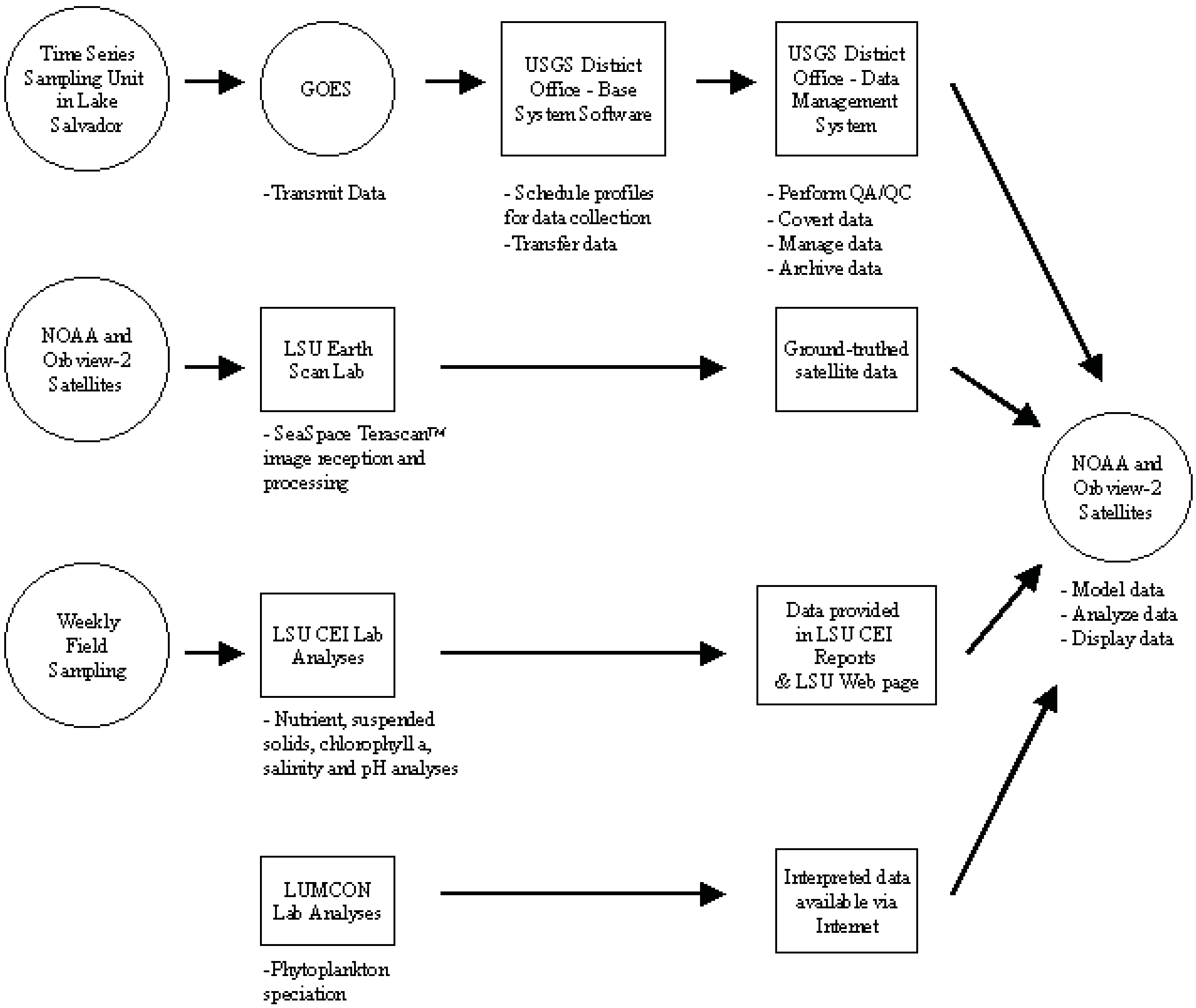
In order to effectively assess water quality and the impacts of water quality management activities, such as river diversions into estuaries, it is necessary to monitor water quality over time (i.e., monitor pre- and post-diversion water quality). The water quality monitoring should take into account 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



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™ 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 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

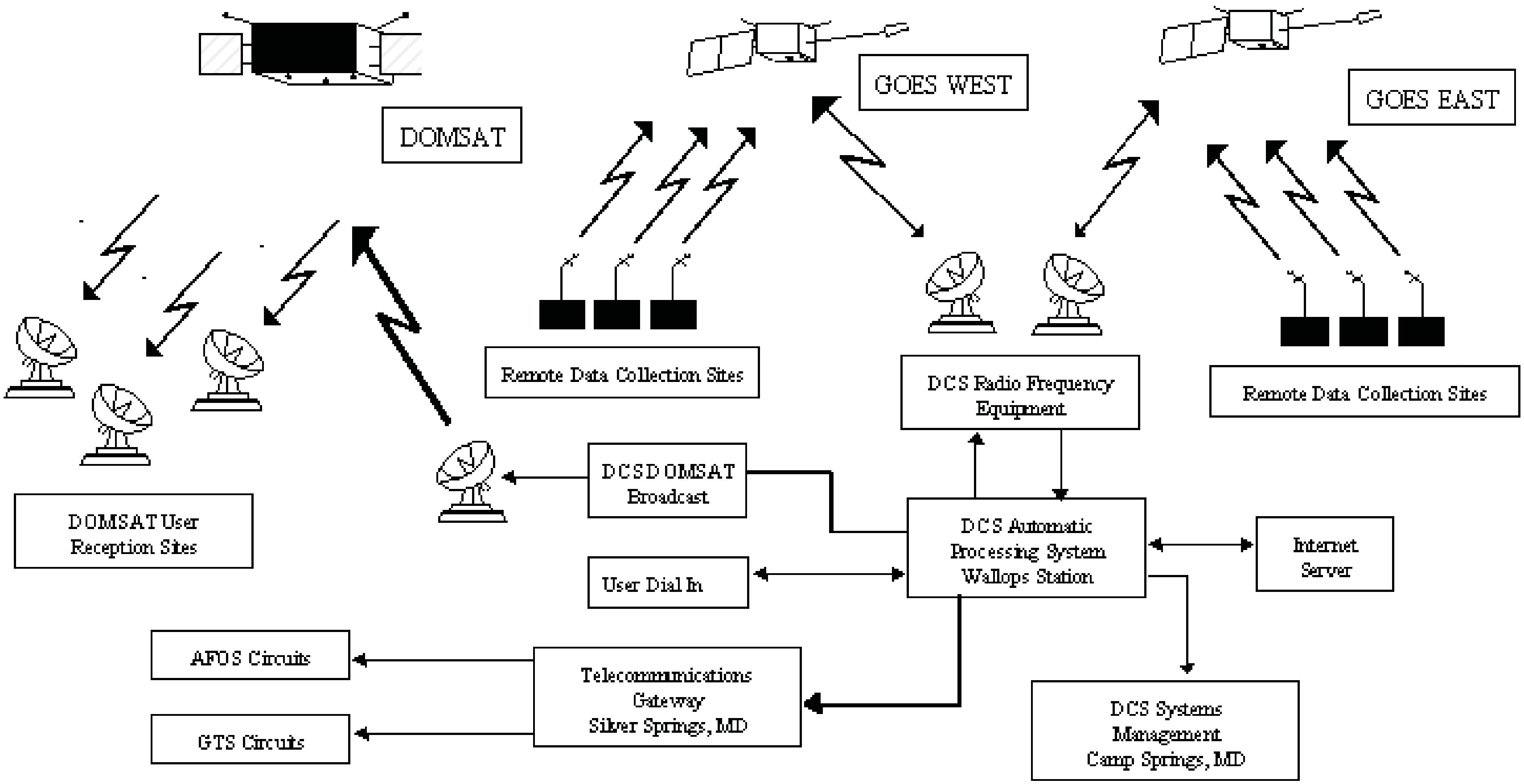
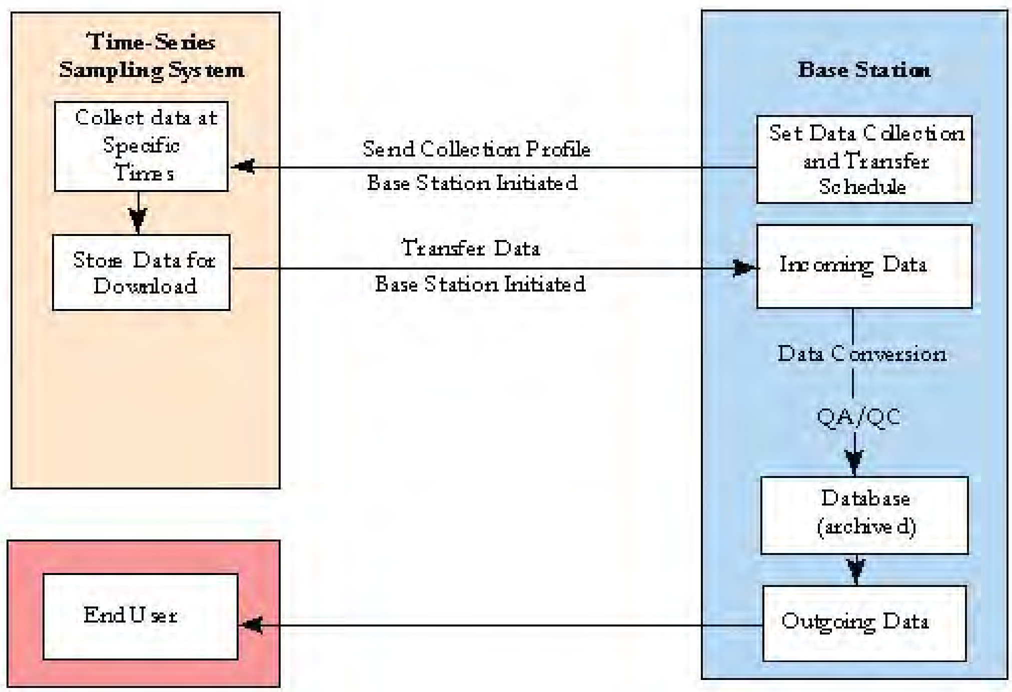


Figure 4.2 Schematic of the GOES DATA Collection System (DCS) and Data Transfer Process
Source: http://www.osd.noaa.gov/sats/dcs/dcs-figure.htm

Figure 4.3. Data Transfer and Management Diagram



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.

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 it 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

Table 4.4. Concluded - Common Troubleshooting Issues and Actions

Symptoms	Possible Cause	Action
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
Turbidity probe unstable or inaccurate. Error messages appear during calibration	Probe requires cleaning	Follow probe cleaning procedure
	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	-30 C (-22 F) - without heater to 70 C (158 F)	-30 C (-22 F) - without heater to 60 C (140 F)
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

■ 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-enhanced imagery 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™, which is produced by SeaSpace. You can find SeaSpace's Web site at http://www.seaspace.com. The TeraScan™ 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™ 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/manurefy.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 μg/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 (550 C) and pre-weighed glass fiber filter (Whatman Type GF/F or equivalent). The filters are dried (at 60 C) then re-weighed to determine total suspended load in mg/l. The filters are then combusted at 550 C, 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, deionized 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

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]

Many coccoid cyanobacteria occur in aggregates, especially when suspended particulate matter concentrations are high, which do not break up during size fractionation.

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 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://its.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.

5. PRESENTING 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™ 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™ 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™ 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™ 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™ software suite. More information about this software can be found on SeaSpace's Web site (**http://www.seaspace.com**).

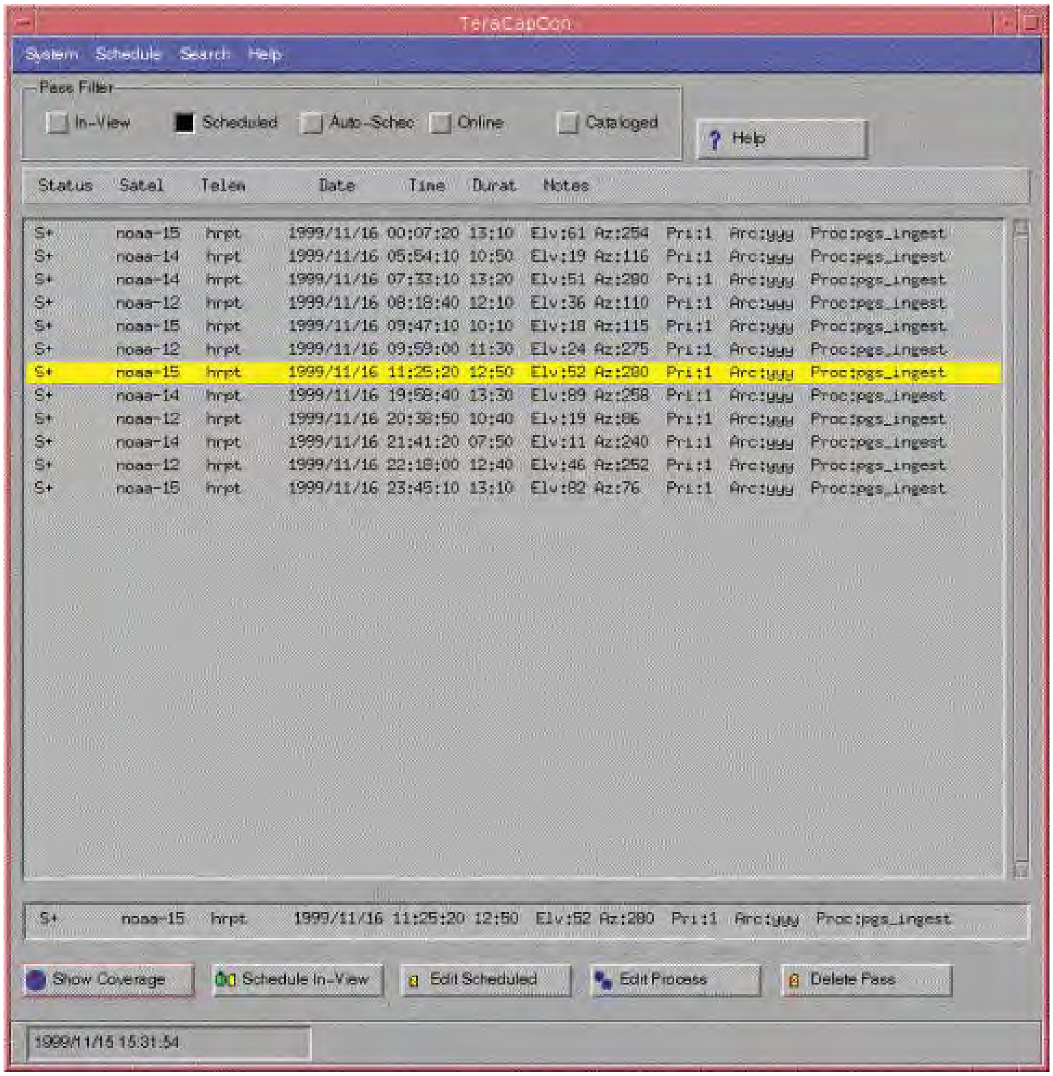
TeraCapCon

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

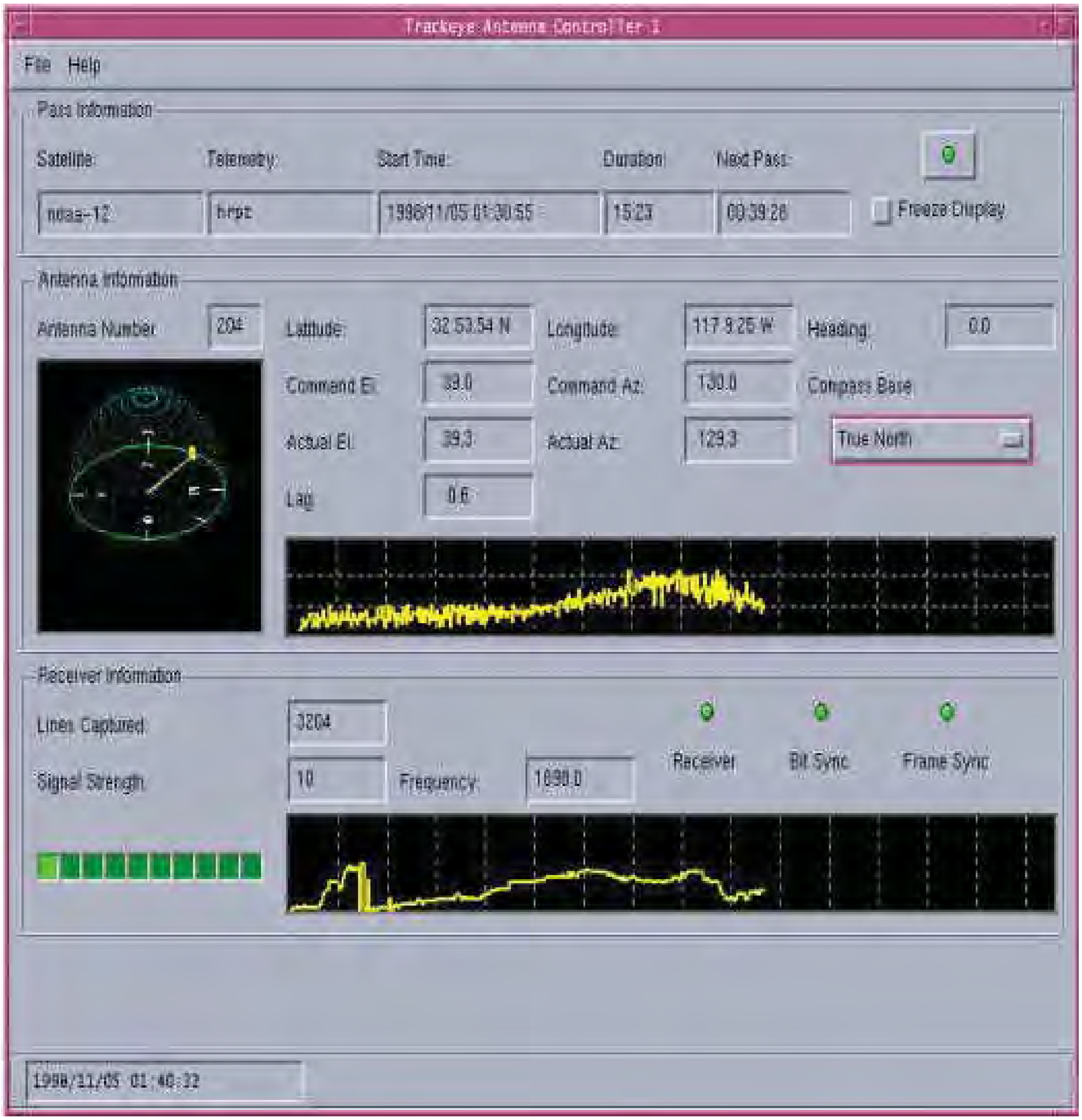


[Image Courtesy of SeaSpace Corporation].

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

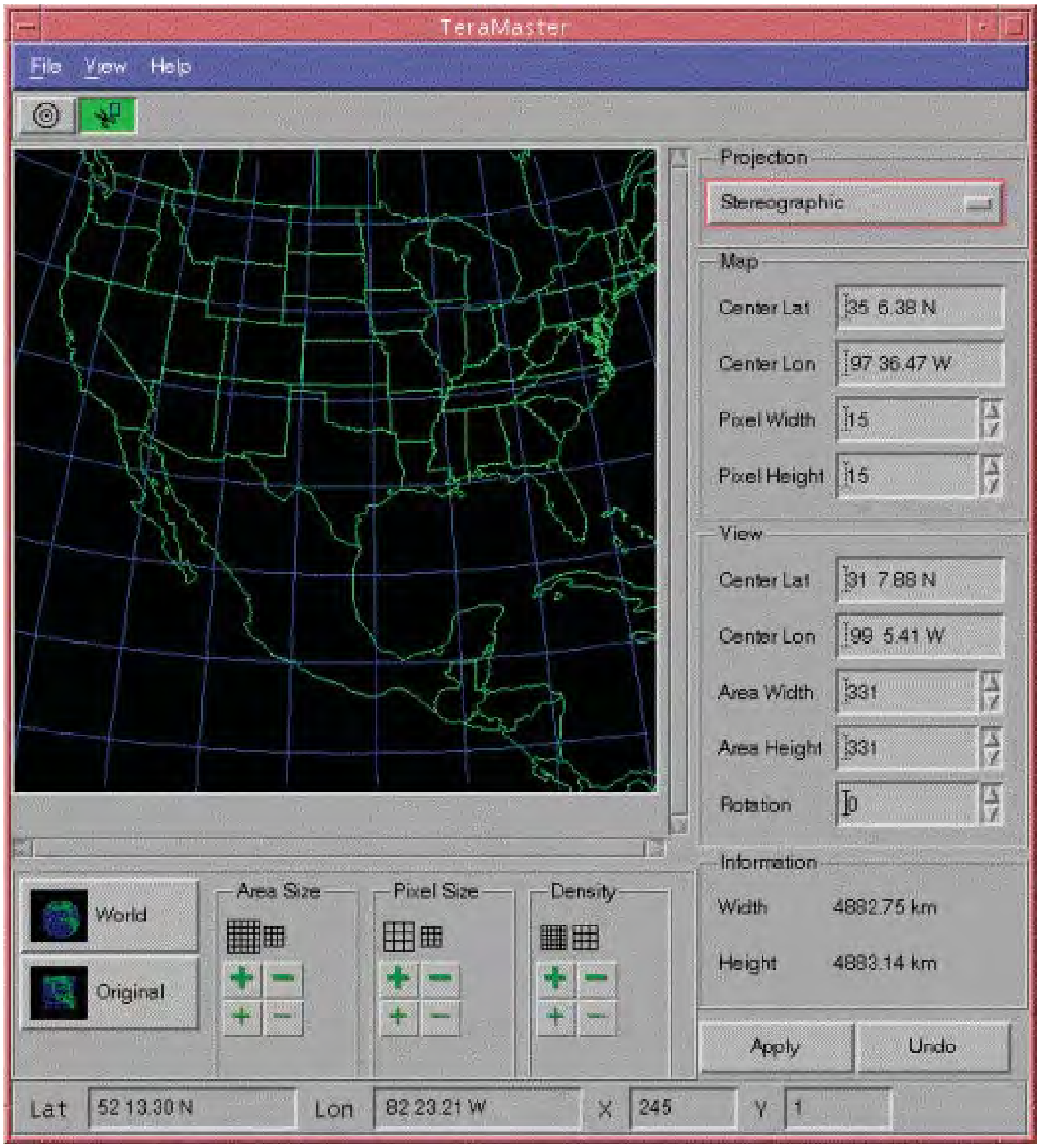


[Image Courtesy of SeaSpace Corporation].

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



[Image Courtesy of SeaSpace Corporation]

TeraScan™ Product Generation System (TeraPGS)

TeraPGS automatically generates and distributes products (TeraScan™ 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™ 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.

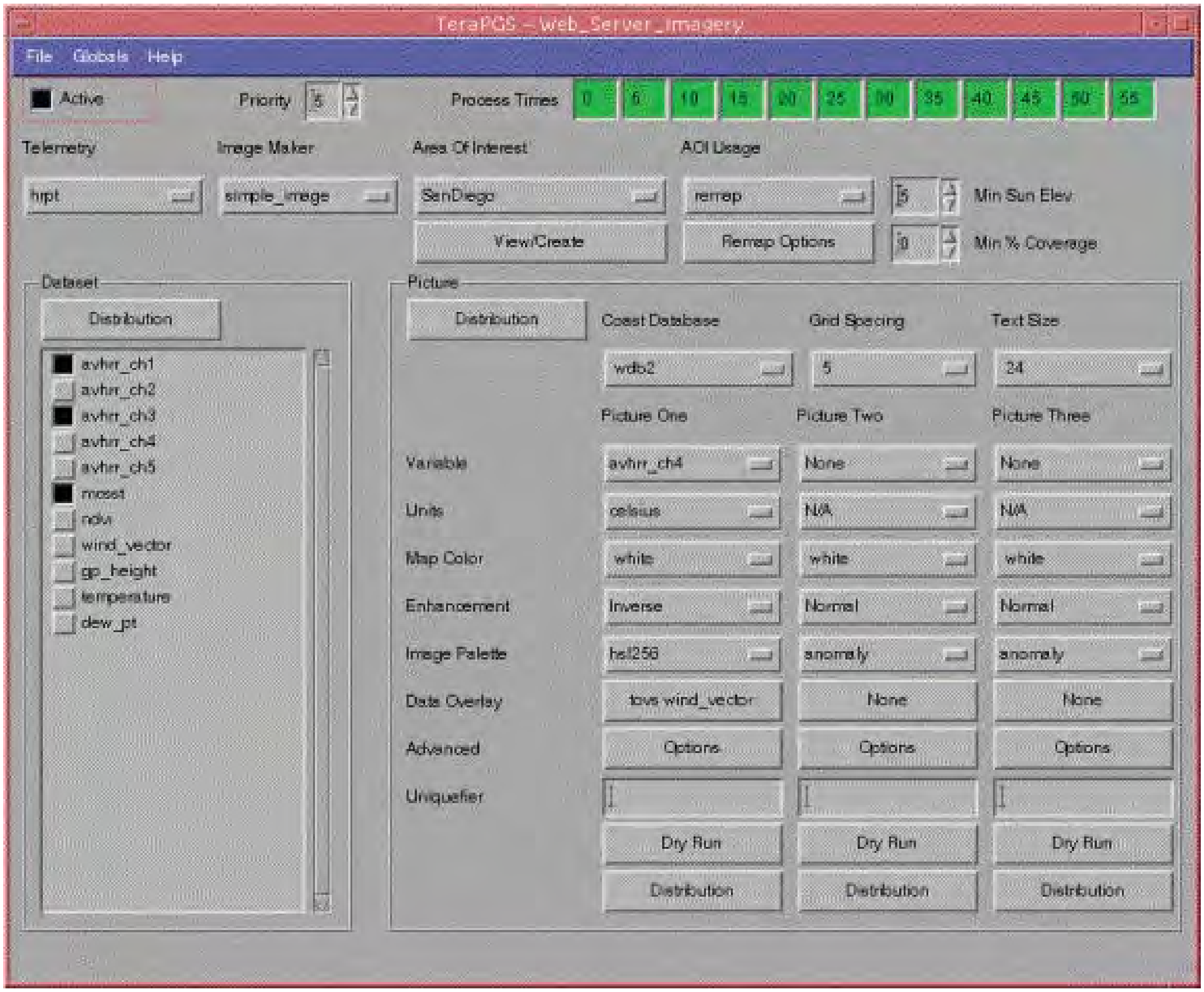
- Delivery destinations and times.

- 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



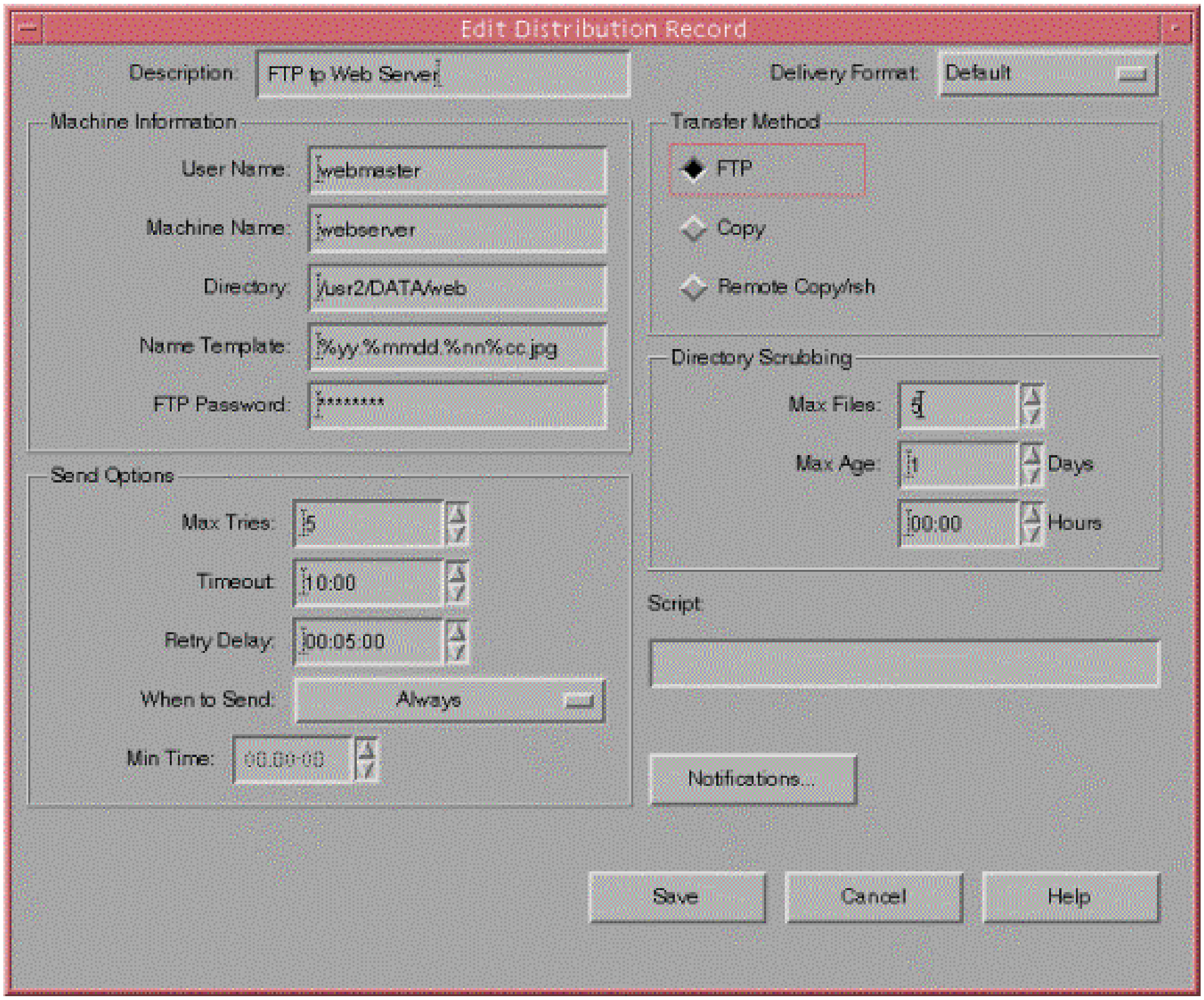
[Image Courtesy of SeaSpace Corporation]

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

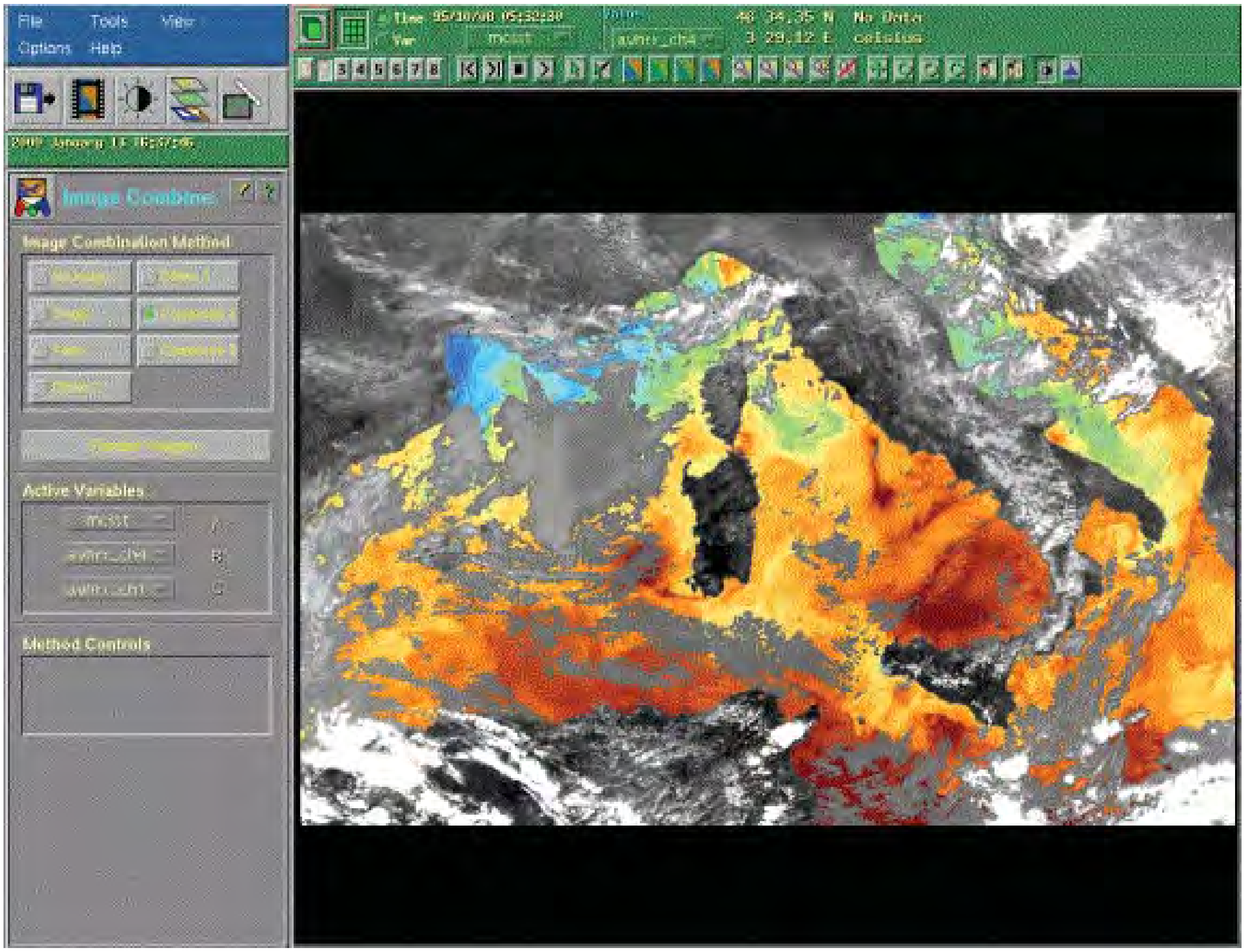


[Image Courtesy of SeaSpace Corporation]

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



[Image Courtesy of SeaSpace Corporation]

Training

SeaSpace offers basic hands-on, instructor-led training courses for its TeraScan™ 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™ training see the following Web site: **http://www.seaspace.com**/service/support/training.shtml.

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	•Cable television programs	•E-mail messages	•Briefings	•Banners
•Educational curricula	•Exhibits	•Web pages	•Fairs and festivals	•Buttons
•Newsletters	•Kiosks	•Subscriber list servers	•One-on-one meetings	•Floating key chains for boaters
•Posters	•Public service announcements (radio)		•Public meetings	•Magnets
•Question-and-answer sheets	•Videos		•Community days	•Bumper stickers
•Editorials			•Media interviews	•Coloring books
•Fact sheets			•Press conferences	•Frisbee discs
•Newspaper and magazine articles			•Speeches	•Mouse pads
•Press releases				•Golf tees
•Utility bill inserts or stuffers				

- 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	•Hotline that distributes products upon request
•Partners' mailing list	•Journals or newsletters of partner organizations
•Phone/Fax	•Meetings, events, or locations (e.g., libraries, schools, marinas, public beaches, tackle shops, and sailing clubs) where products are made available
•E-mail	
•Internet	
•TV	
•Radio	
•Print media	

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 - Terrobonne 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.

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

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

Name/Telephone No.	Affiliation	Address
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 813.553.3335	Department of Marine Science	University of South Florida 140 7th Avenue S. 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
Dr. Byron D. Tapley	UT Center for Space Research	3925 West Braker Lane Suite 200 Austin, TX 78759-5321
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

APPENDIX C

JEFFERSON PARISH BROCHURE

Coastal Use Permit Requirements

[illegible]

- Uses of Local Concern [illegible]
- Uses of State Concern [illegible]

The CZM Program [illegible]

Do I need a Coastal Use Permit?

A permit or letter of no objection from the CZM Program may be required [illegible]

[illegible] and a permit is generally required. The Corps New Orleans District [illegible] will provide a wetland determination upon request.

What is a wetland determination and how do I request one?

A wetland determination is a field survey conducted to identify wetland areas on a specific parcel of property [illegible]

Compensatory mitigation [illegible] To request a wetland determination form, please call the CZM Program at 736-6440 or call a Corps representative [illegible]

What information do I need to submit to the CZM Program to determine if a permit or authorization is required?

- Provide a letter requesting whether a coastal use permit is required from Jefferson Parish. The letter should include a description of the proposed activity and the location where the activity will occur. For example: [illegible]
- [illegible]
- Provide a property survey [illegible]
- Information submitted should be on regular 8 1/2 x 11 inch sheets of paper.

Jefferson Parish Environmental & Development Control Department

Coastal Zone Management Program

[illegible]

Jefferson, Louisiana [illegible]

Phone

(504) 736-6440

Fax

(504) 736-6[illegible]

Internet

[illegible]

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 66% 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 - $2,275,382

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 2,080 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 water. 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 - $3,927,621

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 3.5 miles of levee constructed with dredged material from the waterway; and 3.5 miles of rock armor.

Barataria Basin Landbridge – Phase I
Priority List 7 - $10,352,345

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 - $888,420

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 900,000 Christmas trees to construct approximately 15,900 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.

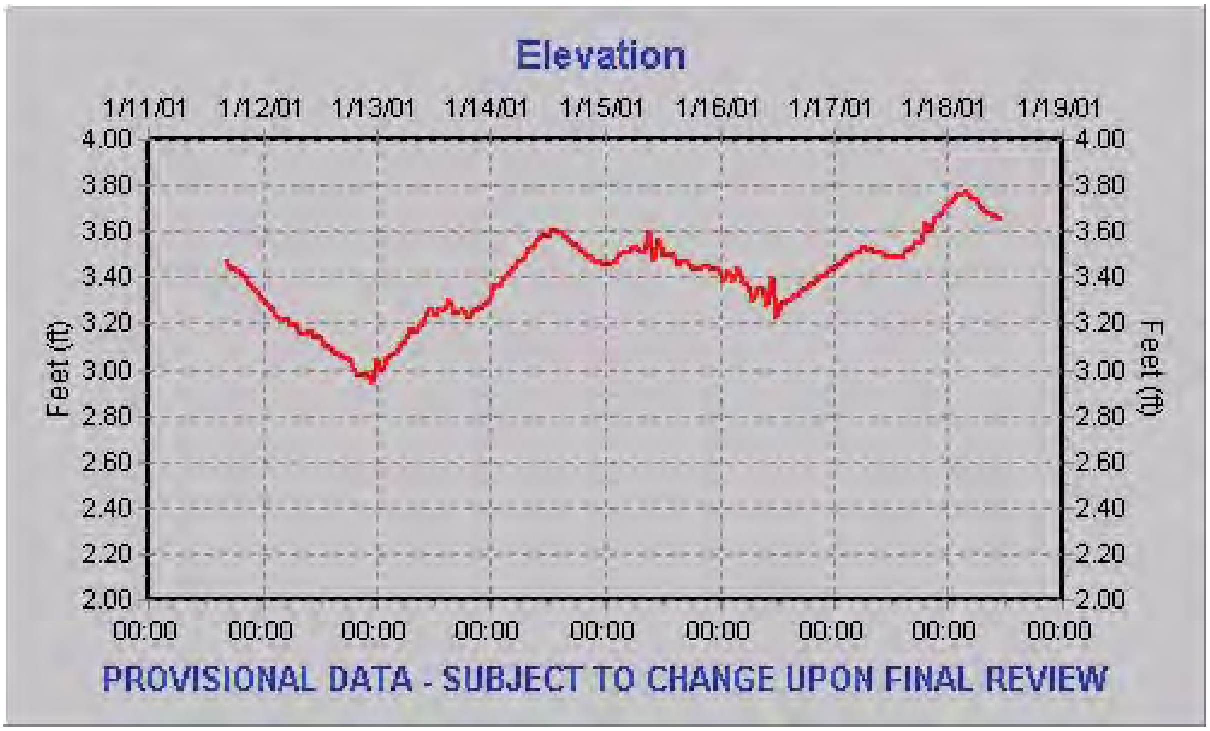
This project could not take place without a huge volunteer effort and strong corporate sponsorship. Each year, approximately 500 volunteers help in this hands-on project. Please call 736-6440 to volunteer.

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.

APPENDIX D

EXAMPLE DATA FROM USGS HYDROWATCH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APPENDIX E

EXAMPLE DATA FROM EARTH SCAN LABORATORY
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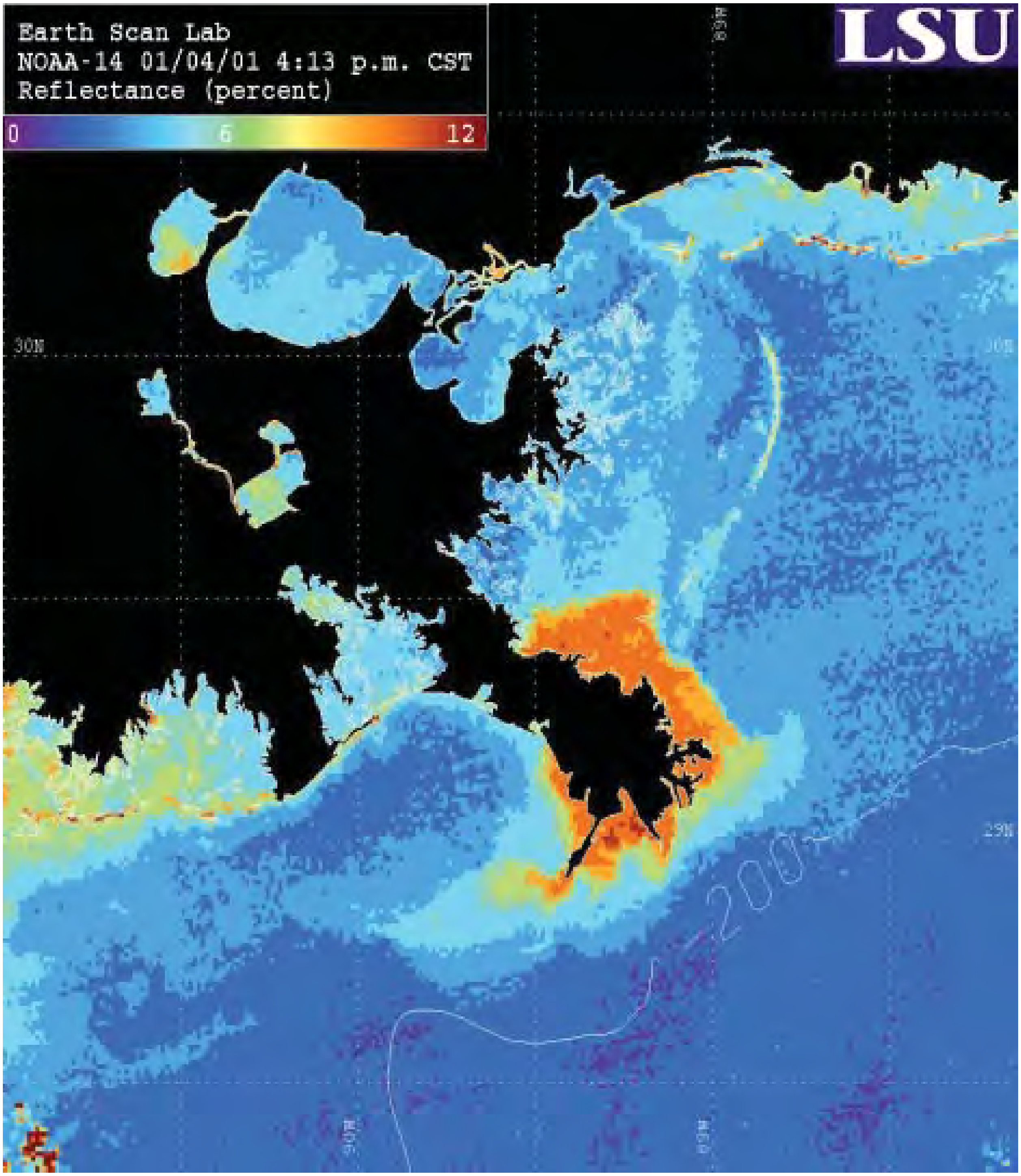
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July 2002

Community-Based Ultraviolet Radiation (UV) Risk Education

The SunWise Program Handbook

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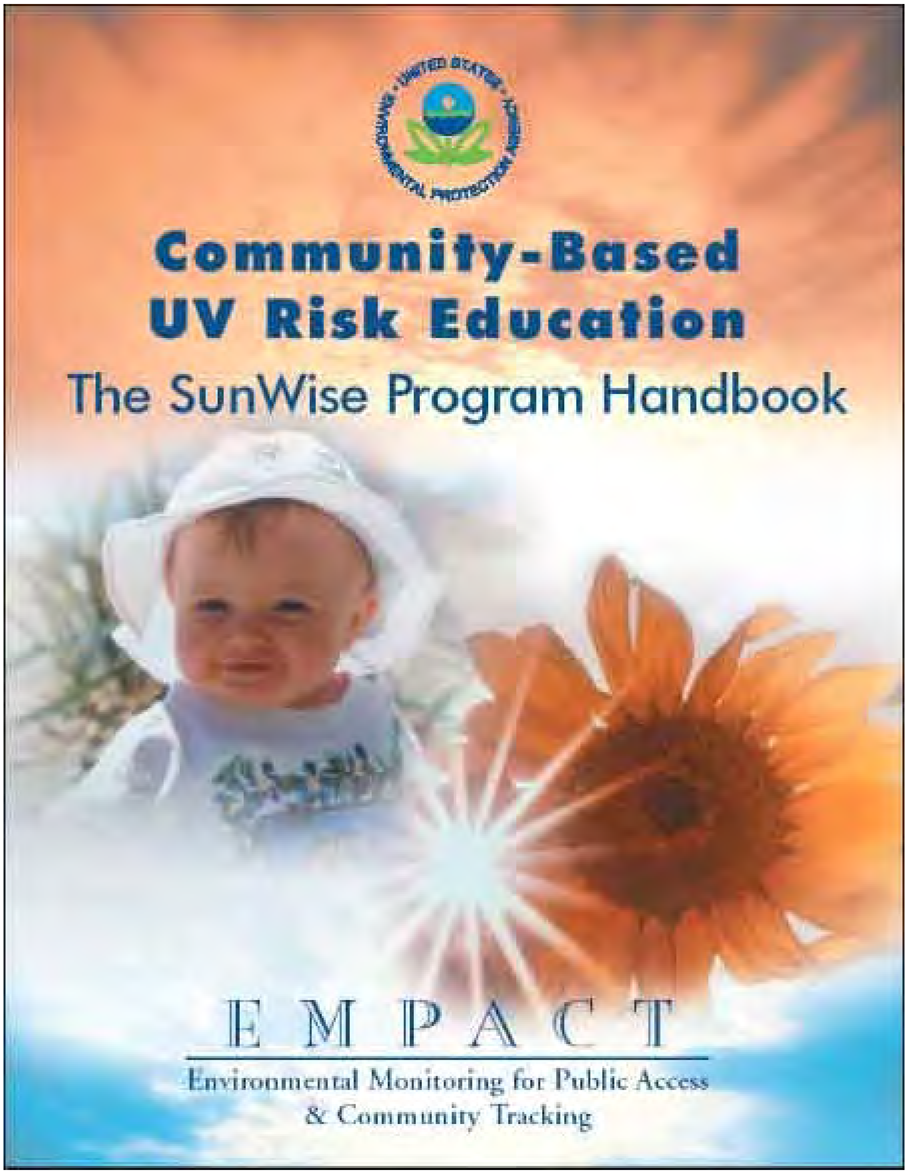
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Community-Based
UV Risk Education
The SunWise Program Handbook
EMPACT
Environmental Monitoring for Public Access
& Community Tracking

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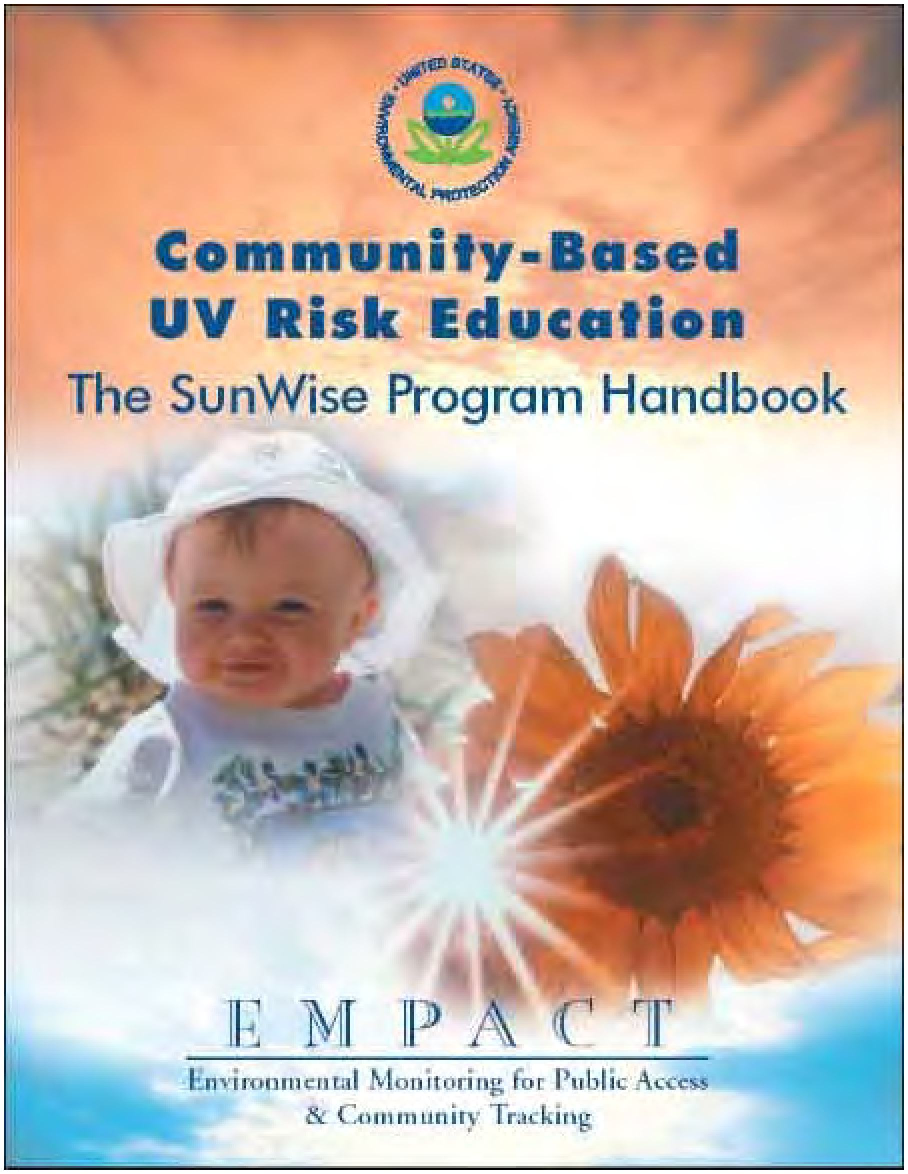
Community-Based
UV Risk Education
The SunWise Program Handbook
EMPACT
Environmental Monitoring for Public Access
& Community Tracking

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Acknowledgments

The development of this handbook was managed by Dr. Dan Petersen (U.S. Environmental Protection Agency). While developing this handbook, we sought the input of many individuals. Gratitude is expressed to each person for their involvement and contributions.

Ms. Debbie Brennan, Central Middle School, Tinley Park, Illinois

Ms. Dottie Fundakowski, Center for Creative Learning, Rockwood School District, Missouri

Dr. Alan Geller, Boston University Medical Center

Ms. Lannie Hagan, University of Colorado at Boulder's (CU's) Science Explorer Program, Boulder, Colorado

Ms. Betty Lacey, Montgomery County Medical Society Alliance of Dayton, Ohio

Mr. Greg Morrison, Goddard Middle School, Glendora, California

Mr. Kevin Rosseel, U.S. Environmental Protection Agency, SunWise Program, Washington, DC

Dr. Mona Sariaya, Centers for Disease Control and Prevention

Mr. Craig Sinclair, Anti-Cancer Council of Victoria, Australia

Disclaimer

This document has been reviewed by the U.S. Environmental Protection Agency (EPA) and approved for publication.

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1.0 INTRODUCTION

The sun is necessary for life, and while some exposure to sunlight is enjoyable, too much can be dangerous. There is increased concern that, due to the depletion of the ozone layer, more of the sun's rays are reaching Earth than ever before. Overexposure to ultraviolet (UV) radiation can lead to adverse health effects, such as blistering sunburns, skin cancer, eye problems, and premature aging of the skin. More than 1 million people in the United States are diagnosed with skin cancer each year, making it the most common form of cancer in the country. In fact, 90 percent of skin cancers are linked to sun exposure.[1]

Skin cancer and other health risks are largely preventable, however. Communities have access to a host of tools to help understand the risks from overexposure to the sun and how to protect themselves from harmful UV radiation. One of the most useful tools is the UV Index, which is a daily forecast of the level of UV exposure for a particular area of the country.

This handbook is designed to provide you with instruction and guidance on how to inform your community about the risks posed by overexposure to UV radiation and the steps that residents can take to reduce these risks. You will also learn more about the UV Index and how it can be incorporated into a successful sun protection education program. This handbook was developed by the U.S. Environmental Protection Agency's (EPA's) Environmental Monitoring for Public Access and Community Tracking (EMPACT) program. EPA created EMPACT in 1996 to take advantage of new technologies that make it possible to provide environmental information to the public in near-real time. EPA partnered with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS) to help achieve nationwide consistency in measuring environmental data, managing the information, and delivering it to the public.

EMPACT projects have been initiated in 156 metropolitan areas. (See table at the end of this chapter.) These projects cover a wide range of environmental issues, such as groundwater contamination, ocean pollution, smog, and overall ecosystem quality.

EMPACT projects aim to help communities:

- Collect, manage, and distribute time-relevant environmental information.
- Provide their residents with easy-to-understand, practical information they can use to make informed, day-to-day decisions.

Some projects have been initiated directly by EPA; others have been launched by communities with the help of EPA-funded Metro Grants. EMPACT projects have helped local governments build monitoring infrastructures and disseminate environmental information to millions of people.

1.1 What Is EPA's SunWise Program?

The SunWise School Program is an EMPACT project that raises awareness of the health risks of overexposure to the sun and aims to change behaviors to reduce these risks. This national program reaches out to children in grades K through 8, their teachers, and their caregivers. Through the use of classroom-, school-, and community-based lessons and activities, SunWise helps children:

- Follow action steps to reduce their exposure to UV radiation (see Chapter 4).
- Develop skills for sustained SunWise behavior and appreciate the environment around them.

SunWise activities and publications discuss the causes and effects of UV radiation, as well as how to monitor local and national UV levels using the UV Index.

The SunWise Web site (www.epa.gov/sunwise) provides detailed information on the program and is a comprehensive online resource for sun safety information. In addition, NOAA's Climate Prediction Center (www.cpc.ncep.noaa.gov) provides daily updates of the UV forecast for U.S. and international cities.

SunWise
a school program that **radiates** good ideas

1.2 What Is the Purpose of This Handbook?

This handbook provides information your community will need to develop a UV risk education program. The handbook is organized as follows:

- **Chapter 2** describes the health and environmental concerns of UV radiation, including detailed information on skin cancer, skin aging, cataracts, and immune system suppression. It describes the different types of UV radiation and discusses the relationship between ozone depletion and increased UV radiation, including the science of ozone depletion.
- **Chapter 3** includes detailed information on the UV Index, including when and why it was established, what it measures, what UV monitoring systems exist, and how the UV Index is influenced by factors such as elevation, cloud cover, time of day, and latitude.
- **Chapter 4** discusses how to communicate sun protection and public health information to residents. A UV/sun protection outreach project can take many forms, from a sustained, multi-year, community-wide effort to a seasonal campaign at parks and recreation centers. This chapter of the handbook explains the steps involved in developing a sun protection outreach program for a community and provides profiles of successful initiatives in the United States and internationally. It also describes a variety of successful tools and strategies that can be used in schools and communities, and it provides guidance for communicating information about sun protection and health risks to the community.

This handbook is designed for decision-makers and public health officials who may be considering whether to implement a UV risk communication or outreach program in their community, and for outreach coordinators or other individuals who are in charge of implementing community-based programs.

This handbook references supplementary sources of information, such as Web sites, publications, organizations, and contacts, that can help the user find more-detailed guidance. Interspersed throughout the handbook are success stories and lessons learned from communities and organizations that have already implemented UV outreach programs.

1.3 EMPACT Metropolitan Areas

Albany-Schenectady-Troy, NY
Albuquerque, NM
Allentown-Bethlehem-Easton, PA
Anchorage, AK
Appleton-Oshkosh-Neenah, WI
Little Rock-North Little Rock, AR
Los Angeles-Riverside-Orange County, CA
Louisville, KY
Lubbock, TX

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, NY
Burlington, VT

Canton-Massillon, OH
Charleston-North Charleston, SC
Charleston, WV
Charlotte-Gastonia-Rock Hill, NC-SC
Chattanooga, TN-GA
Cheyenne, WY
Chicago-Gary-Kenosha, IL-IN-WI
Cincinnati-Hamilton, OH-KY-IN
Cleveland-Akron, OH
Colorado Springs, CO
Columbia, SC
Columbus, SC
Columbus, GA-AL
Columbus, OH
Corpus Christi, 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

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
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
Providence-Fall River-Warwick, RI-MA
Provo-Orem, UT

Raleigh-Durham-Chapel Hill, NC
Reading, PA
Reno, NV
Richmond-Petersburg, VA
Roanoke, VA
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
Sound Bend, IN
Spokane, WA
Springfield, MA

Hickory-Morgantown-Lenoir, NC
Honolulu, HI
Houston-Galveston-Brazoria, TX
Huntington-Ashland, 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
Lexington, KY
Lincoln, NE

Springfield, MO
Stockton-Lodi, CA
Syracuse, NY

Tallahassee, FL
Tampa-St. Petersburg-Clearwater, FL
Toledo, OH
Tucson, AZ
Tulsa, OK

Utica-Rome, NY

Visalia-Tulare-Porterville, CA

Washington-Baltimore, DC-MDVA-WV
West Palm Beach-Boca Raton, FL
Wichita, KS

York, PA
Youngstown-Warren, OH

[1]American Cancer Society, "Cancer Facts and Figures 1999."

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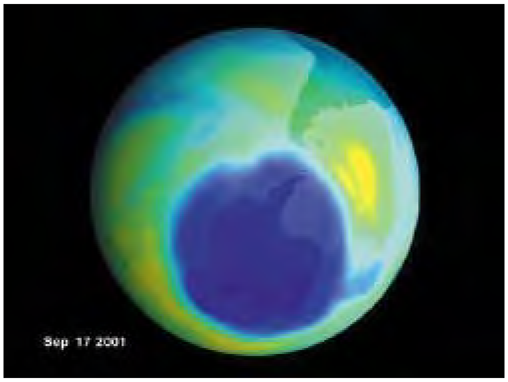
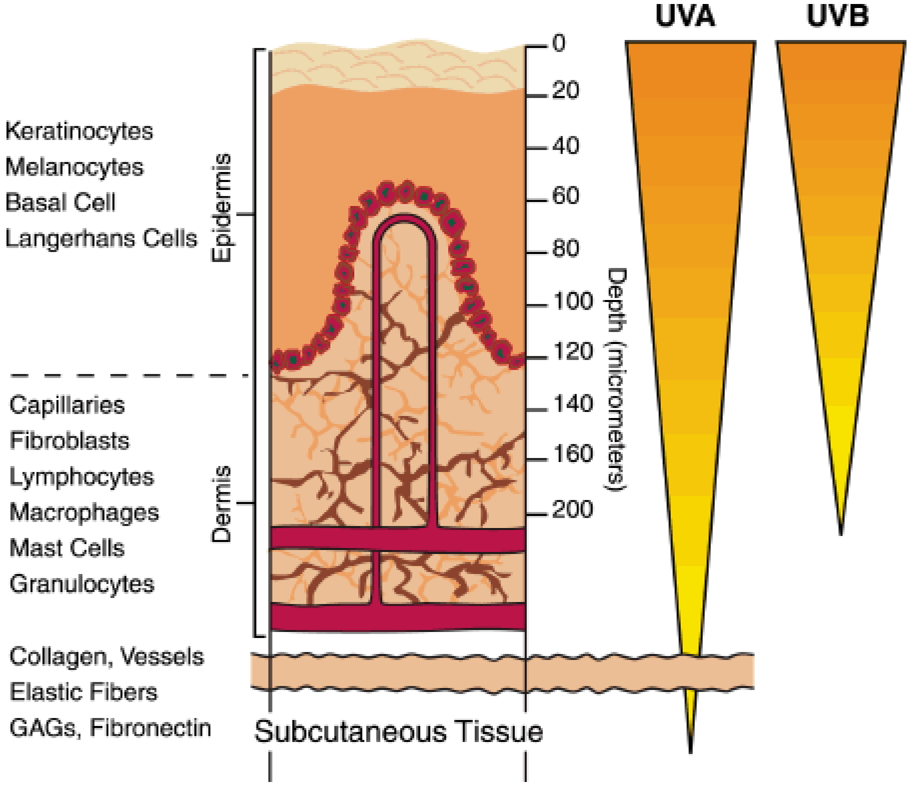
2.0 HEALTH AND ENVIRONMENTAL CONCERNS OF UV RADIATION



Ultraviolet (UV) radiation is a natural but dangerous part of the sun's energy. The ozone layer, located between 6 and 30 miles above the Earth in the stratosphere, blocks most of this radiation from reaching the Earth's surface and makes our planet livable. A dramatic loss of stratospheric ozone was first noticed in the mid-1980s above Antarctica. Since then, scientists have confirmed significant seasonal losses of stratospheric ozone over Antarctica and the Arctic region, and less dramatic losses in mid-latitude regions such as North America. The depletion of the ozone layer has created heightened concern about the health and environmental effects of increased UV radiation. UV radiation is known to cause a number of different health effects, including skin cancer and cataracts, and increased UV radiation is suspected to be contributing to a number of environmental problems, including the worldwide decline in frog populations and the bleaching of coral reefs.

2.1 What Is UV Radiation?

UV radiation is an invisible form of energy that has a shorter wavelength than either blue or violet light. UV radiation is made up of three components: UV-A, UV-B, and UV-C rays. Although the ozone layer does not absorb UV-A rays, it does absorb most UV-B rays and virtually all UV-C rays. UV-A rays penetrate deep into the skin and heavily contribute to premature aging, while UV-B rays mostly impact the surface of the skin and are the primary cause of sunburn. Both UV-A and UV-B have been linked to a number of other health effects, including skin cancer, and UV-B rays have been implicated in environmental effects from UV radiation. The main threat resulting from the depletion of the ozone layer is increased UV-B effects, even though UV radiation is only about 2 percent UV-B.



2.2 How Does the Ozone Layer Block UV Radiation?

The ozone layer is very important because it absorbs most UV-B rays and virtually all UV-C rays. The ozone molecules that make up the stratospheric ozone layer are each made up of three oxygen atoms. When ozone absorbs UV radiation, it creates heat as it splits into a pair of oxygen atoms and a lone oxygen atom, which eventually recombine to form ozone again. The molecular structure of ozone can be altered by human-made chemicals that are emitted into the air. When this happens, the stratospheric ozone layer can be depleted.

Chlorofluorocarbons (CFCs) are the principal cause of ozone depletion, although a number of synthetic halocarbon chemicals also are known to reduce stratospheric ozone. CFCs were once widely used as propellants in spray cans, as refrigerants and electronics cleaning agents, and in foam and insulating products. Other ozone-depleting substances include pesticides such as methyl bromide, halons used in fire extinguishers, and methyl chloroform used in industrial processes. CFCs now are banned from production in the United States and many other countries, but they still are found in certain products. CFCs can escape into the air during CFC manufacturing, from leaks in air conditioners and refrigerators, and when used appliances are disposed before recovering the remaining CFCs within them.

When CFCs are released into the air, they do not break down. Instead, they are mixed and dispersed by atmospheric currents. This process can continue for 2 to 5 years, until the CFCs eventually reach the stratosphere. In the stratosphere, CFCs break down and release chlorine atoms when exposed to UV radiation. The chlorine atoms destroy ozone, but are not destroyed themselves. As a result, each chlorine atom can destroy a large amount of ozone (up to 100,000 ozone molecules) before it is eventually removed from the stratosphere by other atmospheric processes.

Ozone depletion is heightened above the North Pole and especially the South Pole. The very cold, dark winters of the polar regions cause stratospheric ice clouds to form, and this promotes the breakdown of CFCs. Each spring above Antarctica, up to 60 percent of the ozone layer disappears and does not return to normal until the summer. The Arctic loses up to 25 percent of its ozone layer each spring, while mid-latitude regions, such as North America, lose up to 5 percent. Global warming, which occurs when greenhouse gases prevent heat from escaping from the lower atmosphere into the stratosphere, can set the stage for increased ozone depletion by creating a colder environment in the stratosphere.

In 1987, countries from around the world recognized the threat to the ozone layer and signed a treaty—the Montreal Protocol on Substances that Deplete the Ozone Layer—to reduce the global production of ozone-depleting substances. Amendments in 1990, 1992, 1995, and 1997 strengthened the treaty to promote the earliest possible restoration of the ozone layer. Scientists predict that ozone depletion will peak between 2000 and 2010. With full compliance from participating countries, the ozone layer is expected to be restored by the middle of this century. Until that time, however, increased levels of UV radiation will reach the Earth's surface.

2.3 How Does UV Radiation Affect Your Skin, Eyes, and Immune System?

Overexposure to UV radiation can cause a number of health effects, including skin cancer, accelerated skin aging, cataracts, and a suppressed immune system.

Skin Cancer

Everyone knows the short-term discomfort of too much sun—redness, tenderness, swelling, and even blistering. However, overexposure to the sun and repeated sunburns can lead to a much worse condition—skin cancer. More than 1 million Americans are diagnosed with skin cancer every year, representing nearly half of all cancers diagnosed annually. One in every five Americans will get some type of skin cancer in his or her lifetime. There are three main types of skin cancer: melanoma, basal cell carcinomas, and squamous cell carcinomas. (See Section 2.5 for descriptions of the different types of skin cancer and how to recognize them.)

Skin Aging

Repeated overexposure to the sun causes changes in the skin called actinic (solar) degeneration. Over time, the skin becomes thick, wrinkled, and leathery. This condition occurs gradually, often appearing many years after the majority of a person's exposure to the sun. Up to 90 percent of the visible skin changes commonly attributed to aging are caused by sun exposure.[2] Many people believe that photoaging is a normal, but unavoidable, part of growing older. However, with proper protection from UV radiation, photoaging can be substantially avoided.

Cataracts

Research has shown that UV radiation increases the chances of developing cataracts, a form of eye damage that involves a loss of transparency in the lens of the eye. Although curable with modern eye surgery, cataracts affect millions of Americans each year. If left untreated, cataracts can cause cloudy vision and lead to total blindness.

Exposure to UV radiation may also increase the chances of other types of eye damage, including pterygium, a tissue growth on the white of the eye that can block vision, and macular degeneration. The macula is the part of the retina near the center, where your vision is most sensitive. Macular degeneration may include development of spots that can result in blindness.

Immune System Suppression

Scientists have found that sunburn can affect disease-fighting white blood cells for up to 24 hours after exposure to the sun, making your body more prone to infections and cancers. Sun exposure can aggravate diseases such as herpes simplex (cold sores), chicken pox, and lupus. Repeated exposure to UV radiation might cause more long-lasting damage to the body's immune system. Mild sunburns can directly suppress the immune functions of human skin where the sunburn occurred, even in people with dark skin.

2.4 Are Some People More Prone to the Effects of UV Radiation?

Skin Type

Everyone, regardless of race or ethnicity, is subject to the potential adverse effects of overexposure to the sun. However, skin type affects the degree to which some people burn and the time it takes them to burn. The Food and Drug Administration classifies skin type on a scale from 1 to 6. The lower the number, the lighter the skin color. Individuals with fair skin, skin types 1 and 2, tend to burn more rapidly and more severely. Individuals with darker skin, skin types 5 and 6, do not burn as easily.

The same individuals who are most likely to burn are also most vulnerable to skin cancer. Studies have shown that individuals with large numbers of freckles and moles also have a higher risk of developing skin cancer. Although individuals with higher-number skin types are less likely to develop skin cancer, they should still take action to protect their skin and eyes from overexposure to the sun. Dark-skinned individuals can and do get skin cancer.

Other factors

Factors other than skin type may affect a person's vulnerability to the sun's rays. Some medications, such as antibiotics and antihistamines and even certain herbal remedies, can cause extra sensitivity to the sun's rays. People taking medications should contact their physician to learn about potential risks resulting from sun exposure.

2.5 Recognizing the Signs of Skin Cancer

Skin cancer is one of the most treatable forms of cancer. Early detection of skin cancer can decrease chances of the cancer spreading to other parts of the body and increase chances of survival. The survival rate for patients with early stages of melanoma has increased from about 50 percent in the 1950s to about 90 percent today. Nonmelanoma skin cancers have an even higher cure rate—95 percent or higher if detected early.

Skin cancer occurs most commonly on areas of the body most exposed to the sun, such as the face, neck, ears, forearms, and hands.

Different Types of Skin Cancer

Melanoma is the most deadly form of skin cancer and one of the fastest-growing types of cancer in the United States, according to the American Cancer Society. New cases of melanoma in this country have more than doubled in the past 2 decades, with more than 53,000 cases expected in 2002. An estimated 7,400 people will die from melanoma in 2002, almost 4 times as many deaths as nonmelanoma skin cancers. Melanoma can spread to other parts of the body quickly, but when detected in its earliest stages, it is usually curable.

Melanomas often start as small, mole-like growths. The growth, an uncontrolled development of pigment-producing cells in the skin, leads to the formation of dark-pigmented malignant moles or tumors, called melanomas. Melanomas can appear suddenly without warning but also can develop from or near a mole. For this reason, people should know the location and appearance of moles on their bodies so they will notice any changes. Melanomas are most frequently found on the upper backs of men and women, and the legs of women, but they can occur anywhere on the body. To recognize potential problems, conduct periodic self examinations and watch for changes that meet the ABCDs of melanoma:

Asymmetry: One half of the growth does not match the other half.

Border irregularity: The edges of the growth are ragged, notched, or blurred.

Color: The pigmentation of the growth is not uniform. Shades of tan, brown, and black are present. Dashes of red, white, and blue also may appear.

Diameter: Any growth greater than the size of a pencil eraser should be examined by a doctor immediately.

The two types of **nonmelanoma skin cancers**—basal cell carcinomas and squamous cell carcinomas—are not as fatal as melanoma. An estimated 1 million Americans will develop nonmelanoma skin cancers in 2002, while approximately 2,200 will die from the disease.[3] Nonmelanoma skin cancers are the most common skin cancer found in fair-skinned people.

Basal cell carcinomas are tumors that usually appear as small, fleshy bumps or nodules on sun-exposed areas such as the face, lips, neck, ears, and hands, but may appear anywhere. This cancer does not grow quickly and rarely spreads to other parts of the body. It can, however, penetrate below the skin to the bone and cause considerable local damage.

Squamous cell carcinomas are tumors that might appear as nodules or as red, scaly patches. This cancer can develop into large masses, and unlike basal cell carcinoma, it can spread to other parts of the body. It is the most destructive type of skin cancer.

Going to the Doctor

A person should see a doctor or dermatologist if he or she sees any of the signs of skin cancer. To identify the warning signs, individuals can periodically examine their skin, especially after prolonged periods in the sun. Skin self-examinations consist of regularly looking over the entire body, including the back, scalp, soles of feet, between the toes, and on the palms of the hands. If there are any changes in the size, color, shape or texture of a mole, the development of a new mole, or any other unusual changes in the skin, a person should see his or her dermatologist immediately. As part of its screening program, the American Academy of Dermatology (AAD) can inform individuals annually when it is time to schedule their yearly visit for a skin cancer screening. AAD's Web site allows an individual to locate a skin cancer screening location in his or her community and sign up for annual notification. Volunteer dermatologists provide free skin cancer screenings as part of the program. See www.aad.org.

2.6 Why Are Children and Teenagers Most Vulnerable to Overexposure?

School-aged children spend a lot of time outdoors. They usually have the summer off and often spend many days swimming at beaches and community pools, playing team sports such as baseball and soccer, and attending summer camp. These outdoor activities mean more sun exposure. In fact, an estimated 80 percent of a person's sun exposure occurs before age 18.[4] Many dermatologists believe there might be a link between childhood sunburns and malignant melanoma later in life. Therefore, it is especially important for parents and caregivers to ensure that children consistently use sunscreen and take other protective measures. In addition, parents must remember to be good role models for children; parents who get a sunburn are more likely to have kids who get a sunburn.

2.7 What Are the Environmental Threats from UV Radiation?

In the regions of the world where ozone depletion has occurred, increased UV radiation threatens plants and wildlife on land and in the sea. These areas include Antarctica, the Arctic, and mid-latitude regions such as North America.

On land, increased UV radiation is suspected of contributing to population declines and limb deformities in frogs and other amphibians. It also is known to be damaging to some plants, particularly agricultural crops. UV damage to crops can affect growth and food quality, as well as the ability of plants to withstand pests and diseases. Crops, plants, and trees also provide food and shelter for many animals, so if these resources are damaged, other species and even entire ecosystems also can be affected.

In the sea, increased UV radiation damages sea grasses, sea urchins, corals, krill, and microscopic plants and animals known as plankton. Many of these organisms are important food resources. Plankton and krill are at the bottom of the marine food chain and feed a multitude of creatures, from starfish to whales. UV radiation also is suspected to be one of the reasons why some colorful corals are turning white and dying.

In addition, in areas with high levels of air pollution, an increase in UV radiation can worsen air quality. Increased UV-B radiation causes an increase in the reaction of nitrogen oxides with volatile organic compounds (byproducts of vehicle exhaust, industrial emissions, and chemical solvents), producing increased amounts of groud-level ozone. Exposure to ground-level ozone causes many health problems.

Although UV radiation has negative impacts on plants and wildlife, not all species are affected equally. Some agricultural crops are more tolerant of UV radiation than others, and some marine creatures are able to repair some UV damage at night. On the other hand, in areas affected by additional environmental impacts, such as pollution, UV affects might be more damaging.

[2]Taylor, C.R. et al, Photoaging/Photodamage and Photoprotection, J Am Acad Dermotol, 1990: 22: 1-15.

[3]American Cancer Society, “Cancer Facts and Figures 2002.”

[4]Stern RS, Weinstein MC, Baker SG. Risk reduction for nonmelanoma skin cancer with childhood sunscreen use. Arch Dermatol. 1986: 122: 537-545

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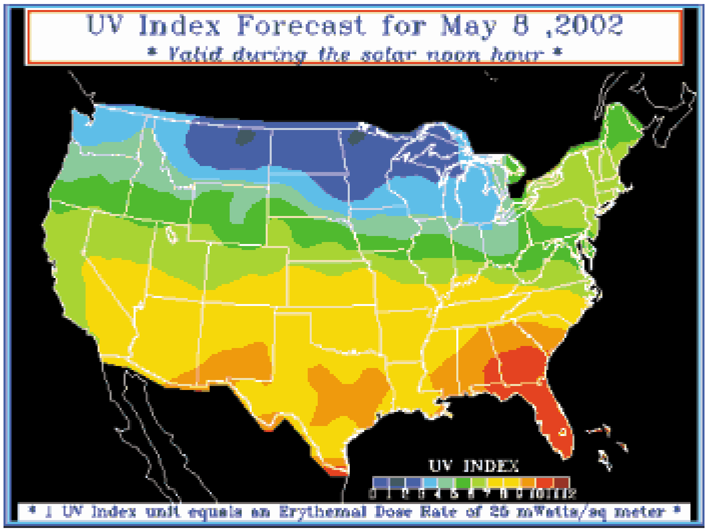
3.0 WHAT IS THE UV INDEX?

Developed by the National Weather Service (NWS), the UV Index forecasts the next day's ultraviolet (UV) radiation intensity at different locations on the Earth's surface for "solar noon," which is when the sun is at its highest point in the sky.

NWS first began testing an "Experimental UV Index" for 58 U.S. cities on June 28, 1994, in cooperation with EPA and the Centers for Disease Control and Prevention (CDC). Scientists at the NWS Climate Prediction Center developed the forecasting tool and its supporting science. In April 1995, NWS deleted the "experimental" and made the UV Index an official product. NWS subsequently has encouraged meteorologists to make similar UV Indices widely available across the country. In addition, it has worked with EPA and CDC, meteorologists, health and medical professionals, and the World Meteorological Organization to ensure there is consistency among different UV Indices. As a result, these groups, as well as the general public, use the UV Index and accept its widespread dissemination.



3.1 How Is the UV Index Calculated?

To derive the UV Index, scientists collect ozone data from satellite observations and atmospheric pressure and temperature forecasts and scale the information to produce an index with a range of 0 to 15. The UV Index is adjusted to account for the potential presence of clouds and the elevation of the location. The lower the number, the less UV radiation is reaching the surface. Low numbers occur when the sun is low in the sky (i.e., during winter) and during overcast conditions. A higher number is forecasted when the sun is higher in the sky (i.e., during summer) and during clear or only partly cloudy conditions.

NWS uses a computer model to calculate the UV Index. The model takes into account a number of factors, including the amount of stratospheric ozone and clouds overhead, latitude, elevation, and time of year. The model first calculates a UV "dose" rate, or the amount of UV radiation to which a person will be exposed at the next day's solar noon under "clear sky" (no clouds) conditions. Higher elevations will increase the UV dose rate because there is less atmosphere to absorb and scatter UV rays. Greater cloud cover will tend to reduce the UV dose rate because clouds screen out some—but not all—UV rays. The UV dose rates are then adjusted for the effects of elevation and cloud cover at specific locations.

Quick changes in cloud conditions can alter the predicted UV Index forecast. The UV Index is applicable to a 30-mile radius around the city for which it is forecasted. Because the UV Index does not take into account differences in surface reflectivity, individuals must make adjustments based on these factors. You get much more UV on snow, sand, water, and concrete, since these surfaces reflect the sun's rays back onto your skin, just like a mirror. The brighter the surface, the more UV is reflected—fresh snow and dry sand reflect the most.

The resulting value is the next day's UV Index forecast. The UV forecasts for select locations are provided daily using a 0 to 10+ scale, where 0 indicates a minimal likely level of exposure to UV rays and 10+ means a very high level of exposure. EPA's SunWise Web site (www.epa.gov/sunwise) includes a feature that allows the user to enter his or her ZIP code and receive the UV Index forecast for that location for the current day. (See Chapter 4 to determine what steps you can take to protect yourself from the sun under different UV Index situations.) For more information on how the UV index is calculated and validated, see Appendix D: How is the UV Index Calculated?

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4.0 RAISING AWARENESS IN THE COMMUNITY

As a person begins to gather information about ultraviolet (UV) exposure and its risks, he or she will want to consider how to effectively communicate this information to others in the community. A UV risk education project can take many forms, from a sustained, multi-year community-wide effort to a shortduration or seasonal campaign at selected venues, such as schools, recreation centers, or parks. This chapter of the handbook is designed to help the user determine the kind of project that is right for his or her community by providing:

- Examples of UV risk education projects.
- Steps involved with outreach planning.
- Educational tools and resources that can be used in your schools and community.
- Messages that every UV risk education program should convey.
- Guidelines and sample language for successfully communicating information about sun protection and health risks to the community.

4.1 Developing an Effective Outreach Program

Community outreach programs can take many forms, depending on issues such as the groups most at risk, the scope of the effort, the available resources, and the commitment of key leaders. Across the United States, different UV risk education programs have been developed and conducted with varying levels of effectiveness. In general, community-wide programs with a strong mass media component have been most effective, and sustained activities have proven more effectual than shorter or one-time projects. Additionally, sun protection and health risk messages have more resonance when they are consistent and repeated. People also tend to trust the "messenger," so consider credible sources within the community (e.g, schoolteachers, pediatricians, dermatologists) to deliver your messages.

Many communities will want to build on existing UV risk education programs, such as SunWise, PoolCool, and the SunWise Stampede. Schools can join EPA's SunWise School program to receive free educational materials for classes and assistance with developing school policies that promote sun safety. In addition, the Centers for Disease Control and Prevention have recently issued guidelines urging schools to try to protect children from excess sunlight by implementing policies designed to minimize students' midday sun exposure. Be aware that sunscreen technically is considered an over-the-counter drug, similar to aspirin or cough drops, and in most state school districts, it is prohibited from student use without doctors' and parents' permission to allow nurses or aides to administer it. However, this is a barrier that can be overcome, as students in the Rockwood, Missouri, school district successfully demonstrated (see Appendix B: Case Studies of UV Risk Education Programs). Swimming pool managers can contact the PoolCool program for free sun-safety signs and technical support to promote sun protection during pool activities. Local zoos can participate in SunWise Stampede, a program designed to promote sun safety to zoo visitors. (See Appendix A: List of Resources for more information on these and other UV/sun protection programs.)

Other communities will want to develop their own UV risk education programs or modify educational materials from existing programs. Throughout this chapter, a wide variety of ideas are presented for UV risk education projects. Regardless of the type of program you ultimately choose to implement, it is important to first think through issues such as your goals, audiences, messages, resources, available tools, and measurement options before committing to a plan of action.

Lastly, it can help to work with others who are also interested in promoting sun safety in your community. For example, you can contact your local chapter of the American Cancer Society (ACS) (see the "In My Community" section of the

ACS Web site (www.cancer.org) to ask about working with volunteers or ACS staff. Another option is to inspire others in your community to become sun safety advocates. For example, parents especially can be strong advocates for sun safety. They can inspire others by giving informal presentations on sun safety at the local library or at a parent-teacher association, by setting up a table and distributing sun safety brochures at a community festival or sporting event, or by working with the local media to broadcast messages on sun safety. By working with other like-minded individuals, you can have more of an impact on UV risk education efforts by expanding the reach of your effort, by having more resources available, and by having a stronger voice to advocate for policies and programs in your community that promote sun safety.

Step 1: What Are You Trying To Accomplish?

The first step in any outreach effort is to define what you want to accomplish. In general, UV risk education programs aim to:

- Increase awareness of sun exposure, UV radiation health risks, and sun safety measures.
- Change behaviors and attitudes to ensure sun safety.
- Change policies to reduce sun exposure and encourage sun safety.

Getting your community's residents to change the way they view sun exposure and tanning and to always practice sun-safe behaviors is ultimately the best way to prevent skin cancer and the other adverse health effects of UV overexposure. It can, however, be difficult to effect permanent attitude and behavior change. For this reason, many communities will begin or also seek to make changes at the policy level. Policy changes have proven effective because they don't rely on individuals to take voluntary actions. Additionally, policies can serve as reminders to people of the importance of a particular behavior. Examples of community policies to encourage sun safety and reduce sun exposure include:

- Providing shade infrastructure at community parks, recreational areas, or school grounds.
- Requiring the posting of signs at recreational sites, such as parks, beaches, and pools, that encourage sunscreen and hat use and limiting time spent in the sun.
- Requiring parents to provide their children with hats and sunscreen at community outdoor camps.
- Requiring teachers to apply sunscreen to children before recess or enforcing a no hat, no play rule at schools: children who do not wear a hat must sit or play in the shade during recess and other outdoor breaks.
- Requiring very brief sunscreen breaks for children at outdoor pools, camps, and recreation sites.
- Passing legislation that encourages sun safety and education. For example, California introduced a sun safety law that specifies skin cancer as a type of employment "injury" for lifeguards. Under the bill, affected lifeguards could potentially receive payment through the workers' compensation system.

Some communities also craft their programs to not only encourage sun safety, but also to specifically raise awareness of skin cancer. Goals for these programs can include:

- Increasing people's knowledge of what skin cancers look like.
- Increasing the number of people who seek medical advice and early screening.
- Encouraging medical practitioners to educate patients and adults about skin cancer and check all adult patients.

Keep in mind that, with the right tools, many outreach programs (both short- and long-term) can be effective in raising a community's knowledge of sun exposure, skin cancer and other health risks, and sun-safe practices, but more sustained and intense programs are generally more successful in effecting permanent behavior change and attitudes.

As you begin to define your goals, keep in mind how you will measure achievement of them. For example, if one of your aims is to change behaviors of elementary school-age children at recess, how will you make sure this goal is achieved? Or if you seek to have the UV Index broadcast on your local television channel daily, how will you track these broadcasts? Whenever possible, define your goals in concrete, measurable terms and consider how you will follow up. You might also consider seeking the help of someone experienced in measurement as you define your goals—consider hiring or recruiting a volunteer with a background in statistics or market research. (See “Step 6: How Will You Measure Success?”)

Developing a Sun Protection Policy for Schools

To ensure the success of sun protection policies at schools, it is important to work with parents, students, and school staff to help them understand the purpose of the policy and to encourage them to implement it. Adjust the policy based on the recommendations of the school community. Consider the following suggestions:

- Form a committee that includes representatives from the school community affected by the policy.
- Conduct information sessions to explain the purpose of the policy.
- Consider sun protection measures that might already be in place at the school.
- Prepare a draft policy and ask for comments.
- Request endorsement of the final policy from the school council or other appropriate organization.
- After implementing the policy, publicize it to ensure everyone is aware of the policy and its purpose.
- Monitor and evaluate the success of the policy.

(This information was adapted from Australia’s SunSmart program. For more information, go to www.sunsmart.com.au.)

Step 2: Who Are You Trying To Reach?

Successful outreach hinges on defining and understanding the target audiences you are trying to reach within the community. Outreach can be targeted at a variety of audiences, including:

- Children/young adults
- Parents and adult caregivers
- Outdoor occupational workers and recreational users
- Health care community
- Community leaders and activists
- Older adults and senior citizens

An outreach project can be directed at one or more primary audiences, such as children, or focus more specifically on a particular subset within an audience, such as elementary school-age children. A broad, community-based effort will most likely target multiple audiences, including children and their parents or adult caregivers, businesses and workers, the health community, community group leaders, the school district, and community and recreational directors.

When considering the audiences at which to direct your program, look at your community and determine the groups of people most at risk and the places where people are likely to be sun-exposed. In many communities, children are a primary target audience program, given that the majority of a person’s lifetime exposure takes place before age 18. Other individuals most at risk from adverse health effects due to overexposure to the sun include people who:

- Spend a large amount of time outdoors (e.g., construction workers, people at the beach).
- Have lighter skin types.
- Have certain diseases such as lupus.
- Are taking certain medications such as antibiotics, antihistamines, or some herbal remedies.

However, anyone who spends time outdoors, regardless of their risk level, are subject to the potential adverse effects of overexposure to the sun. Keep in mind that often a more in-depth educational message can be delivered to a smaller group of people, while a more simple message can be delivered to many people. Audiences that receive a more in-depth message are probably more likely to change their behavior than those receiving a more simple message.

Children and Young Adults

Many successful programs have been developed that reach out to children and young people directly, most frequently in schools, but also in childcare organizations, recreational centers and sites, service programs (e.g., 4-H, girl and boy scouts), and other community organizations that serve large numbers of children.

Within the school system, teachers, administrators, superintendents, nurses, and parent/teacher organizations can all be effective partners in changing behaviors, instituting policies, and generally spreading the sun protection word. An easy step for your community would be to find an elementary school teacher who is interested in joining EPA's SunWise Program. The teacher would then receive free teaching materials and classroom activities. Once this teacher's class has implemented the program, results and messages can be shared with other classrooms, schools, and even the community at large through activities and events such as sports matches, parents' nights, presentations in the auditorium, and exhibitions in school halls or community libraries. Teachers can also work with parent-teacher associations to encourage school sun protection policies or with school nurses who also can promote sun protection to students.

Older children can be effective messengers in delivering the sun protection message to their peers and younger classmates and siblings. Children look up to older peers, and the message may resonate more for teenagers if they hear it from someone their own age. Parental influence also can be beneficial, especially if used in concert with other factors, such as opportunities for children to self-select types of personal sun protection (e.g., hats, sunscreen, clothing).

Effective Messages: Having a SunWise Field Day

As participants in a SunWise pilot, students in 6th and 7th grade health classes at Brownstown Middle School in Brownstown, Michigan, successfully reached out to the rest of the school in sending a SunWise message. Prior to one of the school's annual field days, when students compete in outdoor events, the students in the health classes launched a sun-safe campaign, encouraging their schoolmates to use sunscreen, hats, and sunglasses during the event. To help spread the safety message, the classes made posters to hang in the school's hallways and asked local businesses to donate sunscreen for the students to use on the field day. Teachers noted no incidences of sunburn as a result.

SunWise students at the same school also have planted oak saplings on the school grounds to eventually provide protective shade for students participating in outdoor activities.

For examples of other successful SunWise schools, see Appendix C.

Parents and Adult Caregivers

Parents, child-care workers, and other adult caregivers are important target audiences because they often are role models

and can be instrumental in encouraging children to practice sun-safe behaviors. Additionally, parents often influence the organizational policies within schools and the community that can promote sun protection for children, and can be effective champions in changing practices or policies. Parents and caregivers can be reached though a variety of ways, such as through health events conducted at schools and community recreational sites; through educational materials distributed at schools, recreational centers, and community sites; through radio, print, and television announcements; and through the health care system.

Outdoor Occupational Workers and Recreational Users

Don't overlook other people who might be at particular risk of sun overexposure in your community, including those who work outside (e.g., lifeguards, farmers, fishers, landscapers, construction workers) and those who spend a lot of time engaged in outdoor recreational activities, including both children and adults. Occupational UV risk education programs should look at targeting the workers themselves, as well as the businesses that employ them. Trade organizations and unions are other potential audiences. Recreational UV risk education programs could reach out to individuals and groups such as zoo workers, park rangers, golf course and tennis court managers, fitness centers, marinas, sports and bicycle shops, and community garden clubs. You might consider a training program to help community workers, such as lifeguards, parks and recreational directors, or camp leaders, incorporate sun protection messages and practices into their programs. With these audiences, it is especially important to communicate the potential health effects of UV overexposure and the importance of medical consultations, screening, and early detection.

Health Care Community

Maternity nurses, school nurses, dermatologists, pediatricians, and other medical practitioners can all play key roles in communicating sun protection and health risk messages to their patients. Many of these individuals are already working with their patients to communicate this information; others, like school nurses, can receive training and encouragement to do so. Some communities have found that reaching out to new parents in maternity wards and through well child visits is particularly effective; not only does this encourage parents to protect babies and toddlers from sun exposure, it can also instill these behaviors in children as they grow older. The health care community can be important allies in not only encouraging sun safety, but also in raising awareness of skin cancer signs and stressing the importance of screening.

Community Leaders and Activists

Outreach efforts are most successful when there are champions behind the cause, volunteering to help with whatever needs to be done—from stuffing envelopes to rallying community support. Look to those individuals in your community who have the ear of your residents for help in spearheading your efforts and spreading the word. Community activists, such as those already working on health or children's issues, also can be effective partners.

Older Adults and Senior Citizens

Older adults and senior citizens are still at risk of overexposure to the sun, particularly those who spend large amounts of times outdoors. This audience, in particular,

requires education and awareness-building concerning the health effects of sun overexposure, such as skin cancer, which could now be manifesting. The health community, senior citizen centers, assisted living centers, and organizations directed at retired individuals are all potential avenues for reaching these individuals and encouraging early screening and detection of sun-related health issues.

Step 3: What Do You Want To Communicate?

Think about the key points or messages you want to communicate through your effort. While the messages will vary depending on the audience you are targeting, they should be consistent, repeated, and delivered by credible sources or role models. It is also important to think through the potential barriers you might encounter, such as people's desire for a suntan or enjoyment of sports and other outdoor activities, in attempting to reach out to different target audiences.

Section 4.3, "Communicating UV Risk Information to the Community," presents some basic communication guidelines to consider when reaching out to the public about UV radiation and sun exposure. It also provides sample text and sun protection messages that can be incorporated into your actual outreach products.

If you are considering a large media component in your outreach, it is useful to pretest the chosen messages and slogans with your targeted audiences (through means such as surveys or focus groups) before executing the actual campaign. Testing will help you determine if your messages are appropriate and effective. Depending on the scope of your effort, you might hire a professional or find a volunteer who has market research experience. But don't forget that a number of community and national campaigns on sun protection and skin cancer have already been successfully launched, and you can also learn from the formative research and testing that these programs have already conducted when developing your own messages (see Appendix B: Case Studies of UV Risk Education Programs).

Step 4: Who Will Lead the Effort?

Within a community, various individuals and government offices share responsibility for communicating public health information to residents. Consider building a coalition with these and other individuals who will commit to and help execute your mission. For a short-duration or limited effort, you may need to simply identify a handful of committed people who can work with you to reach your targeted audience. These may be people within your organization, your school system, or the community at large.

For a school-based program, such as SunWise, an individual teacher might initially take the lead role, incorporating lessons focusing on sun protection in the classroom and encouraging sun-safe behaviors at recess and after school. This individual and the class can also become "champions" for spreading these messages to other classrooms and schools. Within the school system, a group of parents from a parent-teacher organization can also be effective leaders in encouraging policy changes, such as planting trees around the playground or requiring children to wear hats and sunscreen at recess.

Leadership for a program can also come from unexpected sources. In Dayton, Ohio, a group of dermatologists were the impetus behind the Raising Awareness About Your Skin (RAYS) program; however, the program's development and leadership were carried out by the Montgomery County Ohio Medical Alliance, a volunteer group made up of doctors' spouses. (See Appendix C: Successful SunWise Programs for more information on RAYS.)

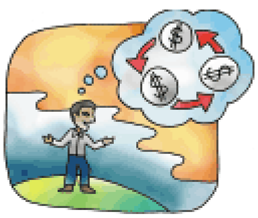
For a broad-based community effort, such as the Safe Skin Project conducted in Falmouth, Massachusetts, (see Appendix B: Case Studies of UV Risk Education Programs) you might want to set up a town-wide advisory board made up of community leaders, organization representatives, and select community members. The advisory board would be instrumental in planning and implementing the program, as well as for gaining recognition and support in the community. Members of such a board could include:

- Elected officials
- Local health department officials

- Pediatricians and physicians
- Dermatologists
- Maternity nurses
- Child-care directors
- Recreational program directors
- School superintendents, teachers, and nurses
- Parents
- Teenagers

In some communities, advisory boards are made up of people with a history of working together. The advantages to this approach are that people know and feel comfortable working with each other. In other communities, there is an intentional effort to build a board of "unlikely partners"—people that might view sun protection from quite different experiences and perspectives. While establishing this kind of advisory board may require more up-front effort, it can also yield more positive results.

Finally, you might want to team up with other communities in your area to develop a regional campaign. The advantages of a regional campaign are many, including the ability to pool resources, share responsibilities, reach out to more people, and deliver consistent and repeated messages in a larger geographic area.



Step 5: How Will You Fund Your Outreach Program?

Resources are essential to any outreach effort. While the resources required for an outreach effort will vary depending on the scale and goals of your program, it's important to consider early on what type of resources (e.g., personnel, facilities, research, publicity) are required, if they are readily available, and how will they be managed, as these decisions can impact your effort. Consider local sources of funding, such as from the city or county government, as well as state and even national sources, such as grants from government agencies or organizations that fund health-based research or work on children's health issues (see Appendix A: List of Resources for more information).

Sponsors or partnering organizations also can be recruited to lend their resources and credibility to the program. Think of the various sectors of your community, and of the organizations and agencies that could help carry out your objective, particularly those that are already working with your targeted audiences. For example, Australia's SunSmart campaign partnered with several recreational organizations, including tennis and cricket associations. When considering sponsors, think in terms of your community's variety of racial and ethnic groups, income levels, occupations, and political views. Once you have recruited sponsors, solidify their commitment. Consider a pledge of participation to help sponsors understand their role and make explicit their commitment to the program.

Donations, bartering agreements, and volunteer support can also be useful in stretching your outreach dollar. The RAYS program, for example, received funding from the Children's Medical Center in Dayton, Ohio, in exchange for printing the center's name on the program's risk education CD-ROM. In addition, consider asking a local printer or copier to print your sun protection flyer at no cost; in return, provide a credit thanking the printer on the cover, which also serves to advertise the business.

Step 6: How Will You Measure Success?

Measuring the impacts of your program provides many benefits. It is always useful to know if your outreach is having an effect and if you are accomplishing what you set out to do. Additionally, having concrete measures of the results you have achieved might help you improve your program, consider ways to redirect your resources for future efforts, and even solicit additional funding.

You can measure success in a variety of ways, depending on the goals you establish. For this reason, it is important to think about measurement when you are establishing goals. (See Step 1: What are You Trying to Accomplish?) In many cases, it is useful to have baseline knowledge and information to evaluate trends in your community and predict what is in store in the near future. Many groups and communities that have instituted UV risk education programs make use of surveys, which are conducted before and after the launch of a program to measure attitude and behavior change. Some programs also have conducted follow-up surveys at different intervals (e.g., 3 months, 6 months, or 1 year) to gauge longterm behavior change regarding sun safety.

Communities interested in conducting attitudinal/behavior surveys might consider looking at those that have already been done (see the text box, "Sample Survey Questions," and Appendix A: List of Resources) for ideas on the types of questions to ask. Many surveys ask respondents to check the sun protection measures currently in place; after a program is implemented, the surveys are repeated and then cross-checked to see if improvements have been made. Some surveys also attempt to gauge respondents' awareness and attitudes regarding sun exposure before and after a program is implemented. Others also include questions designed to gather information to determine if policy, education, and training goals have been met. Any survey you develop should be closely linked to the goals you establish.

Sample Survey Questions

The following questions are from the community surveys given during the Falmouth Safe Skin Project (see section 4.2, Successful UV Risk Education Programs, for more information).

- Has your child ever had a painful sunburn? (Y/N)
- During a typical week this past summer, how often did your child go to the beach? (Never, 1-2, 3-5, every day)
- In the past 5 years, has your child intentionally worked on getting a suntan? (Y/N)
- Have your child's sunbathing habits changed compared to last year? (More, less, same, never)
- When going to the beach on a hot, sunny day, does your child wear a shirt or hat? (All, most, rarely, never)
- How often does your child use sunscreen at the beach? (Always, often, sometimes, rarely, never)
- How often does your child use sunscreen when outside in the summer but not at the beach? (Always, often, sometimes, rarely, never)
- During the past summer, if your child was outside for 6 hours on a hot day, how much of the time did he or she have on sunscreen? (6 hours, 3-5, 1-2, never)
- Compared with last year, how likely is your child this year to use sunscreen? (More, same, less)
- In the past 5 years, have you (as a parent) intentionally worked on getting a suntan? (Y/N)
- How often do you use sunscreen when you are sunbathing? (Always, often, sometimes, rarely, never)
- Do you find it difficult to protect your children from the sun? (Y/N)
- During the past summer, on hot days, how often did you insist that your child use sunscreen? (Every day, most days, half the time, less than half the time, rarely, never)
- Do you (as a parent) think that people look more healthy when they have a suntan? (Y/N)
- Does your child really enjoy getting a suntan? (Y/N)
- Compared with last year, has your child's interest in getting a tan __? (increased, stayed the same, decreased)

This summer, my child told me that sunscreen prevents skin cancer. (Y/N)

- Have you (as a parent) ever heard of the disease malignant melanoma? (Y/N)

Given the technical nature of developing and administering scientific surveys, you might consider recruiting or hiring a statistician or market research expert (possibly as a member of your advisory board) to help you define goals and measure outcomes, particularly if the media is a major component of your program.

Step 7: What Outreach Tools and Community Events Will You Need To Communicate Your Messages?

Many organizations, including EPA, have already developed free tools that are available to the public. You may be able to use or modify these tools to meet your needs, especially those developed as part of EPA's SunWise School Program. (See Appendix A: List of Resources.) Be aware that most government-produced materials are typically in the public domain, which means they are available for public use and dissemination; programs developed by the private sector or other organizations may, however, be copyrighted. If you have doubts about the legality of using existing materials, contact the organization for more information.

There are many benefits to using existing materials, including saving money and resources, and accessing pretested messages. Some communities, however, might want to launch their own targeted campaigns, with their own slogans and artwork. Even if you develop your own materials, however, you might get useful ideas and save some time by looking at some existing tools.

The topics of sun safety and UV awareness can be explored through community events and a variety of outreach products spanning print, multimedia, electronic, and event formats. The table on the following page provides some examples.

The community events and products you choose should be based on the audience profile information you assembled in "Step 2: Who Are You Trying to Reach?" Think about which communication mediums are used most frequently and are most credible to your targeted audience. Then consider how you can use them as a vehicle for your message. A communications professional can provide valuable guidance in selecting the outreach products that will best meet your goals within your resource and time constraints. Questions to consider when choosing your products include:

- How much information does your audience need to have? How much does your audience know now?
- 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 the 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?
- 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 may be rapidly and widely disseminated by the media.

Print	Events

Fact sheets, brochures

Checklists

Health screening reminders

Newspaper articles, editorials by health professionals or elected officials

Articles in health, school, recreation department newsletters

Articles in children- and parent-oriented magazines

Public service announcements in health or community publications

Bill stuffers, postcards

Press releases, media kits

Curricula and other educational materials for children

Electronic

Web pages

E-mail messages

Computer-based or animated presentations at events or libraries

Multimedia

Posters	Exhibits
Radio public service announcements	Kiosks
Cable TV programs	Videos
Signs	

Community days or fairs

National Skin Cancer Awareness Month

School events

School field days

Sports events

Health fairs

Small group meetings

One-on-one meetings

Public meetings

Press conferences

Media interviews

Novelty Items

Cups

Hats

Frisbees

UV-sensitive beads

T-shirts

Banners

Bumper stickers

Mouse pads

Buttons

Magnets

Step 8: How Will You Distribute Your Products?

Effective distribution is essential to the success of any outreach effort. There are many avenues for distribution. Before choosing your route, consider the following questions:

- 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 may have limited access to it.

- Are sufficient resources available to fund and implement distribution via the mechanisms of interest?

The table on the following page lists some examples of distribution mechanisms and provides tips and ideas for their use in your community outreach efforts.

Successful outreach may generate requests for further information or concern about health and safety issues. Consider whether and how you will handle this interest. You may want to define, for example, who will handle requests for additional information and even indicate on the outreach product where people can go for further information (e.g., provide a contact name, number, or address.) In planning a follow-up strategy, also consider directing people to EPA for further information about SunWise and the UV Index. EPA's SunWise Web site at www.epa.gov/sunwise is an excellent resource, linking to a wealth of sun safety materials and resources.

Medium	Characteristics	SunWise-Specific Ideas
Mailing lists	Highly focused on a target audience of your choice. You can tailor the message included in different mailings.	–Identify mailing lists from partner organizations or community organizations that include decisionmakers, parents, educators, environmental groups, and health professionals. –Use existing SunWise informational materials inyour mailings.
Phone/Fax	More time-intensive and personal communication.	–Conduct a phone survey on sun safety awareness in your community. Use the opportunity to speak to people one-on-one about SunWise.
E-mail	Effective, economical way of reaching community members in the workplace.	–Target the e-mail lists of partner organizations, corporations, schools, healthcare, and child-care facilities. –Use existing SunWise materials to create and send out an e-mail detailing the action steps for protection, and how people can find out more about the UV Index and sun-safe behavior.
Internet	Reaches diverse audience, but site might need promotion to attract initial attention. Also, make sure your target audience is Web-savvy and has ready access to the Internet.	–Create a community portal site about sun safety. Link to EPA's SunWise Web site.
Journals or	More in-depth treatment of your	–See www.epa.gov/sunwise/presskit.html for

newsletter	message, may use direct quotes from press releases; requires advance planning.	example press releases that you can send to local journals and newsletters to promote sun safety and encourage schools to join SunWise. –Write your own press release on a SunWise news story of local interest in your community, such as a school project or community partnership, to attract media attention. –Develop and track media contacts, such as meteorologists, to get them involved in a UV Index story for your community.
Television	Highly visible media designed to visually portray your message.	–Work with weather departments at your local station to work in segments on UV Index and sun safety. –Contact an assignment editor with an idea to profile a skin cancer survivor in your community. Include a sun safety message. –Prepare a SunWise media kit for your local station, include existing materials from the SunWise Program, such as brochures and fact sheets. Also, include a press release giving the information a local spin—such as a school's SunWise project or a company's UV awareness efforts.
Radio	Brief sound bites in which tone and delivery are important.	–Prepare a public service announcement on the importance of SunWise behavior. –Arrange for a respected health professional or community leader to participate in a talk show, delivering a sun safety message.
Hotline	Sustained effort, requires external promotion.	–Participate in a local health hotline by providing staff with sun safety information.
Meeting, events, or locations	One-time, high-profile opportunities to deliver your message to a target audience.	–Create a SunWise event of your own. Involve schools, companies, and organizations. Consider having a radio or TV station co-sponsor the event. –Look for ways to tie in with local events, such as fairs, parades, conferences, or sports events, to house a SunWise exhibit or distribute SunWise materials.

4.2 Successful UV Risk Education Programs

A number of UV/sun protection education programs have been successfully implemented in communities nationwide, as well as internationally. These programs educate youth and communities about sun protection through activities inside and outside of school. As a result, these concentrated efforts have had numerous positive effects on people's behaviors. For example, a community in Massachusetts reduced sunburn rates of children under 6 years old by more than 75 percent. In addition, a pilot project in Georgia improved the sun-safe behaviors of a youth soccer organization, while an in-school program in Australia focused on teaching teenagers proper sun-safe behavior by exploring myths about sun exposure and the pressures of tanning. For detailed information on many of these programs, see Appendix B: Case Studies of UV Risk Education Programs.

Working With the Media

In a growing number of communities, media institutions are key players, even partners,

in community-wide education programs. Some communities have relied primarily on media-based campaigns to deliver sun protection messages through newspapers, radio stations, television stations, and outdoor or transit advertising. The media has the advantage of reaching large numbers of people and can inspire people to become sun safety advocates. Long-term media coverage (periodically over at least 1 year) is most effective at raising people's awareness. Meteorologists who work for the media can play a particularly important role in broadcasting the UV Index daily and explaining what this measurement means in terms of sun protection. Newspapers also can print the UV Index daily. In general, media messages should be based upon an understanding of the prevailing culture and the level of community awareness of the issue.

If you are new to media work, it is important to realize that you don't need special training or experience to effectively promote your story. Take advantage of free media coverage by sending press releases or public service announcements (see the Centers for Disease Control and Prevention's Choose Your Cover campaign at www.cdc.gov/ChooseYourCover/preview.htm) to local media outlets or by asking newspapers and television stations to cover a local sun safety presentation, meeting, or start of a new SunWise Program at a nearby school. What you do need is the readily available information on basic methods for communicating with the media. You can find this information in books and "how-to" guides published by nonprofit organizations. Also, see Appendix A: List of Resources for more information to help you get started.

4.3 Communicating UV Risk Education Information to the Community

Communicating information on environmental and health risk topics can be challenging. Frequently, this information can be technical, full of unfamiliar terms and jargon. In addition, talking to people about health issues can be frightening, particularly when you are dealing with potentially life-threatening health effects, such as cancer. As you begin to implement your outreach and develop or tailor existing products, you will want to make sure that these products present your messages and information as clearly, accurately, and sensitively as possible.

Writing for the Public

Information should be conveyed in simple, clear terms. Principles of effective writing for the public include:

- Avoid using scientific jargon and acronyms. Where possible, translate technical terms into everyday language the public can easily understand. For example, use "skin" instead of "dermal." If you need to use technical terms or acronyms, make sure you define them.
- Use the active voice. Active voice means putting the subject of your sentence before the verb rather than after. For example, "Overexposure to UV radiation can cause skin cancer" is written in active voice. "Skin cancer can be caused by overexposure to UV radiation" is not.
- Keep sentences short.
- In written materials, use headings and other format devices to provide a very clear, well-organized structure.

The Web site www.plainlanguage.gov provides many useful guidelines and examples for writing in clear, plain English.

Know Your Audience

As you develop communication materials for a specific audience, remember to consider what the audience members are 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 or interesting to the target audience. In addition, 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.

Clinical Information and Photographs

Many programs have made use of testimonials and clinical pictures of actual skin cancer cases to communicate the importance of sun protection in reducing health risks. These tools can send a memorable message, and make an impression on children and adults alike. “Scary” messages and tools need to be used with sensitivity, however, when directed at younger children.

Essential UV Risk and Sun Protection Messages: Sample Text for Outreach Products

The rest of this section contains the messages that every UV risk education program should convey and sample text for outreach products. These examples, presented in a question-and-answer format, are written in a plain-English style designed to be easily understood by the public. You can use this text as a model to stimulate ideas for your own outreach materials or you can incorporate any of this text directly into your products. You also can use fact sheets, brochures, or other materials developed by the SunWise Program. These materials are available from www.epa.gov/sunwise.

What Are the Risks From Overexposure to Sunlight?

- We are all at risk from exposure to too much sun. This is because the sun contains harmful ultraviolet (UV) rays, called UV-A and UV-B, which can penetrate into the skin and eyes. Everybody, regardless of race or ethnicity, may be affected by overexposure to sunlight.
- Overexposure to UV radiation can cause a painful sunburn. Over time, it can also lead to skin cancer, early aging of the skin, and other skin disorders; cataracts and other eye damage; and suppression of the immune system.
- More UV radiation is reaching the Earth’s surface than ever before because pollution has thinned the ozone layer, which is high in the Earth’s atmosphere and shields us from the sun’s UV rays. There has been a continued increase in the reporting of skin cancer in the United States—1.3 million cases annually. In fact, one in five Americans will develop skin cancer in their lifetime.
- There is no such thing as a healthy suntan. Any change in your natural skin color is a sign of skin damage. Every time your skin color changes after sun exposure, your risk of developing sun-related ailments increases.

Who Is Most at Risk?

- You may be at greater risk of contracting skin cancer if your skin always burns or burns easily, and if you have fair skin, blond or red hair, or blue, green, or gray eyes.
- You may also be at increased risk of skin cancer if you have a history of blistering sunburns in early childhood, many moles, or a family history of skin cancer.
- People who spend a lot of time outdoors may be at higher risk for health effects from UV radiation.
- Children are particularly at risk of overexposure because they tend to spend a lot of time outdoors and can burn more easily. An estimated 80 percent of a person’s sun exposure occurs before age 18. Blistering sunburns during childhood can significantly increase the risk of developing skin cancer later in life.
- Certain diseases, such as lupus, and certain medications, such as antibiotics, antihistamines, and even some herbal remedies, can make you more sensitive to the sun’s harmful rays.
- Everyone is equally at risk for eye damage.

When and Where Is the Sun Strongest?

- The intensity of the sun’s UV rays reaching the Earth’s surface varies and should be considered when you plan outdoor activities. You can obtain a daily forecast of UV intensity for your area from the Internet (see “What is the UV Index?” below).
- UV radiation is strongest at midday (from 10 a.m. to 4 p.m.) and during the summer. Also, exposure to UV radiation is greater at lower latitudes (i.e., the further south you are in the U.S.) and at higher altitudes.
- Up to 80 percent of the sun’s UV rays pass through clouds. This means that you can burn on a cloudy day

even if it doesn't feel warm.

- Snow, water, and sand reflect the sun's rays, so skiers, swimmers, boaters, and beachcombers are exposed from both direct and reflected sunlight.

How Can I Protect Myself and My Family?

Always Use Sunscreen

- Sunscreens protect your skin in two ways: by reflecting UV radiation away from your skin and by absorbing UV radiation before it can penetrate your skin.
- All sunscreens sold in the United States contain a Sun Protection Factor (SPF) label to indicate how much protection the sunscreen will provide when used properly. The higher the SPF, the greater the protection from UV-B rays. An SPF of 30 blocks out 96 percent of harmful UV-B rays (the primary cause of sunburn). An SPF of 15 offers 93 percent protection from UV-B. Many sunscreens—called "broad-spectrum" sunscreens—also protect the skin from UV-A rays (the primary cause of premature skin aging). **For these reasons, use of a broad-spectrum sunscreen with an SPF of at least 15 is recommended.**
- Apply about 1 ounce of sunscreen 20 minutes before going out into the sun (or as directed by the manufacturer) to give it time to absorb into your skin. Reapply sunscreen—about 1 ounce—every 2 hours or more if you are swimming or perspiring.
- Apply sunscreen to all areas of your body that are not covered by clothing or a hat and that might be exposed to the sun, including ears, feet, hands, back, bald spots, and the back of the neck, as well as areas under bathing suit straps, necklaces, bracelets, and sunglasses. To protect your lips, use a lip balm of at least SPF 15.
- Discard sunscreen after the expiration date or after 3 years, because the ingredients can become less effective over time.
- Sunscreens labeled "water resistant" should maintain their protection level for 40 minutes of water immersion. Sunscreens labeled "very water resistant" should maintain their protection level for 80 minutes of water immersion. Reapply these sunscreens regularly because heavy perspiration, water, and towel drying diminish their effectiveness.
- Occasionally, sunscreen ingredients cause skin irritation or reactions. If this happens, try using sensitive skin formulas or brands made for children.
- Using sunscreens does not mean that it is safe to spend more time in the sun, because they don't block all of the sun's damaging rays. In fact, there is no evidence that sunscreens protect you from malignant melanoma—the deadliest form of skin cancer. So when you use sunscreen, be sure to use other protective measures as well, including limiting your time in the sun and wearing protective clothing, hats, and sunglasses.

Limit Your Time in the Sun

- The sun's UV rays are strongest between 10 a.m. and 4 p.m. Whenever possible, limit your exposure to the sun during these hours.
- When you are outside, stay in the shade as much as possible. Staying under cover is one the best ways to protect yourself from the sun.
- Remember that incidental time in the sun can add up to long-term sun damage. This includes, for example, time spent walking the dog, window shopping, performing outdoor chores, or jogging at lunch.
- Sun exposure is not required to get a sufficient amount of vitamin D. Most people get sufficient vitamin D in their diets. If you are concerned about getting enough vitamin D, you can drink vitamin D-fortified milk daily or take a multivitamin.

Wear Protective Sunglasses

- Sunglasses that provide 99 to 100 percent UV-A and UV-B protection will greatly reduce sun exposure that can lead to cataracts and other eye damage. Check the label when buying sunglasses. Be aware that dark, polarizing, or mirror lenses by themselves do not offer effective protection. Protective wrap-around frames provide the best protection

- If you wear corrective lenses, you should add UV-protective coating or obtain prescription sunglasses if you spend significant periods outside.

Wear a Wide Brimmed Hat

- Whenever possible, wear a hat with a wide brim. This offers good sun protection to your eyes, ears, face, and the back of your neck—areas particularly prone to overexposure from the sun. Be aware that baseball caps, visors, and narrow-brimmed hats provide less protection, particularly for the ears and nape of the neck.
- Choose a hat made from a close-weave fiber. If you can see through the hat, then sunlight will also get through.

Wear Protective Clothing

- Clothing that is tightly woven, loose-fitting, and full-length (in other words, with a collar, long sleeves, and long pants or skirts) provides good protection from the sun's harmful rays.
- UV rays can pass through the holes and spaces of loosely knit fabrics. Also, wet, faded, or older clothing provides less protection.

Avoid Sunlamps, Tanning Parlors, and Suntan Products

- Sunbeds and sunlamps emit UV light that can damage the skin and unprotected eyes.
- Suntan products do not contain a sunscreen and do not provide any protection against sun exposure.

Protect Children and Babies

- Children typically spend so much time outdoors that they are at high risk for overexposure to sunlight. Studies increasingly suggest a link between early sun exposure and skin cancer as an adult. Encourage your children to take all the safety steps listed above whenever they go outside. Started early and followed consistently, each of these steps will become an accepted habit, as easy as fastening seatbelts every time you drive the car.
- Keep babies out of direct sunlight. The American Academy of Pediatrics recommends using sunscreen on infants for small areas such as the face and back of the hands where protection from clothing is inadequate. For infants younger than 6 months, consult your physician.
- EPA has been working with schools and communities across the nation to launch the SunWise School Program. SunWise teaches children in elementary schools and their caregivers about how to protect themselves from overexposure to the sun. Educating children about sun safety is the key to reducing the risk of future UV-related health problems. For more information about SunWise, visit the program's Web site at www.epa.gov/sunwise.

Check the UV Index

- The UV Index forecasts the next day's likely intensity of UV rays. This is a useful tool for planning your outdoor activities to protect yourself from overexposure to sunlight. See below for more information on where to find the UV Index and how to use it.

What Is the UV Index and How Can I Use It?

- The UV Index is reported daily for localities across the United States. It forecasts the next day's likely intensity of UV rays.
- Calculated by the National Weather Service, the UV Index takes into account many factors, including the amount of ozone and clouds overhead, latitude, elevation, and time of year.
- UV Index forecasts are reported on a scale of 1 through 10+ as follows:

INDEX NUMBER	INTENSITY LEVEL
0 to 2	Minimal
3 to 4	Low
3 to 4	Moderate
3 to 4	Hight
10+	Very High

The higher the UV Index, the stronger the sun and the greater the need to follow all the sun protection measures. When a UV intensity of 5 or more is predicted for your area, it is especially important to protect yourself against sun exposure. The UV Index should not be used to determine the best time to go out and get a tan.

- You can obtain your local UV Index forecast daily from local weather stations or newspapers. EPA's Web site provides the UV Index forecast for your ZIP code. The address is www.epa.gov/sunwise/uvindex.html.
- Because the UV Index is a forecast, it won't always be exactly correct, but it is very reliable. The UV Index is 84 percent accurate to within ±2.
- Remember that snow, water, and sand reflect the sun's light, so you can get a double dose of UV exposure in these environments. The UV Index does not take these factors into account. If you are outdoors in these environments, your actual exposure will be higher than the UV Index value indicates.
- Some medications and diseases (e.g., lupus erythematosus) cause serious sun sensitivity. The UV Index is not intended for use by seriously sunsensitive individuals. Consult your doctor about additional precautions you may need to take.

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Appendix A:
List of Resources

The following list of Web sites, contact information, and additional suggestions can help you get started with your UV risk education project. This list includes examples of existing UV risk outreach tools, information on successful UV risk education strategies, financial assistance resources, volunteer groups that might be able to provide assistance, measurement resources, and information on working with the media.

Examples of Existing UV Risk Outreach Tools

- **SunWise www.epa.gov/sunwise.** Teachers and schools can join EPA's SunWise Program and receive a number of educational and outreach products. These include the SunWise Tool Kit (which includes a UV-sensitive frisbee), the SunWise Internet Learning Site, and UV Database. Students and teachers can use the SunWise Internet Learning Site and UV Database to report and interpret daily measurements of UV radiation, explore interactive Web-based games and activities, and link to other educational activities and resources. Go to www.nhtsa.dot.gov/people/injury/airbags/buckleplan/buckleup/media.html to join the SunWise Program.
- **SunSmart www.sunsmart.com.au.** Australia's SunSmart Internet site provides comprehensive educational material, technical assistance tools, and sample sun-safe policies for primary and secondary schools, child-care facilities, community health service organizations, local government, medical specialists, workplaces, community groups, sport and recreation clubs, and the tourism industry.
- **Choose Your Cover www.cdc.gov/ChooseYourCover.** The Choose Your Cover Web site includes facts and statistics about skin cancer, information about the program, and access to all campaign and educational materials, some of which can be ordered online.
- **PoolCool http://splash.hawaii.edu/sbsp/projects/poolcool/home.html.** PoolCool is a sun safety program especially designed for use at swimming pools. Swimming pools that join PoolCool receive an educational toolkit, sun safety signs, and technical support to promote sun safety during swimming lessons and other pool activities. For more information, contact Tom Elliot, Project Coordinator, at poolcool@crch.hawaii.edu or 808 586-3076, extension 69916.
- **Sunwise Stampede www.foundation.sdsu.edu/sunwisestampede/index.html.** Sunwise Stampede is a sun safety program that encourages zoo visitors to protect themselves from UV radiation. The program consists of a tip sheet for parents, coupons for sunscreen and hats, art activities for children, and sun protection signs and reminders. The Sunwise Stampede Web site includes fun educational games for children. For more information, contact Sunwise Stampede at blewis@projects.sdsu.edu or 619 594-8745.
- **Raising Awareness About Your Skin (RAYS).** The RAYS program is a skin cancer and sun awareness program for middle and high school students developed by the RAYS Task Force of the Montgomery County Ohio Medical Alliance. Contact RAYS at RAYSTaskforce@aol.com to receive a CD-ROM with slide presentations, study guides, and tests.

Successful UV Risk Education Strategies

- **Guide to Community Preventive Services www.thecommunityguide.org/guide_basics/guide_basics_f.html.** The Guide to Community Preventive Services is a federally-sponsored initiative that will help communities develop effective skin cancer (and other disease) prevention education programs. The cancer chapter, which will provide recommendations on successful skin cancer prevention strategies, should be complete by summer 2002.
- **Plain English Network www.plainlanguage.gov.** This Web site is dedicated to helping make all communication materials more userfriendly through the use of plain English, which means to organize and write information with the reader's needs in mind. For tips on writing user-friendly documents, go to www.blm.gov/nhp/NPR/pe_toc.html.

Financial Assistance

- **EPA Grants Administration Division www.epa.gov/ogd/index.htm.** EPA and other government agencies provide grants to organizations that address a variety of environmental issues. To access funding opportunities, go to www.epa.gov/ogd/grants/funding_opportunities.htm. For information on how to apply for a government grant, go to www.epa.gov/ogd/grants/how_to_apply.htm.
- **The Foundation Center www.foundationcenter.org.** As the most authoritative source of up-to-date information on private philanthropy in the United States, the Foundation Center provides print, CD-ROM, and online resources to help individuals and organizations identify appropriate grant sources and develop targeted proposals. To get started, visit www.fdncenter.org/about/fchelp.html for easy access to Foundation Center services. Note that some grants are available only to nonprofit organizations.

Volunteer Groups that Could Provide Assistance

- **Environmental Alliance for Senior Involvement www.easi.org/about.html.** The Environmental Alliance for Senior Involvement (EASI) seeks to increase opportunities for older adults to play an active, visible role in protecting and improving the environment in their communities. Contact EASI to learn more about the availability of senior volunteers at easi@easi.org or 540 788-3274.
- **Experience Corps® www.experiencecorps.org/index.html.** Experience Corps® provides schools and youth-serving organizations with older adults who serve as volunteers to improve the academic performance and development of young people. Go to www.experiencecorps.org/site/sites/map.html to find an Experience Corps® in your area.

Measurement Resources

- **Surveys Developed by Other UV Risk Education Programs.** Many UV risk education programs use surveys to measure their effectiveness in changing sun protection attitudes and behavior. Contact any of the programs listed above or mentioned in this handbook's case studies. (See Appendix B: Case Studies of UV Risk Education Programs to request sample surveys.)
- **InnoNet Evaluation Resources www.innonet.org/workstation/about.cfm.** InnoNet helps organizations improve their effectiveness. Go to www.innonet.org/resources/eval_resources.cfm for answers to frequently asked questions on how to evaluate programs and for background information on a number of evaluation topics.

Working With the Media

- **It All Adds Up to Cleaner Air Campaign, Effective Media Relations http://www.epa.gov/oms/transp/traqpedo/italladd/advisory.htm .** This Web page provides good descriptions of different media types and instructions on successfully working with the media to get your message out to the public.
- **Buckle Up America Campaign, Working With the Media www.nhtsa.dot.gov/people/injury/airbags/buckleplan/buckleup/media.html.** Although focused on increasing seat belt use, this Web page provides helpful suggestions on generating media attention and creating newsworthy information.

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Appendix B:
Case Studies of UV Risk Education Programs

School-Based Program: SunWise

EPA developed the SunWise School Program to raise awareness of the health risks associated with UV overexposure and to encourage behavior change to reduce these risks. EPA focused on schools because children are at particular risk for sun exposure. Along with traditional education practices that promote sun protection, SunWise encourages schools to implement infrastructure enhancements, such as providing shade through canopies and trees, and to establish policies such as requiring hats, sunscreen, and sunglasses when outdoors. The program is designed to provide maximum flexibility—elements can be used as stand-alone teaching tools or to complement existing school curricula. Though based in schools, SunWise also supports community partnerships, such as inviting guest speakers to school assemblies.

SunWise Partner Schools receive materials and tools free of charge to help implement SunWise in their classrooms and communities. The SunWise Toolkit contains cross-curricular classroom lessons and background information for K through 8 learning levels. The toolkit also includes tools, including a UV-sensitive frisbee, a hand-held UV meter (if requested), and the On the Trail of the Missing Ozone comic book, that reinforce sun safety lessons. To reward your students for their participation in the SunWise Program, the kit also contains an easily photocopied "Certificate of SunWisdom."

Along with the toolkit, SunWise offers several brochures, fact sheets, and activity books with suggestions and recommendations for sun safety practices and activities. The program also maintains an Internet Learning site and a newsletter highlighting issues, trends, and success stories. The SunWise Web site (www.epa.gov/sunwise) gives details on the program and the importance of sun safety and is divided into sections for educators, students, health care providers, and the media.

The SunWise Web site offers a database for partner schools to enter their local daily UV forecast and intensity data. This collected data can then be accessed to create maps and graphs that can be used as educational tools. For more information, go to www.epa.gov/sunwise or contact Kevin Rosseel at rosseel.kevin@epa.gov.

Community-Wide Program: Working with New Hampshire Caregivers To Protect Children from the Sun (The SunSafe Project)

By training a variety of caregivers on how to promote sun protection to children and parents, health specialists at Dartmouth Medical School in New Hampshire demonstrated that community-wide UV risk education programs can lead to long-term positive changes in sun protection behavior. After initial SunSafe project interventions at New Hampshire schools, daycare centers, primary care physician offices, and beaches in 1996, and then a brief follow-up in 1997, the proportion of children 2 to 11 years of age practicing at least some sun protection behavior increased from 58 percent to 73 percent. SunSafe also resulted in an increase in the proportion of children fully protected by sunscreen, clothes, and shade (from 31 percent to 50 percent), a decrease in the proportion of children without any sun protection (from 42 percent to 27 percent), and an increase in the proportion of parents receiving sun protection information from physicians and schools (from 46 percent to 62 percent).

Ten New Hampshire communities participated in the SunSafe project, with five receiving interventions, and five acting as controls. Instead of targeting children and parents directly, project organizers instead focused on teachers, primary care physicians, and lifeguards.

- Teachers at schools and daycare centers received SunSafe curricula with lesson plans and educational activities modeled after Australia's SunSmart program (see page 48).
- Primary care physicians received a manual that teaches office staff and clinicians how to promote sun protection during medical checkups. In addition, to enhance sun protection counseling, project organizers provided physicians with educational posters, pamphlets, and self-adhesive reminder notes.
- Lifeguards received displays about the UV Index and sun protection to be posted at beaches. Project organizers also encouraged lifeguards to provide SunSafe pamphlets and free sunscreen samples to beachgoers. In addition to providing outreach and educational materials, organizers visited principals,

teachers, physicians, and lifeguards to encourage implementation of the SunSafe project and provide technical assistance with activities. All outreach and educational materials conveyed the same basic messages:

- Avoid or limit exposure during the sun's peak hours of 11am to 2pm. Teach your child to seek shade if he or she is outside during peak hours.
- Cover up with clothing and a hat with a brim. Wear a shirt and long shorts that go to the knee or below.
- Block the sun's rays through the use of a sunscreen with an SPF of 15 or higher. Be sure to put sunscreen on all areas not covered up.
- Say something to your friends and family about being SunSafe. Remind them that shirts, hats, and sunscreen are important for the whole family to use every time you are going to be out in the sun.

To track changes in children's sun protection behavior, project organizers trained a number of observers to visit beaches, interview parents, and detail children's sun protection behavior. Based on their observations and analyses, Dartmouth Medical School health specialists demonstrated that the SunSafe UV risk education project provided long-term benefits to the community.

Since completing the study in 1998, project organizers have initiated a new SunSafe project that targets adolescents. This project, which will run through 2003, will provide educational materials to middle school teachers and outdoor sports and recreation staff, and will ask teenagers to participate in a survey and keep a diary to track their sun protection behavior during the summer. For more information, contact the SunSafe Project, Department of Community and Family Medicine, Dartmouth Medical School, at 603 650-1566, or visit the SunSafe Web site at www.dartmouth.edu/dms/sunsafe/.

Outdoor Recreation Program: Helping Georgia Soccer Coaches Promote Sun Protection

In Georgia, where sports are played almost year-round, more than 75,000 youth play soccer in recreational and competitive leagues. To address the need to protect soccer-playing youth from overexposure to the sun, university medical researchers and health communication professionals developed a UV risk education pilot project that trained soccer coaches to promote sun-safe behavior to young soccer players. The project focused on eight soccer teams of the St. Simons Island's youth soccer association in south Georgia.

To determine the content of the soccer coach training program, project organizers conducted a pretest survey to understand the sun protection practices and beliefs among soccer coaches and parents of soccer-playing youth. The pretest identified, for example, that coaches and parents believed it would be difficult for them to get youths to practice sun protection behaviors. The pretest also underscored knowledge gaps, such as in understanding the differences between waterproof, water-resistant, and sports sunscreens.

Project organizers randomly selected half of the soccer coaches who had participated in the pretest survey to receive the UV risk education training. Based on the results and insights gained from the pretest, the program trained coaches to serve as role models by practicing sun-safe behaviors themselves, encouraging youth to apply sunscreen before coming to games and soccer practices, and educating parents about the importance of sun protection. To complete the training, coaches attended a sun protection seminar and received an informational booklet on sunburn prevention strategies, skin cancer, and the importance of reducing sun exposure in youth. During the course of the season, coaches promoted sun protection to youths and parents, and served as positive role models.

In addition to informing the content of the training program, the pretest survey provided baseline data that project organizers used in conjunction with a post-test survey to evaluate the effectiveness of the pilot project. The evaluation showed that as a result of the program, coaches and parents were more likely to tell youths to wear sunscreen, and coaches were better able to get youths to practice sun-safe behaviors. For more information, contact Roxanne Parrott of the Office of Health Communication, University of Georgia, at rparrott@arches.uga.edu.

Young Adult Program: School-Based Education for Teenagers in Australia

Because teenagers are often susceptible to peer pressure, it is a particular challenge to influence them to adopt behaviors that their peers might find socially unacceptable. Researchers from the Center for Health Promotion and Cancer Prevention Research at the University of Queensland in Australia developed a school-based UV risk education curriculum that sought to address the peer pressures that teenagers face.

Health and physical education teachers at 13 schools in Queensland, Australia, taught the curriculum to students every year for 3 years, from 8th to 10th grade, during a 4- to 6-week period just prior to summer vacation. Through role playing, problem-solving, and student-directed activities, students explored the myths about sun exposure, the role of peer pressure in tanning, and motivations for acting in health-compromising or health-enhancing ways. Students also learned to plan ahead for sun safety and practiced critical thinking by analyzing how the mass media favors certain images. To help students put their newly acquired knowledge to work, teachers encouraged them to create advertisements that debunked media images and to brainstorm possible sun protection school policies that students might find acceptable.

To measure the effectiveness of the curriculum, researchers used surveys before and after each year's program to assess students' sun protection knowledge, attitudes, and behavior. To ensure the results of the surveys were due to the curriculum and not to any other factors, the researchers also surveyed students in 13 other schools in Queensland that did not receive the curriculum. In the 9th grade, the students receiving the curriculum showed a marked improvement in knowledge and some behavior change compared to students not receiving the curriculum; however, when the students were surveyed in the 10th grade, it appeared they were not practicing sun-safe behaviors as often as before. The researchers attribute the regression in behavior to the many social and cultural pressures teenage students face inside and outside of school, such as the priority given to sun protection by peers and the acceptability of wearing hats or long-sleeved shirts in public. For more information, contact Dr. John Lowe at the Center for Health Promotion and Cancer Prevention Research, Medical School at the University of Queensland in Australia at j.lowe@mailbox.uq.edu.au.

National and Community-Wide Program: Australia's SunSmart Program

Australia's SunSmart program, an initiative of the Anti-Cancer Council of Victoria, promotes awareness of skin cancer and sun protection measures to children, teenagers, and adults. The SunSmart program includes a media campaign, outreach programs, and research efforts. The media campaign includes advertisements in magazines and trade journals, television commercials, and press coverage of SunSmart activities and messages.

Through a variety of outreach programs, SunSmart provides technical assistance, research, training, and a variety of educational and promotional resources to organizations that can reach many at-risk individuals. SunSmart outreach programs target primary and secondary schools, child-care facilities, community health service organizations, local government, medical specialists, workplaces, community groups, sport and recreation clubs, and the tourism industry. One goal of SunSmart is to encourage these organizations to institute sun-safe policies, such as requiring participation in educational programs or the building of shade infrastructure.

To determine the effectiveness of its media and outreach activities and to guide future changes to the program, the Anti-Cancer Council of Victoria periodically evaluates SunSmart. In its most recent evaluation, the council determined the following to be key elements to SunSmart's success:

- Consistency and continuity. SunSmart has been successful because it has been able to sustain its efforts over the long term—SunSmart has been operating full-scale since 1988. SunSmart has achieved consistency and continuity because it has been hosted by a stable and supportive organization with common goals and a strong research capability, and it has had reliable and sufficient funding from its host organization and outside sources with similar health promotion goals.
- Research and evaluation. SunSmart has tailored its efforts based on research of its target audience's attitudes and behaviors towards sun protection and skin cancer and on aspects of society that could support or undermine health messages. In addition, the progress of SunSmart has been consistently evaluated, helping the organization reshape its focus when necessary to achieve its goals.

More information on SunSmart can be found at www.sunsmart.com.au.

Media-Based Program: Choose Your Cover

Through the Choose Your Cover media campaign, the CDC develops and distributes sun-safe public service announcements (PSAs) and press releases to broadcast and print outlets nationwide. The campaign also has included several strategic partnerships to further disseminate sun protection messages. For example, since 1999, CDC has worked with Seventeen magazine to sponsor photography and T-shirt contests that educate young adults about skin cancer and sun-safe behaviors. In addition, the campaign has included partnerships with the U.S. Olympic

Synchronized Swimming Team and the Weather Channel.

Another important component of the Choose Your Cover campaign are educational materials, including posters, brochures, and a Web site. The Choose Your Cover Web site www.cdc.gov/ChooseYourCover includes facts and statistics about skin cancer, information about the program, and access to all campaign and educational materials, some of which can be ordered online. A number of state health programs have incorporated or modified Choose Your Cover materials into their own skin cancer prevention programs.

National Program: National Skin Cancer Prevention Education Program

The Choose Your Cover campaign is only one part of CDC's National Skin Cancer Prevention Education Program (NSCPEP) www.cdc.gov/cancer/nscpep/index.htm. In addition to the Choose Your Cover media campaign, CDC conducts research, funds outreach programs, and builds partnerships to extend the reach and improve the effectiveness of skin cancer prevention efforts in the United States. For example, CDC established the National Council on Skin Cancer Prevention, a coalition of organizations dedicated to fighting skin cancer on a nationwide basis. The goals of the coalition—which includes 24 organizations, including the American Academy of Dermatology and the American Cancer Society—are to:

- Increase skin cancer awareness and prevention behaviors among all populations, particularly those at high risk.
- Develop and support partnerships to extend and reinforce core messages for behavior change.
- Coordinate nationwide efforts to reduce skin cancer incidence and mortality.
- Develop a national skin cancer prevention and education plan.

CDC also established a Federal Council on Skin Cancer Prevention to promote sun-safe behaviors among federal agency employees and their families.

To support innovative state and national skin cancer prevention education initiatives, CDC funds a number of outreach programs through NSCPEP. One currently funded program, PoolCool, seeks to educate parents, lifeguards, pool managers, and young children about sun-safe behavior when they visit swimming pools. NSCPEP research focuses on determining national trends in sun protection behaviors and evaluating current skin cancer prevention efforts. CDC research also supports the *Guide to Community Preventive Services*, a federally sponsored initiative that will help communities develop effective skin cancer (and other disease) prevention education programs. For more information on this guide, see www.thecommunityguide.org/guide_basics/guide_basics_f.html.

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Appendix C:
Examples of Successful SunWise Programs

Raising Awareness About Your Skin (RAYS), Montgomery County, Ohio

RAYS is an active volunteer committee that educates students throughout Montgomery County, Ohio, about the dangers of ultraviolet radiation. The committee has reached 19,500 students in 35 school districts.

Consisting of more than 32 dermatologists, plastic surgeons, internists, obstetricians, optometrists, and neurologists, along with 25 other volunteers, the committee arranges assemblies and classroom presentations in middle and high schools throughout the year. Volunteers use SunWise lesson plans and a captivating slide presentation to teach students about the early signs of skin cancer and what risky behaviors to avoid. In addition, volunteers provide SunWise materials and information to schools and encourage teachers and administrators to join the SunWise Program. The committee's efforts have been tremendously successful. Not only has the program been highlighted on the news several times and won the prestigious Health Awareness Promotion (HAP) award, but its message has reached an incredible number of students.

The program got its start in 1999 when a group of dermatologists from the Ohio Medical Association passed a resolution to teach students throughout the state about the hazards of the sun and tanning salons. Volunteers from the Montgomery County Medical Alliance decided to take action on the resolution.

When the committee read about the SunWise Program in a newspaper article and used SunWise materials, it succeeded in attracting schools to the idea.

For more information about RAYS, send an e-mail to RAYSTASKFORCE@ aol.com.

Center for Creative Learning, St. Louis, Missouri

For the past 4 years, students at the Center for Creative Learning in Missouri's Rockwood School District have learned about ozone depletion, sun safety, and skin cancer prevention. As part of their SunWise participation, students in Dottie Fundakowski's class have conducted videoconferences with EPA SunWise staff, allowing them to interact with a scientific expert. In addition to answering specific questions posed by the students, SunWise staff reminded students of their responsibility to protect their skin and eyes from UV radiation.

Two of Dottie's students even launched their own skin cancer awareness campaign as their final class project. The project, called "Got Sunscreen?" after the "Got Milk?" advertisements, was presented to parents, school administrators, and community experts. The two students designed T-shirts emblazoned with their campaign name and filmed a commercial showing the benefits of using sunscreen.

In addition, two other students of Dottie's petitioned the Rockwood School Board in an effort to change the district policy to allow students to carry and apply sunscreen at school, for example, during recess or on outdoor field trips. Sunscreen technically is considered an over-the-counter drug, similar to aspirin or cough drops, and in most state school districts, they are prohibited from student use without doctors' and parents' permission to allow nurses or aides to administer them. The two students pointed out that if it is difficult to use sunscreen, fewer students will apply it, and the risk for skin damage will increase. The students presented their case well, and the Rockwood School policy now allows students to apply sunscreen while on school grounds. They received national press coverage for their efforts.

Central Middle School, Tinley Park, Illinois

A group of Illinois students recently discovered that asking the right questions can also save lives. Debbie Brennan, the learning coordinator at Central Middle School in Tinley Park, Illinois, works with the top 5 percent of the seventh and eighth grade students as part of the school's gifted program. Brennan practices "inquiry learning," a loose system that allows students to ask questions about a topic of their choice and conduct activities to answer them.

"A few years ago in May, a group of my students noticed some high school kids lined up outside a tanning salon in preparation for their prom," Brennan said. "I overheard them complaining that tanning causes skin cancer, and I asked them how they knew for sure." To find the answer, the students began a research project on the effects of exposure to ultraviolet (UV) radiation. Not long after that, Brennan discovered EPA's SunWise Web site. She began working with

EPA to create activities based on SunWise materials that fit the Illinois state learning standards, incorporating language, fine arts, science, and math.

For many of their activities, the students conduct both group and individual research and then find creative ways to share what they learn. One part of their research effort was to contact the American Cancer Society, which sent them information, bookmarks, and stickers related to sun safety. Brennan has also forged relationships with a local oncologist and a Chicago-based meteorologist, both of whom are available to answer students' questions.

To share what they learned, the students created flyers on sun safety and distributed them to local youth sports teams. The students also decorated and gave away visors and bandanas with UV-sensitive paint and performed experiments by applying sunscreen to necklaces they made from UV-sensitive beads. As part of a long-term activity, the students monitor and chart daily local UV intensity. The students also share their information by writing articles for the school newsletter, posting articles and notices on a school bulletin board, and posting information on their Web site www.ccsd146.k12.il.us/central/projects.html.

Science Explorer Program, University of Colorado at Boulder

For the University of Colorado at Boulder's (CU's) Science Explorer Program, teachers and students put new science curricula to the test. In a series of 30 oneday workshops held throughout the state, Colorado and New Mexico teachers and students tried out new science lessons focused on ground-level and stratospheric ozone, as well as UV radiation.

Teams comprised of one teacher and five students, from fifth through eighth grade, participated in three 75-minute classes throughout the workshops. Each class featured a variety of ozone-related, hands-on lessons; for example, the teams searched for ground-level ozone by using Schoenbein paper—a special paper made of cornstarch, distilled water, and potassium iodide—which turns blue or purple when in contact with ozone.

In another activity, students and teachers learned about the effects of stratospheric ozone depletion—such as increased UV radiation reaching Earth's surface. Using color-changing, UV-sensitive Frisbees, the teams evaluated the effectiveness of various sun-protection materials, including sunscreen, sunglasses, and fabrics. The teams also constructed chemical models of ozone molecules out of gumdrops and toothpicks. Studying the conditions of Antarctica, over which an ozone hole exists, is another topic for curricula activities. After participating in the Science Explorer activities, students and teachers took their new knowledge and materials back to their classrooms to share with fellow students and colleagues.

Designed to encourage student interest and aptitude in science, math, and technology in Colorado and the West, the CU-Boulder Science Discovery Program has been operating the Science Explorer Program for 15 years, introducing new curricula to about 300 teachers each year.

For more information about CU's Science Explorer program, contact Lannie Hagan at 303 492-0771.

Goddard Middle School, Glendora, California

Students in Glendora, California, are using technology to explore the science behind SunWise. Greg Morrison's science class at Goddard Middle School uses many tools, including the Internet, CD-ROMs, videos, and laboratory experiments to collect, report, and analyze UV-related data. In a favorite class activity, students use hand-held UV monitors, available from EPA, to measure the intensity of UV rays at ground level. After gathering this data, the students can upload their results to the SunWise Web site.

With the help of the local Rotary Club's Teacher Mini Grant Program, Morrison runs another popular experiment using UV-sensitive beads to teach students about the sun's UV rays and the effects of UV radiation on human skin and health. Outside, students observe the beads changing from clear, light colors to darker colors, corresponding to the strength of the sun's UV rays. The students then examine and record the effectiveness of different types of sun protection, covering the beads with sunscreens of various SPF levels, sunglasses, wet and dry clothing, and plastic.

In addition, Morrison uses video tapes of national newscasts about the ozone layer, which further demonstrate the scope and breadth of the subject. All these sun-science activities and students' work are featured on Morrison's class Web site, www.morrisonlabs.com.

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Appendix D:
How Is the UV Index Calculated?

The UV Index is calculated by collecting data on stratospheric ozone levels and forecasted cloud amounts and then transforming these data into a useful metric that describes how intense the next day's UV radiation will be.

The calculation begins with measurements of current total stratospheric ozone levels for the entire globe, obtained via two satellites operated by the National Oceanic and Atmospheric Administration (NOAA). These data are then used to produce a forecast of stratospheric ozone levels for the next day for various cities in the United States.

Next, a mathematical model is used to determine the amount of UV radiation expected to reach the Earth's surface based on the forecasted stratospheric ozone levels. This mathematical model—a radiative transfer model—takes into account the time of day, latitude of the city, and day of the year, and then determines the expected UV levels for wavelengths measuring 290 nanometers to 400 nanometers.

Because some UV wavelengths are more dangerous to human skin than others, another mathematical function is used to apply a greater emphasis or weight to the magnitude of the more dangerous UV wavelengths than the less dangerous UV wavelengths. The weighted UV wavelength levels are then integrated together to produce a new value that represents how dangerous the UV radiation is to human skin.

Cloud cover and elevation affect the level of UV radiation reaching the Earth's surface, so another calculation is made to take these factors into account. Cloudier skies limit the amount of UV radiation reaching the surface, and cities at higher elevations receive more UV radiation. (Although atmospheric pollutants, haze, and surface reflection (e.g., from sand, water, or snow) also affect the level of UV exposure, the UV Index currently does not account for these effects).

Lastly, to obtain the UV Index, the adjusted value is scaled down by dividing it by a conversion factor and rounding this number to the nearest whole number. Note: the UV Index is calculated differently in different countries around the world. This section only represents how the United States calculates the UV Index.

Each year, the National Weather Service (NWS) gathers data on the level of UV radiation reaching the Earth's surface to measure the accuracy of the UV Index. Several government agencies, private companies, hospitals, and universities collect and provide these surface UV data to NWS, which then conducts statistical analyses of the data to determine discrepancies. These validations have shown that the UV Index forecast is quite accurate.

Surface UV data are often collected using Brewer spectrophotometers. These monitoring devices are automated instruments that can infer the amount of total ozone in the stratosphere based on measurements of the UV radiation that reaches the Earth's surface. To ensure that all UV monitoring devices are taking similar and accurate measurements, NOAA's Central UV Calibration Facility compares UV readings from different monitoring devices and calibrates the devices as needed based on recommendations from the National Institutes of Standards and Technology.

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Appendix E:
Examples of UV Monitoring Networks and Scientific Studies in the United States

The National Oceanic and Atmospheric Administration monitoring and satellite equipment used for collecting data to help calculate the UV Index (see Appendix D: How is the UV Index Calculated?) is just one of several UV monitoring networks in the United States. A number of government agencies, universities, and institutions have developed other UV monitoring networks to study the effects of UV radiation on human health, ecological processes, wildlife, and climate. These data are sometimes publicly available on the Internet.

University of Georgia (UGA)/EPA Monitoring Network or UV-Net Program

The UGA/EPA Monitoring Network is used to validate the UV Index. This network consists of 21 monitoring devices located in 14 different national parks and 7 urban areas across the country. See www.epa.gov/uvnet/ for more information and to access data.

Park Research and Intensive Monitoring of Ecosystems Network (PRIMENet)

PRIMENet is a joint EPA/National Park Service program to assess the effects of environmental stressors, including UV radiation, on ecological systems nationwide. The UGA/EPA Monitoring Network's 14 monitoring devices are located in national parks and are used in PRIMENet. A major research aim of PRIMENet is to investigate the effects of UV radiation on frogs and other amphibians. For general information on PRIMENet, see www.forestry.umt.edu/research/MFCES/programs/primenet/. For information on PRIMENet amphibian studies, see http://www.forestry.umt.edu/research/MFCES/programs/primenet/research.htm.

U.S. Department of Agriculture (USDA) UV-B Monitoring Program

The USDA UV-B Monitoring Program uses a network of 36 monitoring devices located throughout the United States, including Hawaii and Alaska. These monitors quantify the atmospheric effects that influence UV radiation and assess the potential impacts of increased UV radiation levels on agricultural crops and forests. For more information and to access data, see http://uvb.nrel.colostate.edu/UVB/.

National Science Foundation (NSF) Polar UV Monitoring Network

The NSF Polar UV Monitoring Network includes six monitoring devices that measure UV spectral irradiance at the polar regions. These data are used by researchers studying the effects of ozone depletion on terrestrial and marine biological systems. For more information and access to data, see www.biospherical.com/nsf/index.asp.

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Appendix F:
Frequently Asked Questions

Q: Why is overexposure to the sun dangerous?

A: The sun emits powerful ultraviolet (UV) radiation that can cause a number of health problems as a result of overexposure. In addition to causing sunburn, UV radiation can cause health problems that might not become apparent until many years after sun exposure. These problems include skin cancer, premature aging of the skin, cataracts, and suppression of the immune system.

Q: Is skin cancer a significant problem in the United States?

A: Skin cancer is the most common form of cancer in the United States. In addition, the incidence of malignant melanoma, the most dangerous form of skin cancer, is increasing more quickly in the United States than for any other form of cancer. Although skin cancer can usually be cured if detected and treated early, if detected late or left untreated, skin cancer can cause considerable damage, disfigurement, and even death.

Q: If I have darker skin, do I still need to be concerned about skin cancer?

A: Although the incidence of skin cancer is lower in people with darker skin, the disease can still occur and often is not detected until it has reached a later, more dangerous stage. In addition to skin cancer, overexposure to the sun can cause other health problems in all populations, regardless of skin type. These include cataracts, premature aging of the skin, and immune suppression.

Q: How is the ozone layer related to UV radiation and skin cancer?

A: The ozone layer serves as a shield in the upper reaches of the atmosphere to protect the Earth from most of the UV radiation emitted by the sun. In recent years, scientists have documented seasonal depletions of the ozone layer over Antarctica, the Arctic, and mid-latitude regions such as North America. Because the depletion of the ozone layer allows more UV radiation to reach the Earth's surface, scientists are concerned that this phenomenon might create an increased threat to human health.

Q: What's causing ozone layer depletion and how can it be fixed?

A: Scientists have determined that a variety of synthetic halocarbon chemicals, such as chlorofluorocarbons, are responsible for depleting the ozone layer. Countries around the world have recognized this threat and signed a treaty—the Montreal Protocol on Substances that Deplete the Ozone Layer—to reduce the global production of ozone-depleting substances. With full compliance from participating countries, the ozone layer should be restored by the middle of the 21st century. Until that time, increased levels of UV radiation will reach the Earth's surface.

Q: How can I prevent the health problems associated with overexposure to UV radiation?

A: A number of sun-safe behaviors can help reduce the risks associated with overexposure to UV radiation. These include:

- Limiting your time in the sun between 10 a.m. and 4 p.m.
- Seeking shade whenever possible.
- Using a broad-spectrum sunscreen with a SPF of at least 15.
- Wearing a wide-brimmed hat and if possible, tightly woven, full-length clothing.
- Wearing UV-protective sunglasses.
- Avoiding sunlamps and tanning salons.
- Watching for the UV Index daily and taking appropriate precautions based on the Index level.

  In addition, by educating children and others in your community, you can help them understand the risks of overexposure to UV radiation and can encourage them to adopt sun-safe behaviors as well.

Q. When I go out in the sun, my skin tends to tan, not burn. I like the way a tan looks, but is this safe for my

skin?

A: There is no such thing as a healthy suntan. Any change in your natural skin color is a sign of skin damage. Every time your skin color changes after sun exposure, your risk of developing sun-related ailments increases.

Q: What is the UV Index and where can I find it?

A: Developed by the National Weather Service and EPA, the UV Index provides a daily forecast (on a 0 to 10+ scale) of the expected intensity of UV radiation from the sun and helps people determine appropriate sun-safe behaviors. The lower the number, the less UV radiation is reaching the Earth's surface. Lower numbers occur during overcast conditions or early and later in the day, while higher numbers occur during clear or partly cloudy conditions and in the middle of the day. The Index considers many factors, including latitude, day of the year, time of day, ozone, elevation, and predicted cloud conditions at solar noon. You can determine the UV Index for your ZIP code by accessing the following Web site at www.epa.gov/sunwise/uvindex.html.

Q: What is SunWise?

A: SunWise is a UV risk education program created by EPA to teach elementary and middle school students about the science of UV radiation and sun-safe behaviors. Schools participating in SunWise receive a variety of ready-made educational materials and gain access to the SunWise Internet database where students can enter and view UV measurement data. In addition to sponsoring classroom and schoolwide activities, SunWise schools are encouraged to form community partnerships and organize sun-safe events. For more information, visit www.epa.gov/sunwise.

Q: How do I get SunWise educational materials?

A: Join SunWise by signing up through the SunWise Web site at www.epa.gov/sunwise/join.html.

Q: Why does SunWise focus on children and schools?

A: Children spend many hours outdoors during recess, physical education classes, after-school activities, and sports programs. As a result, most of the average person's lifetime sun exposure occurs before the age of 18. Schools and teachers can play a major role in protecting children from overexposure to UV radiation by teaching sun-safe behaviors.

Q: In addition to SunWise, are there any other UV risk education programs that I could join?

A: In addition to SunWise, a number of local, state, and national UV risk education programs exist. See Appendix B: Case Studies of UV Risk Education Programs, for information on some of these programs. You can also contact your local or state health department for more information.

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Appendix G: Glossary

Basal Cell Carcinoma: Skin cancer tumors that might appear as slow-growing, translucent, pearly nodules, which can crust, discharge pus, or even bleed. These tumors typically develop where you are most exposed to the sun—on the face, lips, tops of ears, and hands.

Chlorofluorocarbons (CFCs): Stable, low-toxic, and inexpensive chemicals that were most commonly used as refrigerants, solvents, and aerosol propellants until scientists discovered their destructive power. When strong UV radiation breaks down CFCs, they release atomic chlorine, which accelerates the natural destruction of ozone and contributes to ozone depletion. Nations around the world have agreed to reduce and eventually eliminate production of CFCs.

EMPACT: Environmental Monitoring for Public Access and Community Tracking, a program begun by EPA in 1996, helps communities collect, manage, and distribute environmental information, providing residents with up-to-date and easy-to-understand information they can use to make informed, day-to-day decisions.

Melanoma: The most fatal form of skin cancer. Malignant melanomas can appear suddenly without warning as a dark mole or other dark spot on the skin and can spread quickly.

Montreal Protocol: The Montreal Protocol on Substances that Deplete the Ozone Layer is an agreement adopted by international governments in 1987 to reduce and eventually eliminate the emissions of human-made ozone-depleting substances such as chlorofluorocarbons. The agreement has since been strengthened four times as scientists discovered the severity of ozone depletion.

National Weather Service (NWS): Government agency that provides weather, hydrologic, and climate forecasts and warnings for the United States. NWS issues the UV Index daily.

Ozone Depletion: Acceleration of the natural process of destroying and regenerating stratospheric ozone caused by human-made chemicals such as chlorofluorocarbons. The ozone found in the upper atmosphere (stratosphere) is destroyed and regenerated naturally, but certain human-made chemicals accelerate this process and damage the protective ozone layer. As this ozone layer breaks down, it absorbs smaller amounts of UV radiation, allowing the UV radiation to reach the Earth.

Spectrophotometer: An instrument for measuring the relative intensities of light in different parts of the spectrum. Scientists use spectrophotometers to measure the amount of UV radiation reaching the Earth.

Squamous Cell Carcinoma: Skin cancer tumors that might appear as nodules or red, scaly patches, which can develop into large masses and spread to other parts of the body.

Stratosphere: Portion of the atmosphere extending from about 10 km to about 50 km above the Earth. The stratosphere includes the stratospheric ozone layer, which absorbs most of the sun's harmful rays.

Stratospheric Ozone: A bluish gas composed of three oxygen atoms. Found in the upper atmosphere, it helps shield the Earth from the sun's UV radiation. Natural processes destroy and regenerate ozone in the atmosphere. When ozonedepleting substances such as chlorofluorocarbons accelerate the destruction of ozone, there is less ozone to block UV radiation from the sun, allowing more UV radiation to reach the Earth.

Sunscreen: A substance, usually a lotion, that is applied to skin to protect it from UV radiation. Sunscreen protects by reflecting UV radiation away from skin and by absorbing UV radiation before it can penetrate your skin.

SunWise School Program: EPA program that aims to teach grades K-8 school children and their caregivers how to protect themselves from overexposure to the sun. The program raises children's awareness of stratospheric ozone depletion and ultraviolet radiation, and encourages simple sun-safety practices.

SunWise Partner Schools: Participants in the SunWise School Program receive materials and tools for students to actively learn about the health and environmental effects of the sun. Schools sponsor cross-curricular classroom lessons, including measuring and posting UV Index measurements on the Internet.

UV Index: A tool developed by the National Weather Service that predicts the next day's UV intensity on a scale from 0 to 10+, helping people determine appropriate sun-protective behaviors. The lower the number, the less amount of radiation is reaching the Earth's surface. Based on this number, people should take appropriate sun-safe precautions.

UV Monitoring Networks: Combination of ground-based and satellite data monitoring stations that track changes in the ozone layer around the world and help validate the UV index. Using scientific data gathered by monitoring networks, scientists study a wide variety of health and environmental effects of UV radiation on humans, crops, forests, and ecological processes on land and in water.

UV Radiation A portion of the electromagnetic spectrum with wavelengths shorter than visible light. UV radiation produced by the sun is responsible for sunburn and other adverse health effects. Scientists classify UV radiation into three types: UV-A, UV-B, and UV-C.

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EPA/625/R-00/003
February 2000

Report of the December 15, 1999 EPA Satellite Forum on Ozone Monitoring, Mapping, and Public Outreach

U.S. Environmental Protection Agency
National Risk Management Research Laboratory
Office of Research and Development
Cincinnati, Ohio 45268

NOTICE

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ACKNOWLEDGMENTS

Development of the December 15, 1999 Satellite Forum on Ozone Mapping, Monitoring, and Public Outreach was managed by Scott Hedges (U.S. Environmental Protection Agency [EPA], National Risk Management Research Laboratory), with technical guidance from Dennis Doll (EPA, Education and Outreach Group) and Richard Wayland (EPA, Office of Air Quality, Planning and Standards). Gratitude is expressed to Karl Coleman and the production crew at North Carolina State University, to Alison Davis of EPA's Office of Air Quality, Planning and Standards who moderated the satellite forum, and to each of the presenters for their time and contributions.

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1. INTRODUCTION

This report provides a summary of the U.S. Environmental Protection Agency's (EPA's) December 15, 1999 satellite forum on technology transfer tools for ozone monitoring, mapping, and public outreach.

Chapter 1 provides information about the purpose of the satellite broadcast, along with background information on the planning and production of the broadcast. Chapter 2 contains summaries of the presentations made during the satellite forum. Chapter 3 summarizes the live question-and-answer sessions held during the broadcast. Appendix A contains the agenda for the broadcast. Appendix B provides information about viewership, and Appendix C contains the satellite forum Workshop Guide, which was prepared by North Carolina State University. The Workshop Guide contains the presentation materials prepared by individual speakers.

2. BACKGROUND AND PURPOSE

The U. S. Environmental Protection Agency (EPA) created the EMPACT program in 1997 to take advantage of new technologies that make it possible to provide environmental information to the public in near real time. EMPACT is working with 86 metropolitan areas across the country to help deliver time-relevant environmental information to the general public to help them understand the condition of their environment and make day-to-day environmental risk management decisions. A key function of EMPACT is to integrate technical communication among the 86 EMPACT communities, state agencies, and EPA.

As part of EMPACT's technical communication efforts, one of the EMPACT projects, AirNow, was discussed in a satellite videoconference broadcast on December 15, 1999. The purpose of AirNow is to provide the public with real-time information about ozone pollution in an easy-to-understand pictorial format. AirNow is a collaborative effort among EPA, state and local air quality agencies, and regional organizations to collect, quality assure, and transfer real-time air quality information to the public.

The videoconference was convened by EPA's Office of Air Quality, Planning and Standards (OAQPS), in conjunction with and support from the EMPACT program. The December 15 videoconference was the second in a three-part series dealing with AirNow. The first, which was broadcast on November 10, 1999, focused on the Air Quality Index (AQI). The third, scheduled for Spring, 2000, will focus on the health effects of ozone.

Participants in the satellite forum included representatives of EPA and state and local air quality agencies. They provided information on several topics, including: the EMPACT program; major components of AirNow's program to design, implement, and operate an ozone monitoring network, an automated data transfer system (ADTS), an ozone mapping system (MapGen), and conduct public outreach; and key sections of the technology transfer handbook and companion CD-ROM entitled *Ozone Monitoring, Mapping, and Public Outreach: Delivering Real-Time Ozone Information to Your Community*. (The complete agenda is included in this report as Appendix A.)

Target audiences for the satellite forum included managers and decision-makers interested in implementing ozone programs in their communities or learning about new technologies and new approaches for disseminating real-time information; technicians responsible for implementing ozone programs; and communications specialists involved in communicating information to the public about ozone

The satellite forum was produced by EPA's Air Pollution Distance Learning Network (APDLN), a digital educational satellite broadcasting network of 127 governmental and university broadcast affiliates located across the United States. The APDLN is a collaborative partnership between EPA, State and local air pollution control agencies, and North Carolina State University. The broadcast could be viewed at one of the 127 APDLN satellite downlink sites; at another site with satellite downlink capability using Ku and C band satellite coordinates; or via a live Internet simulcast.

Efforts were made to publicize the broadcast through the EPA EMPACT steering committee, EMPACT project leads, participating agencies in the Ozone Mapping Project, and other agencies and organizations such the Northeast States for Coordinated Air Use Management (NESCAUM), the Mid-Atlantic Regional Air Management Association (MARAMA), STAPPA/ALAPCO, the Air and Waste Management Association (AWMA), the Ozone Transport Commission (OTC), and the Local Government Environmental Assistance Network (LGEAN). Special emphasis was placed on publicizing the broadcast in EMPACT communities not served by an APDLN satellite downlink facility.

Videocassettes (VHS format) of the December 15 broadcast are available. Individuals in the public sector (i.e., state, local, and federal agencies) may obtain copies from Dennis Shipman, U.S. EPA, Office of Air Quality, Planning and Standards, Education and Outreach Group (919-541-54770, e-mail: shipman.dennis@epa.gov). There is no fee for copies to the public sector. Individuals in the private sector may obtain copies from Christine Murphy, Industrial Extension Service, North Carolina State University (919-515-5874, e- mail: Christine_Murphy@ncsu.edu). The fee is $35.00.

3. PRESENTATION SUMMARIES

This chapter contains summaries of each of the presentations made during the December 14 satellite broadcast. Appendix C, the Workshop Guide prepared by North Carolina State University, contains each speaker's presentation overheads.

Environmental Monitoring
Denice Shaw
U.S. Environmental Protection Agency
Office of Research and Development/EMPACT Program

Denice Shaw provided background on EPA's EMPACT Program. She explained that the EMPACT program is a Presidential initiative whose mission is to assist communities to implement sustainable monitoring that provides current and accurate information to citizens about their environment. It is operated by a steering committee with members from each of the EPA regions and program offices and from partner Federal agencies including the U.S. Geological Survey (USGS) and the National Oceanographic and Atmospheric Administration (NOAA).

The EMPACT Program stresses the need for community ownership of the program, projects, and data. Monitoring and data management are managed locally (with the provisions that are necessary for secondary access to the data). Data interpretation is the responsibility and privilege of the community. All projects are executed through community leadership and are based on sound science.

Ms. Shaw stated that EMPACT serves as a model within EPA for environmental monitoring and as a catalyst for incorporating new and innovative science.

EMPACT projects monitor parameters that affect human and ecological health. EMPACT projects include monitoring of air quality (such as AirNow), drinking water, beaches, rivers, lakes, and streams. EMPACT currently has monitoring projects in 84 cities across the U.S. It also supports a series of research grants for community-led monitoring in 16 cities. The program also supports pure research to advance the ability to do real-time monitoring and reporting of environmental information.

Ms. Shaw concluded by stating that the EMPACT Program exists to provide communities with the opportunity to implement new technology, data management solutions, and communication tools to provide citizens and the public with accurate and timely information about their environment.

The Ozone Mapping Project
Chet Wayland
U.S. EPA, Office of Air Quality, Planning and Standards

Mr. Wayland provided background information on the Ozone Mapping Project. He explained that the project is a collaborative effort among federal, state, and local air quality agencies to collect, quality assure, and transfer real-time air quality information to the public. He added that the project is intended to provide the public with fast and easy access to understandable air quality information that can assist them in making good health-based decisions about their daily activities.

He then provided a brief history of the Ozone Mapping Project. The Maryland Department of the Environment and the Maryland Chapter of the American Lung Association initiated the concept of ozone mapping in late 1994, and it was put into operation on a regional basis in the Baltimore-Washington, D.C. area in 1995. In 1997, ozone mapping was piloted on a regional basis by Region 1 of the U.S. EPA, covering 14 northeastern states. In 1998, under a grant from the EMPACT Program, EPA/OAQPS expanded the Ozone Mapping Project and undertook full implementation of the mapping system in the eastern U.S.

Mr. Wayland then provided an overview of the mapping process and its five primary components: state and local monitoring networks, the Automated Data Transfer System, the Data Collection Center, map generation, and outreach:

- *State and local monitoring networks* are the actual monitors in the field that states maintain to collect ozone data. (Mr. Wayland displayed a map showing the location of ozone monitors in states that participated in the Ozone Mapping Project in 1999.)

- *The Automated Data Transfer System* is the system used to transfer data from the monitors to state host computers and then to EPA's Data Collection Center.

- *The Data Collection System* is the heart of the ozone mapping system. It is where the data are stored, manipulated, quality assured, and prepared for map generation.

- *Map Generation.* Once the data are quality assured and ready to be gridded and interpolated, ozone maps are generated. The following types of maps are generated each day and following each of the seven daily polls: animated maps for that day, and maps showing the previous day's peak ozone levels (both 1-hour and 8-hour averages). The map's colors correspond to the colors associated with the Air Quality Index.

- *Outreach.* The ozone maps are disseminated via EPA's AIRNOW website (http://www.epa.gov/airnow); via state/local agencies that participate in the Ozone Mapping project; and via Weather Service Providers (WSPs) who provide the maps to local television stations for incorporation in weather broadcasts.

Currently, the ozone mapping project covers 61 EMPACT cities with complete coverage in 29 eastern states and California. Future plans are to extend coverage throughout the contiguous U.S. EPA will also expand mapping beyond ozone to include other pollutants; real-time mapping of particulate matter is scheduled for 2001.

Mr. Wayland discussed how the Ozone Mapping Project has been received by the public. He stated that, between May and September 1999, the AIRNOW website received over 1.2 million "hits" per month (which is double the number received in 1998). The program has received numerous positive comments from the public, including daycare providers, asthmatics, outdoor workers, exercisers, and air awareness program providers. Major successes in 1999 including getting the Weather Channel and major weather service providers to cover the ozone map. Additionally, the Ozone Mapping Project received the Government Technology Leadership Award in 1998.

Mr. Wayland concluded by saying that comments received about the Ozone Mapping Project have been very helpful, and they will continue to be helpful as the program continues to move forward.

Data Collection and Transfer for Ozone Mapping

Phil Dickerson
U.S. EPA, Office of Air Quality, Planning and Standards

Mr. Dickerson provided an overview of the Automated Data Transfer System (ADTS). He also explained how to set up a State Host Computer (SHC) to connect with the EPA Data Collection Center (DCC) and the ADTS. Finally, he provided troubleshooting tips on using the ADTS.

He began his presentation by providing a brief overview of the regulations, found in 40 CFR 58, that pertain to ambient air monitoring networks. In 1979, EPA promulgated ambient air monitoring regulations, which established SLAMS (State and Local Monitoring Stations) networks (used to demonstrate if an area is meeting national ambient air quality standards [NAAQS]) and NAMS (National Air Monitoring Stations) networks (used to supply data for national policy and trend analyses). Then, in 1993, EPA promulgated the PAMS (Photochemical Assessment Monitoring Stations) rule. PAMS are required to obtain more comprehensive and representative data about ozone air pollution in ozone nonattainment areas designated as serious, severe, or extreme. (The ozone mapping system generally makes use of these already installed monitoring networks.) In July, 1997, EPA promulgated rules that require monitoring for fine particulate matter.

Mr. Dickerson then discussed the ADTS. He described the ADTS as the "heart" of the DCC. The ADTS runs on EPA's Valley internal UNIX Server, which is located in Research Triangle Park, North Carolina. It is responsible for merging data provided by State Host Computers, QA/QC of that data, and making calculations such as daily peak values and Air Quality Index (AQI) values.

He then described how data flow within the ADTS. He explained that ozone monitors measure ground-level ozone concentrations. These data are fed into “data loggers” that record and store the data. State Host Computers (SHCs) poll the data loggers at specified polling times and ready the data for delivery to the ADTS. SHCs connect to the DCC before the end of each polling window and transfer the observations from midnight until the polling hour. The ADTS then merges all agency data received from the SHCs into a master file. Among other things, the ADTS runs a QA/QC program on the data, calculates peaks and AQI values, interpolates for single hours missing. It also generates gridded data for delivery to Weather Service Providers, and then produces the master observed data (OBS) file. Every participating agency in the Ozone Mapping System can access the master OBS file, which is a good way for them to check their own data and see what the data in surrounding areas look like. Once the ozone animations have been checked by the DCC operations crew, they are posted to the AIRNOW website (http://www.epa.gov/airnow).

Mr. Dickerson explained the steps involved in setting up a State Host Computer to connect to the DCC/ADTS is to obtain an EPA user ID and password. He said that he can set these up for new users or they can be set up by your local EPA Regional Office. He explained that, to convert the data acquisition platform’s format to the Ozone Mapping System format, SHCs must either run the ESC Ozone Mapping Module or custom software to convert the data from the agency’s acquisition system’s format to the ozone mapping system’s format. Once the data are in their proper format, the user ID and password assigned by EPA are used to forward the data to the DCC via FTP (file transfer protocol). Shortly after the data are delivered to the DCC, it is run through the ADTS, and then the master OBS file and is available for use in generating ozone maps.

Mr. Dickerson next provided a number of troubleshooting tips for using the DCC. He said that EPA security policies mandate that a user has only three tries to log into the DCC. After the third try, the user’s account is locked. He advised that users be careful when experimenting. After two tries, wait an hour or two before trying again to log on so that you do not immediately encounter your third unsuccessful log-in attempt and have your account disabled.

He also said that users who have trouble connecting to the DCC should check with their local firewall/security group to see if their FTP access is restricted. If so, some modifications to your firewall may be necessary.

He also advised users to troubleshoot in discrete segments. For example, as a first step, check to see if you are getting your data from the data logger onto the State Host Computer. Next, make sure the data are getting converted to Ozone Mapping System format. As a third step, make sure your user ID and password are valid by trying a manual FTP. Next, log into the DCC to see what your data look like; make sure it arrived in the proper directory and has the correct format. Finally, make sure your data look correct in the master OBS file after the QA/QC process.

Mr. Dickerson concluded his presentation by urging people to call EPA if they experience a problem. With a highly automated system that takes data from nearly 50 users, things can get overlooked and problems can recur for days on end. Because EPA does not want to miss your data, call if you have a problem.

Making Ozone Maps

Neil Wheeler
Sonoma Technology, Inc.

Mr. Wheeler provided an overview of the Map Generator (MapGen) software and its capabilities.

MapGen produces still-frame images, both in the Windows BMP format and in CompuServe GIF format; animations (BMP and GIF) and gridded ASCII files. He explained that MapGen works by reading ozone monitoring station data and interpolating them to regular grid locations. MapGen can use two different interpolation/extrapolation techniques: (1) inverse distance weighing, where the influence of the station drops off proportional to the distance from the grid point; or (2) Kriging, which uses a correlation of values to create a model of what values should be at the regular grid. The gridded data can then be passed on to a contouring routine or written to a file for later use. The end result are maps that contain color-filled contours that represent different concentration levels of ozone and their associated health effects.

He then discussed the minimum requirements for operating MapGen. These include: an IBM PC-compatible computer with a Pentium processor (133 MHz or better); 16 megabytes of RAM; 100 megabytes of free disk space; a super VGA monitor with 24-bit color display; and Windows 95, 98, or NT 4.0.

MapGen can be downloaded from MCNC's web site (http://envpro.ncsc.org/OMS). The download files can be accessed by anonymous file transfer protocol (ftp) or through a web browser. The *readme.txt* file explains how to install the software. The current release of MapGen on the MCNC web site is approximately two years old. An updated version will be available in 2000.

Mr. Wheeler then described sources of data that can be used to generate maps with MapGen. Data are available from EPA's Data Collection Center (DCC). In addition, some currently available polling software packages have an ozone mapping module that converts data to a form suitable for use with MapGen. In addition, a conversion program (*airs2oms*) is distributed with MapGen that reads data in AIRS (Aerometric Information Retrieval System) formats and generates MapGen-ready files.

Mr. Wheeler explained that making maps with MapGen is basically a 6-step process: reading the data; selecting the area you want to map; selecting a variable (e.g., peak or average concentrations); selecting gridding and other options; adding annotations such as graphics or text; and finally plotting or animating the map. He then conducted a live demonstration of how to make a map using MapGen. The demonstration showed how to use MapGen's file, customize, plot, animate, and help menus.

One of the powerful things about MapGen is its scripting capability. It includes a complete scripting language (which is documented in the MapGen User's Guide). MapGen also features sample scripts that can be used with scheduling software to generate maps on a regular basis.

Mr. Wheeler completed his presentation by discussing resources that can be accessed for troubleshooting MapGen. These include the MapGen User's Guide, which is available from the MapGen help menu. The User's Guide is also available at http://envpro.ncsc.org/OMS. MCNC also maintains a "ticket" system, which can be accessed at http://envpro.ncsc.org/products/ticket.html. This system allows a user to enter a "ticket" with problems, comments, or suggestions. Users can also review previously entered tickets. The technology transfer handbook *Ozone Monitoring, Mapping, and Public Outreach: Delivering Real-Time Ozone Information to Your Community*, released in September, 1999, is also a useful troubleshooting resource. It is available in HTML and PDF formats on the EPA AIRNOW website (http://www.epa.gov/airnow). In addition, EPA's WebBoard (http://ttnwww.rtpnc.epa.gov/ozmap) contains a conference area where users can post questions and check to see if any questions have been addressed in previous postings.

If users need additional information about MapGen, they can contact Steve Fine of MCNC at 919-248-9255 (fine@ncsc.org) or Neil Wheeler of Sonoma Technology, Inc. at 707-665-9900 (neil@sonomatech.com).

The EPA Ozone Handbook
Jan Connery
Eastern Research Group, Inc.

Jan Connery of Eastern Research Group, Inc. (ERG) provided information about EPA's handbook *Ozone Monitoring, Mapping, and Public Outreach: Delivering Real-Time Ozone Information to Your Community*. (She explained that ERG is the contractor that provided support to EPA in developing the handbook.)

Ms. Connery explained that the goal in writing the handbook was to provide communities with a complete map to designing an ozone program at the local level. EPA wanted the handbook to be a useful tool to communities at all stages in program development—from those who currently have nothing in place and are considering whether to establish a program, to communities that have some components in place and would now like to have a comprehensive program.

The handbook, which is available in both print and CD-ROM formats, was written with several audiences in mind: managers and decisionmakers who may be considering whether to develop an ozone program; technicians responsible for setting up and operating ozone monitoring, data transfer, and mapping systems; and communications specialists who would be responsible for ozone outreach programs.

Ms. Connery discussed the content of the handbook. For ozone monitoring, the handbook explains how to design, site, operate, and maintain an ozone monitoring system. In the area of data collection and transfer, it provides guidance on how to develop, operate, and maintain a system to retrieve, manage, and distribute real-time ozone data. It also explains how to use that ozone data to create ozone maps. It also provides guidance on how to develop an outreach program to communicate information about real-time ozone levels to the public. Finally, the handbook contains references to more than 100 web-based information sources, such as other organizations' websites, EPA technical guidance, downloadable software products, and Internet news groups.

To help make the handbook as relevant and useful as possible for local communities, EPA sought the input of the user community at three stages. At the beginning of the project, managers from state and local air quality agencies across the country were asked about what types of guidance they would find useful, and their answers were used to shape the handbook's content. Also, state and local air quality agencies that have experience in setting up ozone programs were interviewed to develop detailed case studies for the handbook. These case studies highlight the successes and lessons learned by these agencies in developing and implementing their own ozone programs. Finally, two agencies—the Maryland Department of the Environment and the Mississippi Department of Environmental Quality—pilot-tested a draft version of the handbook, and their input was used to produce the final version.

As the last portion of her presentation, Ms. Connery discussed Chapter 6 of the handbook, which provides step-by-step guidance on how to develop an ozone outreach plan. She explained that a first step is to determine the goals of your outreach effort—in other words, what do you want to achieve through outreach? For ozone outreach, for example, a goal might be to motivate members of the public to reduce their personal exposure to ozone when levels are high, or take action such as carpooling to help reduce ozone levels. Another early step in outreach planning is to identify your target audiences. Target audiences for ozone programs might include the public, school children, physicians, business leaders, journalists, and weather broadcasters. The next step is to develop key points or messages. For ozone, a message for the public might be that "elevated ozone levels can harm your health" or that "you can access the ozone map to find out about current ozone levels." A final step is to identify what types of outreach mechanisms or products would be most appealing to the target audience and what distribution channels will be used to get the outreach information or materials to target audiences.

Ms. Connery said that many innovative ozone outreach programs have already been implemented in communities across the country. These have included:

- Working with TV stations and weather service providers to have the ozone map shown regularly during weather reports.

- Launching intensive campaigns to encourage broadcast and print media coverage during ozone season.

- Creating web sites that include ozone maps and other ozone-related information.

- Working with schools to provide information about ozone in science and health classes.

- Developing “ozone action day” programs aimed at encouraging people, businesses, and industries to take voluntary measures to help reduce ozone levels on days when they are high.

- Operating hotlines that provide recorded information about current and forecasted ozone levels.

Ms. Connery concluded her presentation by emphasizing the importance of partnership. For ozone outreach, some key partners have included schools, local media, and local businesses. Partnering with other organizations to implement outreach programs is a great way to leverage costs, strengthen the outreach effort, and increase its success in achieving the outreach goals.

North Carolina’s Air Awareness Program
Lisa Grosshandler
North Carolina Department of Natural Resources

Ms. Grosshandler provided information about the Air Awareness program, North Carolina’s outreach and education program about ground-level ozone. Her discussion focused on the following key aspects of the program: coalitions, forecasting, and education.

The Air Awareness program includes coalitions of key business in each of the regions for which the program is in effect. The Air Awareness program holds meetings with these coalitions that are intended to introduce coalition members to the concept of ground-level ozone, its health effects, the ozone standard, and how the standard could affect North Carolina businesses. The Air Awareness program works with each coalition to set up a kick-off event at the beginning of each ozone season. These events have been both large and small, depending on the wishes of the local metropolitan area. The larger events have reached both school children and the general public. For example, in the Triangle area, a kick-off event was held at the Durham Bulls park in connection with a game. At that event, Greg Fishel, a television meteorologist from WRAL-TV in Raleigh, gave the first ozone forecast of the season. The Air Awareness program includes an end-of-season thank-you to coalitions, both in the local newspaper and at an end-of-season lunch.

Forecasting is another key feature of the Air Awareness program. During the ozone season, color-coded forecasts are provided through a website, a toll-free hotline, and an automated system that sends out forecasts via fax and e-mail. During weekdays, forecasts are given by 3:00 p.m. every day. Ozone Action Days are called on predicted Code Orange and Code Red days. On Ozone Action Days, the public and businesses are asked to take voluntary actions to reduce the precursors to ozone formation.

Ms. Grosshandler said that North Carolina has placed a great deal of emphasis on ozone education. She then provided information about several of the education tools used by the Air Awareness program. These include: an "Ozone Zone" educational video that presents information on ozone in a humorous way (and which also includes the U.S. EPA's "Ozone: Double Trouble" video); an "Air Jeopardy" game, which is played on computers in a classroom setting; the "Air Adventures" puppet show, which is performed for pre-kindergarten through second grade students and shows how ozone is formed and how it affects plants and people; the Air Avenger Superhero, who is a costume character who talks to children about ways to reduce air pollution and who also appears in animated videos; and various classroom activities, which may include live demonstrations of monitoring equipment. Ms. Grosshandler showed an animated video clip featuring the Air Avenger.

Other educational tools include: an exhibit both that is taken to teacher conferences, fairs, and other events; contests, such as an end-of-season contest for coalition members and a coloring contest for kids; a media campaign, which includes animated videos/commercials featuring the Air Avenger and radio spots geared to adults; coalition site-coordinator training; and a media day, which is a 2-hour training that provides television and radio personnel with information about ozone and its health effects. Ms. Grosshandler commented that media days have been very helpful in getting the media to agree to provide ozone forecasts. In 1999, the ozone forecast was provided in 75 percent of the state's markets.

Ms. Grosshandler concluded her presentation by discussing some of the challenges that face the Air Awareness program. Among other things, these include quantifying the success of the program. (North Carolina is looking into U.S. EPA guidance on how to quantify emissions reductions that result from voluntary programs.) Another challenge is keeping the program fresh (e.g., coming up with new ideas and fresh faces and keeping coalition members excited throughout the ozone season—especially with as many Code Orange days as North Carolina has). She concluded her presentation by advising states and localities that are developing ozone outreach programs to talk to other states about their ozone education and outreach programs and the lessons they have learned.

Ozone Comes to Television!

Greg Fishel
WRAL-TV, Raleigh, North Carolina

Mr. Fishel, a meteorologist from WRAL-TV in Raleigh, North Carolina, explained how his station displayed ozone data during newscasts throughout the 1999 ozone season. In addition to showing ozone maps during news broadcasts, on Code Orange and Code Red days, the station displayed "ozone alert" icons in the corner of the screen during other programming.

According to Mr. Fishel, WRAL-TV's coverage of ozone data in 1999 was a natural outgrowth of the strong relationship the station has developed with the North Carolina Division of Air Quality over the last two or three years. He commented that real-time ozone data is an effective way to illustrate for the public the reality of air quality problems. He added that showing ozone data on television promotes public actions to reduce ozone concentrations; when people see real-time ozone data, they are more likely to be motivated to take steps to reduce ground-level ozone.

Mr. Fishel explained how the station accesses and displays ozone data. The North Carolina Division of Air Quality retrieves ozone concentration data by polling ozone monitors throughout the state. They then send it to the U.S. EPA, which processes the data and sends it to Weather Service Providers (WSPs). WRAL-TV receives its data from Weather Central, Inc., a WSP based in Madison, Wisconsin. The station retrieves the data from Weather Central via dial-up connection. (In 2000, Weather Central will deliver data via satellite.) Once WRAL receives its data from Weather Central, they transfer the data to a graphic display system (an SGI Octane), which interpolates the hourly data to make color-contoured, animated ozone maps. (The maps are based on the colors specified in EPA's Air Quality Index rule.)

Mr. Fishel then discussed several steps that could be taken to improve the process of getting real-time ozone information on television. First, the "observation-to-display" time needs to be reduced. Currently, it takes nearly three hours for data collected at monitors to be ready for display on the air. (In 1999, the only option available to WRAL-TV was to show viewers a recap of what happened earlier in the day.) Second, this transmission speed limited the number of ozone monitors in North Carolina that could be polled at any given hour. If transmission speeds were improved, data from all monitoring stations could be included in television broadcasts, which would provide a more complete picture of North Carolina air quality. Finally, it would be helpful to provide the public with forecast data in the same format as observed data. Mr. Fishel commented that this would help improve people's understanding of ozone data if the display modes for forecasted and observed data were consistent.

Mr. Fishel concluded his presentation by stating that feedback about WRAL-TV's ozone coverage has been positive. The public is genuinely interested in seeing a type of data they have not seen before. Also, seeing ozone data in near real-time has helped the public see that air quality is a legitimate issue in North Carolina. He also commented that the public expressed some concern about threshold level for displaying ozone alert icons. WRAL-TV displayed these icons on both Code Orange and Code Red days. Because Code Orange days are so frequent in North Carolina, some people were concerned that the public might be "desensitized" by the frequent appearance of the Code Orange icon; however, the station chose to display the Code Orange icon as a service to individuals whose health is affected when concentrations reach "Code Orange" levels.

Ozone Maps on Television
Tim Dye
Sonoma Technology, Inc.

Tim Dye of Sonoma Technology, Inc., explained how ozone maps get on television. It is particularly important to get ozone maps on television, he said, because television reaches such a broad audience. One broadcast of the ozone map can reach millions of households.

In 1995, the Maryland Department of the Environment and the American Lung Association were able to get ozone maps shown on WRC-TV in the Baltimore-Washington, D.C. area. Then, in 1996, the New Jersey Department of Environmental Protection was successful in having the local PBS channel show the maps. In 1998, the U.S. EPA, in cooperation with 20 Eastern states and California, approached the Weather Service Providers (WSPs), and the ozone map received some limited television coverage that year. In Sacramento, the ozone map received good coverage by one local station in 1998. In 1999, EPA, in cooperation with 30 Eastern states and California, worked closely with the WSPs and improved television coverage of the map. Mr. Dye then provided background on how the U.S. EPA has worked with WSPs to get them to carry the ozone map. He said that EPA made an informational presentation at the 1998 National Association of Broadcasters meeting and exhibited at the 1998 and 1999 American Meteorological Society’s Broadcaster’s meetings.

Mr. Dye then provided some detailed information about WSPs. He explained that WSPs are companies that supply weather data, images, and forecasts to television stations, newspapers, private industry, and the public. There are five WSPs: AccuWeather, Kavouras, the Weather Channel, Weather Central, and Weather Services International (WSI). He said that television stations want their graphics to be distinct from those of other television stations, and WSPs have the hardware and software that conform to television standards and allow stations to customize the maps to achieve a distinctive look. He added that television weathercasters do not have the time to manipulate images or download images, such as the ozone map, from the web. WSPs provide high-speed, automated delivery of data in the form that television stations want and need.

He then showed a schematic illustrating the flow of ozone data from ozone monitors to television stations. He explained that WSPs reformat gridded ozone data supplied to them by EPA and send the reformatted data to television stations by satellite or dial-up connection. Television stations then conduct further customization of the data and maps.

He reported that the response from WSPs has been generally favorable. At this point, Weather Central has been the most positive of the WSPs and picked up the ozone map in both 1998 and 1999. In addition, the Weather Channel has posted city-specific ozone forecasts on its website. In 1999, WSI and Kavouras both ingested the data and sent it to television stations. AccuWeather, however, has yet to sense a demand for the ozone maps from its client stations and therefore has not yet picked up the ozone map. Mr. Dye cited some issues that are preventing widespread distribution of the ozone map: it is not yet a nationwide product; it is not a year-round product;

and the information is not as “real-time” as weathercasters desire. (EPA is focusing on this issue to try to improve turnaround time.) In addition, WSPs are reluctant to invest resources in a product for which the demand is unknown at this time.

Mr. Dye then played a series of video clips showing how the ozone map has been covered during weather broadcasts.

He said that television coverage of the ozone map has been particularly successful in North Carolina and in Sacramento, California—due largely to the efforts of Lisa Grosshandler and Kerry Shearer, the ozone public information officers for North Carolina and Sacramento, respectively. Kerry and Lisa were successful because they met with and educated television meteorologists, generated interest in the ozone maps, encouraged local television stations to contact WSPs to show demand for the maps, and stayed in touch with the stations throughout the ozone season. The results are that the ozone map received more “air play” in these regions than in any other region covered by the ozone map.

Mr. Dye concluded his presentation by talking about what is needed to get additional coverage of the ozone map on television stations. He urged state public outreach officials to contact television stations to: explain that the ozone maps are available; encourage the stations to contact their WSP; explain to weathercasters how ozone affects health; explain what the ozone maps show; and develop relationships with television stations.

Ozone Action Days: The Baltimore-Washington, D.C. Metropolitan Region’s ENDZONE Program

Tad Aburn and Randy Mosier
Air Quality Planning Program, Maryland Department of the Environment

Tad Aburn, Randy Mosier, and additional staff from Maryland’s Air Quality Planning Program discussed the ENDZONE program, the ozone outreach and education program for the Baltimore-Washington, D.C. metropolitan region.

Mr. Aburn explained that Maryland has been working on its ozone program since the early 1990s. The program has evolved from a simple forecasting program to a multifaceted program that includes forecasting, mapping, and media campaigns. He then provided a brief history of the ozone program for the Baltimore-Washington area. In 1993, the Maryland Department of the Environment worked with the University of Maryland to develop and test an ozone forecasting methodology. In 1994, color-coded forecasting began in the Baltimore area, and in 1995, forecasting was expanded to cover the Washington area. 1995 was also the first year of the ENDZONE program. The Ozone Action Days program was initiated in 1996. “Code Red” media coverage was extensive during both the 1995 and 1997 ozone seasons. In 1999, both Ozone Action Days and ENDZONE partnerships increased significantly.

Bill Buroughs, Managing Director of ENDZONE Partners, discussed ENDZONE's outreach campaign. ENDZONE ran an extensive public education campaign in 1999 and spent $204,000 to broadcast messages across the Baltimore-Washington region. He then showed a video clip about Ozone Action days that was broadcast during the 1999 ozone season.

Next, Jonathan Priday of Maryland's Air Quality Planning Program discussed the ENDZONE Partner's Ozone Action Days program. He said that the backbone of any ozone outreach program is its partners. ENDZONE Partners include businesses, local nonprofit agencies, and state and local agencies. ENDZONE Partners receive daily ozone forecasts via fax or e-mail. They also are notified when air quality levels exceed federal standards. On Ozone Action Days, ENDZONE Partners recommend that people limit using light-duty vehicles (including refueling), avoid non-industrial painting, and curtail the use of land and garden equipment and consumer aerosol products. Mr. Priday then showed a video clip on Ozone Action Days, which was aired by WJZ-TV.

Michael Woodman, a meteorologist with Maryland's Air Quality Planning Program, provided information about ozone forecasting. He said that the forecast is developed by reviewing satellite images and other forecasting services provided by the National Weather Service and then plugging weather information into an ozone regression model developed by the University of Maryland. The final ozone forecast is determined during a conference call with meteorologists from the Maryland Department of the Environment, the University of Maryland, the Virginia Department of Environmental Quality, and the Washington Council of Governments.

Next, Chuck Cramer, a planner with Maryland's Air Quality Planning Program, explained how the ozone forecast is distributed to the public. The forecast is faxed to over 50 media outlets (e.g., local television and radio stations and newspapers) and to over 300 businesses in the region. Businesses then pass the forecast information along to their employees. Mr. Cramer said that the forecast has generated more media coverage than all other media efforts combined and has resulted in routine daily media coverage of ozone air quality. "Code Red" has become a message that is widely understood within the Baltimore-Washington media market.

Finally, Randy Mosier, a planner with Maryland's Air Quality Planning Program, explained Maryland's ozone mapping system and discussed the results of the ozone outreach initiative. Mr. Mosier said that the map was originally conceptualized and piloted by the Maryland Department of the Environment and the American Lung Association of Maryland. The map is based on data collected from monitors in Maryland, Washington, D.C., Virginia, Pennsylvania, and Delaware. A software package was developed for use by local television stations to show the formation and movement of ozone pollution across the region. The map was first aired on television stations in Baltimore and Washington in 1995.

Mr. Mosier then discussed some of the successes of ozone outreach efforts in the Baltimore-Washington region. The Ozone Action Days program has grown steadily, from 91 partners in 1996 to over 300 in 1999. He said that daily forecasts have made "Code Red" a common phrase that has people talking about air quality all the time. Survey results have shown that seven out of ten people across the region have heard the “Code Red” message, and 90 percent of the public in the region see air quality as a top environmental problem. In addition, more that 40 percent of the public believe that they can individually make a difference in air quality, and 35 percent reported taking voluntary actions to help reduce ground-level ozone during “Code Red” alerts.

Mr. Mosier concluded his presentation by sharing some lessons learned. He said that it is important to begin an outreach program by getting state and local government agencies on board. It is also important to develop a strong relationship with local media outlets and to work closely with regulated industries who may be willing to develop a program (i.e., participate as an Ozone Action Day partner) and be seen as participating in a positive environmental activity. He advised folks to have plenty of informational material on hand during site visits to media, businesses and industries, and other agencies. Finally, it is important to get a head start on the summer ozone season.

4. SUMMARY OF LIVE QUESTION-AND-ANSWER SESSIONS

This chapter contains a summary of the two live question-and-answer sessions that were held during the December 15 satellite broadcast. Questions were received from viewers by phone or fax during the broadcast. Each question that was asked during each session is presented, followed by a summary of the participant's response.

Question and Answer Session #1

Panel: Chet Wayland, EPA/OAQPS
Phil Dickerson, EPA/OAQPS
Neil Wheeler, Sonoma Technology, Inc.
Charles Pietarinen, New Jersey DEP
Jan Connery, ERG, Inc.

***[For Chet Wayland]* How will the Ozone Mapping Project continue after the EMPACT program ends?**

Mr. Wayland explained that EPA established the Ozone Mapping Project to try to build the infrastructure for ozone monitoring, data transfer, and mapping within states and local communities. After EMPACT funding ends, states and localities will be in a position to continue to provide the real-time data. EPA's Office of Air Quality, Planning and Standards will continue to maintain the Data Collection Center and the map generation operations in Research Triangle Park, North Carolina.

***[For Chet Wayland]* When will the ozone mapping project be expanded to add additional pollutants?**

Mr. Wayland noted that Charles Pietarinen of the New Jersey DEP mentioned during his presentation that New Jersey already provides real-time particulate matter (PM) data for the state of New Jersey. Many areas of the country already have the capability to provide PM data. EPA hopes to provide some PM data on the AIRNOW website as early as this summer (the summer of 2000). If not by then, then definitely by the summer of 2001, EPA hopes to have the data collection system set up and ready to handle PM data.

***[For Phil Dickerson]* Please explain how the ADTS (Automatic Data Transfer System) calculates peak 8-hour concentrations.**

Mr. Dickerson explained that because data on peak concentrations are available only the following day, and peak values are calculated from that data. EPA does not do any kind of predictive modeling.

***[For Neil Wheeler]* The ozone animations give the appearance that the ozone plume migrates from one area to another, sometimes counter to the winds. Can you display animated wind vectors on the map to clarify this origin/movement confusion?**

Mr. Wheeler explained that wind vectors cannot be displayed on the ozone maps. He commented that it would be a nice feature, particularly for air quality analysts and meteorologists. The ozone maps were designed as tools for public outreach, and unfortunately, they don't have the capability to show wind vectors.

***[For Neil Wheeler]* How small an area can be mapped with MapGen?**

Mr. Wheeler explained that there is essentially very little limitation on the size of areas you can map with MapGen. MapGen allows you to show something as small as a football field, if observations were available at that resolution.

***[For Charles Pietarinen]* Does the New Jersey DEP provide Air Quality Index (AQI) reports and/or forecasts for $PM_{2.5}$ or annual PM_{10}?**

Mr. Pietarinen responded that New Jersey does not provide AQI products for the annual (PM_{10}) standards. New Jersey does have continuous measurements of $PM_{2.5}$ at five locations that are included in the index calculation, and New Jersey uses a tool called Smokeshade as a surrogate measure for PM_{10} at thirteen locations in the state.

***[For Charles Pietarinen]* What are some the issues regarding the mapping of particulates?**

Mr. Pietarinen said that one issue involves establishing enough monitoring sites so that you have sufficient spatial coverage to create a legitimate map for that parameter. A second issue has to do with averaging time. For ozone, a one-hour predictor is used for an eight-hour value. This type of system doesn't seem to work as well for fine particulate matter, for which the standard is based on a 24-hour average.

***[For Phil Dickerson]* What do you do if a state or local agency finds incorrect values after the data have been submitted to the data collection center? Can those values be corrected?**

Mr. Dickerson explained that there are seven polls each day. Each poll is inclusive from midnight of that day until the current polling hour. At any poll, a state or local agency can resubmit data that occurred before that poll. Also, there is a "last-chance" poll the following day which EPA uses to calculate the peak maps. A state or local agency can deliver its entire data set for that day during that poll. It becomes more complicated if a state or local agency needs to change data after the "last-chance" poll, because EPA then has to re-QA the data and redraw maps. EPA encourages agencies to check their data daily to try to correct errors on the same day, if possible.

[For Phil Dickerson] **Can an agency set its own quality assurance parameters?**

Mr. Dickerson said that the QA system is very flexible. The full range of QA parameters, such as maximum, minimum, and rate of change, can be set for every station and every hour.

[For Neil Wheeler] **When is the updated version of MapGen going to be available?**

Mr. Wheeler responded that an updated version of MapGen was delivered to EPA in June, 1999, but it was not put into general distribution due to budget constraints. However, a completely new release will be made available this year (2000). In the interim, if people need to get the latest version of MapGen, they should contact Phil Dickerson.

[For Neil Wheeler] **Is there some way to show only a few roads and rivers on the map?**

Mr. Wheeler explained that MapGen includes the entire data sets for roadways and rivers, so when applying the roads/rivers feature, the maps contains an awful lot of information. He suggested the following ways to create maps with a subset of roads and/or rivers. (1) Create your own customized data set with a geographical information system (GIS) and select only certain road types or certain areas. (MapGen includes documentation that explains how to do this.); or (2) Generate an image with all the roads or rivers. Taking that image and using it as a background, trace in roads or rivers with a graphics tool such as Corel Draw or any tool that works with Windows metafiles. The Windows metafiles can be used with MapGen to provide an overlay. That way, you can create maps that include only the roads that you want to show.

[For Jan Connery] **Where can a person get more information on setting up an Ozone Action Day Program? How do they find out what's involved?**

Ms. Connery responded that the EMPACT guidance manual *Ozone Monitoring, Mapping, and Public Outreach* includes a chapter devoted to outreach. Furthermore, EPA has developed an entire guidance document devoted to the subject of developing community action programs. The document, entitled *Community Action Programs: A Blueprint for Program Design* was published in 1999. It leads the reader through all the steps involved in setting up this type of program, and it provides examples for some of the materials that existing programs have used. It can be obtained at http://www.epa.gov/oms/traq.

[For Charles Pietarinen] **Which of your public outreach efforts have been most successful?**

Mr. Pietarinen said that New Jersey's most successful efforts are media-oriented because they reach the largest audience. New Jersey's daily press releases, which include the air quality index and forecast values, as well as New Jersey's air quality media advisories have been the most successful in reaching people. He added that New Jersey is very excited about the web-based applications it has developed. The website address is http://www.state.nj.us/dep/airmon.

***[For Jan Connery]* Can you talk about how to build partnerships? What types of roles partners could play, and who those partners could be?**

Ms. Connery emphasized that partnerships are tremendously important to outreach programs. Identifying partners is one of the first steps to take in establishing an ozone outreach program. Partners for ozone outreach efforts might include businesses; the media; elected officials; transportation agencies; gas stations; schools; and day care centers.

Many ozone outreach programs currently have businesses as partners. Businesses can instantly notify hundreds or thousands of their employees through e-mail or voice mail. They can create incentives for participating in Ozone Action Days such as flex time, vanpooling, telecommuting options, free lunches, and prizes. They can also help track participation and provide leadership and funding.

One of the key things to think about in recruiting businesses is to help them understand the benefits they will receive from their involvement, such as good PR and recognition from the press. Many Ozone Action Day programs make a point of publicizing the role of partners through the media so that the partners can receive widespread recognition. Additionally, Ozone Action Day programs host ozone season kickoffs and end-of-the-season events to recognize partners and present awards.

Ms. Connery stated that another key partner is the media. They provide a very important channel for educating and notifying the public. Information about ozone levels can be conveyed on the news, through weather broadcasts, traffic advisories, talk shows, and—if budgets can support it—paid advertising. It is very important to start working with the media before the ozone season begins. Ms. Connery recommended meeting with the media in person to get their buy-in and support and to explain the program, and how they can help. She also recommended making an effort to keep in touch with them throughout ozone and provide them information they need.

***[For Chet Wayland]* Is the National Weather Service picking up ozone maps, and will they distribute them to local media outlets nationwide?**

Mr. Wayland began by explaining the difference between the National Weather Service and Weather Service Providers. The National Weather Service is a federal agency that gathers and maintains U.S. meteorological data. Weather Service Providers, on the other hand, are private agencies that collect the data from the National Weather Service and other entities and then distribute the data to local TV stations in their proper formats.

Mr. Wayland explained that the Ozone Mapping Project is working to provide ozone data and the ozone map to all Weather Service Providers. The map was made available to Weather Service Providers this past summer. He encouraged people involved in ozone outreach to talk to their local TV contacts and tell them that the data are available from Weather Service Providers for their local weather forecast.

***[For Charles Pietarinen]* Does the New Jersey program get together with media outlets before the ozone season starts?**

Mr. Pietarinen stated that New Jersey usually holds an Ozone Action Day media event before ozone season starts. The event is designed to increase awareness and to thank partners and get them geared up for the upcoming season. In past years, New Jersey has also held a media event for the press and television stations to let them know how ozone information is being made available to them and to suggest ways that they can use it. He added that some TV and radio stations carry New Jersey's ozone information on a daily basis. Others only want to pick it up when there is a "real" story because pollution is very high.

***[For Charles Pietarinen]* What is one of the more creative outreach efforts you have seen?**

The Philadelphia Ozone Action Partner has a mascot called the Smoginator, who does radio spots. One of my favorite outreach events was held at Veterans Stadium where the Philadelphia Phillies play. It was an ozone-free barbeque to kick off the season. We invited Ozone Action partners and we held a student poster contest. Winners were invited to meet the Philly Phanatic (the team mascot) and get free hot dogs. There were also some vendor demonstrations of electric lawnmowers and solvent-free paints.

***[For Jan Connery]* Have any attempts been made to evaluate the success of ozone outreach efforts?**

Ms. Connery stated that a number of programs conduct some form of evaluation to track their successes, and they have shown very good results. Some of the things to look at when planning an evaluation are: how many people you are reaching through your program; how effectively your messages and materials are raising awareness and understanding; and how your efforts are motivating people to change their behavior.

Before you start your outreach program, you can administer a pre-campaign survey to identify current understanding and awareness and establish a baseline. Using focus groups, you can also test your messages and your draft outreach products. Once you have implemented your program, you can conduct periodic evaluations and end-of-the-season evaluations. By comparing these results to the baseline, you can understand how well your program is working and identify areas for improvement.

Ms. Connery stated that telephone surveys are cost-effective and can be done rapidly. It is important to try to reach people the evening of the ozone action day while their experiences and choices of the day are fresh in their minds. Ms. Connery highly recommended devoting a portion of an ozone outreach budget to evaluation.

Question and Answer Session #2

Panel: Chet Wayland, EPA/OAQPS
Greg Fishel, WRAL Television
Lisa Grosshandler, NC DAQ

***[For Chet Wayland]* How can I get ozone maps on the air?**

Mr. Wayland said that first you need to determine if ozone maps are currently available in your area. He said that the maps are currently available for thirty states in the U.S. EPA hopes to expand the maps nationwide by the end of 2000. Next, contact your local TV stations, who you need to work with very closely to make sure the maps get on the air. Explain that the maps are available from their Weather Service Provider. Explain to them how ozone affects health and why it is important to show the maps on the air. Explain what the map shows in terms of the different colors, the contour levels, and the accompanying health messages. You will want to develop a relationship with that TV station so that when they have questions, they know who to call. Work with them daily, if needed, to make sure they understand what the product is.

***[For Greg Fishel]* When did you start using the maps, and how can we convince our own local stations to participate?**

Mr. Fishel said that the summer of 1999 was the first year that his station used the ozone maps. As Chet Wayland mentioned, the map will soon be available from all the different Weather Service Providers. He said that the only reason the ozone map was not covered by all the stations in his market this past summer was that only one Weather Service Provider had made the map available at that time. Mr. Fishel said that as all the providers get involved, there shouldn't be any reason why television stations wouldn't want access to the ozone data.

***[For Greg Fishel]* Is this information that stations are hungry for, or do people need to pitch it to them?**

Mr. Fishel replied that stations want to provide the information as a public service, but they need to be educated about the importance of air quality and how it relates to health. Mr. Fishel said that he could not think of a public service that would be much more valuable than giving people information that relates to their health.

***[For Chet Wayland]* When are the ozone maps valid? In other words, if a local station has a noon broadcast, are the maps real-time, or are they delayed?**

Mr. Wayland replied that EPA calls the maps "real-time," but to be more accurate, they should probably be called "near real-time." In 1999, EPA polled the states every two hours to get the data. When the data come in, EPA has to do some processing on it. EPA then ships it out to the

Weather Service Providers, who make it available to the local TV stations. Unfortunately, in some cases it took over 2½ hours to get the data to the TV stations.

Mr. Wayland said that EPA is redesigning the way in which the Agency is shipping data out to the Weather Service Providers. In 2000, Weather Central [a Weather Service Provider] is going to ship their data to their stations via satellite versus modem and file transfer protocol (ftp). Mr. Wayland said that this should improve the time it takes to get data to local stations and, ideally, EPA hopes to cut the current time in half. For example, on a 5:00 p.m. forecast, you would be able to get data that was current as of 4:00 p.m. Mr. Wayland concluded by stating that EPA hopes to go to hourly polling, and then the data will be available every hour. He hopes that in 2000, after a poll, data should be able to reach local TV stations within 45 to 50 minutes.

[For Chet Wayland] **Are the data being shown for a particular time an estimate of an average based on current data?**

Mr. Wayland said that this is in fact correct. He added that the eight-hour average for ozone creates a tough communications challenge, especially when dealing with real-time data. Real data comes in every hour from the monitors, and EPA again collects the data every two hours. EPA then displays the data using the Air Quality Index, which is based on the eight-hour average. If EPA were to show data based on an eight-hour average calculation, the noon eight-hour average would not be shown until 4:00 p.m., because it is based on the midpoint eight-hour average. EPA has developed a surrogate approach that allows the Agency to relate one-hour data to the eight-hour averages. The correlation is very good, somewhere between 0.80 and 0.94, depending on where you live. Mr. Wayland concluded by saying that if technology ever advances to the point where data are received instantaneously, we can obviously shorten that window. Right now, with the eight-hour component, this approach is the best we can do.

[For Greg Fishel] **Do you have any advice from lessons you've learned?**

Mr. Fishel said that on Code Orange and Code Red days, his station started putting little icons in the corner of the TV screen at times throughout the day to let people know that it is a Code Red or Code Orange day. However, the station also used an icon to alert people when a heat advisory was in effect. The station found that people were confused by the ozone and the heat icons. Of course, in a lot of cases, ozone and heat warnings coincided. However, we wanted to make sure that we were not confusing people, so we changed the color and the shape of the icons to make them more easily distinguishable.

[For Greg Fishel] **Will it desensitize people if you continue to use Code Orange days as the threshold for displaying your icons on the screen?**

Mr. Fishel responded that his station has been concerned about possibly desensitizing people, but they post the icons for Code Orange days in the interest of public health. He reported that the station has received some complaints from people who said that they do not want the icon on their screen unless it's a Code Red day. At this point, however, his station has taken the attitude that there are enough affected people with respiratory issues to justify posting the icon on Code Orange days.

[For Lisa Grosshandler] **How has it worked out having a fun outreach campaign on something as serious as ozone?**

Ms. Grosshandler responded that warning folks on the dangers of ozone is a very serious matter, but her agency wanted to avoid a "sky is falling" advertising campaign.

Her agency used the Air Avenger to gear its ad campaign toward children. They modeled the campaign after their recycling outreach program, which was also targeted at children. They are now trying to educate children on what ground-level ozone is, in hopes that they will transfer that knowledge to their parents. She added that some of the Air Avenger commercials produced in the last year have been very serious in their approach to getting across what the color codes are and what they mean. They have also produced radio ads that are geared more towards adults and use adult humor to get across the message. She also said that they are now trying to put together a focus group to help generate ideas about where to go from here.

[For Lisa Grosshandler] **Did you have a good budget for this, and does a campaign like this take a lot of money?**

Ms. Grosshandler responded that the campaign has taken a fair amount of money. Educating the public is an important part of North Carolina's ozone reduction strategy, and they have been very fortunate in receiving support for their outreach program. She commented that the most expensive part of the program was not producing the ads, but buying the time to place the ads on television.

[For Lisa Grosshandler] **Do you see your campaign moving to a more hard-nosed approach in this next year?**

Ms. Grosshandler stated that although they will try to focus a bit more on the seriousness of ozone, they will also keep the fun side of the campaign for the kids.

APPENDIX A
Agenda

APPENDIX B
Satellite Broadcast Viewership

APPENDIX B
Satellite Broadcast Viewership

1. Attendance at Air Pollution Distance Learning Network (APDLN) Downlink Sites

As of February 3, 2000, 58 of the 127 APDLN downlink sites had reported on attendance at the December 15 satellite broadcast. A total of 117 people attended the broadcast at the 58 sites reporting. (Note that this number does not reflect a complete count of all attendees at APDLN downlink sites but only the total number of attendees at sites that reported. EPA's Education and Outreach Group estimates total attendance at APDLN downlink sites to have been 196 individuals.)

The chart below shows the number of attendees for each site reporting. Sites that reported zero attendees are not listed. EMPACT metropolitan areas are designated with an asterisk.

City	Attendees
Montgomery, AL	14
Little Rock, AR*	3
Ventura, CA	1
San Diego, CA*	2
Fresno, CA*	4
Washington, DC*	4
Clearwater, FL*	6
Orlando, FL*	1
West Palm Beach, FL*	4
Fort Lauderdale, FL*	3
Atlanta, GA*	3
Urbandale, IA	5
Indianapolis, IN*	6
Evansville, IN	2
Frankfort, KY	3
Boston, MA*	4

City	Attendees
Lansing, MI	5
Asheville, NC	3
Bismarck, ND	1
Trenton, NJ	1
Albany, NY*	4
Dayton, OH*	4
Akron, OH*	1
Oklahoma City, OK*	5
Philadelphia, PA*	2
Columbia, SC	4
Nashville, TN*	2
Austin, TX*	4
Arlington, TX	3
Salt Lake City, UT*	3
Richmond, VA*	2
Madison, WI	3
Charleston, WV*	1
TOTAL	**117**

2. Internet Simulcast Viewership

A total of 25 individuals accessed the URL address to view the December 15 satellite broadcast via Internet simulcast. The available data do not provide the geographic location of those who accessed the simulcast.

3. Viewership at Ku and C Band Downlink Sites

There are no data available on the number of individuals who viewed the broadcast using Ku and C band coordinates. ERG implemented a web-based sign-in and evaluation form that would have provided some data on individuals who viewed the broadcast via Internet and Ku and C band. Completion of the forms was voluntary and required logging on to ERG's website to access the forms. Unfortunately, due to an interruption in service with ERG's Internet Service Provider on the day of the satellite broadcast, the evaluation form did not function and no data were received.

APPENDIX C

Environmental Programs

APTI Workshop T-040

Ozone Monitoring, Mapping and Public Outreach

Workshop Guide

APTI Workshop T-040

Developed by Environmental Programs - North Carolina State University

EPA Cooperative Assistance Agreement CT-825724

This project has been funded wholly or in part by the United States Environmental Protection Agency (USEPA) under Cooperative Assistance Agreement CT-825724 to North Carolina State University. The contents of this document do not necessarily reflect the views and policies of the EPA, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Appendix C is reprinted from *T040-99 Study Guide - AQI: Ozone Monitoring, Mapping, and Public Outreach* with permission of North Carolina State University.

(Revision: 9/99)

Fax Question Sheet

APTI Workshop T-040

Ozone Monitoring, Mapping and Public Outreach

December 15, 1999

Voice: (800) 742-9813 ***Fax: (800) 553-7656***

P/ease write your question *and direct if* to *the* appropriate *presenter if possible.*

Question for: ______________________________

Question from: ______________________________

City/State: ________________ Office Phone Number: (   ) ____________

Spacenet Inc. Trouble Line: 1 (800) 770-2887

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APTI Workshop T-040

Ozone Monitoring, Mapping and Public Outreach

Presented by OAQPS

Broadcast Agenda

December 15, 1999 1 :OOpm ET

SECTION		TOPIC
1		Introduction *Chet Way/and*
2		EPA's EMPACT Program *Denice Shaw*
3		The Ozone Mapping Project *Chet Way/and*
4		Data Collection and Transfer for Ozone Mapping *Phil Dickerson*
5		Success Story: New Jersey's Ozone Data Transfer System *Charles Pietarinen*
6		Making Ozone Maps *Neil Wheeler*
7		Use of the Ozone Monitoring, Mapping and Public Outreach Technology Transfer Handbook and CD *Jan Connery*
	10 MIN.	BREAK
8		Questions and Answers
9		North Carolina's Air Awareness Program Lisa *Grosshandler and Greg Fischel*
10		Getting the Ozone Maps on Television *Tim Dye*
11		The DC-Baltimore Area's Endzone Program *Tad Abut-n & Randy Mosier*
12		Questions and Answers and Wrap up

Online Conference Site

In addition to submitting questions via fax machine or telephone during the broadcast, North Carolina State University Environmental Programs offers another means for you to communicate with the instructor and other course participants. An online conference site on the World Wide Web allows you to have your questions answered and participate in class discussions after the broadcast has ended.

Use your Web Browser to access the online conference site at:

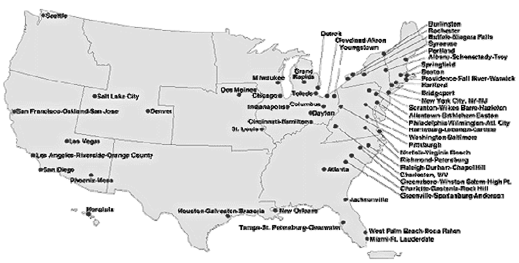
www.epin.ncsu.edu/t-040/

The Next 31 Pages are for Viewing ONLY

Environmental Monitoring

Denice Shaw, Ph.D.
Program Director
EMPACT

Where Are We Working?



Mission

- Assist communities to implement sustainable monitoring that provides current and accurate information about local environments

"Right To"

- Information based on best available science
- Accurate and quality assured information
- Current information about local environmental conditions

Background

- Agency model for monitoring incorporating new and innovative science
- Monitor parameters that affect human and ecological health
- Executed through community projects based on scientific collaborations

Background

- Steering committee
- 150+ participants and partners
- Community Owned
  - Monitoring
  - Data management (with provision for secondary access)
  - Interpretation
  - Access

Status

- Monitoring projects in 84 Cities
- Research grants for community-led monitoring in 16 cities (FY98)
- Research to advance real-time monitoring

AIRNOW - The Ozone Mapping Project

Chet Wayland

What is the Ozone Mapping Project?

- A collaborative effort between the Federal, State and Local Air Agencies to collect, quality assure, and transfer real-time air quality information to the public

What is the Ozone Mapping Project?

- Intended to provide the public with fast and easy access to understandable air quality information that can assist them in making good health-based decisions about their daily activities

History of the Ozone Mapping Project

- Mapping concept initiated by the Maryland Department of Environment and the Maryland-American Lung Association in the Baltimore area in late 1994

History of the Ozone Mapping Project

- Ozone mapping piloted in the northeast United States by EPA Region I in 1997

History of the Ozone Mapping Project

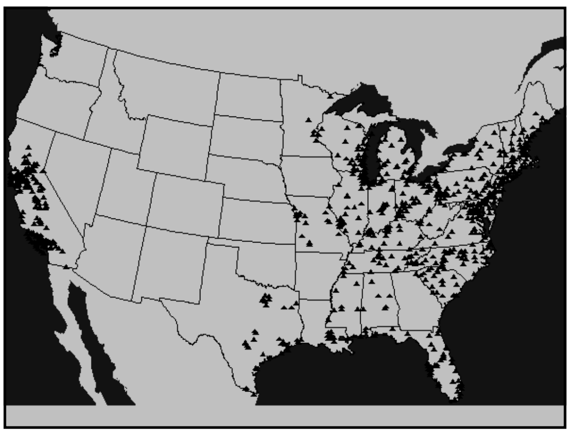
- Full implementation of the automated real-time ozone mapping system in the eastern United States begins in 1998 under the support of the EMPACT Program

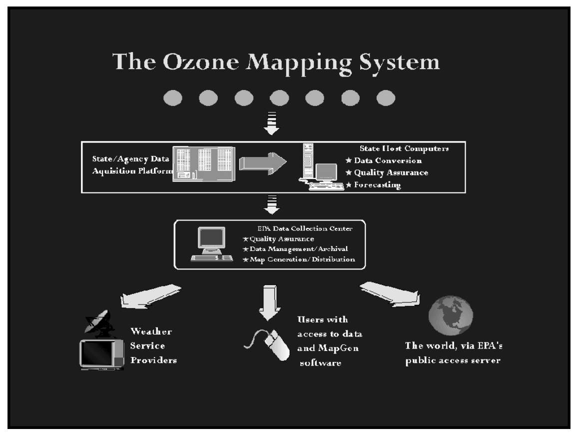
Overview of the Mapping Process

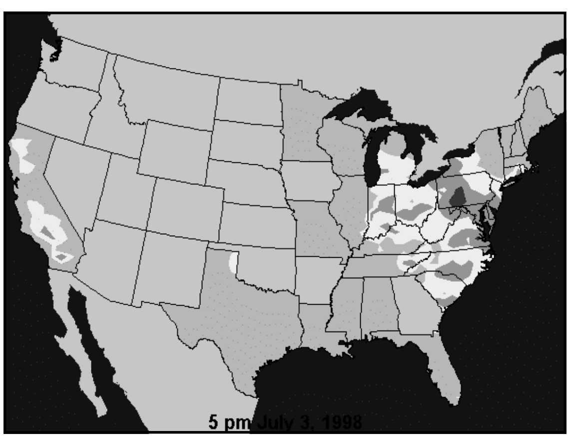
- 5 primary components
- State and Local monitoring networks
- Automated Data Transfer System (ADTS)

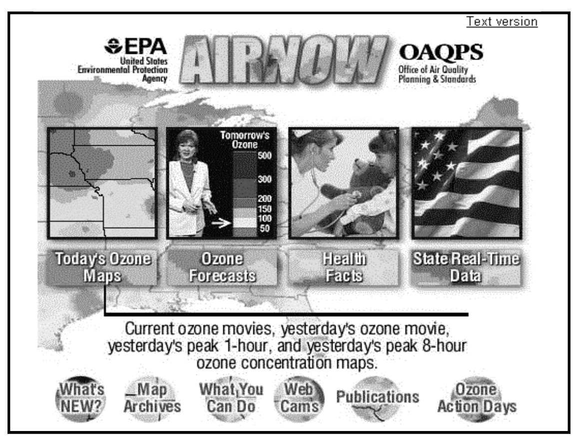
Overview of the Mapping Process

- Data Collection Center (DCC)
- Map Generation
- Outreach









Recap of Overview of the Mapping Process

- 5 primary components
- State and Local monitoring networks
- Automated Data Transfer System (ADTS)

Recap Overview of the Mapping Process

- Data Collection Center (DCC)
- Map Generation
- Outreach

What Areas are Participating in the Mapping Project?

- Current geographical coverage includes 61 EMPACT cities with complete coverage in 29 eastern States and California

What Areas are Participating in the Mapping Project?

- Future plans are to complete coverage in the contiguous United States and expand beyond ozone to include other pollutants such as particulate matter

How has the Ozone Mapping Project been Received by the Public?

- AIRNOW website received over 1.2 million accesses per month (May '99 - September '99)

How has the Ozone Mapping Project been Received by the Public?

- Numerous positive comments from the public (daycare, asthmatics, outdoor workers, exercisers, air awareness programs)

How has the Ozone Mapping Project been Received by the Public?

- Maps and forecasts carried by The Weather Channel and major Weather Service Providers as well as local TV weather forecasters

How has the Ozone Mapping Project been Received by the Public?

- Ozone Mapping Project received the Government Technology Leadership Award in 1998

Data Collection and Transfer for Ozone Mapping

Phil Dickerson,
EPA
OAQPS

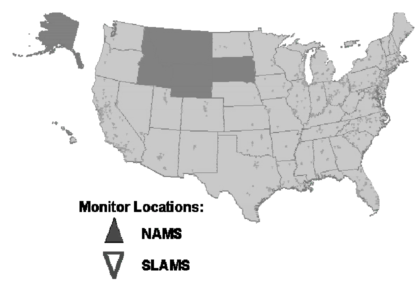
Regulatory History and Types of Monitoring Networks

- See 40CFR58:
  - Ambient Monitoring Regulations, May 1979
  - PAMS rules, February 1993
  - PM-fine regulations, July 1997

Regulatory History and Types of Monitoring Networks

- The ozone mapping system generally makes use of already installed monitoring networks

NAMS/SLAMS Ozone Monitors



How Ozone Monitoring Networks Measure Ground-level Ozone Concentrations:

- Data is fed into "data-loggers", which store the values for retrieval by data acquisition platforms

Description of the Automatic Data Transfer System (ADTS):

- The heart of the Data Collection Center
- Runs on EPA's Valley internal UNIX server
- Responsible for merging, QA/QC, all calculations (AQI, peaks)

Data Flow Within the ADTS - Overview of Using ADTS:

- Monitors collect ozone, record concentrations to data-loggers
- The State Host Computer (SHC) polls the data-logger at specified polling times

Data Flow Within the ADTS - Overview of Using ADTS:

- The SHC connects to the DCC before end of polling window and transfers the observations from midnight until the polling hour

Data Flow Within the ADTS - Overview of Using ADTS:

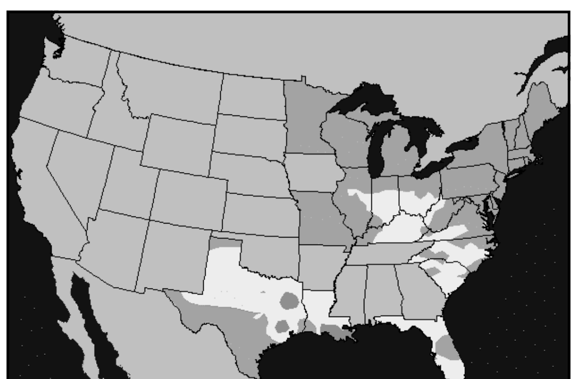
- ADTS merges all the agency data files into a master file, runs QA/QC program, calculates peaks and AQI values, interpolates for single hours missing, generates gridded data for Weather Service Providers, then produces the master OBS file

Data Flow Within the ADTS - Overview of Using ADTS:

- The master OBS file is available to all participating agencies and is also used by the MapGen software to generate the ozone animations and daily peak maps

Data Flow Within the ADTS - Overview of Using ADTS:

- Once the ozone animations have been checked by the DCC operations crew, they are posted to EPA's public web site



September 11, 1999

Setting up a host computer to connect to the DCC/ADTS:

- Must get an EPA user ID and password
  - Can be set up by your local EPA Regional Office, or by myself

Setting up a host computer to connect to the DCC/ADTS:

- SHC must either run the ESC Ozone Mapping Module, or custom software, to convert the data acquisition platform's format to the OMS format

Setting up a host computer to connect to the DCC/ADTS:

- Once the data is in the proper format, the user ID and password assigned by EPA are used to FTP the data to the DCC
- Shortly after the data is delivered, it is run through ADTS and the master OBS file is available for your use

Troubleshooting tips:

- EPA security policies mandate that you get only three tries to log into the DCC before your account is locked
- Be careful when experimenting
  - if you use two tries, wait an hour or two before trying again

Troubleshooting tips:

- If you have trouble connecting to the DCC, check with your local firewall/security group to see if your FTP access is restricted

Troubleshooting tips:

- Troubleshoot in discrete segments
  - 1) make sure you're getting the data from the data-logger
  - 2) make sure the data is getting converted to OMS format
  - 3) make sure your user ID and password are valid by trying a manual FTP

Troubleshooting tips:

- 4) log into the DCC and see what your data looks like
- 5) make sure your data looks correct in the master OBS file

Troubleshooting tips:

- **The most important troubleshooting tip:**
  - Call us immediately if you have a problem
    - With a highly automated system taking data from nearly 50 users, things can get overlooked and problems can reoccur for days on end
    - We do not want to miss your data, so call us if you have a problem

APTI Workshop T-040
AQI: Ozone Monitoring, Mapping and Public Outreach

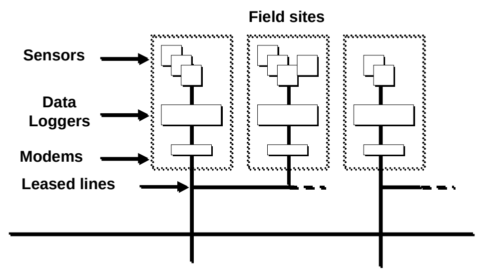
New Jersey's Ozone Data Transfer System

Charles Pietarinen
New Jersey Department of Environmental Protection

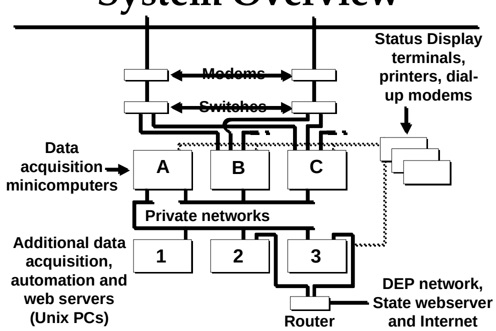
New Jersey's Ozone Data Transfer System

- Key features of the system
- How the system helps us provide timely data to the public
- Public outreach activities
- Lessons learned

System Overview



System Overview



Central System

Central System: Status Display

How the System Helps Provide Timely Data to the Public

- Reliability - greater than 99.999% uptime since 1991
- One minute polling cycle, while not essential, does help

How the System Helps Provide Timely Data to the Public

- Continuous data validation - plus ability to "filter" data
- Separate calibration files and remote calibration capability

How the System Helps Provide Timely Data to the Public

- Operating systems allow scripting, unattended file transfer, e-mail, etc.
- Custom report generator
- Report scheduling
- Dial-in capability

Public Outreach Activities

- AQI reports and forecasts, all pollutants, twice daily
- Toll-free recordings updated twice daily
- Touch-screen kiosks

Public Outreach Activities

- 24-hour-a-day web page and GIS updates
- Ozone mapping starting in 1996
- E-mail notification on unhealthy days

Touch Screen Kiosks

- Forecasts and current data on all pollutants
- Multimedia information on air pollution, health effects, etc.
- Historical air quality data
- Interactive game
- Used in designing web page

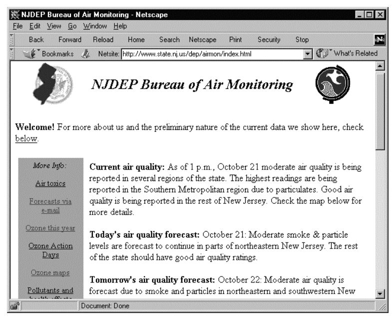
Air Quality Data on the Web

- Target audience: general public
- Provide current forecasts and air quality data for all pollutants
- Year-to-date ozone summaries
- Historical ozone data

Air Quality Data on the Web

- Explanatory information on the AQI, weather and air pollution, trends, standards, health effects, toxics, Ozone Action Days and more

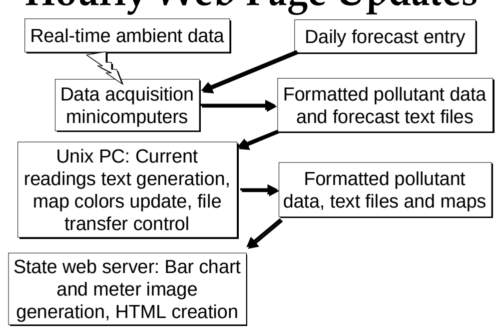
Web Content: Current/Forecast



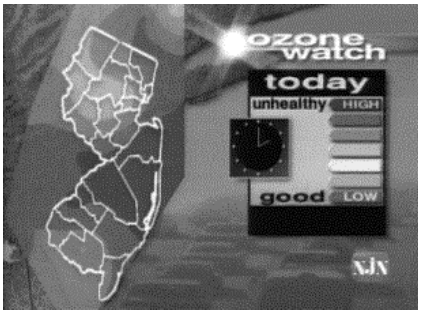
Web Design Considerations

- Main message visible at top
- Short page download time
- Layers of increasing detail
- Main message readable with any browser (including vision-impaired)

Hourly Web Page Updates



Ozone Mapping on TV



Lessons Learned

- System must be automated to be sustainable
- Media coverage is the most difficult part
- Make your point - know your audience

Lessons Learned

- Plan for new uses
- Accept that some bad data will get out
- Ozone is only part of the story

Making Ozone Maps

Neil Wheeler
Sonoma Technology, Inc.

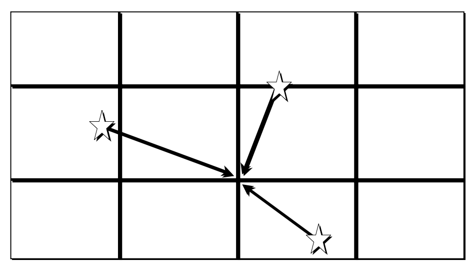
Overview

- The Map Generator software and its capabilities
- Obtaining the Map Generator
- Using the Map Generator
- Troubleshooting

The Map Generator (MapGen)

- How it works
  - Read station data
  - Interpolation to grid
  - Contouring
  - Annotation
  - Animation

"Gridding"



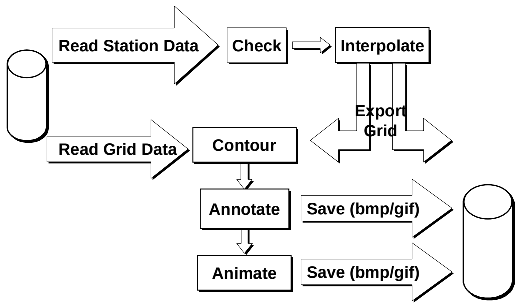
Interpolation/Extrapolation

- Inverse distance weighting
  - $1/R^N$
  - Maximum radius of influence
  - Temporally invariant
- Kriging
  - Variogram models and correlation
  - Spatially and temporally invariant

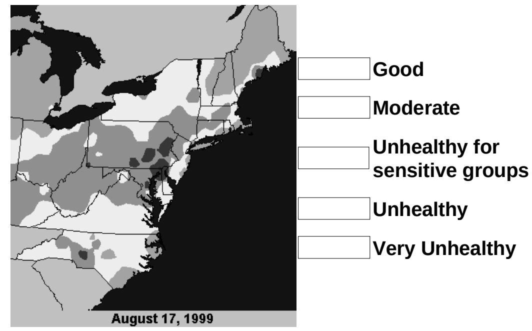
MapGen

- What it Produces
  - Still-frame images BMP or GIF
  - Animations: BMP (internal) or GIF (external)
  - Gridded ASCII files

Mapping Process



Color Filled Contours



Requirements

- 133 MHz Pentium-class CPU
- 16 MB RAM
- 100 MB free space on hard disk
- Windows 95/98/NT
- SVGA with 24-bit color display

Obtaining MapGen

- http:/envpro.ncsc.org/OMS
  - "Documentation"
  - "Register for and download MapGen"

Obtaining MapGen

- Note instructions on access via ftp
- http:/envpro.ncsc.org/OMS/pub
  - readme.txt
  - mg980611.exe (11 MB)
  - Updates

Using MapGen

- Getting Data
  - Polling software OMS modules
  - Data Collection Center
  - AIRS (airs2oms)
  - Other converters
  - Peaks and 8-hour averages
    - "QC" Quality Control/Merge Processor

Using MapGen

- Read data
- Select area
- Select variable
- Select options
- Annotation
- Plot/animate

MapGen Demonstration

- file menu
- customize menu
- plot menu
- animate menu
- help menu

Scripting MapGen

- Scripting language
- Sample scripts
- Scheduling
- Generic dates

Troubleshooting

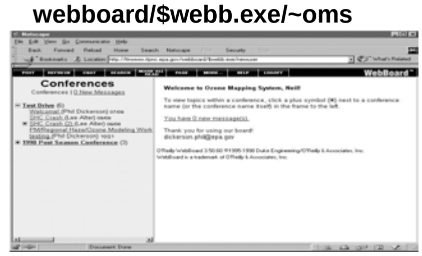
- MGS user guide
  - Help Menu
  - http://envpro.ncsc.org/OMS
- MCNC ticket system
  - http://envpro.ncsc.org/products/ticket.html
  - Enter a new ticket
  - Review previously entered tickets

Troubleshooting

- Ozone monitoring, mapping and public outreach: delivering real-time ozone information to your community
  - EPA/625/R-99/007
  - September 1999
  - http://www.epa.gov/airprogm/oar/oaqps/airnow/cdmanual.pdf

Troubleshooting

- EPA's WebBoard Conferences
  - http://ttnwww.rtpnc.epa.gov/ozmap/webboard/$webb.exe/~oms

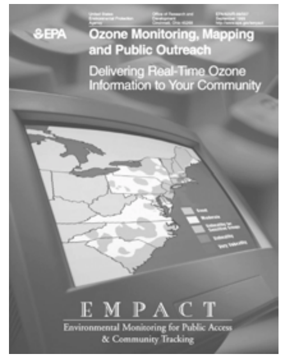


For further information about MapGen

- Steve Fine (MCNC)
  - (919) 248-9255
  - fine@ncsc.org
- Neil Wheeler (Sonoma Technology, Inc.)
  - (707) 665-9900
  - neil@sonomatech.com

The EPA Ozone Handbook

Janice Connery



The EPA Ozone Handbook Covers:

- Ozone monitoring: System design, siting, operation
- Data collection and transfer: System development, operation, and maintenance

The EPA Ozone Handbook Covers:

- Ozone mapping: How to create ozone maps
- Ozone outreach program: How to communicate ozone information to your community.

User Input Obtained for:

- Outline development
- Case studies
- Pilot testing of draft handbook

Requirements for Using the CD-ROM

- MAC- and PC-compatible
- CD-ROM drive
- Internet connection
- Internet browser (i.e., Netscape Navigator or Microsoft Internet Explorer)

Web Address

- http://www.epa.gov/airnow
  - Download the handbook

Web Address

- http://www.epa.gov/ttbnrmrl
  - Download the handbook
  - Order a print or CD-ROM copy of the handbook

Seven

- EMPACT Program U.S. EPA (8722R) 401 M Street, SW Washington, DC 20460
- Phone: 202-564-6791
- Fax: 202-656-1966
  - Order a copy of the handbook or CD-ROM

Key Steps in Creating an Outreach Plan for Ozone

- Define outreach goals
- Identify target audience(s)
- Develop key points/ "messages"
- Identify outreach products
- Identify distribution avenues

Successful Ozone Outreach Programs

- Getting ozone maps on TV
- Launching campaigns to encourage coverage media during ozone season
- Creating Web sites

Successful Ozone Outreach Programs

- Working with schools
- Developing "ozone action day" programs
- Operating hotlines

North Carolina's Air Awareness Program

Lisa Grosshandler

Key aspects of the North Carolina Air Awareness Program

- Coalitions
- Forecasting
- Education

Coalitions

- Site coordinators
- Kick-off events
- End-of-season thank you

Forecasting

- Color-coded forecast issued
- Forecasts are given by 3:00
- Ozone Action Days are called on predicted Orange and Red days

Education

- "Ozone Zone" educational video
- Air Jeopardy!
- "Air Adventures" puppet show
- Air Avenger Superhero
- Bookstore activities
- Classroom activities

Education

- Exhibit booth
- Contests
- Media Campaign
- Media Day
- Coalition site-coordinator training

Challenges for the NCAA

- Quantifying the success of the program
- Keeping it fresh

Ozone Comes to Television!

Greg Fishel

Reasons for Showing Ozone Data on Television

- Previous involvement with Air Awareness Program
- More effective way to show public reality of air quality problems
- Promote public action to reduce ozone concentrations

How We Get the Data

- DAQ retrieves data and sends to EPA
- EPA sends data to Weather Central Inc.
- We retrieve data from Weather Central via dial-up connection

How We Display the Data

- Data is transferred to an SGI Octane for display in animation form
- Color table is created for displaying the five different categories of air quality
- Data is displayed as an animation with time steps of one hour

Improvements Needed

- Need to reduce "observation to display" time (currently almost 3 hours)
- Need to make sure that all sensors are polled
- Need for forecast data from air quality models

Feedback

- Public genuinely interested in seeing a type of data they have not seen before
- Some concern about threshold level for displaying alerts

Ozone Maps on Television

Tim Dye
Sonoma Technology, Inc.
Petaluma, CA
Tim@sonomatech.com
(707) 665-9900

Purpose:

- Explain how ozone maps get on TV
- How you can help

Outline:

- Brief history of ozone maps on TV
- How did we get ozone maps on TV
- Response from Weather Service Providers

Outline:

- Example video clips
- Case studies:
  - Sacramento, CA
  - Raleigh-Durham, NC
- How you can help

History of the Ozone Map and Television

- 1995 Maryland Department of the Environment and the American Lung Association
  - Local mapping in Baltimore-DC area
  - Sent image to WRC-TV
  - Very labor intensive

History of the Ozone Map and Television

- 1996 New Jersey Department of Environmental Protection
  - Local mapping in New Jersey
  - Sent image to PBS News

History of the Ozone Map and Television

- 1997 Northeast/Mid-Atlantic states (NESCAUM-MARAMA)
- Sacramento, CA
- Began working to get ozone maps on TV

History of the Ozone Map and Television

- 1998 EPA in cooperation with states
  - 20 states
  - Approached TV stations and Weather Service Providers (WSPs)
  - Some limited TV coverage

History of the Ozone Map and Television

- 1998 Sacramento, CA
  - Expanded mapping in Sacramento Metropolitan area
  - Approached local TV stations
  - Good TV coverage on one station

History of the Ozone Map and Television

- 1999 EPA in cooperation with states
  - 30 states
  - Worked closely with WSPs
  - Improved TV coverage

How Did We Get Ozone Maps on TV

- Weather Service Providers (WSPs) are companies that supply...
  - weather data,
  - images,
  - forecast
- ...to TV stations, newspapers, private industry, and the public

Why Work with WSPs

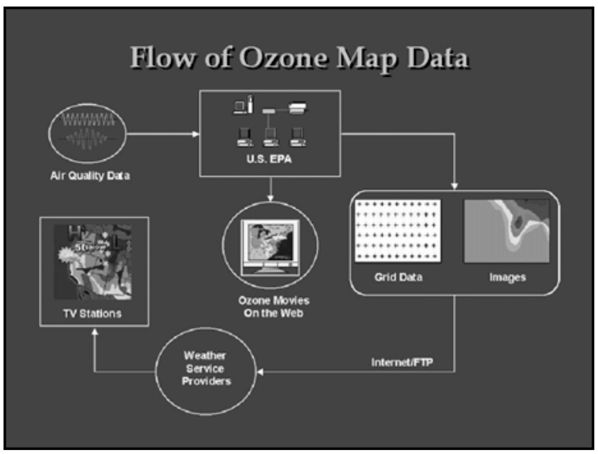
- TV stations want their own look and feel
- WSPs have software/hardware for TV standards
- TV Weathercasters are busy
- WSPs provide reliable high-speed data delivery

EPA Contacted Weather Service Providers

- 1998 National Association of Broadcasters Meeting
- 1998-1999 AMS Broadcaster's meetings
- Explained products (ozone maps and city-specific forecasts)

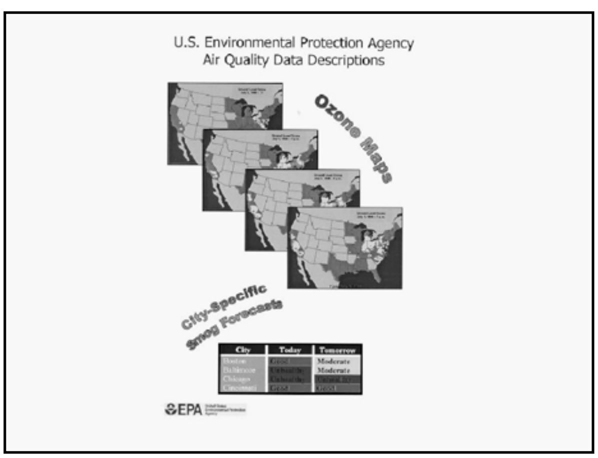
EPA Contacted Weather Service Providers

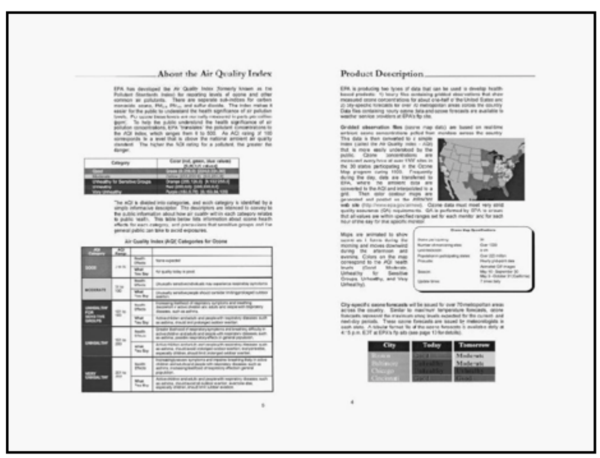
- Five WSPs
  - AccuWeather
  - Kavouras
  - The Weather Channel
  - Weather Central
  - Weather Services International (WSI)



How Did We Get Ozone Maps on TV

- Provided educational materials to WSPs
  - Several contact people were available to answer questions
  - 12 page pamphlet describing all aspect of the ozone map





Response From Weather Service Providers

- Generally Favorable
- WSPs want to see the demand increase - helps their business
- Weather Central - most positive; picked up in 1998 & 1999
- The Weather Channel - posted ozone forecasts on web page

Response From Weather Service Providers

- WSI - ingested data; sent to TV stations
- Kavouras - ingested data
- AccuWeather - waiting to hear from TV clients

Response From Weather Service Providers

- Some issues are preventing wide spread distribution on TV
  - Not yet nation wide
  - Not a year-round product
  - Not as real-time as TV weathercasters desire
  - Unknown demand

EXAMPLE VIDEO CLIPS

Case Studies Sacramento, Ca and Raleigh-Durham, NC

- Met with TV meteorologists
- Educated meteorologists
- Generated interest in the ozone maps
- Encouraged local TV stations to contact WSPs

Case Studies Sacramento, Ca and Raleigh-Durham, NC

- Continued to stay in touch
- Results: ozone maps get more "air play" - dozens of times

How Can You Help

- EPA has done most of its job
- WSPs have basically finished their job
- Now, it's up to state and local air quality staff

How Can You Help

- Here's what's needed:
  1 Local/state staff contact TV stations
    - Explain that ozone maps are available
    - Encourage them to contact their WSP
    - Explain how ozone affects health
    - Explain what ozone maps show
    - Develop relationships with TV stations

How Can You Help

2 WSPs will see the demand

3 Greater dissemination of ozone maps

Ozone Action Days: The Baltimore / Washington D.C. Metropolitan Region's ENDZONE Program

Tad Aburn
Program Manager
Air Quality Planning Program
Maryland Department of the Environment

MDE

Ozone Action Days: The Baltimore / Washington D.C. Metropolitan Region's ENDZONE Program

Randy Mosier
Planner
Air Quality Planning Program
Maryland Department of the Environment

MDE

Background - ENDZONE's Integrated Approach

- 1993 -- Forecasting methodology tested
- 1994 -- Ozone Pollution Map piloted/Color-coded forecasting begins in Baltimore area
- 1995 -- Ozone Pollution Map airs, color-coded forecasting spreads to DC, ENDZONE Partners begins

Background - ENDZONE's Integrated Approach

- 1996 -- Ozone Action Days program starts
- 1997 -- Ozone Map spreads throughout the Northeast, "Code Red" press coverage explodes

Background - ENDZONE's Integrated Approach

- 1998 -- Media campaign, kids program, Ozone Mapping extends throughout most of the nation
- 1999 - Ozone Action Days / ENDZONE partnership increases significantly, forecasting methodology continues to improve

ENDZONE Partners Objectives

- Inform the public and businesses about air quality issues
- Promote and advance behavioral changes that will improve air quality

ENDZONE Partners Objectives

- Increase the number of member/partners in both the ENDZONE Partners and the Ozone Action Days Program

ENDZONE Partners Objectives

- Coordinating concerted media campaigns in the Baltimore/Washington D.C. metropolitan region
- Increasing public outreach
- Improving ozone forecasting efforts

ENDZONE™
PARTNERS
www.endzone-partners.org

OZONE ACTION DAYS
Do Your Share For Cleaner Air

ENDZONE Partners / Ozone Action Days Strategies

- Focus on the four areas of voluntary behavior change that will contribute most to avoiding ozone episodes, at the least cost

ENDZONE Partners / Ozone Action Days Strategies

- light duty vehicles (including refueling)
- non-industrial painting
- lawn and garden equipment
- consumer aerosol products

ENDZONE Partners / Ozone Action Days Strategies

- Continue to alert all segments of the population about the health risks of ground-level ozone
- Increase partnership for both Ozone Action Days and ENDZONE
- Work towards transitioning the program to an 8-hour standard for ground-level ozone

Recruiting and Working with ENDZONE Partners

- Membership open to any individual or organization willing to help stimulate voluntary actions
- Recruiting for ENDZONE Partners done mainly by Board of Directors

Recruiting and Working with ENDZONE Partners

- Recruiting for Ozone Action Days Partners performed by staff from Maryland Department of the Environment, Baltimore Metropolitan Council, Metropolitan Washington Council of Governments and Commuter Connections

Recruiting and Working with ENDZONE Partners

- Membership Benefits
  - Members receive daily ozone forecasts either via fax or email, and notification when air quality levels exceed federal standards

Recruiting and Working with ENDZONE Partners

- Informational brochures describing the Ozone Action Days Program, Air Quality Forecast Guide, and health tips and pollution prevention activities are provided - flags, forecast display charts and other promotional materials are also distributed to increase awareness

Recruiting and Working with ENDZONE Partners

- Staff work individually with each member providing support for developing and maintaining an Ozone Action Days program

Ozone Forecasting and Outreach

- Ozone Forecasting began in Baltimore during 1994 - expanded to Washington in 1995
- Dissemination of the color-coded ozone forecasts is the most under-appreciated element of MDE's and ENDZONE's integrated approach

Ozone Forecasting and Outreach

- "Code Red" air quality has become a message that is understood across the Baltimore / Washington media market

Ozone Forecasting and Outreach

- Has generated more media coverage than all other outreach efforts combined
- Results in routine daily media coverage of ozone air quality

Ozone Forecasting and Outreach

- Often results in the message being heard repeatedly throughout the day on radio and TV stations
- Has driven explosive coverage during severe ozone events

Ozone Forecasting and Outreach

- Forecast determined by meteorologists from Maryland Department of the Environment, University of Maryland, Virginia Department of Environmental Quality and the Washington Council of Governments

Ozone Forecasting and Outreach

- Regression models and scientific expertise used to determine forecast
- Forecast set to color codes to indicate different levels of severity

Ozone Forecasting and Outreach

- Faxed to local media and businesses who disseminated the message to the public and employees

Ozone Forecasting and Outreach

- Forecasts distributed to over 50 media outlets -- local television, radio stations, newspapers, state road signs and the National Weather Service

Ozone Pollution Mapping in Maryland

- Third piece of comprehensive effort in 1995
- Software package developed for local television stations to show the formation and movement of ozone pollution

Ozone Pollution Mapping in Maryland

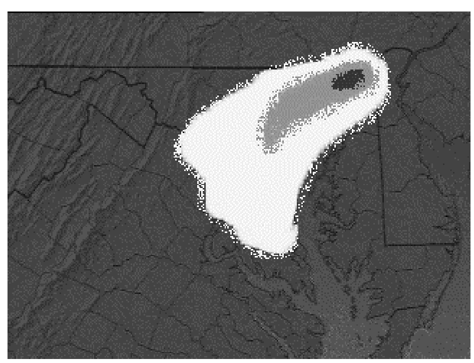
- Originally conceptualized (and piloted) by MDE and the American Lung Association of Maryland
- Collected data from monitors in Maryland, D.C., Virginia, Pennsylvania and Delaware

Ozone Pollution Mapping in Maryland

- Map aired on television stations in Baltimore and Washington in 1995 - In 1996, New Jersey public television began airing map

Ozone Pollution Mapping in Maryland

- Daily viewed by 860,000 people in the metropolitan area
- Now part of EPA/AIRNOW Ozone Mapping effort



Successes in Our Outreach and Education Efforts

- Daily Forecasts have made "Code Red" air quality a common phrase and have people talking about air quality all the time.

Successes in Our Outreach and Education Efforts

- Ozone Action Days Program grows steadily throughout the years
  - 1996 - 91 Partners
  - 1997 - 200 + Partners
  - 1998 - 260 + Partners
  - 1999 - 300 + Partners

Successes in Our Outreach and Education Efforts

- ENDZONE Partnership paid membership increases as well
  - 1997 - 27 Partners
  - 1998 - 42 Partners
  - 1999 - 52 Partners

Successes in Our Outreach and Education Efforts

- Survey results have shown
  - 7 out of 10 people across the region have heard the "Code Red" message
  - 90% of the public in the Baltimore and Washington region see air quality as a top environmental problem

Successes in Our Outreach and Education Efforts

- More than 40% believe that they can individually make a difference
- 25% reported taking voluntary actions to help reduce ground-level ozone during "Code Red" alerts

Successes in Our Outreach and Education Efforts

- Less direct (but equally important) success
  - Several programs that originally generated significant public opposition are now on the ground and running smoothly

Lessons Learned

- Start by getting state and local government agencies on board
- Develop a strong relationship with local media outlets
- Work closely with regulated industries who may be more willing to be seen participating in a positive environmental activity

Lessons Learned

- Disseminate daily color coded forecasts to the media
  - It will end up being the cornerstone of your program
  - It's simple and inexpensive

Lessons Learned

- Research businesses in your area to determine good candidates for an Ozone Action Days program (i.e. businesses with...)
  - large number of employees
  - work processes which could be episodically curbed

Lessons Learned

  - staff who could potentially telecommute and carpool
  - dynamic staff
- Have plenty of informational material on hand during site visits
- Take advantage of and promote the AIRNOW Ozone Map
- Get a head start on summer

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

Office of Environmental
Information
Washington, DC 20460

EPA/625/R-00/012
January 2001
http://www.epa.gov/empact

EPA

Lead-Safe Yards
Developing and Implementing a Monitoring, Assessment, and Outreach Program for Your Community

E M P A C T

Environmental Monitoring for Public Access
& Community Tracking

Preface

This technology transfer handbook is intended to serve as: a) a case study of the EMPACT Community-Based Lead Assessment and Educational Pilot Project in Boston (also known as the Lead-Safe Yard Project or LSYP) that highlights the successes and lessons learned from the project, and b) a "hands on" reference for community members, especially community organizations, to use in identifying and reducing risks from residential soil that may be contaminated with lead. The emphasis is on contamination from non-industrial sources, such as the historic use of exterior house paint or gasoline that contained lead. The handbook provides step-by-step guidance for measuring lead levels in soil, interpreting results in terms of potential risks from these levels, and planning and implementing simple and cost-effective landscaping techniques to reduce these risks. While the focus is on community organizations with access to professional assistance, some recommendations may be suitable for the individual homeowner, landlord, or tenant to consider.

Based on the case study from the Pilot Project in Boston, the handbook was written to be complementary to, and used in conjunction with, EPA and HUD regulations and associated guidance. In particular, EPA has proposed a regulation entitled "TSCA Title IV, Section 403 Lead; Identification of Dangerous Levels of Lead." At the time of the handbook's publication, this rule, which establishes standards for lead-based paint hazards in most pre-1978 housing and child-occupied facilities, was not yet finalized. Nothing in the handbook should be construed as official Agency guidance or regulation contradictory to the Final Section 403 Rule.

These simple, low-cost landscape treatment measures are presented as additional options beyond the permanent measures that may be required by state, local, or federal regulations. For cases in which permanent solutions such as soil removal would be preferable and/or required, but are not immediately possible due to cost or other practical considerations, the handbook offers interim controls that may provide an immediate risk reduction, especially when combined with continuing maintenance practices. Users of the handbook should consult applicable state, local, and federal regulations before deciding on any course of action.

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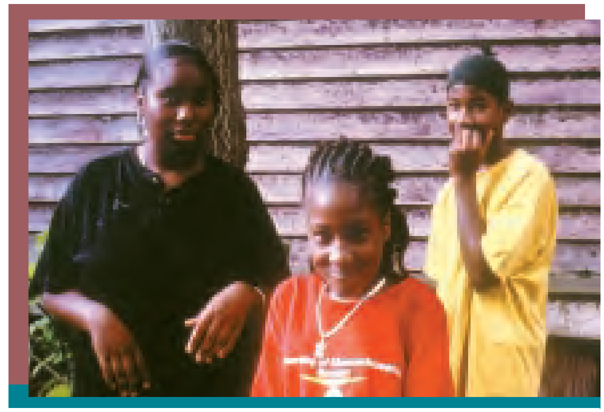
1 Introduction



onmental

Over the past few decades, blood lead levels in children have declined dramatically. However, lead poisoning remains a serious environmental health threat for children today. The legacy of lead-based paint and leaded gasoline will be with us for many years to come. Without further action, large numbers of young children, particularly in older, urban neighborhoods, will continue to be exposed to lead in amounts that could impair their ability to learn and to reach their full potential.

Recent efforts at the state and federal levels to reduce childhood lead poisoning have focused primarily on controlling hazards from lead-based paint. This focus is likely to continue. In February 2000, the President's Task Force on Environmental Health Risks and Safety Risks to Children released a federal, interagency strategy for eliminating childhood lead poisoning. The strategy calls for the control of lead paint hazards in 2.3 million homes where children under age 6 live (you can access the strategy at http://www.epa.gov/children/whatwe/leadhaz.pdf). To support the Task Force's recommendations, the federal budget for 2001 includes a 50-percent increase in lead paint hazard control grants issued by the U.S. Department of Housing and Urban Development (HUD).

While considerable attention has been given to lead-paint hazards in homes, less attention has been paid to lead-contaminated soil that surrounds these homes. Generally, this has been because of the more significant contribution to lead poisoning in children made by deteriorated lead paint and leaded dust on the interiors of homes. However, evidence exists that soil can be a source of exposure. As lead poisoning rates decline and average childhood blood lead levels decline, lead exposure from soil may be a more significant portion of the exposure for children. Therefore, it warrants attention.

This EMPACT technology transfer handbook is designed with two main goals in mind. The first goal is to present a case study showing how one community-based program—the EMPACT Lead-Safe Yard Project (LSYP) in Boston, Massachusetts—is using a variety of low-cost techniques to reduce children's exposure to elevated levels of lead in residential soil. The second—and perhaps more important—goal is to provide you with step-by-step guidance for developing a similar program to address the problem of lead in soil in your own community. The guidance in the handbook is based on the experience of the EMPACT LSYP, as well as that of several other programs. These other programs are highlighted at points throughout the handbook.

The handbook is written primarily for community organizers, non-profit groups, local government officials, tribal officials, and other decision-makers who will implement, or are considering implementing, lead-safe yard programs. At the same time, much of the information will be useful to individual homeowners interested in finding low-cost ways to reduce children's exposure to lead in soil. Before attempting to implement the techniques described in this handbook, however, homeowners need to be aware of the hazards associated with working with lead-contaminated soil. All homeowners should carefully read those passages of the handbook that describe soil-lead hazards, safety guidelines for working with lead-contaminated soil, and federal and state regulations governing acceptable work practices (in particular, see Sections 3.1, 3.3, 6.2, 6.4, and 7.6).

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, at President Clinton's direction. 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 make informed, day-to-day decisions. By the year 2001, residents in 86 of the largest metropolitan areas in the United States will 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, the U.S. Geological Survey, the U.S. Department of Interior, and the National Partnership for Reinventing Government. EPA will work closely with these federal entities to help achieve nationwide consistency in measuring environmental data, managing information, and delivering that information 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, such as groundwater contamination, ocean pollution, smog, ultraviolet radiation, and ecosystem quality. Some of these projects have been initiated directly by EPA. Others have been launched by the 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.

Communities selected for Metro grants 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.

1.2 About the EMPACT Lead-Safe Yard Project

During the winter of 1998, EPA's EMPACT program funded "A Community-Based Lead Assessment and Educational Pilot Project," also known as the Lead-Safe Yard Project (http://www.epa.gov/region01/leadsafe). The project is a joint effort between EMPACT, EPA's New England Regional Laboratory, and several community partners. The three primary objectives of the project are:

1) To generate real-time data of lead concentrations in residential yard soils using innovative field-portable x-ray fluorescence (XRF) technology, and to communicate these data to residents for the purpose of informing them of the health risks of lead in soil.

2) To plan and implement low-cost and sustainable landscape measures in residents' yards that would reduce children's risk of exposure to contaminated soil and that residents would be taught to maintain.

3) To develop a template that other communities and public agencies can use to address the issue of lead in residential soil.

The initial target community selected for the pilot project was a several-block area in the Bowdoin Street neighborhood, consisting of approximately 150 mostly older, wood-framed houses in the North Dorchester section of Boston. This is an inner-city community, with a large minority and immigrant population. Bowdoin Street is situated in the "lead belt" of Boston, where the majority of children in the city with elevated blood levels reside.

During the pilot phases, the project's community partners in the Boston area were Boston University School of Public Health, the Bowdoin Street Community Health Center, and a non-profit landscaping company called Dorchester Gardenlands Preserve. The project team identified five tasks to be carried out by the partners:

- Outreach and education, led by the Health Center.
- Safety training, conducted by staff from the Health Center.
- Sampling and analysis, led by the EPA Regional Laboratory with assistance from a certified industrial hygienist from the Health Center.

- Soil mitigation, performed by the landscaping company.
- Creation of a template for community action, led by Boston University School of Public Health with assistance from all partners.

The pilot project was funded in two phases, which took place in the summers of 1998 and 1999. During these two years, the project addressed 42 residences in the target area, at no cost to the homeowners; conducted a number of seminars on lead-safe yard work; and developed a "Tool Kit" for use by other communities (the materials in the Tool Kit have been incorporated into this handbook).

The third phase of the project, launched in June 2000, is targeting a different community: the Dudley Street neighborhood, which is also located in the "lead belt" of Boston. The partners in this phase include Boston University School of Public Health, the Dudley Street Neighborhood Initiative (a local planning and organizing agency), and several commercial landscapers. The objective of this phase is to use refined landscape measures and an improved educational approach in treating yards of homes that meet requirements for structural lead abatement of interior and exterior paint, or that have already been lead abated and are lead safe. As of September 2000, 18 homeowners had enrolled to have their yards tested for elevated soil-lead levels, and testing had been completed at most of the properties. The project's goal is to complete soil testing and implement landscape treatments at 20 or more properties by the end of the year.

1.2.1 Related Lead-Safe Yard Programs

A key objective of the EMPACT LSYP is to disseminate a template of materials and methods to public agencies whose mission is to prevent childhood lead poisoning. The ultimate goal is to institutionalize soil remediation as part of a comprehensive lead poisoning prevention program in high-risk neighborhoods.

Based on the success of the pilot phase of the EMPACT LSYP, the City of Boston has already initiated two "spinoff" soil-lead programs, using the EMPACT project's template:

- Lead Safe Boston, an office within the Boston Department of Neighborhood Development that assists homeowners financially and technically in home de-leading, is spearheading a HUD-funded lead-safe yard project that will target as many as 25 residential properties by the end of 2000. This demonstration project is meant to show how local government agencies can integrate soil-lead mitigation into ongoing home de-leading work. As of September 2000, Lead Safe Boston had enrolled 20 properties for soil-lead testing and yard treatments, and had completed treatments at nearly half of the properties. Lead Safe Boston has also done extensive work to revise materials in the EMPACT LSYP's template (such as permission forms and contractor agreements) to meet the more rigorous legal standards required of a city agency. Many of the materials developed by Lead Safe Boston appear as samples in this handbook.
- The Office of Environmental Health, part of the Boston Public Health Commission (BPHC), initiated another spinoff lead-safe yard project in the year 2000 to address nine residential properties in an area of North Dorchester. These nine residences have previously undergone structural abatement of lead paint and are slated for yard intervention utilizing the EMPACT LSYP's template. BPHC is leading the outreach effort and funding the landscaping work. EPA's New England Regional Laboratory is providing testing support, and Lead Safe Boston is assisting with contract services.

EMPACT LEAD-SAFE YARD PROJECT RECOGNIZED FOR EXCELLENCE

Because of the EMPACT LSYP's innovative approaches and far-reaching impacts, project partners have received several prestigious awards for their work. These include:

- **1999 Regional Science Award. The EPA Region 1 Science Council selected for this award Rob Maxfield and Paul Carroll, both from EPA's Office of Environmental Measurement and Evaluation, for their work on the EMPACT LSYP. The award noted that these scientists "demonstrated environmental leadership and utilized innovative yet simple solutions to this age old problem while gaining acceptance at the local, municipal, and national levels." The two also received EPA Bronze Medals for this work.**
- **1999 Harvard Award for Excellence in Children's Health. LSYP project partner Bowdoin Street Health Center received this award for its work with the EMPACT LSYP. This annual award, cosponsored by the Harvard Center for Children's Health at the School of Public Health, the City of Boston, and Children's Hospital, recognizes a Boston organization for extraordinary work in the area of child and adolescent health.**
- **2000 Boston University School of Public Health Award for Excellence in Public Health Practice. Patricia Hynes, Professor of Public Health, was recognized during National Public Health Week 2000 for her work with the EMPACT LSYP. Boston University School of Public Health selected this as one of three examples of excellence in public health research and intervention work being done by the school's faculty.**

1.2.2 Lead-Safe Yard Research Study

EPA New England and the National Center for Lead Safe Housing (http://www.leadsafehousing.org) are leading a HUD-funded research study to document the effectiveness of the low-cost interim soil control measures used by the EMPACT LSYP. Other partners in the study include the Boston Department of Neighborhood Development and Boston University. This research study will include a retrospective evaluation of the soil intervention work conducted during the first two phases of the EMPACT LSYP (1998 and 1999). It also will examine data collected during the summer of 2000 by all three Boston-based lead-safe yard projects: the EMPACT project, the Lead Safe Boston demonstration project, and the BPHC project (data will be collected before, during, and after each yard intervention). The principal objective of the study is the preparation of a technical paper that will document the effectiveness of low-cost interim soil control measures in reducing risk to residents and to make this data available to HUD for policy development. The research study will also seek to answer several technical questions about the suitability of field-portable XRF technology for soil-lead testing.

1.3 About This Handbook

A number of cities have expressed interest in beginning lead-safe yard programs, but they are limited by available resources. The Technology Transfer and Support Division of the EPA Office of Research and Development's (ORD's) National Risk Management Laboratory initiated the development of this handbook to help interested communities learn more about the EMPACT LSYP and to provide them with the technical information they need to develop their own programs. ORD, working with the LSYP from Region 1, produced the handbook to leverage EMPACT's investment in the project and minimize the resources needed to implement it in new cities.

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 the EMPACT LSYP Web site at http://www.epa.gov/region01/leadsafe. This Web site is in turn hyperlinked to the main EMPACT Program Web site (http://www.epa.gov/empact) and the ORD Technology Transfer Web site. In addition, you can obtain a copy of the handbook by contacting the EMPACT Program office at:

EMPACT Program
Office of Environmental Information
U.S. EPA (2831R)
1200 Pennsylvania Avenue
Washington, DC 20460
(202) 564-5179

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 Acknowledgments

EPA and the EMPACT LSYP would like to recognize the following people and organizations for their substantial contributions to the contents of this handbook:

- Sandra Duran, a construction specialist with the Boston Department of Neighborhood Development in the City of Boston's Public Facilities Department, for creating many of the forms used during the third phase of the EMPACT LSYP and creating the specifications for construction contracting.
- The EPA New England Lead Program in the Office of Ecosystem Protection, for assistance in reviewing early drafts of the handbook.
- The New England Lead Coordinating Committee (NELCC), funded by EPA New England and the State Lead Programs, and the participants of the Lead in Soils Design Charrette, whose early work developing landscape treatments for lead-contaminated soil provided a foundation for the EMPACT LSYP's low-cost mitigation approach.
- The EPA New England Urban Initiative, whose outreach and capacity-building efforts established many of the community and city partnerships that made this project possible.

1.5 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

The EMPACT Lead-Safe Yard Project
http://www.epa.gov/region01/leadsafe

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60 Westview Street
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(781) 860-4640

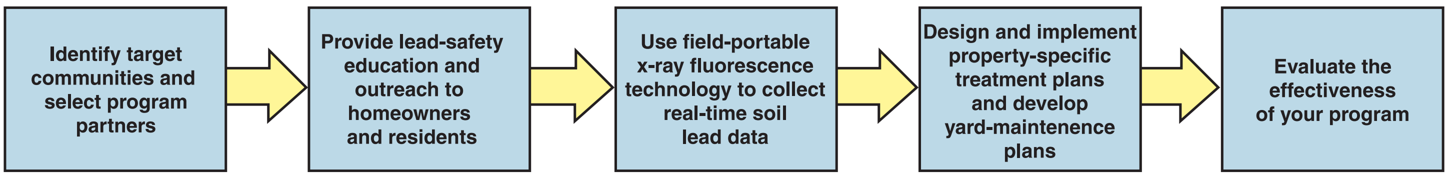
H. Patricia Hynes
Professor of Environmental Health
Director, Urban Environmental Health Initiative
Boston University School of Public Health
715 Albany Street
Boston, MA 02118
(617) 638-7720

The Dudley Street Neighborhood Initiative
http://www.dsni.org

The National Center for Lead Safe Housing
http://www.leadsafehousing.org

2 How To Use This Handbook

This handbook provides information your community can use to create and implement a lead-safe yard program. It presents detailed guidance, based on the experience of the EMPACT Lead-Safe Yard Project, on how to:



The handbook provides simple "how to" instructions on each facet of planning and implementing a lead-safe yard program, along with important background information on lead poisoning and the hazards of lead-contaminated soil:

- **Chapter 3** discusses why lead in general, and lead-contaminated soil in particular, is a health hazard; what data are available on lead in soil; and what standards and regulations may apply to your program.
- **Chapter 4** describes the steps in beginning a program: identifying potential target communities, getting to know the community, and selecting partners for the program.
- **Chapter 5** provides guidance on education and outreach to homeowners and residents about the problem of lead in soil and the benefits of participating in a lead-safe yard program.
- **Chapter 6** provides detailed information about data collection and management, focusing on the use of the field-portable x-ray fluorescence instrument to collect real-time data.
- **Chapter 7** describes soil mitigation strategies and techniques, including sample specifications, costs, and legal issues.
- **Chapter 8** discusses how to develop and implement a maintenance plan for lead-safe yards, including homeowner education and strategies for ensuring ongoing maintenance.
- **Chapter 9** provides guidance for evaluating the program, stressing the importance of documentation.
- **Chapter 10** outlines the application of lead-safe yard monitoring and mitigation techniques to non-residential settings, such as tot lots, community gardens, and abandoned commercial buildings.

Interspersed throughout the handbook are success stories and lessons learned in the course of the EMPACT LSYP. The handbook also refers you to supplementary sources of information, such as Web sites, guidance documents, and other written materials. In addition, the handbook includes three appendices that present alternatives to the approaches used by the EMPACT LSYP:

- **Appendix A** describes the Safer Soil Pilot Program of Cambridge, Massachusetts, which has used landscaping and other remedial measures to treat residential yards since 1997.
- **Appendix B** proposes four models for less-resource-intensive approaches to implementing lead-safe yard programs.
- **Appendix C** discusses a new option, phytoremediation, being explored to address lead in soil in a cost-effective manner.

Finally, Appendix D presents the EMPACT LSYP Quality Assurance Project Plan.

The handbook is designed for managers and decision-makers who may be considering whether to implement a lead-safe yard program in their communities, as well as for organizers who are actually implementing lead intervention programs. Decision-makers likely will find Chapters 3, 4, 9, and 10 most helpful. The other chapters are written primarily for people who will carry out the program and provide detailed "how to" information. Individual homeowners interested in finding low-cost ways to prevent children's exposure to lead in soil will find Chapters 7 and 8 most useful.

3 Lead in Soil: Why is it a Problem?

This chapter provides an overview of the problems posed by lead in soil. Section 3.1 discusses lead poisoning, its health effects and prevalence, and the pathways through which children and others are exposed to lead. Section 3.2 describes the most common sources of lead in residential soil and summarizes soil-lead levels found in the United States. Section 3.3 reviews evidence indicating that soil is one important pathway for childhood lead exposure. Finally, Section 3.4 describes the national strategy for reducing hazardous exposures to lead and identifies standards and regulations that may affect a lead-safe yard program.

The information in this chapter should be useful to any person interested in soil-lead hazards and mitigation, whether that person be a community organizer responsible for implementing a lead-safe yard program or a homeowner concerned about elevated soil-lead levels in his or her own yard.

3.1 Lead and Lead Poisoning

Lead is a heavy, soft, malleable metal. Due to its physical and chemical properties, people have found countless uses for lead in their daily lives. While certain uses of lead are banned, lead is still found in a myriad of products. Important sources of lead in the environment today include:

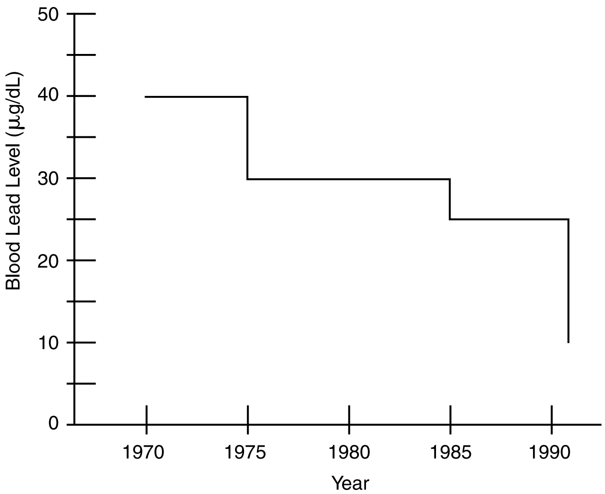
- Lead paint, and resulting lead dust, found in and around homes built before 1978 (when lead-based paint was banned). Lead dust from deteriorated lead-based paint is the most significant contributor to childhood lead poisoning.
- Lead from automobile emissions (before leaded gasoline was finally banned in 1986) that has been deposited on land and surface water.
- Lead in occupational settings (often brought home on clothes or skin).
- Lead from industrial emissions, such as lead smelters, lead mining, hazardous waste sites, and battery-recycling plants.
- Lead in drinking water caused by lead-containing plumbing.
- Lead-containing tableware, such as leaded-crystal glassware and lead-glazed pottery.
- Certain hobbies and activities that use lead (e.g., car radiator repair, target shooting, stained-glass making, glass or metal soldering).
- Certain folk remedies that contain lead (e.g., azarcon, greta).

3.1.1 What Is Lead Poisoning?

Lead poisoning is entirely preventable. However, according to the Centers for Disease Control and Prevention (CDC), nearly 1 million children living in the United States in the early 1990s had lead in their blood at levels high enough to be associated with irreversible damage to their health.

CDC defines elevated blood lead in children as blood lead levels of 10 micrograms of lead per deciliter of blood (µg/dL) or higher. Until the early 1970s, CDC's blood lead levels of concern were 60 µg/dL for children and 80 µg/dL for adults. As the adverse effects of lead became better known,

Blood lead levels considered elevated by the Centers for Disease Control and the Public Health Service.



Source: Centers for Disease Control, 1991, *Preventing Lead Poisoning in Young Children*

CDC lowered the level at which it recommends medical attention, also known as the "blood lead intervention level," on three separate occasions. After research showed that cognitive and developmental damage occurs at blood lead levels as low as 10 µg/dL, CDC lowered the blood lead level of concern to the current 10 µg/dL value in 1991. There is no known safe level of lead in blood.

3.1.2 Health Effects of Lead Poisoning

Lead poisoning affects nearly every system in the body, and often occurs with no noticeable symptoms. Although lead can affect adults, children under the age of six are especially vulnerable to the adverse effects of lead. The incomplete development of the blood-brain barrier in fetuses and very young children (up to 36 months of age) increases the risk of lead's entry into the nervous system. Low but chronic exposure can affect the developing nervous system in subtle but persistent ways. In children, blood lead levels as low as 10 to 15 µg/dL can stunt growth rates, affect attention span, cause learning disabilities, lower IQ scores, impair hearing acuity, and cause behavioral problems. In addition, fetuses exposed to elevated levels of lead can suffer from low birth weight, impaired hearing, and altered gestational age, which can lead to further complications.

In addition to damaging the nervous system, elevated blood lead levels can also affect the kidneys and reproductive system and cause high blood pressure. Very high levels (greater than 80 µg/dL) can cause convulsions, coma, or death. Levels greater than 150 µg/dL are fatal if not treated quickly. Fortunately, exposures resulting in such high levels of lead are rare.

The literature on the health effects of lead is extensive. For more information, see CDC's *Preventing Lead Poisoning in Young Children* (http://aepo-xdv-www-epo.cdc.gov/wonder/prevguid/p0000029/p0000029.htm) and the Agency for Toxic Substances and Disease Registry's *Case Studies in Environmental Medicine: Lead Toxicity* (http://www.atsdr.cdc.gov/HEC/caselead.html). Additional resources and links listed at the end of this chapter provide a wealth of information on this and other lead-related topics.

3.1.3 How Does Lead Enter the Body, and What Happens to Lead in the Body?

Lead enters the body through either ingestion or inhalation. Young children tend to ingest more lead than adults do in a given environment, mainly because of their normal hand-to-mouth behavior. The most common way for a child to ingest lead is by putting objects in the mouth (e.g., toys or hands) that have lead-contaminated dust or dirt on them. Children may also mouth surfaces having lead-based paint (such as window sills) or ingest lead-paint chips or soil (especially children who exhibit pica, a pattern of eating dirt or other non-food substances). Children may also ingest lead if their drinking water contains lead. (Lead in drinking water usually comes from lead-containing pipes, faucets, and solder in the plumbing of older buildings.) Children can also inhale lead via dust from deteriorating paint, dust on clothing brought home by parents exposed to occupational lead sources, or fumes from hobbies or industries that use lead.

Young children tend to ingest more lead than adults do in a given environment, partly because of normal hand-to-mouth behavior. They also take in more food and water per body weight.

The rate at which the body absorbs lead, once it has been ingested, depends on the chemical and physical form of the lead and on the physiological characteristics of the exposed person. Nutritional status and age are the factors having the greatest influence on absorption rates. Adults typically absorb 10 to 15 percent of ingested lead through the gastrointestinal tract, while children and pregnant women can absorb as much as 50 percent. Children are also at higher risk when their nutritional needs are not being adequately met. Calcium, iron, zinc, and protein deficiencies, in particular, increase lead absorption rates. Fasting conditions in adults have a similar impact on the absorption of lead. Lead dust inhaled and deposited into the lower respiratory tract is completely absorbed by both adults and children.

Since lead is an inorganic metal, it is not metabolized and is distributed throughout the body by the bloodstream. Over time, a portion of the lead may be eliminated from the body. The majority, however, remains in the bloodstream, or is absorbed by soft tissue (kidneys, bone marrow, liver, and brain), or mineralizing tissue (bones and teeth). In adults, 95 percent of the lead present in the body is found in teeth and bones, where it remains inert. When the body experiences physiological changes, however—such as pregnancy, lactation, or chronic disease—this inert lead can leach into the bloodstream and raise blood lead levels to dangerous levels. During pregnancy, this mobilized lead can also be transferred to the fetus, which has no defense mechanism against it. This can result in developmental and neurological damage.

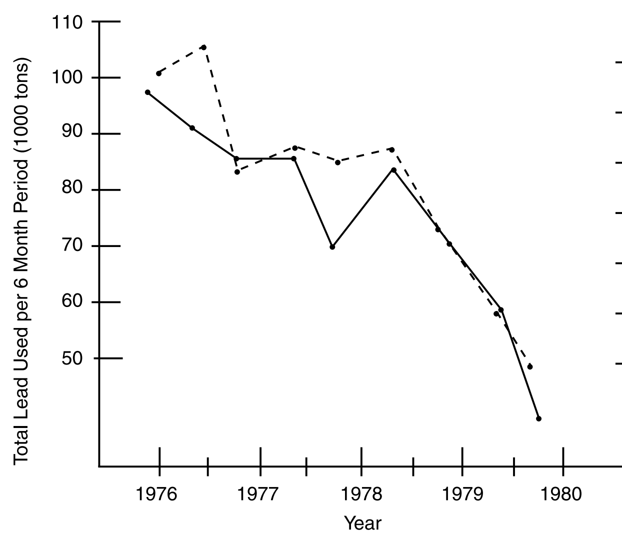
In addition to absorbing a greater proportion of the lead to which they are exposed, children also tend to retain a greater percentage of lead in their blood than do adults. This is partly because a child's body is not as efficient as an adult's at absorbing lead into mineralizing tissue. Consequently, a greater fraction of the lead absorbed remains in the bloodstream and has a toxic effect on internal organs.

3.1.4 How Common Is Lead Poisoning in Children?

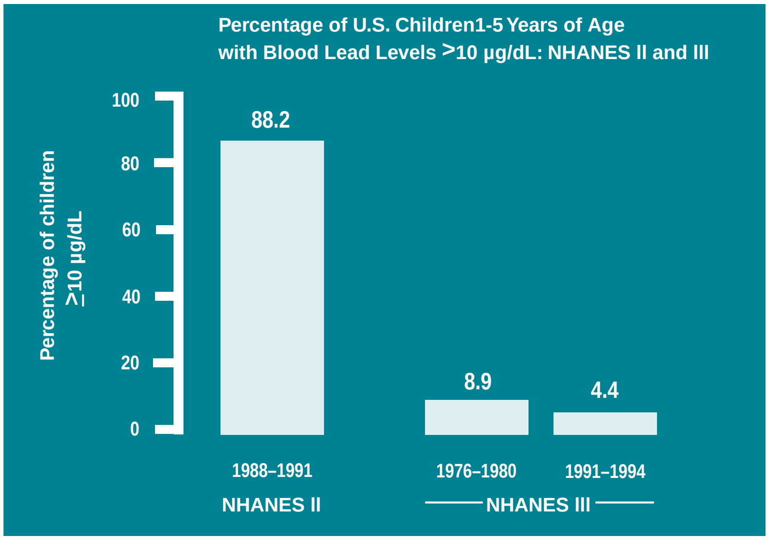
The Second National Health and Nutrition Examination Survey (NHANES II), released in 1980, showed that as recently as 1976, the average blood lead level of the typical American child was 12.8 µg/dL. The survey also revealed that at that time 88.2 percent of American children ages one through five were suffering from some degree of lead poisoning (i.e., over CDC's current level of concern of 10 µg/dL).

In the 1970s, the federal government banned the use of lead-based paint in residential buildings and houses, and phased out the use of lead as an additive in gasoline. These two actions had an immense impact on the blood lead levels of children nationwide. NHANES III reported that by 1988, the national average blood lead level in children had dropped to 2.8 µg/dL and the percentage of children suffering from lead poisoning had dropped to 8.9 percent. By the early 1990s, the average blood lead level of children ages

Change in blood lead levels in relation to a decline in use of leaded gasoline, 1976-1980.



Source: Centers for Disease Control, 1991, *Preventing Lead Poisoning in Young Children*



one through five was 2.3 µg/dL.[1] A fourth NHANES report has recently been completed; though the report has not yet been made public, the survey data apparently suggest that average blood lead levels continue to decrease among children in this age range.

While childhood lead exposure has diminished over the past 25 years, the problem is far from solved. In particular, minority, low-income, inner-city populations continue to lag behind in improvement, relative to national averages:

- 8 percent of impoverished children suffer from lead poisoning compared to only 1 percent of children from high-income families.[2]
- 11.2 percent of all African-American children are lead poisoned compared to 2.3 percent of all white children.[3]
- 50 to 70 percent of the children living in the inner cities of New Orleans and Philadelphia have blood lead levels above 10 µg/dL.[4]

Poor nutrition, deteriorating housing, lack of access to medical care, and language barriers all contribute to placing poor and minority children at risk for lead poisoning. It is important to note, however, that no economic or ethnic/racial group is free from the risk of lead poisoning. A sizable number of affluent families renovating older homes, for example, have placed their children at risk through unsafe lead paint removal techniques.

3.2 Sources and Levels of Lead in Soil

When lead is deposited in soil from anthropogenic sources, it does not biodegrade or decay and is not rapidly absorbed by plants, so it remains in the soil at elevated levels. Lead is estimated to have a half-time of residence in soil of 1,000 years.[5] In soils with a pH of greater than or equal to 5 and with at least 5 percent organic matter (which immobilizes the lead), atmospheric lead is retained in the upper 2 to 5 centimeters of undisturbed soil.[6] Urban soils or other soils that have been turned under or otherwise disturbed may be contaminated to much greater depths.

EPA estimates that 23 percent, or 18 million, of the privately owned homes in the United States built before 1980 have soil-lead levels above 400 parts per million (ppm); that 3 percent, or 2.5 million, have levels exceeding 2,000 ppm; and that 3 percent, or 2.5 million, exceed 5,000 ppm.[7]

[1] Natural Resources Defense Council, *Our Children at Risk: The 5 Worst Environmental Threats to Their Health,* Chapter 3: Lead, Washington, DC, 1997. Available at http://nrdc.org/health/kids/ocar/ocarinx.asp
[2] Ibid.
[3] Ibid.
[4] Mielke, H.W., "Lead in the Inner Cities," *American Scientist,* vol. 87, no. 1, Jan/Feb 1999.
[5] Benninger et al., *The Use of Natural Pb-10 as a Heavy Metal Tracer in the River-Estuarine System,* ACS Symposium Series #18, Marine Chemistry and the Coastal Environment, 1975.
[6] U.S. Environmental Protection Agency, *Air Quality Criteria for Lead,* Research Triangle Park, NC, EPA600-8-83-018F, 1986.
[7] U.S. Environmental Protection Agency, *Distribution of Soil Lead in the Nation's Housing Stock,* 1996.

Lead in residential soil comes from several different sources, including lead-based exterior paint and automobile tailpipe emissions from vehicles burning leaded gasoline. Industrial emissions are also a source of residential soil contamination in some areas. These sources of contamination are discussed in more detail below.

3.2.1 Lead-Based Paint

EPA has found building age to be the strongest statistical predictor of soil lead, with soil around private homes built before 1940 having significantly higher levels of lead in soil than homes built between 1960 and 1979.[8] While the use of lead paint in residential buildings was federally banned in the United States in 1978, many homes built prior to 1978 still contain lead-based paint. Paint used in homes built between 1950 and 1978 contained between 0.5 and 50 percent lead, and the paint used prior to 1950 contained higher concentrations. One estimate is that more than 3 million tons of lead-based paint remain in the 57 million homes built prior to 1980.[9]

Since a large portion of this lead-based paint covers building exteriors, it continues to be a significant source of soil contamination. Lead-based paint contaminates soil as the paint film weathers and reaches the soil in the form of chips and dust. Renovating, remodeling, and performing routine home maintenance will also mobilize this lead if proper precautions are not taken. As the paint on a building's exterior deteriorates, lead paint chips and dust concentrate in the surrounding soil. Dry scraping, sanding, and blasting of lead-based paint can mobilize large amounts of lead in a short time and significantly increase lead concentrations in soil. Lead concentrations in soil are typically highest in the drip zone, or dripline, the area surrounding and extending out about 3 feet from the perimeter of a building.

3.2.2 Leaded Gasoline

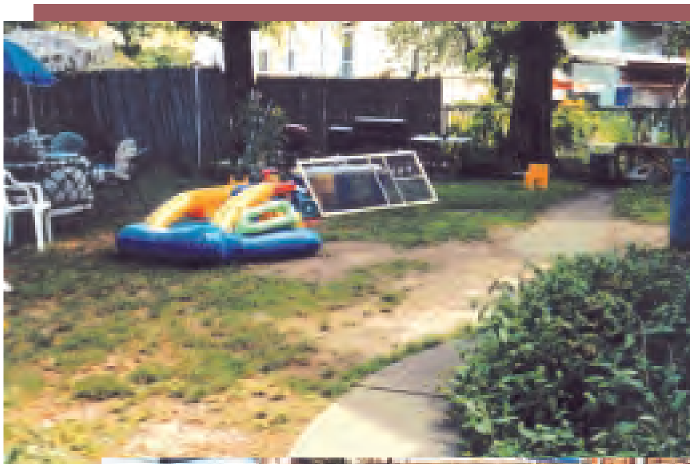
The use of lead as a gasoline additive was phased out during the 1970s and banned in the United States in 1986. It has been estimated that 4 to 5 million metric tons of lead, emitted from automobile tailpipes as fine dust particles, remain in the environment in dust and soil.[10] This represents approximately 75 percent of the total amount of lead added to gasoline. The remaining 25 percent was deposited on internal engine surfaces or ended up in the oil. The lead dust that became airborne would migrate until hitting a barrier such as the side of a house or some other structure, to which it would adhere. Subsequent rains washed this lead dust down into the surrounding soil, where it accumulated over time.

Scientists estimate that 4 to 5 million metric tons of lead emitted from automobile tailpipes prior to 1986 remain in the environment in dust and soil.

Soil-lead levels within 25 meters of roadways are typically 30 to 2,000 ppm higher than natural levels, and can sometimes be as

[8]Ibid.
[9]Centers for Disease Control, *Preventing Lead Poisoning in Young Children,* 1991.
[10]Ibid.

high as 10,000 ppm.[11] Some researchers have found that soil-lead concentrations typically are highest in older, inner-city neighborhoods, especially those near high-traffic routes, and that soil-lead concentrations diminish with distance from the city center. Another study found that soil-lead concentrations are 10 to 100 times higher in old communities in large cities than in comparable neighborhoods in smaller cities, perhaps because traffic volume is higher and vehicles remain inside the city longer.[12]



A back yard in Dorchester, Massachusetts, with areas of bare, contaminated soil. When children play outdoors, lead-contaminated dirt and dust can get on hands, clothes, toys, and food.

3.2.3 Industrial Emissions

Communities near industrial and mining activities that release lead (or released lead in the past) may also have elevated levels of lead in residential soils. Examples of such industries and activities are lead smelting or refining plants, lead mining, auto repair, battery recycling or manufacturing, bridge and water tank repainting and reconstruction, plastic manufacturing, shipbuilding, glass manufacturing, printing, and hazardous waste sites. EPA has found lead levels in soils next to smelters as high as 60,000 ppm.[13]

3.3 Soil as an Exposure Pathway for Lead

While deteriorated lead-containing paint in housing is generally accepted as the leading source of lead exposure to children, outdoor activities where individuals come into contact with lead-contaminated soil also represent an exposure pathway that can be significant. When children play outdoors, lead-contaminated dirt and dust can get on hands, clothes, toys, and food. Putting these items in the mouth can lead to ingestion of lead.

Children can also breathe lead dust or lead-contaminated dirt stirred up by the wind or by outdoor play activities. During dry periods, dust from bare patches of contaminated soil can readily become airborne, increasing the chance that it will be inhaled. Also, airborne lead dust and lead-contaminated dirt can settle on play clothes and shoes and can be tracked into homes, further increasing exposure. Pets, as well, can track lead-contaminated soil into homes on their coats and paws.

The relative contribution of lead-contaminated soil versus lead-based paint and house dust is the subject of research and debate. Although there are differing opinions among researchers and experts as to the degree of significance of exposure to lead-contaminated soil, evidence does exist that soil is one important pathway for lead exposure among children. Some researchers have shown an asso-

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11 Ibid.
12 Mielke, H.W., "Lead in the Inner Cities," American Scientist, vol. 87, no. 1, Jan/Feb 1999.
13 U.S. Environmental Protection Agency, *Air Quality Criteria for Lead.*

ciation between increases in blood lead and increases in soil or dust concentrations. Factors that influence this relationship include access to soil, behavior patterns, presence of ground cover, seasonal variation of exposure conditions, and the particle size and chemical form of the lead. Others have found an association between time spent outdoors and children putting soil or dirt in their mouths, which, in turn, is associated with elevated blood lead levels.[14]

In 1996, EPA published the Integrated Report of the Urban Soil Lead Abatement Demonstration Project. This report assessed the scientific data from studies in three cities (Boston, Baltimore, and Cincinnati) to determine whether abatement of lead in soil could reduce blood lead levels of inner-city children. The report concludes that when soil is a significant source of lead in the child's environment, the abatement of that soil will result in a reduction in exposure that will, under certain conditions, cause a reduction in childhood blood lead concentrations. Important factors in reducing blood lead levels were thought to be (1) the past history of exposure of the child to lead, as reflected in pre-abatement blood lead levels; (2) the magnitude of the reduction in soil-lead concentrations; (3) the magnitude of other sources of lead exposure; and (4) a direct exposure pathway between soil and the child.[15]

CREATING A LEAD-SAFE RESIDENCE

As the various pathways for lead exposure in young children become better understood, the importance of addressing all of the sources of lead in and around the home has also become clearer. For example, even if the interior of a home is certified as deleaded, a lead-contaminated yard can remain a dangerous source of lead exposure for children living there. Conversely, soil mitigation work will be ineffective if nothing is done about heavily leaded exterior paint on a home, because recontamination of the yard is likely to occur.

Because lead in yard soil is only one aspect of a multi-layered problem, the EMPACT Lead-Safe Yard Project decided in Phase 3 to address yards only for residences where structural lead abatement had been completed. Even in such homes, however, some lead probably remains, and precautions must be taken (e.g., using lead-safe renovation techniques) to prevent recontamination of the yard.

Howard Mielke, a leading researcher on lead poisoning and prevention, reviewed other evidence for soil lead as an important exposure pathway in a 1999 article.[16] Mielke demonstrated a strong correlation between soil lead and blood lead in several studies.

3.4 Standards and Guidelines for Lead Poisoning Prevention

This section provides an overview of federal guidelines and standards that may affect a lead-safe yard program. When determining the requirements that apply to your program, it is important to check with the state or tribal agency that addresses lead poisoning prevention. For example, many states have requirements for training and certification of contractors performing lead hazard evaluation and abatement work. For a list of state/tribal lead poisoning prevention agencies, see http://www.ncsl.org/programs/ESNR/pbdir.htm.

3.4.1 The Federal Regulatory Infrastructure

Title X of the 1992 Housing and Community Development Act (available online at http://www.epa.gov/lead/titleten.html) otherwise known as the Residential Lead-Based Paint Hazard Reduction Act (Public Law 102-550), mandated the creation of an infrastructure that

[14]Bruce Lanphear and Klaus Roghmann, "Pathways of Lead Exposure in Urban Children," *Environmental Research,* vol. 74, 63–73, 1997.

[15]U.S. Environmental Protection Agency, *Integrated Report of the Urban Soil Lead Abatement Demonstration Project,* EPA600-P-93-001aF, Office of Research and Development.

[16]Mielke, H.W., "Lead in the Inner Cities," *American Scientist,* vol. 87, no. 1, Jan/Feb 1999.

would correct lead paint hazards in housing. Title X also redefined "lead paint hazards" and how they can be controlled, and created Title IV of the Toxic Substances Control Act (TSCA), under which EPA sets lead hazard standards, work practice standards, and training requirements for lead abatement workers. Based on scientific research in the 1980s, Congress defined "hazard" to include deteriorated lead paint and the lead-contaminated dust and soil it generates. The infrastructure has been developed and includes the following:

- Grant programs to make homes lead safe, now active in over 200 cities.
- Training of thousands of workers doing housing rehabilitation, remodeling renovation, repainting, and maintenance to help them do their work in a lead-safe way.
- Licensing of inspectors and abatement contractors.
- Compliance with and enforcement of lead safety laws and regulations.
- Disclosure of lead paint problems before sale or lease.
- National and local education and outreach programs.
- Promulgation of federal standards of care.
- Worker protection regulations.

The box below lists federal agencies and their programs related to lead poisoning prevention. For a more detailed overview of these federal programs, see "Current and Ongoing Federal Programs and Activities" in *Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint Hazards* (http://www.epa.gov/children/whatwe/leadhaz.pdf).

FEDERAL AGENCY ROLES IN LEAD POISONING PREVENTION

Agency	Programs and Duties
Department of Housing and Urban Development **http://www.hud.gov/lea/leahome.html**	Lead Hazard Control Grant Program, enforcement of Disclosure Rule (with EPA and DoJ) and federally assisted housing lead paint regulations, National Survey of Lead Paint in Housing, Lead Hotline (with EPA), Internet listing of lead paint professionals, public education and training of housing professionals and providers and others, technical assistance, research.
Department of Health and Human Services: Centers for Disease Control and Prevention **http://www.cdc.gov/nceh/lead/lead.htm**	Blood Lead Screening Grant Program, public education to medical and public health professionals and others, National Health and Nutrition Examination Survey, quality control for laboratories analyzing blood lead specimens, research.
Health Care Financing Administration **http://www.hcfa.gov**	Covers and reimburses for lead screening an diagnosis, lead poisoning treatment, and follow-up services for Medicaid-eligible children.

FEDERAL AGENCY ROLES IN LEAD POISONING PREVENTION

Agency	Programs and Duties
National Institute of Child Health and Human Development **http://www.nichd.nih.gov**	Conducts and supports laboratory, clinical, and epidemiological research on the reproductive, neurobiologic, developmental, and behavioral processes, including lead poisoning related research.
Health Resources and Services Administration **http://www.hrsa.gov**	Directs national health programs to assure quality health care to under-served, vulnerable, and special need populations including children with lead poisoning.
Agency for Toxic Substances and Disease Registry **http://www.atsdr.cdc.gov**	Studies blood lead in populations near Superfund sites and funds state health agencies to undertake this type of work.
Food and Drug Administration **http://www.fda.gov**	Enforces standards for lead in ceramic dinnerware; monitors lead in food.
National Institutes of Health **http://www.nih.gov**	Conducts basic research on lead toxicity.
Environmental Protection Agency **http://www.epa.gov/opptintr/lead/index.html**	Licenses lead paint professionals (or delegates this responsibility to states); environmental laboratory accreditation; enforcement of Disclosure Rule (with HUD and DoJ) and Pre-Renovation Notification Rule; hazardous waste regulation; public education to parents, environmental professionals, and others; training curriculum design; Lead Hotline (with HUD); research; addresses lead contamination at industrial waste sites, including drinking water and industrial air emissions.
Department of Justice **http://www.usdoj.gov**	Enforces Federal Lead Paint Disclosure Rule (with HUD and EPA); defends federal lead paint regulations; enforces pollution statutes, including hazardous waste laws.
Consumer Product Safety Commission **http://www.cpsc.gov**	Enforces ban of lead paint; investigates and prevents the use of lead paint in consumer products; initiates recalls of lead-containing products that present a hazard; conducts dockside surveillance and intercepts imported products that present a risk of lead poisoning; recommends elimination of lead from consumer products through Guidance Policy on lead.

FEDERAL AGENCY ROLES IN LEAD POISONING PREVENTION

Agency	Programs and Duties
Occupational Safety and Health Administration **http://www.osha-slc.gov/SLTC/lead/index.html**	Enforces worker protection regulations.
Department of the Treasury **http://www.ustreas.gov**	Evaluates financial incentives (such as tax credits) for lead hazard control.
Department of Energy **http://www.energy.gov**	Conducts weatherization activities in a lead-safe manner.
Department of Defense **http://www.defenselink.mil**	Administers lead-based paint/lead hazard management programs in 250,000 family housing and child-occupied facilities worldwide, administers childhood lead poisoning prevention programs on installations worldwide, administers research and development programs to develop new cost-effective technologies for lead paint management and abatement, partners with other federal agencies to develop policies and guidance for lead hazard management on a national level.

3.4.2 The Federal Strategy To Eliminate Lead Poisoning

The interagency President's Task Force on Environmental Health Risks and Safety Risks to Children has proposed a coordinated federal strategy to eliminate childhood lead poisoning, focusing on lead paint hazards (*Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint Hazards,* available at http://www.epa.gov/children/whatwe/leadhaz.pdf). The goals of the Strategy are:

- By 2010, to eliminate lead paint hazards in housing where children under six live.
- By 2010, to eliminate elevated blood lead levels in children.

To accomplish these goals, the Task Force makes the following recommendations:

Act before children are poisoned:

- Increase the availability of lead-safe dwellings by increasing federal grants for low-income housing and leveraging private and other non-federal funding.
- Promote education for universal lead-safe painting, renovation, and maintenance work practices.
- Ensure compliance with existing lead paint laws.

Identify and care for lead-poisoned children:

Improve early intervention by expanding blood lead screening and follow-up services for at-risk children, especially Medicaid-eligible children.

Conduct research:

Improve prevention strategies, promote innovative ways to drive down lead hazard control costs, and quantify the ways in which children are exposed to lead.

Measure progress and refine lead poisoning prevention strategies:

Implement monitoring and surveillance programs.

The Strategy notes that research is needed to help develop, evaluate, and market new products, such as x-ray fluorescence technologies. It also notes that research is needed to test the effectiveness of specific actions to reduce exposure to lead in soil and dust. These are areas in which the EMPACT Lead-Safe Yard Project and other similar programs can make significant contributions through their data and experience.

3.4.3 Federal Regulations and Guidelines Affecting Lead-Safe Yard Programs

EPA and the Department of Housing and Urban Development have issued regulations governing lead contamination in residential buildings and soil. EPA regulates lead contamination in homes and yards from lead-based paint under Title IV of TSCA. EPA's Resource Conservation and Recovery Act (RCRA) regulations also regulate lead-contaminated soil in certain situations. HUD's regulations parallel the TSCA regulations and apply to residential buildings that are either federally owned or receive federal assistance under HUD programs.

3.4.3.1 Proposed Rule Under TSCA (40 CFR Part 745)

EPA is currently preparing a final rule under TSCA Section 403, "Lead; Identification of Dangerous Levels of Lead," which will establish standards for lead-based paint hazards, including a hazard level and level of concern for lead-contaminated residential soils. The pending rule is being designed to contribute to the lead hazard identification and abatement mandates specified under Title X, "The Residential Lead-Based Paint Hazard Reduction Act of 1992."

The Section 403 rule is expected to directly affect HUD and other federal agencies that own residential property by requiring soil abatement (such as soil removal or paving) before property sale if soil-lead hazards are identified. It will also indirectly affect property owners who receive federal housing assistance by potentially requiring hazard abatement or reduction. However, this pending rule will not by itself require residential soil abatement, but will instead provide standards for use in other regulations currently being implemented under Title X.

3.4.3.1.1 Are the Treatments in This Handbook Consistent With Federal Regulations?

The EMPACT LSYP was designed before the Section 403 rule was drafted; however, it can be considered to be complementary to the pending Section 403 rule. The project complements the "focus on prevention" objective of TSCA Title IV and the pending Section 403 rule by providing residents (particularly low-income urban minority residents) with practical low-cost yard improvements and landscaping measures that will reduce exposure to lead-contaminated soils. These low-cost measures may be used, in the case of federally owned or assisted properties, as interim shorter-term solutions until permanent, higher-cost solutions are employed. In addition, these low-cost measures may also provide longer-term, but not permanent, protection at non-federally and if needed, federally owned/assisted properties so long as homeowners and/or residents carefully and conscientiously follow specific maintenance procedures developed by the LSYP.

The tables below show the actions recommended for different soil levels by the EMPACT LSYP and the pending Section 403 rule. Following the tables is a discussion of the context for the two sets of recommended actions, as well as a comparison of the sampling plans used in each approach.

EMPACT LEAD-SAFE YARD PROJECT

Soil-Lead Level (parts per million)*	Recommended Interim Action
> 5,000 (very high)	If soil removal or permanent barriers are not possible: • Install semi-permanent barrier, such as a wood-framed dripbox filled with gravel or mulch. • Relocate gardens—unsafe for all types of gardening.
2,000–5,000 (high)	• Relocate gardens—unsafe for all types of gardening. • Relocate children's play area, pet area, and picnic area, if possible. If not, install wood platform or wood-framed raised play and picnic area filled with woodchips. • Install path of walking stones for high-traffic areas. • Seed and fertilize grassy areas, or cover with mulch or woodchips if not suitable for grass.
400–2,000 (moderately high)	• Install raised-bed garden and supplement with clean topsoil. • Install wood-framed raised play and picnic area filled with woodchips. • Install path of walking stones for high-traffic areas. • Seed and fertilize grassy areas, or cover with mulch or woodchips if not suitable for grass.
< 400 (urban background)	• No treatment necessary.

*Based on in situ XRF analysis of surface soils (typically 15 to 25 samples per yard) and lead concentration mapping of the entire yard to include areas of special concern (play areas, gardens, outside eating areas, pet runs, etc.).

PROPOSED SECTION 403
BARE SOIL-LEAD HAZARD IDENTIFICATION

Soil Lead Level (parts per million)**	Recommended Interim Action
> 1,200 (hazard standard)	Eliminate hazard: • Remove contaminated soil install permanent covering.
400–1,200 (level of concern)	Implement interim controls: • Cover bare soil • Use doormats in entryways. • Wash hands, toys, etc., more frequently.
< 400	• No action

** For the yard, concentration is derived from an arithmetic mean of two composite samples, one from the drip line and one from mid-yard. For identified play areas, a single composite sample is used.

The EMPACT LSYP's mitigation strategy currently focuses on application of interim controls, though some permanent measures (blacktop) have been used for car park areas. Clearly, permanent controls are desirable where the resources are available to implement them. The EMPACT LSYP targeted its mitigation measures toward low-cost/no-cost options to address neighborhoods and homes where hazards exist and resources for mitigating these hazards are limited.

It must be noted that the EMPACT LSYP approach to soil measurement is different from the proposed standard in several respects:

1) The EMPACT LSYP maps the entire yard with 15 to 25 field screening XRF analyses; this results in clear identification of hazard areas and the detailed information needed to apply controls in a cost-effective manner.

2) Surface soils are analyzed in situ to provide data on the soil material most likely to come into contact with the residents. Standard protocols would use field collection and offsite analysis of composite grab samples.

3) The proposed 403 rule only applies to bare soil, while the EMPACT LSYP measures all yard surfaces.

4) The proposed 403 rule relies on average measurements (composites) that will most often result in lower lead concentrations than the discrete in situ measurements used to map yards in the EMPACT LSYP.

For these reasons, the proposed 403 standards and the action levels used for the EMPACT LSYP may not be directly comparable. Nonetheless, before applying the EMPACT project's model to your situation, you will need to consult local regulatory authorities to determine the requirements you must meet. State/tribal and local government regulations may be more restrictive than existing federal guidance.

3.4.3.2 Resource Conservation and Recovery Act (40 CFR Parts 240–299)

RCRA regulates the disposal of solid and hazardous waste. EPA's interpretations of RCRA regulations state that soils contaminated with lead-based paint as a result of routine residential maintenance and/or natural weathering or chalking of lead-based paint fall under the household waste exclusion and are not regulated as hazardous waste. This means that material may be disposed of off site in accordance with the regulations governing solid (non-hazardous) waste, known as RCRA Subtitle D, as well as applicable state and local regulations. Lead-contaminated soil that falls under the household waste exclusion need not be tested to determine if it is hazardous waste; if it is tested and found to be hazardous waste, it is still exempt from the RCRA hazardous waste regulations. You should check with state and local authorities, however, to see what testing they require.

3.4.3.3 Lead-Based Paint Poisoning Prevention in Certain Residential Structures (40 CFR Part 35)

This HUD rule establishes procedures to eliminate, as far as practicable, lead-based paint hazards in residential properties that are federally owned or receive federal assistance under HUD programs. The rule requires lead inspection and screening to be performed at all federally owned or assisted target housing, or any time a child under six years of age is found to exhibit an environmental intervention blood lead level (> 20 µg/dL for a single test or 15 to 19 µg/dL in two tests taken at least three months apart). Target housing is defined as any residence built prior to 1978, excluding housing for the elderly or those with disabilities (unless children under the age of six are expected to reside there) or zero bedroom dwellings. Where a soil-lead hazard is found to exist, action is required to reduce the hazard.

The rule establishes six levels of protection: abatement of the lead-contaminated soil, abatement of the lead soil hazards, interim controls, paint stabilization, ongoing lead-based paint maintenance, and safe work practices during rehabilitation.

- When abatement (the permanent elimination of lead) is required for soil, the standards promulgated under TSCA must be followed. Abatement can be achieved through either soil removal and replacement with uncontaminated soil or permanent covering of the contaminated area (e.g., with pavement or concrete).
- Interim controls are steps taken to temporarily reduce lead exposure or hazards. They include impermanent surface coverings (e.g., sod, gravel, bark, artificial turf) and land use controls (e.g., fencing, warning signs, landscaping).
- The remaining actions (paint stabilization, ongoing lead-based paint maintenance, and safe work practices during rehabilitation) are not directly applicable to soil, but can help reduce the potential for increased soil contamination.

The specific level of protection required depends on the type of housing and the type of federal ownership or assistance. Once the required remedial action has been completed, the soil must pass the clearance examinations outlined in the regulations or further action will be required.

3.5 For More Information

3.5.1 Additional Resources

Agency for Toxic Substances and Disease Registry. 1992. *Analysis Paper: Impact of Lead-Contaminated Soil on Public Health.* Available online at http://www.atsdr.cdc.gov/cxlead.html.

Agency for Toxic Substances and Disease Registry. *Philadelphia Neighborhood Lead Study, Philadelphia, Pennsylvania. Report of Lead Exposure Pilot Study.* Division of Health Studies. Atlanta, GA. Available from NTIS (order # PB92-123777INZ).

Agency for Toxic Substances and Disease Registry. 1999. *Toxicological Profile for Lead (draft).* Atlanta: U.S. Department of Health and Human Services, Public Health Service.

American Academy of Pediatrics Committee on Drugs. 1995. "Treatment Guidelines for Lead Exposure in Children." *Pediatrics.* 96:155–160. Available online at http://www.aap.org/policy/00868.html.

Center for Bioenvironmental Research at Tulane and Xavier Universities. 1996. *Lead's Urban Legacy.* Available online at http://www.tmc.tulane.edu/ecme/leadhome/soil.html.

Centers for Disease Control and Prevention. 1997. *Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials.* Available online at http://www.cdc.gov/nceh/lead/guide/1997/guide97.htm, or call (toll-free) 1-888-232-6789.

Department of Housing and Urban Development. 1995. *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing.* Available online at http://www.hud.gov/lea/learules.html.

Department of Housing and Urban Development. 2000. *Residential Lead Desktop Reference, 2nd Edition.* CD-ROM containing more than 140 documents, including ASTM scopes, screening guidance, community outreach materials, lead resources, scientific studies and reports, lead statutes and regulations, lead training materials, regulation support documents, reports to Congress, HUD guidelines, and other resources. Available for $10 by calling HUDUSER at 1-800-245-2691.

Lead-Based Paint Hazard Reduction and Financing Task Force. 1995. *Putting the Pieces Together: Controlling Lead Hazards in the Nation's Housing.* Available online at http://www.hud.gov/lea/leadwnlo.html.

Mielke, H.W. 1990. "Lead Dust-Contaminated Communities and Minority Health: A New Paradigm," *The National Minority Health Conference: Focus on Environmental Contamination.* B.L. Johnson, R.C. Williams and C.M. Harris, Eds. Princeton, New Jersey: Princeton Scientific Publishing Co., Inc.

Mielke, H.W. 1994. "Lead in New Orleans Soils: New Images of an Urban Environment." *Environmental Geochemistry and Health.* 16:123–128.

Mielke, H.W. 1997. "Leaded Dust in Urban Soil Shown To Be Greater Source of Childhood Lead Poisoning Than Leaded Paint." *Lead Perspectives.* 28–31 (March/April).

Mielke, H.W. 1999. "Lead in Inner Cities." *American Scientist.* Vol. 87, No. 1 (January-February).

Mielke, H.W., and J.L. Adams. 1989. "Environmental Lead Risk in the Twin Cities." Center for Urban and Regional Affairs. CURA 89-4. 22 pp.

Mielke, H.W., J.C. Anderson, K.J. Berry, P.W. Mielke, R.L. Chaney, and M. Leech. 1983. "Lead Concentrations in Inner-City Soils as a Factor in the Child Lead Problem." *American Journal of Public Health.* 73:1366–1369.

Mielke, H.W., S. Barroughs, R. Wade, T. Yarrow, and P.W. Mielke. 1984/1985. "Urban Lead in Minnesota: Soil Transect Results of Four Cities." *Journal of the Minnesota Academy of Science.* 50:19–24.

National Research Council. 1993. *Measuring Lead Exposure in Infants, Children and Other Sensitive Populations.* Washington, D.C. National Academy Press. Order online at http://books.nap.edu/catalog/2232.html.

U.S. Congress. 1992. *Residential Lead-Based Paint Hazard Reduction Act of 1992.* Title X (42 USC 4851). Available online at http://www.epa.gov/lead/titleten.html.

U.S. Environmental Protection Agency. 1994. *EPA Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil.* EPA540-F-94-045. Order online at http://www.epa.gov/ncepihom/ordering.htm.

U.S. Environmental Protection Agency. 1995. *EPA Residential Sampling for Lead: Protocols for Dust and Soil Sampling.* EPA747-R-95-001.

U.S. Environmental Protection Agency. 1996. *Distribution of Soil Lead in the Nation's Housing Stock.* Available online at http://www.hud.gov/lea/lealead.pdf.

U.S. Environmental Protection Agency. 1997. *Reducing Lead Hazards When Remodeling Your Home.* EPA747-K-97-001. Order online at http://www.epa.gov/ncepihom/ordering.htm.

U.S. Environmental Protection Agency. 1997. *Risk Analysis To Support Standards for Lead in Paint, Dust, and Soil, Volumes 1 & 2.* EPA747-R-97-006. Available online at http://www.epa.gov/ncepihom/ordering.htm.

3.5.2 Links

U.S. Environmental Protection Agency

National Lead Information Center
http://www.epa.gov/lead/nlic.htm
A federally funded hotline and clearinghouse that provides information on lead hazard reduction and exposure prevention. To speak with one of the Center's clearinghouse specialists, call 1-800-424-LEAD Monday through Friday, 8:30 a.m. to 6:00 p.m. EST.

Office of Pollution Prevention and Toxics (OPPT)
http://www.epa.gov/opptintr/lead/index.html
Responsible for EPA programs related to lead poisoning prevention and lead regulation. OPPT also provides educational packets for parents, teachers, daycare providers, and librarians, as well as technical information and publications.

Integrated Risk Information System (IRIS)
http://www.epa.gov/iris
An electronic database containing information on human health effects that may result from exposure to various chemicals in the environment. The information in IRIS is intended for those without extensive training in toxicology, but with some knowledge of health sciences.

Lead Poisoning Prevention Outreach Program
http://www.nsc.org/ehc/lead.htm
Funded through a cooperative agreement between EPA and the Environmental Health Center.

Department of Housing and Urban Development,
Office of Lead Hazard Control
http://www.hud.gov/lea/leahome.html
Sets standards for evaluation and management of lead in federally assisted housing, and promotes efforts to reduce lead hazards in privately owned housing. In addition, provides grants to communities to reduce lead hazards in housing.

Centers for Disease Control and Prevention
Childhood Lead Poisoning Prevention Program
http://www.cdc.gov/nceh/lead/lead.htm
Promotes state and local screening efforts and develops improved treatments for lead exposure. CDC also provides a database, 1990 Census Data on Housing and Population—Interactive Query, that allows you to search by county or zip code to find the percentage of houses built before 1950.

Agency for Toxic Substances and Disease Registry (ATSDR)
http://www.atsdr.cdc.gov
An agency of the U.S. Public Health Service established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund. ATSDR is required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List to determine if people are being exposed to hazardous substances, which includes lead. The public can search by region to see which health assessments are currently available in an online database located at http://www.atsdr.cdc.gov/HAC/PHA.

National Conference of State Legislatures
http://www.ncsl.org/programs/ESNR/pbdir.htm
Contains NCSLnet Search—a directory of state lead poisoning prevention contacts.

Consumer Product Safety Commission
http://www.cpsc.gov
Identifies and regulates sources of lead exposure in consumer products.

Occupational Safety and Health Administration
http://www.osha-slc.gov/SLTC/lead/index.html
Develops work practice standards and worker exposure limits to protect workers from occupational lead exposure.

4 Beginning the Program

This chapter provides guidance on important first steps that you will need to take as you start your lead-safe yard program. Section 4.1 presents a brief overview of the structure of a lead-safe yard program and outlines the roles and responsibilities of program partners, based on the EMPACT Lead-Safe Yard Project model. Section 4.2 discusses the critical process of selecting program partners who can best help you meet your program's objectives within your target community. Section 4.3 presents guidance on identifying potentially impacted communities that you may want to target with your program. Finally, Section 4.4 provides tips on getting to know your target community in terms of the cultures and languages of residents, the types and conditions of housing stock, and other factors.

The information in this chapter is designed primarily for managers and decision-makers who may be considering whether to implement lead-safe yard programs in their communities, as well as for organizers who are implementing such programs.

4.1 Program Structure: Overview of a Lead-Safe Yard Program

The EMPACT LSYP is a multifaceted project that engages in a variety of activities—everything from distributing flyers to planting grass. These activities can be grouped into four main categories, which make up the main components of the project: education and outreach, soil sampling, yard treatment, and program evaluation.

The following paragraphs summarize these activities to provide an overview of how the EMPACT LSYP works. These activities are described in much greater detail in Chapters 5 through 9.

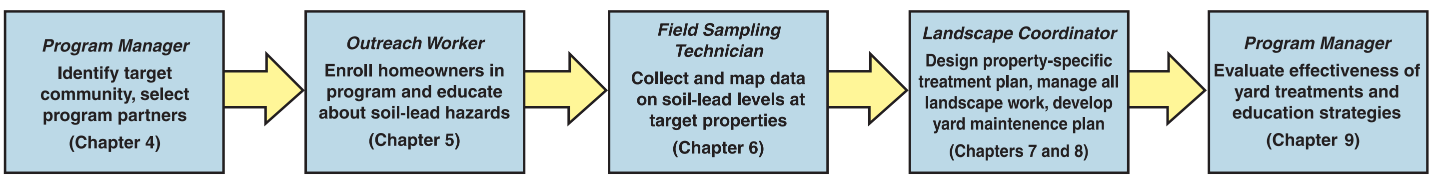
Outreach During the outreach phase, the EMPACT LSYP approaches homeowners in the target community to educate them about the hazards of lead in soil and to enroll them in the project. Outreach workers make contact with homeowners though flyers, letters, phone calls, and knocking on doors. Lead hazard education is conducted using a variety of tools (printed handouts, videos, quizzes), and then homeowners are asked to enroll in the project by signing a permission form. Finally, outreach workers interview participating homeowners about the activities that take place in their yards; these yard uses are mapped on a plot plan, which is then given to the EMPACT LSYP's soil sampling team and landscaping team.

Sampling During the soil sampling phase, a field sampling technician (usually a licensed, trained lead inspector) collects data on soil-lead levels in the yards of participating homeowners, using field-portable x-ray fluorescence technology. Relying on the yard-use map created during the outreach phase, the technician develops a sampling plan that focuses on high-risk and high-use yard areas, where the potential for dangerous exposures to lead-contaminated soil is highest. Sampling results are transcribed onto a color-coded map of the property's lead levels, which is then given to the homeowner and passed on to the landscaping team.

Treatment The EMPACT LSYP provides each participating homeowner with up to $3,000 worth of free landscaping materials and labor for yard treatment. Treatment is conducted by one or more landscaping teams, headed by a landscape coordinator. This coordinator meets with the homeowner to go over the color-coded map of sampling results and to develop a treatment plan. A typical treatment plan combines various landscaping measures (e.g., wood-framed drip boxes, newly planted grass and shrubs, stone walkways) with changes to the residents' yard use patterns (e.g., moving a children's play area to a safe part of the yard). Once the treatment plan has been implemented by the landscaping team, the coordinator develops a property-specific maintenance manual to help the homeowner maintain the treatment measures.

Evaluation The EMPACT LSYP is currently involved in a major research study to evaluate the effectiveness of its low-cost yard treatment measures. Evaluation is the last phase of the project; however, an effective evaluation process depends on adequate documentation of the project's work during all phases. Key to the EMPACT LSYP's evaluation process is a property-specific case file begun by the outreach worker for each home, and maintained by all members of the EMPACT LSYP team.

The flow chart below summarizes the basic structure of the EMPACT LSYP. The chart identifies the main activities of the project, the team members responsible for these activities, and the flow of work between team members. It also indicates where in this handbook you can go for more information about specific activities.



4.2 Selecting Program Partners

As described in Chapter 1, the EMPACT LSYP is a partnership of several public, private, and non-profit organizations. These include a university, a federal government laboratory, a community planning agency, and private landscape contractors.

Why are so many partners needed for what is essentially a small-scale program? The activities conducted by the EMPACT LSYP demand a number of specialized skills, from communication and language skills to soil sampling training, from landscape design experience to management skills. Each partner plays a different role in the project, based on the specific skills and qualifications that partner has to offer.

For example, EPA's New England Regional Laboratory, a founding partner in the EMPACT LSYP, offers the technical skills needed for analysis of soil-lead levels. The laboratory's staff also have the training to work safely in contaminated soil without endangering their own health. The Dudley Street Neighborhood Initiative, the project's community partner, does not offer these kinds of technical skills, but contributes something just as important: familiarity with the Dudley Street neighborhood and the communication skills necessary to work closely with its multilingual residents.

In starting your own lead-safe yard 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,

LESSONS LEARNED: YOUTH EMPLOYMENT AND TRAINING

In its pilot phase, the EMPACT LSYP wished to incorporate youth employment and training into its work. The project hired high school students, who learned on the job while being supervised by adults. This system turned out to be problematic in the pilot phase. It was logistically complex, and costs changed because the on-the-job training meant the work was accomplished more slowly than it would have with trained landscapers. For this reason, it is advisable to get your program organized and running smoothly, then determine which components of the program are a good match for youth training and employment. At that point, you can focus on this aspect of a program.

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 target community. For example:

- An organization or agency that already has strong ties to the community can be ideal for conducting outreach and education for your program. Neighborhood health centers or community action programs can be a good choice.
- A nearby college or university can help with any research components of your program, or may be able to provide assistance and equipment for the sampling activities. (See Appendix B for a more detailed discussion of this type of approach.) Make sure to check with your state or tribal lead poisoning prevention agency about certification requirements for lead inspectors. See Chapter 6 for more information on finding a qualified person to conduct the sampling and analysis components of your program.
- Landscaping companies are key partners for the design and landscaping components of your program. A non-profit landscaping company specializing in community gardening and small parks can be a good choice. Another approach (being implemented by the EMPACT LSYP in Phase 3) is to develop a pool of small private landscaping companies. Encouraging companies to bid on lead-safe yard work, as described in Section 7.5, is a good way to obtain these services in a cost-effective manner. Landscaping companies should be bonded and insured, and should have the skills to manage the work involved in treating yards to meet your specifications.

As described in Chapter 1, the EMPACT program selected partners who could carry out specific activities. The community partners (Bowdoin Street Health Center, and later the Dudley Street Neighborhood Initiative) led the education and outreach work; the EPA Regional Laboratory led the sampling and analysis activities, with assistance from a certified industrial hygienist from the Health Center; a non-profit landscaping company performed the soil mitigation work; and Boston University School of Public Health led the effort to develop a template for community action for use by other programs.

4.3 Identifying Potentially Impacted Communities

The first step in beginning your lead-safe yard program is to identify communities that may have homes with elevated soil-lead levels. For this purpose, you can determine where the important predictors of lead in soil are present. These predictors include large numbers of children with elevated blood lead levels; a preponderance of older wood-framed housing (generally with wooden clapboard), which is likely to have exterior lead-based paint; and heavy traffic flows, which are likely to have caused deposition of lead from leaded gasoline. These characteristics are discussed in Sections 4.3.1 through 4.3.3. Industrial emissions of lead can also cause elevated soil-lead levels at residences nearby (see Section 4.3.4).

You will also want to consider other characteristics of neighborhood life that can contribute to the success of a program, such as the presence of a community organization that can partner with you and help you get to know the community (see Section 4.3.5).

4.3.1 Children With Elevated Blood Lead Levels

For Phases 1 and 2, the EMPACT LSYP reviewed available blood lead data for children aged six months to six years from the Massachusetts Childhood Lead Paint Poisoning Prevention Program. The target community was within the so-called "lead belt" in Boston (see map on page 3). Your city or state childhood lead program or health department likely has similar blood lead data, organized by census tract or zip code. You can look up state and local lead poisoning prevention contacts in your area on the following Web sites:

> The Lead Program of the National Safety Council's Environmental Health Center:
> http://www.nsc.org/ehc/nlic/contacts.htm
>
> The National Conference of State Legislatures' Directory of State Lead Poisoning Prevention Contacts: http://www.ncsl.org/programs/esnr/pbdir.htm

4.3.2 Older Housing With Lead-Based Paint

Another way to identify potential target communities is to determine which neighborhoods have older, wood-framed housing (generally with wooden clapboard). Such houses are likely to have lead-based exterior paint. As described in Chapter 3, some studies have found a strong link between building age and soil-lead contamination. Therefore, neighborhoods with older housing (especially homes built before 1950) are more likely than newer communities to have a soil-lead problem. The presence of lead-based paint is also considered an important predictor of elevated soil-lead levels. Both EMPACT study areas, the Bowdoin Street neighborhood in North Dorchester and the Dudley Street neighborhood in Roxbury and Dorchester, consist of predominantly older, wood-framed homes with painted exteriors (generally wooden clapboard).

The Centers for Disease Control provides a database, *1990 Census Data on Housing and Population* that allows you to search by county, zip code, or census tract for the percentage of houses built before 1950. The database is at http://www.cdc.gov/nceh/lead/lead.htm.

EMPACT LSYP SITE SELECTION CRITERIA

High incidence of lead poisoning

Pre-1970 painted housing (generally wooden clapboard)

Low-income/immigrant population

Contiguous neighborhood (for neighborhood-wide impact)

An existing health organization focused on the lead issue

Existing neighborhood environmental activities the project could build on and enhance

Keep in mind that some communities may contain vacant lots, greens, and parks in residential areas that may have historical lead contamination from gasoline deposition, past industrial activity, or former housing. See Chapter 10 for tips on applying lead-safe yard mitigation strategies to non-residential sites, such as tot lots, playgrounds, community gardens, and vacant lots.

4.3.3 Heavy Traffic Flows

Some studies stress the concentration of lead-contaminated yards in congested high-traffic, inner-city regions (see Chapter 3), pointing to the importance of lead accumulations from leaded gasoline. Both EMPACT study areas are in heavily traveled inner-city neighborhoods.

4.3.4 Industrial Emissions

Communities near industries that emit lead (or have emitted lead in the past), such as lead smelters, lead mines, battery recycling plants, and incinerators, may also have elevated levels of lead in residential soils. You can find out where such industries are locating by contacting your state environmental agency or EPA Regional office, or by searching EPA's Toxic Release Inventory (TRI) database for facilities in your area that have reported releases of lead to the environment. (http:\\www.epa.gov\enviro\html\toxic_releases.html).

4.3.5 Other Community Characteristics

The EMPACT LSYP took into account several additional factors in potential target communities that would contribute to the project's success. For example, the project targeted homes that were located on adjacent streets rather than in dispersed areas. This made the work more efficient and made it possible that homeowners would become interested in the lead-safe yard activities going on nearby. It also meant that the neighborhood children would be better protected, because children often play in yards near their own.

The project also favored working in service areas of active community-based organizations—first the Bowdoin Street Health Center and later the Dudley Street Neighborhood Initiative (http://www.dsni.org). Both of the selected neighborhoods had a history of environmental health activities. The EMPACT LSYP could, therefore, build upon previous initiatives and take advantage of neighborhood connections already made by these community organizations.

4.4 Getting To Know the Community

Once you have identified your target community, your task is to learn more about it. Make sure you have your target area clearly mapped and marked so that you can begin planning. Next, find out the key "statistics" about the community. Some of the questions you will want to answer about the community include:

- What are the cultures and languages of the people who live there?
- What are the residents' income and education levels?
- What is the percentage of home ownership/owner-occupied dwellings?
- What is the percentage of housing built before 1978?
- What is the condition of the older housing stock?
- What organizations and agencies are active in the community?
- What prior work has gone on in the community to prevent lead poisoning?

- What are the numbers, percentages, and location of lead-poisoned children in the community?
- Have any homes in the area been de-leaded?
- What are the names, addresses, and phone numbers of homeowners in the target area?

Information such as income and education levels and age of housing can be obtained from census data; other questions about the community such as cultural characteristics can be provided by your community partners. All this information will help you form a clear picture of your target community and the best ways to reach them. The EMPACT LSYP, for example, knew that many residents in the Bowdoin Street neighborhood spoke Spanish, Cape Verdean Creole, or Haitian Creole, so that conducting spoken and written outreach and education in these languages would be critical to the success of the program. Sample outreach flyers in four languages are included on pages 41 to 44 in Chapter 5.

5 Communicating About Lead in Soil and Your Lead-Safe Yard Program

This chapter describes how to provide education and outreach to homeowners and residents about the problem of lead in soil and the benefits of participating in a lead-safe yard program. Section 5.1 presents strategies for approaching homeowners and residents to inform them about your program and to develop a sense of trust and credibility within your target community. Section 5.2 discusses methods for educating people about soil-lead hazards and the benefits of your program. Section 5.3 is devoted to establishing an application process for enlisting homeowners in your program and obtaining their consent for the work that will be done on their property.

The information in this chapter is designed primarily for managers who are implementing lead-safe yard programs, as well as for outreach workers who are responsible for communicating about lead in soil and your lead-safe yard program.

5.1 Approaching Homeowners and Residents

Once you have learned the basics about your target community, you can begin your education and outreach efforts.

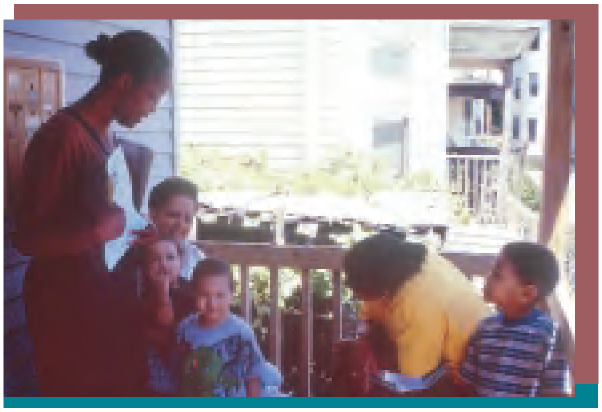
First, determine who will be conducting outreach and education for your program. If possible, the outreach worker should be a person who lives in the community and is respected and credible. People who do not live in the community can sometimes be very effective, however (such as a lead nurse from a community health center, or someone otherwise familiar with the community and the issues people there are facing).

Walk around your target community on a pleasant day and talk to people face to face.

A good next step is to develop an area-appropriate flyer, such as the EMPACT LSYP's flyer on pages 41 to 44 ("Dorchester Lead-Safe Yard Program"). You can ask area businesses to post the flyer or allow you to do so. You can also distribute flyers to all the homes in your target neighborhood(s), then follow up by calling all the homeowners to inform them of the project and their eligibility. Sending informational letters to the targeted neighborhood homeowners might be an effective alternative. Examples of initial and follow-up letters used by the Lead Safe Boston program (a spinoff of the EMPACT LSYP) are included on pages 45 and 58 to 59. Other ways of increasing awareness of your program within the community include radio promotions and forums at other local promotional events.

The next step is to focus on meeting people face to face. This is important because people need to get to know and trust you before they open their home to your project. Below are some tips for effective ways to approach people in person:

- Walk around the area on a pleasant day or holiday, when people are most likely to be out of doors. Weekend door knocking is recommended.
- Vary the times of day at which you do outreach, but always be respectful of "normal waking hours" for people, unless you have been otherwise invited. Try not to go at family rush hours (around 8 to 10 a.m. or 4 to 6:30 p.m.); going at these times may turn people off to the project.



Residents will need to get to know you before they open their home to your project.

- If the area has a high percentage of non-English speakers and you don't speak the languages spoken in the area, try to get a friend or co-worker who speaks the most prevalent language to walk with you.
- Be sure to take project flyers with your name and number on them, permission slips, and information/referrals about lead testing, treatment, and de-leading programs.
- Attend events and meetings in the neighborhood to give out flyers and get to know people. The EMPACT LSYP outreach worker found that outdoor events such as community picnics are good venues for outreach work. Community garden and food projects may also yield receptive audiences.
- Remember that news about a project like this spreads by word of mouth and visible results. Any negative perceptions will travel twice as fast as positive ones, so try to make only positive impressions!

The EMPACT LSYP engaged in a wide variety of additional activities to promote the project as well as to enhance community lead awareness. These included:

- Participation in a "Lead Expo" at a community center, in the citywide Lead Awareness Week, and in the neighborhood Multicultural Festival.
- Footage about the project on the local cable station (Neighborhood Network News).
- Discussion of the project in a segment entitled "Removing Lead from a Low-Income Community" on National Public Radio's *Living on Earth,* an award-winning environmental news magazine.
- Presentations at workshops and conferences, including the Second Syracuse Lead Conference (October 1999) in Syracuse, New York, and the Toxics Action '99 conference at Boston College in Newton, Massachusetts.

5.2 Educating People About Lead and Lead in Soil

Once you have identified people interested in the program and willing to speak with you at greater length, you will have the opportunity to provide education about the problem of lead exposure, explain the benefits of your program, and answer questions. The EMPACT LSYP's Education and Outreach Plan is presented in the box on page 39.

In conducting education, you should convey the basic dangers of lead first—how and why lead is dangerous to families' health, as well as what people can do to protect themselves (de-leading, proper nutrition, cleaning, etc.) Remember that you need to educate people not only about lead in soil, but about all the sources of lead in and around the home. It is important to follow up on the advice you give about these issues, so that people don't get frustrated and give up on slow-moving assistance programs.

Many city or state childhood lead programs have developed excellent written materials on lead poisoning prevention that you can use with residents. Examples of some used by the EMPACT program, from the Boston Childhood Lead Poisoning Prevention Program, are included on pages 46 to 55. Using the Internet, you can also access educational materials developed by EPA and other federal agencies. These materials include:

Protect Your Family From Lead in Your Home
(EPA 747-K-99-001, http://www.epa.gov/opptintr/lead/leadpdfe.pdf) is a 16-page educational pamphlet that provides general information about lead and lead hazards. A Spanish-language version can be found on HUD's Web site at http://www.hud.gov/lea/leadpdfs.pdf.

Lead in Your Home: A Parent's Reference Guide
(EPA 747-B-98-002, http://www.epa.gov/lead/leadrev.pdf) is a more comprehensive guidebook, 67 pages long, that recommends steps parents can take to reduce their family's risk of lead exposure and prevent lead poisoning.

What Every Parent Should Know About Lead Poisoning in Children
(http://www.cdc.gov/nceh/lead/faq/cdc97a.htm) is a one-page fact sheet from the Centers for Disease Control and Prevention that provides basic information about lead poisoning and lead-paint hazards.

Keep in mind that written materials are not always enough to get the message across. The EMPACT LSYP has found that outreach workers need to develop creative ways of emphasizing and reinforcing the lead hazard message (e.g., by using tools such as films and quizzes), and to create repeated opportunities for homeowner re-education. For tips on creative education strategies, see "Lessons Learned: Education and Outreach" on page 38, and Sections 8.4 and 8.5.

For your lead-safe yard program, you will want to give special emphasis to why addressing lead in soil can help protect health. You will need to explain how lead gets into soil, how children playing in yards with contaminated soil are exposed to lead, and how dirt and dust containing lead can also be tracked into the home. Once the levels of lead in a yard's soil are tested, you can go over the recommended actions (based on these levels) for the yard (see Section 7.4). Finally, the residents need to understand that landscaping measures do not remove the contaminated soil; the landscaping needs to be properly maintained to control exposure to the lead hazard, and future home improvements need to be done safely to prevent recontamination.

5.3 Next Steps: Enlisting the Homeowner in the Program

If a homeowner has shown interest in your program based on your initial outreach and education, you can encourage him or her to take the next steps. The EMPACT LSYP found that at this point in the process it was important to reassure homeowners that they would not be penalized if they did not participate, and that there was no catch to the free landscaping provided.

The process of enlisting the homeowner into your program can be as formal or informal as you want to make it. One option is to establish a formal application process that the homeowner will complete before participating in the program. Lead Safe Boston, a spinoff of the EMPACT LSYP run by the City of Boston (see Section 1.2.1), requires homeowners to fill out an application form and submit copies of their insurance policy, their water and sewer payment plan, and a recent real estate tax bill. Lead Safe Boston's application form is included on pages 56 to 57.

Once accepted into the program, the homeowner should sign a "permission slip" or consent form that establishes an agreement between the program and the homeowner to allow testing of the

LESSONS LEARNED: EDUCATION AND OUTREACH

A key to the success of a lead-safe yard program like EMPACT's is that residents understand why lead in soil is harmful to their children. Without this understanding, it is more likely that the landscaping measures will not be maintained, greatly reducing their effectiveness in protecting children from lead exposure.

In its first two phases, the EMPACT LSYP followed a model commonly used for community education and outreach: a bilingual outreach worker from the community health center conducted typical outreach activities, including walking in the neighborhood, door knocking, distributing flyers, speaking at community meetings, and talking with people one on one. These efforts were culturally specific to the neighborhood and conducted at an appropriate literacy level.

After Phase 2 was completed, the project returned to the residences where yard work had been done to evaluate how the work had held up and what had been learned. They found that people had not really taken in the problem of lead in soil, but viewed the project as more of a landscaping program.

To remedy this shortcoming, in Phase 3 the project implemented a more comprehensive education program, using several new approaches. The community outreach worker received more extensive training on the lead issue. She helped devise a new plan to show community residents a video, "The Thief of Childhood," as a teaching tool about the hazards of lead. After watching the video, residents were given a short quiz (see box on page 40). The quiz motivated the resident to pay attention to the video, whose key messages were reinforced by the questions. The outreach worker graded the quizzes and discussed the answers with the residents. Thus, the education work used three different modes of learning: visual (the video), written (the quiz), and oral (discussion of the video, quiz, and educational flyers). The quiz will be used again when the yard mitigation work is completed, to see whether the residents have retained the information.

So far, the project has judged this new approach to be more effective than using literature alone. The video and quiz seem to be an engaging, interactive "hook" to promote a better understanding of the lead problem and the health benefits of a lead-safe yard.

Another video that could be used for the same purpose is EPA's "Little Moccasins" Lead Safety Program video, created for day care centers, clinics, and families. This 22-minute animated video was developed by the Houlton Band of Maliseet Indians with funding from EPA's Lead Program. An interactive "First Steps" CD-ROM is also available, presenting helpful information on lead poisoning prevention in the form of video clips, games, and songs. Ordering information for the CD-ROM and both videos is found in Section 5.4. Ask your community or state lead officials to recommend other videos appropriate for your audience.

property, participation in a design session, and subsequent remediation through landscaping. The permission form should include language regarding the homeowner's duty to have their property in testable and workable condition (removal of trash, debris, and old cars; notification about/relocation of pets). Again, the permission form can be formal or informal, depending on the needs of your program. A very simple form, used by the EMPACT LSYP during Phases 1 and 2, is shown on page 60. A more detailed consent form, developed by Lead Safe Boston, is shown on pages 61 to 62.

At this point you should establish a case file that contains all the information related to application, testing, mitigation, and follow-up for the property. The EMPACT outreach worker keeps all this information, including "before and after" photographs, in a binder, which is given to the homeowner when the work is completed.

Next, the outreach worker conducts a homeowner interview. The interview is designed to obtain information about the activities that take place in the yard and the ages and numbers of people who use the yard. The questionnaire that the EMPACT outreach worker uses is shown on pages 63 and 64 (filled out for a hypo thetical home).

To map out yard use patterns, the outreach worker uses a house plot plan, as shown on page 65. Plot plans can be developed in one of several ways. For example, the outreach worker can visit the municipal assessor's office to photocopy official drawings showing the footprint of the house and all property lines. A plot plan can also be developed using a geographic information system (GIS), or the outreach worker can simply draw one by hand, using a measuring tape and pen and paper. The plot plan developed during this outreach phase will be used later as a guide for the field testing crew and for the landscape coordinator, as described in Chapters 6 and 7.

The next step in the process is testing of the yard soil, followed by a design session with the homeowner if the yard is found to have high levels of lead. These steps are described in detail in Chapters 6 and 7 of this handbook.

5.4 For More Information

Your local or state childhood lead poisoning prevention program may have good educational materials on lead issues.

Lead education materials developed by EPA's Office of Pollution Prevention and Toxics can be accessed at http://www.epa.gov/lead/leadpbed.htm.

The following Web sites list state and local lead poisoning prevention contacts:

> The Lead Program of the National Safety Council's Environmental Health Center:
> http://www.nsc.org/ehc/nlic/contacts.htm

LEAD-SAFE YARD EDUCATION AND OUTREACH PLAN

1. **Make appointment with interested applicants to discuss the problem of lead poisoning and the lead-safe yard and home program.**
2. **Home visit: First, ask them if they have had experience with lead poisoning. Have they had a child, relative, or neighbor who was lead poisoned? Using theeducational pamphlet, discuss five key points about lead poisoning:**

   —How does a child usually get lead poisoned? (Paint chips, dust and dirt on hands and toys, lead in water)

   —How do you avoid lead in drinking water? (Run tap water until it is cold)

   —How do you avoid lead in the home? (Specific lead-safe home cleaning and maintenance procedures)

   —Why is dust on children's hands and toys, as well as on window sills and floors, a problem, especially if the house is not de-leaded? (Children may put hands, fingernails, toys, or food dropped on floor in their mouths)

   —What foods are good for preventing lead poisoning? (Foods high in iron, calcium, and vitamin C, and low-fat foods)

   This is a good time to show the photos of the LSYP.
3. **Give the homeowner the video which is available in multiple languages, explores the dangers of lead paint poisoning, its adverse health effects, and practical measures for protecting children (see Section 5.4 for ordering information). Also give the homeowner the set of questions to answer after viewing the video. (The answer sheet can be returned immediately after watching the video, or later, with the lead-safe yard and home application.)**
4. **Explain the application process and documentation needed for the lead-safe yard program.**
5. **Leave the application, video, and sheet of questions (if the homeowner hasn't returned it already) with your business card.**

The National Conference of State Legislatures' Directory of State Lead Poisoning Prevention Contacts: http://www.ncsl.org/programs/esnr/pbdir.htm

For guidance on writing clearly and effectively for a general audience, try http://www.plainlanguage.gov.

Video: "Lead Paint Poisoning: The Thief of Childhood" (20 minutes, 1996)

This video explores the dangers of lead-paint poisoning and its adverse health effects. It provides information, education, and practical advice on protecting children, using interviews and discussions with educators, health care providers, and culturally and linguistically diverse parents whose children have been lead poisoned. The video is available in English, Spanish, Cape Verdean Creole, Haitian Creole, and Vietnamese. Available for $10 from: City of Boston, Office of Environmental Health, 1010 Massachusetts Avenue, Boston, MA 02118. Phone 617-534-5966, Fax 617-534-2372.

Video: "Little Moccasins" Lead Safety Program Video (22 minutes)

This lead poisoning prevention video was developed for day care providers, clinics, and families by the Houlton Band of Maliseet Indians, with funding from EPA's Lead Program. The video is available in English, but may soon be available in Spanish and some Native American languages. Available free of charge from Philip Quint, Lead Director, Houlton Band of Maliseet Indians, at 1-800-545-8524 or 1-207-532-4273. **E-mail quint@ainop.com**.

CD-ROM: "First Steps"

This CD-ROM, developed by the Houlton Band of Maliseet Indians with funding from EPA's Lead Program, presents helpful interactive information on lead poisoning prevention in the form of video clips, games, and songs. Course manuals are available on the CD in English, Spanish, and Native American motif. Available free of charge from Philip Quint, Lead Director, Houlton Band of Maliseet Indians, at 1-800-545-8524 or 1-207-532-4273. **E-mail quint@ainop.com**.

QUIZ TO ACCOMPANY FILM, "THE THIEF OF CHILDHOOD"

1. By what year was lead no longer used in new house paint?

2. How can a child get lead poisoned?

a) paint chips **b) dust**

c) drinking water **d) all of these**

3. Name some foods that are good for children and that help decrease blood lead poisoning.

4. How can you avoid lead in drinking and cooking water?

5. How can you avoid lead hazards from home interiors?

6. Name two ways in which lead has gotten into yard soil.

7. Give three suggestions for protecting children in the home and yard from becoming lead poisoned.

DORCHESTER LEAD-SAFE YARD PROGRAM

FREE SOIL TESTING IN YOUR YARD FOR LEAD

WE ARE LOOKING FOR 50 YARDS IN YOUR NEIGHBORHOOD
WITH HIGH LEVELS OF LEAD
IF YOUR YARD MEETS A CERTAIN LEVEL, YOU COULD BE
ELIGIBLE FOR $700 WORTH OF FREE MATERIALS AND LABOR
WHICH WILL MAKE YOUR YARD SAFER AND ATTRACTIVE
WITHOUT ANY COST TO YOU!

The Dorchester Lead-Safe Yard Program is a collaboration of the Bowdoin Street Health Center, the New England Environmental Protection Agency Laboratory, Boston University School of Public Health and Garden Futures. The purpose of this pilot program is to show that low cost methods exist which will make your yard safer. By improving the safety of your yard, we hope this will further reduce the risk of our children six years of age and younger becoming lead poisoned.

Your neighborhood has been chosen for this pilot project because there are a number of children with high levels of lead in their blood. Lead is especially hazardous to children. This is the main reason we want to conduct this pilot program. Because children play in many parts of this neighborhood, you do not have to have children six years of age or younger to participate.

We will first test your yard for lead content and if your yard qualifies, we will work with you on certain methods of reducing exposure to elevated lead levels. Staff from Garden Futures will provide landscape materials and labor to complete the work in your yard.

If you are interested in participating in this program, please call the number listed at the bottom of this page. We will be in the neighborhood speaking with you and your neighbors about this program. If you have questions, please do not hesitate to call.

FOR MORE INFORMATION OR TO PARTICIPATE IN THIS PROJECT, CALL

Bowdoin Street Health Center, (617) 822-5318

PROGRAMA DE PATIOS SIN PLOMO DE DORCHESTER

(Dorchester Lead-Safe Yard Program)

PRUEBAS DE PLOMO GRATUITAS EN SU PATIO

ESTAMOS BUSCANDOS 50 PATIOS EN EL VECINDARIO CON ALTOS NEVELES DE PLOMO EN LA TIERRA.

SI SU PATIO CONTIENE PLOMO, USTED PUEDE SER ELEGIBLE PARA RECIBIR 700 DOLARES, ENTRE MATERIALES Y TRABAJO, PARA REMOVER EL PLOMO DE LA TIERRA Y EMBELLECER SU PATIO SIN COSTO ADICIONAL PARA USTED.

El Programe de Patios sin Plomo de Dorchester es una colaboración del Centro de Salud de Bowdoin Street, el Laboratorio de la Agencia de Protección Ambiental de Nueva Inglaterra, la Escuela de Salud Pública de Boston University y Garden Futures. El objectivo de este programa piloto es il mostrar que existen métodos a bajo costo que harán sus patios más seguros. Mejorando los patios esperamos reducir el riesgo que corren los niños de seis años y menores de acabar envenenados com plomo.

Su vecindario ha sido escogido para este programma piloto debido al alto número de niños envenenados o con altos niveles de plomo en la sangrue. El plomo es realmente perjudicial para los niños, y eelo es la razón por la que queremos realizar este programa. Debido a que los niños juegan en diferentes partes del vecindario, usted no tiene que tener niños de seis años o menores para participar.

Primero mediremos la tierra de su patio para ver si esta contiene plomo, y si es elegible trbajaremos con uste par mostrarle ciertos métodos para reducir el nivel de plomo en la tierra. Personal de Garden Futures trabajaran proveyendole materiales jardineria y trbajarán para completar el trabajo en su patio.

Si usted está interesado en participar en este programa, por favor llame a la persona listada más abajo en esta página. Estaremos en el vecindario hablando con usted y sus vecinos sobre este programa. Si tiene alguna pregunta, por favor llamenos.

Para Más información o Para Participar en este Programa, Llame
Bowdoin Street Health Center, (617) 822-5318

Dorchester Lead-Safe Yard Program

Um teste gratuito para detectar veneno de chumbo no seu pátio/quintal. Procuramos 5 pátios, na vizinhança, com nível de veneno de chumbo elevado. Se o seu pátio/quintal mostrar um nível elevado de veneno de chumbo no solo você se qualificar a receber uma quantia de $700 no valor de materiais e mão-de-obra, o que lhe irá ajudar a tornar o seu quintal mais atractivo e seguro. Este programa lhe será oferecido sem nenhum custo monetário.

Este programa e uma colaboraçao de Bowdoin Street Health Center, New England Environmental Protection Agency Laboratory, Boston University School of Public Health e Garden Futures. O propósito do programa e para mostrar que existen meios, a preços accessíveis, para remover o veneno de chumbo do solo, e tornar o seu pátio/quintal mais seguro. Ao reduzir o nivel de chumbo no solo, esperemos que ira diminuir a possibilidade dos seus filhos, menores de seis anos di idade, contrairem veneno de chumbo no sangue.

A sua vizinhança foi escolhida para este programa porque existe un numero elevado de criancas contaminadas de chumbo no sangue, o que é bastante projudicial, e pode causar graves problemas de saúde. Porque as crianças brincam em varios lugares, não e necessario que você tenha filhos/as para poder participar neste programa.

Faremos un teste para detectar resdios de chumbo. Se o seu pátio qualificar, entraremos em contacto consigo para discutirmos meios de como reduzir o nível do chumbo. O pessoal de Garden Futures providenciará materiais e mão-de-obra. Se você está interesada/o em participar neste programa, por favor contacte:

Bowdoin Street Health Center, (617) 822-5318

Pwogram Ki Okipe Lakou Kont Plon

Tes Gratis Nan Lakou Pou Plon

Nap Chache Sinkant Pie Nan Lakou Ki Nan Zòn Nan

Ki Genyen Yon Nivo Plon Ki Wo.

Si lakou a genyen Yon nivo plon, ou kapab elijib pou yon zafe de set san dola an mateiyo & men dèv sak ka fè lakou bel, san danje e gratis.

Pwogram sila ki pou kimbe lakou san danje. Marè avek Bowdoin St. Sant pou Sante, N.E. EPA, B.U.S. of P.H. & Garden Futures. Rezon pwogram sa se pou montre ou metod bon mache ki egziste pou fè lakou san danje ak plon. Pake timoun yo ap jwe tout kote. Ou pa bezyen gen timoun sizan ou byen timoun pi piti pou patisipe.

Nap Teste lakou pou plon, si lakou a kalifye nap travay ak ou pou redwi nivo plon an. Nap ba ou materyo ak zouti pou travay sila.

Si ou enterese patisipe nan pwogram nan souple rele moun sa ke ou we nan an ba fey la. Nap pale ak ou e ak vwazen ou o sijè pwogram nan.

Si yon gen keksyon pa ezite rele:

Bowdoin Street Health Center, (617) 822-5318

Department of Neighborhood Development

Boston's Public Facilities Department

Thomas M. Menino, Mayor
Charlotte Golar Richie, Chief and Director

January 5, 2000

Dear Property Owner:

The City of Boston's Lead Safe Boston program, in conjunction with the National Center for Lead Safe Housing and the Environmental Protection Agency, would like to offer you the chance to improve the quality of the grounds surrounding your home through a unique program:

Low Level Soil Treatment Demonstration Project

There is no cost involved or work required on the part of the property owner!

Properties meeting project criteria and enrolled in the program will be part of an effort to demonstrate low-cost soil interventions through the use of landscape treatments that will enhance the appearance of your home!

What the Program Can Offer You!

Up to **$3000** to cover the design, acquisition and installation of landscape elements.
Comprehensive testing/sampling of soil surrounding your home.
Scaled drawings of your property identifying lead hazard areas.
Fully developed plans showing proposed treatments and plantings.
Supervised construction and installation of all landscape treatments.
Detailed educational information.

What We Ask Property Owners To Do!

Answer a questionnaire concerning Lead Paint Hazards.
Allow project staff to sample the soil surrounding your home.
Participate in and provide feedback during the landscape design process.
Enjoy your newly landscaped yard!!!

A representative of Lead Safe Boston and The National Center for Lead Safe Housing will soon be contacting you about your possible involvement in this program.

We hope you decide to join us in this important endeavor!

Please call the Lead Safe Boston office at (617) 635-0190 with any questions regarding the program.

Fact Sheet: LEAD

What is Lead?

Lead is a poisonous metal found in nature. Because it is durable and persistent, it was used in house paint, pipes, cans, old toys, cribs, and furniture.

If a house was built before 1978, it probably has lead paint. Lead dust can be created by just opening and closing windows.

What does lead poisoning do to my child?

Lead poisoning can damage your child's brain, cause hearing loss and learning disabilities, and impair motor skills.

How can my child be exposed?

Your child can be exposed to lead by touching window sills, ledges, and other areas which have lead dust, and then putting their fingers in their mouths. This is normal behavior for children.

Finding the Lead

The only way to find out where the lead is in the house is to have a lead inspection done by a licensed inspector. If the inspector finds lead, then a licensed contractor must come in and make the house safe. You cannot live in the house while this is happening.

Lead Dust is Invisible

The most common way for children to be poisoned is by exposure to lead dust.

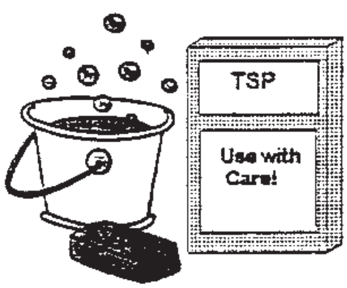
What Can I Do?

Make sure your child has a well-balanced diet, which includes milk (for calcium), dark green, leafy vegetables (for iron), and vitamin C. Have your child's blood tested regularly.

Wash Hands and Toys Often!

Wash your child's hands and toys often, and keep fingernails short.

Run the tap water for a few minutes every morning. Use only COLD water for cooking and drinking. Hot water concentrates the lead.



Keep It Clean!

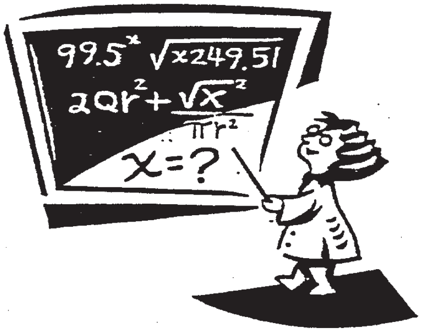
Wipe windows, windowsills and dusty surfaces with warm water and TSP. Throw used paper towels away after wiping.

Don't Disturb Leaded Paint!

Make sure that there is no loose or flaking paint. NEVER scrape painted surfaces.

For more information, contact the Boston Childhood Lead Poisoning Prevention Program at the Boston Public Health Commission
1010 Massachusetts Avenue, 2nd Floor, Boston, MA 02118
(617) 534-5966

How Much Do You Know About Lead Poisoning?



MYTH
There is no way to prevent children from being lead poisoned.

FACT
Lead poisoning is completely preventable Get the facts and learn how to protect your child by getting lead out of your home safely.

MYTH
Children have to eat paint chips, or chew on walls, to be lead poisoned.

FACT
Children can be poisoned simply by breathing lead dust. They can also be poisoned by having lead dust on their toys or fingers and then putting their fingers in their mouths.

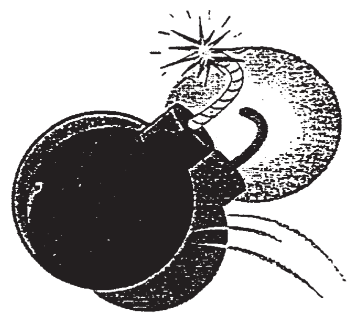
MYTH
Only children with very high levels of lead in their blood will be hurt by the lead.

FACT
Low levels of lead in a child's blood can cause long term problems and permanently affect learning and behavior.

MYTH
Only children who live in the inner city can be lead poisoned.

FACT
Any child, from any neighborhood, can be lead poisoned. Lead paint can be in any home built before 1978.

MYTH
Lead poisoning is not a real problem. Many people grew up in homes with lead paint and are perfectly healthy.



FACT
The lead paint that existed in homes twenty years ago is much more dangerous now. As lead paint gets older, it is likely to peel, chip, and create lead dust. This is a real health hazard.

MYTH
Having a home deleaded is much more dangerous than just leaving the lead paint there.

FACT
Lead removal must be done by a licensed deleader who will use safe techniques and who will clean up properly.

For more information, contact the Boston Childhood Lead Poisoning Prevention Program at the Boston Public Health Commission
1010 Massachusetts Avenue, 2nd Floor, Boston, MA 02118
(617) 534-5966

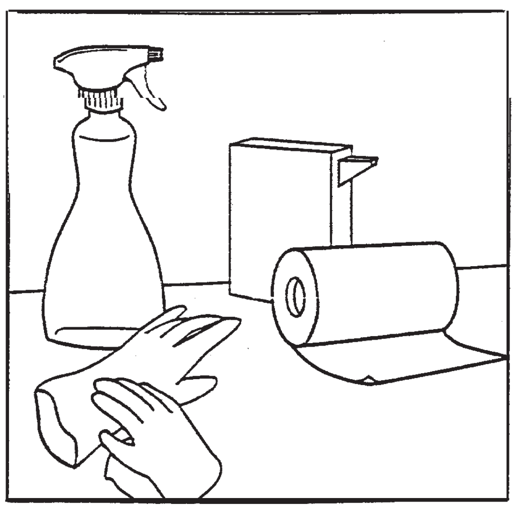
TEMPORARILY REDUCING LEAD PAINT HAZARDS BY CLEANING

1 **Wear plastic gloves to clean**
Protect yourself from exposure to lead.

2 **Pick up all chips by hand or use a damp paper towel (Window areas often have lots of paint chips)**
- Seal chips and paper towels in a plastic bag and throw out. ***Do not use a household vacuum or broom to clean up lead paint chips or dust!***

3 **Wash household surfaces**
- Use TSP, a lead-specific detergent, or any all-purpose, non-abrasive cleaner.
- Scrub well for best results. (Don't scrub hard enough to remove the intact paint.)
- Clean window wells, window sills, play areas, and floors at least once or twice a week.
- Keeps children away when cleaning.
- Keep all cleaners safely away from children.

4 **Use a spray bottle to keep dust levels down**
- Use a cleaner already in a spray bottle, or put the cleaner into a spray bottle.
- If you must use a bucket, keep the wash water clean. Never put dirty paper towels into the wash water.



5 **Use paper towels**
- Don't use dish cloths or sponges to clean.
- Use a new paper towel to clean each area.
- Seal the used paper towels and gloves in a plastic bag and throw them out.

6 **Rinse after cleaning**
Use clean water and paper towels for rinsing each area.

7 **Clean up properly**
- Wash your hands when cleaning is done.
- Pour any wash and rinse water down the toilet, not the sink.

Important! Do not use a household vacuum or broom to clean up lead paint chips or dust. This could spread the lead dust into the air and into your vacuum cleaner or broom.

Massachusetts Department of Public Health • Childhood Lead Poisoning Prevention Program

TEMPORARY WAYS TO KEEP CHILDREN SAFE FROM LEAD PAINT HAZARDS

Under the Lead Law, the property owner is responsible for having his or her home deleaded or brought under interim control if it was built before 1978 and a child under the age of six lives there. Deleading permanently reduces the risk of lead poisoning. Until deleading occurs, here are some temporary ways to reduce lead hazards:

1 Clean often

Wet wiping regularly reduces lead dust levels in the home. See other side.

2 Put duct tape or contact paper over peeling paint and plaster

Put duct tape or contact paper on window wells, window sills, walls or other surfaces with peeling paint or plaster. Clean these areas often. Window wells and sills can be cleaned more easily when contact paper or duct tape are put down first. See other side.

3 Keep the lower part of the window closed (if possible)

If a window well is in bad condition, keep the lower part of the window closed and open only the upper part. This will prevent your children from putting their hands or objects in the window well where the lead dust collects. It also helps keep lead dust from blowing into the house.

4 Move furniture to block contact with peeling paint and plaster

By moving a sofa in front of a crack in a wall, you can block a child's access to lead hazards. Never place furniture where a child may climb on it and fall out of a window.

5 Change child's bedroom (if possible)

If your child's bedroom has chipping paint or plaster, consider using another room without chipping paint for the bedroom.

6 Other ideas

Regularly have your child tested for lead poisoning; wash your child's hands and toys often; if you are renovating or repainting call CLPPP for more information on how to do the work safely before you begin; feed your child food high in iron, calcium, and vitamin C and low in fat.

Lead Poisoning and your child health

Lead pain is the most common cause of childhood lead poisoning. When old paint cracks or peels, or when lead paint surfaces rub against each other or are bumped, lead paint dust or chips are created. Children typically become poisoned by putting their fingers which have touched lead dust into their mouths. Lead poisoning can cause lasting damage to children's brains, kidneys and nervous system. Even lower levels of lead can slow children's development and cause learning and behavioral problems. Children under six are at greatest risk.

Keep your child safe

Remember, these are only temporary ways to reduce the risk of lead poisoning from lead paint hazards. The only permanent way to reduce the risk of lead poisoning is to have the home deleaded. The owner of a home built before 1978 is responsible for having it deleaded or brought under interim control when a child under the age of six lives there.

FOR MORE INFORMATION, CONTACT:

Massachusetts Department of Public Health
Childhood Lead Poisoning Prevention Program
617-753-8400 or 800-532-9571 (toll free)
www.magnet.state.ma.us/dph

or your local lead program at

BOSTON

BOSTON CHILDHOOD LEAD POISONING PREVENTION PROGRAM

UNDERSTANDING WHAT BLOOD LEAD (PB) TEST RESULTS MEAN:

IF THE CHILD HAS A PB LEVEL OF:	THEN:
9 ug/dL or below	A child with a blood lead level below 9 is not considered to be poisoned.
10 - 14 ug/dL	The CDC defines a level over ten as a "level of concern." The child should be tested again frequently. Check with your pediatrician. He or she may prescribe multi-vitamins and iron.
15 - 19 ug/dL	The child's pediatrician should be involved in helping bring this blood lead level down by managing the child's diet and increasing nutrition. In addition, the child should be tested frequently. An environmental assessment should be done to find out where the lead is coming from. Prevention measures should be implemented immediately.
20 - 24 ug/dL	Get a complete medical evaluation, and have the child's home inspected for lead. Find and get rid of lead hazards in the child's home, school, and play areas.
25 ug/dL and above	**A child with a blood lead level above 25 is considered poisoned.** A lead inspection in the home is required, and it is essential that the child visit the doctor immediately. This is very serious. Medical treatment such as chelation may be used.
70 ug/dL and above	A child with this level is considered a medical emergency.

For help understanding your child's test result, talk with your pediatrician or health care provider. For information and assistance regarding inspections and removing lead hazards from your home, in Boston contact: **The Boston Childhood Lead Poisoning Prevention Program at (617) 534-5966.**

Outside of Boston, call **The Massachusetts Department of Public Health's Childhood Lead Poisoning Prevention Program at (800) 532-9571.**

For more information, contact the Boston Childhood Lead Poisoning Prevention Program at the Boston Public Health Commission
1010 Massachusetts Avenue, 2nd Floor, Boston, MA 02118
(617) 534-5966

PROGRAMA DE PREVENCIÓN DEL ENVENENAMIENTO INFANTIL CON PLOMO

COMPRENDA EL SIGNIFICADO DE LOS RESULTADOS DEL EXAMEN DE PLOMO EN LA SANGRE (PB):

SI SU NIÑO TIENE UN NIVEL DE:	ENTONCES:
9 ug/dL o menos	Se considera que un niño con un nivel de plomo en la sangre con menos de 9 no está envenenado.
10 - 14 ug/dL	El Centro de Control de Enfermedades (CDC) define un nivel mayor de 10 como un "nivel de interés." El niño debe ser chequeado frecuentemente. Consulte con su pediatra, este le puede recetar multi-vitaminas e hierro.
15 - 19 ug/dL	El pediatra debe colaborar y ayudarle a reducir el nivel de plomo en la sangre de su niño, através de cambios en la dieta y nutrición. También, el niño debe ser chequeado frecuentemente y el ambiente tiene que ser examinado para encontrar la fuente del plomo. Medidas de prevención tienen que ser implementadas inmediatamente.
20 - 24 ug/dL	Su niño necesita una completa evaluación médica. El pediatra puede recetarle hierro. Localize el lugar de donde proviene el plomo y aleje a su niño de este lugar. Recuerde que la fuente de plomo puede estar en su casa, en la escuela y donde juega su niño.
25 ug/dL y mayor	Se considera que un niño con un nivel de plomo en la sangre mayor de 25 está envenenado. Intervenciones ambientales y médicas tienen que ser implementadas inmediatamente. Un tratamiento médico y medicinas pueden reducir el nivel de plomo en la sangre.
70 ug/dL y mayor	Un niño con este nivel es considerado una emergencia médica.

Si necesita más ayuda para comprender los resultados de su niño, hable con su pediatra. Para más información sobre como puede remover el plomo de su casa en Boston, llame al: **Programa de Prevención del Envenenamiento Infantil Con Plomo al (617) 534-5966.**

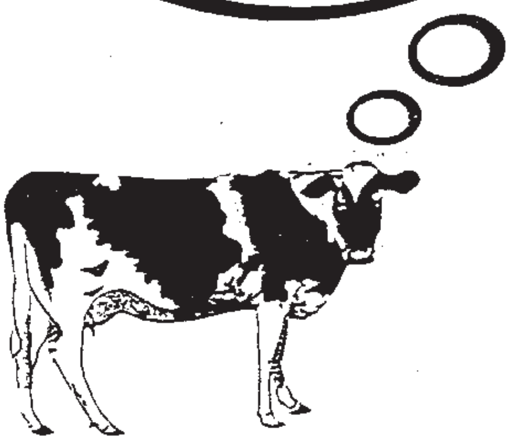
Si usted vive fuera de Boston, llame al **Programa de Prevención del Envenenamiento Infantil Con Plomo del Departamento de Salud Pública de Massachusetts al (800) 532-9571.**

LA COMISIÓN DE SALUD PÚBLICA DE BOSTON
1010 MASSACHUSETTS AVENUE, 2DO PISO / ◆ BOSTON, MASSACHUSETTS ◆ 02118
◆ (617) 534-5966 (VOICE) ◆ (617) 534-2372 (FAX) ◆

Foods That Help Reduce the Harmful Effects of LEAD

Lead is poisonous to the body. Infants, children under six, and pregnant women are at the greatest risk for lead poisoning.

Calcium is very important for growing bodies. Extra calcium will help protect children from lead poisoning!



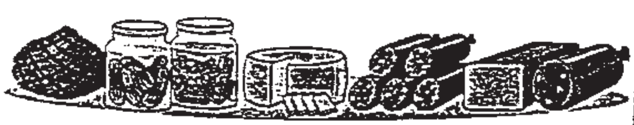
Foods to Eat for <u>Calcium</u>

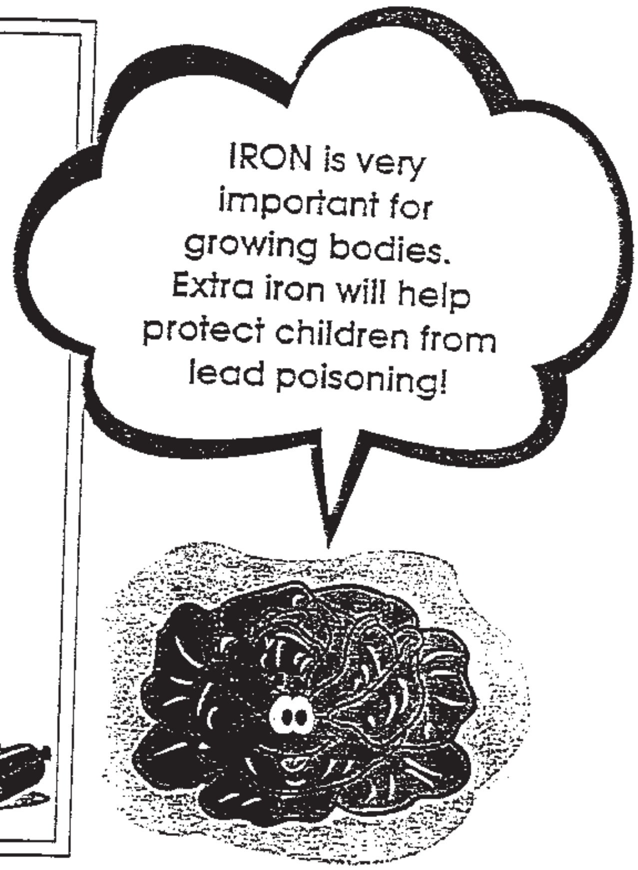
Milk
Yogurt
Tofu
Cheese
Sardines and Tuna
Green leafy vegetables
(Collard greens, broccoli, kale)

Lead looks like calcium, zinc and iron to the body. The body absorbs lead just like these important minerals, but lead is harmful, not helpful, to normal development. This is why it is important for you and your children to eat a balanced diet.

When you don't have enough vitamins and minerals in your diet, your body will absorb more lead. Lead is stored in the bones, just like calcium and iron.

Foods to eat to get IRON
Lean meats
Chicken, Turkey
Black beans
Kidney beans
Rice
Cereal with added iron
Dried fruits
Peanut Butter
Corn Tortillas
Dark green leafy vegetables
(like spinach and kale)





Iron works better with Vitamin C. Eat oranges, mangos, green peppers, tomatos, and drink real fruit juices (not fruit punch or kool aide) to help your body absorb iron.

For more information, contact the Boston Childhood Lead Poisoning Prevention Program at the Boston Public Health Commission
1010 Massachusetts Avenue, 2nd Floor, Boston, MA 02118
(617) 534-5966

CITY OF BOSTON
DEPARTMENT OF NEIGHBORHOOD DEVELOPMENT
LEAD SAFE BOSTON PROGRAM

38 Winthrop Street
Hyde Park, Ma 02136
(617) 635-0190

LEAD SAFE BOSTON YARD PROGRAM APPLICATION

APPLICANT (Owner of Property)

Name: ____

Property Address: ____

I live here _____ I do not live here ____ # units in building ______

Mailing Address (Investor-Owners only):____

Phone: (home) _______________ (work) _______________ SS #_____________________________

Identify your ethnic/racial category ________________ Female Head of Household Yes____ No____

Contact person ___________________________________ Phone (home) _______________________

CO-APPLICANT (Co-owner of property only if listed on deed)

Name: ____

Mailing Address: ____

Phone: (home) _______________ (work) _______________ SS #_____________________________

Identify your ethnic/racial category _______________

Please check the appropriate answer	Yes	No
1. Do you have a current homeowner's insurance policy in place? (If yes, attach a copy of the insurance certificate to application)	________	________
2. Are you current with your Boston Water and Sewer Payments?	________	________
If no, do you have a payment plan in place?	________	________
3. Are you current with you real estate taxes?	________	________

4. Please complete the child information below (use additional sheets if necessary).

Name of Child(ren) Who live on the property	Date of Birth	Unit # where child(ren) lives
______________________	________	____________
______________________	________	____________
______________________	________	____________
______________________	________	____________

****

AUTHORIZATION TO PROCEED WITH
LEAD SAFE YARD PROGRAM APPLICATION

I am interested in participating in the Low level Soil Treatment Demonstration and Evaluation Project, as outlined in the Homeowner Consent Form. I understand in order to be eligible for this grant program I, as the Owner of the Property, must be in good standing with my Boston Water and Sewer account, be current on my real estate taxes and have a homeowner insurance policy in place. I also understand that this program is being offered to protect children and that there must be young children living here: either the child/ren who lived here during the Round 1 evaluation or at least one child under the age of 6 years old.

I hereby certify that the information that is provided in this application is true and complete to the best of my knowledge. I will make this information available for review upon request by the City of Boston's Department of Neighborhood Development, the U.S. Department of Housing and Urban Development, or its designee. I authorize the program to proceed with my application.

Applicant's Signature:_________________________________ Date:________________

Co-Applicant's Signature:______________________________ Date:________________

TERMS SUBJECT TO CHANGE WITHOUT NOTICE
MISSING INFORMATION WILL DELAY PROCESSING THIS APPLICATION AND MAY JEOPARDIZE FUNDING AVAILABILITY!

Department of Neighborhood Development

Boston's Public Facilities Department

Thomas M. Menino, Mayor
Charlotte Golar Richie, Chief and Director

March 28, 2000

Homeowner Name
Homeowner Address
Mattapan, MA 02126

Dear Homeowner:

Thank you for your interest in our Lead Safe Boston Yards Program. As you know from visiting with our outreach person Yvonne Illich of Silver Linings, if you participate in this program you will receive at **no cost to you**, comprehensive testing/sampling of the soil surrounding your home; drawings of your property identifying lead hazard areas; fully developed landscape plans showing proposed treatments; supervised construction and installation of all landscape treatments and detailed educational information about how to maintain your lead safe yard!

On March 6, 2000 we sent you a letter requesting the following documents. As of today, we have not received the documents listed below. It is important to note that we need these items before we can enroll you property in our program. Please use the enclosed self-addressed stamped envelope to send copies of the following documents to our office.

__✓__ Boston Water and Sewer written approved payment plan.

_____ Copy of current insurance policy for the property that will receive yard treatments.

Since this program will begin in early spring and funding is limited, it is very important that the document(s) be forwarded to our office as soon as possible. If your application is still incomplete after April 6, 2000, we will not be able to enroll you in our lead in soil grant program.

We are looking forward to working with you on this Low Level Soil Treatment Demonstration Project. Yvonne Illich will be contacting you later this week to offer you assistance in sending this information to our office. If you have any questions, please contact me at 617/635-0193.

Sincerely,

Sandra R. Duran
Lead Safe Boston

Cc: File

Department of Neighborhood Development

Boston's Public Facilities Department

Thomas M. Menino, Mayor
Charlotte Golar Richie, Chief and Director

June 12, 2000

Homeowner Name
Homeowner Address
Dorchester, MA 02124

Dear Homeowner:

Congratulations, you have been officially enrolled in the Lead Safe Boston Yards Program!

As a participant in our Lead Safe Boston/National Center for Lead-Safe Housing Low Level Soil Treatment Demonstration and Evaluation Project, you will receive a grant of up to $3,000 worth of design and landscaping work to reduce the exposures to lead in soil on your property. For your files, we have attached a copy of the consent form that you signed. This form details the terms of our program that you are required to comply with in exchange for this granted scope of services. This is a very important project and your participation is vital to our efforts to demonstrate that low cost soil treatments are instrumental in reducing dust lead levels found inside homes.

Now that your property has been enrolled, EPA will sample the soil around your home and analyze the samples for their lead content. Once the results are available, one of our landscape contractors will set up an appointment with you to review your current yard use. With your input he or she will design a landscape plan that will abate the lead hazards found around your home.

Once the design is approved, the landscape contractor will schedule another appointment to review the design with you and determine the start date of your project. It is important to note that any debris that the landscape contractor determines needs to be removed in order to facilitate his work must be completed before work can begin.

Once the new landscaping work is complete, the landscape contractor will schedule a convenient time to meet with you to review the work and to explain the information contained in a Homeowner Maintenance Manual that will be yours to keep. Over the course of the following year, there will be times when our outreach person will return to your property to take dust wipes inside the entrance to your home and your tenant's units. We would like to thank you in advance for your cooperation in providing access to these areas.

If you have any questions regarding the program please feel free to contact me at 617/635-0193.

Sincerely,

Sandra R. Duran
Lead Safe Boston

HOMEOWNER PERMISSION FORM

Most homes in Boston have lead in the yard soil. This comes mainly from leaded paint flaking or being scraped off houses and leaded gasoline which was used in cars until recently. Lead in soil can harm children because dirt and dust get on children's hands, toys and other objects that they often put in their mouths. Lead in soil can also be tracked into the house.

PURPOSE OF THE PILOT PROGRAM

The Lead-Safe Yard Program is a project to make yards in your neighborhood safer for residents, especially children. We plan to do this by making low-cost and easy-to-install landscape improvements in yards with high lead levels in soil.

PROGRAM ELEMENTS

1. Analysis.

As part of your voluntary participation in the Lead-Safe Yard Program, the soil around your property at ____
will be analyzed for lead content. We will provide the analysis free of cost.

2. Improvements.

If the lead in your soil is above certain levels, we will suggest different kinds of landscaping options for you to choose. These may include covering the soil with barriers such as: mulch, wood chips, crushed stone, and shrubs. We will discuss options for children's play areas and vegetable garden sites also. We will make the improvements that you choose, with materials and labor provided free of cost.

VOLUNTARY PARTICIPATION

Your participation is voluntary because there is no obligation to reduce or protect against the lead in your soil. If you wish to be part of the Lead-Safe Yard Program, we will make an appointment to analyze your soil and make the results available to you If your soil has high levels of lead, we will make a second appointment to discuss the yard improvements and to plan a schedule for the landscaping work.

Value

If the levels of lead in your soil are above 400 parts per million, you are eligible to receive materials, services, and labor in landscape improvements free of cost from the Lead-Safe Yard Program.

I understand the conditions of this agreement and I agree to participate in the program.

________________________________ ____________________

Signature Date

Homeowner Consent Form
Lead-Safe Boston/National Center for Lead-Safe Housing
Low Level Soil Treatment Demonstration and Evaluation Project

I am interested in participating in the Low Level Soil Treatment Demonstration and Evaluation Project. If I meet the criteria for this project and if my property is accepted for the project, I understand that I will receive up to $3,000 worth of design and landscaping work to reduce the exposures to soil lead on my property in exchange for my participation in the program. The work will be completed in the year 2000 or 2001.

I will receive the following:

1. Up to $3,000 worth of design and landscaping work for my property.
2. Comprehensive testing/sampling of soil surrounding my home.
3. Scaled drawings of my property identifying the lead hazard areas in my yard.
4. Fully developed landscape plans showing proposed treatments and plantings.
5. Results of limited dust testing taken before, immediately after and one year after the work has been done.
6. Detailed educational information about how to maintain my yard.
7. A new door mat after all dust collection activities have been completed.

I agree to do the following:

1. Complete an application form and provide a copy of my homeowner's insurance policy to project staff.
2. Remove any debris, trash, old cars or other identified items that would make soil sampling or landscape work difficult or not possible.
3. Participate in an initial interview to identify my current or planned uses of the yard.
4. Meet with the landscape designer to provide input into the plan.
5. Allow access to my yard for site testing by Region 1 EPA, prior to starting and after completion of the landscape work.
6. Allow access to my home for dust testing by Silver Linings, Inc. Dust testing will take place three times (immediately before the work is done, after work is done, and one year after work is done) and include wipe sampling and laying down a dust collection mat to better measure accumulation of lead dust over time. I will allow Silver Linings, Inc. access to my home to pick up the mats about two weeks after each has been put in place.
7. Meet with the landscape designer after the plan has been developed, to review and approve the plan.
8. Allow the landscape designer access to my yard to complete planned treatments.
9. Cooperate with the landscape designer and allow him/her to use at no cost my utilities (such as lights, heat, power and water) as needed to carry out and complete the work.
10. Meet with the interviewer and landscape designer after work is completed to review my Homeowner Maintenance Manual, conduct dust testing, and complete project evaluation forms.
11. If a one year evaluation of this project is funded, allow one more site visit approximately one year after the yard work has been completed by the interviewer who will conduct dust testing and complete project evaluation forms.
12. Speak with the press and/or participate in a press event and/or publicity related to the Lead Level Soil Treatment Demonstration and Evaluation Project.

I will formally sign off on the proposed scope of work, Form #09 Owner Approval of Scope of Work, and Form #19 Homeowner Education and Project Completion Certificate, indicating that the work has been successfully completed.

I understand that Lead-Safe Boston will oversee the landscape work done in my yard and that the project's interviewer, Yvonne Illich of Silver Linings, will coordinate collection of most of the data for this project. Soil-lead measurements of my yard will be taken by the EPA as soon as it is feasible to sample, depending on weather conditions; I do not need to be present during this sampling. Because of changes in field conditions such as weather, I will not be notified in advance of the EPA sampling date.

If I have any questions about the construction work for this project, they will be answered by Sandra Duran, Lead-Safe Boson at 617-635-0193. If I have questions or concerns about the evaluation aspect of this project, they will be answered by Pat McLaine, National Center for Lead-Safe Housing at 1-800-624-4298.

______________________________ _______________________

Homeowner #1 signature Date

______________________________ _______________________

Homeowner #2 signature Date

______________________________ _______________________

Interviewer signature Date

1 copy to homeowner

1 copy to Evaluation Files

HOMEOWNER YARD USE/TREATMENT OPTIONS INTERVIEW

Name: ______________________________

Address: ______________________________

Using a "clean" copy of the plot plan with house footprint:

1. Show me where people walk through the yard going to and from the house. (exposed soil?) ______________________________

2. Show me where children play (how many and how old?) ______________________________

3. Show me where people raise vegetables (or do other gardening) ______________________________

4. Show me where people eat outside ______________________________

5. Show me where pets (especially dogs) spend their time ______________________________

6. Show me where cars or other vehicles are parked or repaired ______________________________

7. Show me where people walk to hang out clothes ______________________________

8. Show me other areas for:
   Sunbathing ______________________________
   Garbage cans ______________________________
   Recycling bins ______________________________
   Composting ______________________________
   Hobbies ______________________________

9. Tell me any other places and ways children or adults spend their time in the yard. ______________________________

HOMEOWNER YARD USE/TREATMENT OPTIONS INTERVIEW

Name: ______

Address: 10 Home Street

Using a "clean" copy of the plot plan with house footprint:

1. Show me where people walk through the yard going to and from the house. (exposed soil?) from driveway to deck + across grass in front. Soil exposed in front.

2. Show me where children play (how many and how old?) backyard 3 kids (3, 7, 9) and lots of friends!

3. Show me where people raise vegetables (or do other gardening) backyard veg garden (see plot plan)

4. Show me where people eat outside on deck + in backyard (see plot plan)

5. Show me where pets (especially dogs) spend their time no pets

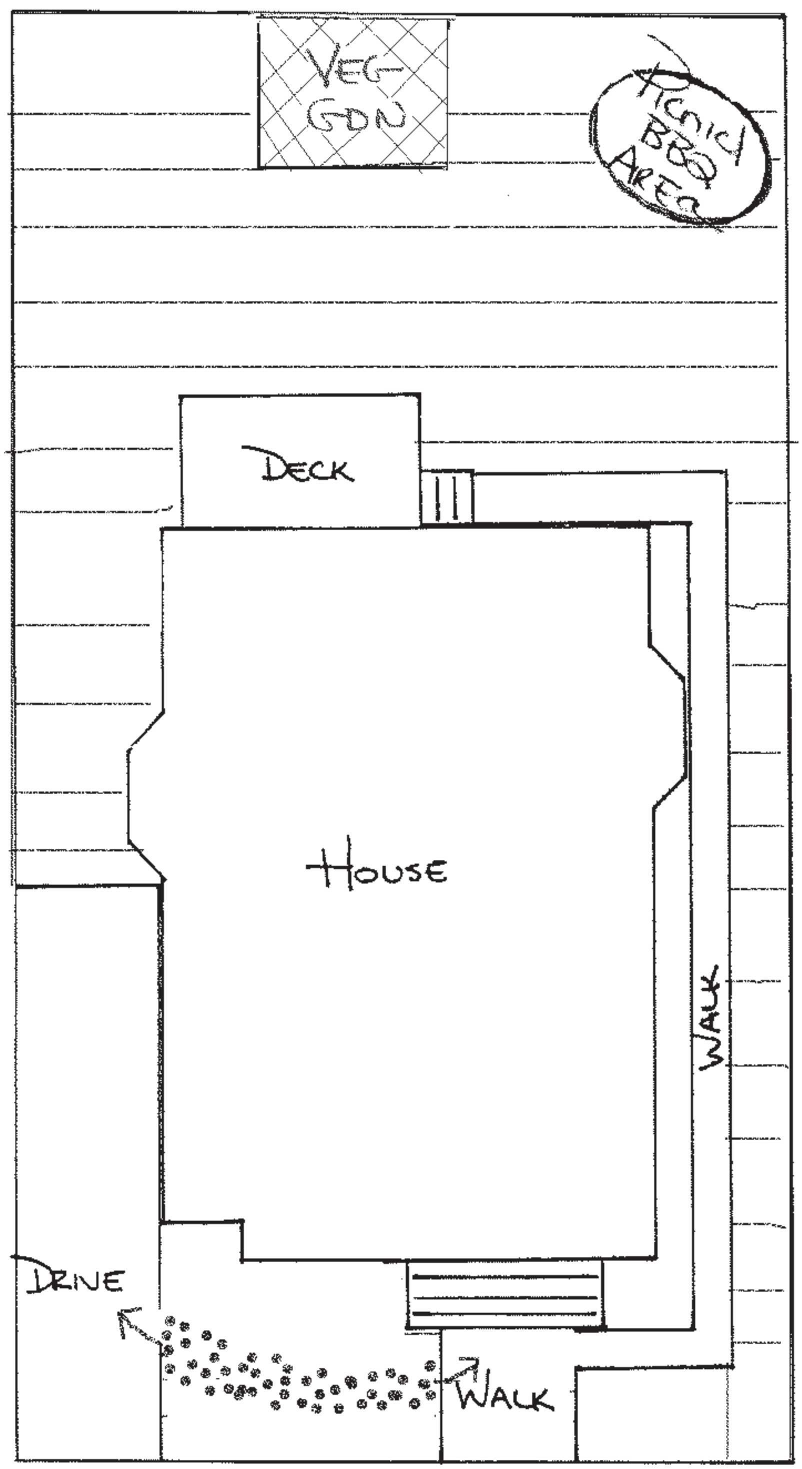
6. Show me where cars or other vehicles are parked or repaired driveway (blacktop)

7. Show me where people walk to hang out clothes backyard

8. Show me other areas for:
   Sunbathing deck
   Garbage cans driveway
   Recycling bins back. walk
   Composting no
   Hobbies no

9. Tell me any other places and ways children or adults spend their time in the yard. outdoor parties in the summer (backyard)

10 HOME STREET



SCALE: 1" = 1'-10"

YARD USE PATTERN KEY

DOTS
High Traffic Area (Exposed Soil)

LINES
High Risk Use Area
(Play Area or Vegetable Garden)

CROSS HATCH
Recreation Area (Picnic or BBQ)

6 Collection and Managing Data on Lead in Soil

This chapter describes a state-of-the-art technique, using field-portable x-ray fluorescence technology, for collecting and managing data on lead in soil. This technique allows inspectors to discern patterns of contamination in a property quickly and accurately. The technology can be used only by trained, certified inspectors who meet federal, state, and local requirements for collection of environmental samples, as described in Section 6.4. This chapter is not intended to provide guidance for inspectors, but to give you, as a program organizer or decision-maker, an overview of the data collection and management process.

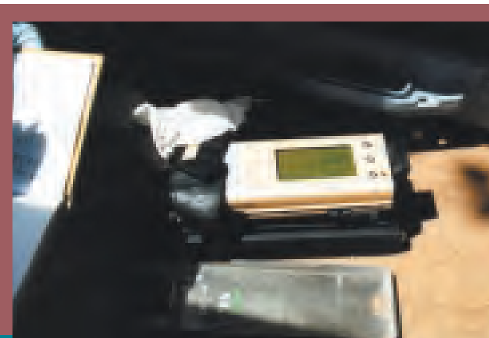
Section 6.1 is an overview of data collection and management techniques used by the EMPACT Lead-Safe Yard Project. Section 6.2 provides information on how to find the necessary equipment and laboratories for testing and how to cut costs. Section 6.3 is a step-by-step description of testing, quality control, and data management procedures that are used by professional inspectors; Section 6.4 discusses health and safety precautions for inspectors; and Section 6.5 is devoted to equipment maintenance.

If you mainly want a general idea of what data collection and management entails, you can focus on Section 6.1 alone. Sections 6.2 through 6.5 present more detailed material for those who are responsible for implementing a lead-safe yard program. Such readers may also be interested in the reproducible site worksheets at the end of this chapter.

6.1 Collecting and Managing Data: An Overview

A key component of the EMPACT Lead-Safe Yard Project is the use of field-portable XRF technology. This technology allows inspectors to provide residents with onsite, real-time data about lead contamination in yards, without having to wait for the results of laboratory analysis. Field-portable XRF requires a substantial capital investment, as noted in Sections 6.2 and 6.5. On the other hand, programs committed to soil inspection for the long haul may find that the investment more than pays for itself. The EMPACT LSYP has conducted XRF analysis on roughly 2,000 soil samples over the past three years, which makes the cost per sample far less than it would have been for laboratory work. After all, sending samples to a lab involves not only charges for the analysis itself but also the expense of sample collection, shipping, and handling.

Studies have affirmed the accuracy of XRF, and it has received EPA verification as well. (For example, EPA's Environmental Technology Verification Program has conducted field demonstrations to test several XRF technologies. Verification Reports and Statements from these tests are available online at



The XRF is a hand-held field-portable device that allows inspectors to get a lead-level reading within seconds.

http://www.epa.gov/etv/verifrpt.htm#monitoring.) What makes XRF technology especially valuable for a lead-safe yard program is that it offers real-time results with a hand-held, battery-powered device. This means that inspectors, while on site, can get parts per million (ppm) lead levels for individual soil samples within seconds, and, if necessary, adjust their testing strategy for the property as a whole accordingly. Experience has shown that lead concentrations in properties often vary significantly and unpredictably. With XRF, inspectors can learn about any unusually high lead levels right away and then take more closely spaced readings in the area from which the high reading came. The result is a clearer delineation of how soil contamination differs from one part of the property to another.

Inspectors mark the location of each XRF reading on a plot plan and record lead levels on a site worksheet.

One concern that has been raised about field-portable XRF is that it tests for lead only at the surface level. Many experts, however, are convinced that this is usually where the lead level in soil actually is highest. Also, the top layer of soil clearly poses the greatest potential health risk because of its accessibility.

When the EMPACT LSYP conducts XRF testing, the first step is to determine some rough guidelines by interviewing the homeowner and observing current conditions in the yard. Several high-risk or high-use areas may be identified. As the sample interview form in Chapter 5 suggests, these could include gardens, picnic areas, and children's play areas, in addition to areas of bare soil and heavy foot traffic. Such parts of the property are singled out for careful inspection. Another target is the drip line, generally a 3-foot-wide strip around the foundation of a house where lead tends to have been washed into the soil by rain.

The EMPACT LSYP's procedure for taking XRF readings is straightforward. The XRF and test guard are placed on the exposed soil surface and depressed to open the shutter. A 30- to 60-second measurement should yield reliable results. As inspectors take these readings, they mark the location of each on a plot plan of the property and record the lead levels on a site worksheet. Also recorded on the worksheet are measurements that fix the location of the reading somewhat more precisely. Any other relevant descriptive information, such as the weather and the general condition of the yard, is noted on the worksheet as well.

The ppm lead levels from different locations within a particular area—say, the east drip line—are averaged to yield a mean value. Depending on this value, the EMPACT LSYP assigns each area to one of its four categories (see Section 3.4.3.1 for a comparison with proposed categories under TSCA Section 403):

- Very high (5000 ppm or more)
- High (2000 to 5000 ppm).
- Moderately high (400 to 2000 ppm).
- Low (400 ppm or less)

Detailed guidance about mitigation strategies for each of these categories is provided in Chapter 7 of this handbook.

The EMPACT LSYP takes several quality control measures to back up XRF readings on every property. Accuracy and reproducibility are checked periodically using continuing calibrations (against a known standard) and replicate measurements, respectively. Inspectors also collect a small number of soil samples for confirmatory lab analysis. Since XRF is still a new technology, its results need to be judged against the gold standard of accepted practice, in this case inductively coupled plasma (ICP) or atomic absorption (AA) methods, both of which are conducted in a laboratory and take about 2 to 4 weeks.

Nevertheless, inspectors often have enough confidence in their XRF findings to give homeowners and landscapers a provisional color-coded map of a property's lead levels well before the results of confirmatory lab tests are available. The map on page 81 is an example. Inspectors may prepare such a drawing before they even leave the site, using markers or colored pencils and a copy of the plot plan. This hand-drawn method is simple, immediately interpretable, and readily accessible to the homeowner. Alternatively, the XRF readings may be taken to an office and used to produce a computer-generated map, as shown on page 82. Either way, homeowners and landscapers can gain a general understanding of what areas of a yard need remediation and start making plans.

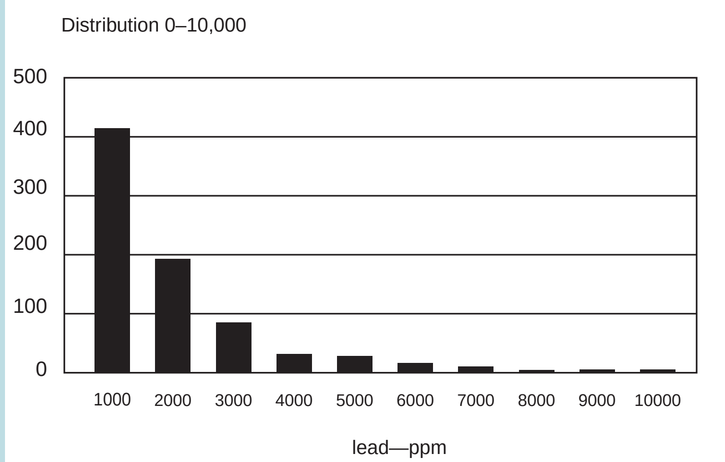
Once a lead-safe yard program has tested a sizable cross-section of properties in a city, it might be useful to record the results on a map to see if a geographical pattern emerges. If such a pattern does emerge, the information could be made available to the public, perhaps on a Web site, to promote awareness of the lead-in-soil problem and help homeowners and communities make more informed decisions.

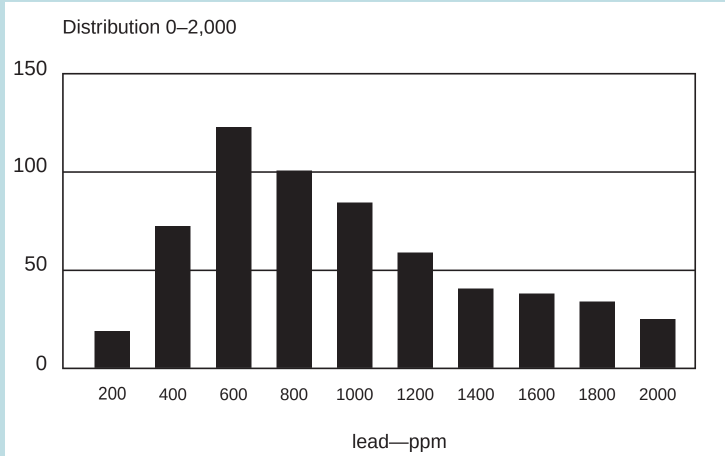
As an example, maps showing the lead content of soil in various parts of New Orleans, Louisiana, are available online at http://www.tmc.tulane.edu/ecme/leadhome/soil.html. Environmental

EMPACT LSYP 1998 ANALYTICAL PROGRAM FINDINGS

In Phase I of the EMPACT Lead-Safe Yard Project, lead in surface soil concentrations measured in the Bowdoin Street neighborhood ranged from 103 to 21,000 ppm.

The mean value for these data was 1,632 ppm (n=781). Twenty-two percent of the measurements were above 2,000 ppm, and 87 percent were above 400 ppm.





Lead Concentration Distribution for Phase 1 Field Work toxicologist Howard Mielke of Xavier University in New Orleans analyzed 3,074 surface soil samples representing 283 census tracts. The data indicate that the most contaminated areas usually lie in the central part of the city, where traffic is heaviest.

6.2 Getting Started

Individual homeowners or groups planning a very limited lead-safe yard program will probably just want to hire a risk assessor certified for use of XRF for soil analysis. In any case, local authorities regulating lead abatement activities should be consulted.Those seeking to implement an extensive program will probably want to buy their own field-portable XRF to be used by trained/certified inspectors working with the program. The EMPACT LSYP uses an instrument manufactured by Niton Corporation[17], which also provides training. For information, call 1-800-875-1578 or visit http://www.niton.com. See Section 6.4.2 for information about XRF use licenses and certification.

An XRF similar to the one used in the EMPACT LSYP, a field portable Niton Model 702, costs about $26,500, making it the most substantial expense a program will face. Day-to-day maintenance of the XRF is generally not costly, though programs will face the additional expense (around $2,600) for replacement of the instrument's radioactive source at least once every two years, if not more frequently (see Section 6.5). Some savings are possible, however. The box below provides some suggestions; for example, it describes a less costly XRF instrument that was not available when the EMPACT LSYP purchased its instrument.

HOW TO CUT COSTS

Recently, Niton has developed a field portable XRF that tests for lead alone, not the wide range of other metals detectable with a 700-series Niton. This instrument, the XL309, costs just $17,000, and a version exclusively for lead in soil is available for $15,000. The main reason the XL309 is so much less expensive is that it lacks a high-resolution silicon pin detector. But this feature is useful largely for measuring levels of elements such as arsenic, which require a great deal of precision. Lead levels, by contrast, are fairly broad measurements. A high-resolution silicon pin detector is not necessary.

A lead-safe yard program may also save money if it can align itself with a university, which is much more likely if the work has a research component. In this case, the school might pick up some or all of the cost of the XRF, and interns paid by the school might conduct inspections under the supervision of a faculty member. This type of approach is described in more detail in Appendix B, which presents less-resource-intensive approaches to implementing lead-safe yard programs.

6.3 Testing Step by Step

This section describes the procedures used by professional inspectors in the EMPACT LSYP for soil testing, quality control, and data management. In developing these procedures, the EMPACT LSYP relied on two primary sources: 1) Method 6200 from EPA publication SW-846 (entitled *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*), EPA's compendium of methods on evaluating hazardous waste; and 2) the Quality Assurance Project Plan (QAPP) that was developed for the EMPACT program. What follows is mainly a summary of the directives from these two sources, along with recommendations and insights from the program's inspectors themselves. You can go to http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm to learn more about SW-846 and obtain a copy online. The EMPACT LSYP's QAPP is provided in Appendix D.

6.3.1 Before Beginning

The inspectors should plan to allot about two hours for testing a typical residence. Homeowners need not be present, but they do have to have signed a permission form (see Chapter 5). Ideally, all

[17] Mention of trade names or commercial products in this publication does not constitute endorsement or recommendation for use.

the information about yard use gained from observations and homeowner interviews will have been incorporated into the plot plan prepared during outreach and education. This plot plan will be used as a guide for testing. See Section 5.3 for guidance on conducting homeowner interviews and developing a plot plan. A sample interview form and plot plan can be found on pages 63 to 65.

Favorable weather conditions are necessary for testing. Experience shows that XRF testing does not work well when the ground is frozen or when the air temperature falls below 40 degrees Fahrenheit. And while high temperatures usually pose no problem, direct sunlight can cause the instrument to overheat. Inspectors should take care to shade it on sunny days, even in relatively cool weather.

Inspectors take at least two readings along the property border on each side of the house.

Soil moisture can not only interfere with readings but also damage the XRF, so soil that is saturated with water should not be tested. This condition is most likely to occur in early spring, when the ground absorbs water inefficiently because it hasn't yet thawed and dried out from the winter months. Inspection should be delayed in the event of rain as well; even after the rain has stopped, testing may still be inadvisable for several hours, because of standing water on the grass. The XRF can generally tolerate humidity, however.

If conditions are favorable, and all the necessary paperwork is in place, inspectors may prepare the property for testing. Debris such as rocks, pebbles, leaves, and roots should be removed, and the ground should be made flat enough to allow uniform contact with the XRF. In some cases grass or plant material may need to be moved aside to expose the soil surface. As they do this, inspectors must remember that lead in soil is mostly a surface phenomenon, and that readings may not be accurate if the ground is disturbed too much.

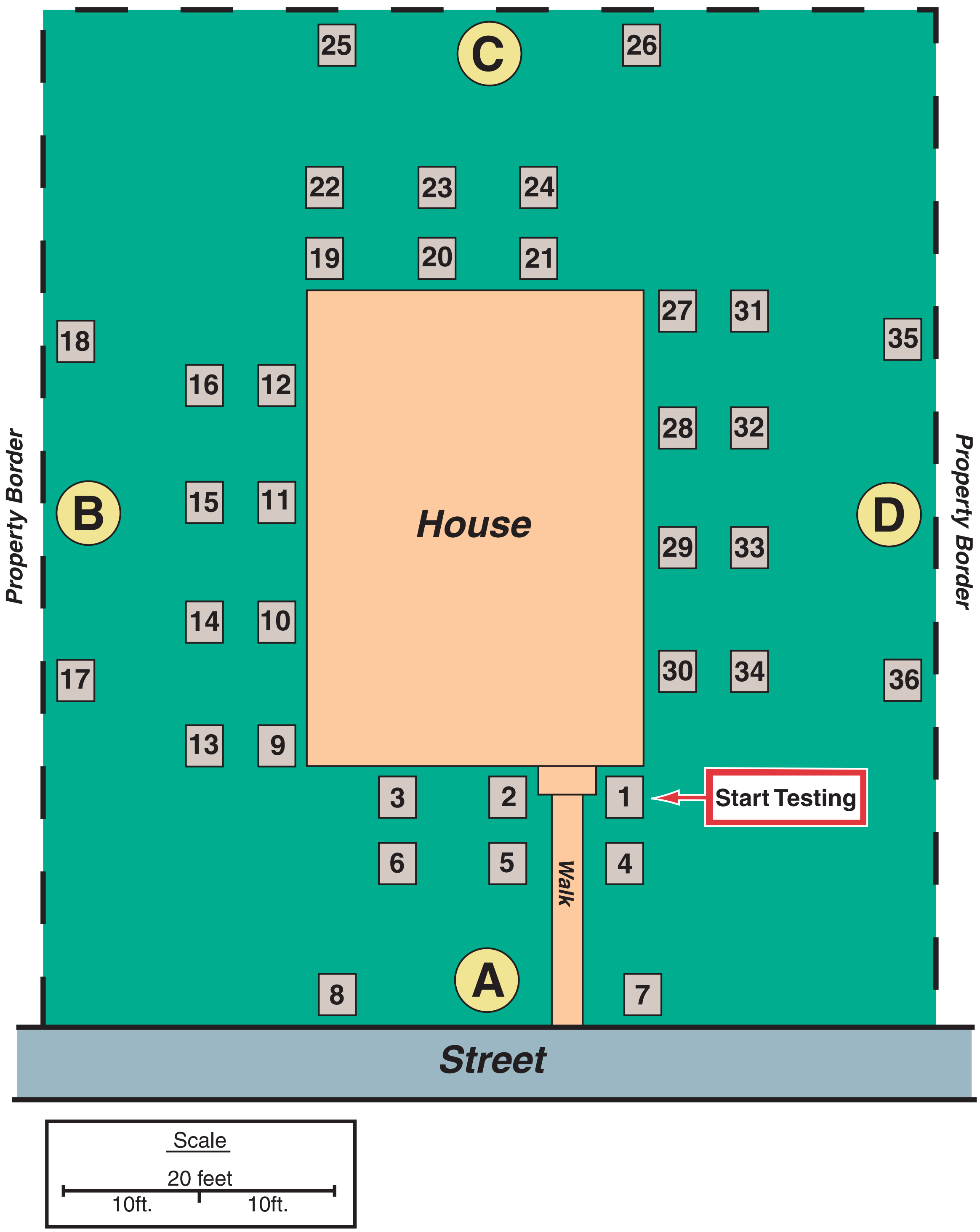
6.3.2 Testing Strategy

Although each property is different and must be approached with its unique characteristics in mind, testing typically focuses on four main concerns: the drip line, play areas, areas of exposed soil, and areas that may be contaminated with lead from sources other than the house, such as structures on abutting properties. In the EMPACT LSYP, if play areas are found to have lead levels greater than 400 ppm, they are tested further to determine the extent of contamination. Other areas are subjected to extra testing if they are found to have levels greater than 2000 ppm.

A variety of formats for testing are possible, but data collection is generally more systematic and efficient if inspectors decide on one format and use it consistently. In the EMPACT LSYP, the sides of the house on a property are labeled A, B, C, and D. The A side is that which bears the house's address, and the B, C, and D sides follow in a clockwise fashion. Inspectors start at the corner where the A and D sides meet, then cover the whole A portion of the yard, and after that the whole B, C, and D portions, until finally they arrive at the A-D corner again.

The pattern for testing a particular area on any of the sides of the house depends on the size and shape of that area. In long, narrow areas such as drip lines, initial XRF readings are generally taken at 10-foot intervals along an imaginary line that extends from one end of the area to the other. If an area is not long enough to yield at least three readings with this method, inspectors mentally divide the imaginary line into thirds and take a reading from each third.

Generic Testing Pattern



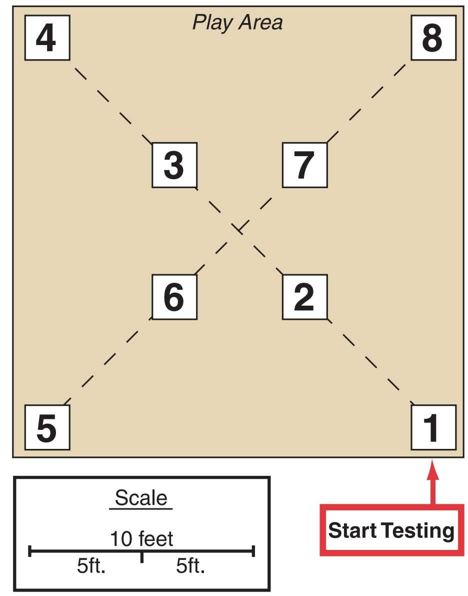
Inspectors then take a second series of XRF readings along an imaginary line that is parallel to the first one but 2 to 5 feet away from it. If the area is in fact a drip line, this second imaginary line usually falls outside it, so lead levels are expected to drop off. If they don't, further testing is conducted to ascertain whether and where they do.

Before completing testing on any one side of the house, inspectors take at least two readings along the property border. These readings are generally evenly spaced. If either reading shows elevated lead levels, additional reading are taken along the border.

For other areas of concern, including play areas, an imaginary X is usually superimposed on the ground. Readings are taken at 5- to 10-foot intervals along each line of the X. If the area is too small to yield at least five readings with this method, inspectors mentally divide the lines of the X into thirds and take a reading from each third.

When sufficient readings have been obtained from a given area, the lead levels are averaged to produce a mean value, and on the basis of this value, the area is assigned to a specific lead-level category, as explained in Section 6.1.

Testing Pattern for Play Areas, Gardens, and Other Areas of Concern



6.3.3 Quality Control

Niton XRFs are factory calibrated, so site-specific calibration is not necessary. Regular checks of the instrument's calibration are an essential aspect of quality control, however. Before inspectors from the EMPACT Lead-Safe Yard Project begin to test a property, they take readings on standard reference materials (SRMs) whose lead levels are known to be 400 ppm, 1,000 ppm, and 5,000 ppm, the anticipated range for lead in urban soil. They also take a reading on a blank—a soil sample whose lead level is less than 100 ppm, which is the detection limit for the XRF instrument they use. If any of these readings fails the quality control criteria (+ 30% for SRMs; < 50 ppm for field blank), possible problems are investigated and the check is re-run until the instrument passes. If it never passes, it is sent back to Niton to be recalibrated. These same calibration checks are conducted at the end of testing on a property, to ensure that the instrument's calibration has remained intact throughout.

> **NOTE!**
>
> **Borderline mean values for an area are judged to fall into the more toxic category rather than the less toxic one. For example, a mean value of 1,980 ppm would earn an area a "high" rating (2,000 to 5,000 ppm). The idea is to avoid the risk of undertreating a contaminated area. Measurements of lead levels are broad, and a difference of just 20 ppm is insignificant.**

In addition, 10 percent of the XRF readings are replicate measures. That is, a particular location is tested a second time, to see if the reading on it falls into the same range. If it doesn't, inspectors try to find out what the problem is and fix it, and calibration checks and further repeat readings are performed until the XRF results are clearly reliable.

The final quality control measure is to collect soil samples for confirmatory ICP or AA analysis. At evenly spaced intervals within a particular area, inspectors scoop up a subsample, which is about a tablespoon of the top half-inch of soil. These subsamples are emptied into a common ziplock bag to create a composite for the area. An XRF reading is then taken on the composite, after which it is ready to be sent to the lab.

Typically, a perimeter composite sample is created by taking twelve subsamples—three from the drip line on each side of the house. Composite samples are also created for every other area designated as high use or high risk, such as gardens and play areas. As in XRF testing, an imaginary X is superimposed on the area. Subsamples—a total of five, if possible—are taken along each line of the X.

6.3.4 Data Management

The two main data management tools, the plot plan and the site worksheet, are versatile and easy to use. As shown on page 81, the plot plan can be converted into a color-coded map of a property's lead levels to help homeowners and landscapers discuss plans for remediation. The plot plan can also be used to formulate a guide for testing, and during the inspection itself, test locations can be recorded on the plot plan, as shown on page 80. Information on developing an initial plot plan can be found in Section 5.3.

The site worksheet offers a simple way to identify the locations marked on the plot plan more closely. It also allows inspectors to keep track of the lead levels found at each location. Finally, it provides convenient spaces to write down any relevant descriptive information: a short form at the top and a "comments" column on the right side. On page 78 is a clean worksheet that groups implementing a lead-safe yard program can reproduce. On page 79 is an example of a site worksheet that has been filled out.

The letters A, B, C, or D in the "sample I.D." column of the filled-out site worksheet tell which side of the house a particular XRF reading came from. The number immediately after each letter corresponds to the testing location noted on the plot plan. The last letter in the "sample I.D." column tells how many feet the testing location was from the foundation of the house.

The number in the "location" column of the worksheet tells how many feet the testing location was from the corner that would be on someone's right when facing the A, B, C, or D side of the house. Thus the right corner on the A side would be the A-D corner; on the B side it would be the A-B corner; on the C side it would be the B-C corner; and on the D side it would be the C-D corner.

The "ppm-lead" column tells the lead levels measured at each testing location. The comment "repeat" in the "comments" column indicates where a second reading was taken on a test location as a quality control measure.

6.4 Health and Safety Precautions

Testing for lead in soil entails two different kinds of risk. The first comes from the soil itself, which frequently does contain high levels of lead. The second comes from the XRF, which employs radioactive material. Inspectors must guard against both these kinds of risks.

6.4.1 Guarding Against Lead Hazards

The important point to keep in mind is that lead can enter the body through ingestion, which occurs as a result of routine hand-to-mouth activities such as eating, drinking, and smoking. Therefore, inspectors should wear gloves and refrain from hand-to-mouth activities on the job. When their work is done, they should wash their hands and faces and clean off their work shoes after leaving the site. On a windy day, inspectors may need to use face masks to avoid breathing airborne lead-contaminated dust when working at dry, dusty sites.

6.4.2 Guarding Against Radiation Hazards[18]

Portable XRF instruments used for lead-based paint inspections contain radioactive isotopes that emit x-rays and gamma radiation. Proper training and handling of these instruments is needed to protect the instrument operator and any other persons in the immediate vicinity during XRF usage. The XRF instrument should be in the operator's possession at all times. The operator should never defeat or override any safety mechanisms of XRF equipment.

For a discussion of required (and recommended) licenses, certifications, and permits for portable XRF instruments, see the box on page 76.

6.5 Maintaining Equipment

Day-to-day maintenance of the XRF is generally not difficult. The instrument's display window should be cleaned with cotton swabs. The case should be cleaned with a soft cloth. Batteries should be recharged as directed in the owner's manual. Beyond that, inspectors usually just need to take care not to drop the instrument, not to get it wet, and not to neglect the calibration checks described under "Quality Control" in Section 6.3.3.

Over the long term, however, XRF owners face the very significant maintenance concern of replacing the instrument's radioactive source, a cadmium-109 isotope. Like all radioactive isotopes, cadmium-109 decays at a fixed rate. Its half-life, or the amount of time needed for the activity of the radioactive source to decrease by one half, is about fifteen months. After that, the XRF can still be used, but the instrument becomes progressively less efficient. Readings that once took 30 to 60 seconds take progressively longer. Eventually the wait becomes burdensome, and a new cadmium-109 isotope must be purchased from Niton, at a cost of about $2,600.

Niton recommends replacing the isotope source every fifteen months, as soon as its half-life is spent, but most inspectors find that they can postpone the job for another three to nine months. After all, readings are no less accurate, just somewhat less prompt. When inspectors do decide to replace the cadmium-109 isotope, they simply send the XRF to Niton. The corporation not only puts in a new isotope but disposes of the old one, upgrades the instrument's software, and provides whatever preventive maintenance is needed.

SAFE OPERATING DISTANCE

XRF instruments used in accordance with manufacturer's instructions will not cause significant exposure to ionizing radiation. But the instrument's shutter should never be pointed at anyone, even if the shutter is closed. Also, the inspector's hand should not be placed on the end plate during a measurement.

The safe operating distance between an XRF instrument and a person during inspections depends on the radiation source type, radiation intensity, quantity of radioactive material, and the density of the materials being surveyed. As the radiation source quantity and intensity increases, the required safe distance also increases. Placing materials, such as a wall, in the direct line of fire reduces the required safe distance. According to NRC rules, a radiation dose to an individual in any unrestricted area must not exceed 2 millirems per hour. One of the most intense sources currently used in XRF instruments is a 40-millicurie 57Co (cobalt-57) radiation source. Other radiation sources in current use for XRF testing of lead-based paint generally produce lower levels of radiation. Generally, an XRF operator conducting inspections according to manufacturer's instructions would be exposed to radiation well below the regulatory level. Typically, XRF instruments with lower gamma radiation intensities can use a shorter safe distance provided that the potential exposure to an individual will not exceed the regulatory limit.

No people should be near the other side of a wall, floor, ceiling or other surface being tested. The inspector should verify that this is indeed the case prior to initiating XRF testing activities, and check on it during testing.

Finally, the effectiveness of the instrument's radiation shielding should be assessed every six months through a leak test. The XRF manufacturer or owner's manual can be consulted to obtain vendors of leak test kits.

If these practices are observed, the risk of excessive exposure to ionizing radiation is extremely low and will not endanger any inspectors or occupants present in the dwelling.

[18] Adapted from *HUD Guidelines for the Evaluation and Control of Lead Based Paint Hazard Evaluation and Reduction Activities,* Chapter 7: Lead Based Paint Inspection, 1997 Revision. Available at http://www.hud.gov/lea

XRF USE LICENSES AND CERTIFICATION

In addition to training and any required accreditation, a person using a portable XRF instrument for inspection must have valid licenses or permits from the appropriate federal, state, and local regulatory bodies to operate XRF instruments. (These are needed because XRF instruments contain radioactive materials.) All portable XRF instrument operators should be trained by the instrument's manufacturer (or equivalent). XRF operators should provide you with information about their training, licensing, permitting, and certification before an inspection begins. Depending on the state, operators may be required to hold three forms of proof of competency: a manufacturer's training certificate (or equivalent), a radiation safety license, and a state lead-based paint inspection certificate or license. To help ensure competency and safety, HUD and EPA recommend hiring only inspectors who hold all three.

The regulatory body responsible for oversight of the radioactive materials contained in portable XRF instruments depends on the type of material being handled. Some radioactive materials are federally regulated by the U.S. Nuclear Regulatory Commission (NRC); others are regulated at the state level. States are generally categorized as "agreement" and "non-agreement" states. An agreement State has an agreement with NRC to regulate radioactive materials that are generally used for medical or industrial applications. (Most radioactive materials found in XRF instruments are regulated by agreement states). For non-agreement states, NRC retains this regulatory responsibility directly. At a minimum, however, most state agencies require prior notification that a specific XRF instrument is to be used within the state. Fees and other details regarding the use of portable XRF instruments vary from state to state. Contractors who provide inspection services must hold current licenses or permits for handling XRF instruments, and must meet any applicable state or local laws or notification requirements.

Requirements for radiation dosimetry by the XRF instrument operator (wearing dosimeter badges to monitor exposure to radiation) are generally specified by state regulations, and vary from state to state. In some cases, for some isotopes, no radiation dosimetry is required. However, it should be conducted even when not required, for the following five reasons:

- **The cost of dosimetry is low.**
- **XRF instrument operators have a right to know the level of radiation to which they are exposed during the performance of the job. In virtually all cases, the exposure will be far below applicable exposure limits.**
- **Long-term collection of radiation exposure information can aid both the operator (employee) and the employer. The employee benefits by knowing when to avoid a hazardous situation; the employer benefits by having an exposure record that can be used in deciding possible health claims.**
- **The public benefits by having exposure records available to them.**
- **The need for equipment repair can be identified more quickly.**

6.6 Alternative Approaches

A number of organizations that conduct lead-safe yard activities rely on laboratory analysis rather than field-portable XRF for testing of yard soil. For example, Lead-Safe Cambridge, described in Appendix A of this handbook, sends soil samples to a state laboratory for analysis.

A homeowner in an area where no lead-safe yard program exists may also wish to determine whether there is a lead problem in his or her yard. In this case, the homeowner can collect soil samples in ziplock bags and send them to a laboratory for analysis. To determine sampling locations, a homeowner can follow the guidance in Section 6.3, or refer to HUD Guidelines for the Evaluation and *Control of Lead Hazards in Housing, June 1995 (Title X, Section 1017) Appendix 13.3,* available at http://www.hud.gov/lea/learules.html#download.

Homeowners can contact their state or local childhood lead poisoning prevention program for more information about obtaining soil-lead testing. The following Web sites list state and local lead poisoning prevention contacts:

> The Lead Program of the National Safety Council's Environmental Health Center: http://www.nsc.org/ehc/nlic/contacts.htm
>
> The National Conference of State Legislatures' Directory of State Lead Poisoning Prevention Contacts: http://www.ncsl.org/programs/ESNR/pbdir.htm

6.7 For More Information

6.7.1 XRF Accuracy

Verification Reports and Statements on the accuracy of several XRF technologies are available on the Web site of the EPA Environmental Technology Verification Program: http://www.epa.gov/etv/verifrpt.htm#monitoring.

Clark, Scott, William Menrath, Mei Chen, Sandy Roda, and Paul Succop. *Use of a Field Portable X-Ray Fluorescence Analyzer to Determine the Concentration of Lead and Other Metals in Soil and Dust Samples*. Call the University of Cincinnati Department of Environmental Health at 1-513-558-1749.

Shefsky, Stephen. *Comparing Field Portable X-Ray Fluorescence (XRF) to Laboratory Analysis of Heavy Metals in Soil.* Call Niton Corp. at 1-800-875-1578.

6.7.2 Test Methods

Methods 6200, 6010B, and 7420 from EPA's SW-846 (entitled Test Methods for Evaluating Solid Waste, Physical/Chemical Methods). For ordering information, or to obtain a copy online, go to http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm.

Sackett, Donald and Kenneth Martin. *EPA Method 6200 and Field Portable X-Ray Fluorescence Analysis for Metals in Soil.* Call Niton Corp. at 1-800-875-1578.

6.7.3 Quality Control

Shefsky, Stephen. *Sample Handling Strategies for Accurate Lead-in-Soil Measurements in the Field and Laboratory*. Call Niton Corp. at 1-800-875-1578.

SITE WORKSHEET

Site Name:______________________________ Date:____________________

Site Address:____________________________ Weather:__________________

Building Type:___________________ Lot Condition:______________________

Yard Uses:____

SAMPLE I.D.	LOCATION	PPM-LEAD	COMMENTS

A = front, B = left, C = rear, D = right
Location = distance from right corner of house

SITE WORKSHEET

Site Name: ______ **Date:** 10-27-98

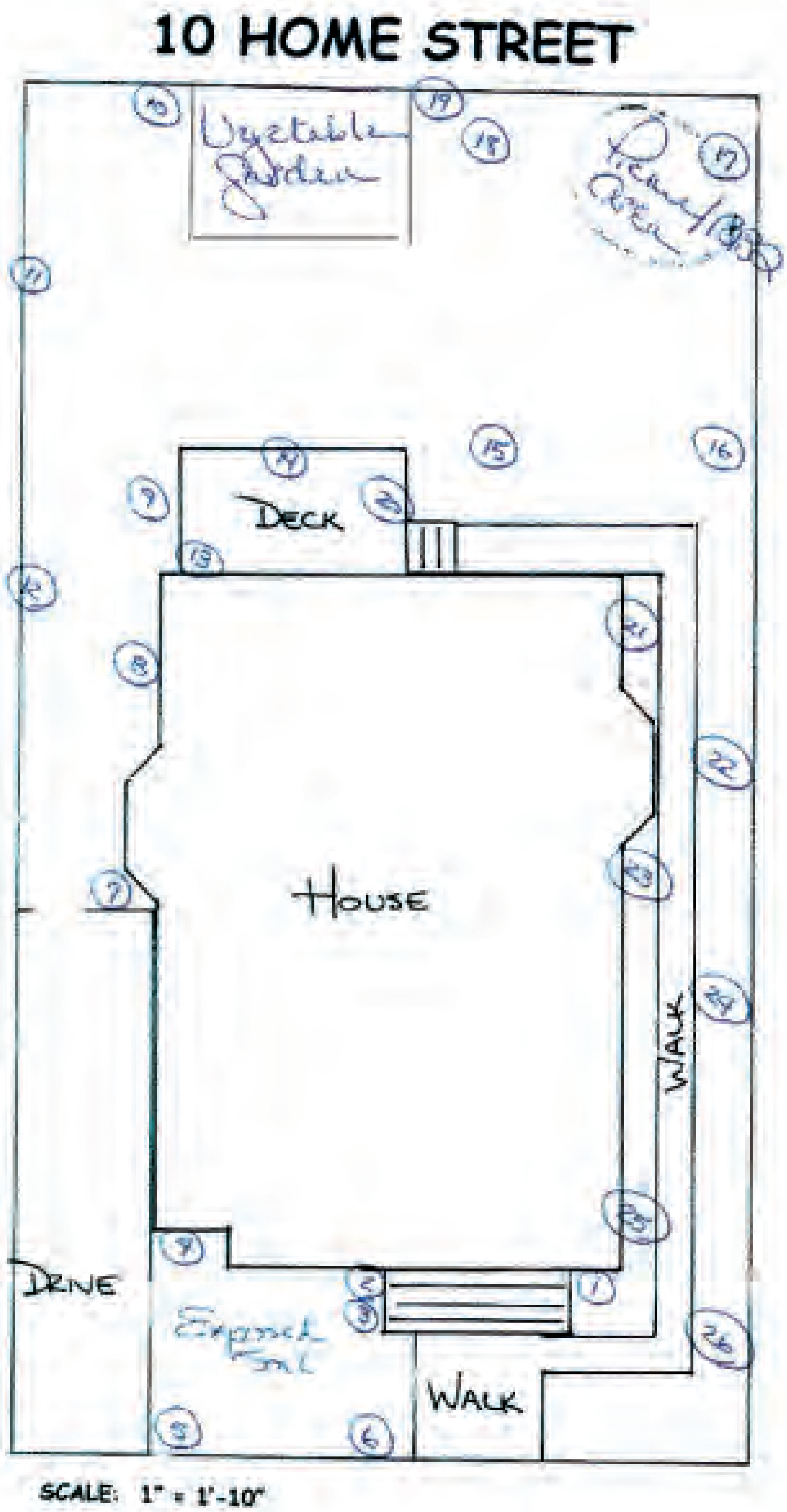
Site Address: 10 Home Street **Weather:** Clear/Cool 55°

Building Type: 2 Family **Lot Condition:** Very Clean

Yard Uses: Picnic Area/Vegetable Garden

SAMPLE I.D.	LOCATION	PPM-LEAD	COMMENTS
A-1-9	0	1772 ± 303	
A-2-9	11	2510 ± 262	
A-3-9	11	3104 ± 287	Repeat
A-4-1	25	4006 ± 309	
A-5-15	25	435 ± 113	
A-6-15	12	705 ± 129	
A-7-4	21	3987 ± 426	
B-8-1	39	3657 ± 305	
B-9-1	60	1432 ± 175	
B-10-1	34	643 ± 113	
B-11-9	69	550 ± 106	
B-12-9	38	1141 ± 137	
C-13-1	0	2940 ± 267	
C-14-18	10	532 ± 118	
C-15-18	26	518 ± 122	
C-16-18	39	738 ± 130	
C-17-32	26	527 ± 109	
C-18-32	10	466 ± 95	

A = front, B = left, C = rear, D = right
Location = distance from right corner of house



LEAD LEVELS COLOR KEY

5000 or more ppm (Very High)

Must be treated with a permanent barrier.
Unsafe for all types of gardening.

2000-5000 ppm (High)

Treatment is necessary for any recreational use by children or adults and for pet areas.
Unsafe for all types of gardening.

400-2000 ppm (Moderately High)

Treatment is recommended for use as a children's play area and for gardenin especially vegetable gardening.

400 or less ppm (Low)

No treatment is necessary for most uses by children, adults, and pets.

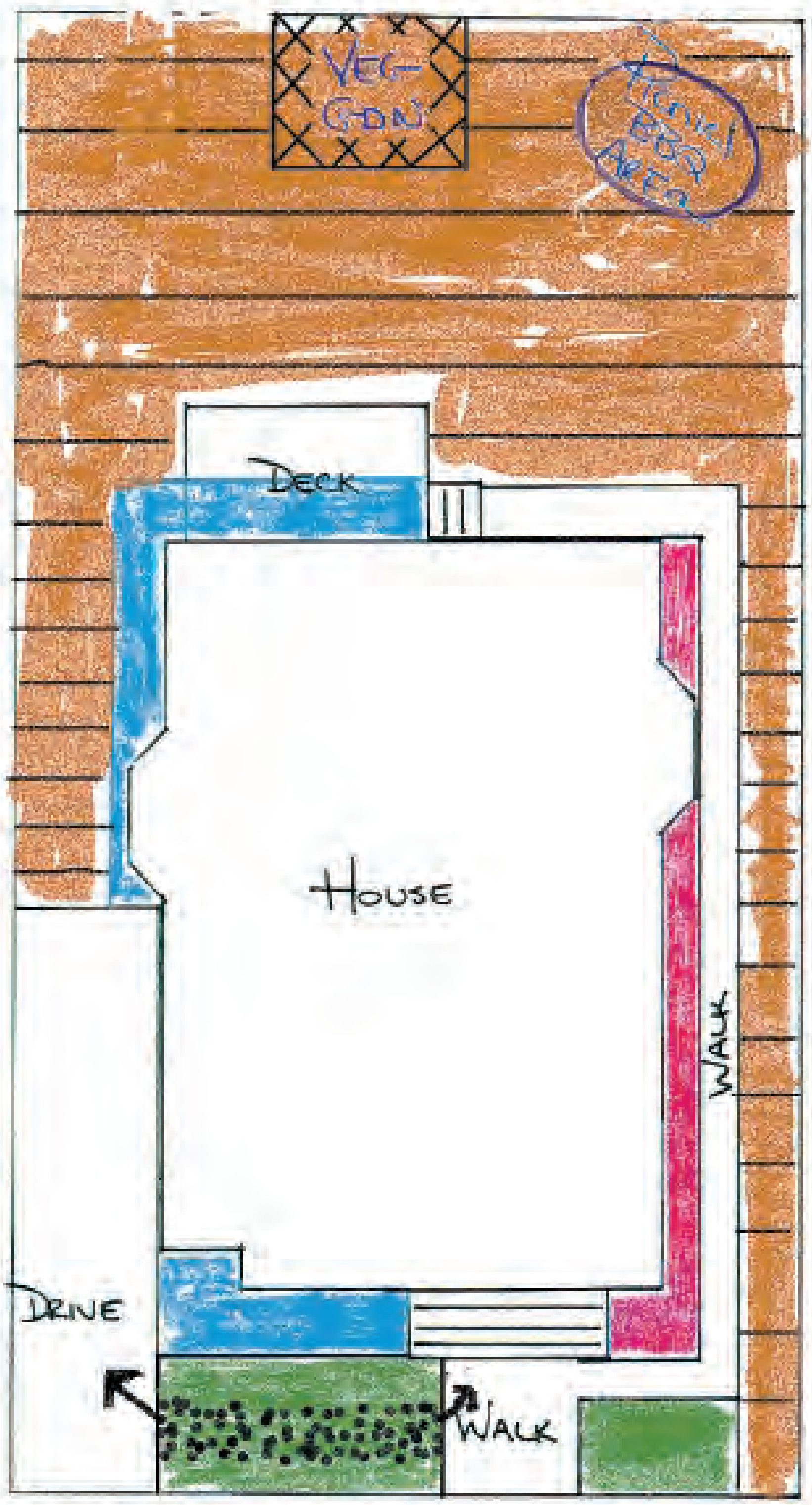
YARD USE PATTERN KEY

DOTS
High Traffic Area (Exposed Soil)

LINES
High Risk Use Area
(Play Area or Vegetable Garden)

CROSS HATCH
Recreation Area (Picnic or BBQ)

10 HOME STREET



SCALE: 1" = 1'-10"

LEAD LEVELS COLOR KEY

5000 or more ppm (Very High)

Must be treated with a permanent barrier.
Unsafe for all types of gardening.

2000-5000 ppm (High)

Treatment is necessary for any recreational use by children or adults and for pet areas.
Unsafe for all types of gardening.

400-2000 ppm (Moderately High)

Treatment is recommended for use as a children's play area and for gardening, especially vegetable gardening.

400 or less ppm (Low)

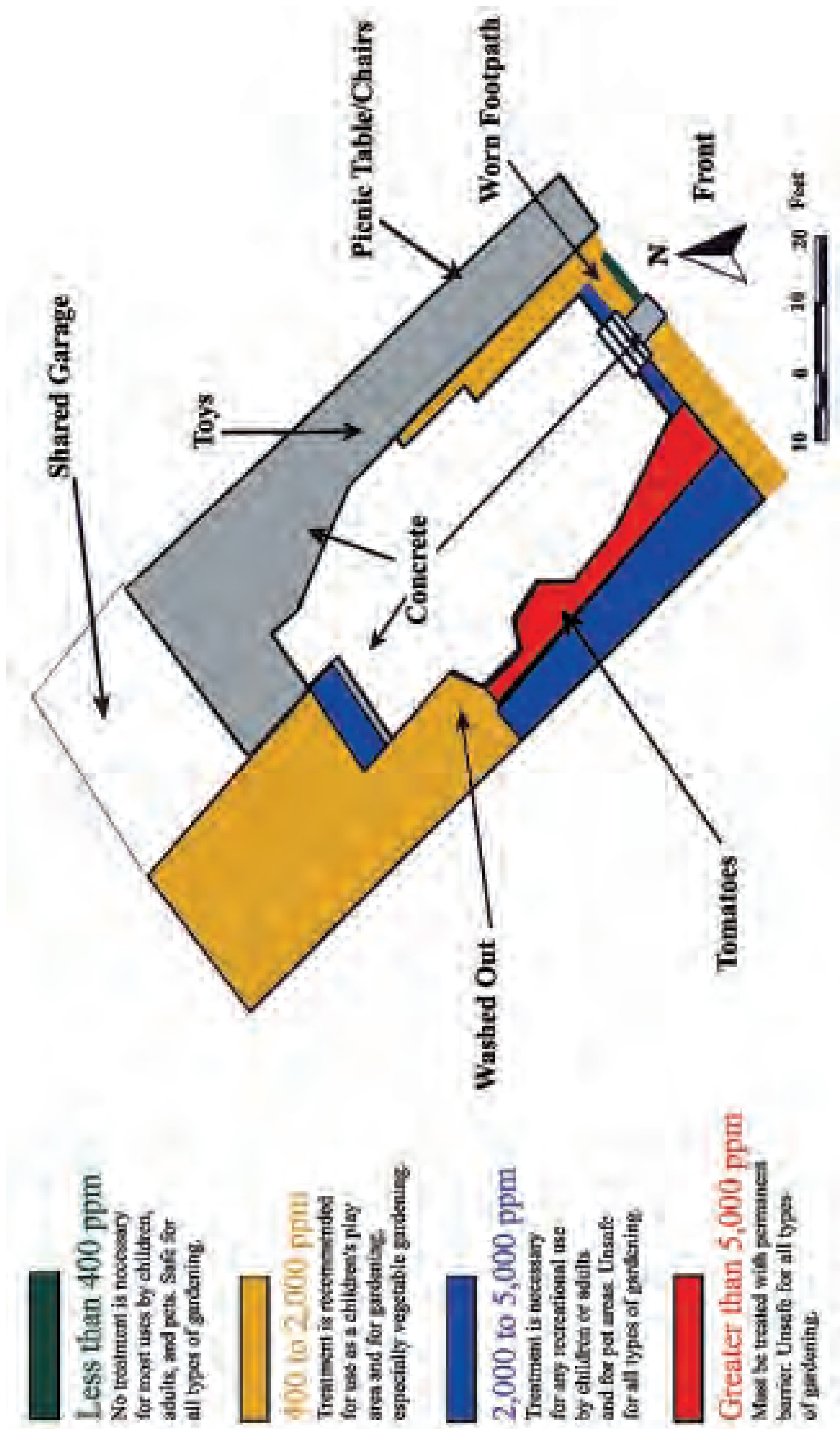
No treatment is necessary for most uses by children, adults, and pets.

YARD USE PATTERN KEY

DOTS
High Traffic Area (Exposed Soil)

LINES
High Risk Use Area
(Play Area or Vegetable Garden)

CROSS HATCH
Recreation Area (Picnic or BBQ)


Shared Garage
Toys
Concrete
Picnic Table/Chairs
Worn Footpath
Front
N
10 0 10 20 Feet
Washed Out
Tomatoes
Less than 400 ppm
No treatment is necessary for most uses by children, adults, and pets. Safe for all types of gardening.
400 to 2,000 ppm
Treatment is recommended for use as a children's play area and for gardening, especially vegetable gardening.
2,000 to 5,000 ppm
Treatment is necessary for any recreational use by children or adults and for pet areas. Unsafe for all types of gardening.
Greater than 5,000 ppm
Must be treated with permanent barrier. Unsafe for all types of gardening.

7 Yard Treatments

Once you have sampled and analyzed a property's soil and determined that a lead hazard exists, the process of designing and implementing landscape treatments can begin. This chapter provides guidance on matching treatments to the hazards you've identified (Section 7.1), and describes specific low-cost treatment measures used by the EMPACT Lead-Safe Yard Project (Section 7.2). The chapter also covers the many "nuts and bolts" issues involved in the treatment process, including:

- Developing a budget for each yard treatment (Section 7.3).
- Meeting with the homeowner to explain the sampling results and areas of concern and to develop/review the treatment plan (Section 7.4).
- Contracting with a landscaper to complete all design and landscaping work on the property (Section 7.5).
- Establishing guidelines to ensure landscaper health and safety (Section 7.6).
- Securing the homeowner's approval and signoff on completed work (Section 7.7).
- Reviewing and approving landscaping work prior to final contractor payment (also in Section 7.7).

If you are a homeowner interested in learning about low-cost landscaping measures for reducing children's exposure to lead in soil, you can focus on Sections 7.1, 7.2, and 7.6. (**Section 7.6, Health and Safety for Landscapers, is essential reading for anyone who intends to do landscaping work in a lead-contaminated yard.**) You should also read Chapter 8, which covers the development of a maintenance plan for the finished yard—a critical part of the treatment process.

Sections 7.3, 7.4, 7.5, and 7.7 present detailed information for those responsible for implementing a lead-safe yard program.

7.1 Matching Treatments to Hazards

There are many ways of protecting children and other people from the hazards of lead-contaminated yard soil. Possible methods include removing and disposing of the contaminated soil, covering it with a permanent barrier such as asphalt, covering it with a non-permanent barrier such as mulch or grass, or changing the way people use their yard to reduce exposures.

To select the best method or methods for a particular property, you need to consider a number of factors, including the level of lead contamination, the frequency and extent of potential exposures, the homeowner's esthetic preferences, the cost of the protective measure, the amount of maintenance it will require, and its likely effectiveness. Protective measures can vary greatly both in the level of protection they provide and in their associated costs. Soil removal, for example, can completely eliminate a soil hazard, whereas use of a non-permanent barrier such as grass cannot. However, soil removal can be prohibitively expensive for many people due to the high cost of soil excavation, transportation, and disposal.

The EMPACT LSYP was created to develop low-cost landscape measures that protect children against exposure to high lead levels in yard soil. The landscape measures described in this handbook were selected for four main reasons:

- They are relatively inexpensive.
- They can be implemented by the homeowner or a program partner with a minimum of tools and experience.
- They are attractive and enhance the value of the yard.
- They are effective in reducing lead concentrations at the yard surface, and they therefore effectively reduce the potential for children's exposures.

All of the measures presented here could be characterized as interim controls. None provide the sort of permanent protection you could achieve through soil abatement (that is, by removing or paving contaminated soil), nor are they meant as a substitute for abatement. In fact, in circumstances where soil-lead levels are greatly elevated (i.e., above 2,000 ppm) and the possibility of children's exposure is high (i.e., in residential settings), federal regulations recommend or require abatement of the soil hazard (see Section 3.4.3).

The EMPACT LSYP encourages homeowners to follow all federal and state requirements and guidance for soil abatement that apply to them. But the project also recognizes that there will be many situations where homeowners and community organizations cannot afford the cost of abatement measures. In such situations, these landscape measures can provide some degree of long-term, effective protection so long as they are properly applied and well maintained. The key is selecting the right measures based on the existing lead hazards.

7.1.1 Combining Treatment Measures

So how do you choose among the treatment measures presented in this handbook? Your goal in developing a treatment plan is to achieve a delicate balance between the safe use of the yard and the existing lead levels. To do this, you should combine two main approaches:

- **Altering the surface cover.** Select landscape measures that provide a sufficient barrier, based on the soil-lead levels and the types of yard use.
- **Altering the yard use patterns.** Encourage safe yard uses, and discourage certain activities (e.g., gardening, children's play) in the areas of highest contamination. These activities may need to be relocated to a safer part of the yard.

In many cases, you will need to design different treatments for each of the yard areas evaluated during the sampling process: the house dripline, areas of bare soil, areas of unique use such as children's play areas and picnic and gardening areas, and other areas. The illustration on page 86, Characteristics of a Lead-Safe Yard, shows how a number of treatment measures can be combined to create a yard that is safe and attractive and meets the needs of the homeowner and/or residents. In other cases, you may only have to address a single yard area, such as the dripline (where soil-lead levels are usually found to be highest).

The table on page 85 presents a list of treatment measures used by the EMPACT LSYP at specific soil-lead levels. Each measure is described in greater detail in Section 7.2. However, before incorporating these measures into your own program, you should refer to Section 3.4.3 for a discussion of how the EMPACT treatment approach compares with the approach recommended under the

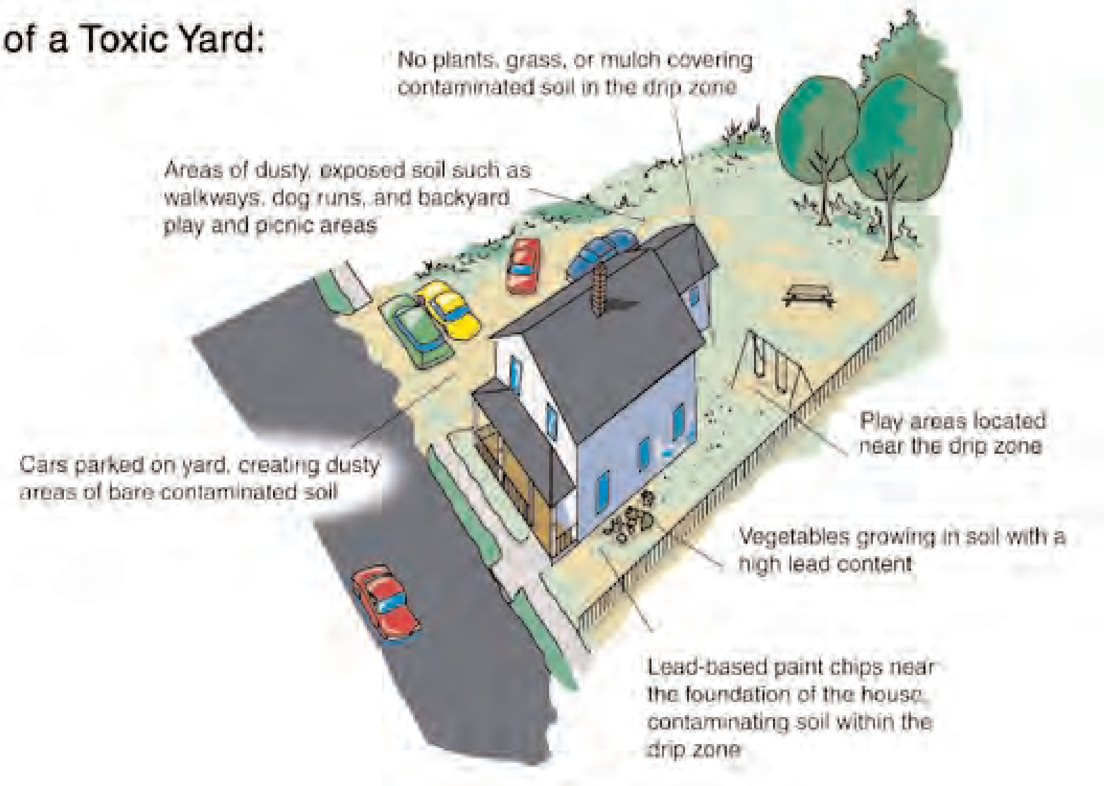
EMPACT LSYP TREATMENT MEASURES

Soil-Lead Level (parts per million)	EMPACT LSYP Treatment Measures
> 5,000 (very high)	If soil removal or permanent barriers are not possible: • Install semi-permanent barrier, such as a wood-framed dripbox filled with gravel or mulch. • Relocate gardens—unsafe for all types of gardening.
2,000–5,000 (high)	• Relocate gardens—unsafe for all types of gardening. • Relocate children's play area, pet area, and picnic area, if possible. If not, install wood platform or wood-framed raised play and picnic area filled with woodchips. • Install path of walking stones for high-traffic areas. • Seed and fertilize grassy areas, or cover with mulch or woodchips if not suitable for grass.
400–2,000 (moderately high)	• Install raised-bed garden and supplement with clean topsoil. • Install wood-framed raised play and picnic area filled with woodchips. • Install path of walking stones for high-traffic areas. • Seed and fertilize grassy areas, or cover with mulch or woodchips if not suitable for grass.
< 400 (urban background)	• No treatment necessary.

Characteristics of a Lead-Safe Yard

Signs of a Healthy Yard:

Signs of a Toxic Yard:



pending TSCA Section 403 rule (information about the rule can be found at http://www.epa.gov/lead/leadhaz.htm). Also keep in mind that decisions on specific landscape measures (e.g., choosing between mulch or grass, or between types of grass) must be made on a yard-by-yard basis to account for variables such as regional climate, yard topography, the amount of available sunlight, and the homeowner's esthetic preferences. These factors will often play a major role in shaping the final treatment plan for a property.

7.2 Treatment Options and Detailed Specifications

This section presents the specific landscape treatments used by the EMPACT LSYP. The treatment measures described here represent a suite of tools that the landscaper can use to address elevated soil-lead levels in specific yard areas: drip zones, grassed areas, parking areas, walkways, recreation and children's play areas, gardens, pet areas, and porches. As mentioned in Chapter 6, these are the high-risk and high-use yard areas where children are most likely to experience dangerous exposures to soil lead. For most of these yard areas, the EMPACT LSYP has developed two or more treatment options, giving the landscape designer some flexibility in selecting treatments that match both the homeowner's esthetic preferences and other variables such as yard topography and the amount of available sunlight.

It is important to keep in mind that not all treatments will be appropriate and/or effective at all locations. The treatments described here were selected by the EMPACT LSYP because they address the conditions found at a majority of sites in the project's target neighborhoods in Boston: high to very high soil-lead levels; inner-city homes that are typically wooden and covered with lead paint; high rates of yard use by children and families; and many areas of bare and partially bare soil. These landscaping measures also work well given Boston's variable climate, with its cold, wet winters and relatively hot, humid summers.

As you develop your own lead-safe yard program, you will no doubt want to pick and choose among the treatments presented here, rejecting some, revising others to fit your specific needs, and devising some entirely new treatments. The work you have done to get to know your target community (see Section 4.4) will help you in this process. In addition, you may want to consult local garden centers, nurseries, landscapers, and arborists for help selecting plants and grasses that will thrive in your area. If you live in an arid or semi-arid climate, for example, you may find yourself using plants that are very different from those used in the Northeast.

Once you have assembled a suite of treatment options that will work in your program area, you should develop detailed specifications that define exactly how the landscaping work should be done and what

PHYTOEXTRACTION: AN EXPERIMENTAL APPROACH

All of the treatment measures used by the EMPACT LSYP focus on employing grass, plants, and other materials as a barrier to reduce children's exposure to lead-contaminated soil. None of these treatments, however, remove the lead from the soil. Today, researchers are experimenting with another approach for using plants to actually extract lead and other contaminants from soil: phytoextraction.

As a technology, phytoextraction is still in its infancy. Researchers are still struggling with a number of questions, such as which plants best absorb certain contaminants, and how to make the technology affordable. The EMPACT LSYP does not use phytoextraction at this point, but may consider it in the future, as more information becomes available about its applicability in residential settings. See Appendix C for a detailed discussion about this promising technology.

materials should be used. These specifications should be provided to the landscaper and included with the landscaping contract (see Section 7.5.1) if you intend to engage a contractor. A set of sample specifications, developed by Lead Safe Boston and used by the EMPACT LSYP, is provided on pages 99 to 100.

7.2.1 Drip Zones

A perimeter mulch bed covering the drip zone.

The drip zone is the narrow 3-foot strip around the foundation of the house. There, soil-lead levels are usually highest, because lead-based paint on the outside of older homes weathers over time and falls into the top layer of soil adjacent to the foundation, contaminating it. Play areas, picnic areas, and vegetable gardens must be located away from the drip zone. In addition, covering the zone with a permanent or semi-permanent barrier provides long-term protection from the contaminated soil.

The EMPACT LSYP uses raised perimeter boxes that not only cover the contaminated soil in the drip zone, but also prevent erosion and offsite transport of the soil and allow for continued weathering of the exterior. Built from 2" by 6" ACQ (Alkaline Copper Quaternary) pressure-treated lumber, the boxes are lined with a filter-fabric weed barrier and then filled with either gravel or mulch and plantings, depending on the homeowner's preference. Plantings, such as evergreen shrubs, azaleas, boxwoods, holly, or thorny bushes, help keep children and pets away from the drip zone. Plantings used by the EMPACT LSYP are listed in the sample specifications on page 99. Consult a local garden center, nursery, or arborist to select plantings appropriate for your area.

7.2.2 Grassed Areas

Maintaining a healthy lawn is one of the best ways to reduce exposure to lead-contaminated soils. A healthy lawn acts as a natural barrier between people and contaminated soils, and provides a safe outdoor space for play and relaxation. Lawns require routine maintenance with water and fertilizer, and should be protected from foot traffic for the first 3 to 4 weeks after seeding. Consult a local garden center or lawn care professional to select grasses that will grow in the soil and climate conditions found in your region. In areas of heavy foot traffic or low light where grass won't grow well, install a stone path or raised mulch bed to cover all bare soil.

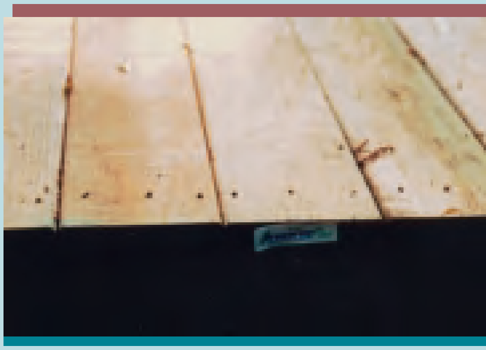
Top: Before—bare soil in drip zone (1660 ppm).
Bottom: After—mulched planting bed covering soil.

- **Existing lawn improvement.** Improvement of an existing lawn can be accomplished quite inexpensively. Rake bare areas to loosen the soil, apply seed mix at the rate specified by the manufacturer, then apply ¼" of top soil over new seed. Water thoroughly.

- **New lawn installation (at existing grade).** Where little or no grass exists on a lawn, the entire lawn area should be rototilled and reseeded (apply water to contain dust during rototilling). Spread ¼" of loam (soil composed of sand, clay, silt, and other organic matter) on top of the seed, then water thoroughly.

Two months post treatment. Lawn growth over previously bare, contaminated soil (1,770 ppm).

- **New lawn installation (raised bed).** For sloped yards, the EMPACT LSYP sometimes uses raised grass beds to create a terraced effect and limit runoff and erosion. A raised grass bed can also be installed in areas where roots or rocky soil prevent grass from growing. In a perimeter box made of 2" by 6" ACQ pressure-treated lumber, install 6" of loam over filter fabric weed barrier. Apply seed mix, then spread ¼" of loam on top of seed and water thoroughly.



Wood platform built with ACQ lumber.

LESSONS LEARNED: USING ACQ PRESSURE-TREATED LUMBER FOR ADDED SAFETY

Over the past 30 years, pressure-treated lumber has become standard for outdoor construction because it deters rot, decay, and termite destruction. The EMPACT Lead-Safe Yard Project used pressure-treated wood for these reasons during its first two years of yard treatments. Recently, however, there has been a growing awareness of the dangers posed by chemicals used in the traditional wood-treatment process. There is some evidence that these chemicals, which include the EPA-listed hazardous compounds arsenic and chromium, can leach out of pressure-treated wood and into the environment.

During its third phase of yard treatments, the EMPACT LSYP began using a relatively new type of pressure-treated lumber: ACQ Preserve. ACQ-treated lumber contains no EPA-listed hazardous compounds and is guaranteed to protect against rot, decay, and termites. In other words, it offers all of the values of traditional pressure-treated lumber with fewer hazards. This is especially important when you use wood in and around gardens and children's play areas, as the EMPACT LSYP does. Costs of ACQ-treated wood vary, though the EMPACT LSYP has found these costs comparable to the costs of traditional pressure-treated wood. For an information sheet on ACQ-treated wood, go to http://www.conradwp.com/acq.htm.

- **Raised mulch bed (with or without plantings).** Raised mulch beds can be used to cover areas of bare soil where grass won't grow well. The beds can serve as children's play areas, or can be filled with various plantings to form an attractive garden area. Install a perimeter box made of 2" by 6" ACQ pressure-treated lumber to completely cover bare soil area. Install 4" of loam and 2" of pine bark mulch over filter fabric weed barrier. Select plantings that are appropriate for the area (e.g., shade, partial shade, full sun; arid or semi-arid soil). Provide recessed egress stepping-stones from the bed to an existing walkway.

7.2.3 Parking Areas

Cars parked on yards destroy grassed areas, turning them into dusty areas of bare contaminated soil. Cars should be confined to designated parking areas covered with gravel or asphalt. Heavy landscape timbers can be sunk at the perimeter of the parking area to define the edge and prevent stones from spreading into grass areas. All lots, whether gravel or asphalt, should have at least a 2-percent pitch across the surface to ensure that water will not puddle. Detailed specifications for creating a gravel or asphalt parking area are included on page 99.


A stone driveway.


Install stepping stones to prevent contaminated soil from being tracked into the house.

7.2.4 Walkways

Worn dirt paths create dust. By installing stepping stones in areas where people regularly walk, you keep contaminated soil from being tracked into the house. Alternatives include concrete walks, cement stepping stones, gravel over filter fabric, recycled concrete, and brick paths.

7.2.5 Recreation and Children's Play Areas

If possible, swing sets, sand boxes, and other children's play areas should be relocated away from the drip zone and other areas of highly contaminated soil. The same is true for picnic, barbecue, and other family recreation areas that receive heavy use. If relocation is not possible, the EMPACT LSYP uses one of two options:

- **Wood Platform**. A wood deck, made from ACQ pressure-treated 2" by 6" stock, can serve as a site for picnics, cook-outs, and children's play, and provides long-term protection from contaminated soil. Decking should be installed with a ¼" pitch to drain rainwater off the surface.

- **Raised bed filled with mulch or woodchips.** Raised beds can be used to cover areas of bare and/or highly contaminated soil. The beds provide an effective barrier and a safe, attractive place for children's play and family gatherings. Install a perimeter box made of 2" by 6" ACQ pressure-treated lumber, then install 4" of loam and 2" of pine bark mulch or woodchips over filter fabric weed barrier.

7.2.6 Gardens

Homeowners and residents should take precautions when gardening in or around lead-contaminated soil. Though plants generally do not accumulate lead, it is possible for a plant to absorb some lead in settings where soil-lead levels are very high. In addition, lead-contaminated dust can settle on the surface of garden plants.

Basic precautions include washing all vegetables with a vinegar-water solution, locating gardens away from roads and highly contaminated yard areas, and planting crops that are less likely to absorb or accumulate lead. In general, this means planting fruiting crops (e.g., corn, beans, squash, peppers, cucumbers, tomatoes, strawberries, apples) and avoiding root crops and leafy vegetables (e.g., carrots, radishes, lettuce, collard greens, spinach) since they are more likely to absorb lead from soils or become coated with lead-contaminated dust. Two excellent resources on lead in gardens are:

Lead in the Home Garden and Urban Soil Environment,
by Carl J. Rosen and Robert C. Munter
http://www.extension.umn.edu/distribution/horticulture/DG2543.html

Lead Contamination in the Garden, a fact sheet by Terry Logan
http://ohioline.ag.ohio-state.edu/hyg-fact/1000/1149.html

The EMPACT LSYP recommends relocating gardens away from the drip zone and other areas of highly contaminated soil. The EMPACT LSYP treatment approach recommends using raised beds in areas of moderate contamination (400 to 2,000 ppm). (Please refer to Section 3.4.3 for a discussion of how the EMPACT treatment approach compares with the approach recommended under the pending TSCA Section 403 rule.) Beds should be framed with 2" by 8" ACQ pressure-treated wood, lined with a filter-fabric weed barrier, then filled with 6" of loam that has been tested for lead levels (levels over 400 ppm are unacceptable). Gardening is considered safe in yard areas where lead levels are below 400 ppm.

7.2.7 Porches

The soil found underneath porches is often contaminated with lead from paint chips and with other chemicals that leach from pressure-treated wood used in outdoor construction. Because it receives little sunlight, this soil is also naturally bare. The EMPACT LSYP has developed two strategies to discourage children from playing in contaminated soil beneath porches:

- **Lattice and Trim Barricade.** All exposed soil under porches is to be barricaded by ACQ wood framing, lattice, and pine trim. Prep, prime, and paint pine trim or apply two coats of wood sealant. Install a framed access door of like material. If loose soil is likely to be blown out from under porches, a covering of gravel or pea stone over bare soil would be appropriate.

- **Raised bed filled with mulch or gravel.** Install a wood box made from 2" by 6" ACQ pressure-treated lumber along footprint of porch. Line the box with filter-fabric weed barrier, then fill with either 2" of loam and 3" of pine bark mulch or 3" of loam and 2" of crushed stone.

Top: Before—bare soil under porch deck.
Bottom: After—area barricaded with lattice and trim.

7.2.8 Pet Areas

By tracking lead-contaminated soil and dust indoors, dogs and other pets can be a major source of lead exposure for humans. Pets that play regularly in certain parts of the yard can also create dusty areas of bare contaminated soil. If possible, pet areas should be located away from areas of highly contaminated soil. If not, install a wood box made from 2" by 6" ACQ pressure-treated lumber to completely cover the bare soil area. Line the box with a filter-fabric weed barrier, then fill it with 4" of loam and 2" of pine bark mulch or woodchips.

7.3 Developing a Budget for Each Yard Treatment

Once you have selected a suite of treatment measures for your program, you may want to develop a standard budget that can be used to guide each yard treatment. This budget will represent the maximum amount that the landscaper is authorized to expend in designing and implementing a treatment plan for each home.

Three main factors will drive the budget development process: the amount of funding available to your program, the number of yards you hope to treat, and the actual costs of materials and labor needed to create a lead-safe yard. Some yards will obviously cost more than others to treat. Your goal is to establish a reasonable budget for an average yard, with the possibility of authorized cost overruns at certain yards where treatments turn out to be unusually expensive.

A sample budget developed by the EMPACT Lead-Safe Yard Project is shown on page 101. The budget was developed in two steps. First, the project team calculated an allowance for each individual treatment measure by estimating the total cost of labor and materials. There are a number of reference books that can help with this process. The RSMeans Company, for example, offers several such books, including *Means Site Work & Landscape Cost Data 2000* (ISBN 0-87629-547-2) and *Landscape Estimating, 3rd Edition* by Sylvia H. Chattin (ISBN 0-87629-534-0). These books can be found in some libraries and bookstores or ordered online (http://www.rsmeans.com). Keep in mind that labor and material costs vary by region. You may want to consult a local landscaper as you develop allowances for each measure.

Second, the project team identified ways in which the individual measures might be cost-effectively combined to create a lead-safe yard. The goal was to make the yard lead safe by addressing as many areas as possible within a set budget (in this case, $3,000), while giving homeowners some freedom to choose the types of landscape measures they prefer. Note that the budget includes a standardized construction management allowance of $500, which allows the landscaper to cover costs such as landscape design, permits and fees, a workmanship and materials warranty, insurance, construction oversight, and the development of a maintenance manual for the completed yard.

Remember that the standard budget you develop represents the maximum amount that the landscaper is authorized to expend for each yard. Some yard treatments will cost less than the maximum. For this reason, you should consider developing a standard cost estimate sheet that the landscape coordinator can complete for each yard. A sample cost estimate sheet is shown on page 102.

SOURCES OF FREE MATERIALS

Parks departments

Recycling centers

Tree services

Corporate sponsors

Local nurseries

LESSONS LEARNED: ESTIMATING TREATMENT COSTS

The experience of the EMPACT Lead-Safe Yard Project illustrates the importance of accurately estimating the per-yard costs of materials and labor. At the inception of the project, the project team set a target of treating 70 yards over the first two years, with a goal of expending about $750 per yard in landscape labor and materials that would be offered free to the participating homeowners. However, the project quickly found that treatment costs were running much higher than expected, partly because the project had chosen to employ a landscape team of city youths who were learning on the job (see also Section 4.2, "Selecting Program Partners"). The average cost per yard was roughly $2,100, with $300 going toward materials and $1,800 toward labor. Project management and indirect costs amounted to another $900 per yard. Because of these unexpected costs, the project was forced to scale back its objectives, though it still managed to treat 42 yards over the two-year period.

The EMPACT LSYP is currently investigating alternative models for organizing a lead-safe yard program that could reduce current average costs, in particular costs for labor, management, and overhead. For example, the EMPACT LSYP is investigating a model based on the principles developed by Habitat for Humanity, in which the work involved in achieving a lead-safe yard is carried out with the help of the homeowner by using volunteer labor and donated materials. See Appendix B for more information on this and other proposed models.

7.4 Homeowner Design Session

The EMPACT LSYP has found that it is critical to include the homeowner in designing landscape treatments for his or her yard. Why? First, the homeowner is the person who can best verify that the selected treatments provide enough actual protection from the lead-contaminated soil, based on the way the yard is used. Second, the homeowner is there to ensure that the selected landscape treatments meet his or her approval in terms of their esthetic value. A homeowner who is unhappy with the appearance or layout of his or her yard is unlikely to commit the money and effort needed to maintain the landscape treatments year after year.

Chapter 5 of this handbook described the necessity of creating a permission form to document the homeowner's participation in your lead-safe yard program. That permission form should also specify the homeowner's role in choosing treatment options, should soil-lead levels on his or her property turn out to be elevated. The homeowner design session is where these choices are made.

The EMPACT LSYP has tried using both the outreach worker and the landscape coordinator for the design session. The landscape coordinator is the better option. However, the outreach worker should facilitate a smooth transition for the homeowner from the outreach/sampling phase to the design phase. For example, the outreach worker should convey names, numbers, and any linguistic barriers to the landscape coordinator soon after the soil sampling is complete. The outreach worker may also want to attend the initial meeting between the landscape coordinator and homeowner to maintain a sense of familiarity, trust, and continuity for the homeowner. During the design session, the landscape coordinator will do three things:

1) **Communicate with the homeowner about the testing results.** Using the color-coded map developed during the data-collection phase, the landscape coordinator should describe the testing results, the areas of concern, and the need for changes.

2) **Ask follow-up questions about yard uses**. During their initial meeting, the outreach worker should have interviewed the homeowner about the activities that take place in the yard and the ages and numbers of people who use the yard. Yard uses should have been mapped on a plot plan using colored markers or crayons (see Section 5.3). During the design session, the landscape coordinator should review the yard uses with the homeowner and ask any follow-up questions.

3) **Work with the homeowner to select appropriate treatments based on the lead levels, the yard uses, and the homeowner's esthetic preferences.** The selected treatments should be mapped on the plot plan showing yard uses, and this treatment plan should be used by the landscaper as a blueprint for work to be done. A sample treatment plan is shown on page 103. See Section 7.1 above for guidance on matching treatments to hazards.

You may wish to develop a legally binding form that the homeowner can sign at the conclusion of the design session, stating that he or she understands and approves of the final treatment plan. A sample homeowner's approval form is included on page 104.

7.5 Contracting With a Landscaper

Early in the development of your lead-safe yard program, you will want to identify a program partner for the design and landscape components of your project (see Section 4.2, "Selecting Program Partners"). This could be a non-profit landscaping company, a private landscaping company, or even a team of youth volunteers who have been trained in landscaping techniques. Another option, currently being tested by the EMPACT LSYP, is to develop a pool of landscaping contractors trained at designing and implementing landscape treatments that can reduce exposure to lead-contaminated soil. Why create a contractor pool? By training and partnering with multiple contractors, you create competition—a market—for the work you have to offer, and you also build "capacity" within your community for this type of work. This is an important goal of your program: to increase your community's base of knowledge about soil-lead hazards and strategies for yard treatment.

No matter who you use for the design and landscape components of your project, you will need to develop a contract for the work. If you have chosen to use only a single landscaper, this process will be relatively straightforward: you will simply negotiate an agreement for the property or properties requiring treatment, and then capture the agreement in the form of a contract. Guidance on developing a contract is provided below.

If you have succeeded in creating a contractor pool, you will need to develop a system for choosing which contractor to use at a particular property. Here are two possible ways of doing this:

- **Group the properties geographically, then assign several to each contractor.** Under this scenario, each contractor is given a budget for each property he or she is assigned, and is asked to develop and implement a treatment plan within the budget. This method is relatively noncompetitive, in that contractors are not asked to bid against one another. However, over time, you can determine which contractors do the best and most cost-effective work, and then increase their workload.

- **Solicit bids for the property (or properties) requiring treatment.** This works best if you (or a professional landscape designer) have already developed a treatment plan for each property, identifying which landscape measures will be used. Each contractor is then given a copy of the treatment plan(s), along with detailed specifications for the work to be done, and is asked to submit a bid. The work goes to the lowest bidder. The disadvantage of this method is that the landscape contractor is not included in the development of the treatment plan.

Whatever method you use, you should consider assigning or awarding several properties at a time to each contractor, rather than one at a time. This allows contractors to benefit from the economies of scale when buying materials and planning their work.

7.5.1 Developing a Contract

To simplify the contracting process, you should develop a standardized contract for use at every property. This contract should define the scope of services the contractor will perform, the timeframe for the work, the contractor's legal responsibilities, and the details of compensation. The sample contract on pages 105 to 108 shows some of the details that should be incorporated into a standardized contract, including:

- **Warranty**—Contractors should provide a warranty guaranteeing their work from defects in workmanship and materials for a specified period. The EMPACT LSYP requires a one-year warranty from its contractors.

- **Draws**—The term "draws" refers to the timing of compensation. Many contractors will want one-third of their compensation up front, one-third at the halfway point, and the final third upon completion of the project. You should attempt to negotiate a payment schedule that is mutually acceptable, though you should keep in mind that draws are typically market-driven.

- **Insurance**—Each contractor should be required to maintain general liability and workman's compensation insurance to protect against claims due to bodily injury or property damage and claims under state workman's compensation acts.

- **Pollution insurance**—Most general liability insurance policies do not cover injury or illness caused by pollution (for example, illness caused by lead exposure). You should look into the costs and the potential necessity of pollution insurance in your state and consider encouraging contractors to purchase such insurance.

7.6 Health and Safety for Landscapers

Before any field work begins, your program should develop safety guidelines that protect your soil sampling team and landscape workers from the risks associated with working with lead-contaminated soil. All field workers should be educated about lead hazards, health effects, safe work practices, and any federal or state regulations that apply to their work.

OSHA regulation 1926.62, the "lead in construction standard," applies to all private sector workers, no matter how few are employed. Although it does not apply to workers in the public sector, it is nevertheless a useful reference on responsible practices. The regulation, available online at http://www.osha-slc.gov/OshStd_data/1926_0062.html, requires a written description of the work to be done, an estimate of the anticipated exposure to lead, and a statement detailing the precautions to be taken. If the anticipated exposure to lead reaches the "action level"—30 micrograms per cubic centimeter of air, averaged over an 8-hour day—extensive guidelines come into play to protect workers.

Since the lead to which landscapers in the EMPACT LSYP are exposed falls below the action level, compliance with the lead in construction standard has not been difficult. However, to be on the

LEAD-SAFE YARD PROGRAM HEALTH AND SAFETY

I. Primary route of entry of lead into the body is ingestion:

A. Lead can enter the body through normal hand-to-mouth activities.

B. Small amounts of lead left on hands or clothing can impact blood lead levels.

C. Lead-contaminated soil can be transferred to the interior of dwelling (by pets, shoes, clothing).

II. Preventive measures:

A. Avoid dust-generating activities.

B. Dampen soil to minimize dust generation.

C. Keep children and pets away from area where work is being done.

D. Wear leather or comparable work gloves to minimize hand contamination.

E. Do not smoke* or eat while in work area.

F. Wash face and hands before smoking* or eating.

G. Remove shoes/boots before entering a dwelling to limit contaminated soil transfer.

H. Wash work clothing separately from other clothing.

*** Do not smoke at all.**

safe side, the project has adopted an important contract requirement that goes beyond what OSHA stipulates for enterprises whose employees are exposed to lead below the action level. This requirement is health and safety training for landscapers. One of the main points conveyed in the training is that lead enters the body chiefly through ingestion, which happens as a result of routine hand-to-mouth activities such as eating, drinking, and smoking. An information sheet used in the training is shown in the box, "Lead-Safe Yard Program Health and Safety."

Even small amounts of lead on the hands can affect blood lead levels. Also, lead on clothing is easily transferred to the hands, and then from the hands to the mouth. Another danger is that lead will be brought into the home on landscapers' clothing, especially their boots or shoes.

A key precaution is to avoid activities that generate dust. When the ground must be disturbed, as is often the case in landscaping, it should be dampened to minimize the dust that may be generated. Leather or comparable work gloves should be worn to cut down on hand contamination, and landscapers should not eat, drink, or smoke in the work area. After they leave, they should wash their face and hands before doing any of these activities. They should remove their boots or shoes at the door of their home to keep from tracking in contaminated soil, and they should wash their work clothing separately from their other clothing.

Blood lead tests are advisable to make sure such measures are effective, and in fact are mandated by OSHA for employees exposed to lead at or above the action level. Almost any doctor at almost any clinic can perform this service, but an occupational health physician and an occupational health clinic are recommended, primarily for skillful interpretation of test results.

Landscapers should have their lead levels taken before doing any work and then every two months for the next six months. If levels are still less than 40 µg/dL, the time between tests can increase to six months. If levels are between 40 and 50 µg/dL, testing should continue every two months. Levels above 50 µg/dL should trigger monthly testing, and if they don't decrease, the landscaper should be removed from the work area. However, this step may well be avoided. As soon as blood lead levels rise, employers should try to find out why and remedy the situation. Often the cause is some break in the accepted work practices, which can be handled by re-educating the employee.

The EMPACT LSYP has not seen any elevated blood lead levels among its team members as a result of exposure to lead in soil during landscaping work.

7.7 Approval and Signoff on Work Complete

After all landscape work and construction is complete, both you and the homeowner should inspect the property. You should look for the following things:

- That all landscape treatments have been successfully implemented as per the scope of work agreed to during the design session.
- That, for each treatment measure, the landscaper has followed the detailed specifications defining exactly how the work should be done and what materials should be used.
- That the property has been left in a clean state. The homeowner must approve any material remaining on site after completion of the landscape work.

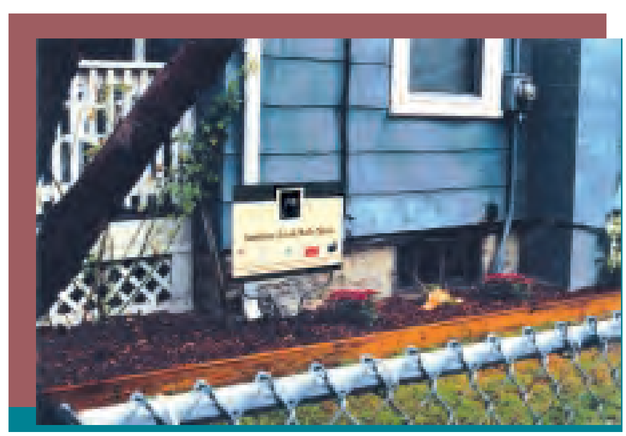
This process of approving the completed work can be as formal or informal as you want to make it. During Phases 1 and 2, the EMPACT LSYP approved each yard treatment during an informal visit between the outreach worker and the homeowner (the outreach worker also used these visits to reinforce the lead hazard education delivered during previous visits). On the other hand, Lead Safe Boston, a spinoff of the EMPACT LSYP run by the City of Boston, has developed a legally binding project completion certificate (see page 109) to be signed by the homeowner and the landscape contractor after the property has been inspected and all work approved. The certificate also serves as a lien waiver, in which both the homeowner and contractor discharge Lead Safe Boston from any legal claims that may arise in connection with the work performed under the program.

Lead Safe Boston has also created an additional form (see page 110) for the contractor to sign upon receipt of final payment. The form certifies that the contractor:

- Has paid all debts associated with the work done on the property.
- Discharges the program and the homeowner from any claims made by subcontractors, material suppliers, or workers, in connection with the work performed under the program.
- Has completed all work on the property according to the terms of the contract.
- Warrants the completed work against workmanship and material defects for the period stipulated in the contract.
- Has been paid in full for all work complete.

7.8 Handing Over the Case File

At the conclusion of the yard treatment process, after all landscape work has been inspected and approved, you should present the homeowner with the case file that has been developed for his or her property. This file should be a binder containing all information related to the property, including copies of application and permission forms, testing results, treatments plans, and approval forms. The binder should also contain a copy of the maintenance manual that the landscape coordinator develops for the property (see Chapter 8). Keep a copy of each case file for your program's records.



A finished project.

7.9 For More Information

For information on U.S. EPA's proposed standards (TSCA 403) for lead-based paint hazards (including lead-contaminated residential soils), visit the Office of Pollution Prevention and Toxics at http://www.epa.gov/lead/leadhaz.htm.

The Department of Housing and Urban Development's Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally Owned Residential Property and Housing Receiving Federal Assistance (24 CAR Part 35) can be found online at http://www.hud.gov/lea/.

For an information sheet on ACQ pressure-treated lumber, go to http://www.conradwp.com/acq.htm.

Two excellent resources on lead in gardens are:

> *Lead in the Home Garden and Urban Soil Environment*, by Carl J. Rosen and Robert C. Munter, http://www.extension.umn.edu/distribution/horticulture/DG2543.html
>
> *Lead Contamination in the Garden*, a fact sheet by Terry Logan, http://ohioline.ag.ohio-state.edu/hyg-fact/1000/1149.html

The RSMeans Company publishes two reference books that can help with the process of estimating landscaping costs. The books, *Means Site Work & Landscape Cost Data 2000* (ISBN 0-87629-547-2) and *Landscape Estimating, 3rd Edition* by Sylvia H. Chattin (ISBN 0-87629-534-0), can be ordered online at http://www.rsmeans.com.

Information on OSHA's "lead in construction standard" (OSHA Regulation 1926.62) can be found online at http://www.osha-slc.gov/OshStd_data/1926_0062.html.

Sample Specifications for Yard Treatments

SUGGESTED PLANTINGS

Azalea evergreen hybrid (2 gallon)

Torch azalea (2 gallon)

Japanese boxwood (1 gallon)

Common boxwood (2 gallon)

American holly (2'-3')

Regal privet (18"-24")

Columbine (1 gallon)

Chrysanthemum (1 gallon)

Foxglove (1 gallon)

Day lily (1 gallon)

Black-eyed susan (1 gallon)

Hosta (1 gallon)

Drip Zone

Raised perimeter box filled with gravel (no plantings). Install 2" x 6" ACQ pressure-treated wood box 3' from foundation wall. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground to a minimum depth of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 3" of loam and 2" of ¾" crushed stone over filter fabric weed barrier.

Raised perimeter box filled with mulch and plantings. Install 2" x 6" ACQ pressure-treated wood box 3' from foundation wall. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground to a minimum depth of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 4" of loam and 3" of pine bark mulch over filter fabric weed barrier. Install a minimum of ten perennials per the list of plantings or approved equal.

Grassed Areas

Existing lawn improvement. Rake bare areas to loosen soil. Apply rye, fescue, and bluegrass seed mix at the rate specified by manufacturer. Apply ¼"of top soil over new seed and water thoroughly.

New lawn installation (at existing grade). Rototill existing lawn bed 6" deep. Apply water to contain dust during rototilling. Apply rye, fescue, and blue grass seed mixture at the rate specified by manufacturer. Spread ¼" loam on top of seed. Water thoroughly.

New lawn installation (raised bed). Install 2" x 6" ACQ pressure-treated wood box at owner-approved location. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 6" of loam over filter fabric weed barrier. Apply rye, fescue, and blue grass seed mixture at the rate specified by manufacturer. Spread ¼" loam on top of seed. Water thoroughly.

Raised mulch bed (with plantings). Install 2" x 6" ACQ pressure-treated wood box to completely cover bare soil area. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 4" of loam and 2" of pine bark mulch over filter fabric weed barrier. Install a minimum of ten perennials per the list of plantings or approved equal. Provide recessed egress stepping-stones from bed to walkway.

Parking Areas

Gravel parking areas. Install 6" of compacted gravel/crushed stone base to all areas designated as parking areas. Top of base shall be 2" to 3" below finish grade of surrounding area. Install a top layer of 1-1/2" to 2" of processed gravel or crushed stone (3/8" or ¾" size) over gravel/crushed stone base. Final grade is to have a minimum of 2% pitch across the surface to ensure that water will not puddle.

Asphalt parking areas. Level surface by preparing a 6" gravel base over a uniformly graded and compacted subgrade. Form, spread, and roll 2" of bituminous base coat and 1" topcoat to create a driveway 10' wide. Final grade is to have a minimum of 2% pitch across the surface to ensure that water will not puddle.

Walkways

Stone path. Install round or square red patio stepping stones at all egresses from front to rear yard. All stones shall protrude no more than ½" above the existing or new grade.

Recreation and Children's Play Areas

Raised play area. Install 2" x 6" ACQ pressure-treated wood box. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 4" of loam and 2" of pine bark mulch or woodchips over filter fabric weed barrier.

Wood platform. Install a 10' x 12' ACQ wood platform built from 2" x 6" stock, 16" on center with 5/4" x 6" radius edge decking. All decking and joints to be mechanically fastened with 3" galvanized screws. Platform shall be installed with a ¼" pitch to drain rainwater off of surface.

Garden Areas

Raised vegetable garden bed. Install 2" x 8" ACQ pressure-treated wood box at owner approved location. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 6" of loam over filter fabric weed barrier.

Pet Areas

Raised pet area filled with mulch or woodchips. Install 2" x 6" ACQ pressure-treated wood box to completely cover bare soil area. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 4" of loam and 2" of pine bark mulch or woodchips over filter fabric weed barrier.

Porches

Bare soil under porches (lattice and trim). All exposed soil under porches is to be barricaded by ACQ wood framing, lattice, and pine trim. Prep, prime, and paint pine trim or apply two coats of wood sealant. Install framed access door of like material. Include galvanized metal hasp and hinges.

Bare soil under porches (mulch bed). Install 2" x 6" ACQ pressure-treated wood box along footprint of porch. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 2" of loam and 3" of pine bark mulch over filter fabric weed barrier.

Bare soil under porches (gravel bed). Install 2" x 6" ACQ pressure-treated wood box along footprint of porch. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 3" of loam and 2" of ¾" crushed stone over filter fabric weed barrier.

SAMPLE BUDGET FOR YARD TREATMENTS

	Allowance
House perimeter (drip zone) Each house receives approximately 150 l.f. of perimeter raised boxes installed 3' from foundation wall where feasible. (Exceptions to perimeter boxes are existing asphalt/concrete paving, bulkhead, under rear porches, etc.). Fill perimeter boxes with homeowner's choice of:	
Option #1: 6" of pine bark mulch, filter fabric, and ten 1-gallon plantings (i.e., common boxwoods, azaleas, holly, or equal). Plantings to include compost/top soil/manure.	$1060.00
Or Option #2: 4" of gravel, filter fabric (no plantings).	$1060.00
Bare soil area under rear porch area (all areas matching this criteriaon to receive treatment)	
Option #1: Barricade exposed soil by wood framing and lattice secured to porch framing/supports. Install access door of like material with hasp.	$350.00
Or Option #2: Area under porch to received raised perimeter boxes, filter fabric, and installation of 6" of pine bark mulch or 4" of gravel.	$ 350.00
Back yard (homeowner to choose one option)	
Option #1: Each house shall receive a 10' x 12' wood platform built from 2" x 6" ACQ stock, 16" o.c. with 5/4" x 6" radius edge decking.	$780.00
Each house shall also receive approximately 10' x 12' area of lawn. Treatment to include rototilling soil 6" deep, installing filter fabric, adding 6" of conditioned top soil to be spread by hand, perimeter edging to be constructed of 2" x 6" ACQ stock, and a 6# shade mix to be installed by push spreader.	$250.00
Or Option #2: Each house shall receive a 10' x 12' wood platform built from 2" x 6" ACQ stock, 16" o.c. with 5/4" x 6" radius edge decking.	$780.00
Each house shall also receive approximately 10' x 12' garden area. Treatment to include rototilling soil 6" deep, installing filter fabric, adding 6" of conditioned top soil to be spread by hand, perimeter edging to be constructed of 2" x 6" ACQ stock.	$250.00
Or Option #3: Each house shall receive approximately 20' x 24' area of woodchips. Treatment to include installation of filter fabric, adding 2" of topsoil spread by hand and covered with 6" of woodchips, and installation of perimeter edging to be constructed of 2" x 8" ACQ stock.	$905.00
Each house shall also receive misc. treatments to adjoin mulched area to egresses. Misc. treatments to include up to 30 additional 12" x 12" red patio stepping stones, misc. plantings, additional mulching, etc.	$125.00
Walkways	
Each house shall receive up to 30 red patio stepping stones, 12" x 12", to be used at major egresses.	$60.00
SUBTOTAL (house perimeter, rear porch, back yard, and walkways)	$2500.00
CONSTRUCTION MANAGEMENT ALLOWANCE (general requirements; landscape design and site development; construction oversight; homeowner education and maintenance manual development)	$500.00
TOTAL (APPROXIMATE) COST PER LOT	$3000.00

SAMPLE COST ESTIMATE SHEET

Property address: ______________________________

____

House perimeter (homeowner to choose one option)

Option #1 ________ l.f.

Perimeter box with pine bark mulch, filter fabric, and plantings. $__________

Or Option #2 ________ l.f.

Perimeter box with gravel, filter fabric; no plantings. $__________

Bare soil area under rear porch area (all areas matching this criteria to receive treatment)

Option #1

Wood framing, lattice, access door, stepping stones. $__________

Or Option #2

Raised perimeter boxes, filter fabric, and mulch or gravel. $__________

Back yard (homeowner to choose one option)

Option #1

Installed 10' x 12' x 6" ACQ wood platform. $__________

New 10' x 12' area of lawn with ACQ perimeter edging. $__________

Or Option #2

Installed 10' x 12' x 6" ACQ wood platform. $__________

New 10' x 12' x 6" garden area framed with ACQ wood. $__________

Or Option #3

New 20' x 24' x 8" area of woodchips framed with ACQ wood. $__________

Stepping stones, misc. plantings, additional mulching, etc. $__________

Walkways

Egress stepping stones. $__________

Misc. treatments:

Existing lawn improvement. $__________

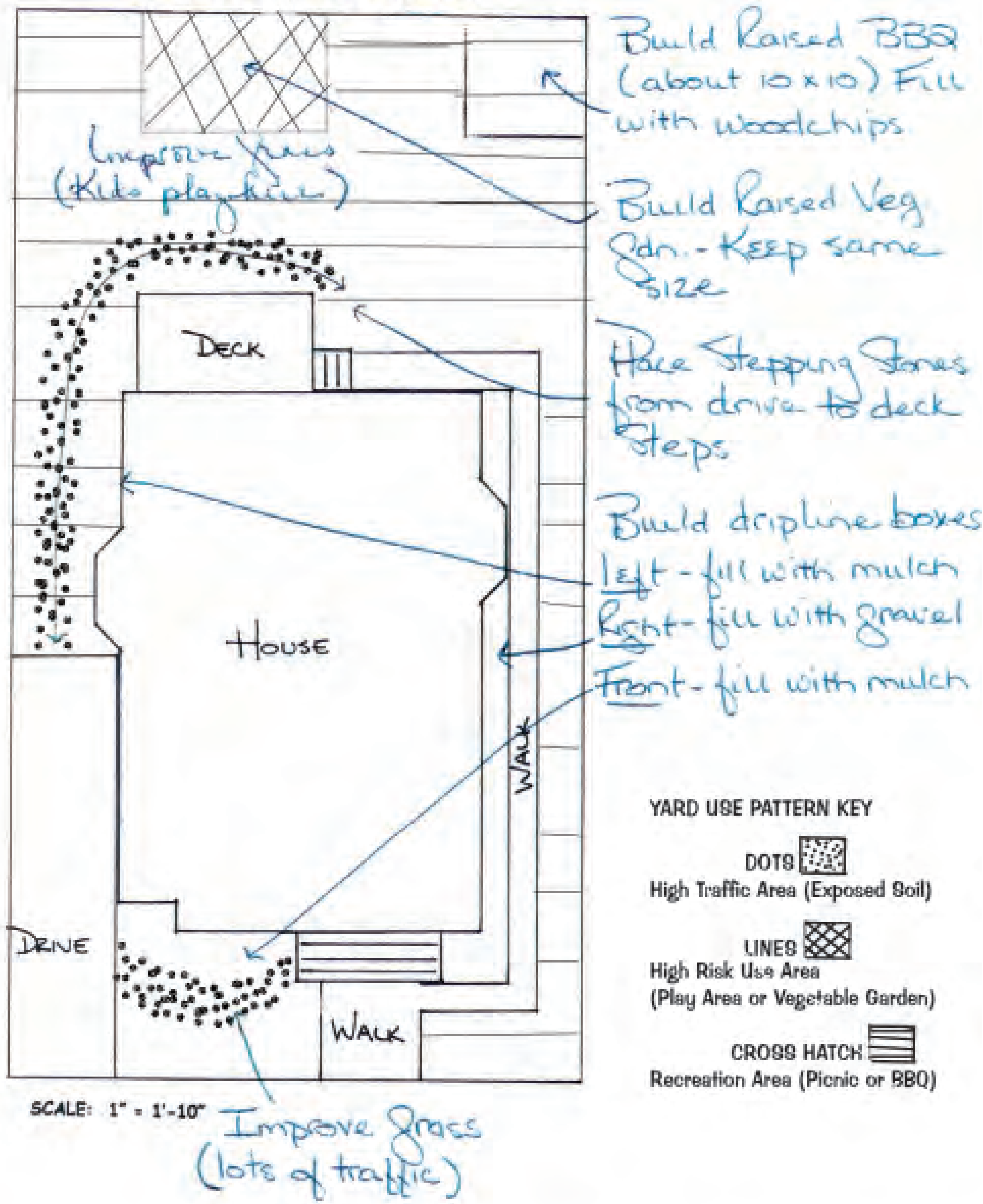
Additional edging, material, plantings, etc. $__________

Total (Approximate) Cost $__________

Cost Estimate Submitted by: ____________________ Date: ____________________

Company name: ______________________________

10 HOME STREET



SAMPLE FORM:
HOMEOWNER'S APPROVAL OF TREATMENT PLAN

Date: ____________________

Property Owner: ____

Property Address: ____

____

I/We have reviewed the construction documents (specifications, plans, drawings, etc.) for the proposed treatment of the soil around my/our property and attest that they are complete, accurate and conform to my/our wishes.

I/We authorize the program to proceed with my/our application using said construction documents fully aware that said documents may change. I/We understand that any changes to the documents will be reviewed by me/us and I/We shall approve such changes prior to commencement of the work by the landscaper. I/We also understand that [the lead-safe yard program coordinator] must approve all changes to the proposed scope of work before work begins.

Date of Specifications/Plans: ____

Date Landscaper can begin scope of work: ______________________________

Number of days required to complete scope of work: ________________ Calendar Days

____________________	__________	____________________	__________
Owner #1	Date	Landscaper	Date
____________________	__________	____________________	__________
Owner #2	Date	Program Coordinator	Date

CONSULTANT CONTRACT

THIS CONSULTANT CONTRACT (the "Contract") is made as of this ____ day of _________, 200__ between (Organization Name), with its principal office located at (Organization Street Address, City, State, Zip, hereinafter called "(Organization acronym)", and (Contractor Name), the principal place of business of which is located at (Contractor Street Address, City, State, Zip).

WHEREAS, the (Organization acronym) desires to engage the Consultant as an independent contractor, and the Consultant desires to accept such engagement on the terms and conditions set forth hereinafter;

NOW, THEREFORE, in consideration of the covenants and agreements herein contained, the (Organization acronym) and the Consultant agree with each other as follows:

1. **Scope of Services.**

- Obtain completed Homeowner Yard Use Interview and plot plan, developed by the Environmental Protection Agency, from (the organization acronym).
- Design and landscape (number of) properties recruited and enrolled from (Target Area). All landscaping designs shall include but not be limited to the attached Attachment A Lead Safe Boston/National Center for Lead Safe Housing Standard Plan for Low Level Lead Soil Treatment dated December 29, 1999.
- Meet with homeowner within ten business days after receipt of testing results and homeowner use questionnaire from (Organization acronym/name) to complete Landscaper Information Sheet and to discuss current and future use of yard.
- Generate landscape design within five business days from the date of meeting with the homeowner. Obtain (Organization acronym/name) approval of design; obtain homeowner approval of same. Provide (Organization acronym/name) with four copies.
- Generate property specific cost proposals and submit to (Organization acronym/name) for approval.
- Secure planting stock and materials required for specific project(s).
- Pay for and post all necessary fees/permits.
- Install landscapes as per owner and (Organization acronym) approved designs within thirty days from the date of landscape plan approval.
- Generate homeowner maintenance manual specific to each property. Provide (Organization name) with three copies and homeowner with one copy.
- Conduct 30-minute educational session with homeowner to review homeowner maintenance procedures and manual.
- Obtain homeowner and (Organization acronym) final approval of landscape work.
- Leave property in a clean state. Owner must approve any material remaining on site after completion of landscape installation.
- Provide a 1-year workmanship and materials warranty from date of final homeowner approval. This warranty is limited to defects in workmanship and materials attributable to the consultant only and does not cover losses caused by: acts of God, third parties or failure of the homeowner to comply with the maintenance procedures and manual.
- Coordinate with Lead Safe Boston representatives and/or other applicable agencies in the execution of this contract.
- Complete all work as per local, state and federal rules and regulations.

1. **Compensation.** The (Organization acronym/name) shall reimburse Consultant on a semimonthly basis for (Contractor name) services on receipt of itemized invoices as follows:

- $(Negotiated amount)/ea. On completion of initial visit with homeowner to discuss landscape design
- $(Negotiated amount)/ea. On completion and approval of landscape design and maintenance manual.
- Half of property specific cost proposal (less design fee) on commencement of landscape installation.
- Balance on completion and approval of installation and 30-minute educational session with homeowner to review homeowner maintenance procedures and manual.
- No one property shall exceed $3,000 including general conditions, design work and maintenance manual without prior approval from (Organization acronym/name).
- Invoices shall reflect actual costs per property and are to be submitted semimonthly to (Organization acronym/name) for processing and payment.

2. **Term.** The term of this Contract shall be from (Start Date) to (End Date). Either party on 30 days notice may terminate this contract. In the event of premature termination by the (Organization acronym/name), the Consultant shall be paid for all work completed prior to the termination as well as the reasonable value of all work partially completed and all materials obtained and stored on-site.

3. **Benefits.** The (Organization acronym/name) is not responsible for any insurance or other fringe benefits, including, but not limited to social security, worker's compensation, income tax withholdings, retirement or leave benefits, for Consultant or employees of Consultant. The Consultant assumes full responsibility for the provisions of all such insurances and fringe benefits for himself or herself and all Consultant's employees.

4. **General Liability and Workman's Compensation.** The contractor shall purchase and maintain such insurance as will protect him/her from claims under the Workman's Compensation Acts (chapter 152 of the Massachusetts General Laws) and from claims for damages because of bodily injury, including death and all property damage including, without limitation to, damage to the buildings and adjoining the site of construction which might arise from and during operations under any Contract, whether such operations be by himself/herself or by any subcontractor or anyone directly or indirectly employed by either of them. The Contractor shall, without limiting the generality of the foregoing, conform to the provisions of the Section A of Chapter 149 of the Massachusetts General Laws, which Section is incorporated herein by reference and made a part hereof.

General Liability Insurance Minimum bodily injury limits of $100,000 per person and $300,000 per accident, and $300,000 aggregate during any twelve-month period, shall include the following:

a. Public Liability (bodily injury and property damage)

b. Independent Contractor's Protective Liability

c. All Risk Insurance - covering all contractor equipment with provisions of waiver of Subrogation against the Owner

d. Comprehensive All Risk Motor Vehicle Liability Insurance—minimum bodily injury limits of $100,000 per person, per accident, and property damage limit of $300,000 per accident

5. **Arbitration.** Any controversy or claim arising out of, or relating to, this Contract or the breach thereof, shall be settled by arbitration in accordance with the rules then obtaining of the American Arbitration Association. Judgement upon the award rendered may be entered in any Court having jurisdiction thereof. Any award rendered hereunder shall be final and binding on all parties thereto.

6. **Construction.** This Contract shall be construed, interpreted and applied under and in accordance with the laws of Massachusetts.

7. **Parties Bound.** The terms and provisions of this Contract shall be binding upon the parties hereto, their legal representatives, successors and assigns.

8. **Federal Requirements.** The Consultant's services may be reimbursed in part from funds under a contract funded directory or indirectly by the U.S. Department of Housing and Urban Development. Consultant is bound by the provisions of that contract.

9. Entire Agreement. This instrument contains the entire agreement between the parties. No statement, promises or inducements made by any party hereto, or agent of either party hereto, which is not contained in this written contract, shall be valid or binding; and this contract may not be enlarged, modified or altered except in writing and signed by the parties.

IN WITNESS WHEREOF, the parties have caused to be properly executed on their respective behalf, this Consultant Contract, effective for all intents and purposes as of
(Month, Day, Year).

(Organization Name)

By: ____

Title: ____

(Contractor's Name)

By:____

Title:____

ATTACHMENT A—Narrative
Lead Safe Boston/National Center for Lead-Safe Housing
Standard Plan for Low Level Lead Soil Treatment
December 29, 1999

Goals of the Low Level Soil Treatments
The goal of this project will be to improve the lead safety in homes by the reduction of exposure to high levels of lead in soil. All work will be based on soil assessments conducted by EPA. EPA will conduct all soil testing and provide to the vendor/contractor a plot plan indicating areas of concern.

Abatement strategies shall be designed to change the use of the yards while providing a lead safe area for children and families to enjoy.

Outreach and Enrollment
The outreach and enrollment component of the project will be undertaken by a contractor already in use by The National Center (Silver Linings). Outreach will focus on a pool of properties deleaded under Lead Safe Boston's Round 1 Evaluation project. These properties will be targeted primarily because of the extensive data collected to date.

Typical Yard
When the deleading of a home was complete, the single soil treatment conducted by Lead Safe Boston deleading contractors included a final cleanup of the soil by hand raking after abatement of the structure as per the Massachusetts Lead Law. The properties averaged 4000 s.f. and the footprint of the home averaged 1000 s.f. In addition, the yards are mostly flat, compacted soil with evidence of tree roots and shade. Most properties do not have driveways.

General Requirements
The General Requirements are to include but are not limited to: permits/fees, a 1 year workmanship and material warranty period, general liability and worker's compensation requirements (see attached).

Landscaping and Site Development
Landscaping and Site Development is to include generation of the initial Landscape design based on use and the plot plan provided by EPA. Also to be included is the generation of the maintenance manual for the homeowner education component.

Construction Oversight
The construction oversight allowance is to include construction monitoring, final inspection/sign off and homeowner final approval. The date of final homeowner approval will be the starting date of the 1 year warranty period.

Homeowner Education
The homeowner education allowance is to include two on-site meetings: initial meeting to obtain homeowner approval and a final meeting to review all site specific maintenance manuals and work completed by the vendor/contractor.

Design
The Consultant shall use this document as a guideline for all landscape design decisions.

SAMPLE PROJECT
COMPLETION CERTIFICATE

Date: ____________________ Building ID: ________________________________

Property Owner: ____

Property Address: ____

____

I/We have inspected my/our property and found that the work conducted to make our yard lead safe has been successfully completed according to the scope of work I/we approved dated _______________. I/We have met with [Contractor name] and attended a 30-minute educational session to review the Lead Safe Yard Maintenance Procedure Manual. [Contractor Name] has provided me/us with a copy of this manual for my use.

In accordance with the scope of work and in connection with the final payment made to the contractor, I hereby agree to discharge, and hold [Your Program] harmless from any and all claims which arise against the Owner and/or his/her property, in connection with the work performed under this Program.

Homeowner Name	Date	Homeowner Name	Date

Inspection has been made of the yard made lead safe through the [Your Program]. I have examined the work and found all the work to be completed in a satisfactory manner and in accordance with the scope of work dated _______________.

Program Representative	Date

In accordance with the contract dated _______________ and in connection of the final payment made thereunder, I hereby agree to discharge, and hold the Owner and [Your Program] harmless from, any and all claims (including all liens resulting therefrom) which arise against the Owner of his/her property the contractor as its assignee now has or ever had by virtue of, or in connection with the work performed under, said Agreement.

That also in consideration of said final payment I hereby agree to discharge, and hold the Owner harmless from, any and all claims (including all liens resulting therefrom) which may be brought within forty (40) days of the date hereof by all sub-contractors, all suppliers of materials and equipment, and performers of work, labor or services arising by virtue of, or in connection with the work performed under, said Agreement.

That I warrant same for one (1) year from the date hereof, against workmanship and materials defects. One-year warranty does not cover losses caused by: acts of God, third parties or failure of the homeowner to comply with the maintenance procedures and manual.

Contractor Name	Date

SAMPLE FORM:
CONTRACTOR'S AFFIDAVIT OF PAYMENT OF DEBTS, RELEASE OF CLAIMS, WARRANTY OF WORKMANSHIP AND RECEIPT OF PAYMENT

Property Address:____

____

Pursuant to the Agreement between [Contractor Name] and [Your Program], dated ____/____/, for the scope of work conducted at the above listed property, the undersigned, acting on behalf of the contractor, hereby certified and agrees as follows:

1) That he/she has paid in full, or has otherwise satisfied obligations for all materials and equipment provided, and for all work, labor, and services performed and for all known claims for all damages arising by virtue of, or in connection with the work performed under, said Agreement for which the owner of his/her property might in any way be held responsible.

2) That in accordance with said Agreement and in connection of the final payment made thereunder he/she hereby releases the Owner and [Your Program] of any lien, or claim or right to lien on said property resulting therefrom, which against the owner of his property the contractor or its assignee now has or ever had by virtue of, or in connection with the work performed under, said Agreement.

3) That also in consideration of said final payment he/she hereby agrees to discharge, and hold the Owner and [Your Program] harmless from, any and all claims (including all liens resulting therefrom) which may be brought within forty (40) days from the date hereof by all subcontractors, all suppliers of materials and equipment, and all performers of work, labor, or services arising by virtue of, or in connection with the work performed under, said Agreement.

4) That all work in connection with said Agreement has been performed in accordance with terms thereof.

5) That he warrants same for one (1) year from the date hereof, against workmanship and materials defects. The one-year warranty does not cover losses caused by: acts of God, third parties, or failure of the homeowner to comply with the maintenance procedures and manual.

6) That he/she has received from [Your Program] all sums of money payable to the contractor under said Agreement and any modifications or changes thereof.

By: ____________________________________ ______________

Contractor Name **Date**

8 Yard Maintenance

Since the start of the EMPACT Lead-Safe Yard Project in 1998, the project's leaders have gained a heightened appreciation of the importance of yard maintenance to the project's overall success. It is safe to say that good maintenance is as critical as gathering accurate soil samples or selecting appropriate treatment measures.

This chapter explains the importance of yard maintenance (Section 8.1) and provides guidance on making maintenance an integral part of your lead-safe yard program. Section 8.2 presents specific maintenance guidelines for the landscape treatments found in Chapter 7. Section 8.3 describes the development of a property-specific maintenance manual and presents a sample manual used by the EMPACT Lead-Safe Yard Project. Section 8.4 provides tips on homeowner education, while Section 8.5 suggests creative ways of encouraging ongoing maintenance.

All of these sections will be useful to someone responsible for implementing a lead-safe yard program. Homeowners interested in applying landscape treatments to their own yards can focus on Sections 8.1, 8.2, and 8.3.

8.1 The Importance of Yard Maintenance

Why is yard maintenance such an important part of a successful lead-safe yard program? The answer is quite simple. All of the landscape measures used by the EMPACT LSYP are interim controls: that is, they are designed to protect children and other people from existing soil-lead hazards without permanently abating the hazards. These landscaping measures provide protection only so long as they are kept in good repair. Evergreen shrubs, for example, will discourage children from playing in the drip zone only if the shrubs are kept alive. Grass serves as a protective barrier only if it is healthy and well maintained. Likewise, a mulch-filled pet area must be raked regularly to maintain a 6-inch mulch barrier and keep pets from contacting lead-contaminated soil.

The good news is that all of these landscape measures can provide effective, continuing protection if well maintained. And most maintenance tasks are relatively simple—as easy as tightening a screw, watering a lawn, or raking a gravel drive.

8.2 Maintenance Requirements for EMPACT Treatment Measures

The table on pages 114 to 116 summarizes all maintenance tasks required for the landscape treatments described in Section 7.2 of this handbook. The table includes information on the optimum frequency of maintenance and the tools needed for each task.

8.3 Developing a Property-Specific Maintenance Manual

For each completed yard treatment, the landscape coordinator should prepare a property-specific maintenance manual that can be provided to the homeowner as part of the case file for his or her property (see Section 7.8). This maintenance manual should tell the homeowner what maintenance tasks need to be performed, when it is best to do them, and what tools (if any) are required for each job.

The maintenance manual used by the EMPACT LSYP during its Phase 1 and 2 treatments is shown on pages 117 through 122. The manual has several features that make it effective and easy to use:

- It is easily customized for each yard treated. The landscape coordinator simply places a checkmark next to each treatment measure used in that particular yard.
- It is easy to read. The homeowner simply looks for the checkmarks identifying the treatments used, then follows the maintenance guidelines provided.
- It is keyed to correspond with the treatment plan developed during the design session. The letters identifying particular treatment measures match up with those shown on the site worksheet (see page 79 in Chapter 7).
- It includes a list of materials used for yard maintenance, their typical costs, and places they can be obtained (including sources of free materials).

8.4 Educating Homeowners About Yard Maintenance

At the conclusion of each yard treatment, the landscape coordinator should meet with the homeowner to review all landscape work that has been completed in the yard, pass on the property-specific maintenance manual, and explain the information it contains.

This meeting provides a perfect opportunity to educate the homeowner about the importance of yard maintenance and to re-emphasize some of the key lessons of your program. The EMPACT LSYP has found that homeowners often don't retain the information on soil-lead hazards that was presented to them by the outreach coordinator (see Lessons Learned below). For this reason, the landscape coordinator should use this opportunity to review the following:

- The results of the soil-lead sampling and the areas of concern.
- Why lead-contaminated soil is harmful to children and other people.
- The landscape treatments that were employed and how they protect against harmful exposures.
- The homeowner's responsibility in maintaining the landscape installations.

Throughout the meeting, the landscape coordinator should emphasize that the landscape treatments will only be effective if well maintained. He or she should also emphasize that all involved maintenance is easy and inexpensive to perform.

8.5 Strategies for Encouraging Ongoing Maintenance

Once you have finished treating a yard, met with the homeowner one last time, thanked him or her for participating, and said goodbye, the success of that yard treatment is almost entirely in the homeowner's hands. If he or she completes all maintenance tasks as outlined in the maintenance manual, the treatments that have been installed can provide ongoing protection for many years. On the other hand, if the homeowner neglects all maintenance, the benefits of the yard treatment will be limited.

LESSONS LEARNED: RE-EDUCATING HOMEOWNERS ABOUT SOIL-LEAD HAZARDS

During Phases 1 and 2 of the EMPACT Lead-Safe Yard Project, the project team made focused efforts to educate homeowners about the need for maintaining the landscape treatments that were installed in their yards. These efforts included the creation of a homeowner packet for each completed property; the packet contained a record of the soil-lead sampling results, a color-coded plot plan showing treatments used, and a property-specific maintenance manual identifying maintenance tasks needed for that yard.

In the spring of 2000, less than two years after the first Phase 1 treatments were completed, members of the EMPACT team revisited several of the Phase 1 and 2 properties to evaluate the level of maintenance that had taken place. The results were disappointing. Their observations indicated that, at some properties, little or no maintenance had occurred. Many of the landscape installations (especially those requiring frequent attention from the homeowner, such as grassed areas and plantings) had degraded to the point where they no longer appeared to provide effective protection. Some homeowners were unable to locate their maintenance manuals when asked.

In assessing the reasons for these disappointing results, the project team found that many of the homeowners perceived the LSYP as a "yard beautification" project rather than as a risk-prevention program designed to protect children from dangerous lead exposures. Though each homeowner had been given extensive information about soil-lead hazards and how landscape measures could help protect their family's health, the homeowners had not always retained this message. The project team concluded that they needed to find new strategies for emphasizing the lead hazard message during Phase 3 of the project, and for creating repeated opportunities for homeowner re-education.

The strategies devised by the project team included sending out reminders about the need for yard maintenance, holding community-wide lead-safe yard maintenance days, and offering annual educational events about soil-lead hazards. These strategies are presented in Section 8.5. Additional strategies are described in Section 5.2, "Educating People About Lead and Lead in Soil."

Organize a presentation on lead poisoning and soil-lead hazards to encourage ongoing yard maintenance within the community.

Here are three strategies for encouraging ongoing maintenance over time:

- **Send out reminders.** Try developing a standard maintenance reminder that can be sent out annually to all homeowners who have participated in your program.
- **Hold community maintenance days.** Once or twice a year (perhaps in spring and/or fall), organize a community-wide "Lead-Safe Yard Maintenance Day." Such an event could be combined with community clean-up days.
- **Offer annual educational events within your community about soil-lead hazards.** For example, you might want to organize a presentation on lead poisoning and soil-lead hazards at a local community center or community college.

Above all, remember to be creative in communicating your message about soil-lead hazards, and repeat it at every opportunity.

Maintenance Required for EMPACT Landscape Treatments

Yard Area	Treatment Measure	Maintenance Tasks	Frequency	Tools Needed
Drip zone	Raised perimeter box filled with mulch and plantings	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Three times a year	None
		Replenish mulch to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
		Water plantings	Regularly	Sprinkler, garden hose
	Raised perimeter box filled with gravel	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Annually	None
Grassed areas	Existing lawn improvement OR New lawn installation (at existing grade)	Apply grass fertilizer	Twice a year (spring and fall)	None
		Water lawn	Regularly	Sprinkler, garden hose
		Reseed bare spots	Annually (spring or early fall)	Rake, seed mixture
	New lawn installation (raised bed)	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Apply grass fertilizer	Twice a year (spring and fall)	None
		Water lawn	Regularly	Sprinkler, garden hose
		Reseed bare spots	Annually (spring or early fall)	Rake, seed mixture
	Raised mulch bed (with plantings)	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Three times a year	None
		Replenish mulch to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
		Water plantings	Regularly	Sprinkler, garden, hose

Yard Area	Treatment Measure	Maintenance Tasks	Frequency	Tools Needed
Parking areas	Gravel parking area	Remove weeds and debris	Twice a year (spring and fall)	None
		Rake to maintain evenly spread top layer of 1 ½ " to 2"	As needed	Rake
	Asphalt parking area	No maintenance needed	None	None
Recreation and children's play areas	Wood platform	Check that all screws and other connections are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Sweep to maintain cleanliness	As needed	Broom
	Raised bed filled with mulch or woodchips	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Three times a year	None
		Replenish mulch to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
Pet areas	Raised pet area filled with mulch or woodchips	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Twice a year	None
		Rake to maintain 6" depth	As needed	Rake
		Replenish mulch or woodchips to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
Bare soil under porches	Install lattice and trim	Check that all screws, nails, and other connections on installation are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Scrape, sand, and paint or apply additional coats of sealant	Annually	Scraper, sandpaper, paintbrush, paint or sealant

Maintenance Required for EMPACT Landscape Treatments

Yard Area	Treatment Measure	Maintenance Tasks	Frequency	Tools Needed
Bare soil under porches	Raised bed filled with mulch or gravel along footprint of porch	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Annually	None
		Rake to maintain evenly spread top layer	As needed	Rake
		For mulch beds, replenish mulch to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
Garden areas	Raised vegetable garden bed	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Add additional loam (or compost)	Annually	Shovel, wheelbarrow
Walkways	Stone path	Sweep to maintain cleanliness	As needed	Broom

Lead-Safe Yards

Maintenance Made Simple

Dorchester Lead Safe Yards Program

1999

LOOK FOR THE ✓ THAT SHOWS THE TREATMENTS USED IN YOUR YARD AND FOLLOW THE GUIDELINES

✓ **A. Pressure Treated Wood Dripline Boxes**

MAINTENANCE
Once a year:
Check to make sure that all screws and other connections are secure

Look for and remove splinters

Tools Needed:
Screwdriver and/or hammer

Dripline Boxes are Lined with Perforated Plastic or Landscape Film Then Filled with One of the Following:

✓ **Mulch**

MAINTENANCE
Three times a year:
Remove weeds and debris spring and summer

Tools Needed:
None

Every two years:
Replenish mulch to 6" depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

✓ **Gravel**

MAINTENANCE
Once a year:
Remove weeds and debris

Tools Needed:
None

☐ **Mulch Over Gravel**

MAINTENANCE
Three times a year:
Remove weeds and debris spring and summer

Tools Needed:
None

Every two years:
Replenish mulch to 2" depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

B. Pressure Treated Wood Raised Picnic/Play Areas

MAINTENANCE
Once a year:
Check to make sure that all screws
and other connections are secure

Look for and remove splinters

Tools Needed:
Screwdriver and/or hammer

Pressure Treated Wood Raised Play or Picnic Areas are Lined with Perforated Plastic or Landscape Fabric and then Filled with One of the Following:

Woodchips *

MAINTENANCE
Three times a year:
Remove weeds and debris
spring and summer

Tools Needed:
None

Every two years:
Replenish wood chips to 6" depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

Gravel

MAINTENANCE
Once a year:
Remove weeds and debris

Tools Needed:
None

Mulch

MAINTENANCE
Three times a year:
Remove weeds and debris
spring and summer

Tools Needed:
None

Every two years:
Replenish mulch to 6" depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

* See Resource List for Sources of Free Materials

C. **Pressure Treated Wood Raised Garden Plots**

MAINTENANCE
Once a year:
Check to make sure that all screws
and other connections are secure

Look for and remove splinters

Tools Needed:
Screwdriver and/or hammer

Pressure Treated Wood Raised Garden Plots are Lined with Landscape Film and then filled with Loam and Compost: *

MAINTENANCE
Once a year:
Add additional Compost
Early spring

Tools Needed:
Shovel
Wheelbarrow

D. Covered Surface Areas for People, Cars and Pets

√ Stepping Stone Paths

MAINTENANCE
Sweep as needed

Tools Needed:
Broom

√ Grassed Areas

(Recommended for sunny spaces)

MAINTENANCE
Twice a year:
Apply grass fertilizer
spring and fall

Tools Needed:
None

Water regularly especially
during hot, dry weather

Tools Needed:
Sprinkler
Garden hose

Every Year:
Reseed bare spots
spring or early fall

Tools Needed:
Rake

Gravel Driveways and Paths

(Gravel spread to 2"depth)

MAINTENANCE
Twice a year:
Remove weeds and debris
spring and fall

Tools Needed:
None

Rake as needed to
maintain 2" depth

Tools Needed:
Rake

Areas For Pets

(Woodchips spread to 6" depth)

MAINTENANCE
Twice a year:
Remove weeds and debris
spring and summer

Tools Needed:
None

Rake as needed to
maintain 6" depth

Tools Needed:
Rake

Every two years: *
Replenish woodchips to
maintain 6 " depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

* See Resource List for Sources of Free Materials

RESOURCES AND TYPICAL COSTS

Prepared for Dorchester Lead Safe Yards Program 1999

MATERIAL	SOURCE	TYPICAL COST
Gravel	Building Supply or Garden Center	$20.00 per cubic yard plus delivery
Mulch	Garden Center	$25.00 per cubic yard $6.00 per 3 cubic foot bag plus delivery
Woodchips	Tree Service or Recycling Center or Parks Department	FREE FREE FREE
Pressure Treated Lumber (2"x 6")	Lumber Yard	$.75 per linear foot plus delivery
Grass Seed	Garden Center	$10.00 per 3 lb. bag (covers 1700 sq. ft.)
Grass Fertilizer	Garden Center	$10.00 per bag (covers 5000 sq. ft.)
Plastic in Rolls	Hardware Store	$3.00 per 3'x50' roll
Landscape Fabric	Garden Center	$15.00 per 3'x50' roll
Compost	Garden Center or Recycling Center or Parks Department	$5.00 per 50 lb. bag FREE FREE
Stepping Stones	Building Supply or Garden Center	$2.00 per 12" pre-cast square or round stone

9 Evaluating Your Lead-Safe Yard Program

This chapter provides guidance on evaluating the effectiveness of your lead-safe yard program. Section 9.1 suggests questions that you may want to focus on during your evaluation. Section 9.2 discusses the need for documenting your program's work at key evaluation points.

The information in this chapter is designed primarily for managers and organizers who are responsible for running lead-safe yard programs.

9.1 Focusing Your Evaluation

How effectively does your program reduce young children's exposure to lead? To answer this, you will need to evaluate your program.

As described in Section 1.2.2, EPA New England and the National Center for Lead Safe Housing (http://www.leadsafehousing.org) are currently leading a HUD-funded research study to document the effectiveness of the low-cost interim soil control measures used by the EMPACT Lead-Safe Yard Project. The study will include a retrospective evaluation of the soil intervention work conducted during Phases 1 and 2 of the EMPACT LSYP. It also will examine data collected during the summer of 2000 by all three Boston-based lead-safe yard programs: the EMPACT project, the Lead Safe Boston demonstration project, and the Boston Public Health Commission project. Soil-lead data will be collected before, during, and after each yard intervention, mainly to document the effectiveness of the landscape treatment measures in reducing risk to residents.

In designing an approach to evaluating your own program, you can focus on any of a number of criteria. Some of these are easily measurable, others are not. Here are four questions you may want to look at in your evaluation:

- How effective were the yard treatments in reducing soil-lead levels?
- How well did the yard treatments hold up over time?
- What effect did the yard treatments have on children's blood lead levels?
- How well did your program educate residents about lead poisoning?

9.2 Documenting Evaluation Points

An effective strategy for evaluating mitigation work is to compare the yard at three points in time: pre-treatment, immediately after treatment, and one year after treatment. Key to conducting an evaluation is adequate documentation of the program's work. Throughout this handbook, tools for documenting lead-safe yard activities have been identified. The following documentation should be contained in the case file you began upon initial contact with the homeowner:

- Homeowner application materials and consent form (Chapter 5).
- Results of educational 'quiz' (Chapter 5).
- "Homeowner Yard Use/Treatment Options Interview" Form (Chapter 5).
- "Before and after" photographs of the yard.

- Site worksheet (with monitoring results) and color-coded plot plan (Chapter 6).
- Treatment plan (Chapter 7).
- Contract (Chapter 7).
- Cost estimate sheet (Chapter 7).
- "Homeowner's Approval of Treatment Plan" Form (Chapter 7).
- Project Completion Certificate (Chapter 7).
- Any information available about blood lead levels of children living in the home.

When you return a year later, you should again obtain the homeowner's permission for inspecting the yard and taking additional measurements and photographs. A sample form is shown on page 126 ("Homeowner Permission Form—One Year Follow Up"). Your photos and notes from the follow-up visit will help document how well the landscaping measures have been maintained. You should also get input from the owner on:

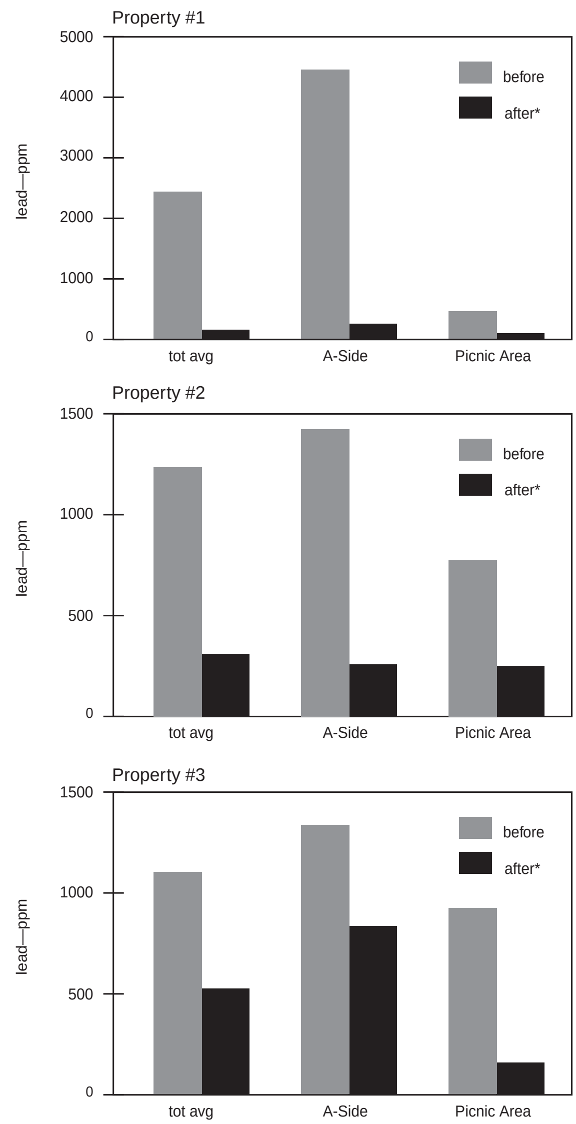
- His or her impressions of the benefits and/or drawbacks of the landscaping done at the home.
- How hard or easy it was for the homeowner (or another resident) to maintain the landscaping measures and whether the maintenance plan was clear and easy to follow.
- How your lead-safe yard program could be improved (e.g., through better treatment measures or better maintenance procedures).

You can also try to evaluate how well your educational efforts worked; the EMPACT outreach worker, for example, plans to readminister the quiz that she gives following the educational video, 'Lead Poisoning: The Thief of Childhood.' Finally, you can ask the residents if they are willing to give you the results of any lead testing done on children who live at the home.

All of this information will help you document and assess the various aspects of the program. This evaluation will be of value to your project team, your funders, the community, and each family involved in the program.

ASSESSING REDUCTIONS IN SOIL-LEAD LEVELS

In the summer of 1999, the EMPACT Lead-Safe Yard Project returned to several residences in the Bowdoin Street neighborhood to assess changes in surface soil-lead levels. All of these residences had been treated one year earlier, during Phase 1 of the project. Retesting efforts focused on play areas and/or areas that had been found to have high soil-lead levels during the initial testing. As illustrated in the graphs below, the results of the retesting showed that lead concentrations in the yard surfaces were significantly lower at each site. This indicated to the project team that the landscape barriers installed at the sites during the yard treatments were effectively covering the contaminated soil below. In the year 2001, the EMPACT LSYP intends to do another round of retesting at 25 sites.



Lead Concentration Before and After Mitigation for Three Phase 1 Properties

*Soil-lead concentrations were sampled 10 to 13 months after mitigation.

Homeowner Permission Form
Boston Lead Safe Yard Program
One Year Follow Up

Your yard has been made more safe for children to play in and for you to enjoy by the landscaping improvements that we have done through the Lead Safe Yard Program. Thank you for your cooperation during this community effort.

Now that we have finished a large number of yards in your neighborhood, we would like to inspect the work to see how well the improvements are holding up over time. We would like your permission to talk with you and to visually inspect all of the landscape improvements made by our program. During the visual inspection, we would also make some measurements and take a few photographs of the work. The inspection will take about an hour. This evaluation is funded by Lead-Safe Boston and the U.S. Department of Housing and Urban Development (HUD) and coordinated by the National Center for Lead-Safe Housing.

I give my permission for a visual inspection and measurements of the landscape improvements made by the Boston Lead Safe Yard Program.

______________________________ ____________________
Homeowner #1 signature Date

______________________________ ____________________
Homeowner #2 signature Date

______________________________ ____________________
Lead-Safe Yards Evaluation staff or Interviewer Date

10 Non-Residential Applications of Lead-Safe Mitigation Strategies

Many of the mitigation strategies and approaches incorporated into a lead-safe yard program can be applied to non-residential properties as well. Properties such as tot lots, playgrounds, community gardens, and vacant lots where children play may contain high levels of lead in their soil. Also, while children should not be playing at abandoned industrial sites or commercial buildings, these properties can be sources of increased exposure if children have access to areas of lead-contaminated soil. Specific mitigation approaches that have proven successful in reducing lead exposure risk at residential properties can be just as effective when applied to certain non-residential properties.

At tot lots and playgrounds, for instance, raised sand boxes can be constructed. The bottoms of these boxes should be lined with perforated plastic, landscaping fabric, or even indoor-outdoor carpeting to create a barrier between the lead-contaminated soil and the clean sand in which the children play. Clean sand should be tested to ensure that it does not contain lead levels of concern (i.e., greater than 400 parts per million). Similar raised boxes can be built around playground equipment and play areas and filled with sand, gravel, or mulch. Another alternative is to lay down rubber matting in play areas, or even paving lots. Planting and maintaining healthy grass cover is yet another option for play areas. Planting evergreen shrubs in areas with especially high lead levels can also be effective in keeping children from playing in these areas.

Community gardens can also incorporate lead-safe yard principles to protect against lead exposure. Raised garden boxes can be constructed, lined with perforated plastic or landscaping fabric, and filled with clean loam and compost. Loam should be tested to ensure that it does not contain lead above the 400-ppm level. Clean compost should be added yearly to replenish nutrients and help control lead levels.

Vacant lots where children play can be made lead-safe by covering exposed areas of soil. Planting grass is one approach, but other materials such as woodchips, mulch, or even gravel could be used. To keep children from playing in areas with high levels of lead in the soil, plant evergreen bushes and shrubs.

For abandoned industrial sites and commercial buildings, construct barriers (such as fences or walls) to keep children out of these potentially dangerous areas.

Appendix A Safer Soil Pilot Program of Cambridge, Massachusetts

About the Program

The Lead-Safe Cambridge (LSC) program works to make the homes of income-qualified people in Cambridge, Massachusetts, lead safe through interior and external lead hazard control. It began the Safer Soil Pilot Program in 1997 to build on this effort by making the yards of participants in its interior de-leading program lead safe as well.

After soil sampling was initiated for the Safer Soil Pilot Program, LSC found that over 95 percent of the yards it investigated contained soil with lead levels above 400 parts per million. Currently, all homeowners participating in LSC are eligible for additional assistance under the Safer Soil Pilot Program. However, after September 2000, participation in the Safer Soil Pilot Program will be required, in keeping with new federal regulations.

Under the pilot program, soil samples are taken from select areas of a home and tested to determine their lead content. If elevated lead levels are found, a landscape planner works with the homeowner and/or tenants to develop an appropriate landscape remediation plan. The Safer Soil Program provides homeowners free soil sampling and grant support to reimburse them for the cost of implementing LSC-recommended soil remediation and landscaping plans. Specifically, the program offers:

- Free soil testing.
- Training on the dangers of lead exposure.
- Free technical advice on preventing lead exposure.
- Grant support of up to $2,000 per unit and $6,000 for three or more units toward the cost of approved materials used to make the yard leadsafe.

Partner Organizations

LSC receives funding for its Safer Soil Pilot Program from the U.S. Department of Housing and Urban Development. LSC collaborates with a number of local non-profit housing groups, including Just-A-Start and Homeowner's Rehab, as well as with the U.S. Environmental Protection Agency and the Massachusetts Department of Environmental Protection.

Outreach Barriers and Strategies

Cambridge is a diverse community. Its residents come from many different cultural backgrounds—English is not always their primary language. Successful communication with homeowners and residents often requires close cooperation and coordination with their English-speaking relatives, as well as the help of multilingual LSC staff members.

Homeowners and tenants are recruited to participate in the program through newspaper ads, Web announcements, property owner workshops (such as Cambridge Homefair), and word of mouth.

As part of its soil education strategy, LSC distributes flyers to educate homeowners about the soil-lead problem and inform them about the program, disseminates fact sheets via the Internet (http://www.ci.cambridge.ma.us/~LeadSafe), and presents lead-safety materials at public meetings throughout Cambridge. In addition, LSC offers two annual Safer Soil workshops, free and open to the public, at which people can learn why lead in soil is a problem, find out how to landscape a yard to make it safer, and get technical advice from a landscape planner. LSC also enlists the help of local garden centers, which sponsor the workshops and offer coupons to workshop participants.

Soil Sampling and Analysis

After their units have been de-leaded under the LSC program, homeowners interested in participating in the Safer Soil Pilot Program sign an agreement with LSC to have their soil tested for lead. LSC takes soil samples from different use areas in each yard—such as driplines, play areas, gardens, walkways, and other bare areas—and sends them to a state laboratory in Jamaica Plain for analysis.

All samples are analyzed using the atomic absorption method (microwave digestion followed by flame atomic absorption spectroscopy). LSC relies on laboratory analysis, as opposed to onsite analysis using field portable x-ray fluorescence technology, because of cost and liability issues. A new XRF costs $15,000 or more (see Section 6.2); because an XRF contains radioactive materials, only a trained technician can use it. Getting sample results back from the laboratory takes about 7 to 10 days, but this has not been a problem.

Once LSC receives the sample results, it reviews them and consolidates them in the form of hand-drawn plot diagrams. These are then presented to (and interpreted for) the homeowners and/or tenants. If the test results reveal that soil on a property exceeds EPA-recommended levels for lead, an LSC landscape planner works with the homeowner and/or tenants to design attractive, usable lead-safe urban yards, providing them with plans, product recommendations, and cost estimates. The landscape planner works with homeowners in the design and construction of these plans. LSC believes that close cooperation with homeowners helps to create a sense of ownership, community, and most importantly, safety for children. In addition, this cooperation makes for longer-term compliance and better maintenance.

Remedial Measures and Yard Treatments

The Safer Soils Pilot Program favors a combination of techniques for remediating lead-contaminated soil around a residence. These include selectively paving contaminated areas, using softer paving materials (such as gravel with brick edging), and incorporating plants and shrubs in the yard. The program often recommends placing plants and shrubs around house driplines to reduce access to these areas while making the yard more attractive.

The program also works to reduce lead toxicity in the soil by rototilling organic matter (such as composted cow manure) and rock phosphate, which bind with lead, into affected areas. Once organic material has been introduced, the Safer Soil Pilot Program recommends taking the additional step of putting down landscape fabric over the contaminated area and covering the fabric with 3 to 4 inches of bark mulch or pea gravel to create a natural barrier. Sodding is another effective option, although its drawbacks include its high cost relative to other treatments and the need for routine watering in its early stages of establishment.

In areas where lead levels in the soil are found to be greater or equal to 5,000 ppm, LSC follows current EPA recommendations for remediating high-lead-content soil by covering the area with an impermeable surface (such as concrete or pavement) or, in extreme cases, removing the soil altogether. However, the Safer Soil program generally tries to avoid complete soil removal, in large part because of its cost and the difficulty of disposing of lead-contaminated soil.

Participants in the Safer Soil program are offered grants to help them pay for the materials they need to remediate their properties. The standard grant is $2,000 per unit and up to $6,000 for three or more de-leaded units. In order to make full use of an available grant, the homeowner (or a landscape contractor) must implement the program's recommendations for the property. Work must be done according to the landscape planner's recommendations; soil must be kept damp in order to prevent unnecessary lead dust exposure. Homeowners can use landscape contractors to execute their Safer Soil landscape plans if they are unable to do the work themselves. If the homeowner chooses to use a landscape contractor, he or she takes the landscape plan and specifications developed by the landscape planner and obtains three estimates for the landscaping work. The landscape planner approves the selected contractor, who then begins work. Homeowners save all receipts for materials and labor and submit them to the landscape planner for reimbursement (up to the total grant amount) after work has been completed.

The Safer Soil program also offers homeowners and tenants guidance on preliminary steps they can take to mitigate children's exposure to lead-contaminated soil. These tips include:

- Establishing a play area away from areas once exposed to old paint, such as the house or a fence.
- Covering leaded dirt with clean gravel or grass (preferably sod).
- Buying or creating a sandbox to cover leaded soil (making sure that the bottom is sealed away from the soil).

Results

To date, 27 yards have been landscaped through the Safer Soil Pilot Program, with 106 yards tested for lead. Landscaping plans and specifications have been developed for an additional 11 yards, and will be implemented in the near future.

Awards and Recognition

In 1999, LSC's Safer Soil Pilot Program was presented a National Merit Award from the American Society of Landscape Architects for its innovative approach to addressing lead in residential soil.

For More Information

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Landscape Planner
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Appendix B Some Proposed Models for Less-Resource-Intensive Approaches to Implementing Lead-Safe Yard Program

To develop feasible working models that can be applied in other communities, the issues of cost-effectiveness and homeowner participation need to be addressed. In the absence of a HUD-funded municipal program, or for those homeowners or residents not eligible for grants or loans from such a program, less costly approaches can be considered. In Boston, the EMPACT Lead-Safe Yard Project is currently investigating the following possibilities, several of which could be drawn upon in carrying out a lead-safe yard program at the local level:

- Using a model based on the principles developed by Habitat for Humanity, in which the work involved in achieving a lead-safe yard is carried out by the homeowner with the help of community volunteers (possibly other residents in the area who would then receive help with their yards). Habitat for Humanity is a non-profit organization that builds and rehabilitates low-cost homes through volunteer labor and donations of money and materials, with the help of homeowner (partner) families.

- Offering courses/workshops for homeowners and for landscapers through a local community college or other adult education program. Such a course would include information on building and landscaping techniques and materials, as well as maintenance required to achieve lead-safe yards. This could be part of a longer course on home maintenance or a course for new homeowners.

- Training environmental science students at a local community college to carry out sampling of yards for lead contamination. Students would be trained in how to draw plot plans, how to take samples, and how to interpret and write up the results, as well as in health and safety issues surrounding the handling of lead-contaminated soil. This would substantially reduce sampling costs, while providing an educational experience for the students concerned.

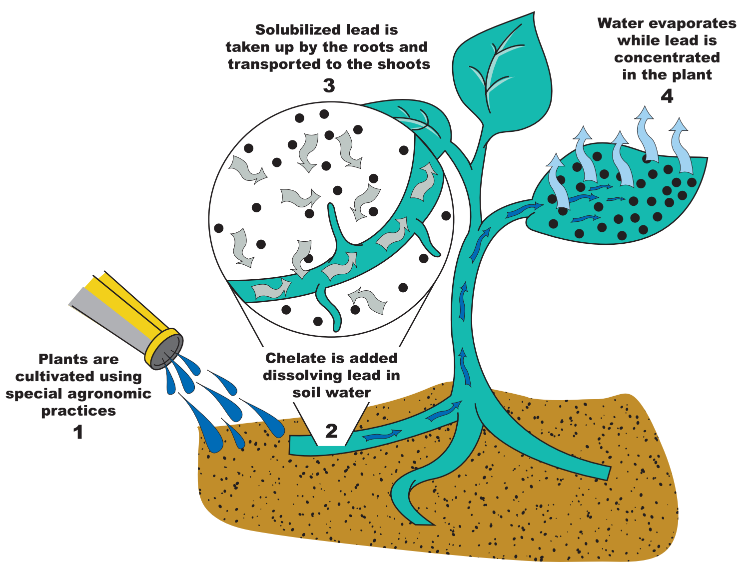
- Involving youth volunteers from a program such as City Year in carrying out the construction and landscaping work for lead-safe yards. City Year, a program of AmeriCorps (the domestic Peace Corps), engages young people aged 17 to 24 in youth development, human services, public health, and environmental programs. Another option would be to contract with a training and construction program such as Youth Build. Youth Build is a youth and community development program that offers job training, education, counseling, and leadership development opportunities to unemployed and out-of-school young adults, aged 16 to 24, through the construction and rehabilitation of affordable housing in their own communities.

Appendix C Future Options—Using Plants to Treat Lead-Contaminated Soils

This handbook focuses on measures that can keep children safe by reducing their risk of exposure to lead. The fact is, though, that unless the lead is permanently removed, exposure can reoccur (for example, if landscaping measures are not maintained).

The most frequently used method of removing the lead is to dig up the contaminated soil and haul it to a hazardous waste facility. This method is costly and requires intensive labor. However, some promising and innovative experiments explore how to minimize lead exposure by actually extracting it from the soil. This angle of research explores how nature itself, through a process called phytoextraction, might hold a potent solution for removing lead and other hazardous metals from contaminated soils.

Phytoextraction involves using living green plants for removing contaminants, such as lead, from soil and water. The term refers to the uptake of metal contaminants by the plant's roots and the subsequent transport of the contaminants to various parts of the plant. In general, plants do not absorb or accumulate lead.[19] But certain plants, such as the sunflower and Indian mustard, absorb remarkably large amounts of metals compared to other plants and actually survive. After the plants are allowed to grow on a contaminated site for a period of time with proper soil amendments to mobilize the metal, they are harvested. After this, they are either disposed of as a hazardous waste or incinerated (and the metals recycled). The schematic below illustrates phytoextraction processes (adapted from http://aspp.org/public_affairs/briefing/phytoremediation.htm).



[19]Carl Rosen and Robert Munter. 1998. *Lead in the Home Garden and Urban Soil Environment.* University of Minnesota Extension Service. FO-2543-GO. http://www.extension.umn.edu/distribution/horticulture/DG2543.html

Scientists have studied phytoremediation (the use of plants to recover contaminated soils and water) extensively. It is slowly becoming an acceptable, and even preferred, technology. Numerous demonstration projects have shown the promise of phytoremediation. For example:

- In Trenton, New Jersey, the Gould National Battery site was home to commercial lead-acid battery manufacturers from the 1930s to the 1980s. In those years, the land became heavily contaminated with lead. Under the Brownfields Initiative, the U.S. Environmental Protection Agency awarded Trenton a grant to restore the site. In 1995, Phytotech Inc. (now Edenspace Systems Corporation) approached the city about using "green technology" to clean up the site. Three crops of plants over a summer reduced lead levels on 75 percent of the treated area to below the New Jersey residential standard of 400 parts per million. See http://www.edenspace.com/CaseStudies.htm.

- In Chernobyl, a team of scientists from Rutgers University headed by plant biologist Ilya Raskin tested phytoextraction to remove radioactive cesium and strontium from a contaminated pond. Sunflowers were set floating on small polystyrene rafts so that their roots dangled in the water. Despite the poisons, the plants thrived. So far, Raskin has used phytoextraction techniques in sites in New Jersey, Massachusetts, and Connecticut.

Only a handful of demonstration projects focused on removal of lead from residential soils. Here's an example from the Boston metro area:

- The Boston Health Department sought a comprehensive strategy to remove lead from a small Dorchester neighborhood that hosted a cluster of childhood lead poisoning cases. Excavation and removal simply cost too much, so the department sought other methods. They teamed with Edenspace Systems Corporation to explore phytoextraction using Indian mustard plants on a 1,000-square-foot test site in the neighborhood. They spread a soil amendment that would loosen the lead so it dissolves in the moisture. They planted Indian mustard, which is well suited for metal removal because it accumulates the metal in its leaves rather than its roots. After six weeks, they harvested the plants and analyzed the soil. Lead concentrations decreased 47 percent, and after a second growing, the overall lead reduction was 63 percent (from 1,500 ppm to under 300 ppm). The harvested plants were incinerated, and the metals in the ash were recycled. Based on the results of the demonstration, Tom Plante of the Boston Health Department feels this method is very effective in reducing lead levels in soil and has the potential for a wide array of applications including brownfields—and now urban residences (if there is enough sunlight and moisture). For more information on this demonstration project, visit the Boston Childhood Lead Poisoning Prevention Program at http://www.tiac.net/users/bdph/oeh/leadhome.htm.

Edenspace Systems Corporation is continuing research on residential soil-lead remediation. One of the challenges of lead remediation in residences is that the plantings can put an entire yard out of use and out of sight for months or even years. Therefore, the company is researching the potential of turf grasses to extract lead from the soil. Making the technology affordable, ensuring proper sunlight and irrigation, bringing heavy machinery into residential neighborhoods, and reaching lead that is too far for plant roots to reach might pose additional challenges. However, research will continue to build on existing knowledge of phytoextraction and help address the potential challenges.

For more information on phytoextraction and other forms of phytoremediation, see the following online resources:

Edenspace Systems Corporation
Edenspace now owns or licenses an array of proprietary techniques used in removing lead, arsenic and other metals from the environment. The resources page provides many useful links to articles on phytoremediation.
http://www.edenspace.com/newpage4.htm

Phytoremediation: using plants to remove pollutants from the environment
An overview of phytoremediation written by Rutgers University plant biologist Ilya Raskin.
http://aspp.org/public_affairs/briefing/phytoremediation.htm

Rutgers University Center for Agriculture and Environmental Technology
One of the pioneer research institutions for phytoremediation.
http://aesop.rutgers.edu/~biotech/brochure/index.html

U.S. EPA Citizen's Guide to Phytoremediation
http://www.epa.gov/swertio1/products/citguide/phyto2.htm

Appendix D

Quality Assurance Project Plan for:

A COMMUNITY BASED ENVIRONMENTAL LEAD ASSESSMENT AND REMEDIATION PROGRAM

Prepared for: ______________________________

Lead Safe Yard Program
USEPA New England Lab
60 Westview Street
Lexington, MA 02421

Prepared by: ______________________________

Paul Carroll, Chemist
Investigations and Analysis Unit, OEME

Approved by: ______________________________

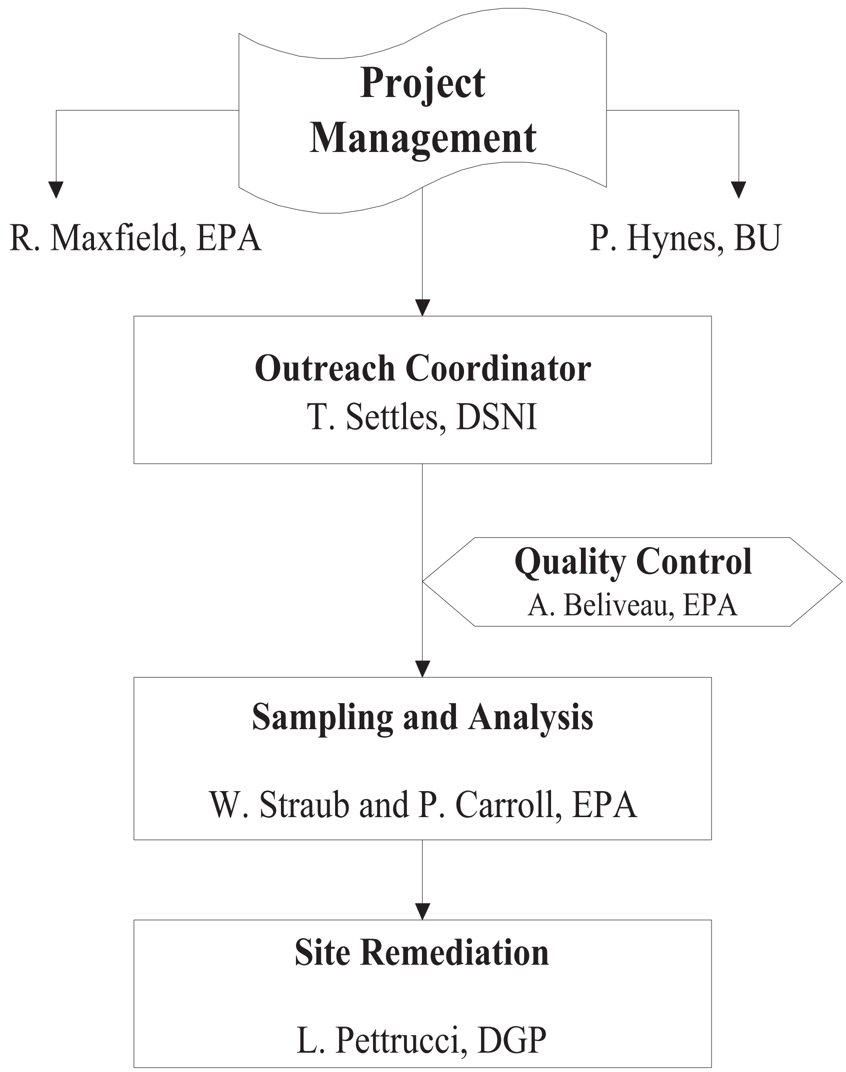
Robert Maxfield, Chief
Investigations and Analysis Unit, OEME

Approved by: ______________________________

Andy Beliveau, QA Officer
Quality Assurance Unit, OEME

1.0 Scope and Application

This QAAP outlines procedures for the field analysis of lead in soil using the Niton 700 Series Field Portable X-Ray Fluorescence Spectrometer. These methods are designed as part of the sampling and analysis protocol for the Lead Safe Yard Program and are applicable to the measurement of lead in urban soils.



2. Project Organization and Responsibility

The Project Managers are in charge of coordinating, maintaining and monitoring all activities, including direction for preparation of work plans, sampling plans, and analytical procedures relative to the project. The Quality Assurance personnel will evaluate and approve QA/QC plans through the course of the project and oversee all data quality assurance aspects of the project. The Outreach Coordinator will be responsible for locating potential properties for sampling and analysis, contacting property owners and gaining consent to work on the property. The sampling and analysis team will be responsible for scheduling and conducting data collection and data reduction procedures, properly maintain samples, develop site sketches and other observations, generate required QA/QC records and implement corrective actions. The site remediation group will apply innovative and cost effective landscape techniques for site improvements.

3. Problem Definition

Lead poisoning continues to be an extremely serious environmental health issue for youth, particularly in poorer inner city neighborhoods with older wood framed housing. While considerable attention has been focused on the lead contaminated paint prevalent on the surfaces of homes in these neighborhoods, less attention has been paid to the lead contaminated soil that surrounds each home. The reasons for this lack of attention by regulators stems from a variety of concerns: perhaps foremost is the cost of soil removal and disposal.

4. Project Description

The overall objective of the proposed project is to produce a summary report documenting the effectiveness of low cost residential soil intervention. The project will incorporate two sampling plans to accomplish this goal. One sampling strategy will be to measure surface soil lead at residential properties in the Greater Boston area. Properties that exceed project specific action levels will be mitigated with simple, low cost methods that are designed to minimize the risk of human exposure to the contaminated soil. Soil surfaces will then be measured to evaluate the effectiveness and durability of the intervention measures over time. A second sampling strategy involves measuring tracked-in soil Pb (house dust) to compare pre and post intervention Pb levels inside the residence. This Quality Assurance Project Plan outlines protocol for the residential soil surface sampling program that will be used in this project.

4a. Project Timeline

Activity	Start	End
Review existing data	11/99	
Determine target community		2/00
Community Outreach	2/00	9/01
Site Investigations	3/00	11/01
Meet with property owners		
Site Remediation	3/00	11/01

5. Sampling Design

The sampling strategy is designed to assess the potential of excessive lead exposure to humans from soil on the property. Each property will be evaluated with focus on four areas of concern: the dripline along the house foundation, play areas in the yard, areas of exposed soil in the yard, and any other potential sources of soil lead contamination including those from abutting properties. Play areas found to contain greater than 400 parts per million (ppm), and other areas that are found to contain greater than 2000 ppm lead will be further characterized to determine the nature and extent of contamination (note Appendix 1, the Sampling Logic Tree). Two soil sampling strategies, in situ and bag sampling, will be used to determine lead content in these residential soils. Descriptions of each along with QA/QC protocol follow.

In-Situ Sampling. Samples will be analyzed with a Niton Model 702 XRF Spectrum Analyzer. The 702 is a field portable multi-element, multi-functional x-ray fluorescence analyzer (FPXRF) equipped with a 10mCi cadmium-109 source and a high resolution Silicon-Pin detector. The hand held, battery powered FPXRF is capable of in-situ analysis techniques. Based upon a minimum detection limit study (MDL), the detection limit for this method is approximately 100 ppm. These data are attached as Appendix 4. This instrument is factory calibrated, has been found to hold calibration quite well, and is software compensated for any deterioration of the source. In addition to the MDL, precision and accuracy studies (1998 and 2000) are attached as Appendix 5.

Soil lead measurements will be taken *in-situ* during the screening phase provided that the surface is not inundated with water. Large nonrepresentative debris, including rocks, pebbles, leaves and roots, will be removed from the soil surface prior to sampling. The area will be smooth enough to allow uniform contact between the FPXRF and the ground surface. The initial sample locations will depend upon the size and shape of the region of interest. A line pattern will be used when the area is linear (e.g. dripline). In-situ measurements will be taken at approximate 10 foot intervals along the line depending upon the length of the building. Additional lines are tested at 2 to 5 foot sampling intervals away from the original sampling area to characterize the extent of any lead contamination. Target patterns will be used for sampling larger, nonlinear areas of potential exposure (e.g. play areas). A large "X" will be superimposed upon the space to be analyzed. In- situ measurements will be taken at 5 to 10 foot intervals along each line of the "X" unless the samplers determine that additional (or less) resolution is required. Screening data and descriptive information about each site will be recorded on the Site Worksheet (Appendix 2).

Quality control checks will consist of replicate measurements, standard reference material (SRM) checks and confirmation samples as defined in Section 10, Acceptance Criteria for Soil Lead by XRF. Replicate measurements will be conducted over a minimum of 10% of the screen samples to indicate the precision of analysis and the homogeneity of the sample matrix. Three point SRM measurements and a blank measurement will be conducted at the beginning and end of each sampling day to ensure linearity over the expected sampling range (e.g. 400-5000 ppm) and to determine that the instrument is operating contaminant free. SRMs (NIST 2586 @ 432 ppm lead in soil) will be used as continuing calibration checks after every 10th screen sample. A minimum of one confirmation sample will be collected from each site. Approximately 4 tablespoons of surface soil, to no more than the approximate depth of 0.5 inches, will be collected into a soil sample container and thoroughly mixed for each confirmation sample. The sample will be properly labeled and returned to the laboratory for analysis by EPA Method 6010A.

Bag Sampling. If site conditions are such that *in-situ* sampling is not appropriate and sampling activities must continue, this bag sampling method will be used to evaluate soil lead conditions on the residential properties. The sampling strategy will be a scaled down version of the *in-situ* strategy. The focus will still be on the dripline of the building on the property, play areas, bare soil and other concerns such as sources from abutting properties. The bag approach involves collecting soil samples into a sampling container and returning them to the laboratory for preparation, XRF analysis and ICP confirmation.

Typically, a minimum of 4 discreet soil samples will be collected from each side of the building perimeter within 1 to 3 feet of the foundation (dripline). These samples will be collected at the very minimum of 2 feet from each other. Bare soil areas are the preference (vs. covered areas).

Composite samples from play areas will consist of aliquots collected along an X shaped grid. These subsamples will be collected at a minimum of 1 foot from each other. Bare soil areas are preferred. This method will also apply to bare areas of soil, vegetable gardens and high use areas noted on the subject property.

The decision to sample along the property boundary will be determined by the samplers at the time of the site visit. If conditions exist on an abutting property that would appear to present a risk of soil lead contamination to the subject property, the following protocol will be followed. Aliquots of surface soil will be collected along the property line(s) of interest. These subsamples will be collected no closer than 1 foot apart and will be located within 1 to 5 of the property line. Subsamples will only be collected on the subject property.

Quality control for the composite method measurements will be identical to QA/QC for the in situ method. Three point SRM measurements and a blank measurement will be conducted at the beginning and end of each sampling day to ensure linearity over the expected sampling range (e.g. 400-5000 ppm). SRMs will be used as continuing calibration checks after every 10th screen sample. A minimum of one confirmation sample will be collected from each site.

All bag samples will be collected according to protocol outlined in Section 7 *(Sample Handling and Chain of Custody Requirements).* The samples will be returned to the EPA laboratory where they will be dried, screened to remove nonrepresentative debris, and analyzed using XRF technology. Select samples will be designated for confirmation analysis by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP).

Confirmation Samples. Confirmation samples are collected during sampling activities to be analyzed at the University of Cincinnati, Hematology and Environmental Laboratory by Atomic Absorption Spectrometry. These samples are collected in selected intervals around the house perimeter (designated HC for house composite), any play areas (PC), from any on-site vegatable gardens (GC) and from any high use areas (HUC).

Typically, 12 subsamples are collected for each perimeter composite sample (3 from each side of the house). If possible, 5 subsamples are collected for each play area composite, garden composite and/or each high use area composite using the target pattern approach. The samples are returned to the EPA laboratory, sieved with a number 10 sieve (U.S.A. Standard Sieve Series) to removed any coarse debris, rebagged and analyzed for lead content using the Niton XRF. Each sample is then labeled (street number and name and composite designation), recorded on a chain of custody form and sent to the U. of C. Lab for the extraction and AA analysis for lead content.

6. Sampling and Analytical Methods Requirements

Parameter	Matrix	# of Samples	Analytical	Containers	Preservation	Hold Time
Lead (XRF) insitu	Soil	TBD	EPA 6200	N/A	N/A	N/A
Lead (XRF) confirmation	Soil	TBD	—	ziplock bags	4°C	1 year
Lead (ICP) confirmation	Soil	TBD	EPA 6010A	ziplock bags	4°C	1 year

7. Sample Handling and Chain of Custody Requirements

The majority of the soil lead measurements will be taken in situ during the site characterization phase. Sample handling and chain of custody requirements will not apply to these procedures. Soil will be collected as confirmation samples and as discreet bag samples. Chain-of-custody (COC) procedures will be followed for these samples to maintain and document possession from the time they are collected until they are delivered to the laboratory for analysis. A sample COC form is attached. The sample handling and COC predator will include:

— sample information on the jar/bag with sample ID, time and date of collection and technician ID, all written in unerasable ink.

—a sample seal attached firmly to the sample cover as soon as possible after collection when using sample jars.

—a chain of custody record containing the project name and number, the sampling station ID, date and time of collection, a brief description of the type of sample collected, parameters for analysis, the samplers name and signature, adequate space for any transferee's name and signature and a comment section to describe any special conditions associated with the samples.

All sample sets will be accompanied by a COC document. Any time the samples are transferred, both the sample custodian and the receiver shall sign and date the COC document. COC documentation will be maintained in the project folder.

8. Quality Control Requirements

Analyte	Analytical Method	Detection Limit*	Quantitation Limit**	Precision***	Accuracy****
Lead	EPA 6200	~ 75 ppm	~225	±50	±25
Lead	EPA 6010A	42 ppb	~120	±20	±10
Lead	Kevex XRF	50 ppm	~150	±20	±20

**Typically 3 times the MDL
***Precision determined by replicate sample analyses
****Accuracy determined by analysis of SRMs

9. Data Management and Documentation

A field log book, dedicated to the project, and field data sheets will be maintained during sampling events. There will be separate field sheets for the screening and additional site characterization phases. Each sheet will include the date, time, property name and address, sample locations, a site sketch that includes sampling locations, sample description, important details about how the sample was collected, analyst(s) names, along with the respective measurement data, and any additional comments that would accurately and inclusively describe the sampling activities. Care will be taken to maintain the logbook and field data sheets neatly with factual, objective language that is free of personal feelings and other terminology that may be deemed inappropriate.

These field data sheets, along with confirmation sample data received from the laboratory will be kept on file at the EPA Region 1 Lab. The confirmation information will include results of sample analyses, method blanks, matrix spike/spike duplicates and acceptance criteria. Copies of the field data sheets and validation information from the confirmation samples will be distributed to members of the remediation team to help determine where remediation activity will take place.

10. Assessment and Response Actions

ACCEPTANCE CRITERIA FOR SOIL LEAD BY XRF(*IN-SITU*)

Audit	Frequency	Limits	Corrective Action
Initial Calibration (SRM) @ 50, 500, 5000 ppm	Run prior to daily sampling events	%RSD=30	Investigate problem and re-run initial calibration until an acceptable calibration is obtained
Continuing Calibration	Sample data must be bracketed every 10th sample (or less) using SRM	%D <±25%	Re-analyze CC and if passes continue sample analysis. If fails investigate problem and re-analyze all samples following the last acceptable CC starting with a new initial calibration.
Field Blank	Varies by site	<100 ppm	Corrective action determined by end user.
Replicate Analysis (Accuracy)	Varies by site	%D <±50%	
Confirmation Samples	Site Dependent, minimum 1/site	Variable	Intrusive sample for conformation and/or confirmation analysis
MDL	When there is a change in the method or instrument.	Instrument Specific	Action taken at data validation level.
IDC	When there is a change in sampling method or instrument	± 30% recovery*	Investigate problem and correct. Re-run.

APPENDICES

Appendix 1 .... Sampling Logic Tree

Appendix 2 .... Site Worksheet

Appendix 3 .... IDC Study

Appendix 4 .... MDL Studies

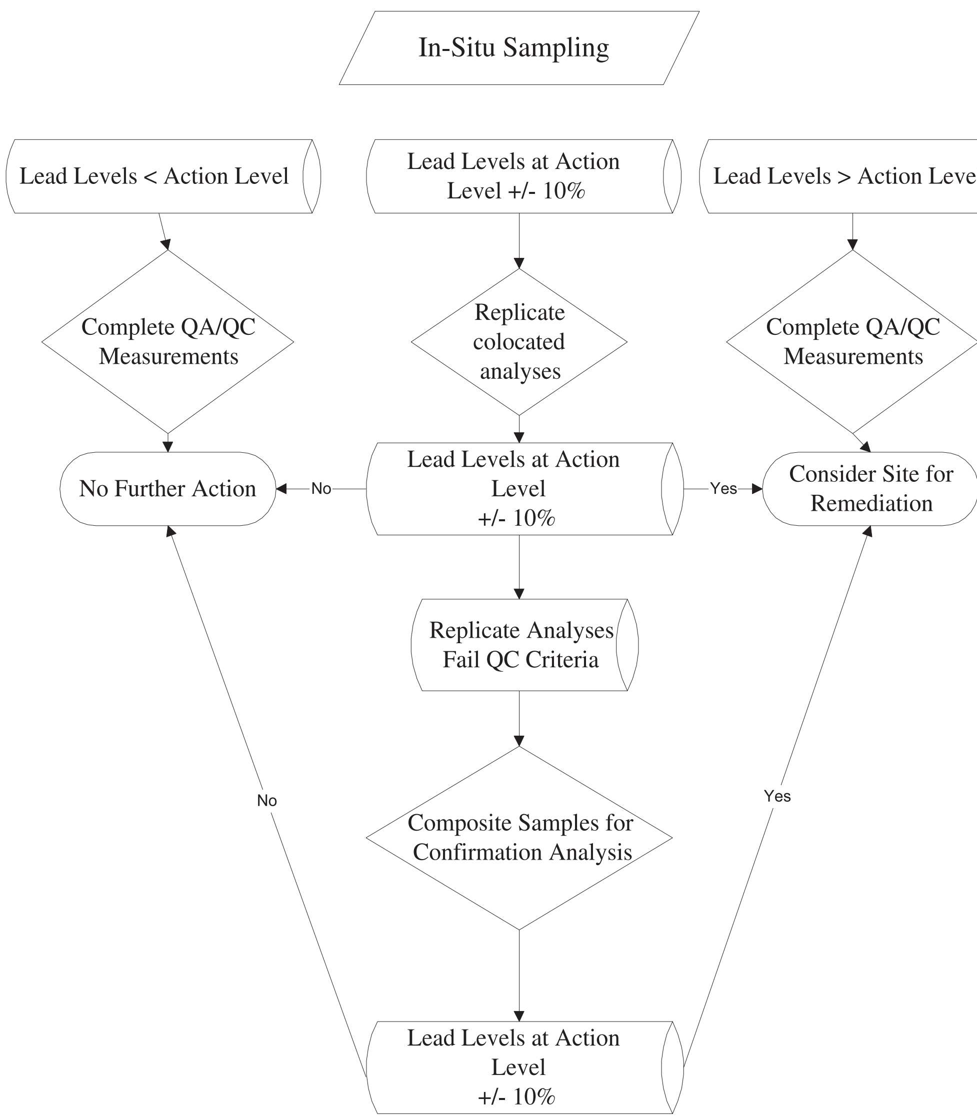
Appendix 5 .... Accuracy Studies

Appendix 6 .... Results of Confirmation Samples

Attached .... Sample Chain of Custody Form

Appendix 1

Sampling Logic Tree



Appendix 2: Site Worksheet

Site Name: ______________________________ Date: __________

Address: ______________________________

____

Building Type: ______________________________

Condition: ______________________________

Lot Condition: ______________________________

Yard Uses: ______________________________

Sample ID	Location	PPM-Lead	Comments	Distance

Appendix 3

INITIAL DEMONSTRATION OF CAPABILITY FOR LEAD IN SOIL BY NITON XRF	
	ppm—lead
IDC1	1123
IDC2	1144
IDC3	1127
IDC4	1225
IDC5	1076
IDC6	1036
IDC7	1095
IDC8	1235
IDC9	1208
IDC10	1228
IDC11	1140
True Value	1162
Average Concentration	1148.8
% True Value	98.9
Standard Deviation	67.2
%RSD	5.9

Criteria: %RSD<30%
%TV<±30%

Appendix 4

MINIMUM DETECTION LIMIT STUDY OF LEAD IN SOIL BY FIELD PORTABLE XRF

	H.P. 600703 5/12/98	H.P. 600703 2/29/00	LCS 0996 2/29/00	NIST 2586 2/29/00
	PPM-Lead	**PPM-Lead**	**PPM-Lead**	**PPM-Lead**
MDL1	190	170	235	365
MDL2	151	209	246	357
MDL3	170	179	303	398
MDL4	177	161	242	355
MDL5	188	220	320	423
MDL6	196	164	254	392
MDL7	170	137	250	422
MDL8	138			
MDL9	138			
MDL10	128			
True Value	129	129	224	432
Avg. Conc.	164.6	177.1	264.3	387.4
% True Value	127.6	137.3	118.0	89.7
Standard Deviation	24.3	28.7	33.2	29.1
MDL	**68.7**	90.3	**104.3**	**91.4**
%RSD	14.8	16.2	12.6	7.5

Criteria: %RSD<30%
%TV<±30%

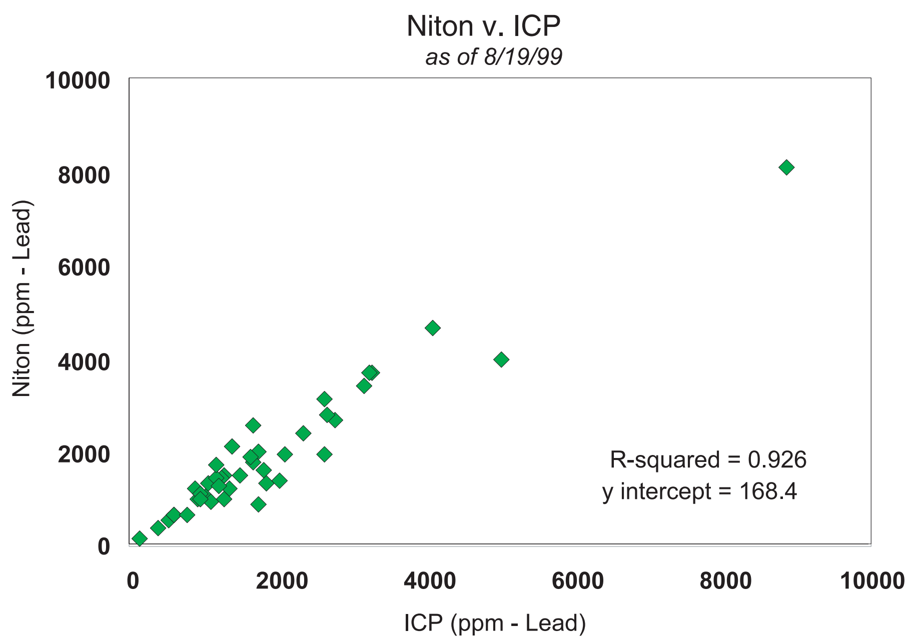
Appendix 5

ACCURACY DATA (1998) FOR LEAD IN SOIL BY FPXRF

	NIST 2710	NIST 2711	LCS 0996	HP 69073	Cleve-1
	5427	1123	268	204	426
	5632	1144	283	190	554
	5651	1127	269	151	526
	5587	1225	280	170	440
	5657	1076	291	177	488
	5372	1036	202	188	490
	5516	1095	383	196	456
	5769	1235	343	170	494
		1208		138	456
		1228		138	441
		1140		128	
				203	
True Value	5532	1162	224	129	433
Average Concentration	5576.4	1148.8	289.9	171.1	477.1
% Recovered	100.8	98.9	129.4	132.6	110.2
Standard Deviation	122.5	64.1	50.3	25.6	38.8
RSD	2.2	5.6	17.4	15.0	8.1

Appendix 5 cont.

ACCURACY DATA (2000) FOR LEAD IN SOIL BY FPXRF						
	NIST 2710	NIST 2711	NIST 2586	LCS 0996	HP 690703	Lot 217
	5580	1070	365	235	170	241
	5780	1140	357	246	209	220
	5590	1190	398	303	179	230
	5970	1290	355	242	161	159
	5490	1110	423	320	220	144
	5610	1070	392	254	164	135
	5530	1160	422	250	137	211
	5780	1170	397	275	242	175
	5460	1090	388	391	232	173
	5750	1140	408	277	146	126
True Value	5532	1162	432	224	129	101
Average Concentration	5654.0	1143.0	390.5	279.3	186.0	181.4
% Recovered	102.2	98.4	90.4	124.7	144.2	179.6
Standard Deviation	152.4	62.8	23.4	45.5	35.1	39.4
RSD	2.7	5.5	6.0	16.3	18.9	21.7



Niton v. ICP
as of 8/19/99
Niton (ppm - Lead)
10000
8000
6000
4000
2000
0
0
2000
4000
6000
8000
10000
ICP (ppm - Lead)
R-squared = 0.926
y intercept = 168.4

The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development, has developed the handbook *Lead-Safe Yards: Developing and Implementing a Monitoring, Assessment, and Outreach Program for Your Community* and is making it available in electronic form on a CD-ROM. EPA has reviewed and approved the contents of this CD-ROM. Mention of trade names or commercial products does not constitute endorsement of their use.

United States Environmental ProtectionAgency | Office of Research and Development Washington, DC 20460 | Office of Environmental Information Washington, DC 20460 | EPA/625/C-00/012 January 2001 http://www.epa.gov/empact

EPA

Lead-Safe Yards

Developing and Implementing a Monitoring, Assessment, and Outreach Program for Your Community

EMPACT

Environmental Monitoring for Public Access & Community Tracking

CD-ROM

System Requirements

Internet browser required (i.e., Netscape Navigator or Microsoft Internet Explorer)

MAC and PC Compatible

Macintosh: Power Macintosh or compatible computer, 4.5MB of application RAM, Apple System Software version 7.1.2 or later, CD-ROM drive, Adobe Acrobat Reader 3.0 or 4.0

Windows: 486 or Pentium processor-based PC, Windows 95, 98, 00 or Windows NT 4.0, 10MB RAM or greater, CD-ROM drive, Adobe Acrobat Reader 3.0 or 4.0

Installation (for both Windows and Macintosh Operating Systems)

1. Insert the CD into your CD-ROM drive.
2. Launch your Internet browser (i.e., Netscape Navigator or Microsoft Internet Explorer).
3. Under your browser's *File* menu, select *Open Page*. Choose *File,* then select the *Start.htm* file found on the CD.
4. Once you have loaded the *Start.htm* file with your browser, a graphic will appear. Click anywhere on the graphic to view the table of contents.
5. Navigate through the CD using your Internet browser.

This CD-ROM provides information your community can use to create and implement a lead-safe yard program. It presents step-by-step instructions on how to:

- Identify target communities and select program partners.
- Provide lead-safety education and outreach to homeowners and residents.
- Use field-portable x-ray fluorescence technology to collect real-time soil lead data.
- Design and implement property-specific treatment plans and develop yard-maintenance plans.
- Evaluate the effectiveness of your program.

It also contains links to Web sites where you can find additional technical guidance.

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EPA Office of Research and Development **Lead-Safe Yards**

DORCHESTER LEAD-SAFE YARD PROGRAM

FREE SOIL TESTING IN YOUR YARD FOR LEAD

WE ARE LOOKING FOR 50 YARDS IN YOUR NEIGHBORHOOD
WITH HIGH LEVELS OF LEAD
IF YOUR YARD MEETS A CERTAIN LEVEL, YOU COULD BE
ELIGIBLE FOR $700 WORTH OF FREE MATERIALS AND LABOR
WHICH WILL MAKE YOUR YARD SAFER AND ATTRACTIVE
WITHOUT ANY COST TO YOU!

The Dorchester Lead-Safe Yard Program is a collaboration of the Bowdoin Street Health Center, the New England Environmental Protection Agency Laboratory, Boston University School of Public Health and Garden Futures. The purpose of this pilot program is to show that low cost methods exist which will make your yard safer. By improving the safety of your yard, we hope this will further reduce the risk of our children six years of age and younger becoming lead poisoned.

Your neighborhood has been chosen for this pilot project because there are a number of children with high levels of lead in their blood. Lead is especially hazardous to children. This is the main reason we want to conduct this pilot program. Because children play in many parts of this neighborhood, you do not have to have children six years of age or younger to participate.

We will first test your yard for lead content and if your yard qualifies, we will work with you on certain methods of reducing exposure to elevated lead levels. Staff from Garden Futures will provide landscape materials and labor to complete the work in your yard.

If you are interested in participating in this program, please call the number listed at the bottom of this page. We will be in the neighborhood speaking with you and your neighbors about this program. If you have questions, please do not hesitate to call.

FOR MORE INFORMATION OR TO PARTICIPATE IN THIS PROJECT, CALL

Bowdoin Street Health Center, (617) 822-5318

PROGRAMA DE PATIOS SIN PLOMO DE DORCHESTER

(Dorchester Lead-Safe Yard Program)

PRUEBAS DE PLOMO GRATUITAS EN SU PATIO

ESTAMOS BUSCANDOS 50 PATIOS EN EL VECINDARIO CON ALTOS NEVELES DE PLOMO EN LA TIERRA.

SI SU PATIO CONTIENE PLOMO, USTED PUEDE SER ELEGIBLE PARA RECIBIR 700 DOLARES, ENTRE MATERIALES Y TRABAJO, PARA REMOVER EL PLOMO DE LA TIERRA Y EMBELLECER SU PATIO SIN COSTO ADICIONAL PARA USTED.

El Programe de Patios sin Plomo de Dorchester es una colaboración del Centro de Salud de Bowdoin Street, el Laboratorio de la Agencia de Protección Ambiental de Nueva Inglaterra, la Escuela de Salud Pública de Boston University y Garden Futures. El objectivo de este programa piloto es il mostrar que existen métodos a bajo costo que harán sus patios más seguros. Mejorando los patios esperamos reducir el riesgo que corren los niños de seis años y menores de acabar envenenados com plomo.

Su vecindario ha sido escogido para este programma piloto debido al alto número de niños envenenados o con altos niveles de plomo en la sangrue. El plomo es realmente perjudicial para los niños, y eelo es la razón por la que queremos realizar este programa. Debido a que los niños juegan en diferentes partes del vecindario, usted no tiene que tener niños de seis años o menores para participar.

Primero mediremos la tierra de su patio para ver si esta contiene plomo, y si es elegible trbajaremos con uste par mostrarle ciertos métodos para reducir el nivel de plomo en la tierra. Personal de Garden Futures trabajaran proveyendole materiales jardineria y trbajarán para completar el trabajo en su patio.

Si usted está interesado en participar en este programa, por favor llame a la persona listada más abajo en esta página. Estaremos en el vecindario hablando con usted y sus vecinos sobre este programa. Si tiene alguna pregunta, por favor llamenos.

Para Más información o Para Participar en este Programa, Llame
Bowdoin Street Health Center, (617) 822-5318

Dorchester Lead-Safe Yard Program

Um teste gratuito para detectar veneno de chumbo no seu pátio/quintal. Procuramos 5 pátios, na vizinhança, com nível de veneno de chumbo elevado. Se o seu pátio/quintal mostrar um nível elevado de veneno de chumbo no solo você se qualificar a receber uma quantia de $700 no valor de materiais e mão-de-obra, o que lhe irá ajudar a tornar o seu quintal mais atractivo e seguro. Este programa lhe será oferecido sem nenhum custo monetário.

Este programa e uma colaboraçao de Bowdoin Street Health Center, New England Environmental Protection Agency Laboratory, Boston University School of Public Health e Garden Futures. O propósito do programa e para mostrar que existen meios, a preços accessíveis, para remover o veneno de chumbo do solo, e tornar o seu pátio/quintal mais seguro. Ao reduzir o nivel de chumbo no solo, esperemos que ira diminuir a possibilidade dos seus filhos, menores de seis anos di idade, contrairem veneno de chumbo no sangue.

A sua vizinhança foi escolhida para este programa porque existe un numero elevado de criancas contaminadas de chumbo no sangue, o que é bastante projudicial, e pode causar graves problemas de saúde. Porque as crianças brincam em varios lugares, não e necessario que você tenha filhos/as para poder participar neste programa.

Faremos un teste para detectar resdios de chumbo. Se o seu pátio qualificar, entraremos em contacto consigo para discutirmos meios de como reduzir o nível do chumbo. O pessoal de Garden Futures providenciará materiais e mão-de-obra. Se você está interesada/o em participar neste programa, por favor contacte:

Bowdoin Street Health Center, (617) 822-5318

Pwogram Ki Okipe Lakou Kont Plon

Tes Gratis Nan Lakou Pou Plon

Nap Chache Sinkant Pie Nan Lakou Ki Nan Zòn Nan

Ki Genyen Yon Nivo Plon Ki Wo.

Si lakou a genyen Yon nivo plon, ou kapab elijib pou yon zafe de set san dola an mateiyo & men dèv sak ka fè lakou bel, san danje e gratis.

Pwogram sila ki pou kimbe lakou san danje. Marè avek Bowdoin St. Sant pou Sante, N.E. EPA, B.U.S. of P.H. & Garden Futures. Rezon pwogram sa se pou montre ou metod bon mache ki egziste pou fè lakou san danje ak plon. Pake timoun yo ap jwe tout kote. Ou pa bezyen gen timoun sizan ou byen timoun pi piti pou patisipe.

Nap Teste lakou pou plon, si lakou a kalifye nap travay ak ou pou redwi nivo plon an. Nap ba ou materyo ak zouti pou travay sila.

Si ou enterese patisipe nan pwogram nan souple rele moun sa ke ou we nan an ba fey la. Nap pale ak ou e ak vwazen ou o sijè pwogram nan.

Si yon gen keksyon pa ezite rele:

Bowdoin Street Health Center, (617) 822-5318

DEPARTMENT OF NEIGHBORHOOD DEVELOPMENT
BOSTON'S PUBLIC FACILITIES DEPARTMENT

THOMAS M. MENINO, MAYOR
CHARLOTTE GOLAR RICHIE, CHIEF AND DIRECTOR

January 5, 2000

Dear Property Owner:

The City of Boston's Lead Safe Boston program, in conjunction with the National Center for Lead Safe Housing and the Environmental Protection Agency, would like to offer you the chance to improve the quality of the grounds surrounding your home through a unique program:

Low Level Soil Treatment Demonstration Project

There is no cost involved or work required on the part of the property owner!

Properties meeting project criteria and enrolled in the program will be part of an effort to demonstrate low-cost soil interventions through the use of landscape treatments that will enhance the appearance of your home!

What the Program Can Offer You!

Up to **$3000** to cover the design, acquisition and installation of landscape elements.
Comprehensive testing/sampling of soil surrounding your home.
Scaled drawings of your property identifying lead hazard areas.
Fully developed plans showing proposed treatments and plantings.
Supervised construction and installation of all landscape treatments.
Detailed educational information.

What We Ask Property Owners To Do!

Answer a questionnaire concerning Lead Paint Hazards.
Allow project staff to sample the soil surrounding your home.
Participate in and provide feedback during the landscape design process.
Enjoy your newly landscaped yard!!!

A representative of Lead Safe Boston and The National Center for Lead Safe Housing will soon be contacting you about your possible involvement in this program.

We hope you decide to join us in this important endeavor!

Please call the Lead Safe Boston office at (617) 635-0190 with any questions regarding the program.

Fact Sheet: LEAD

What is Lead?
Lead is a poisonous metal found in nature. Because it is durable and persistent, it was used in house paint, pipes, cans, old toys, cribs, and furniture.

If a house was built before 1978, it probably has lead paint. Lead dust can be created by just opening and closing windows.

What does lead poisoning do to my child?
Lead poisoning can damage your child's brain, cause hearing loss and learning disabilities, and impair motor skills.

How can my child be exposed?
Your child can be exposed to lead by touching window sills, ledges, and other areas which have lead dust, and then putting their fingers in their mouths. This is normal behavior for children.

Finding the Lead
The only way to find out where the lead is in the house is to have a lead inspection done by a licensed inspector. If the inspector finds lead, then a licensed contractor must come in and make the house safe. You cannot live in the house while this is happening.

Lead Dust is Invisible

The most common way for children to be poisoned is by exposure to lead dust.

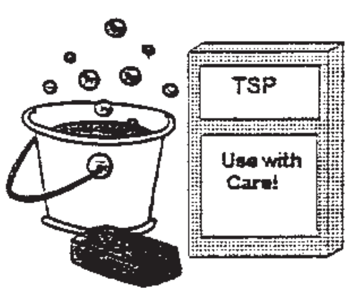
What Can I Do?

Make sure your child has a well-balanced diet, which includes milk (for calcium), dark green, leafy vegetables (for iron), and vitamin C. Have your child's blood tested regularly.

Wash Hands and Toys Often!

Wash your child's hands and toys often, and keep fingernails short.

Run the tap water for a few minutes every morning. Use only COLD water for cooking and drinking. Hot water concentrates the lead.



Keep It Clean!

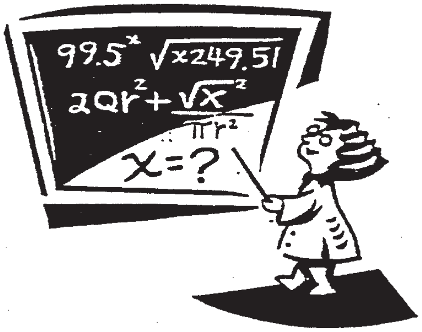
Wipe windows, windowsills and dusty surfaces with warm water and TSP. Throw used paper towels away after wiping.

Don't Disturb Leaded Paint!

Make sure that there is no loose or flaking paint. NEVER scrape painted surfaces.

For more information, contact the Boston Childhood Lead Poisoning Prevention Program at the Boston Public Health Commission
1010 Massachusetts Avenue, 2nd Floor, Boston, MA 02118
(617) 534-5966

How Much Do You Know About Lead Poisoning?



MYTH
There is no way to prevent children from being lead poisoned.

FACT
Lead poisoning is completely preventable Get the facts and learn how to protect your child by getting lead out of your home safely.

MYTH
Children have to eat paint chips, or chew on walls, to be lead poisoned.

FACT
Children can be poisoned simply by breathing lead dust. They can also be poisoned by having lead dust on their toys or fingers and then putting their fingers in their mouths.

MYTH
Only children with very high levels of lead in their blood will be hurt by the lead.

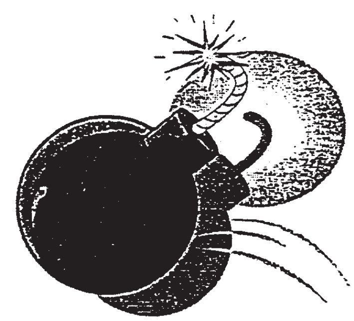
FACT
Low levels of lead in a child's blood can cause long term problems and permanently affect learning and behavior.

MYTH
Only children who live in the inner city can be lead poisoned.

FACT
Any child, from any neighborhood, can be lead poisoned. Lead paint can be in any home built before 1978.

MYTH
Lead poisoning is not a real problem. Many people grew up in homes with lead paint and are perfectly healthy.

FACT
The lead paint that existed in homes twenty years ago is much more dangerous now. As lead paint gets older, it is likely to peel, chip, and create lead dust. This is a real health hazard.

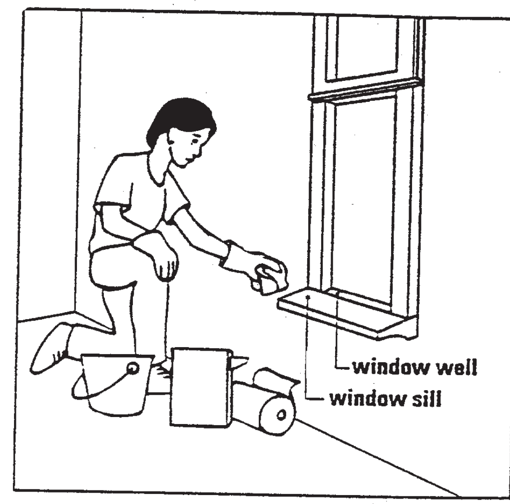


MYTH
Having a home deleaded is much more dangerous than just leaving the lead paint there.

FACT
Lead removal must be done by a licensed deleader who will use safe techniques and who will clean up properly.

For more information, contact the Boston Childhood Lead Poisoning Prevention Program at the Boston Public Health Commission
1010 Massachusetts Avenue, 2nd Floor, Boston, MA 02118
(617) 534-5966

TEMPORARILY REDUCING LEAD PAINT HAZARDS BY CLEANING

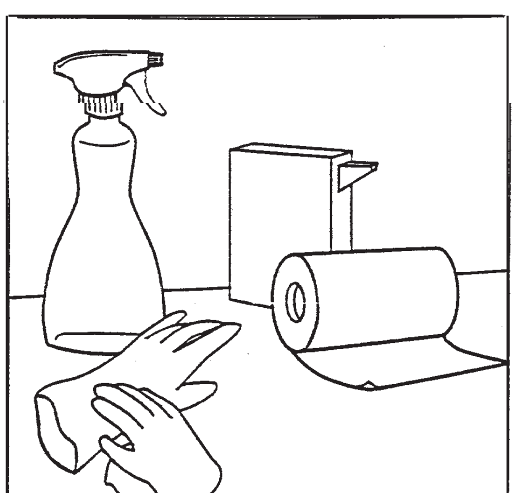


1 **Wear plastic gloves to clean**
Protect yourself from exposure to lead.

2 **Pick up all chips by hand or use a damp paper towel (Window areas often have lots of paint chips)**
- Seal chips and paper towels in a plastic bag and throw out. ***Do not use a household vacuum or broom to clean up lead paint chips or dust!***

3 **Wash household surfaces**
- Use TSP, a lead-specific detergent, or any all-purpose, non-abrasive cleaner.
- Scrub well for best results. (Don't scrub hard enough to remove the intact paint.)
- Clean window wells, window sills, play areas, and floors at least once or twice a week.
- Keeps children away when cleaning.
- Keep all cleaners safely away from children.

4 **Use a spray bottle to keep dust levels down**
- Use a cleaner already in a spray bottle, or put the cleaner into a spray bottle.
- If you must use a bucket, keep the wash water clean. Never put dirty paper towels into the wash water.



5 **Use paper towels**
- Don't use dish cloths or sponges to clean.
- Use a new paper towel to clean each area.
- Seal the used paper towels and gloves in a plastic bag and throw them out.

6 **Rinse after cleaning**
Use clean water and paper towels for rinsing each area.

7 **Clean up properly**
- Wash your hands when cleaning is done.
- Pour any wash and rinse water down the toilet, not the sink.

Important! Do not use a household vacuum or broom to clean up lead paint chips or dust. This could spread the lead dust into the air and into your vacuum cleaner or broom.

TEMPORARY WAYS TO KEEP CHILDREN SAFE FROM LEAD PAINT HAZARDS

Under the Lead Law, the property owner is responsible for having his or her home deleaded or brought under interim control if it was built before 1978 and a child under the age of six lives there. Deleading permanently reduces the risk of lead poisoning. Until deleading occurs, here are some temporary ways to reduce lead hazards:

1 Clean often

Wet wiping regularly reduces lead dust levels in the home. See other side.

2 Put duct tape or contact paper over peeling paint and plaster

Put duct tape or contact paper on window wells, window sills, walls or other surfaces with peeling paint or plaster. Clean these areas often. Window wells and sills can be cleaned more easily when contact paper or duct tape are put down first. See other side.

3 Keep the lower part of the window closed (if possible)

If a window well is in bad condition, keep the lower part of the window closed and open only the upper part. This will prevent your children from putting their hands or objects in the window well where the lead dust collects. It also helps keep lead dust from blowing into the house.

4 Move furniture to block contact with peeling paint and plaster

By moving a sofa in front of a crack in a wall, you can block a child's access to lead hazards. Never place furniture where a child may climb on it and fall out of a window.

5 Change child's bedroom (if possible)

If your child's bedroom has chipping paint or plaster, consider using another room without chipping paint for the bedroom.

6 Other ideas

Regularly have your child tested for lead poisoning; wash your child's hands and toys often; if you are renovating or repainting call CLPPP for more information on how to do the work safely before you begin; feed your child food high in iron, calcium, and vitamin C and low in fat.

Lead Poisoning and your child health
Lead pain is the most common cause of childhood lead poisoning. When old paint cracks or peels, or when lead paint surfaces rub against each other or are bumped, lead paint dust or chips are created. Children typically become poisoned by putting their fingers which have touched lead dust into their mouths. Lead poisoning can cause lasting damage to children's brains, kidneys and nervous system. Even lower levels of lead can slow children's development and cause learning and behavioral problems. Children under six are at greatest risk.

Keep your child safe
Remember, these are only temporary ways to reduce the risk of lead poisoning from lead paint hazards. The only permanent way to reduce the risk of lead poisoning is to have the home deleaded. The owner of a home built before 1978 is responsible for having it deleaded or brought under interim control when a child under the age of six lives there.

FOR MORE INFORMATION, CONTACT:

or your local lead program at

Massachusetts Department of Public Health
Childhood Lead Poisoning Prevention Program
617-753-8400 or 800-532-9571 (toll free)
www.magnet.state.ma.us/dph

BOSTON CHILDHOOD LEAD POISONING PREVENTION PROGRAM

UNDERSTANDING WHAT BLOOD LEAD (PB) TEST RESULTS MEAN:

IF THE CHILD HAS A PB LEVEL OF:	THEN:
9 ug/dL or below	A child with a blood lead level below 9 is not considered to be poisoned.
10 - 14 ug/dL	The CDC defines a level over ten as a "level of concern." The child should be tested again frequently. Check with your pediatrician. He or she may prescribe multi-vitamins and iron.
15 - 19 ug/dL	The child's pediatrician should be involved in helping bring this blood lead level down by managing the child's diet and increasing nutrition. In addition, the child should be tested frequently. An environmental assessment should be done to find out where the lead is coming from. Prevention measures should be implemented immediately.
20 - 24 ug/dL	Get a complete medical evaluation, and have the child's home inspected for lead. Find and get rid of lead hazards in the child's home, school, and play areas.
25 ug/dL and above	**A child with a blood lead level above 25 is considered poisoned.** A lead inspection in the home is required, and it is essential that the child visit the doctor immediately. This is very serious. Medical treatment such as chelation may be used.
70 ug/dL and above	A child with this level is considered a medical emergency.

For help understanding your child's test result, talk with your pediatrician or health care provider. For information and assistance regarding inspections and removing lead hazards from your home, in Boston contact: **The Boston Childhood Lead Poisoning Prevention Program at (617) 534-5966.**

Outside of Boston, call **The Massachusetts Department of Public Health's Childhood Lead Poisoning Prevention Program at (800) 532-9571.**

For more information, contact the Boston Childhood Lead Poisoning Prevention Program at the Boston Public Health Commission
1010 Massachusetts Avenue, 2nd Floor, Boston, MA 02118
(617) 534-5966

Programa de Prevención del Envenenamiento Infantil Con Plomo

COMPRENDA EL SIGNIFICADO DE LOS RESULTADOS DEL EXAMEN DE PLOMO EN LA SANGRE (PB):

SI SU NIÑO TIENE UN NIVEL DE:	ENTONCES:
9 ug/dL o menos	Se considera que un niño con un nivel de plomo en la sangre con menos de 9 no está envenenado.
10 - 14 ug/dL	El Centro de Control de Enfermedades (CDC) define un nivel mayor de 10 como un "nivel de interés." El niño debe ser chequeado frecuentemente. Consulte con su pediatra, este le puede recetar multi-vitaminas e hierro.
15 - 19 ug/dL	El pediatra debe colaborar y ayudarle a reducir el nivel de plomo en la sangre de su niño, através de cambios en la dieta y nutrición. También, el niño debe ser chequeado frecuentemente y el ambiente tiene que ser examinado para encontrar la fuente del plomo. Medidas de prevención tienen que ser implementadas inmediatamente.
20 - 24 ug/dL	Su niño necesita una completa evaluación médica. El pediatra puede recetarle hierro. Localize el lugar de donde proviene el plomo y aleje a su niño de este lugar. Recuerde que la fuente de plomo puede estar en su casa, en la escuela y donde juega su niño.
25 ug/dL y mayor	Se considera que un niño con un nivel de plomo en la sangre mayor de 25 está envenenado. Intervenciones ambientales y médicas tienen que ser implementadas inmediatamente. Un tratamiento médico y medicinas pueden reducir el nivel de plomo en la sangre.
70 ug/dL y mayor	Un niño con este nivel es considerado una emergencia médica.

Si necesita más ayuda para comprender los resultados de su niño, hable con su pediatra. Para más información sobre como puede remover el plomo de su casa en Boston, llame al: **Programa de Prevención del Envenenamiento Infantil Con Plomo al (617) 534-5966.**

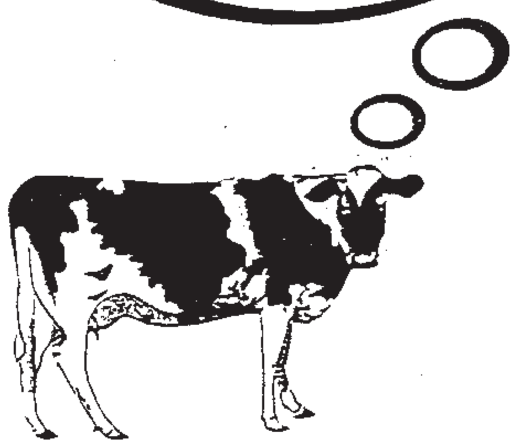
Si usted vive fuera de Boston, llame al **Programa de Prevención del Envenenamiento Infantil Con Plomo del Departamento de Salud Pública de Massachusetts al (800) 532-9571.**

La Comisión de Salud Pública de Boston
1010 Massachusetts Avenue, 2do Piso / ◆ Boston, Massachusetts ◆ 02118
◆ (617) 534-5966 (voice) ◆ (617) 534-2372 (fax) ◆

Foods That Help Reduce the Harmful Effects of LEAD

Lead is poisonous to the body. Infants, children under six, and pregnant women are at the greatest risk for lead poisoning.

Calcium is very important for growing bodies. Extra calcium will help protect children from lead poisoning!



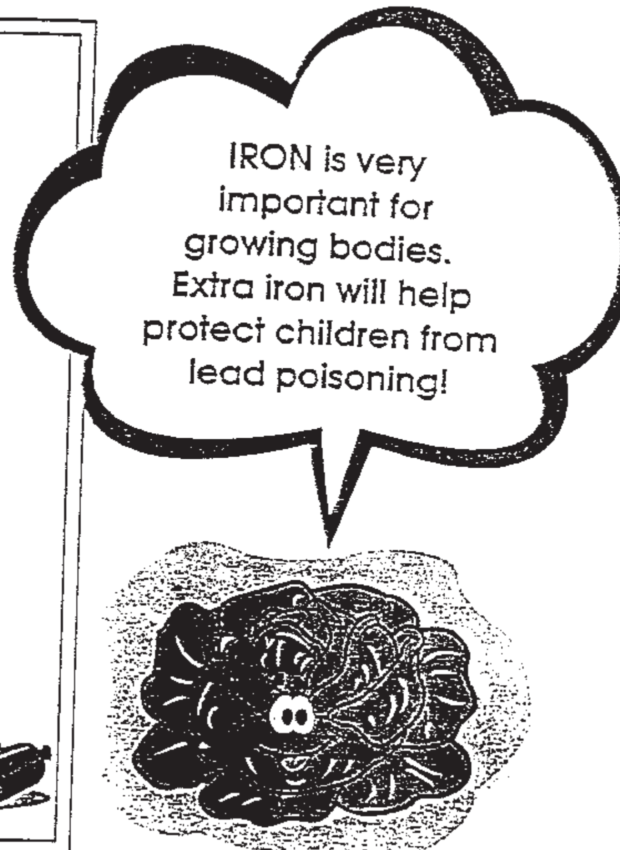
Foods to Eat for <u>Calcium</u>

Milk
Yogurt
Tofu
Cheese
Sardines and Tuna
Green leafy vegetables
(Collard greens, broccoli, kale)

Lead looks like calcium, zinc and iron to the body. The body absorbs lead just like these important minerals, but lead is harmful, not helpful, to normal development. This is why it is important for you and your children to eat a balanced diet.

When you don't have enough vitamins and minerals in your diet, your body will absorb more lead. Lead is stored in the bones, just like calcium and iron.

Foods to eat to get IRON
Lean meats
Chicken, Turkey
Black beans
Kidney beans
Rice
Cereal with added iron
Dried fruits
Peanut Butter
Corn Tortillas
Dark green leafy vegetables
(like spinach and kale)



Iron works better with Vitamin C. Eat oranges, mangos, green peppers, tomatos, and drink real fruit juices (not fruit punch or kool aide) to help your body absorb iron.

For more information, contact the Boston Childhood Lead Poisoning
Prevention Program at the Boston Public Health Commission
1010 Massachusetts Avenue, 2nd Floor, Boston, MA 02118
(617) 534-5966

CITY OF BOSTON
DEPARTMENT OF NEIGHBORHOOD DEVELOPMENT
LEAD SAFE BOSTON PROGRAM

38 Winthrop Street
Hyde Park, Ma 02136
(617) 635-0190

LEAD SAFE BOSTON YARD PROGRAM APPLICATION

APPLICANT (Owner of Property)

Name: ____

Property Address: ____

I live here _____ I do not live here ____ # units in building ______

Mailing Address (Investor-Owners only):_______________________________________

Phone: (home) _______________ (work) _______________ SS #______________________________

Identify your ethnic/racial category ________________ Female Head of Household Yes____ No____

Contact person ____________________________________ Phone (home) _______________________

CO-APPLICANT (Co-owner of property only if listed on deed)

Name: ____

Mailing Address: ____

Phone: (home) _______________ (work) _______________ SS #______________________________

Identify your ethnic/racial category _______________

Please check the appropriate answer	Yes	No
1. Do you have a current homeowner's insurance policy in place? (If yes, attach a copy of the insurance certificate to application)	________	________
2. Are you current with your Boston Water and Sewer Payments?	________	________
If no, do you have a payment plan in place?	________	________
3. Are you current with you real estate taxes?	________	________

4. Please complete the child information below (use additional sheets if necessary).

Name of Child(ren) Who live on the property	Date of Birth	Unit # where child(ren) lives
______________________	________	____________
______________________	________	____________
______________________	________	____________
______________________	________	____________

****

AUTHORIZATION TO PROCEED WITH
LEAD SAFE YARD PROGRAM APPLICATION

I am interested in participating in the Low level Soil Treatment Demonstration and Evaluation Project, as outlined in the Homeowner Consent Form. I understand in order to be eligible for this grant program I, as the Owner of the Property, must be in good standing with my Boston Water and Sewer account, be current on my real estate taxes and have a homeowner insurance policy in place. I also understand that this program is being offered to protect children and that there must be young children living here: either the child/ren who lived here during the Round 1 evaluation or at least one child under the age of 6 years old.

I hereby certify that the information that is provided in this application is true and complete to the best of my knowledge. I will make this information available for review upon request by the City of Boston's Department of Neighborhood Development, the U.S. Department of Housing and Urban Development, or its designee. I authorize the program to proceed with my application.

Applicant's Signature:________________________________ Date:_______________

Co-Applicant's Signature:_____________________________ Date:_______________

TERMS SUBJECT TO CHANGE WITHOUT NOTICE
MISSING INFORMATION WILL DELAY PROCESSING THIS APPLICATION AND MAY JEOPARDIZE FUNDING AVAILABILITY!

DEPARTMENT OF NEIGHBORHOOD DEVELOPMENT

BOSTON'S PUBLIC FACILITIES DEPARTMENT

THOMAS M. MENINO, MAYOR
CHARLOTTE GOLAR RICHIE, CHIEF AND DIRECTOR

March 28, 2000

Homeowner Name
Homeowner Address
Mattapan, MA 02126

Dear Homeowner:

Thank you for your interest in our Lead Safe Boston Yards Program. As you know from visiting with our outreach person Yvonne Illich of Silver Linings, if you participate in this program you will receive at **no cost to you**, comprehensive testing/sampling of the soil surrounding your home; drawings of your property identifying lead hazard areas; fully developed landscape plans showing proposed treatments; supervised construction and installation of all landscape treatments and detailed educational information about how to maintain your lead safe yard!

On March 6, 2000 we sent you a letter requesting the following documents. As of today, we have not received the documents listed below. It is important to note that we need these items before we can enroll you property in our program. Please use the enclosed self-addressed stamped envelope to send copies of the following documents to our office.

__✓__ Boston Water and Sewer written approved payment plan.

_____ Copy of current insurance policy for the property that will receive yard treatments.

Since this program will begin in early spring and funding is limited, it is very important that the document(s) be forwarded to our office as soon as possible. If your application is still incomplete after April 6, 2000, we will not be able to enroll you in our lead in soil grant program.

We are looking forward to working with you on this Low Level Soil Treatment Demonstration Project. Yvonne Illich will be contacting you later this week to offer you assistance in sending this information to our office. If you have any questions, please contact me at 617/635-0193.

Sincerely,

Sandra R. Duran
Lead Safe Boston

Cc: File

Department of Neighborhood Development

Boston's Public Facilities Department

Thomas M. Menino, Mayor
Charlotte Golar Richie, Chief and Director

June 12, 2000

Homeowner Name
Homeowner Address
Dorchester, MA 02124

Dear Homeowner:

Congratulations, you have been officially enrolled in the Lead Safe Boston Yards Program!

As a participant in our Lead Safe Boston/National Center for Lead-Safe Housing Low Level Soil Treatment Demonstration and Evaluation Project, you will receive a grant of up to $3,000 worth of design and landscaping work to reduce the exposures to lead in soil on your property. For your files, we have attached a copy of the consent form that you signed. This form details the terms of our program that you are required to comply with in exchange for this granted scope of services. This is a very important project and your participation is vital to our efforts to demonstrate that low cost soil treatments are instrumental in reducing dust lead levels found inside homes.

Now that your property has been enrolled, EPA will sample the soil around your home and analyze the samples for their lead content. Once the results are available, one of our landscape contractors will set up an appointment with you to review your current yard use. With your input he or she will design a landscape plan that will abate the lead hazards found around your home.

Once the design is approved, the landscape contractor will schedule another appointment to review the design with you and determine the start date of your project. It is important to note that any debris that the landscape contractor determines needs to be removed in order to facilitate his work must be completed before work can begin.

Once the new landscaping work is complete, the landscape contractor will schedule a convenient time to meet with you to review the work and to explain the information contained in a Homeowner Maintenance Manual that will be yours to keep. Over the course of the following year, there will be times when our outreach person will return to your property to take dust wipes inside the entrance to your home and your tenant's units. We would like to thank you in advance for your cooperation in providing access to these areas.

If you have any questions regarding the program please feel free to contact me at 617/635-0193.

Sincerely,

Sandra R. Duran
Lead Safe Boston

HOMEOWNER PERMISSION FORM

Most homes in Boston have lead in the yard soil. This comes mainly from leaded paint flaking or being scraped off houses and leaded gasoline which was used in cars until recently. Lead in soil can harm children because dirt and dust get on children's hands, toys and other objects that they often put in their mouths. Lead in soil can also be tracked into the house.

PURPOSE OF THE PILOT PROGRAM

The Lead-Safe Yard Program is a project to make yards in your neighborhood safer for residents, especially children. We plan to do this by making low-cost and easy-to-install landscape improvements in yards with high lead levels in soil.

PROGRAM ELEMENTS

1. Analysis.
As part of your voluntary participation in the Lead-Safe Yard Program, the soil around your property at ____
will be analyzed for lead content. We will provide the analysis free of cost.

2. Improvements.
If the lead in your soil is above certain levels, we will suggest different kinds of landscaping options for you to choose. These may include covering the soil with barriers such as: mulch, wood chips, crushed stone, and shrubs. We will discuss options for children's play areas and vegetable garden sites also. We will make the improvements that you choose, with materials and labor provided free of cost.

VOLUNTARY PARTICIPATION

Your participation is voluntary because there is no obligation to reduce or protect against the lead in your soil. If you wish to be part of the Lead-Safe Yard Program, we will make an appointment to analyze your soil and make the results available to you If your soil has high levels of lead, we will make a second appointment to discuss the yard improvements and to plan a schedule for the landscaping work.

Value

If the levels of lead in your soil are above 400 parts per million, you are eligible to receive materials, services, and labor in landscape improvements free of cost from the Lead-Safe Yard Program.

I understand the conditions of this agreement and I agree to participate in the program.

______________________________ ______________________

Signature Date

Homeowner Consent Form
Lead-Safe Boston/National Center for Lead-Safe Housing
Low Level Soil Treatment Demonstration and Evaluation Project

I am interested in participating in the Low Level Soil Treatment Demonstration and Evaluation Project. If I meet the criteria for this project and if my property is accepted for the project, I understand that I will receive up to $3,000 worth of design and landscaping work to reduce the exposures to soil lead on my property in exchange for my participation in the program. The work will be completed in the year 2000 or 2001.

I will receive the following:

1. Up to $3,000 worth of design and landscaping work for my property.
2. Comprehensive testing/sampling of soil surrounding my home.
3. Scaled drawings of my property identifying the lead hazard areas in my yard.
4. Fully developed landscape plans showing proposed treatments and plantings.
5. Results of limited dust testing taken before, immediately after and one year after the work has been done.
6. Detailed educational information about how to maintain my yard.
7. A new door mat after all dust collection activities have been completed.

I agree to do the following:

1. Complete an application form and provide a copy of my homeowner's insurance policy to project staff.
2. Remove any debris, trash, old cars or other identified items that would make soil sampling or landscape work difficult or not possible.
3. Participate in an initial interview to identify my current or planned uses of the yard.
4. Meet with the landscape designer to provide input into the plan.
5. Allow access to my yard for site testing by Region 1 EPA, prior to starting and after completion of the landscape work.
6. Allow access to my home for dust testing by Silver Linings, Inc. Dust testing will take place three times (immediately before the work is done, after work is done, and one year after work is done) and include wipe sampling and laying down a dust collection mat to better measure accumulation of lead dust over time. I will allow Silver Linings, Inc. access to my home to pick up the mats about two weeks after each has been put in place.
7. Meet with the landscape designer after the plan has been developed, to review and approve the plan.
8. Allow the landscape designer access to my yard to complete planned treatments.
9. Cooperate with the landscape designer and allow him/her to use at no cost my utilities (such as lights, heat, power and water) as needed to carry out and complete the work.
10. Meet with the interviewer and landscape designer after work is completed to review my Homeowner Maintenance Manual, conduct dust testing, and complete project evaluation forms.
11. If a one year evaluation of this project is funded, allow one more site visit approximately one year after the yard work has been completed by the interviewer who will conduct dust testing and complete project evaluation forms.
12. Speak with the press and/or participate in a press event and/or publicity related to the Lead Level Soil Treatment Demonstration and Evaluation Project.

I will formally sign off on the proposed scope of work, Form #09 Owner Approval of Scope of Work, and Form #19 Homeowner Education and Project Completion Certificate, indicating that the work has been successfully completed.

I understand that Lead-Safe Boston will oversee the landscape work done in my yard and that the project's interviewer, Yvonne Illich of Silver Linings, will coordinate collection of most of the data for this project. Soil-lead measurements of my yard will be taken by the EPA as soon as it is feasible to sample, depending on weather conditions; I do not need to be present during this sampling. Because of changes in field conditions such as weather, I will not be notified in advance of the EPA sampling date.

If I have any questions about the construction work for this project, they will be answered by Sandra Duran, Lead-Safe Boson at 617-635-0193. If I have questions or concerns about the evaluation aspect of this project, they will be answered by Pat McLaine, National Center for Lead-Safe Housing at 1-800-624-4298.

______________________________ ______________________
Homeowner #1 signature Date

______________________________ ______________________
Homeowner #2 signature Date

______________________________ ______________________
Interviewer signature Date

1 copy to homeowner

1 copy to Evaluation Files

HOMEOWNER YARD USE/TREATMENT OPTIONS INTERVIEW

Name: ______________________________

Address: ______________________________

Using a "clean" copy of the plot plan with house footprint:

1. Show me where people walk through the yard going to and from the house. (exposed soil?) ______________________________
2. Show me where children play (how many and how old?) ______________________________
3. Show me where people raise vegetables (or do other gardening) ______________________________
4. Show me where people eat outside ______________________________
5. Show me where pets (especially dogs) spend their time ______________________________
6. Show me where cars or other vehicles are parked or repaired ______________________________
7. Show me where people walk to hang out clothes ______________________________
8. Show me other areas for:
   Sunbathing ______________________________
   Garbage cans ______________________________
   Recycling bins ______________________________
   Composting ______________________________
   Hobbies ______________________________
9. Tell me any other places and ways children or adults spend their time in the yard. ______________________________

HOMEOWNER YARD USE/TREATMENT OPTIONS INTERVIEW

Name: ______________________

Address: 10 Home Street

Using a "clean" copy of the plot plan with house footprint:

1. Show me where people walk through the yard going to and from the house. (exposed soil?) from driveway to deck + across grass in front. Soil exposed in front.

2. Show me where children play (how many and how old?) backyard 3 kids (3, 7, 9) and lots of friends

3. Show me where people raise vegetables (or do other gardening) backyard veg garden (see plot plan)

4. Show me where people eat outside on deck + in backyard (see plot plan)

5. Show me where pets (especially dogs) spend their time no pets

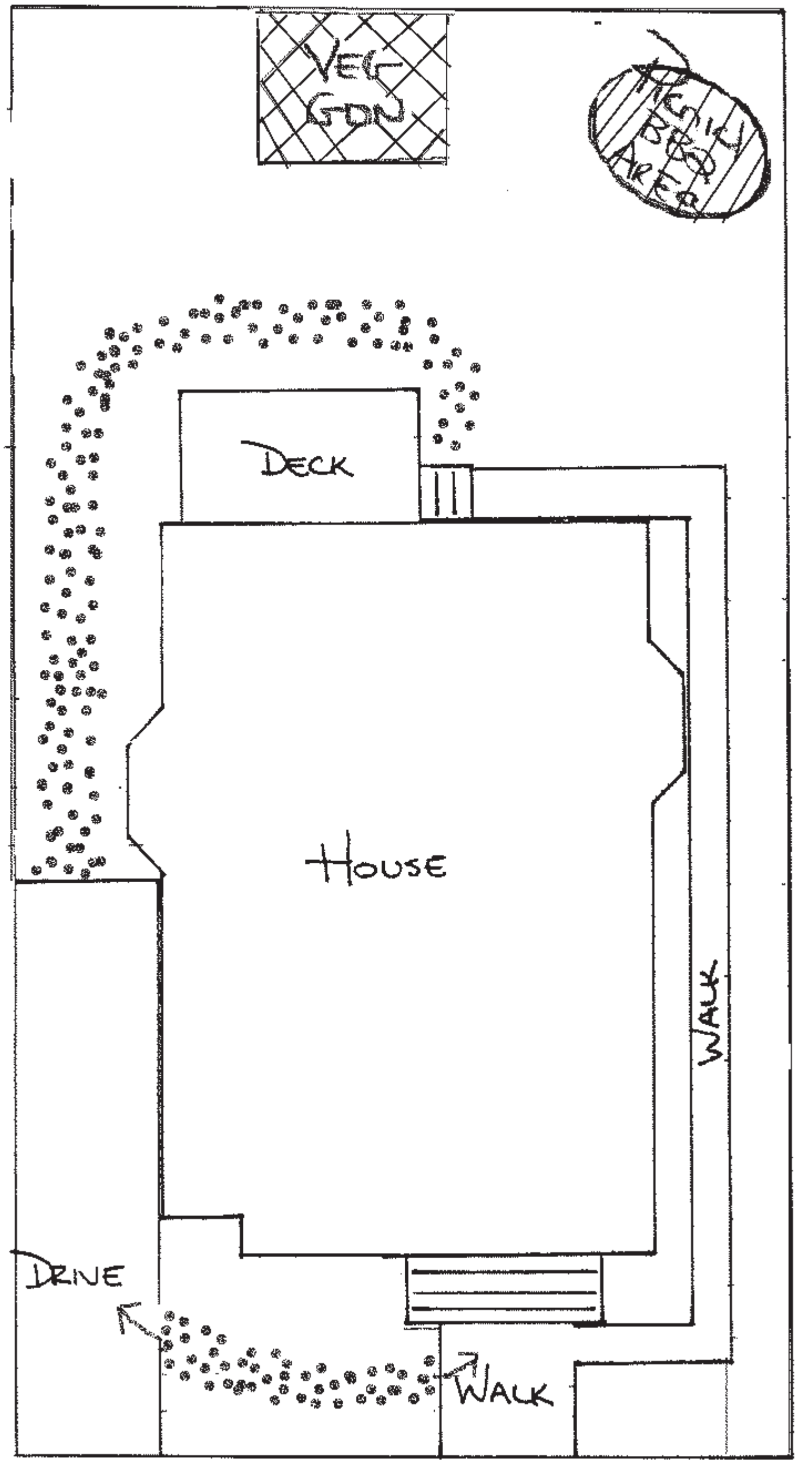
6. Show me where cars or other vehicles are parked or repaired driveway (blacktop)

7. Show me where people walk to hang out clothes backyard

8. Show me other areas for:
   - Sunbathing deck
   - Garbage cans driveway
   - Recycling bins back walk
   - Composting no
   - Hobbies no

9. Tell me any other places and ways children or adults spend their time in the yard. outdoor parties in the summer (backyard)

10 HOME STREET



SCALE: 1" = 1'-10"

YARD USE PATTERN KEY

DOTS
High Traffic Area (Exposed Soil)

CROSS HATCH
High Risk Use Area
(Play Area or Vegetable Garden)

DIAGONAL LINES
Recreation Area (Picnic or BBQ)

SITE WORKSHEET

Site Name:________________________________ Date:____________________

Site Address:______________________________ Weather:__________________

Building Type:____________________ Lot Condition:________________________

Yard Uses:____

SAMPLE I.D.	LOCATION	PPM-LEAD	COMMENTS

A = front, B = left, C = rear, D = right
Location = distance from right corner of house

SITE WORKSHEET

Site Name: **Date:** 10 - 27 - 98

Site Address: 10 Home Street **Weather:** Clear/Cool 55°

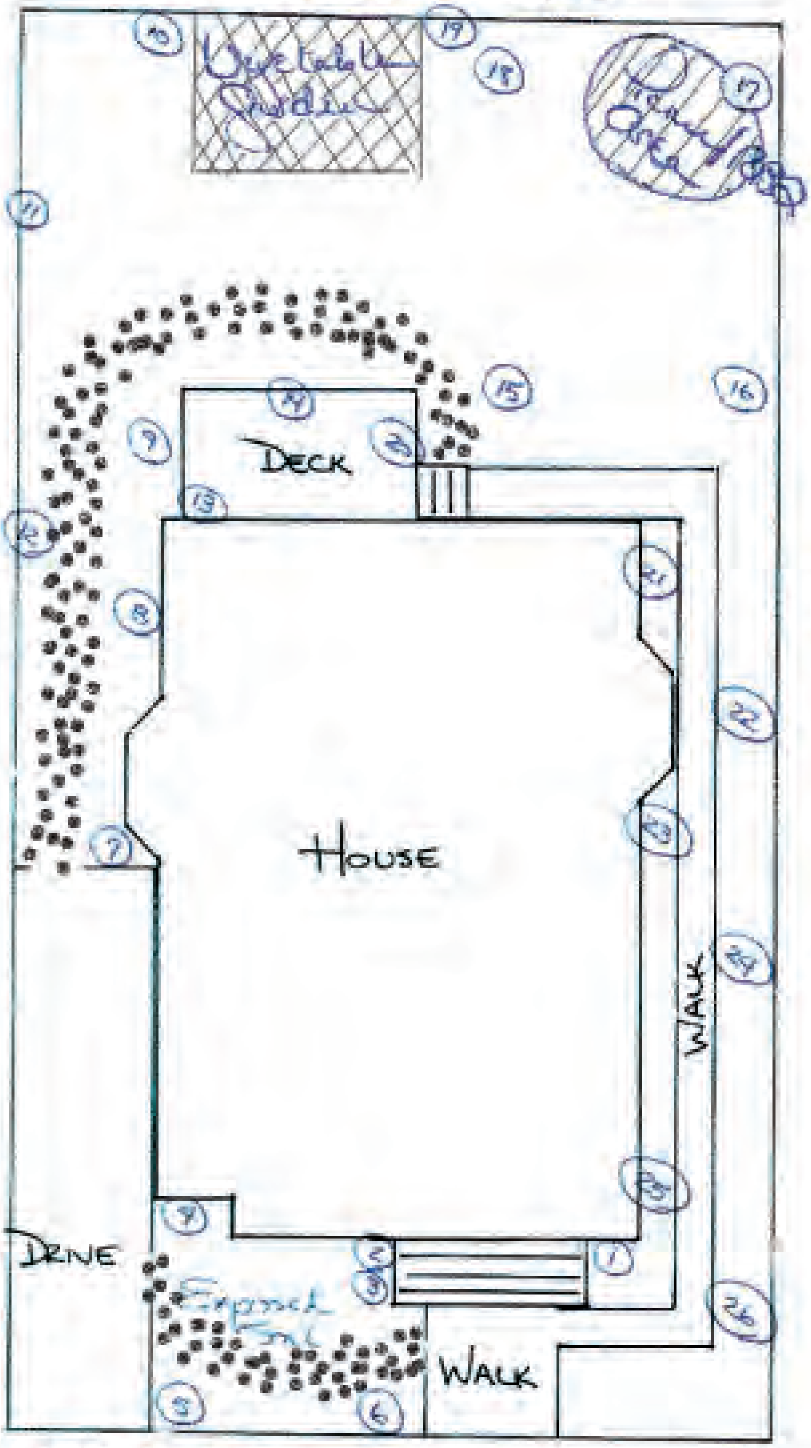
Building Type: 2 Family **Lot Condition:** Very Clean

Yard Uses: Picnic Area/Vegetable Garden

SAMPLE I.D.	LOCATION	PPM-LEAD	COMMENTS
A-1-9	0	1772 ± 303	
A-2-9	11	2510 ± 262	
A-3-9	11	3104 ± 287	Repeat
A-4-1	25	4006 ± 309	
A-5-15	25	435 ± 113	
A-6-15	12	705 ± 129	
A-7-4	21	3987 ± 426	
B-8-1	39	3657 ± 305	
B-9-1	60	1432 ± 175	
B-10-1	34	643 ± 118	
B-11-9	69	550 ± 106	
B-12-9	38	1141 ± 137	
C-13-1	0	2940 ± 267	
C-14-18	10	532 ± 118	
C-15-18	26	518 ± 122	
C-16-18	39	738 ± 130	
C-17-32	26	527 ± 109	
C-18-32	10	466 ± 95	

A = front, B = left, C = rear, D = right
Location = distance from right corner of house

10 HOME STREET



SCALE: 1" = 1'-10"

LEAD LEVELS COLOR KEY

5000 or more ppm (Very High)

Must be treated with a permanent barrier.
Unsafe for all types of gardening.

2000-5000 ppm (High)

Treatment is necessary for any recreational use by children or adults and for pet areas.
Unsafe for all types of gardening.

400-2000 ppm (Moderately High)

Treatment is recommended for use as a children's play area and for gardening, especially vegetable gardening.

400 or less ppm (Low)

No treatment is necessary for most uses by children, adults, and pets.

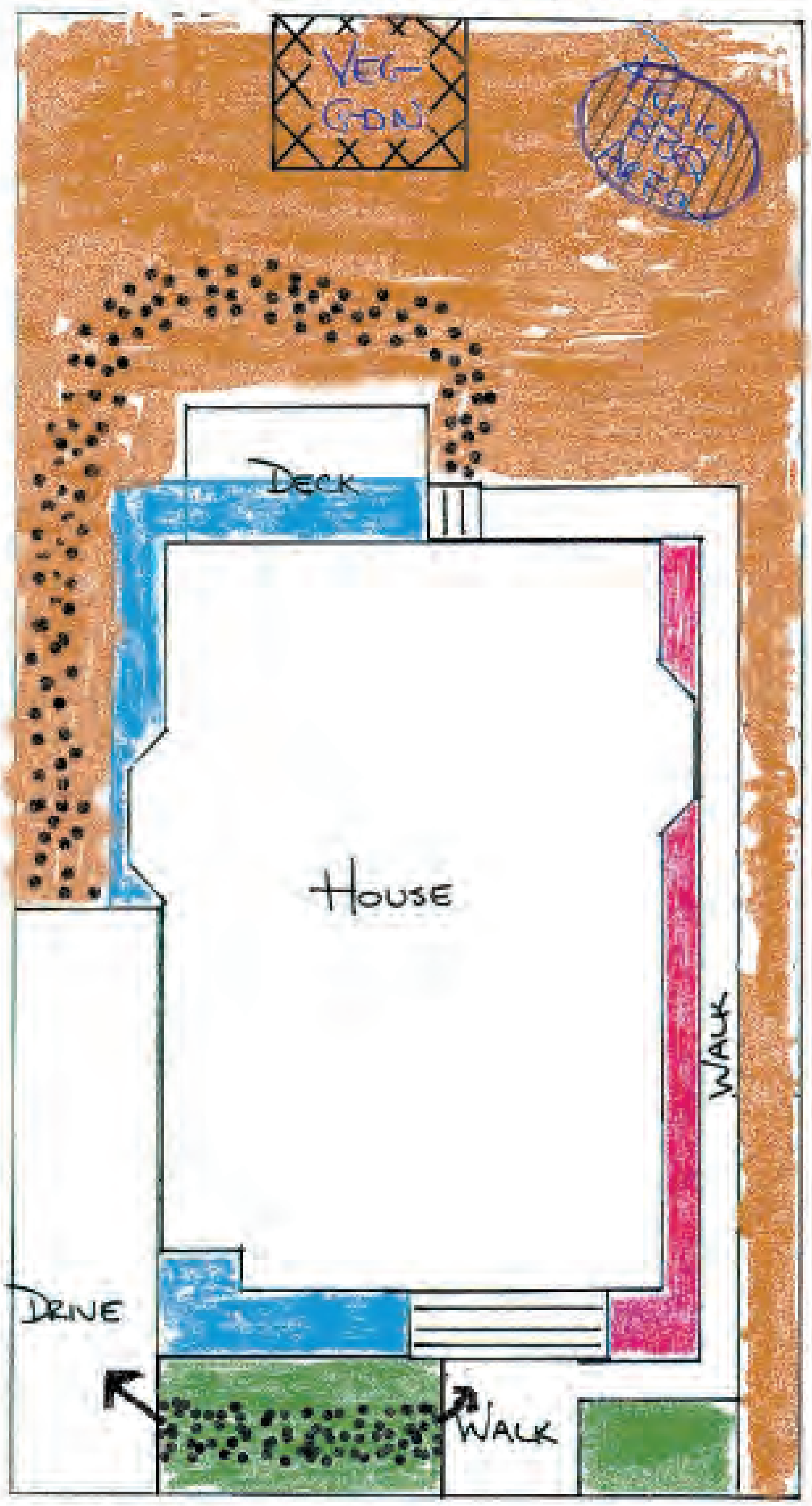
YARD USE PATTERN KEY

DOTS
High Traffic Area (Exposed Soil)

CROSS HATCH
High Risk Use Area
(Play Area or Vegetable Garden)

DIAGONAL LINES
Recreation Area (Picnic or BBQ)

10 HOME STREET



SCALE: 1" = 1'-10"

LEAD LEVELS COLOR KEY

5000 or more ppm (Very High)

Must be treated with a permanent barrier.
Unsafe for all types of gardening.

2000-5000 ppm (High)

Treatment is necessary for any recreational use by children or adults and for pet areas.
Unsafe for all types of gardening.

400-2000 ppm (Moderately High)

Treatment is recommended for use as a children's play area and for gardening, especially vegetable gardening.

400 or less ppm (Low)

No treatment is necessary for most uses by children, adults, and pets.

YARD USE PATTERN KEY

DOTS
High Traffic Area (Exposed Soil)

CROSS HATCH
High Risk Use Area
(Play Area or Vegetable Garden)

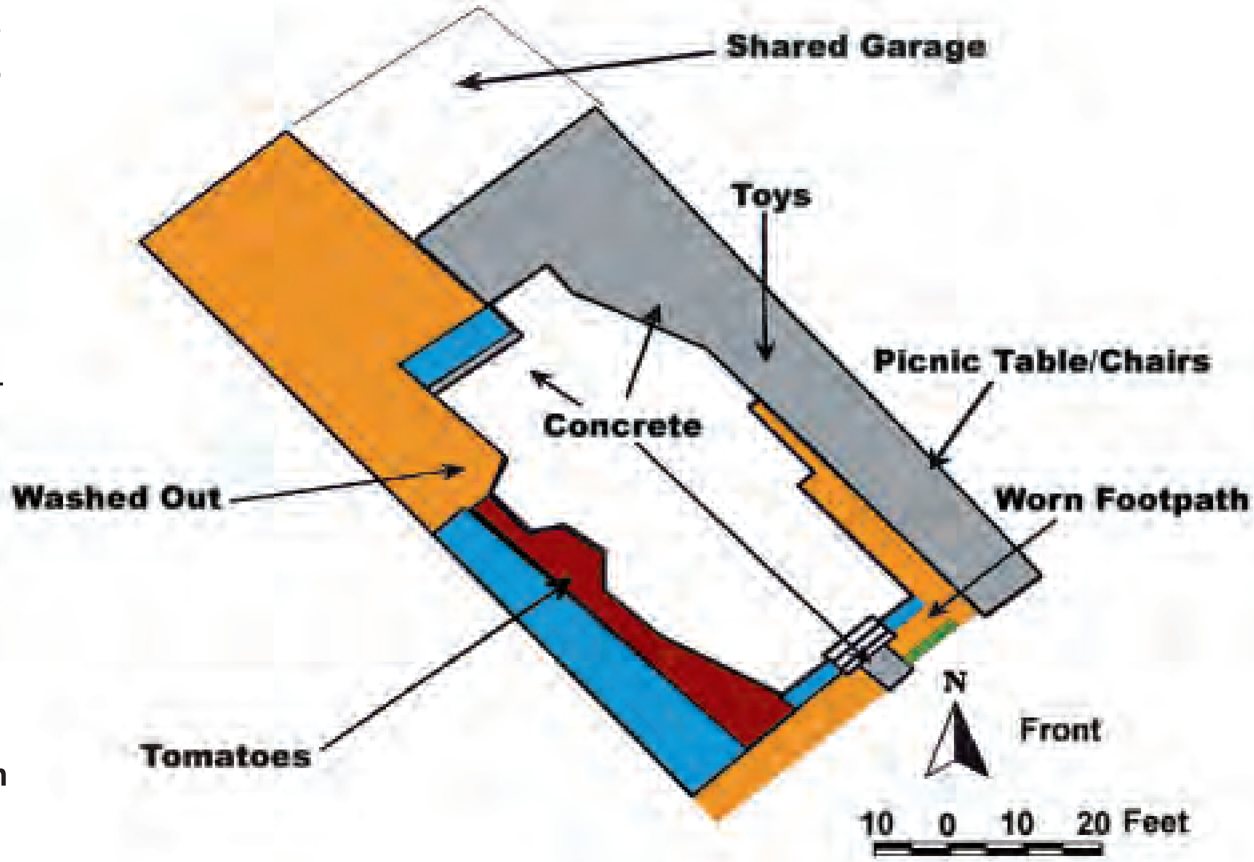
DIAGONAL LINES
Recreation Area (Picnic or BBQ)

Less than 400 ppm
No treatment is necessary for most uses by children, adults, and pets. Safe for all types of gardening.

400 to 2,000 ppm
Treatment is recommended for use as a children's play area and for gardening, especially vegetable gardening.

2,000 to 5,000 ppm
Treatment is necessary for any recreational use by children or adults and for pet areas. Unsafe for all types of gardening.

Greater than 5,000 ppm
Must be treated with permanent barrier. Unsafe for all types of gardening.



SAMPLE COST ESTIMATE SHEET

Property address: ____

____

House perimeter (homeowner to choose one option)

Option #1 ______ **l.f.**

Perimeter box with pine bark mulch, filter fabric, and plantings. $__________

Or Option #2 ______ **l.f.**

Perimeter box with gravel, filter fabric; no plantings. $__________

Bare soil area under rear porch area (all areas matching this criteria to receive treatment)

Option #1

Wood framing, lattice, access door, stepping stones. $__________

Or Option #2

Raised perimeter boxes, filter fabric, and mulch or gravel. $__________

Back yard (homeowner to choose one option)

Option #1

Installed 10' x 12' x 6" ACQ wood platform. $__________

New 10' x 12' area of lawn with ACQ perimeter edging. $__________

Or Option #2

Installed 10' x 12' x 6" ACQ wood platform. $__________

New 10' x 12' x 6" garden area framed with ACQ wood. $__________

Or Option #3

New 20' x 24' x 8" area of woodchips framed with ACQ wood. $__________

Stepping stones, misc. plantings, additional mulching, etc. $__________

Walkways

Egress stepping stones. $__________

Misc. treatments:

Existing lawn improvement. $__________

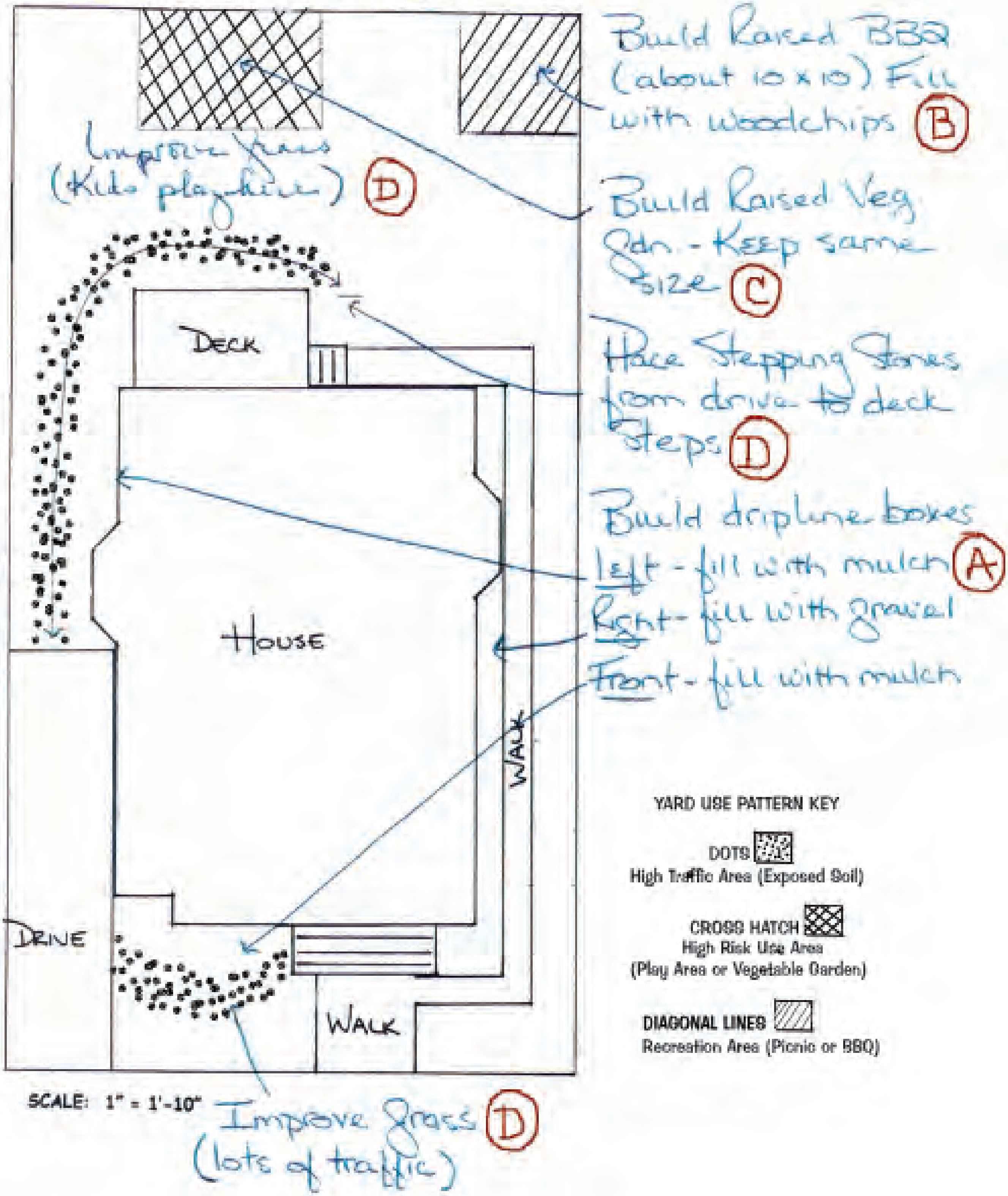
Additional edging, material, plantings, etc. $__________

Total (Approximate) Cost $__________

Cost Estimate Submitted by: ____________________ Date: ____________________

Company name: ____

10 HOME STREET



SAMPLE FORM:
HOMEOWNER'S APPROVAL OF TREATMENT PLAN

Date: ____________________

Property Owner: ____

Property Address: ____

____

I/We have reviewed the construction documents (specifications, plans, drawings, etc.) for the proposed treatment of the soil around my/our property and attest that they are complete, accurate and conform to my/our wishes.

I/We authorize the program to proceed with my/our application using said construction documents fully aware that said documents may change. I/We understand that any changes to the documents will be reviewed by me/us and I/We shall approve such changes prior to commencement of the work by the landscaper. I/We also understand that [the lead-safe yard program coordinator] must approve all changes to the proposed scope of work before work begins.

Date of Specifications/Plans: ____

Date Landscaper can begin scope of work: __________________________________

Number of days required to complete scope of work: ____________ Calendar Days

____________________	__________	____________________	__________
Owner #1	Date	Landscaper	Date
____________________	__________	____________________	__________
Owner #2	Date	Program Coordinator	Date

CONSULTANT CONTRACT

THIS CONSULTANT CONTRACT (the "Contract") is made as of this ____ day of _________, 200__ between (Organization Name), with its principal office located at (Organization Street Address, City, State, Zip, hereinafter called "(Organization acronym)", and (Contractor Name), the principal place of business of which is located at (Contractor Street Address, City, State, Zip).

WHEREAS, the (Organization acronym) desires to engage the Consultant as an independent contractor, and the Consultant desires to accept such engagement on the terms and conditions set forth hereinafter;

NOW, THEREFORE, in consideration of the covenants and agreements herein contained, the (Organization acronym) and the Consultant agree with each other as follows:

1. **Scope of Services.**

- Obtain completed Homeowner Yard Use Interview and plot plan, developed by the Environmental Protection Agency, from (the organization acronym).
- Design and landscape (number of) properties recruited and enrolled from (Target Area). All landscaping designs shall include but not be limited to the attached Attachment A Lead Safe Boston/National Center for Lead Safe Housing Standard Plan for Low Level Lead Soil Treatment dated December 29, 1999.
- Meet with homeowner within ten business days after receipt of testing results and homeowner use questionnaire from (Organization acronym/name) to complete Landscaper Information Sheet and to discuss current and future use of yard.
- Generate landscape design within five business days from the date of meeting with the homeowner. Obtain (Organization acronym/name) approval of design; obtain homeowner approval of same. Provide (Organization acronym/name) with four copies.
- Generate property specific cost proposals and submit to (Organization acronym/name) for approval.
- Secure planting stock and materials required for specific project(s).
- Pay for and post all necessary fees/permits.
- Install landscapes as per owner and (Organization acronym) approved designs within thirty days from the date of landscape plan approval.
- Generate homeowner maintenance manual specific to each property. Provide (Organization name) with three copies and homeowner with one copy.
- Conduct 30-minute educational session with homeowner to review homeowner maintenance procedures and manual.
- Obtain homeowner and (Organization acronym) final approval of landscape work.
- Leave property in a clean state. Owner must approve any material remaining on site after completion of landscape installation.
- Provide a 1-year workmanship and materials warranty from date of final homeowner approval. This warranty is limited to defects in workmanship and materials attributable to the consultant only and does not cover losses caused by: acts of God, third parties or failure of the homeowner to comply with the maintenance procedures and manual.
- Coordinate with Lead Safe Boston representatives and/or other applicable agencies in the execution of this contract.
- Complete all work as per local, state and federal rules and regulations.

1. **Compensation.** The (Organization acronym/name) shall reimburse Consultant on a semimonthly basis for (Contractor name) services on receipt of itemized invoices as follows:

   - $(Negotiated amount)/ea. On completion of initial visit with homeowner to discuss landscape design
   - $(Negotiated amount)/ea. On completion and approval of landscape design and maintenance manual.
   - Half of property specific cost proposal (less design fee) on commencement of landscape installation.
   - Balance on completion and approval of installation and 30-minute educational session with homeowner to review homeowner maintenance procedures and manual.
   - No one property shall exceed $3,000 including general conditions, design work and maintenance manual without prior approval from (Organization acronym/name).
   - Invoices shall reflect actual costs per property and are to be submitted semimonthly to (Organization acronym/name) for processing and payment.

2. **Term.** The term of this Contract shall be from (Start Date) to (End Date). Either party on 30 days notice may terminate this contract. In the event of premature termination by the (Organization acronym/name), the Consultant shall be paid for all work completed prior to the termination as well as the reasonable value of all work partially completed and all materials obtained and stored on-site.

3. **Benefits.** The (Organization acronym/name) is not responsible for any insurance or other fringe benefits, including, but not limited to social security, worker's compensation, income tax withholdings, retirement or leave benefits, for Consultant or employees of Consultant. The Consultant assumes full responsibility for the provisions of all such insurances and fringe benefits for himself or herself and all Consultant's employees.

4. **General Liability and Workman's Compensation.** The contractor shall purchase and maintain such insurance as will protect him/her from claims under the Workman's Compensation Acts (chapter 152 of the Massachusetts General Laws) and from claims for damages because of bodily injury, including death and all property damage including, without limitation to, damage to the buildings and adjoining the site of construction which might arise from and during operations under any Contract, whether such operations be by himself/herself or by any subcontractor or anyone directly or indirectly employed by either of them. The Contractor shall, without limiting the generality of the foregoing, conform to the provisions of the Section A of Chapter 149 of the Massachusetts General Laws, which Section is incorporated herein by reference and made a part hereof.

General Liability Insurance Minimum bodily injury limits of $100,000 per person and $300,000 per accident, and $300,000 aggregate during any twelve-month period, shall include the following:

a. Public Liability (bodily injury and property damage)

b. Independent Contractor's Protective Liability

c. All Risk Insurance - covering all contractor equipment with provisions of waiver of Subrogation against the Owner

d. Comprehensive All Risk Motor Vehicle Liability Insurance—minimum bodily injury limits of $100,000 per person, per accident, and property damage limit of $300,000 per accident

5. **Arbitration.** Any controversy or claim arising out of, or relating to, this Contract or the breach thereof, shall be settled by arbitration in accordance with the rules then obtaining of the American Arbitration Association. Judgement upon the award rendered may be entered in any Court having jurisdiction thereof. Any award rendered hereunder shall be final and binding on all parties thereto.

6. **Construction.** This Contract shall be construed, interpreted and applied under and in accordance with the laws of Massachusetts.

7. **Parties Bound.** The terms and provisions of this Contract shall be binding upon the parties hereto, their legal representatives, successors and assigns.

8. **Federal Requirements.** The Consultant's services may be reimbursed in part from funds under a contract funded directory or indirectly by the U.S. Department of Housing and Urban Development. Consultant is bound by the provisions of that contract.

9. Entire Agreement. This instrument contains the entire agreement between the parties. No statement, promises or inducements made by any party hereto, or agent of either party hereto, which is not contained in this written contract, shall be valid or binding; and this contract may not be enlarged, modified or altered except in writing and signed by the parties.

IN WITNESS WHEREOF, the parties have caused to be properly executed on their respective behalf, this Consultant Contract, effective for all intents and purposes as of
(Month, Day, Year).

(Organization Name)

By: ____

Title: ____

(Contractor's Name)

By:____

Title:____

ATTACHMENT A—Narrative
Lead Safe Boston/National Center for Lead-Safe Housing
Standard Plan for Low Level Lead Soil Treatment
December 29, 1999

Goals of the Low Level Soil Treatments

The goal of this project will be to improve the lead safety in homes by the reduction of exposure to high levels of lead in soil. All work will be based on soil assessments conducted by EPA. EPA will conduct all soil testing and provide to the vendor/contractor a plot plan indicating areas of concern.

Abatement strategies shall be designed to change the use of the yards while providing a lead safe area for children and families to enjoy.

Outreach and Enrollment

The outreach and enrollment component of the project will be undertaken by a contractor already in use by The National Center (Silver Linings). Outreach will focus on a pool of properties deleaded under Lead Safe Boston's Round 1 Evaluation project. These properties will be targeted primarily because of the extensive data collected to date.

Typical Yard

When the deleading of a home was complete, the single soil treatment conducted by Lead Safe Boston deleading contractors included a final cleanup of the soil by hand raking after abatement of the structure as per the Massachusetts Lead Law. The properties averaged 4000 s.f. and the footprint of the home averaged 1000 s.f. In addition, the yards are mostly flat, compacted soil with evidence of tree roots and shade. Most properties do not have driveways.

General Requirements

The General Requirements are to include but are not limited to: permits/fees, a 1 year workmanship and material warranty period, general liability and worker's compensation requirements (see attached).

Landscaping and Site Development

Landscaping and Site Development is to include generation of the initial Landscape design based on use and the plot plan provided by EPA. Also to be included is the generation of the maintenance manual for the homeowner education component.

Construction Oversight

The construction oversight allowance is to include construction monitoring, final inspection/sign off and homeowner final approval. The date of final homeowner approval will be the starting date of the 1 year warranty period.

Homeowner Education

The homeowner education allowance is to include two on-site meetings: initial meeting to obtain homeowner approval and a final meeting to review all site specific maintenance manuals and work completed by the vendor/contractor.

Design

The Consultant shall use this document as a guideline for all landscape design decisions.

CONSULTANT CONTRACT

THIS CONSULTANT CONTRACT (the "Contract") is made as of this ____ day of _________, 200__ between (Organization Name), with its principal office located at (Organization Street Address, City, State, Zip, hereinafter called "(Organization acronym)", and (Contractor Name), the principal place of business of which is located at (Contractor Street Address, City, State, Zip).

WHEREAS, the (Organization acronym) desires to engage the Consultant as an independent contractor, and the Consultant desires to accept such engagement on the terms and conditions set forth hereinafter;

NOW, THEREFORE, in consideration of the covenants and agreements herein contained, the (Organization acronym) and the Consultant agree with each other as follows:

1. **Scope of Services.**
   - Obtain completed Homeowner Yard Use Interview and plot plan, developed by the Environmental Protection Agency, from (the organization acronym).
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IN WITNESS WHEREOF, the parties have caused to be properly executed on their respective behalf, this Consultant Contract, effective for all intents and purposes as of
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(Organization Name)

By: ____

Title: ____

(Contractor's Name)

By:____

Title:____

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The homeowner education allowance is to include two on-site meetings: initial meeting to obtain homeowner approval and a final meeting to review all site specific maintenance manuals and work completed by the vendor/contractor.

Design
The Consultant shall use this document as a guideline for all landscape design decisions.

SAMPLE PROJECT
COMPLETION CERTIFICATE

Date: ____________________ Building ID: ________________________________

Property Owner: ____

Property Address: ____

____

I/We have inspected my/our property and found that the work conducted to make our yard lead safe has been successfully completed according to the scope of work I/we approved dated ______________. I/We have met with [Contractor name] and attended a 30-minute educational session to review the Lead Safe Yard Maintenance Procedure Manual. [Contractor Name] has provided me/us with a copy of this manual for my use.

In accordance with the scope of work and in connection with the final payment made to the contractor, I hereby agree to discharge, and hold [Your Program] harmless from any and all claims which arise against the Owner and/or his/her property, in connection with the work performed under this Program.

Homeowner Name	Date	Homeowner Name	Date

Inspection has been made of the yard made lead safe through the [Your Program]. I have examined the work and found all the work to be completed in a satisfactory manner and in accordance with the scope of work dated ______________.

Program Representative	Date

In accordance with the contract dated ________________ and in connection of the final payment made thereunder, I hereby agree to discharge, and hold the Owner and [Your Program] harmless from, any and all claims (including all liens resulting therefrom) which arise against the Owner of his/her property the contractor as its assignee now has or ever had by virtue of, or in connection with the work performed under, said Agreement.

That also in consideration of said final payment I hereby agree to discharge, and hold the Owner harmless from, any and all claims (including all liens resulting therefrom) which may be brought within forty (40) days of the date hereof by all sub-contractors, all suppliers of materials and equipment, and performers of work, labor or services arising by virtue of, or in connection with the work performed under, said Agreement.

That I warrant same for one (1) year from the date hereof, against workmanship and materials defects. One-year warranty does not cover losses caused by: acts of God, third parties or failure of the homeowner to comply with the maintenance procedures and manual.

Contractor Name	Date

SAMPLE FORM:
CONTRACTOR'S AFFIDAVIT OF PAYMENT OF DEBTS, RELEASE OF CLAIMS, WARRANTY OF WORKMANSHIP AND RECEIPT OF PAYMENT

Property Address: ____

____

Pursuant to the Agreement between [Contractor Name] and [Your Program], dated ____/____/, for the scope of work conducted at the above listed property, the undersigned, acting on behalf of the contractor, hereby certified and agrees as follows:

1) That he/she has paid in full, or has otherwise satisfied obligations for all materials and equipment provided, and for all work, labor, and services performed and for all known claims for all damages arising by virtue of, or in connection with the work performed under, said Agreement for which the owner of his/her property might in any way be held responsible.

2) That in accordance with said Agreement and in connection of the final payment made thereunder he/she hereby releases the Owner and [Your Program] of any lien, or claim or right to lien on said property resulting therefrom, which against the owner of his property the contractor or its assignee now has or ever had by virtue of, or in connection with the work performed under, said Agreement.

3) That also in consideration of said final payment he/she hereby agrees to discharge, and hold the Owner and [Your Program] harmless from, any and all claims (including all liens resulting therefrom) which may be brought within forty (40) days from the date hereof by all subcontractors, all suppliers of materials and equipment, and all performers of work, labor, or services arising by virtue of, or in connection with the work performed under, said Agreement.

4) That all work in connection with said Agreement has been performed in accordance with terms thereof.

5) That he warrants same for one (1) year from the date hereof, against workmanship and materials defects. The one-year warranty does not cover losses caused by: acts of God, third parties, or failure of the homeowner to comply with the maintenance procedures and manual.

6) That he/she has received from [Your Program] all sums of money payable to the contractor under said Agreement and any modifications or changes thereof.

By: ______________________________ ______________

Contractor Name **Date**

LEAD-SAFE YARDS

MAINTENANCE MADE SIMPLE

Dorchester Lead Safe Yards Program

1999

LOOK FOR THE ☑ THAT SHOWS THE TREATMENTS USED IN YOUR YARD AND FOLLOW THE GUIDELINES

☑ A. **Pressure Treated Wood Dripline Boxes**

MAINTENANCE
Once a year:
Check to make sure that all screws and other connections are secure

Look for and remove splinters

Tools Needed:
Screwdriver and/or hammer

Dripline Boxes are Lined with Perforated Plastic or Landscape Film Then Filled with One of the Following:

☑ **Mulch**

MAINTENANCE
Three times a year:
Remove weeds and debris spring and summer

Tools Needed:
None

Every two years:
Replenish mulch to 6" depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

☑ **Gravel**

MAINTENANCE
Once a year:
Remove weeds and debris

Tools Needed:
None

☐ **Mulch Over Gravel**

MAINTENANCE
Three times a year:
Remove weeds and debris spring and summer

Tools Needed:
None

Every two years;
Replenish mulch to 2" depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

B. Pressure Treated Wood Raised Picnic/Play Areas

MAINTENANCE
Once a year:
Check to make sure that all screws and other connections are secure

Look for and remove splinters

Tools Needed:
Screwdriver and/or hammer

Pressure Treated Wood Raised Play or Picnic Areas are Lined with Perforated Plastic or Landscape Fabric and then Filled with One of the Following:

Woodchips *

MAINTENANCE
Three times a year:
Remove weeds and debris spring and summer

Tools Needed:
None

Every two years:
Replenish wood chips to 6" depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

Gravel

MAINTENANCE
Once a year:
Remove weeds and debris

Tools Needed:
None

Mulch

MAINTENANCE
Three times a year:
Remove weeds and debris spring and summer

Tools Needed:
None

Every two years:
Replenish mulch to 6" depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

* See Resource List for Sources of Free Materials

C. Pressure Treated Wood Raised Garden Plots

MAINTENANCE
Once a year:
Check to make sure that all screws
and other connections are secure

Look for and remove splinters

Tools Needed:
Screwdriver and/or hammer

Pressure Treated Wood Raised Garden Plots are Lined with Landscape Film and then filled with Loam and Compost: *

MAINTENANCE
Once a year:
Add additional Compost
Early spring

Tools Needed:
Shovel
Wheelbarrow

D. Covered Surface Areas for People, Cars and Pets

√ Stepping Stone Paths

MAINTENANCE

Sweep as needed

Tools Needed:
Broom

Gravel Driveways and Paths

(Gravel spread to 2"depth)

MAINTENANCE

Twice a year:
Remove weeds and debris
spring and fall

Tools Needed:
None

Rake as needed to
maintain 2" depth

Tools Needed:
Rake

√ Grassed Areas

(Recommended for sunny spaces)

MAINTENANCE

Twice a year:
Apply grass fertilizer
spring and fall

Tools Needed:
None

Water regularly especially
during hot, dry weather

Tools Needed:
Sprinkler
Garden hose

Every Year:
Reseed bare spots
spring or early fall

Tools Needed:
Rake

Areas For Pets

(Woodchips spread to 6" depth)

MAINTENANCE

Twice a year:
Remove weeds and debris
spring and summer

Tools Needed:
None

Rake as needed to
maintain 6" depth

Tools Needed:
Rake

Every two years: *
Replenish woodchips to
maintain 6 " depth

Tools Needed:
Mulch fork or rake
Shovel
Wheelbarrow

* See Resource List for Sources of Free Materials

RESOURCES AND TYPICAL COSTS

Prepared for Dorchester Lead Safe Yards Program 1999

MATERIAL	SOURCE	TYPICAL COST
Gravel	Building Supply or Garden Center	$20.00 per cubic yard plus delivery
Mulch	Garden Center	$25.00 per cubic yard $6.00 per 3 cubic foot bag plus delivery
Woodchips	Tree Service or Recycling Center or Parks Department	FREE FREE FREE
Pressure Treated Lumber (2"x 6")	Lumber Yard	$.75 per linear foot plus delivery
Grass Seed	Garden Center	$10.00 per 3 lb. bag (covers 1700 sq. ft.)
Grass Fertilizer	Garden Center	$10.00 per bag (covers 5000 sq. ft.)
Plastic in Rolls	Hardware Store	$3.00 per 3'x50' roll
Landscape Fabric	Garden Center	$15.00 per 3'x50' roll
Compost	Garden Center or Recycling Center or Parks Department	$5.00 per 50 lb. bag FREE FREE
Stepping Stones	Building Supply or Garden Center	$2.00 per 12" pre-cast square or round stone

Homeowner Permission Form
Boston Lead Safe Yard Program
One Year Follow Up

Your yard has been made more safe for children to play in and for you to enjoy by the landscaping improvements that we have done through the Lead Safe Yard Program. Thank you for your cooperation during this community effort.

Now that we have finished a large number of yards in your neighborhood, we would like to inspect the work to see how well the improvements are holding up over time. We would like your permission to talk with you and to visually inspect all of the landscape improvements made by our program. During the visual inspection, we would also make some measurements and take a few photographs of the work. The inspection will take about an hour. This evaluation is funded by Lead-Safe Boston and the U.S. Department of Housing and Urban Development (HUD) and coordinated by the National Center for Lead-Safe Housing.

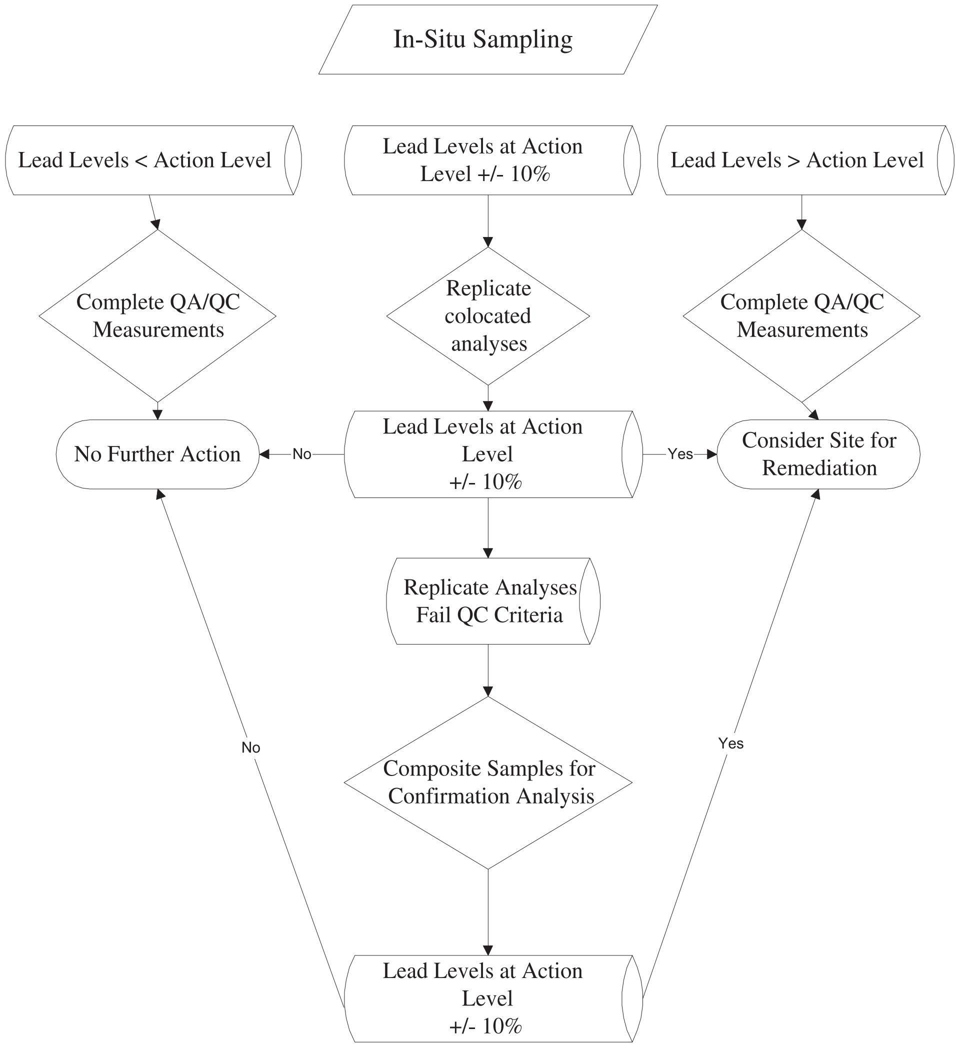
I give my permission for a visual inspection and measurements of the landscape improvements made by the Boston Lead Safe Yard Program.

______________________________ ____________________
Homeowner #1 signature Date

______________________________ ____________________
Homeowner #2 signature Date

______________________________ ____________________
Lead-Safe Yards Evaluation staff or Interviewer Date

Sampling Logic Tree



Appendix 2: Site Worksheet

Site Name: ______________________________ Date: __________

Address: ____

____

Building Type: ____

Condition: ____

Lot Condition: ____

Yard Uses: ____

Sample ID	Location	PPM-Lead	Comments	Distance

Appendix 3

INITIAL DEMONSTRATION OF CAPABILITY FOR LEAD IN SOIL BY NITON XRF

	ppm—lead
IDC1	1123
IDC2	1144
IDC3	1127
IDC4	1225
IDC5	1076
IDC6	1036
IDC7	1095
IDC8	1235
IDC9	1208
IDC10	1228
IDC11	1140
True Value	1162
Average Concentration	1148.8
% True Value	98.9
Standard Deviation	67.2
%RSD	5.9

Criteria: %RSD<30%
%TV<±30%

MINIMUM DETECTION LIMIT STUDY OF LEAD IN SOIL BY FIELD PORTABLE XRF

	H.P. 600703 5/12/98	H.P. 600703 2/29/00	LCS 0996 2/29/00	NIST 2586 2/29/00
	PPM-Lead	**PPM-Lead**	**PPM-Lead**	**PPM-Lead**
MDL1	190	170	235	365
MDL2	151	209	246	357
MDL3	170	179	303	398
MDL4	177	161	242	355
MDL5	188	220	320	423
MDL6	196	164	254	392
MDL7	170	137	250	422
MDL8	138			
MDL9	138			
MDL10	128			
True Value	129	129	224	432
Avg. Conc.	164.6	177.1	264.3	387.4
% True Value	127.6	137.3	118.0	89.7
Standard Deviation	24.3	28.7	33.2	29.1
MDL	**68.7**	90.3	**104.3**	**91.4**
%RSD	14.8	16.2	12.6	7.5

Criteria: %RSD<30%
%TV<±30%

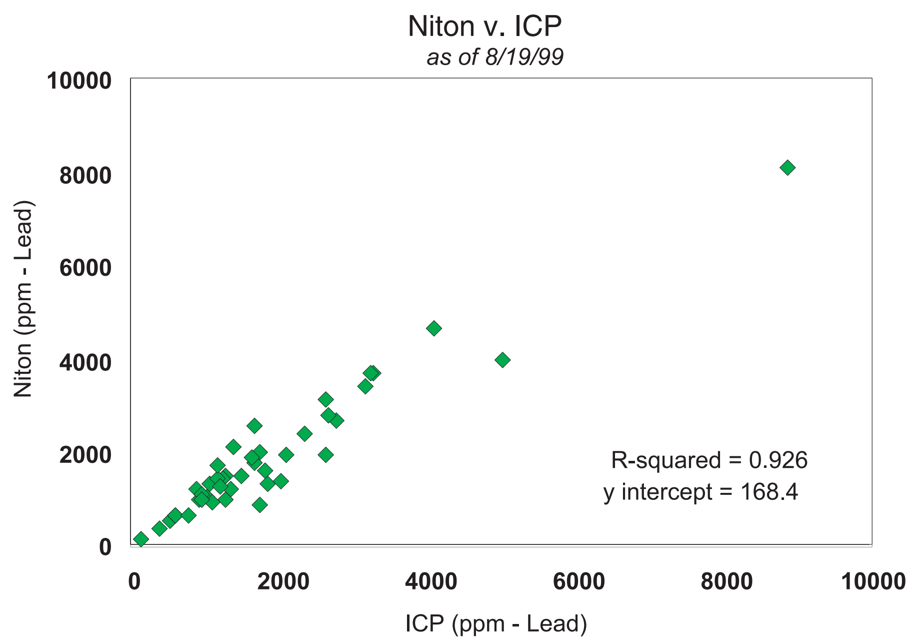
Appendix 5

ACCURACY DATA (1998) FOR LEAD IN SOIL BY FPXRF

	NIST 2710	NIST 2711	LCS 0996	HP 69073	Cleve-1
	5427	1123	268	204	426
	5632	1144	283	190	554
	5651	1127	269	151	526
	5587	1225	280	170	440
	5657	1076	291	177	488
	5372	1036	202	188	490
	5516	1095	383	196	456
	5769	1235	343	170	494
		1208		138	456
		1228		138	441
		1140		128	
				203	
True Value	5532	1162	224	129	433
Average Concentration	5576.4	1148.8	289.9	171.1	477.1
% Recovered	100.8	98.9	129.4	132.6	110.2
Standard Deviation	122.5	64.1	50.3	25.6	38.8
RSD	2.2	5.6	17.4	15.0	8.1

ACCURACY DATA (2000) FOR LEAD IN SOIL BY FPXRF

	NIST 2710	NIST 2711	NIST 2586	LCS 0996	HP 690703	Lot 217
	5580	1070	365	235	170	241
	5780	1140	357	246	209	220
	5590	1190	398	303	179	230
	5970	1290	355	242	161	159
	5490	1110	423	320	220	144
	5610	1070	392	254	164	135
	5530	1160	422	250	137	211
	5780	1170	397	275	242	175
	5460	1090	388	391	232	173
	5750	1140	408	277	146	126
True Value	5532	1162	432	224	129	101
Average Concentration	5654.0	1143.0	390.5	279.3	186.0	181.4
% Recovered	102.2	98.4	90.4	124.7	144.2	179.6
Standard Deviation	152.4	62.8	23.4	45.5	35.1	39.4
RSD	2.7	5.5	6.0	16.3	18.9	21.7


Niton v. ICP
as of 8/19/99
10000
8000
6000
4000
2000
0
Niton (ppm - Lead)
0
2000
4000
6000
8000
10000
ICP (ppm - Lead)
R-squared = 0.926
y intercept = 168.4

ATTACHMENT A—Narrative
Lead Safe Boston/National Center for Lead-Safe Housing
Standard Plan for Low Level Lead Soil Treatment
December 29, 1999

Goals of the Low Level Soil Treatments
The goal of this project will be to improve the lead safety in homes by the reduction of exposure to high levels of lead in soil. All work will be based on soil assessments conducted by EPA. EPA will conduct all soil testing and provide to the vendor/contractor a plot plan indicating areas of concern.

Abatement strategies shall be designed to change the use of the yards while providing a lead safe area for children and families to enjoy.

Outreach and Enrollment
The outreach and enrollment component of the project will be undertaken by a contractor already in use by The National Center (Silver Linings). Outreach will focus on a pool of properties deleaded under Lead Safe Boston's Round 1 Evaluation project. These properties will be targeted primarily because of the extensive data collected to date.

Typical Yard
When the deleading of a home was complete, the single soil treatment conducted by Lead Safe Boston deleading contractors included a final cleanup of the soil by hand raking after abatement of the structure as per the Massachusetts Lead Law. The properties averaged 4000 s.f. and the footprint of the home averaged 1000 s.f. In addition, the yards are mostly flat, compacted soil with evidence of tree roots and shade. Most properties do not have driveways.

General Requirements
The General Requirements are to include but are not limited to: permits/fees, a 1 year workmanship and material warranty period, general liability and worker's compensation requirements (see attached).

Landscaping and Site Development
Landscaping and Site Development is to include generation of the initial Landscape design based on use and the plot plan provided by EPA. Also to be included is the generation of the maintenance manual for the homeowner education component.

Construction Oversight
The construction oversight allowance is to include construction monitoring, final inspection/sign off and homeowner final approval. The date of final homeowner approval will be the starting date of the 1 year warranty period.

Homeowner Education
The homeowner education allowance is to include two on-site meetings: initial meeting to obtain homeowner approval and a final meeting to review all site specific maintenance manuals and work completed by the vendor/contractor.

Design
The Consultant shall use this document as a guideline for all landscape design decisions.

EPA/625/R-00/012
January 2001

Lead-Safe Yards

Developing and Implementing a Monitoring, Assessment, and Outreach Program for Your Community

United States Environmental Protection Agency
National Risk Management Laboratory
Office of Research and Development
Cincinnati, OH 45268

NEXT

United States Environmental Protection Agency
Office of Research and Development Washington, DC 20460
Office of Environmental Information Washington, DC 20460
EPA/625/R-00/012
January 2001
http://www.epa.gov/empact

EPA

Lead-Safe Yards

Developing and Implementing a Monitoring, Assessment, and Outreach Program for Your Community

EMPACT

Environmental Monitoring for Public Access & Community Tracking

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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.

NEXT: CHAPTER 1

Preface

This technology transfer handbook is intended to serve as: a) a case study of the EMPACT Community-Based Lead Assessment and Educational Pilot Project in Boston (also known as the Lead-Safe Yard Project or LSYP) that highlights the successes and lessons learned from the project, and b) a “hands on” reference for community members, especially community organizations, to use in identifying and reducing risks from residential soil that may be contaminated with lead. The emphasis is on contamination from non-industrial sources, such as the historic use of exterior house paint or gasoline that contained lead. The handbook provides step-by-step guidance for measuring lead levels in soil, interpreting results in terms of potential risks from these levels, and planning and implementing simple and cost-effective landscaping techniques to reduce these risks. While the focus is on community organizations with access to professional assistance, some recommendations may be suitable for the individual homeowner, landlord, or tenant to consider.

Based on the case study from the Pilot Project in Boston, the handbook was written to be complementary to, and used in conjunction with, EPA and HUD regulations and associated guidance. In particular, EPA has proposed a regulation entitled “TSCA Title IV, Section 403 Lead; Identification of Dangerous Levels of Lead.” At the time of the handbook’s publication, this rule, which establishes standards for lead-based paint hazards in most pre-1978 housing and child-occupied facilities, was not yet finalized. Nothing in the handbook should be construed as official Agency guidance or regulation contradictory to the Final Section 403 Rule.

These simple, low-cost landscape treatment measures are presented as additional options beyond the permanent measures that may be required by state, local, or federal regulations. For cases in which permanent solutions such as soil removal would be preferable and/or required, but are not immediately possible due to cost or other practical considerations, the handbook offers interim controls that may provide an immediate risk reduction, especially when combined with continuing maintenance practices. Users of the handbook should consult applicable state, local, and federal regulations before deciding on any course of action.

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Chapter 1: Introduction

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Lead poisoning remains a serious environmental health threat for children today.

Over the past few decades, blood lead levels in children have declined dramatically. However, lead poisoning remains a serious environmental health threat for children today. The legacy of lead-based paint and leaded gasoline will be with us for many years to come. Without further action, large numbers of young children, particularly in older, urban neighborhoods, will continue to be exposed to lead in amounts that could impair their ability to learn and to reach their full potential.

Recent efforts at the state and federal levels to reduce childhood lead poisoning have focused primarily on controlling hazards from lead-based paint. This focus is likely to continue. In February 2000, the President's Task Force on Environmental Health Risks and Safety Risks to Children released a federal, interagency strategy for eliminating childhood lead poisoning. The strategy calls for the control of lead paint hazards in 2.3 million homes where children under age 6 live (click here to access the strategy). To support the Task Force's recommendations, the federal budget for 2001 includes a 50-percent increase in lead paint hazard control grants issued by the U.S. Department of Housing and Urban Development (HUD).

While considerable attention has been given to lead-paint hazards in homes, less attention has been paid to lead-contaminated soil that surrounds these homes. Generally, this has been because of the more significant contribution to lead poisoning in children made by deteriorated lead paint and leaded dust on the interiors of homes. However, evidence exists that soil can be a source of exposure. As lead poisoning rates decline and average childhood blood lead levels decline, lead exposure from soil may be a more significant portion of the exposure for children. Therefore, it warrants attention.

This EMPACT technology transfer handbook is designed with two main goals in mind. The first goal is to present a case study showing how one community-based program—the EMPACT Lead-Safe Yard Project (LSYP) in Boston, Massachusetts—is using a variety of low-cost techniques to reduce children's exposure to elevated levels of lead in residential soil. The second—and perhaps more important—goal is to provide you with step-by-step guidance for developing a similar program to address the problem of lead in soil in your own community. The guidance in the handbook is based on the experience of the EMPACT LSYP, as well as that of several other programs. These other programs are highlighted at points throughout the handbook.

The handbook is written primarily for community organizers, non-profit groups, local government officials, tribal officials, and other decision-makers who will implement, or are considering implementing, lead-safe yard programs. At the same time, much of the information will be useful to individual homeowners interested in finding low-cost ways to reduce children's exposure to lead in soil. Before attempting to implement the techniques described in this handbook, however, homeowners need to be aware of the hazards associated with working with lead-contaminated soil. All homeowners should carefully read those passages of the handbook that describe soil-lead hazards, safety guidelines for working with lead-contaminated soil, and federal and state regulations governing acceptable work practices (in particular, see Sections 3.1, 3.3, 6.2, 6.4, and 7.6).

1.1 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, at President Clinton's direction. 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 make informed, day-to-day decisions. By the year 2001, residents in 86 of the largest metropolitan areas in the United States will 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, the U.S. Geological Survey, the U.S. Department of Interior, and the National Partnership for Reinventing Government. EPA will work closely with these federal entities to help achieve nationwide consistency in measuring environmental data, managing information, and delivering that information 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, such as groundwater contamination, ocean pollution, smog, ultraviolet radiation, and ecosystem quality. Some of these projects have been initiated directly by EPA. Others have been launched by the 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.

Communities selected for Metro grants 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.

1.2 About the EMPACT Lead-Safe Yard Project

During the winter of 1998, EPA's EMPACT program funded "A Community-Based Lead Assessment and Educational Pilot Project," also known as the Lead-Safe Yard Project. The project is a joint effort between EMPACT, EPA's New England Regional Laboratory, and several community partners. The three primary objectives of the project are:

1. To generate real-time data of lead concentrations in residential yard soils using innovative field-portable x-ray fluorescence (XRF) technology, and to communicate these data to residents for the purpose of informing them of the health risks of lead in soil.
2. To plan and implement low-cost and sustainable landscape measures in residents' yards that would reduce children's risk of exposure to contaminated soil and that residents would be taught to maintain.
3. To develop a template that other communities and public agencies can use to address the issue of lead in residential soil.

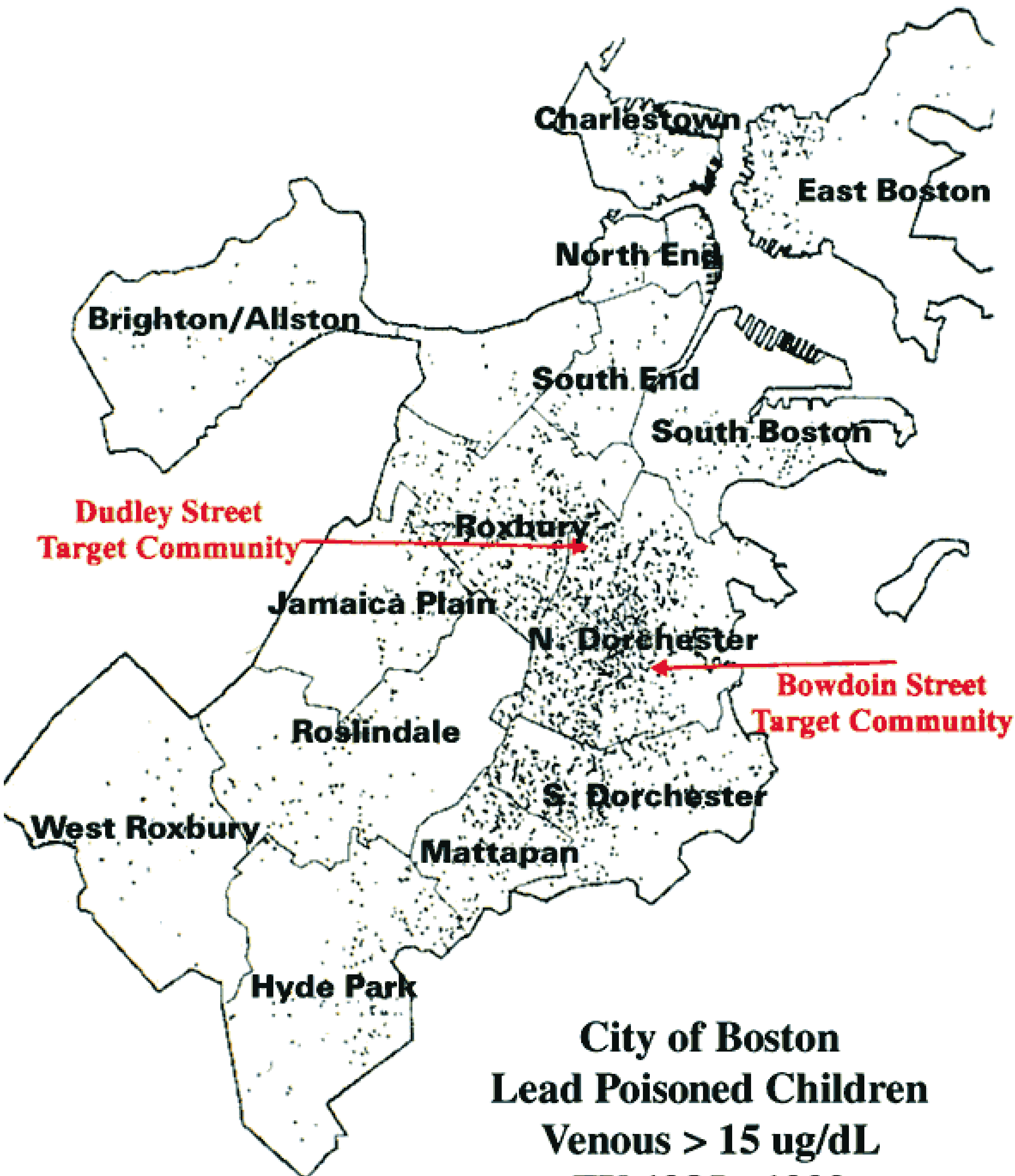
The initial target community selected for the pilot project was a several-block area in the Bowdoin Street neighborhood, consisting of approximately 150 mostly older, wood-framed houses in the North Dorchester section of Boston. This is an inner-city community, with a large minority and immigrant population. Bowdoin Street is situated in the "lead belt" of Boston, where the majority of children in the city with elevated blood levels reside.

During the pilot phases, the project's community partners in the Boston area were Boston University School of Public Health, the Bowdoin Street Community Health Center, and two non-profit landscaping companies, Dorchester Gardenlands Preserve and Garden Futures. The project team identified five tasks to be carried out by the partners:

- Outreach and education, led by the Health Center.
- Safety training, conducted by staff from the Health Center.
- Sampling and analysis, led by the EPA Regional Laboratory with assistance from a certified industrial hygienist from the Health Center.
- Soil mitigation, performed by the landscaping companies.
- Creation of a template for community action, led by Boston University School of Public Health with assistance from all partners.

The pilot project was funded in two phases, which took place in the summers of 1998 and 1999. During these two years, the project addressed 42 residences in the target area, at no cost to the homeowners; conducted a number of seminars on lead-safe yard work; and developed a "Tool Kit" for use by other communities (the materials in the Tool Kit have been incorporated into this handbook).

The third phase of the project, launched in June 2000, is targeting a different community: the Dudley Street neighborhood, which is also located in the "lead belt" of Boston. The partners in this phase include Boston University School of Public Health, the Dudley Street Neighborhood Initiative (a local planning and organizing agency), and several commercial landscapers. The objective of this phase is to use refined landscape measures and an improved educational approach in treating yards of homes that meet requirements for structural lead abatement of interior and exterior paint, or that have already been lead abated and are lead safe. As of September 2000, 18 homeowners had enrolled to have their yards tested for elevated soil-lead levels, and testing had been completed at most of the properties. The project's goal is to complete soil testing and implement landscape treatments at 20 or more properties by the end of the year.



1.2.1 Related Lead-Safe Yard Programs

A key objective of the EMPACT LSYP is to disseminate a template of materials and methods to public agencies whose mission is to prevent childhood lead poisoning. The ultimate goal is to institutionalize soil remediation as part of a comprehensive lead poisoning prevention program in high-risk neighborhoods.

Based on the success of the pilot phase of the EMPACT LSYP, the City of Boston has already initiated two "spinoff" soil-lead programs, using the EMPACT project's template:

- Lead Safe Boston, an office within the Boston Department of Neighborhood Development that assists homeowners financially and technically in home de-leading, is spearheading a HUD-funded lead-safe yard project that will target as many as 25 residential properties by the end of 2000. This demonstration project is meant to show how local government agencies can integrate soil-lead mitigation into ongoing home de-leading work. As of September 2000, Lead Safe Boston had enrolled 20 properties for soil-lead testing and yard treatments, and had completed treatments at nearly half of the properties. Lead Safe Boston has also done extensive work to revise materials in the EMPACT LSYP's template (such as permission forms and contractor agreements) to meet the more rigorous legal standards required of a city agency. Many of the materials developed by Lead Safe Boston appear as samples in this handbook.
- The Office of Environmental Health, part of the Boston Public Health Commission (BPHC), initiated another spinoff lead-safe yard project in 2000 to address nine residential properties in an area of North Dorchester. These nine residences have previously undergone structural abatement of lead paint and are slated for yard intervention utilizing the EMPACT LSYP's template. BPHC is leading the outreach effort and funding the landscaping work. EPA's New England Regional Laboratory is providing testing support, and Lead Safe Boston is assisting with contract services.

EMPACT Lead-Safe Yard Project Recognized for Excellence

Because of the EMPACT LSYP's innovative approaches and far-reaching impacts, project partners have received several prestigious awards for their work. These include:

- 1999 Regional Science Award. The EPA Region 1 Science Council selected for this award Rob Maxfield and Paul Carroll, both from EPA's Office of Environmental Measurement and Evaluation, for their work on the EMPACT LSYP. The award noted that these scientists "demonstrated environmental leadership and utilized innovative yet simple solutions to this age old problem while gaining acceptance at the local, municipal, and national levels." The two also received EPA Bronze Medals for this work.

1.2.2 Lead-Safe Yard Research Study

EPA New England and the National Center for Lead Safe Housing are leading a HUD-funded research study to document the effectiveness of the low-cost interim soil control measures used by the EMPACT LSYP. Other partners in the study include the Boston Department of Neighborhood Development and Boston University. This research study will include a retrospective evaluation of the soil intervention work conducted during the first two phases of the EMPACT LSYP (1998 and 1999). It also will examine data collected during the summer of 2000 by all three Boston-based lead-safe yard projects: the EMPACT project, the Lead Safe Boston demonstration project, and the BPHC project (data will be collected before, during, and after each yard intervention). The principal objective of the study is the preparation of a technical paper that will document the effectiveness of low-cost interim soil control measures in reducing risk to residents and to make this data available to HUD for policy development. The research study will also seek to answer several technical questions about the suitability of field-portable XRF technology for soil-lead testing.

1.3 About This Handbook

A number of cities have expressed interest in beginning lead-safe yard programs, but they are limited by available resources. The Technology Transfer and Support Division of the EPA Office of Research and Development's (ORD's) National Risk Management Laboratory initiated the development of this handbook to help interested communities learn more about the EMPACT LSYP and to provide them with the technical information they need to develop their own programs. ORD, working with the LSYP from Region 1, produced the handbook to leverage EMPACT's investment in the project and minimize the resources needed to implement it in new cities.

Both print and CD-ROM versions of the handbook are available for direct online ordering from ORD's Technology Transfer Web site. A PDF version of the handbook can also be downloaded from the EMPACT LSYP Web site. This Web site is in turn hyperlinked to the main EMPACT Program Web site and the ORD Technology Transfer Web site. In addition, you can obtain a copy of the handbook by contacting the EMPACT Program office at:

- 1999 Harvard Award for Excellence in Children's Health. LSYP project partner Bowdoin Street Health Center received this award for its work with the EMPACT LSYP. This annual award, cosponsored by the Harvard Center for Children's Health at the School of Public Health, the City of Boston, and Children's Hospital, recognizes a Boston organization for extraordinary work in the area of child and adolescent health.

- 2000 Boston University School of Public Health Award for Excellence in Public Health Practice. Patricia Hynes, Professor of Public Health, was recognized during National Public Health Week 2000 for her work with the EMPACT LSYP. Boston University School of Public Health selected this as one of three examples of excellence in public health research and intervention work being done by the school's faculty.

EMPACT Program
Office of Environmental Information
U.S. EPA (2831R)
1200 Pennsylvania Avenue
Washington, DC 20460
phone: (202) 564-3220
fax: (202) 565-1966

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.

1.4 Acknowledgments

EPA and the EMPACT LSYP would like to recognize the following people and organizations for their substantial contributions to the contents of this handbook:

- Sandra Duran, a construction specialist with the Boston Department of Neighborhood Development in the City of Boston's Public Facilities Department, for creating many of the forms used during the third phase of the EMPACT LSYP and creating the specifications for construction contracting.
- The EPA New England Lead Program in the Office of Ecosystem Protection, for assistance in reviewing early drafts of the handbook.
- The New England Lead Coordinating Committee (NELCC), funded by EPA New England and the State Lead Programs, and the participants of the Lead in Soils Design Charrette, whose early work developing landscape treatments for lead-contaminated soil provided a foundation for the EMPACT LSYP's low-cost mitigation

approach.

- The EPA New England Urban Environment Initiative, whose outreach and capacity-building efforts established many of the community and city partnerships that made this project possible.

1.5 For More Information

Try the following resources for more on the issues and programs this handbook discusses:

The EMPACT Program

The EMPACT Lead-Safe Yard Project

Robert Maxfield
Environmental Investigation and Analysis
EPA Region 1 Laboratory
60 Westview Street Lexington, MA 02173
(781) 860-4640

Address Change effective Spring 2001
11 Technology Drive
North Chelmsford, MA 01863-2431
(617) 918-8300

H. Patricia Hynes
Professor of Environmental Health
Director, Urban Environmental Health Initiative
Boston University School of Public Health
715 Albany Street
Boston, MA 02118
(617) 638-7720

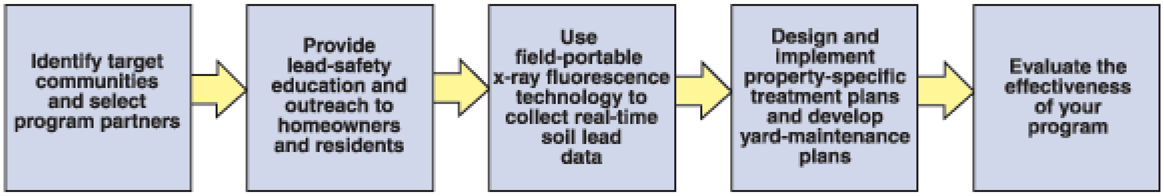
The Dudley Street Neighborhood Initiative

The National Center for Lead Safe Housing

Hynes, H. P., R. Maxfield, P. Carroll, and R. Hillger. "Dorchester Lead-Safe Yard Project: A Pilot Program to Demonstrate Low-Cost, On-Site Techniques to Reduce Exposure to Lead-Contaminated Soil." *Journal of Urban Health: Bulletin of the New York Academy of Medicine.* Volume 78, No. 1, March 2001.

Chapter 2: How To Use This Handbook

This handbook provides information your community can use to create and implement a lead-safe yard program. It presents detailed guidance, based on the experience of the EMPACT Lead-Safe Yard Project, on how to:



The handbook provides simple "how to" instructions on each facet of planning and implementing a lead-safe yard program, along with important background information on lead poisoning and the hazards of lead-contaminated soil:

- **Chapter 3** discusses why lead in general, and lead-contaminated soil in particular, is a health hazard; what data are available on lead in soil; and what standards and regulations may apply to your program.
- **Chapter 4** describes the steps in beginning a program: identifying potential target communities, getting to know the community, and selecting partners for the program.
- **Chapter 5** provides guidance on education and outreach to homeowners and residents about the problem of lead in soil and the benefits of participating in a lead-safe yard program.
- **Chapter 6** provides detailed information about data collection and management, focusing on the use of the field-portable x-ray fluorescence instrument to collect real-time data.
- **Chapter 7** describes soil mitigation strategies and techniques, including sample specifications, costs, and legal issues.
- **Chapter 8** discusses how to develop and implement a maintenance plan for lead-safe yards, including homeowner education and strategies for ensuring ongoing maintenance.
- **Chapter 9** provides guidance for evaluating the program, stressing the importance of documentation.
- **Chapter 10** outlines the application of lead-safe yard monitoring and mitigation techniques to non-residential settings, such as tot lots, community gardens, and abandoned commercial buildings.

Interspersed throughout the handbook are success stories and lessons learned in the course of the EMPACT LSYP. The handbook also refers you to supplementary sources of information, such as Web sites, guidance documents, and other written materials. In addition, the handbook includes three appendices that present alternatives to the approaches used by the EMPACT LSYP:

- **Appendix A** describes the Safer Soil Pilot Program of Cambridge, Massachusetts, which has used landscaping and other remedial measures to treat residential yards since 1997.
- **Appendix B** proposes four models for less-resource-intensive approaches to implementing lead-safe yard programs.
- **Appendix C** discusses a new option, phytoremediation, being explored to address lead in soil in a cost-effective manner.

Finally, **Appendix D** presents the EMPACT LSYP Quality Assurance Project Plan.

The handbook is designed for managers and decision-makers who may be considering whether to implement a lead-safe yard program in their communities, as well as for organizers who are actually implementing lead intervention programs. Decision-makers likely will find Chapters 3, 4, 9, and 10 most helpful. The other chapters provide detailed "how to" information and are written primarily for people who will carry out the program. Individual homeowners interested in finding low-cost ways to help prevent children's exposure to lead in soil will find Chapters 7 and 8 most useful.

NEXT CHAPTER

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Chapter 3: Lead In Soil: Why Is It a Problem?

3.1 | 3.2 | 3.3 | 3.4 | 3.5

This chapter provides an overview of the problems posed by lead in soil. Section 3.1 discusses lead poisoning, its health effects and prevalence, and the pathways through which children and others are exposed to lead. Section 3.2 describes the most common sources of lead in residential soil and summarizes soil-lead levels found in the United States. Section 3.3 reviews evidence indicating that soil is one important pathway for childhood lead exposure. Finally, Section 3.4 describes the national strategy for reducing hazardous exposures to lead and identifies standards and regulations that may affect a lead-safe yard program.

The information in this chapter should be useful to any person interested in soil-lead hazards and mitigation, whether that person be a community organizer responsible for implementing a lead-safe yard program or a homeowner concerned about elevated soil-lead levels in his or her own yard.

3.1 Lead and Lead Poisoning

Lead is a heavy, soft, malleable metal. Due to its physical and chemical properties, industry has found countless uses for lead in our daily lives. While certain uses of lead are banned, lead is still found in a myriad of products. Important sources of lead in the environment today include:

- Lead paint, and resulting lead dust, found in and around homes built before 1978 (lead-based paint was banned in 1978). Lead dust from deteriorated lead-based paint is the most significant contributor to childhood lead poisoning.
- Lead from automobile emissions (before leaded gasoline was finally banned in 1986) that has been deposited on land and surface water.
- Lead in occupational settings (often brought home on clothes or skin).
- Lead from industrial emissions, such as lead smelters, lead mining, hazardous waste sites, and battery-recycling plants.
- Lead in drinking water caused by lead-containing plumbing.
- Lead-containing tableware, such as leaded-crystal glassware and lead-glazed pottery.
- Certain hobbies and activities that use lead (e.g., car radiator repair, target shooting, stained-glass making, glass or metal soldering).
- Certain folk remedies that contain lead (e.g., azarcon, greta).

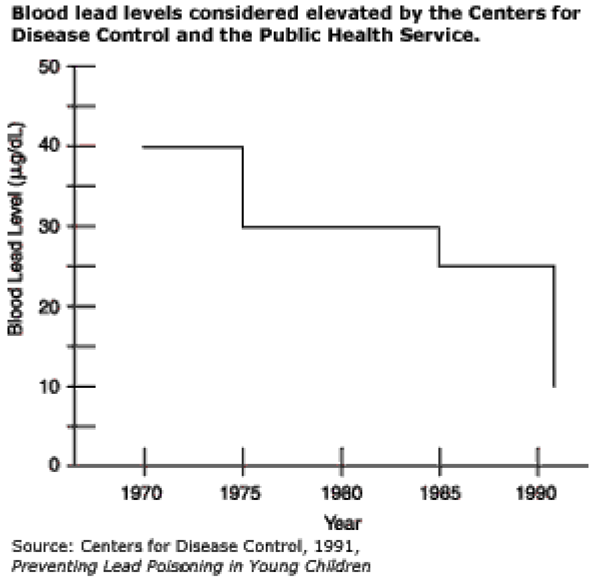
3.1.1 What Is Lead Poisoning?

Lead poisoning is entirely preventable. However, according to the Centers for Disease Control and Prevention (CDC), nearly 1 million children living in the United States in the early 1990s had lead in their blood at levels high enough to cause irreversible damage to their health.

CDC defines elevated blood lead in children as blood lead levels of 10 micrograms of lead per deciliter of blood (µg/dL) or higher. Until the early 1970s, CDC's blood lead levels of concern were 60 µg/dL for children and 80 µg/dL for adults. As the adverse effects of lead became better known, CDC lowered the level at which it recommends medical attention, also known as the "blood lead intervention level," on three separate occasions. After research showed that cognitive and developmental damage occurs at blood lead levels as low as 10 µg/dL, CDC lowered the blood lead level of concern to the current 10 µg/dL value in 1991. There is no known safe level of lead in blood.

3.1.2 Health Effects of Lead Poisoning

Lead poisoning affects nearly every system in the body, and often occurs without noticeable symptoms. Although lead can affect



adults, children under the age of six are especially vulnerable to the adverse effects of lead. The incomplete development of the blood-brain barrier in fetuses and very young children (up to 36 months of age) increases the risk of lead's entry into the nervous system. Low but chronic exposure can affect the developing nervous system in subtle but persistent ways. In children, blood lead levels as low as 10 to 15 µg/dL can stunt growth rates, affect attention span, cause learning disabilities, lower IQ scores, impair hearing acuity, and cause behavioral problems. In addition, fetuses exposed to elevated levels of lead can suffer from low birth weight, impaired hearing, and altered gestational age, which can lead to further complications.

In addition to damaging the nervous system, elevated blood lead levels can also affect the kidneys and reproductive system and cause high blood pressure. Very high levels (greater than 80 µg/dL) can cause convulsions, coma, or death. Levels greater than 150 µg/dL are fatal if not treated quickly. Fortunately, exposures resulting in such high levels of lead are rare.

The literature on the health effects of lead is extensive. For more information, see CDC's *Preventing Lead Poisoning in Young Children* and the Agency for Toxic Substances and Disease Registry's *Case Studies in Environmental Medicine: Lead Toxicity*. Additional resources and links listed at the end of this chapter provide a wealth of information on this and other lead-related topics.

3.1.3 How Does Lead Enter the Body, and What Happens to Lead in the Body?

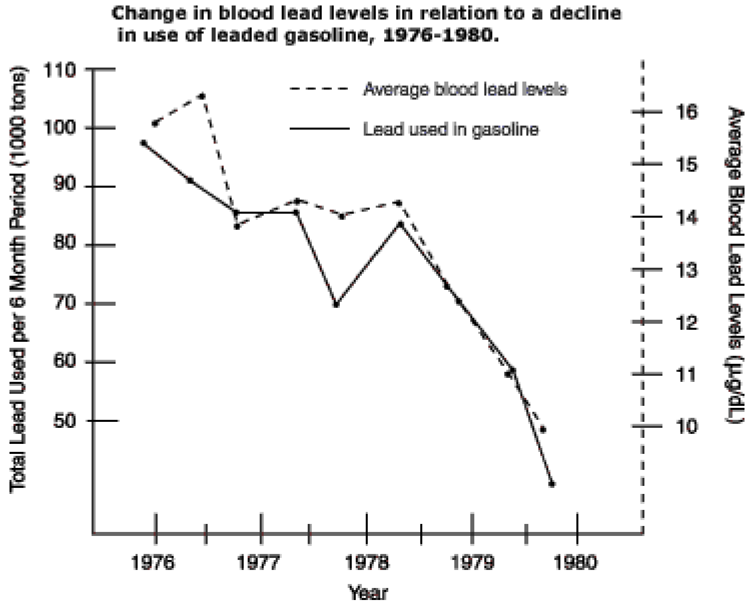
Lead enters the body through either ingestion or inhalation. Young children tend to ingest more lead than adults do in a given environment, mainly because of their normal hand-to-mouth behavior. They also take in more food and water per kilogram of body weight. The most common way for a child to ingest lead is by putting objects in the mouth (e.g., toys or hands) that have lead-contaminated dust or dirt on them. Children may also mouth surfaces having lead-based paint (such as window sills) or ingest lead-paint chips or soil (especially children who exhibit pica, a pattern of eating dirt or other non-food substances). Children may also ingest lead if their drinking water contains lead. (Lead in drinking water usually comes from lead-containing pipes, faucets, and solder in the plumbing of older buildings.) Children can also inhale lead via dust from deteriorating paint, dust on clothing brought home by parents exposed to occupational lead sources, or fumes from hobbies or industries that use lead.

The rate at which the body absorbs lead, once it has been ingested, depends on the chemical and physical form of the lead and on the physiological characteristics of the exposed person. Nutritional status and age are the factors having the greatest influence on absorption rates. Adults typically absorb 10 to 15 percent of ingested lead through the gastrointestinal tract, while children and pregnant women can absorb as much as 50 percent. Children are also at higher risk when their nutritional needs are not being adequately met. Calcium, iron, zinc, and protein deficiencies, in particular, increase lead absorption rates. Fasting conditions in adults have a similar impact on the absorption of lead. Lead dust inhaled and deposited into the lower respiratory tract is completely absorbed by both adults and children.

Since lead is an inorganic metal, it is not metabolized and is distributed throughout the body by the bloodstream. Over time, a portion of the lead may be eliminated from the body. The majority, however, remains in the bloodstream, or is absorbed by soft tissue (kidneys, bone marrow, liver, and brain), or mineralizing tissue (bones and teeth). In adults, 95 percent of the lead present in the body is found in teeth and bones, where it remains inert. When the body experiences physiological changes, however—such as pregnancy, lactation, or chronic disease—this inert lead can leach into the bloodstream and raise blood lead levels to dangerous levels. During pregnancy, this mobilized lead can also be transferred to the fetus, which has no defense mechanism against it. This can result in developmental and neurological damage.

In addition to absorbing a greater proportion of the lead to which they are exposed, children also tend to retain a greater percentage of lead in their blood than do adults. This is partly because a childs body is not as efficient as an adults at absorbing lead into mineralizing tissue. Consequently, a greater fraction of the lead absorbed remains in the bloodstream and has a toxic effect on internal organs.

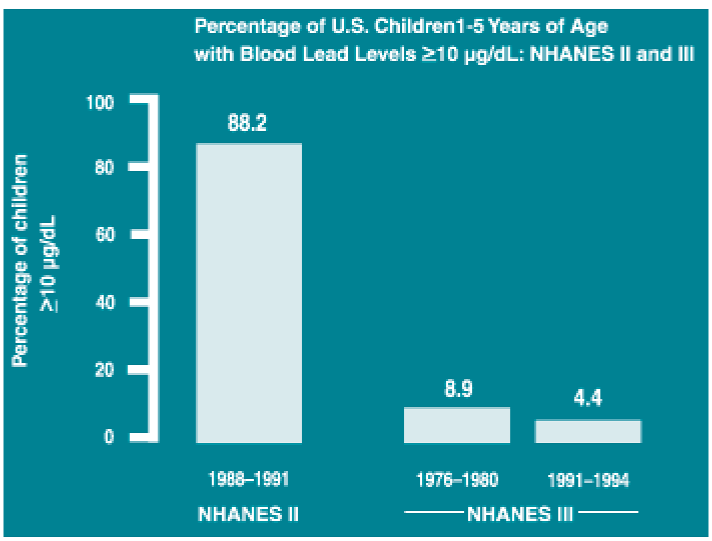
3.1.4 How Common Is Lead Poisoning in Children?



Source: Centers for Disease Control, 1991, *Preventing Lead Poisoning in Young Children*

The Second National Health and Nutrition Examination Survey (NHANES II), released in 1980, showed that as recently as 1976, the average blood lead level of the typical American child was 12.8 µg/dL. The survey also revealed that at that time 88.2 percent of American children ages one through five were suffering from some degree of lead poisoning (i.e., over CDC's current level of concern of 10 µg/dL).

In the 1970s, the federal government banned the use of lead-based paint in residential buildings and houses, and phased out the use of lead as an additive in gasoline. These two actions had an immense impact on the blood lead levels of children nationwide. NHANES III reported that by 1988, the national average blood lead level in children had dropped to 2.8 µg/dL and the percentage of children suffering from lead poisoning had dropped to 8.9 percent. By the early 1990s, the average blood lead level of children ages one through five was 2.3 µg/dL.[1] A fourth NHANES report has recently been completed; though the report has not yet been made public, the survey data apparently suggest that average blood lead levels continue to decrease among children in this age range.



While childhood lead exposure has diminished over the past 25 years, the problem is far from solved. In particular, minority, low-income, inner-city populations continue to lag behind in improvement, relative to national averages:

- 8 percent of impoverished children suffer from lead poisoning compared to only 1 percent of children from high-income families.[2]
- 11.2 percent of all African-American children are lead poisoned compared to 2.3 percent of all white children.[3]
- 50 to 70 percent of the children living in the inner cities of New Orleans and Philadelphia have blood lead levels above 10 µg/dL.[4]

Poor nutrition, deteriorating housing, lack of access to medical care, and language barriers all contribute to placing poor and minority children at risk for lead poisoning. It is important to note, however, that no economic or ethnic/racial group is free from the risk of lead poisoning. A sizable number of affluent families renovating older homes, for example, have placed their children at risk through unsafe lead paint removal techniques.

3.2 Sources and Levels of Lead in Soil

When lead is deposited in soil from anthropogenic sources, it does not biodegrade or decay and is not rapidly absorbed by plants, so it remains in the soil at elevated levels. Lead is estimated to have a half-time of residence in soil of 1,000 years.[5] In soils with a pH of greater than or equal to 5 and with at least 5 percent organic matter (which immobilizes the lead), atmospheric lead is retained in the upper 2 to 5 centimeters of undisturbed soil.[6] Urban soils or other soils that have been turned under or otherwise disturbed may be contaminated to much greater depths.

EPA estimates that 23 percent, or 18 million, of the privately owned homes in the United States built before 1980 have soil-lead levels above 400 parts per million (ppm); that 3 percent, or 2.5 million, have levels exceeding 2,000 ppm; and that 3 percent, or 2.5 million, exceed 5,000 ppm.[7] Lead in residential soil comes from several different sources, including lead-based exterior paint and automobile tailpipe emissions from vehicles burning leaded gasoline. Industrial emissions are also a source of residential soil contamination in some areas. These sources of contamination are discussed in more detail below. Lead in residential soil comes from several different sources, including lead-based exterior paint and automobile tailpipe emissions from vehicles burning leaded gasoline. Industrial emissions are also a source of residential soil contamination in some areas. These sources of contamination are discussed in more detail below.

3.2.1 Lead-Based Paint

EPA has found building age to be the strongest statistical predictor of soil lead, with soil around private homes built before 1940 having significantly higher levels of lead in soil than homes built between 1960 and 1979.[8] While the use of lead paint in residential buildings was federally banned in the United States in 1978, many homes built prior to 1978 still contain lead-based paint. Paint used in homes built between 1950 and 1978 contained between 0.5 and 50 percent lead, and the paint used prior to 1950 contained higher concentrations. One estimate is that more than 3 million tons of lead-based paint remain in the 57 million homes built prior to 1980.[9]

Since a large portion of this lead-based paint covers building exteriors, it continues to be a significant source of soil contamination. Lead-based paint contaminates soil as the paint film weathers and reaches the soil in the form of chips and dust. Renovating, remodeling, and performing routine home maintenance will also mobilize this lead if proper precautions are not taken. As the paint on a buildings exterior deteriorates, lead paint chips and dust concentrate in the surrounding soil. Dry scraping, sanding, and blasting of lead-based paint can mobilize large amounts of lead in a short time and significantly increase lead concentrations in soil. Lead concentrations in soil are typically highest in the drip zone, or dripline, the area surrounding and extending out about 3 feet from the perimeter of a building.

Scientists estimate that 4 to 5 million metric tons of lead emitted from automobile tailpipes prior to 1986 remain in the environment in dust and soil.

3.2.2 Leaded Gasoline

The use of lead as a gasoline additive was phased out during the 1970s and banned in the United States in 1986. It has been estimated that 4 to 5 million metric tons of lead, emitted from automobile tailpipes as fine dust particles, remain in the environment in dust and soil.[10] This represents approximately 75 percent of the total amount of lead added to gasoline. The remaining 25 percent was deposited on internal engine surfaces or ended up in the oil. The lead dust that became airborne would migrate until hitting a barrier such as the side of a house or some other structure, to which it would adhere. Subsequent rains washed this lead dust down into the surrounding soil, where it accumulated over time.

Soil-lead levels within 25 meters of roadways are typically 30 to 2,000 ppm higher than natural levels, and can sometimes be as high as 10,000 ppm.[11] Some researchers have found that soil-lead concentrations typically are highest in older, inner-city neighborhoods, especially those near high-traffic routes, and that soil-lead concentrations diminish with distance from the city center. Another study found that soil-lead concentrations are 10 to 100 times higher in old communities in large cities than in comparable neighborhoods in smaller cities, perhaps because traffic volume is higher and vehicles remain inside the city longer.[12]


A back yard in Dorchester, Massachussetts, with areas of bare, contaminated soil. When children play outdoors, lead-contaminated dirt and dust can get on hands, clothes, toys, and food.

3.2.3 Industrial Emissions

Communities near industrial and mining activities that release lead (or released lead in the past) may also have elevated levels of lead in residential soils. Examples of such industries and activities are lead smelting or refining plants, lead mining, auto repair, battery recycling or manufacturing, bridge and water tank repainting and reconstruction, plastic manufacturing, shipbuilding, glass manufacturing, printing, and hazardous waste sites. EPA has found lead levels in soils next to smelters as high as 60,000 ppm.[13]

3.3 Soil as an Exposure Pathway for Lead

While deteriorated lead-containing paint in housing is generally accepted as the leading source of lead exposure to children, outdoor activities where individuals come into contact with lead-contaminated soil also represent an exposure pathway that can be significant. When children play outdoors, lead-contaminated dirt and dust can get on hands, clothes, toys, and food. Putting these items in the mouth can lead to ingestion of lead.

Children can also breathe lead dust or lead-contaminated dirt stirred up by the wind or by outdoor play activities. During dry periods, dust from bare patches of contaminated soil can readily become airborne, increasing the chance that it will be inhaled. Also, airborne lead dust and lead-contaminated dirt can settle on play clothes and shoes and can be tracked into homes, further increasing exposure. Pets, as well, can track lead-contaminated soil into homes on their coats and paws.

The relative contribution of lead-contaminated soil versus lead-based paint and house dust is the subject of research and debate. Although there are differing opinions among researchers and experts as to the degree of significance of exposure to lead-contaminated soil, evidence does exist that soil is one important pathway for lead exposure among children. Some researchers have shown an association between increases in blood lead and increases in soil or dust concentrations. Factors that influence this relationship include access to soil, behavior patterns, presence of ground cover, seasonal variation of exposure conditions, and the particle size and chemical form of the lead. Others have found an association between time spent outdoors and children putting soil or dirt in their mouths, which, in turn, is associated with elevated blood lead levels.[14]

In 1996, EPA published the Integrated Report of the Urban Soil Lead Abatement Demonstration Project. This report assessed the scientific data from studies in three cities (Boston, Baltimore, and Cincinnati) to determine whether abatement of lead in soil could reduce blood lead levels of inner-city children. The report concludes that when soil is a significant source of lead in the child's environment, the abatement of that soil will result in a reduction in exposure that will, under certain conditions, cause a reduction in childhood blood lead concentrations. Important factors in reducing blood lead levels were thought to be (1) the past history of exposure of the child to lead, as reflected in pre-abatement blood lead levels; (2) the magnitude of the reduction in soil-lead concentrations; (3) the magnitude of other sources of lead exposure; and (4) a direct exposure pathway between soil and the child.[15]

Howard Mielke, a leading researcher on lead poisoning and prevention, reviewed other evidence for soil lead as an important exposure pathway in a 1999 article.[16] Mielke demonstrated a strong correlation between soil lead and blood lead in several studies.

Creating a Lead-Safe Residence

As the various pathways for lead exposure in young children become better understood, the importance of addressing all of the sources of lead in and around the home has also become clearer. For example, even if the interior of a home is certified as deleaded, a lead-contaminated yard can remain a dangerous source of lead exposure for children living there. Conversely, soil mitigation work will be ineffective if nothing is done about heavily leaded exterior paint on a home, because recontamination of the yard is likely to occur.

Because lead in yard soil is only one aspect of a multi-layered problem, the EMPACT Lead-Safe Yard Project decided in Phase 3 to address yards only for residences where structural lead abatement had been completed. Even in such homes, however, some lead probably remains, and precautions must be taken (e.g., using lead-safe renovation techniques) to prevent recontamination of the yard.

3.4 Standards and Guidelines for Lead Poisoning Prevention

This section provides an overview of federal guidelines and standards that may affect a lead-safe yard program. When determining the requirements that apply to your program, it is important to check with the state or tribal agency that addresses lead poisoning prevention. For example, many states have requirements for training and certification of contractors performing lead hazard evaluation and abatement work. Click here for an online list of state/tribal lead poisoning prevention agencies.

3.4.1 The Federal Regulatory Infrastructure

Title X of the 1992 Housing and Community Development Act (available online), otherwise known as the Residential Lead-Based Paint Hazard Reduction Act (Public Law 102-550), mandated the creation of an infrastructure that would correct lead paint hazards in housing. Title X also redefined "lead paint hazards" and how they can be controlled, and created Title IV of the Toxic Substances Control Act (TSCA), under which EPA sets lead hazard standards, work practice standards, and training requirements for lead abatement workers. Based on scientific research in the 1980s, Congress defined "hazard" to include deteriorated lead paint and the lead-contaminated dust and soil it generates. The infrastructure has been developed and includes the following:

- Grant programs to make homes lead safe, now active in over 200 cities.
- Training of thousands of workers doing housing rehabilitation, remodeling renovation, repainting, and maintenance to help them do their work in a lead-safe way.
- Licensing of inspectors and abatement contractors.
- Compliance with and enforcement of lead safety laws and regulations.
- Disclosure of lead paint problems before sale or lease.
- National and local education and outreach programs.
- Promulgation of federal standards of care.
- Worker protection regulations.

The box below lists federal agencies and their programs related to lead poisoning prevention. For a more detailed overview of these federal programs, see "Current and Ongoing Federal Programs and Activities" in *Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint Hazards* (PDF).

Federal Agency Roles in Lead Poisoning Prevention

Agency	Programs and Duties
Department of Housing and Urban Development	Lead Hazard Control Grant Program, enforcement of Disclosure Rule (with EPA and DOJ) and federally assisted housing lead paint regulations, National Survey of Lead Paint in Housing, Lead Hotline (with EPA), Internet listing of lead paint professionals, public education and training of housing professionals and providers and others, technical assistance, research.

Department of Health and Human Services: Centers for Disease Control and Prevention	Blood Lead Screening Grant Program, public education to medical and public health professionals and others, National Health and Nutrition Examination Survey, quality control for laboratories analyzing blood lead specimens, research.
Health Care Financing Administration	Covers and reimburses for lead screening and diagnosis, lead poisoning treatment, and follow-up services for Medicaid-eligible children.
National Institute of Child Health and Human Development	Conducts and supports laboratory, clinical, and epidemiological research on the reproductive, neurobiologic, developmental, and behavioral processes, including lead poisoning related research.
Health Resources and Services Administration	Directs national health programs to assure quality health care to under-served, vulnerable, and special need populations including children with lead poisoning.
Agency for Toxic Substances and Disease Registry	Studies blood lead in populations near Superfund sites and funds state health agencies to undertake this type of work.
Food and Drug Administration	Enforces standards for lead in ceramic dinnerware; monitors lead in food.
National Institutes of Health	Conducts basic research on lead toxicity.
Environmental Protection Agency	Licenses lead paint professionals (or delegates this responsibility to states); environmental laboratory accreditation; enforcement of Disclosure Rule (with HUD and DOJ) and Pre-Renovation Notification Rule; hazardous waste regulation; public education to parents, environmental professionals, and others; training curriculum design; Lead Hotline (with HUD); research; addresses lead contamination at industrial waste sites, including drinking water and industrial air emissions.
Department of Justice	Enforces Federal Lead Paint Disclosure Rule (with HUD and EPA); defends federal lead paint regulations; enforces pollution statutes, including hazardous waste laws.
Consumer Product Safety Commission	Enforces ban of lead paint; investigates and prevents the use of lead paint in consumer products; initiates recalls of lead-containing products that present a hazard; conducts dockside surveillance and intercepts imported products that present a risk of lead poisoning; recommends elimination of lead from consumer products through Guidance Policy on lead.
Occupational Safety and Health Administration	Enforces worker protection regulations.
Department of the	Evaluates financial incentives (such as tax credits) for lead hazard control.

Treasury	
Department of Energy	Conducts weatherization activities in a lead-safe manner.
Department of Defense	Administers lead-based paint/lead hazard management programs in 250,000 family housing and child-occupied facilities worldwide, administers childhood lead poisoning prevention programs on installations worldwide, administers research and development programs to develop new cost-effective technologies for lead paint management and abatement, partners with other federal agencies to develop policies and guidance for lead hazard management on a national level.

3.4.2 The Federal Strategy To Eliminate Lead Poisoning

The interagency President's Task Force on Environmental Health Risks and Safety Risks to Children has proposed a coordinated federal strategy to eliminate childhood lead poisoning, focusing on lead paint hazards (*Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint Hazards,* available online as a PDF). The goals of the Strategy are:

- By 2010, to eliminate lead paint hazards in housing where children under six live.
- By 2010, to eliminate elevated blood lead levels in children.

To accomplish these goals, the Task Force makes the following recommendations:

Act before children are poisoned:

- Increase the availability of lead-safe dwellings by increasing federal grants for low-income housing and leveraging private and other non-federal funding.
- Promote education for universal lead-safe painting, renovation, and maintenance work practices.
- Ensure compliance with existing lead paint laws.

Identify and care for lead-poisoned children:

Improve early intervention by expanding blood lead screening and follow-up services for at-risk children, especially Medicaid-eligible children.

Conduct Research:

Improve prevention strategies, promote innovative ways to drive down lead hazard control costs, and quantify the ways in which children are exposed to lead.

Measure progress and refine lead poisoning prevention strategies:

Implement monitoring and surveillance programs.

The Strategy notes that research is needed to help develop, evaluate, and market new products, such as x-ray fluorescence technologies. It also notes that research is needed to test the effectiveness of specific actions to reduce exposure to lead in soil and dust. These are areas in which the EMPACT Lead-Safe Yard Project and other similar programs can make significant contributions through their data and experience.

3.4.3 Federal Regulations and Guidelines Affecting Lead-Safe Yard Programs

EPA and the Department of Housing and Urban Development have issued regulations governing lead contamination in residential buildings and soil. EPA regulates lead contamination in homes and yards from lead-based paint under Title IV of TSCA. EPA's Resource Conservation and Recovery Act (RCRA) regulations also regulate lead-contaminated soil in certain situations. HUD's regulations parallel the TSCA regulations and apply to residential buildings that are either federally owned or receive federal assistance under HUD programs.

3.4.3.1 Proposed Rule Under TSCA (40 CFR Part 745)

EPA is currently preparing a final rule under TSCA Section 403, "Lead; Identification of Dangerous Levels of Lead," which will establish standards for lead-based paint hazards, including a hazard level for lead-contaminated residential soils. The pending rule is being designed to contribute to the lead hazard identification and abatement mandates specified under Title X, "The Residential Lead-Based Paint Hazard Reduction Act of 1992."

The Section 403 rule is expected to directly affect HUD and other federal agencies that own residential property by requiring soil abatement (such as soil removal or paving) before property sale if soil-lead hazards are identified. It will also indirectly affect property owners who receive federal housing assistance by potentially requiring hazard abatement or reduction. However, this pending rule will not by itself require residential soil abatement, but will instead provide standards for use in other regulations currently being implemented under Title X.

3.4.3.1.1 Are the Treatments in This Handbook Consistent With Federal Regulations?

The EMPACT LSYP was designed before the Section 403 rule was drafted; however, it can be considered to be complementary to the pending Section 403 rule. The project complements the "focus on prevention" objective of TSCA Title IV and the pending Section 403 rule by providing residents (particularly low-income urban minority residents) with practical low-cost yard improvements and landscaping measures that will reduce exposure to lead-contaminated soils. These low-cost measures may be used, in the case of federally owned or assisted properties, as interim shorter-term solutions until permanent, higher-cost solutions are employed. In addition, these low-cost measures may also provide longer-term, but not permanent, protection at non-federally and if needed, federally owned/assisted properties so long as homeowners and/or residents carefully and conscientiously follow specific maintenance procedures developed by the LSYP.

The tables below show the actions recommended for different soil levels by the EMPACT LSYP and the pending Section 403 rule. Following the tables is a discussion of the context for the two sets of recommended actions, as well as a comparison of the sampling plans used in each approach.

Empact Lead-Safe Yard Project

Soil-Lead Level (parts per million)*	Recommended Interim Action
> 5,000 (very high)	If soil removal or permanent barriers are not possible: • Install semi-permanent barrier, such as a wood-framed dripbox filled with gravel or mulch. • Relocate gardens—unsafe for all types of gardening.
2,000-5,000 (high)	• Relocate gardens—unsafe for all types of gardening. • Relocate children's play area, pet area, and picnic area, if possible. If not, install wood platform or wood-framed raised play and picnic area filled with woodchips. • Install path of walking stones for high-traffic areas. • Seed and fertilize grassy areas, or cover with mulch or woodchips if not suitable for grass.

400-2,000 (moderately high)	• Install raised-bed garden and supplement with clean topsoil. • Install wood-framed raised play and picnic area filled with woodchips. • Install path of walking stones for high-traffic areas. • Seed and fertilize grassy areas, or cover with mulch or woodchips if not suitable for grass.
< 400 (urban background)	• No treatment necessary.

*Based on in situ XRF analysis of surface soils (typically 15 to 25 samples per yard) and lead concentration mapping of the entire yard to include areas of special concern (play areas, gardens, outside eating areas, pet runs, etc.).

Proposed Section 403
Bare Soil-Lead Hazard Identification

Soil-Lead Level (parts per million)**	Recommended Interim Action
> 1,200 (hazard standard)	Eliminate hazard: • Remove contaminated soil or install permanent covering.
400–1,200 (level of concern)	Implement interim controls: • Cover bare soil • Use doormats in entryways. • Wash hands, toys, etc., more frequently.
< 400	No action

** For the yard, concentration is derived from an arithmetic mean of two composite samples, one from the drip line and one from mid-yard. For identified play areas, a single composite sample is used.

The EMPACT LSYP's mitigation strategy currently focuses on application of interim controls, though some permanent measures (blacktop) have been used for car park areas. Clearly, permanent controls are desirable where the resources are available to implement them. The EMPACT LSYP targeted its mitigation measures toward low-cost/no-cost options to address neighborhoods and homes where hazards exist and resources for mitigating these hazards are limited.

It also must be noted that the EMPACT LSYP approach to soil measurement is different from the proposed standard in several respects:

1. The EMPACT LSYP maps the entire yard with 15 to 25 field screening XRF analyses; this results in clear identification of hazard areas and the detailed information needed to apply controls in a cost-effective manner.
2. Surface soils are analyzed in situ to provide data on the soil material most likely to come into contact with the residents. Standard protocols would use field collection and offsite analysis of composite grab samples.
3. The proposed 403 rule applies to bare soil, while the EMPACT LSYP measures all yard surfaces.
4. The proposed 403 rule relies on average measurements (composites) rather than the discrete in situ measurements used to map yards in the EMPACT LSYP.

For these reasons, the proposed 403 standards and the action levels used for the EMPACT LSYP may not be directly comparable. Nonetheless, before applying the EMPACT project's model to your situation, you will need to consult local regulatory authorities to determine the requirements you must meet. State/tribal and local government regulations may be more restrictive than existing federal guidance.

3.4.3.2 Resource Conservation and Recovery Act (40 CFR Parts 240-299)

RCRA regulates the disposal of solid and hazardous waste. EPA's interpretations of RCRA regulations state that soils contaminated with lead-based paint as a result of routine residential maintenance and/or natural weathering or chalking of lead-based paint fall under the household waste exclusion and are not regulated as hazardous waste. This means that material may be disposed of off site in accordance with the regulations governing solid (non-hazardous) waste, known as RCRA Subtitle D, as well as applicable state and local regulations. Lead-contaminated soil that falls under the household waste exclusion need not be tested to determine if it is hazardous waste; if it is tested and found to be hazardous waste, it is still exempt from the RCRA hazardous waste regulations. You should check with state and local authorities, however, to see what testing they require.

3.4.3.3 Lead-Based Paint Poisoning Prevention in Certain Residential Structures (40 CFR Part 35)

This HUD rule establishes procedures to eliminate, as far as practicable, lead-based paint hazards in residential properties that are federally owned or receive federal assistance under HUD programs. The rule requires lead inspection and screening to be performed at all federally owned or assisted target housing, or any time a child under six years of age is found to exhibit an environmental intervention blood lead level ($\geq$20 µg/dL for a single test or 15 to 19 µg/dL in two tests taken at least three months apart). Target housing is defined as any residence built prior to 1978, excluding housing for the elderly or those with disabilities (unless children under the age of six are expected to reside there) or zero bedroom dwellings. Where a soil-lead hazard is found to exist, action is required to reduce the hazard.

The rule establishes six levels of protection: abatement of the lead-contaminated soil, abatement of the lead soil hazards, interim controls, paint stabilization, ongoing lead-based paint maintenance, and safe work practices during rehabilitation.

- When abatement (the permanent elimination of lead) is required for soil, the standards promulgated under TSCA must be followed. Abatement can be achieved through either soil removal and replacement with uncontaminated soil or permanent covering of the contaminated area (e.g., with pavement or concrete).
- Interim controls are steps taken to temporarily reduce lead exposure or hazards. They include impermanent surface coverings (e.g., sod, gravel, bark, artificial turf) and land use controls (e.g., fencing, warning signs, landscaping).
- The remaining actions (paint stabilization, ongoing lead-based paint maintenance, and safe work practices during rehabilitation) are not directly applicable to soil, but can help reduce the potential for increased soil contamination.

The specific level of protection required depends on the type of housing and the type of federal ownership or assistance. Once the required remedial action has been completed, the soil must pass the clearance examinations outlined in the regulations or further action will be required.

3.5 For More Information

3.5.1 Additional Resources

Agency for Toxic Substances and Disease Registry. 1992. *Analysis Paper: Impact of Lead-Contaminated Soil on Public Health*. Available online.

Agency for Toxic Substances and Disease Registry. *Philadelphia Neighborhood Lead Study, Philadelphia, Pennsylvania. Report of Lead Exposure Pilot Study.* Division of Health Studies. Atlanta, GA. Available from NTIS (order # PB92-123777INZ).

Agency for Toxic Substances and Disease Registry. 1999. *Toxicological Profile for Lead (draft).* Atlanta: U.S. Department of Health and Human Services, Public Health Service.

American Academy of Pediatrics Committee on Drugs. 1995. "Treatment Guidelines for Lead Exposure in Children." *Pediatrics*. 96:155-160. Available online.

Center for Bioenvironmental Research at Tulane and Xavier Universities. 1996. *Lead's Urban Legacy.* Available online.

Centers for Disease Control and Prevention. 1997. *Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials.* Available online, or call (toll-free) 1-888-232-6789.

Department of Housing and Urban Development. 1995. *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing.* Available online.

Department of Housing and Urban Development. 2000. *Residential Lead Desktop Reference, 2nd Edition.* CD-ROM containing more than 140 documents, including ASTM scopes, screening guidance, community outreach materials, lead resources, scientific studies and reports, lead statutes and regulations, lead training materials, regulation support documents, reports to Congress, HUD guidelines, and other resources. Available for $10 by calling HUDUSER at 1-800-245-2691.

Lead-Based Paint Hazard Reduction and Financing Task Force. 1995. *Putting the Pieces Together: Controlling Lead Hazards in the Nation's Housing.* Available online.

Mielke, H.W. 1990. "Lead Dust-Contaminated Communities and Minority Health: A New Paradigm," *The National Minority Health Conference: Focus on Environmental Contamination.* B.L. Johnson, R.C. Williams and C.M. Harris, Eds. Princeton, New Jersey: Princeton Scientific Publishing Co., Inc.

Mielke, H.W. 1994. "Lead in New Orleans Soils: New Images of an Urban Environment." *Environmental Geochemistry and Health.* 16:123-128.

Mielke, H.W. 1997. "Leaded Dust in Urban Soil Shown To Be Greater Source of Childhood Lead Poisoning Than Leaded Paint." *Lead Perspectives.* 28-31 (March/April).

Mielke, H.W. 1999. "Lead in Inner Cities." *American Scientist.* Vol. 87, No. 1 (January-February).

Mielke, H.W., and J.L. Adams. 1989. "Environmental Lead Risk in the Twin Cities." Center for Urban and Regional Affairs. CURA 89-4. 22 pp.

Mielke, H.W., J.C. Anderson, K.J. Berry, P.W. Mielke, R.L. Chaney, and M. Leech. 1983. "Lead Concentrations in Inner-City Soils as a Factor in the Child Lead Problem." *American Journal of Public Health.* 73:1366-1369.

Mielke, H.W., S. Barroughs, R. Wade, T. Yarrow, and P.W. Mielke. 1984/1985. "Urban Lead in Minnesota: Soil Transect Results of Four Cities." *Journal of the Minnesota Academy of Science.* 50:19-24.

National Research Council. 1993. *Measuring Lead Exposure in Infants, Children and Other Sensitive Populations.* Washington, D.C. National Academy Press. Order online.

U.S. Congress. 1992. *Residential Lead-Based Paint Hazard Reduction Act of 1992.* Title X (42 USC 4851). Available online.

U.S. Environmental Protection Agency. 1994. *EPA Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil.* EPA540-F-94-045. Order online.

U.S. Environmental Protection Agency. 1995. *EPA Residential Sampling for Lead: Protocols for Dust and Soil Sampling.* EPA747-R-95-001.

U.S. Environmental Protection Agency. 1996. *Distribution of Soil Lead in the Nation's Housing Stock.* Available online (PDF).

U.S. Environmental Protection Agency. 1997. *Reducing Lead Hazards When Remodeling Your Home.* EPA747-K-97-001. Order online.

U.S. Environmental Protection Agency. 1997. *Risk Analysis To Support Standards for Lead in Paint, Dust, and Soil,*

Volumes 1 & 2. EPA747-R-97-006. Available online.

3.5.2 Links

U.S. Environmental Protection Agency

National Lead Information Center
A federally funded hotline and clearinghouse that provides information on lead hazard reduction and exposure prevention. To speak with one of the Center's clearinghouse specialists, call 1-800-424-LEAD Monday through Friday, 8:30 a.m. to 6:00 p.m. EST.

Office of Pollution Prevention and Toxics (OPPT)
Responsible for EPA programs related to lead poisoning prevention and lead regulation. OPPT also provides educational packets for parents, teachers, daycare providers, and librarians, as well as technical information and publications.

Integrated Risk Information System (IRIS)
An electronic database containing information on human health effects that may result from exposure to various chemicals in the environment. The information in IRIS is intended for those without extensive training in toxicology, but with some knowledge of health sciences.

Lead Poisoning Prevention Outreach Program
Funded through a cooperative agreement between EPA and the Environmental Health Center.

Department of Housing and Urban Development,
Office of Lead Hazard Control
Sets standards for evaluation and management of lead in federally assisted housing, and promotes efforts to reduce lead hazards in privately owned housing. In addition, provides grants to communities to reduce lead hazards in housing.

Centers for Disease Control and Prevention
Childhood Lead Poisoning Prevention Program
Promotes state and local screening efforts and develops improved treatments for lead exposure. CDC also provides a database, 1990 Census Data on Housing and Population—Interactive Query, that allows you to search by county or zip code to find the percentage of houses built before 1950.

Agency for Toxic Substances and Disease Registry (ATSDR)
An agency of the U.S. Public Health Service established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund. ATSDR is required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List to determine if people are being exposed to hazardous substances, which includes lead. The public can search by region to see which health assessments are currently available in an online database.

National Conference of State Legislatures
Contains NCSLnet Search—a directory of state lead poisoning prevention contacts.

Consumer Product Safety Commission
Identifies and regulates sources of lead exposure in consumer products.

Occupational Safety and Health Administration
Develops work practice standards and worker exposure limits to protect workers from occupational lead exposure.

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[1]Natural Resources Defense Council, *Our Children at Risk: The 5 Worst Environmental Threats to Their Health*, Chapter 3: Lead, Washington, DC, 1997. Available online.

[2]Ibid.

[3]Ibid.

[4]Mielke, H.W., “Lead in the Inner Cities,” *American Scientist*, vol. 87, no. 1, Jan/Feb 1999.

[5]Benninger et al., *The Use of Natural Pb-10 as a Heavy Metal Tracer in the River-Estuarine System*, ACS Symposium Series #18, Marine Chemistry and the Coastal Environment, 1975.

[6]U.S. Environmental Protection Agency, *Air Quality Criteria for Lead*, Research Triangle Park, NC, EPA600-8-83-018F, 1986.

[7]U.S. Environmental Protection Agency, *Distribution of Soil Lead in the Nation's Housing Stock*, 1996.

[8]Ibid.

[9]Centers for Disease Control, *Preventing Lead Poisoning in Young Children*, 1991.

[10]Ibid.

[11]Ibid.

[12]Mielke, H.W., “Lead in the Inner Cities,” *American Scientist*, vol. 87, no. 1, Jan/Feb 1999.

[13]U.S. Environmental Protection Agency, *Air Quality Criteria for Lead*.

[14]Bruce Lanphear and Klaus Roghmann, “Pathways of Lead Exposure in Urban Children,” *Environmental Research*, vol. 74, 63–73, 1997.

[15]U.S. Environmental Protection Agency, *Integrated Report of the Urban Soil Lead Abatement Demonstration Project*, EPA600-P-93-001aF, Office of Research and Development.

[16]Mielke, H.W., “Lead in the Inner Cities,” *American Scientist*, vol. 87, no. 1, Jan/Feb 1999.

Chapter 4: Beginning the Program

4.1 | 4.2 | 4.3 | 4.4

This chapter provides guidance on important first steps that you will need to take as you start your lead-safe yard program. Section 4.1 presents a brief overview of the structure of a lead-safe yard program and outlines the roles and responsibilities of program partners, based on the EMPACT Lead-Safe Yard Project model. Section 4.2 discusses the critical process of selecting program partners who can best help you meet your program's objectives within your target community. Section 4.3 presents guidance on identifying potentially impacted communities that you may want to target with your program. Finally, Section 4.4 provides tips on getting to know your target community in terms of the cultures and languages of residents, the types and conditions of housing stock, and other factors.

The information in this chapter is designed primarily for managers and decision-makers who may be considering whether to implement lead-safe yard programs in their communities, as well as for organizers who are implementing such programs.

4.1 Program Structure: Overview of a Lead-Safe Yard Program

The EMPACT LSYP is a multifaceted project that engages in a variety of activities—everything from distributing flyers to planting grass. These activities can be grouped into four main categories, which make up the main components of the project: education and outreach, soil sampling, yard treatment, and program evaluation.

The following paragraphs summarize these activities to provide an overview of how the EMPACT LSYP works. These activities are described in much greater detail in Chapters 5 through 9.

Outreach During the outreach phase, the EMPACT LSYP approaches homeowners in the target community to educate them about the hazards of lead in soil and to enroll them in the project. Outreach workers make contact with homeowners though flyers, letters, phone calls, and knocking on doors. Lead hazard education is conducted using a variety of tools (printed handouts, videos, quizzes), and then homeowners are asked to enroll in the project by signing a permission form. Finally, outreach workers interview participating homeowners about the activities that take place in their yards; these yard uses are mapped on a plot plan, which is then given to the EMPACT LSYPs soil sampling team and landscaping team.

Sampling During the soil sampling phase, a field sampling technician (usually a licensed, trained lead inspector) collects data on soil-lead levels in the yards of participating homeowners, using field-portable x-ray fluorescence technology. Relying on the yard-use map created during the outreach phase, the technician develops a sampling plan that focuses on high-risk and high-use yard areas, where the potential for dangerous exposures to lead-contaminated soil is highest. Sampling results are transcribed onto a color-coded map of the property's lead levels, which is then given to the homeowner and passed on to the landscaping team.

Treatment The EMPACT LSYP provides each participating homeowner with up to $3,000 worth of free landscaping materials and labor for yard treatment. Treatment is conducted by one or more landscaping teams, headed by a landscape coordinator. This coordinator meets with the homeowner to go over the color-coded map of sampling results and to develop a treatment plan. A typical treatment plan combines various landscaping measures (e.g., wood-framed drip boxes, newly planted grass and shrubs, stone walkways) with changes to the residents' yard use patterns (e.g., moving a children's play area to a safe part of the yard). Once the treatment plan has been implemented by the landscaping team, the coordinator develops a property-specific maintenance manual to help the homeowner maintain the treatment measures.

Evaluation The EMPACT LSYP is currently involved in a major research study to evaluate the effectiveness of its low-cost yard treatment measures. Evaluation is the last phase of the project; however, an effective evaluation process depends on adequate documentation of the project's work during all phases. Key to the EMPACT LSYP's evaluation process is a property-specific case file begun by the outreach worker for each home, and maintained by all members of the EMPACT LSYP team.

The flow chart below summarizes the basic structure of the EMPACT LSYP. The chart identifies the main activities of the project, the team members responsible for these activities, and the flow of work between team members. It also indicates where in this handbook you can go for more information about specific activities.

4.2 Selecting Program Partners

As described in Chapter 1, the EMPACT LSYP is a partnership of several public, private, and non-profit organizations. These include a university, a federal government laboratory, a community planning agency, and private landscape contractors.

Why are so many partners needed for what is essentially a small-scale program? The activities conducted by the EMPACT LSYP demand a number of specialized skills, from communication and language skills to soil sampling, from landscape design experience to management skills. Each partner plays a different role in the project, based on the specific skills and qualifications that partner has to offer.

For example, EPA's New England Regional Laboratory, a founding partner in the EMPACT LSYP, offers the technical skills needed for analysis of soil-lead levels. The laboratory's staff also have the training to work safely in contaminated soil without endangering their own health. The Dudley Street Neighborhood Initiative, the project's community partner, does not offer these kinds of technical skills, but contributes something just as important: familiarity with the Dudley Street neighborhood and the communication skills necessary to work closely with its multilingual residents.

In starting your own lead-safe yard 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 target community. For example:

- An organization or agency that already has strong ties to the community can be ideal for conducting outreach and education for your program. Neighborhood health centers or community action programs can be a good choice.
- A nearby college or university can help with any research components of your program, or may be able to provide assistance and equipment for the sampling activities. (See Appendix B for a more detailed discussion of this type of approach.) Make sure to check with your state or tribal lead poisoning prevention agency about certification requirements for lead inspectors. See Chapter 6 for more information on finding a qualified person to conduct the sampling and analysis components of your program.
- Landscaping companies are key partners for the design and landscaping components of your program. A non-profit landscaping company specializing in community gardening and small parks can be a good choice. Another approach (being implemented by the EMPACT LSYP in Phase 3) is to develop a pool of small private landscaping companies. Encouraging companies to bid on lead-safe yard work, as described in Section 7.5, is a good way to obtain these services in a cost-effective manner. Landscaping companies should be bonded and insured, and should have the skills to manage the work involved in treating yards to meet your specifications.

As described in Chapter 1, the EMPACT program selected partners who could carry out specific activities. The community partners (Bowdoin Street Health Center, and later the Dudley Street Neighborhood Initiative) led the education and outreach work; the EPA Regional Laboratory led the sampling and analysis activities, with assistance from a certified industrial hygienist from the Health Center; a non-profit landscaping company performed the soil mitigation work; and Boston University School of Public Health led the effort to develop a template for community action for use by other programs.

Lessons Learned: Youth Employment and Training

In its pilot phase, the EMPACT LSYP wished to incorporate youth employment and training into its work. The project hired high school students, who learned on the job while being supervised by adults. This system turned out to be problematic in the pilot phase. It was logistically complex, and costs changed because the on-the-job training meant the work was accomplished more slowly than it would have with trained landscapers. For this reason, it is advisable to get your program organized and running smoothly, then determine which components of the program are a good match for youth training and employment. At that point, you can focus on this aspect of a program.

4.3 Identifying Potentially Impacted Communities

The first step in beginning your lead-safe yard program is to identify communities that may have homes with elevated soil-lead levels. For this purpose, you can determine where the important predictors of lead in soil are present. These predictors include large numbers of children with elevated blood lead levels; a preponderance of older wood-framed housing (generally with wooden clapboard), which is likely to have exterior lead-based paint; and heavy traffic flows, which are likely to have caused deposition of lead from leaded gasoline. These characteristics are discussed in Sections 4.3.1 through 4.3.3. Industrial emissions of lead can also cause elevated soil-lead levels at nearby residences (see Section 4.3.4).

You will also want to consider other characteristics of neighborhood life that can contribute to the success of a program, such as the presence of a community organization that can partner with you and help you get to know the community (see Section 4.3.5).

4.3.1 Children With Elevated Blood Lead Levels

For Phases 1 and 2, the EMPACT LSYP reviewed available blood lead data for children aged six months to six years from the Massachusetts Childhood Lead Paint Poisoning Prevention Program. The target community was within the so-called "lead belt" in Boston (see map on page 3). Your city or state childhood lead program or health department likely has similar blood lead data, organized by census tract or zip code. You can look up state and local lead poisoning prevention contacts in your area on the following Web sites:

The Lead Program of the National Safety Council's Environmental Health Center

The National Conference of State Legislatures' Directory of State Lead Poisoning Prevention Contacts

EMPACT LSYP Site Selection Criteria

High incidence of lead poisoning
Pre-1970 painted housing (generally wooden clapboard siding)
Low-income/immigrant population
Contiguous neighborhood (for neighborhood-wide impact)
An existing health organization focused on the lead issue
Existing neighborhood environmental activities the project could build on and enhance

4.3.2 Older Housing With Lead-Based Paint

Another way to identify potential target communities is to determine which neighborhoods have older, wood-framed housing (generally with wooden clapboard siding). Such houses are likely to have lead-based exterior paint. As described in Chapter 3, some studies have found a strong link between building age and soil-lead contamination. Therefore, neighborhoods with older housing (especially homes built before 1950) are more likely than newer communities to have a soil-lead problem. The presence of lead-based paint is also considered an important predictor of elevated soil-lead levels. Both EMPACT study areas, the Bowdoin Street neighborhood in North Dorchester and the Dudley Street neighborhood in Roxbury and Dorchester, consist of predominantly older, wood-framed homes with painted exteriors.

The Centers for Disease Control provides an online database, *1990 Census Data on Housing and Population* that allows you to search by county, zip code, or census tract for the percentage of houses built before 1950.

Keep in mind that some communities may contain vacant lots, greens, and parks in residential areas that may have historical lead contamination from gasoline deposition, past industrial activity, or former housing. See Chapter 10 for tips on applying lead-safe yard mitigation strategies to non-residential sites, such as tot lots, playgrounds, community gardens, and vacant lots.

4.3.3 Heavy Traffic Flows

Some studies stress the concentration of lead-contaminated yards in congested high-traffic, inner-city regions (see Chapter 3), pointing to the importance of lead accumulations from leaded gasoline. Both EMPACT study areas are in heavily traveled inner-city neighborhoods.

4.3.4 Industrial Emissions

Communities near industries that emit lead (or have emitted lead in the past), such as lead smelters, lead mines, battery recycling plants, and incinerators, may also have elevated levels of lead in residential soils. You can find out where such industries are locating by contacting your state environmental agency or EPA Regional office, or by searching EPA's Toxic Release Inventory (TRI) database for facilities in your area that have reported releases of lead to the environment.

4.3.5 Other Community Characteristics

The EMPACT LSYP took into account several additional factors in potential target communities that would contribute to the project's success. For example, the project targeted homes that were located on adjacent streets rather than in dispersed areas. This made the work more efficient, as well as more visible to nearby homeowners who might become interested in the project. It also meant that the neighborhood children would be better protected, because children often play in yards near their own.

The project also favored working in service areas of active community-based organizations—first the Bowdoin Street Health Center and later the Dudley Street Neighborhood Initiative. Both of the selected neighborhoods had a history of environmental health activities. The EMPACT LSYP could, therefore, build upon previous initiatives and take advantage of neighborhood connections already made by these community organizations.

4.4 Getting To Know the Community

Once you have identified your target community, your task is to learn more about it. Make sure you have your target area clearly mapped and marked so that you can begin planning. Next, find out the key "statistics" about the community. Some of the questions you will want to answer about the community include:

- What are the cultures and languages of the people who live there?
- What are the residents' income and education levels?
- What is the percentage of home ownership/owner-occupied dwellings?
- What is the percentage of housing built before 1978?

- What is the condition of the older housing stock?
- What organizations and agencies are active in the community?
- What prior work has gone on in the community to prevent lead poisoning?
- What are the numbers, percentages, and location of lead-poisoned children in the community?
- Have any homes in the area been de-leaded?
- What are the names, addresses, and phone numbers of homeowners in the target area?

Information such as income and education levels and age of housing can be obtained from census data; other questions about the community such as cultural characteristics can be provided by your community partners. All this information will help you form a clear picture of your target community and the best ways to reach them. The EMPACT LSYP, for example, knew that many residents in the Bowdoin Street neighborhood spoke Spanish, Cape Verdean Creole, or Haitian Creole, so that conducting spoken and written outreach and education in these languages would be critical to the success of the program. Sample outreach flyers in four languages are included at the end of Chapter 5.

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Chapter 5: Communicating About Lead in Soil and Your Lead-Safe Yard Program

5.1 | 5.2 | 5.3 | 5.4

This chapter describes how to provide education and outreach to homeowners and residents about the problem of lead in soil and the benefits of participating in a lead-safe yard program. Section 5.1 presents strategies for approaching homeowners and residents to inform them about your program and to develop a sense of trust and credibility within your target community. Section 5.2 discusses methods for educating people about soil-lead hazards and the benefits of your program. Section 5.3 is devoted to establishing an application process for enlisting homeowners in your program and obtaining their consent for the work that will be done on their property.

The information in this chapter is designed primarily for managers who are implementing lead-safe yard programs, as well as for outreach workers who are responsible for communicating about lead in soil and your lead-safe yard program.

This chapter contains links to documents in PDF format. To view them, you will need Adobe's Acrobat Reader. Click here to download Acrobat Reader.

5.1 Approaching Homeowners and Residents

Once you have learned the basics about your target community, you can begin your education and outreach efforts.

Walk around your target community on a pleasant day and talk to people face to face.

First, determine who will be conducting outreach and education for your program. If possible, the outreach worker should be a person who lives in the community and is respected and credible. People who do not live in the community can sometimes be very effective, however (such as a public health nurse from a community health center, or someone otherwise familiar with the community and the issues people there are facing).

A good next step is to develop an area-appropriate flyer, such as this EMPACT LSYP flyer (PDF). You can ask area businesses to post the flyer or allow you to do so. You can also distribute flyers to all the homes in your target neighborhood(s), then follow up by calling all the homeowners to inform them of the project and their eligibility. Sending informational letters to the targeted neighborhood homeowners might be an effective alternative. This chapter includes examples of letters used by the Lead Safe Boston program (a spinoff of the EMPACT LSYP): an initial letter (PDF), a follow-up letter asking for information (PDF), and a follow-up letter for new enrollees (PDF). Other ways of increasing awareness of your program within the community include radio promotions and forums at other local promotional events (such as Boston's Lead Safety Awareness Week and community spring cleanup events).

The next step is to focus on meeting people face to face. This is important because people need to get to know and trust you before they open their home to your project. Below are some tips for effective ways to approach people in person:

- Walk around the area on a pleasant day or holiday, when people are most likely to be out of doors. Weekend door knocking is recommended.
- Vary the times of day at which you do outreach, but always be respectful of "normal waking hours" for people, unless you have been otherwise invited. Try not to go at family rush hours (around 8 to 10 a.m. or 4 to 6:30


Residents will need to get to know you before they open their home to your project.

p.m.); going at these times may turn people off to the project.
- If the area has a high percentage of non-English speakers and you don't speak the languages spoken in the area, try to get a friend or co-worker who speaks the most prevalent language to walk with you.
- Be sure to take project flyers with your name and number on them, permission slips, educational materials, and information/referrals about lead testing, treatment, and de-leading programs.
- Attend events and meetings in the neighborhood to give out flyers and get to know people. The EMPACT LSYP outreach worker found that outdoor events such as community picnics are good venues for outreach work. Community garden and food projects may also yield receptive audiences.
- Remember that news about a project like this spreads by word of mouth and visible results. Any negative perceptions will travel twice as fast as positive ones, so try to make only positive impressions!

The EMPACT LSYP engaged in a wide variety of additional activities to promote the project as well as to enhance community lead awareness. These included:

- Participation in a "Lead Expo" at a community center, in the citywide Lead Awareness Week, and in the neighborhood Multicultural Festival.
- Footage about the project on the local cable station (Neighborhood Network News).
- Discussion of the project in a segment entitled "Removing Lead from a Low-Income Community" on National Public Radio's *Living on Earth*, an award-winning environmental news program.
- Presentations at workshops and conferences, including the Second Syracuse Lead Conference (October 1999) in Syracuse, New York, and the Toxics Action '99 conference at Boston College in Newton, Massachusetts.

5.2 Educating People About Lead and Lead in Soil

Once you have identified people interested in the program and willing to speak with you at greater length, you will have the opportunity to provide education about the problem of lead exposure, explain the benefits of your program, and answer questions. The EMPACT LSYP's Education and Outreach Plan is presented in the box below.

In conducting education, you should convey the basic dangers of lead first—how and why lead is dangerous to families' health, as well as what people can do to protect themselves (de-leading, proper nutrition, cleaning, etc.). Remember that you need to educate people not only about lead in soil, but about all sources of lead in and around the home. It is important to follow up on the advice you give about these issues, so that people don't get frustrated and give up on slow-moving assistance programs.

Many city or state childhood lead programs have developed excellent written materials on lead poisoning prevention that you can use with residents. Examples of some fact sheets used by the EMPACT program, from the Boston Childhood Lead Poisoning Prevention Program, are included at the end of this chapter. Using the Internet, you can also access educational materials developed by EPA and other federal agencies. These materials include:

> *Protect Your Family From Lead in Your Home* (PDF) (EPA 747-K-99-001)
> is a 16-page educational pamphlet that provides general information about lead and lead hazards. A Spanish-language version (PDF) can be found on HUD's Web site.
>
> *Lead in Your Home: A Parent's Reference Guide* (PDF) (EPA 747-B-98-002)
> is a more comprehensive guidebook, 67 pages long, that recommends steps parents can take to reduce their family's risk of lead exposure and prevent lead poisoning.
>
> *What Every Parent Should Know About Lead Poisoning in Children*

is a one-page fact sheet from the Centers for Disease Control and Prevention that provides basic information about lead poisoning and lead-paint hazards.

Keep in mind that written materials are not always enough to get the message across. The EMPACT LSYP has found that outreach workers need to develop creative ways of emphasizing and reinforcing the lead hazard message (e.g., by using tools such as films and quizzes), and to create repeated opportunities for homeowner re-education. For tips on creative education strategies, see "Lessons Learned: Education and Outreach" below, and Sections 8.4 and 8.5.

For your lead-safe yard program, you will want to give special emphasis to why addressing lead in soil can help protect health. You will need to explain how lead gets into soil, how children playing in yards with contaminated soil are exposed to lead, and how dirt and dust containing lead can also be tracked into the home. Once the levels of lead in a yard's soil are tested, you can go over the recommended actions (based on these levels) for the yard (see Section 7.4). Finally, the residents need to understand that landscaping measures do not remove the contaminated soil, that landscaping needs to be properly maintained in order to control exposure to the lead hazard, and that future home improvements need to be done safely to prevent recontamination.

5.3 Next Steps: Enlisting the Homeowner in the Program

If a homeowner has shown interest in your program based on your initial outreach and education, you can encourage him or her to take the next steps. The EMPACT LSYP found that at this point in the process it was important to reassure homeowners that they would not be penalized if they did not participate, and that there was no catch to the free landscaping provided.

The process of enlisting the homeowner into your program can be as formal or informal as you want to make it. One option is to establish a formal application process that the homeowner will complete before participating in the program. Lead Safe Boston, a spinoff of the EMPACT LSYP run by the City of Boston (see Section 1.2.1), requires homeowners to fill out an application form and submit copies of their insurance policy, their water and sewer payment plan, and a recent real estate tax bill. Click here to see Lead Safe Boston's application form (PDF).

Lessons Learned: Education and Outreach

A key to the success of a lead-safe yard program like EMPACT's is that residents understand why lead in soil is harmful to their children. Without this understanding, it is more likely that the landscaping measures will not be maintained, greatly reducing their effectiveness in protecting children from lead exposure.

In its first two phases, the EMPACT LSYP followed a model commonly used for community education and outreach: a bilingual outreach worker from the community health center conducted typical outreach activities, including walking in the neighborhood, door knocking, distributing flyers, speaking at community meetings, and talking with people one on one. These efforts were culturally specific to the neighborhood and conducted at an appropriate literacy level.

After Phase 2 was completed, the project returned to the residences where yard work had been done to evaluate how the work had held up and what had been learned. They found that people had not really taken in the problem of lead in soil, but viewed the project as more of a landscaping program.

To remedy this shortcoming, in Phase 3 the project implemented a more comprehensive education program, using several new approaches. The community outreach worker received more extensive training on the lead issue. She helped devise a new plan to show community residents a video, “The Thief of Childhood,” as a teaching tool about the hazards of lead. After watching the video, residents were given a short quiz. The quiz motivated the resident to pay attention to the video, whose key messages were reinforced by the questions. The outreach worker graded the quizzes and discussed the answers with the residents. Thus, the education work used three different modes of learning: visual (the video), written (the quiz), and oral (discussion of the video, quiz, and educational flyers). The quiz will be used again when the yard mitigation work is completed, to see whether the residents have retained the information.

So far, the project has judged this new approach to be more effective than using literature alone. The video and quiz seem to be an engaging, interactive “hook” to promote a better understanding of the lead problem in general and the health benefits of a lead-safe yard.

Another video that could be used for the same purpose is EPA's "Little Moccasins" Lead Safety Program video, created for day care centers, clinics, and families. This 22-minute animated video was developed by the Houlton Band of Maliseet Indians with funding from EPA's Lead Program. An interactive "First Steps" CD-ROM is also available, presenting helpful information on lead poisoning prevention in the form of video clips, games, and songs. Ordering information for the CD-ROM and both videos is found in Section 5.4. Ask your community or state lead officials to recommend other videos appropriate for your audience.

Once accepted into the program, the homeowner should sign a "permission slip" or consent form that establishes an agreement between the program and the homeowner to allow testing of the property, participation in a design session, and subsequent remediation through landscaping. The permission form should include language regarding the homeowner's duty to have their property in testable and workable condition (removal of trash, debris, and old cars; notification about/relocation of pets). Again, the permission form can be formal or informal, depending on the needs of your program. A very simple form, used by the EMPACT LSYP during Phases 1 and 2, is shown here (PDF). A more detailed consent form, developed by Lead Safe Boston, is shown here (PDF).

At this point you should establish a case file that contains all the information related to application, testing, mitigation, and follow-up for the property. The EMPACT outreach worker keeps all this information, including "before and after" photographs, in a binder, which is given to the homeowner when the work is completed.

Next, the outreach worker conducts a homeowner interview. The interview is designed to obtain information about the activities that take place in the yard and the ages and numbers of people who use the yard. This chapter includes an EMPACT questionnaire for a hypothetical home, shown blank (PDF) and filled out (PDF).

To map out yard use patterns, the outreach worker uses a house plot plan (PDF). Plot plans can be developed in one of several ways. For example, the outreach worker can visit the municipal assessor's office to photocopy official drawings showing the footprint of the house and all property lines. A plot plan can also be developed using a geographic information system (GIS), or the outreach worker can simply draw one by hand, using a measuring tape and pen and paper. The plot plan developed during this outreach phase will be used later as a guide for the field testing crew and for the landscape coordinator, as described in Chapters 6 and 7.

The next step in the process is testing of the yard soil, followed by a design session with the homeowner if the yard is found to have high levels of lead. These steps are described in detail in Chapters 6 and 7 of this handbook.

5.4 For More Information

Your local or state childhood lead poisoning prevention program may have good educational materials on lead issues.

Lead education materials developed by EPA's Office of Pollution Prevention and Toxics are available online.

Lead-Safe Yard Education and Outreach Plan

1. Make appointment with interested applicants to discuss the problem of lead poisoning and the lead-safe yard and home program.
2. Home visit: First, ask them if they have had experience with lead poisoning. Have they had a child, relative, or neighbor who was lead poisoned? Using the educational pamphlet, discuss five key points about lead poisoning:
    - How does a child usually get lead poisoned? (Paint chips, dust and dirt on hands and toys, lead in water)
    - How do you avoid lead in drinking water? (Run tap water until it is cold)
    - How do you avoid lead in the home? (Specific lead-safe home cleaning and maintenance procedures)
    - Why is dust on children's hands and toys, as well as on window sills and floors, a problem, especially if the house is not de-leaded? (Children may put hands, fingernails, toys, or food dropped on floor in their mouths)
    - What foods are good for preventing lead poisoning? (Foods high in iron, calcium, and vitamin C, and low-fat foods)

This is a good time to show the photos of the LSYP.

3. Give the homeowner the video which is available in multiple languages, explores the dangers of lead paint poisoning, its adverse health effects, and practical measures for protecting children (see Section 5.4 for ordering information). Also give the homeowner the set of questions to answer after viewing the video. (The answer sheet can be returned immediately after watching the video, or later, with the lead-safe yard and home application.)
4. Explain the application process and documentation needed for the lead-safe yard program.
5. Leave the application, video, and sheet of questions (if the homeowner hasn't returned it already) with your business card.

The following Web sites list state and local lead poisoning prevention contacts:

The Lead Program of the National Safety Council's Environmental Health Center

The National Conference of State Legislatures' Directory of State Lead Poisoning Prevention Contacts

For guidance on writing clearly and effectively for a general audience, try this site.

Video: "Lead Paint Poisoning: The Thief of Childhood" (20 minutes, 1996)

This video explores the dangers of lead-paint poisoning and its adverse health effects. It provides information, education, and practical advice on protecting children, using interviews and discussions with educators, health care providers, and culturally and linguistically diverse parents whose children have been lead poisoned. The video is available in English, Spanish, Cape Verdean Creole, Haitian Creole, and Vietnamese. Available for $10 from: City of Boston, Office of Environmental Health, 1010 Massachusetts Avenue, Boston, MA 02118. Phone 617-534-5966, Fax 617-534-2372.

Video: "Little Moccasins" Lead Safety Program Video (22 minutes)

This lead poisoning prevention video was developed for day care providers, clinics, and families by the Houlton Band of Maliseet Indians, with funding from EPA's Lead Program. The video is available in English, but may soon be available in Spanish and some Native American languages. Available free of charge from Philip Quint, Lead Director, Houlton Band of Maliseet Indians, at 1-800-545-8524 or 1-207-532-4273. E-mail quint@ainop.com.

CD-ROM: "First Steps"

This CD-ROM, developed by the Houlton Band of Maliseet Indians with funding from EPA's Lead

Program, presents helpful interactive information on lead poisoning prevention in the form of video clips, games, and songs. Course manuals are available on the CD in English, Spanish, and Native American motif. Available free of charge from Philip Quint, Lead Director, Houlton Band of Maliseet Indians, at 1-800-545-8524 or 1-207-532-4273. E-mail quint@ainop.com.

Quiz To Accompany Film, "The Thief of Childhood"

1. By what year was lead no longer used in new house paint?
2. How can a child get lead poisoned?
   a. paint chips
   b. dust
   c. drinking water
   d. all of these
3. Name some foods that are good for children and that help decrease blood lead poisoning.
4. How can you avoid lead in drinking and cooking water?
5. How can you avoid lead hazards from home interiors?
6. Name two ways in which lead has gotten into yard soil.
7. Give three suggestions for protecting children in the home and yard from becoming lead poisoned.

Example Documents

All of these documents are PDFs; you will need Adobe's free Acrobat Reader to view them. Click here to download Acrobat Reader.

Flyer: Dorchester Lead-Safe Yard Program
Flyer: Dorchester Lead-Safe Yard Program (Spanish Version)
Flyer: Dorchester Lead-Safe Yard Program (Portuguese Version)
Flyer: Dorchester Lead-Safe Yard Program (Haitian Creole Version)
Letter to Homeowners: Lead Safe Boston Program, Initial Letter
Letter to Homeowners: Lead Safe Boston Program, Follow-Up #1
Letter to Homeowners: Lead Safe Boston Program, Follow-Up #2
Fact Sheet: Lead
Fact Sheet: Temporarily Reducing Lead Paint Hazards by Cleaning
Fact Sheet: Temporary Ways To Keep Children Safe From Lead Paint Hazards
Fact Sheet: Understanding What Blood Lead (Pb) Test Results Mean
Fact Sheet: Understanding What Blood Lead (Pb) Test Results Mean (Spanish Version)
Fact Sheet: Foods That Help Reduce the Harmful Effects of Lead
Sample Form: Lead Safe Boston Program Application
Sample Form: Homeowner Permission Form
Sample Form: Homeowner Consent Form
Sample Form: Homeowner Yard Use/Treatment Options Interview Form (Blank)
Sample Form: Homeowner Yard Use/Treatment Options Interview Form (Completed)
House Plot Plan

NEXT CHAPTER

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Chapter 6: Collecting and Managing Data on Lead in Soil

6.1 | 6.2 | 6.3 | 6.4 | 6.5 | 6.6 | 6.7

This chapter describes a state-of-the-art technique, using field-portable x-ray fluorescence technology, for collecting and managing data on lead in soil. This technique allows inspectors to discern patterns of contamination at a property quickly and accurately. This technology is suitable for use by trained, certified inspectors who meet federal, state, and local requirements for collection of environmental samples, as described in Section 6.4. This chapter is not intended to provide guidance for inspectors, but to give you, as a program organizer or decision-maker, an overview of the data collection and management process.

Section 6.1 is an overview of data collection and management techniques used by the EMPACT Lead-Safe Yard Project. Section 6.2 provides information on how to find the necessary equipment and laboratories for testing and how to cut costs. Section 6.3 is a step-by-step description of testing, quality control, and data management procedures that are used by professional inspectors; Section 6.4 discusses health and safety precautions for inspectors; and Section 6.5 is devoted to equipment maintenance.

If you mainly want a general idea of what data collection and management entails, you can focus on Section 6.1 alone. Sections 6.2 through 6.5 present more detailed material for those who are responsible for implementing a lead-safe yard program. Such readers may also be interested in the reproducible site worksheets at the end of this chapter.

This chapter contains links to documents in PDF format. To view them, you will need Adobe's Acrobat Reader. Click here to download Acrobat Reader.

6.1 Collecting and Managing Data: An Overview

A key component of the EMPACT Lead-Safe Yard Project is the use of field-portable XRF technology. This technology allows inspectors to provide residents with onsite, real-time data about lead contamination in yards, without having to wait for the results of laboratory analysis. Field-portable XRF requires a substantial capital investment, as noted in Sections 6.2 and 6.5. On the other hand, programs committed to soil inspection for the long haul may find that the investment more than pays for itself. The EMPACT LSYP has conducted XRF analysis on roughly 2,000 soil samples over the past three years, which makes the cost per sample far less than it would have been for laboratory work. After all, sending samples to a lab involves not only charges for the analysis itself but also the expense of sample collection, shipping, and handling.

The XRF is a hand-held field-portable device that allows inspectors to get a lead-level reading within seconds.

Inspectors mark the location of each XRF reading on a plot plan and record lead levels on a site worksheet.

Studies have affirmed the accuracy of XRF, and it has received EPA verification as well. (For example, EPA's Environmental Technology Verification Program has conducted field demonstrations to test several XRF technologies. Verification Reports and Statements from these tests are available online.) What makes XRF technology especially valuable for a lead-safe yard program is that it offers real-time results with a hand-held, battery-powered device.

This means that inspectors, while on site, can get parts per million (ppm) lead levels for individual soil samples within seconds, and, if necessary, adjust their testing strategy for the property as a whole accordingly. Experience has shown that lead concentrations in properties often vary significantly and unpredictably. With XRF, inspectors can learn about any unusually high lead levels right away and then take more closely spaced readings in the area from which the high reading came. The result is a clearer delineation of how soil contamination differs from one part of the property to another.

One concern that has been raised about field-portable XRF is that it tests for lead only at the surface level. Many experts, however, are convinced that this is usually where the lead level in soil actually is highest. Also, the top layer of soil clearly poses the greatest potential health risk because of its accessibility.

When the EMPACT LSYP conducts XRF testing, the first step is to determine some rough guidelines by interviewing the homeowner and observing current conditions in the yard. Several high-risk or high-use areas may be identified. As the sample interview form in Chapter 5 suggests, these could include gardens, picnic areas, and children's play areas, in addition to areas of bare soil and heavy foot traffic. Such parts of the property are singled out for careful inspection. Another target is the drip line, generally a 3-foot-wide strip around the foundation of a house where lead tends to accumulate in soil due to flaking and peeling paint from exterior surfaces.

The EMPACT LSYP's procedure for taking XRF readings is straightforward. The XRF and test guard are placed on the exposed soil surface and depressed to open the shutter. A 30- to 60-second measurement should yield reliable results. As inspectors take these readings, they mark the location of each on a plot plan of the property and record the lead levels on a site worksheet. Any other relevant descriptive information, such as the weather and the general condition of the yard, is noted on the worksheet as well.

The lead levels from different locations within a particular area—say, the east drip line—are averaged to yield a mean value. Depending on this value, the EMPACT LSYP assigns each area to one of its four categories (see Section 3.4.3.1 for a comparison with proposed categories under TSCA Section 403):

- Very high (5000 ppm or more)
- High (2000 to 5000 ppm).
- Moderately high (400 to 2000 ppm).
- Low (400 ppm or less)

Detailed guidance about mitigation strategies for each of these categories is provided in Chapter 7 of this handbook.

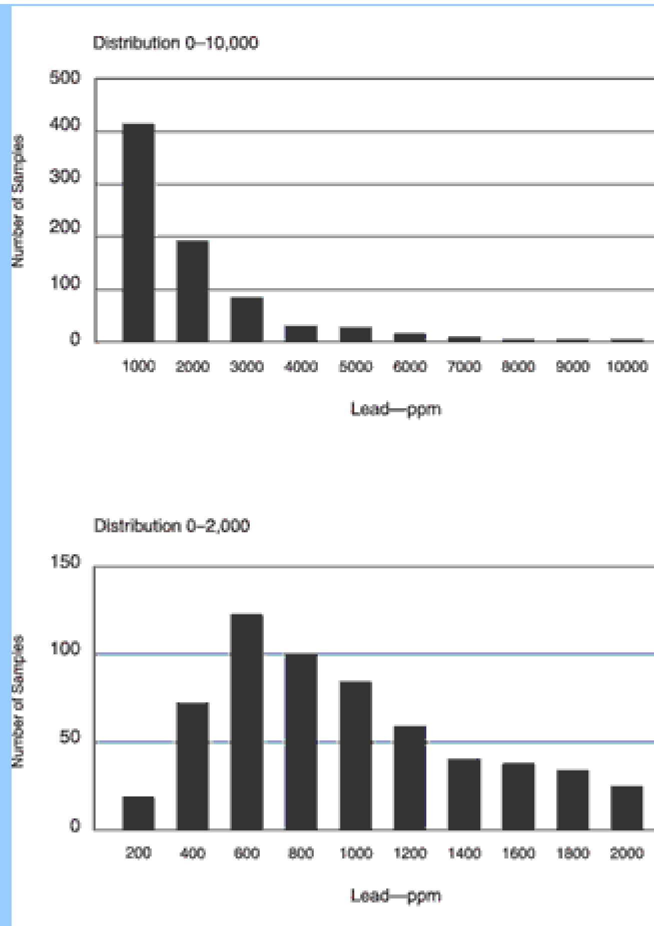
The EMPACT LSYP takes several quality control measures to back up XRF readings on every property. Accuracy and reproducibility are checked periodically using continuing calibrations (verification against a known standard) and replicate measurements, respectively. Inspectors also collect a small number of soil samples for confirmatory lab analysis. Since XRF is still a new technology, its results need to be judged against the gold standard of accepted practice, in this case inductively coupled plasma (ICP) or atomic absorption (AA) methods, both of which are conducted in a laboratory and take about 2 to 4 weeks.

Nevertheless, inspectors often have enough confidence in their XRF findings to give homeowners and landscapers a provisional color-coded map (PDF) of a property's lead levels well before the results of confirmatory lab tests

EMPACT LSYP 1998
Analytical Program Findings

In Phase I of the EMPACT Lead-Safe Yard Project, lead in surface soil concentrations measured in the Bowdoin Street neighborhood ranged from 103 to 21,000 ppm.

The mean value for these data was 1,632 ppm (n=781). Twenty-two percent of the measurements were above 2,000 ppm, and 87 percent were above 400 ppm.



Lead Concentration Distribution for Phase 1 Field Work

are available. Inspectors may prepare such a drawing before they even leave the site, using markers or colored pencils and a copy of the plot plan. This hand-drawn method is simple, immediately interpretable, and readily accessible to the homeowner. Alternatively, the XRF readings may be taken to an office and used to produce a computer-generated map (PDF). Either way, homeowners and landscapers can gain a general understanding of what areas of a yard need remediation and start making plans.

Once a lead-safe yard program has tested a sizable cross-section of properties in a city, it might be useful to record the results on a map to see if a geographical pattern emerges. If such a pattern does emerge, the information could be made available to the public, perhaps on a Web site, to promote awareness of the lead-in-soil problem and help homeowners and communities make more informed decisions.

As an example, maps showing the lead content of soil in various parts of New Orleans, Louisiana, are available online. Environmental toxicologist Howard Mielke of Xavier University in New Orleans analyzed 3,074 surface soil samples representing 283 census tracts. The data indicate that the most contaminated areas usually lie in the central part of the city, where traffic is heaviest.

6.2 Getting Started

Individual homeowners or groups planning a very limited lead-safe yard program will probably just want to hire a risk assessor certified for use of XRF for soil analysis. In any case, local authorities regulating lead abatement activities should be consulted.Those seeking to implement an extensive program will probably want to buy their own field-portable XRF to be used by trained/certified inspectors working with the program. The EMPACT LSYP uses an instrument manufactured by Niton Corporation[17], which also provides training. For information, call 1-800-875-1578 or visit www.niton.com. See Section 6.4.2 for information about XRF use licenses and certification.

An XRF similar to the one used in the EMPACT LSYP, a field portable Niton Model 702, costs about $26,500, making it the most substantial expense a program will face. Day-to-day maintenance of the XRF is generally not costly, though programs will face the additional expense (around $2,600) for replacement of the instrument's radioactive source at least once every two years, if not more frequently (see Section 6.5). Some savings are possible, however. The box below provides some suggestions; for example, it describes a less costly XRF instrument that was not available when the EMPACT LSYP purchased its instrument.

A lead-safe yard program may also save money if it can align itself with a university, which is much more likely if the work has a research component. In this case, the school might pick up some or all of the cost of the XRF, and interns paid by the school might conduct inspections under the supervision of a faculty member trained and certified to use the XRF. This type of approach is described in more detail in Appendix B, which presents less-resource-intensive approaches to implementing lead-safe yard programs.

How To Cut Costs

Recently, Niton has developed a field portable XRF that tests for lead alone, not the wide range of other metals detectable with a 700-series Niton. This instrument, the XL309, costs just $17,000, and a version exclusively for lead in soil is available for $15,000. The main reason the XL309 is so much less expensive is that it lacks a high-resolution silicon pin detector. But this feature is useful largely for measuring levels of elements such as arsenic, which require a great deal of precision. Lead levels, by contrast, are fairly broad measurements. A high-resolution silicon pin detector is not necessary.

6.3 Testing Step by Step

This section describes the procedures used by professional inspectors in the EMPACT LSYP for soil testing, quality control, and data management. In developing these procedures, the EMPACT LSYP relied on two primary sources: 1) Method 6200 from EPA publication SW-846 (entitled *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*), EPA's compendium of methods on evaluating hazardous waste; and 2) the Quality Assurance Project Plan (QAPP) that was developed for the EMPACT program. What follows is mainly a summary of the directives from these two sources, along with recommendations and insights from the program's inspectors themselves. Click here to learn more about SW-846 and obtain a copy online. The EMPACT LSYP's QAPP is provided in Appendix D.

6.3.1 Before Beginning

The inspectors should plan to allot about two hours for testing a typical residence. Homeowners need not be present, but they do have to have signed a permission form (see Chapter 5). Ideally, all the information about yard use gained from observations and homeowner interviews will have been incorporated into the plot plan prepared during outreach and education. This plot plan will be used as a guide for testing. See Section 5.3 for guidance on conducting homeowner interviews and developing a plot plan. Also, check out this sample interview form (PDF) and plot plan (PDF).

Favorable weather conditions are necessary for testing. Experience shows that XRF testing does not work well when the ground is frozen or when the air temperature falls below 40 degrees Fahrenheit. And while high temperatures usually pose no problem, direct sunlight can cause the instrument to overheat. Inspectors should take care to shade it on sunny days, even in relatively cool weather.

Soil moisture can not only interfere with readings but also damage the XRF, so soil that is saturated with water should not be tested. This condition is most likely to occur in early spring, when the ground absorbs water inefficiently because it hasn't yet thawed and dried out from the winter months. Inspection should be delayed in the event of rain as well; even after the rain has stopped, testing may still be inadvisable for several hours, because of standing water on the grass. The XRF can generally tolerate humidity, however.

If conditions are favorable, and all the necessary paperwork is in place, inspectors may prepare the property for testing. Debris such as


Inspectors take at least two readings along the property border on each side of the house.

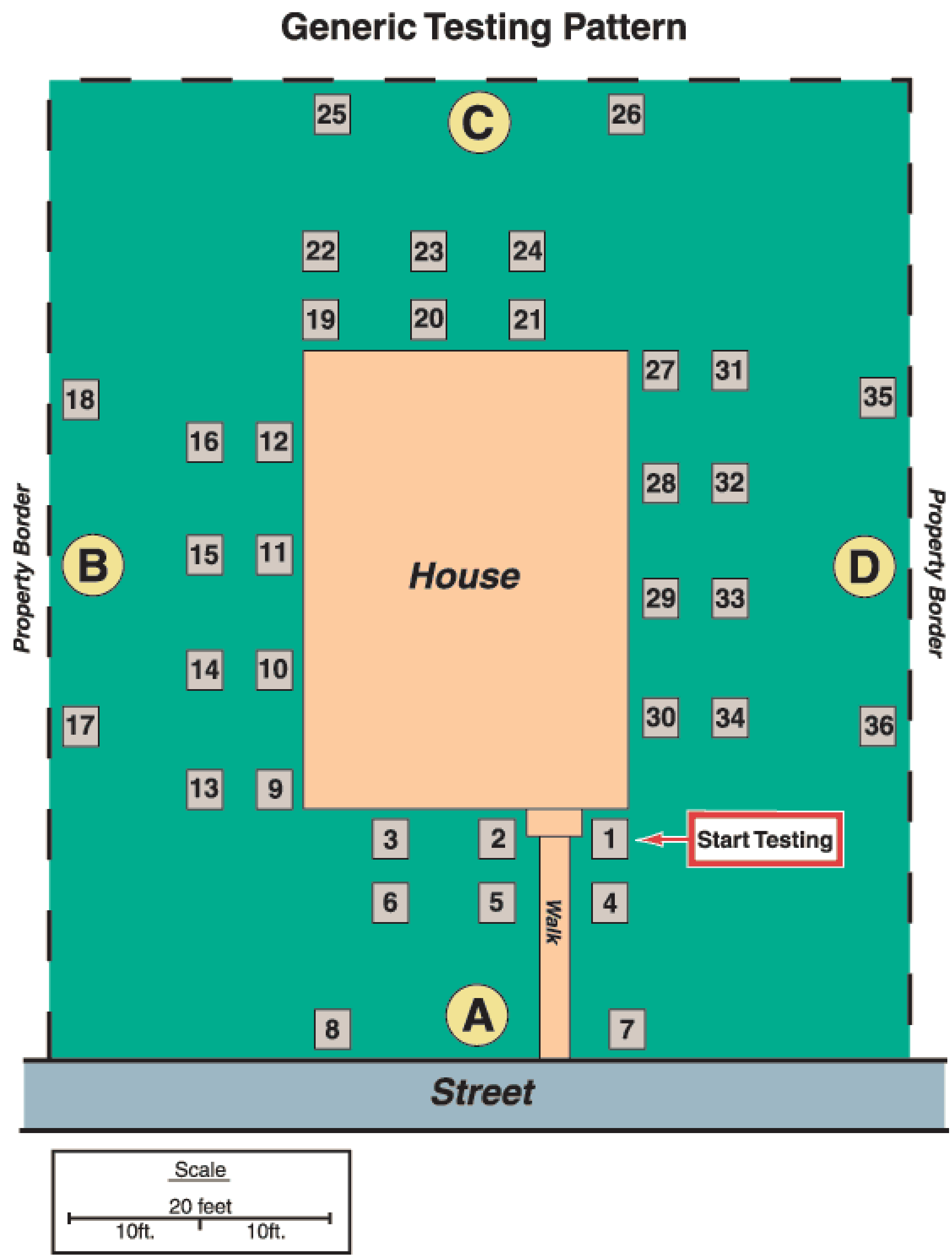
rocks, pebbles, leaves, and roots should be removed, and the ground should be made flat enough to allow uniform contact with the XRF. In some cases grass or plant material may need to be moved aside to expose the soil surface. As they do this, inspectors must remember that lead in soil is mostly a surface phenomenon, and that readings may not be accurate if the ground is disturbed too much.

6.3.2 Testing Strategy

Although each property is different and must be approached with its unique characteristics in mind, testing typically focuses on four main concerns: the drip line, play areas, areas of exposed soil, and areas that may be contaminated with lead from sources other than the house, such as structures on abutting properties. In the EMPACT LSYP, if play areas are found to have lead levels greater than 400 ppm, they are tested further to determine the extent of contamination. Other areas are subjected to extra testing if they are found to have levels greater than 2000 ppm.

A variety of formats for testing are possible, but data collection is generally more systematic and efficient if inspectors decide on one format and use it consistently. In the EMPACT LSYP, the sides of the house on a property are labeled A, B, C, and D (see "Generic Testing Pattern"). The A side is that which bears the house's address, and the B, C, and D sides follow in a clockwise fashion. Inspectors start at the corner where the A and D sides meet, then cover the whole A portion of the yard, and after that the whole B, C, and D portions, until finally they arrive at the A-D corner again.

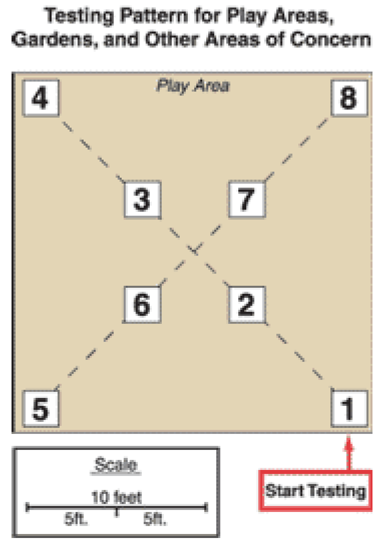
The pattern for testing a particular area on any of the sides of the house depends on the size and shape of that area. In long, narrow areas such as drip lines, initial XRF readings are generally taken at 10-foot intervals along an imaginary line that extends from one end of the area to the other. If an area is not long enough to yield at least three readings with this method, inspectors mentally divide the imaginary line into thirds and take a reading from each third.



Inspectors then take a second series of XRF readings along an imaginary line that is parallel to the first one but 2 to 5 feet away from it. If the area is in fact a drip line, this second imaginary line usually falls outside it, so lead levels are expected to drop off. If they don't, further testing is conducted to ascertain whether and where they do.

Before completing testing on any one side of the house, inspectors take at least two readings along the property border. These readings are generally evenly spaced. If either reading shows elevated lead levels, additional reading are taken along the border.

For other areas of concern, including play areas, an imaginary X is usually superimposed on the ground. Readings are taken at 5- to 10-foot intervals along each line of the X. If the area is too small to yield at least five readings with this



method, inspectors mentally divide the lines of the X into thirds and take a reading from each third.

When sufficient readings have been obtained from a given area, the lead levels are averaged to produce a mean value, and on the basis of this value, the area is assigned to a specific lead-level category, as explained in Section 6.1.

Note!

Borderline mean values for an area are judged to fall into the more toxic category rather than the less toxic one. For example, a mean value of 1,980 ppm would earn an area a "high" rating (2,000 to 5,000 ppm). The idea is to avoid the risk of undertreating a contaminated area. Measurements of lead levels are broad, and a difference of just 20 ppm is insignificant.

6.3.3 Quality Control

Niton XRFs are factory calibrated, so site-specific calibration is not necessary. Regular checks of the instrument's calibration are an essential aspect of quality control, however. Before inspectors from the EMPACT Lead-Safe Yard Project begin to test a property, they take readings on standard reference materials (SRMs) whose lead levels are known to be 400 ppm, 1,000 ppm, and 5,000 ppm, the anticipated range for lead in urban soil. They also take a reading on a blank—a soil sample whose lead level is less than 100 ppm, which is the detection limit for the XRF instrument they use. If any of these readings fails the quality control criteria (±30% for SRMs; < 50 ppm for field blank), possible problems are investigated and the check is re-run until the instrument passes. If it never passes, it is sent back to Niton to be recalibrated. These same calibration checks are conducted at the end of testing on a property, to ensure that the instrument's calibration has remained intact throughout.

In addition, 10 percent of the XRF readings are replicate measures. That is, a particular location is tested a second time, to see if the reading on it falls into the same range. If it doesn't, inspectors try to find out what the problem is and fix it, and calibration checks and further repeat readings are performed until the XRF results are clearly reliable.

The final quality control measure is to collect soil samples for confirmatory ICP or AA analysis. At evenly spaced intervals within a particular area, inspectors scoop up a subsample, which is about a tablespoon of the top half-inch of soil. These subsamples are emptied into a common ziplock bag to create a composite for the area. An XRF reading is then taken on the composite, after which it is ready to be sent to the lab.

Typically, a perimeter composite sample is created by taking twelve subsamples three from the drip line on each side of the house. Composite samples are also created for every other area designated as high use or high risk, such as gardens and play areas. As in XRF testing, an imaginary X is superimposed on the area. Subsamples a total of five, if possible are taken along each line of the X.

6.3.4 Data Management

The two main data management tools, the plot plan and the site worksheet, are versatile and easy to use. The plot plan can be converted into a color-coded map (PDF) of a property's lead levels to help homeowners and landscapers discuss plans for remediation. The plot plan can also be used to formulate a guide for testing, and during the inspection itself, test locations can be recorded (PDF) on the plot plan. Information on developing an initial plot plan can be found in Section 5.3.

The site worksheet offers a simple way to identify the locations marked on the plot plan more closely. It also allows inspectors to keep track of the lead levels found at each location. Finally, it provides convenient spaces to write down any relevant descriptive information: a short form at the top and a "comments" column on the right side. Here is a clean worksheet (PDF) that groups implementing a lead-safe yard program can reproduce. Here is an example of a site worksheet (PDF) that has been filled out.

The letters A, B, C, or D in the "sample I.D." column of the filled-out site worksheet tell which side of the house a particular XRF reading came from. The number immediately after each letter corresponds to the testing location noted on the plot plan. The last letter in the "sample I.D." column tells how many feet the testing location was from the foundation of the house.

The number in the "location" column of the worksheet tells how many feet the testing location was from the corner that would be on someone's right when facing the A, B, C, or D side of the house. Thus the right corner on the A side would be the A-D corner; on the B side it would be the A-B corner; on the C side it would be the B-C corner; and on the D side it would be the C-D corner.

The "ppm-lead" column tells the lead levels measured at each testing location. The comment "repeat" in the "comments" column indicates where a second reading was taken on a test location as a quality control measure.

6.4 Health and Safety Precautions

Testing for lead in soil entails two different kinds of risk. The first comes from the soil itself, which frequently does contain high levels of lead. The second comes from the XRF, which employs radioactive material. Inspectors must guard against both these kinds of risks.

6.4.1 Guarding Against Lead Hazards

The important point to keep in mind is that lead can enter the body through ingestion, which occurs as a result of routine hand-to-mouth activities such as eating, drinking, and smoking. Therefore, inspectors should wear gloves and refrain from hand-to-mouth activities on the job. When their work is done, they should wash their hands and faces and clean off their work shoes after leaving the site. On a windy day, inspectors may need to use face masks to avoid breathing airborne lead-contaminated dust when working at dry, dusty sites.

6.4.2 Guarding Against Radiation Hazards[18]

Portable XRF instruments used for lead-based paint inspections contain radioactive isotopes that emit x-rays and gamma radiation. Proper training and handling of these instruments is needed to protect the instrument operator and any other persons in the immediate vicinity during XRF usage. The

Safe Operating Distance

XRF instruments used in accordance with manufacturer's instructions will not cause significant exposure to ionizing radiation. But the instrument's shutter should never be pointed at anyone, even if the shutter is closed. Also, the inspector's hand should not be placed on the end plate during a measurement.

The safe operating distance between an XRF instrument and a person during inspections depends on the radiation source type, radiation intensity, quantity of radioactive material, and the density of the materials being surveyed. As the radiation source quantity and intensity increases, the required safe distance also increases. Placing materials, XRF instrument should be in the operator's possession at all times. The operator should never defeat or override any safety mechanisms of XRF equipment.

For a discussion of required (and recommended) licenses, certifications, and permits for portable XRF instruments, see the box below.

such as a wall, in the direct line of fire reduces the required safe distance. According to NRC rules, a radiation dose to an individual in any unrestricted area must not exceed 2 millirems per hour. One of the most intense sources currently used in XRF instruments is a 40-millicurie 57Co (cobalt-57) radiation source. Other radiation sources in current use for XRF testing of lead-based paint generally produce lower levels of radiation. Generally, an XRF operator conducting inspections according to manufacturer's instructions would be exposed to radiation well below the regulatory level. Typically, XRF instruments with lower gamma radiation intensities can use a shorter safe distance provided that the potential exposure to an individual will not exceed the regulatory limit.

No people should be near the other side of a wall, floor, ceiling or other surface being tested. The inspector should verify that this is indeed the case prior to initiating XRF testing activities, and check on it during testing.

Finally, the effectiveness of the instrument's radiation shielding should be assessed every six months through a leak test. The XRF manufacturer or owner's manual can be consulted to obtain vendors of leak test kits.

If these practices are observed, the risk of excessive exposure to ionizing radiation is extremely low and will not endanger any inspectors or occupants present in the dwelling.

6.5 Maintaining Equipment

Day-to-day maintenance of the XRF is generally not difficult. The instrument's display window should be cleaned with cotton swabs. The case should be cleaned with a soft cloth. Batteries should be recharged as directed in the owner's manual. Beyond that, inspectors usually just need to take care not to drop the instrument, not to get it wet, and not to neglect the calibration checks described under "Quality Control" in Section 6.3.3.

Over the long term, however, XRF owners face the very significant maintenance concern of replacing the instrument's radioactive source, a cadmium-109 isotope. Like all radioactive isotopes, cadmium-109 decays at a fixed rate. Its half-life, or the amount of time needed for the activity of the radioactive source to decrease by one half, is about fifteen months. After that, the XRF can still be used, but the instrument becomes progressively less efficient. Readings that once took 30 to 60 seconds take progressively longer. Eventually the wait becomes burdensome, and a new cadmium-109 isotope must be purchased from Niton, at a cost of about $2,600.

Niton recommends replacing the isotope source every fifteen months, as soon as its half-life is spent, but most inspectors find that they can postpone the job for another three to nine months. After all, readings are no less accurate, just somewhat less prompt. When inspectors do decide to replace the cadmium-109 isotope, they simply send the XRF to Niton. The corporation not only puts in a new isotope but disposes of the old one, upgrades the instrument's software, and provides whatever preventive maintenance is needed.

XRF Use Licenses and Certification

In addition to training and any required accreditation, a person using a portable XRF instrument for inspection must have valid licenses or permits from the appropriate federal, state, and local regulatory bodies to operate XRF instruments. (These are needed because XRF instruments contain radioactive materials.) All portable XRF instrument operators should be trained by the instrument's manufacturer (or equivalent). XRF operators should provide you with information about their training, licensing, permitting, and certification before an inspection begins. Depending on the state, operators may be required to hold three forms of proof of competency: a manufacturer's training certificate (or equivalent), a radiation safety license, and a state lead-based paint inspection certificate or license. To help ensure competency and safety, HUD and EPA recommend hiring only inspectors who hold all three.

The regulatory body responsible for oversight of the radioactive materials contained in portable XRF instruments depends on the type of material being handled. Some radioactive materials are federally regulated by the U.S. Nuclear Regulatory Commission (NRC); others are regulated at the state level. States are generally categorized as "agreement" and "non-agreement" states. An agreement State has an agreement with NRC to regulate radioactive materials that are generally used for medical or industrial applications. (Most radioactive materials found in XRF instruments are regulated by agreement states). For non-agreement states, NRC retains this regulatory responsibility directly. At a minimum, however, most state agencies require prior notification that a specific XRF instrument is to be used within the state. Fees and other details regarding the use of portable XRF instruments vary from state to state. Contractors who provide inspection services must hold current licenses or permits for handling XRF instruments, and must meet any applicable state or local laws or notification requirements.

Requirements for radiation dosimetry by the XRF instrument operator (wearing dosimeter badges to monitor exposure to radiation) are generally specified by state regulations, and vary from state to state. In some cases, for some isotopes, no radiation dosimetry is required. However, it should be conducted even when not required, for the following five reasons:

- The cost of dosimetry is low.
- XRF instrument operators have a right to know the level of radiation to which they are exposed during the performance of the job. In virtually all cases, the exposure will be far below applicable exposure limits.
- Long-term collection of radiation exposure information can aid both the operator (employee) and the employer. The employee benefits by knowing when to avoid a hazardous situation; the employer benefits by having an exposure record that can be used in deciding possible health claims.
- The public benefits by having exposure records available to them.
- The need for equipment repair can be identified more quickly.

6.6 Alternative Approaches

A number of organizations that conduct lead-safe yard activities rely on laboratory analysis rather than field-portable XRF for testing of yard soil. For example, Lead-Safe Cambridge, described in Appendix A of this handbook, sends soil samples to a state laboratory for analysis.

A homeowner in an area where no lead-safe yard program exists may also wish to determine whether there is a lead problem in his or her yard. In this case, the homeowner can collect soil samples in ziplock bags and send them to a laboratory for analysis. To determine sampling locations, a homeowner can follow the guidance in Section 6.3, or refer to *HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing, June 1995 (Title X, Section 1017)* Appendix 13.3, available online.

Homeowners can contact their state or local childhood lead poisoning prevention program for more information about obtaining soil-lead testing. The following Web sites list state and local lead poisoning prevention contacts:

The Lead Program of the National Safety Council’s Environmental Health Center

The National Conference of State Legislatures’ Directory of State Lead Poisoning Prevention Contacts

6.7 For More Information

6.7.1 XRF Accuracy

Verification Reports and Statements on the accuracy of several XRF technologies are available on the Web sites of the EPA Environmental Technology Verification Program and EPA New England

Clark, Scott, William Menrath, Mei Chen, Sandy Roda, and Paul Succop. *Use of a Field Portable X-Ray Fluorescence Analyzer to Determine the Concentration of Lead and Other Metals in Soil and Dust Samples.* Call the University of Cincinnati Department of Environmental Health at 1-513-558-1749.

Shefsky, Stephen. *Comparing Field Portable X-Ray Fluorescence (XRF) to Laboratory Analysis of Heavy Metals in Soil.* Call Niton Corp. at 1-800-875-1578.

6.7.2 Test Methods

Methods 6200, 6010B, and 7420 from EPA's SW-846 (entitled Test Methods for Evaluating Solid Waste, Physical/Chemical Methods). For ordering information, or obtain a copy online, click here.

Sackett, Donald and Kenneth Martin. *EPA Method 6200 and Field Portable X-Ray Fluorescence Analysis for Metals in Soil.* Call Niton Corp. at 1-800-875-1578.

6.7.3 Quality Control

Shefsky, Stephen. *Sample Handling Strategies for Accurate Lead-in-Soil Measurements in the Field and Laboratory.* Call Niton Corp. at 1-800-875-1578.

Example Documents

All of these documents are PDFs; you will need Adobe's free Acrobat Reader to view them. Click here to download Acrobat Reader.

Site Worksheet (blank)
Site Worksheet (filled out)
Plot Plan (Marked To Show Sampling Locations)
Plot Plan (Color-Coded To Show Lead Levels)
Computer-Generated Map Showing Lead Levels

NEXT CHAPTER

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[17]Mention of trade names or commercial products in this publication does not constitute endorsement or recommendation for use.

[18]Adapted from *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing,* Chapter 7: Lead Based Paint Inspections, 1997 Revision. Available online.

Chapter 7: Yard Treatments

7.1 | 7.2 | 7.3 | 7.4 | 7.5 | 7.6 | 7.7 | 7.8 | 7.9

Once you have sampled and analyzed a property's soil and determined that a lead hazard exists, the process of designing and implementing landscape treatments can begin. This chapter provides guidance on matching treatments to the hazards you've identified (Section 7.1), and describes specific low-cost treatment measures used by the EMPACT Lead-Safe Yard Project (Section 7.2). The chapter also covers the many "nuts and bolts" issues involved in the treatment process, including:

- Developing a budget for each yard treatment (Section 7.3).
- Meeting with the homeowner to explain the sampling results and areas of concern and to develop/review the treatment plan (Section 7.4).
- Contracting with a landscaper to complete all design and landscaping work on the property (Section 7.5).
- Establishing guidelines to ensure landscaper health and safety (Section 7.6).
- Securing the homeowner's approval and signoff on completed work (Section 7.7).
- Reviewing and approving landscaping work prior to final contractor payment (also in Section 7.7).

If you are a homeowner interested in learning about low-cost landscaping measures for reducing children's exposure to lead in soil, you can focus on Sections 7.1, 7.2, and 7.6. **(Section 7.6, Health and Safety for Landscapers, is essential reading for anyone who intends to do landscaping work in a lead-contaminated yard.)** You should also read Chapter 8, which covers the development of a maintenance plan for the finished yard—a critical part of the treatment process.

Sections 7.3, 7.4, 7.5, and 7.7 present detailed information for those responsible for implementing a lead-safe yard program.

This chapter contains links to documents in PDF format. To view them, you will need Adobe's Acrobat Reader. Click here to download Acrobat Reader.

7.1 Matching Treatments to Hazards

There are many ways of protecting children and other people from the hazards of lead-contaminated yard soil. Possible methods include removing and disposing of the contaminated soil, covering it with a permanent barrier such as asphalt, covering it with a non-permanent barrier such as mulch or grass, or changing the way people use their yard to reduce exposures.

To select the best method or methods for a particular property, you need to consider a number of factors, including the level of lead contamination, the frequency and extent of potential exposures, the homeowner's esthetic preferences, the cost of the protective measure, the amount of maintenance it will require, and its likely effectiveness. Protective measures can vary greatly both in the level of protection they provide and in their associated costs. Soil removal, for example, can completely eliminate a soil hazard, whereas use of a non-permanent barrier such as grass cannot. However, soil removal can be prohibitively expensive for many people due to the high cost of soil excavation, transportation, and disposal.

The EMPACT LSYP was created to develop low-cost landscape measures that protect children against exposure to high lead levels in yard soil. The landscape measures described in this handbook were selected for four main reasons:

- They are relatively inexpensive.
- They can be implemented by the homeowner or a program partner with a minimum of tools and experience.
- They are attractive and enhance the value of the yard.
- They are effective in reducing lead concentrations at the yard surface, and they therefore effectively reduce the potential for children's exposures.

All of the measures presented here could be characterized as interim controls. None provide the sort of permanent protection you could achieve through soil abatement (that is, by removing or paving contaminated soil), nor are they meant as a substitute for abatement. In fact, in circumstances where soil-lead levels are greatly elevated (i.e., above 2,000 ppm) and the possibility of children's exposure is high (i.e., in residential settings), federal regulations recommend or require abatement of the soil hazard (see Section 3.4.3).

The EMPACT LSYP encourages homeowners to follow all federal and state requirements and guidance for soil abatement that apply to them. But the project also recognizes that there will be many situations where homeowners and community organizations cannot afford the cost of abatement measures. In such situations, these landscape measures can provide some degree of long-term, effective protection so long as they are properly applied and well maintained. The key is selecting the right measures based on the existing lead hazards.

7.1.1 Combining Treatment Measures

So how do you choose among the treatment measures presented in this handbook? Your goal in developing a treatment plan is to achieve a delicate balance between the safe use of the yard and the existing lead levels. To do this, you should combine two main approaches:

- **Altering the surface cover.** Select landscape measures that provide a sufficient barrier, based on the soil-lead levels and the types of yard use.
- **Altering the yard use patterns.** Encourage safe yard uses, and discourage certain activities (e.g., gardening, children's play) in the areas of highest contamination. These activities may need to be relocated to a safer part of the yard.

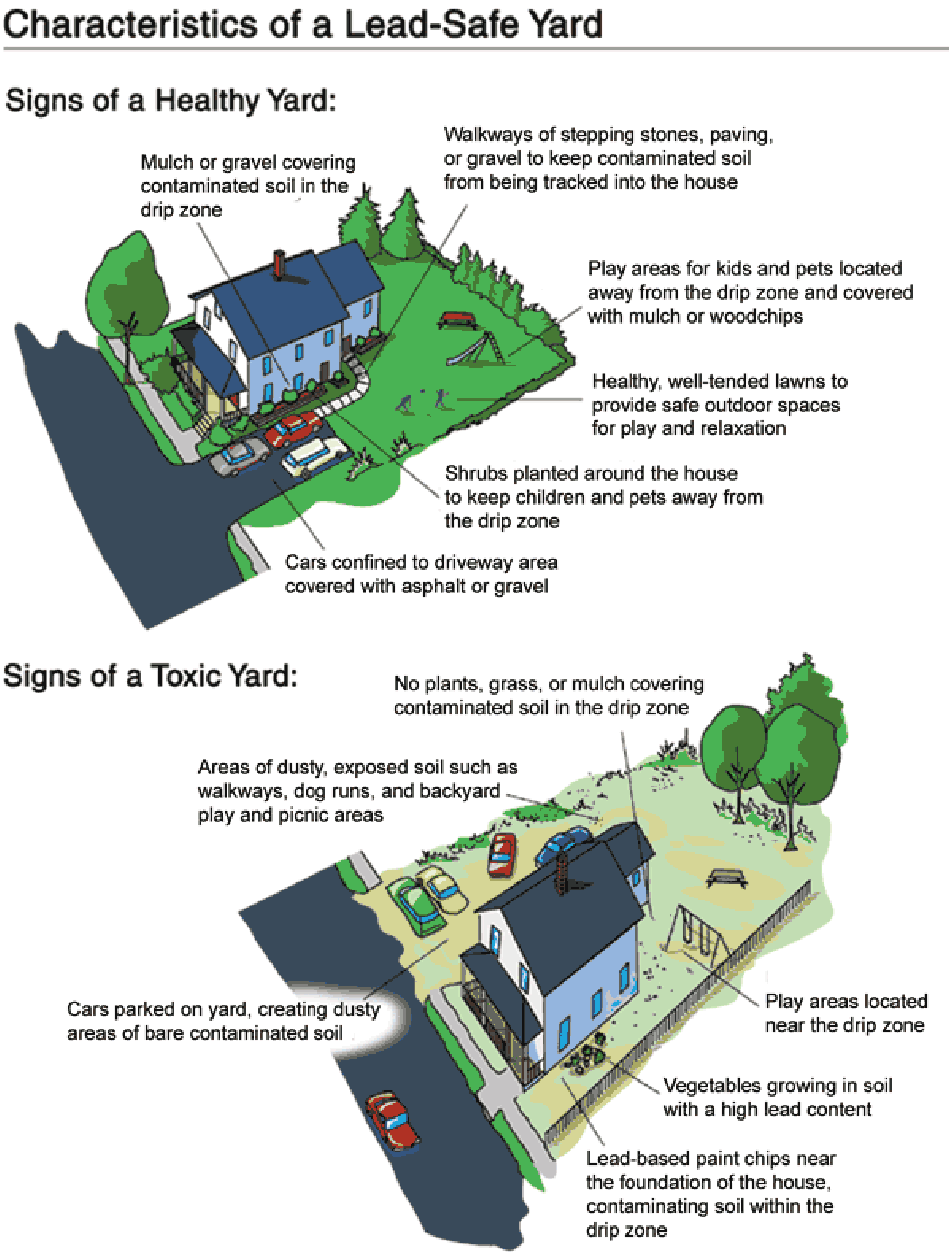
In many cases, you will need to design different treatments for each of the yard areas evaluated during the sampling process: the house dripline, areas of bare soil, areas of unique use such as children's play areas and picnic and gardening areas, and other areas. The illustration below, Characteristics of a Lead-Safe Yard, shows how a number of treatment measures can be combined to create a yard that is safe and attractive and meets the needs of the homeowner and/or residents. In other cases, you may only have to address a single yard area, such as the dripline (where soil-lead levels are usually found to be highest).

The table below presents a list of treatment measures used by the EMPACT LSYP at specific soil-lead levels. Each measure is described in greater detail in Section 7.2. However, before incorporating these measures into your own program, you should refer to Section 3.4.3 for a discussion of how the EMPACT treatment approach compares with the approach recommended under the pending TSCA Section 403 rule (information about the rule can be found online). Also keep in mind that decisions on specific landscape measures (e.g., choosing between mulch or grass, or between types of grass) must be made on a yard-by-yard basis to account for variables such as regional climate, yard topography, the amount of available sunlight, and the homeowner's esthetic preferences. These factors will often play a major role in shaping the final treatment plan for a property.

Empact LSYP Treatment Measures

Soil-Lead Level (parts per million)*	EMPACT LSYP Treatment Measures
> 5,000 (very high)	If soil removal or permanent barriers are not possible: • Install semi-permanent barrier, such as a wood-framed dripbox filled with gravel or mulch. • Relocate gardens—unsafe for all types of gardening.
2,000-5,000 (high)	• Relocate gardens—unsafe for all types of gardening. • Relocate children's play area, pet area, and picnic area, if possible. If not, install wood platform or wood-framed raised play and picnic area filled with woodchips. • Install path of walking stones for high-traffic areas. • Seed and fertilize grassy areas, or cover with mulch or woodchips if not suitable for grass.

400-2,000 (moderately high)	• Install raised-bed garden and supplement with clean topsoil. • Install wood-framed raised play and picnic area filled with woodchips. • Install path of walking stones for high-traffic areas. • Seed and fertilize grassy areas, or cover with mulch or woodchips if not suitable for grass.
< 400 (urban background)	• No treatment necessary.



7.2 Treatment Options and Detailed Specifications

This section presents the specific landscape treatments used by the EMPACT LSYP. The treatment measures described here represent a suite of tools that the landscaper can use to address elevated soil-lead levels in specific yard areas: drip zones, grassed areas, parking areas, walkways, recreation and children's play areas, gardens, pet areas, and porches. As mentioned in Chapter 6, these are the high-risk and high-use yard areas where children are most likely to experience dangerous exposures to soil lead. For most of these yard areas, the EMPACT LSYP has developed two or more treatment options, giving the landscape designer some flexibility in selecting treatments that match both the homeowner's esthetic preferences and other variables such as yard topography and the amount of available sunlight.

It is important to keep in mind that not all treatments will be appropriate and/or effective at all locations. The treatments described here were selected by the EMPACT LSYP because they address the conditions found at a majority of sites in the project's target neighborhoods in Boston: high to very high soil-lead levels; inner-city homes that are typically wooden and covered with lead paint; high rates of yard use by children and families; and many areas of bare and partially bare soil. These landscaping measures also work well given Boston's variable climate, with its cold, wet winters and relatively hot, humid summers.

Phytoextraction: An Experimental Approach

All of the treatment measures used by the EMPACT LSYP focus on employing grass, plants, and other materials as a barrier to reduce children's exposure to lead-contaminated soil. None of these treatments, however, remove the lead from the soil. Today, researchers are experimenting with another approach for using plants to actually extract lead and other contaminants from soil: phytoextraction.

As a technology, phytoextraction is still in its infancy. Researchers are still struggling with a number of questions, such as which plants best absorb certain contaminants, and how to make the technology affordable. The EMPACT LSYP does not use phytoextraction at this point, but may consider it in the future, as more information becomes available about its applicability in residential settings. See Appendix C for a detailed discussion about this promising technology.

As you develop your own lead-safe yard program, you will no doubt want to pick and choose among the treatments presented here, rejecting some, revising others to fit your specific needs, and devising some entirely new treatments. The work you have done to get to know your target community (see Section 4.4) will help you in this process. In addition, you may want to consult local garden centers, nurseries, landscapers, and arborists for help selecting plants and grasses that will thrive in your area. If you live in an arid or semi-arid climate, for example, you may find yourself using plants that are very different from those used in the Northeast.

Once you have assembled a suite of treatment options that will work in your program area, you should develop detailed specifications that define exactly how the landscaping work should be done and what materials should be used. These specifications should be provided to the landscaper and included with the landscaping contract (see Section 7.5.1) if you intend to engage a contractor. A set of sample specifications, developed by Lead Safe Boston and used by the EMPACT LSYP, is provided in the table below.

7.2.1 Drip Zones

The drip zone is the narrow 3-foot strip around the foundation of the house. There, soil-lead levels are usually highest, because lead-based paint on the outside of older homes weathers over time and falls into the top layer of soil adjacent to the foundation, contaminating it. Play areas, picnic areas, and vegetable gardens must be located away from the drip zone. In addition, covering the zone with a permanent or semi-permanent barrier provides long-term protection from the contaminated soil.


A perimeter mulch bed covering the drip zone.

The EMPACT LSYP uses raised perimeter boxes that not only cover the contaminated soil in the drip zone, but also prevent erosion and offsite transport of the soil and allow for continued weathering of the exterior. Built from 2" by 6" ACQ (Alkaline Copper Quaternary) pressure-treated lumber, the boxes are lined with a filter-fabric weed barrier and then filled with either gravel or mulch and plantings, depending on the homeowner's preference. Plantings, such as evergreen shrubs, azaleas, boxwoods, holly, or thorny bushes, help keep children and pets away from the drip zone. Plantings used by the EMPACT LSYP are listed in the sample specifications. Consult a local garden center, nursery, or arborist to select plantings appropriate for your area.

Before—bare soil in drip zone (1,660 ppm). After—mulched planting bed covering soil

Lessons Learned: Using ACQ Pressure-Treated Lumber for Added Safety

Wood platform built with ACQ lumber.

Over the past 30 years, pressure-treated lumber has become standard for outdoor construction because it deters rot, decay, and termite destruction. The EMPACT Lead-Safe Yard Project used pressure-treated wood for these reasons during its first two years of yard treatments. Recently, however, there has been a growing awareness of the dangers posed by chemicals used in the traditional wood-treatment process. There is some evidence that these chemicals, which include the EPA-listed hazardous compounds arsenic and chromium, can leach out of pressure-treated wood and into the environment.

During its third phase of yard treatments, the EMPACT LSYP began using a relatively new type of pressure-treated lumber: ACQ Preserve. ACQ-treated lumber contains no EPA-listed hazardous compounds and is guaranteed to protect against rot, decay, and termites. In other words, it offers all of the values of traditional pressure-treated lumber with fewer hazards. This is especially important when you use wood in and around gardens and children's play areas, as the EMPACT LSYP does. Costs of ACQ-treated wood vary, though the EMPACT LSYP has found these costs comparable to the costs of traditional pressure-treated wood. Click here for an information sheet on ACQ-treated wood.

7.2.2 Grassed Areas

Maintaining a healthy lawn is one of the best ways to reduce exposure to lead-contaminated soils. A healthy lawn acts as a natural barrier between people and contaminated soils, and provides a safe outdoor space for play and relaxation. Lawns require routine maintenance with water and fertilizer, and should be protected from foot traffic for the first 3 to 4 weeks after seeding. Consult a local garden center or lawn care professional to select grasses that will grow in the soil and climate conditions found in your region. In areas of heavy foot traffic or low light where grass won't grow well, install a stone path or raised mulch bed to cover all bare soil.

- **Existing lawn improvement.** Improvement of an existing

Two months post treatment. Lawn growth over previously bare, contaminated soil (1,770 ppm).

lawn can be accomplished quite inexpensively. Rake bare areas to loosen the soil, apply seed mix at the rate specified by the manufacturer, then apply 1/4" of top soil over new seed. Water thoroughly.

- **New lawn installation (at existing grade).** Where little or no grass exists on a lawn, the entire lawn area should be rototilled and reseeded (apply water to contain dust during rototilling). Spread 1/4" of loam (soil composed of sand, clay, silt, and other organic matter) on top of the seed, then water thoroughly.
- **New lawn installation (raised bed).** For sloped yards, the EMPACT LSYP sometimes uses raised grass beds to create a terraced effect and limit runoff and erosion. A raised grass bed can also be installed in areas where roots or rocky soil prevent grass from growing. In a perimeter box made of 2" by 6" ACQ pressure-treated lumber, install 6" of loam over filter fabric weed barrier. Apply seed mix, then spread 1/4" of loam on top of seed and water thoroughly.
- **Raised mulch bed (with or without plantings).** Raised mulch beds can be used to cover areas of bare soil where grass won't grow well. The beds can serve as children's play areas, or can be filled with various plantings to form an attractive garden area. Install a perimeter box made of 2" by 6" ACQ pressure-treated lumber to completely cover bare soil area. Install 4" of loam and 2" of pine bark mulch over filter fabric weed barrier. Select plantings that are appropriate for the area (e.g., shade, partial shade, full sun; arid or semi-arid soil). Provide recessed egress stepping-stones from the bed to an existing walkway.

7.2.3 Parking Areas

Cars parked on yards destroy grassed areas, turning them into dusty areas of bare contaminated soil. Cars should be confined to designated parking areas covered with gravel or asphalt. Heavy landscape timbers can be sunk at the perimeter of the parking area to define the edge and prevent stones from spreading into grass areas. All lots, whether gravel or asphalt, should have at least a 2-percent pitch across the surface to ensure that water will not puddle. Detailed specifications for creating a gravel or asphalt parking area are included in the table below.

7.2.4 Walkways

Worn dirt paths create dust. By installing stepping stones in areas where people regularly walk, you keep contaminated soil from being tracked into the house. Alternatives include concrete walks, cement stepping stones, gravel over filter fabric, recycled concrete, and brick paths.

7.2.5 Recreation and Children's Play Areas

If possible, swing sets, sand boxes, and other children's play areas should be relocated away from the drip zone and other

A stone driveway.

Install stepping stones to prevent contaminated soil from being tracked into the house.

areas of highly contaminated soil. The same is true for picnic, barbecue, and other family recreation areas that receive heavy use. If relocation is not possible, the EMPACT LSYP uses one of two options:

- **Wood Platform.** A wood deck, made from ACQ pressure-treated 2" by 6" stock, can serve as a site for picnics, cook-outs, and children's play, and provides long-term protection from contaminated soil. Decking should be installed with a 1/4" pitch to drain rainwater off the surface.
- **Raised bed filled with mulch or woodchips.** Raised beds can be used to cover areas of bare and/or highly contaminated soil. The beds provide an effective barrier and a safe, attractive place for children's play and family gatherings. Install a perimeter box made of 2" by 6" ACQ pressure-treated lumber, then install 4" of loam and 2" of pine bark mulch or woodchips over filter fabric weed barrier.

7.2.6 Gardens

Homeowners and residents should take precautions when gardening in or around lead-contaminated soil. Though plants generally do not accumulate lead, it is possible for a plant to absorb some lead in settings where soil-lead levels are very high. In addition, lead-contaminated dust can settle on the surface of garden plants.

Basic precautions include washing all vegetables with a vinegar-water solution, locating gardens away from roads and highly contaminated yard areas, and planting crops that are less likely to absorb or accumulate lead. In general, this means planting fruiting crops (e.g., corn, beans, squash, peppers, cucumbers, tomatoes, strawberries, apples) and avoiding root crops and leafy vegetables (e.g., carrots, radishes, lettuce, collard greens, spinach) since they are more likely to absorb lead from soils or become coated with lead-contaminated dust. Two excellent resources on lead in gardens are:

> *Lead in the Home Garden and Urban Soil Environment*,
> by Carl J. Rosen and Robert C. Munter
>
> *Lead Contamination in the Garden*,
> a fact sheet by Terry Logan

The EMPACT LSYP recommends relocating gardens away from the drip zone and other areas of highly contaminated soil. The EMPACT LSYP treatment approach recommends using raised beds in areas of moderate contamination (400 to 2,000 ppm). (Please refer to Section 3.4.3 for a discussion of how the EMPACT treatment approach compares with the approach recommended under the pending TSCA Section 403 rule.) Beds should be framed with 2" by 8" ACQ pressure-treated wood, lined with a filter-fabric weed barrier, then filled with 6" of loam that has been tested for lead levels (levels over 400 ppm are unacceptable). Gardening is considered safe in yard areas where lead levels are below 400 ppm.

7.2.7 Porches

The soil found underneath porches is often contaminated with lead from paint chips and with other chemicals that leach from pressure-treated wood used in outdoor construction. Because it receives little sunlight, this soil is also naturally bare. The EMPACT LSYP has developed two strategies to discourage children from playing in contaminated soil beneath porches:

- **Lattice and Trim Barricade.** All exposed soil under porches is to be barricaded by ACQ wood framing, lattice, and pine trim. Prep, prime, and paint pine trim or apply two coats of wood sealant. Install a framed access door of like material. If loose soil is likely to be blown out from under porches, a covering of gravel or pea stone over bare soil would be appropriate.
- **Raised bed filled with mulch or gravel.** Install a wood box made from 2" by 6" ACQ pressure-treated lumber along footprint of porch. Line the box with filter-fabric weed barrier, then fill with either 2" of loam and 3" of pine bark mulch or 3" of loam and 2" of crushed stone.

Before—bare soil under porch deck.   After—area barricaded with lattice and trim

7.2.8 Pet Areas

By tracking lead-contaminated soil and dust indoors, dogs and other pets can be a major source of lead exposure for humans. Pets that play regularly in certain parts of the yard can also create dusty areas of bare contaminated soil. If possible, pet areas should be located away from areas of highly contaminated soil. If not, install a wood box made from 2" by 6" ACQ pressure-treated lumber to completely cover the bare soil area. Line the box with a filter-fabric weed barrier, then fill it with 4" of loam and 2" of pine bark mulch or woodchips.

7.3 Developing a Budget for Each Yard Treatment

Once you have selected a suite of treatment measures for your program, you may want to develop a standard budget that can be used to guide each yard treatment. This budget will represent the maximum amount that the landscaper is authorized to expend in designing and implementing a treatment plan for each home.

Sources of Free Materials

Parks

Three main factors will drive the budget development process: the amount of funding available to your program, the number of yards you hope to treat, and the actual costs of materials and labor needed to create a lead-safe yard. Some yards will obviously cost more than others to treat. Your goal is to establish a reasonable budget for an average yard, with the possibility of authorized cost overruns at certain yards where treatments turn out to be unusually expensive.

departments

Recycling centers

Tree services

Corporate sponsors

Local nurseries

A sample budget developed by the EMPACT Lead-Safe Yard Project is shown in the table below. The budget was developed in two steps. First, the project team calculated an allowance for each individual treatment measure by estimating the total cost of labor and materials. There are a number of reference books that can help with this process. The RSMeans Company, for example, offers several such books, including *Means Site Work & Landscape Cost Data 2000* (ISBN 0-87629-547-2) and *Landscape Estimating, 3rd Edition* by Sylvia H. Chattin (ISBN 0-87629-534-0). These books can be found in some libraries and bookstores or ordered online. Keep in mind that labor and material costs vary by region. You may want to consult a local landscaper as you develop allowances for each measure.

Second, the project team identified ways in which the individual measures might be cost-effectively combined to create a lead-safe yard. The goal was to make the yard lead safe by addressing as many areas as possible within a set budget (in this case, $3,000), while giving homeowners some freedom to choose the types of landscape measures they prefer. Note that the budget includes a standardized construction management allowance of $500, which allows the landscaper to cover costs such as landscape design, permits and fees, a workmanship and materials warranty, insurance, construction oversight, and the development of a maintenance manual for the completed yard.

Remember that the standard budget you develop represents the maximum amount that the landscaper is authorized to expend for each yard. Some yard treatments will cost less than the maximum. For this reason, you should consider developing a standard cost estimate sheet that the landscape coordinator can complete for each yard. Click here for a sample cost estimate sheet (PDF).

Lessons Learned: Estimating Treatment Costs

The experience of the EMPACT Lead-Safe Yard Project illustrates the importance of accurately estimating the per-yard costs of materials and labor. At the inception of the project, the project team set a target of treating 70 yards over the first two years, with a goal of expending about $750 per yard in landscape labor and materials that would be offered free to the participating homeowners. However, the project quickly found that treatment costs were running much higher than expected, partly because the project had chosen to employ a landscape team of city youths who were learning on the job (see also Section 4.2, “Selecting Program Partners”). The average cost per yard was roughly $2,100, with $300 going toward materials and $1,800 toward labor. Project management and indirect costs amounted to another $900 per yard. Because of these unexpected costs, the project was forced to scale back its objectives, though it still managed to treat 42 yards over the two-year period.

The EMPACT LSYP is currently investigating alternative models for organizing a lead-safe yard program that could reduce current average costs, in particular costs for labor, management, and overhead. For example, the EMPACT LSYP is investigating a model based on the principles developed by Habitat for Humanity, in which the work involved in achieving a lead-safe yard is carried out with the help of the homeowner by using volunteer labor and donated materials. See Appendix B for more information on this and other proposed models.

7.4 Homeowner Design Session

The EMPACT LSYP has found that it is critical to include the homeowner in designing landscape treatments for his or her yard. Why?

First, the homeowner is the person who can best verify that the selected treatments provide enough actual protection from the lead-contaminated soil, based on the way the yard is used. Second, the homeowner is there to ensure that the selected landscape treatments meet his or her approval in terms of their esthetic value. A homeowner who is unhappy with the appearance or layout of his or her yard is unlikely to commit the money and effort needed to maintain the landscape treatments year after year.

Chapter 5 of this handbook described the necessity of creating a permission form to document the homeowner's participation in your lead-safe yard program. That permission form should also specify the homeowner's role in choosing treatment options, should soil-lead levels on his or her property turn out to be elevated. The homeowner design session is where these choices are made.

The EMPACT LSYP has tried using both the outreach worker and the landscape coordinator for the design session. The landscape coordinator is the better option. However, the outreach worker should facilitate a smooth transition for the homeowner from the outreach/sampling phase to the design phase. For example, the outreach worker should convey names, numbers, and any linguistic barriers to the landscape coordinator soon after the soil sampling is complete. The outreach worker may also want to attend the initial meeting between the landscape coordinator and homeowner to maintain a sense of familiarity, trust, and continuity for the homeowner. During the design session, the landscape coordinator will do three things:

1. **Communicate with the homeowner about the testing results.** Using the color-coded map developed during the data-collection phase, the landscape coordinator should describe the testing results, the areas of concern, and the need for changes.
2. **Ask follow-up questions about yard uses.** During their initial meeting, the outreach worker should have interviewed the homeowner about the activities that take place in the yard and the ages and numbers of people who use the yard. Yard uses should have been mapped on a plot plan using colored markers or crayons (see Section 5.3). During the design session, the landscape coordinator should review the yard uses with the homeowner and ask any follow-up questions.
3. **Work with the homeowner to select appropriate treatments based on the lead levels, the yard uses, and the homeowner's esthetic preferences.** The selected treatments should be mapped on the plot plan showing yard uses, and this treatment plan should be used by the landscaper as a blueprint for work to be done. (Click here for a PDF of a sample treatment plan.) See Section 7.1 above for guidance on matching treatments to hazards.

You may wish to develop a legally binding form that the homeowner can sign at the conclusion of the design session, stating that he or she understands and approves of the final treatment plan. Click here for a PDF of a sample homeowner's approval form.

7.5 Contracting With a Landscaper

Early in the development of your lead-safe yard program, you will want to identify a program partner for the design and landscape components of your project (see Section 4.2, "Selecting Program Partners"). This could be a non-profit landscaping company, a private landscaping company, or even a team of youth volunteers who have been trained in landscaping techniques. Another option, currently being tested by the EMPACT LSYP, is to develop a pool of landscaping contractors trained at designing and implementing landscape treatments that can reduce exposure to lead-contaminated soil. Why create a contractor pool? By training and partnering with multiple contractors, you create competition—a market—for the work you have to offer, and you also build "capacity" within your community for this type of work. This is an important goal of your program: to increase your community's base of knowledge about soil-lead hazards and strategies for yard treatment.

No matter who you use for the design and landscape components of your project, you will need to develop a contract for the work. If you have chosen to use only a single landscaper, this process will be relatively straightforward: you will simply negotiate an agreement for the property or properties requiring treatment, and then capture the agreement in the form of a contract. Guidance on developing a contract is provided below.

If you have succeeded in creating a contractor pool, you will need to develop a system for choosing which contractor to use at a particular property. Here are two possible ways of doing this:

- **Group the properties geographically, then assign several to each contractor.** Under this scenario, each contractor is given a budget for each property he or she is assigned, and is asked to develop and implement a treatment plan within the budget. This method is relatively noncompetitive, in that contractors are not asked to bid against one another. However, over time, you can determine which contractors do the best and most cost-effective work, and then increase their workload.
- **Solicit bids for the property (or properties) requiring treatment.** This works best if you (or a professional landscape designer) have already developed a treatment plan for each property, identifying which landscape measures will be used. Each contractor is then given a copy of the treatment plan(s), along with detailed specifications for the work to be done, and is asked to submit a bid. The work goes to the

lowest bidder. The disadvantage of this method is that the landscape contractor is not included in the development of the treatment plan.

Whatever method you use, you should consider assigning or awarding several properties at a time to each contractor, rather than one at a time. This allows contractors to benefit from the economies of scale when buying materials and planning their work.

7.5.1 Developing a Contract

To simplify the contracting process, you should develop a standardized contract for use at every property. This contract should define the scope of services the contractor will perform, the timeframe for the work, the contractor's legal responsibilities, and the details of compensation. This sample contract (PDF) shows some of the details that should be incorporated into a standardized contract, including:

- **Warranty**—Contractors should provide a warranty guaranteeing their work from defects in workmanship and materials for a specified period. The EMPACT LSYP requires a one-year warranty from its contractors.
- **Draws**—The term "draws" refers to the timing of compensation. Many contractors will want one-third of their compensation up front, one-third at the halfway point, and the final third upon completion of the project. You should attempt to negotiate a payment schedule that is mutually acceptable, though you should keep in mind that draws are typically market-driven.
- **Insurance**—Each contractor should be required to maintain general liability and workman's compensation insurance to protect against claims due to bodily injury or property damage and claims under state workman's compensation acts.
- **Pollution insurance**—Most general liability insurance policies do not cover injury or illness caused by pollution (for example, illness caused by lead exposure). You should look into the costs and the potential necessity of pollution insurance in your state and consider encouraging contractors to purchase such insurance.

7.6 Health and Safety for Landscapers

Before any field work begins, your program should develop safety guidelines that protect your soil sampling team and landscape workers from the risks associated with working with lead-contaminated soil. All field workers should be educated about lead hazards, health effects, safe work practices, and any federal or state regulations that apply to their work.

OSHA regulation 1926.62, the "lead in construction standard," applies to all private sector workers, no matter how few are employed. Although it does not apply to workers in the public sector, it is nevertheless a useful reference on responsible practices. The regulation, available online, requires a written description of the work to be done, an estimate of the anticipated exposure to lead, and a statement detailing the precautions to be taken. If the anticipated exposure to lead reaches the "action level"—30 micrograms per cubic centimeter of air, averaged over an 8-hour day—extensive guidelines come into play to protect workers.

Since the lead to which landscapers in the EMPACT LSYP are exposed falls below the action level, compliance with the lead in construction standard has not been difficult. However, to be on the safe side, the project has adopted an important contract requirement that goes beyond what OSHA stipulates for enterprises whose employees are exposed to lead below

Lead-Safe Yard Program Health and Safety

I. Primary route of entry of lead into the body is ingestion:

A. Lead can enter the body through normal hand-to-mouth activities.
B. Small amounts of lead left on hands or clothing can impact blood lead levels.
C. Lead-contaminated soil can be transferred to the interior of dwelling (by pets, shoes, clothing).

II. Preventive measures:

A. Avoid dust-generating activities.
B. Dampen soil to minimize dust generation.
C. Keep children and pets away from area where work is being done.
D. Wear leather or comparable work gloves to minimize hand contamination.
E. Do not smoke* or eat while in work area.
F. Wash face and hands before smoking*

the action level. This requirement is health and safety training for landscapers. One of the main points conveyed in the training is that lead enters the body chiefly through ingestion, which happens as a result of routine hand-to-mouth activities such as eating, drinking, and smoking. An information sheet used in the training is shown in the box, "Lead-Safe Yard Program Health and Safety."

or eating.

G. Remove shoes/boots before entering a dwelling to limit contaminated soil transfer.

H. Wash work clothing separately from other clothing.

* Do not smoke at all.

Even small amounts of lead on the hands can affect blood lead levels. Also, lead on clothing is easily transferred to the hands, and then from the hands to the mouth. Another danger is that lead will be brought into the home on landscapers' clothing, especially their boots or shoes.

A key precaution is to avoid activities that generate dust. When the ground must be disturbed, as is often the case in landscaping, it should be dampened to minimize the dust that may be generated. Leather or comparable work gloves should be worn to cut down on hand contamination, and landscapers should not eat, drink, or smoke in the work area. After they leave, they should wash their face and hands before doing any of these activities. They should remove their boots or shoes at the door of their home to keep from tracking in contaminated soil, and they should wash their work clothing separately from their other clothing.

Blood lead tests are advisable to make sure such measures are effective, and in fact are mandated by OSHA for employees exposed to lead at or above the action level. Almost any doctor at almost any clinic can perform this service, but an occupational health physician and an occupational health clinic are recommended, primarily for skillful interpretation of test results.

Landscapers should have their lead levels taken before doing any work and then every two months for the next six months. If levels are still less than 40 µg/dL, the time between tests can increase to six months. If levels are between 40 and 50 µg/dL, testing should continue every two months. Levels above 50 µg/dL should trigger monthly testing, and if they don't decrease, the landscaper should be removed from the work area. However, this step may well be avoided. As soon as blood lead levels rise, employers should try to find out why and remedy the situation. Often the cause is some break in the accepted work practices, which can be handled by re-educating the employee.

The EMPACT LSYP has not seen any elevated blood lead levels among its team members as a result of exposure to lead in soil during landscaping work.

7.7 Approval and Signoff on Work Complete

After all landscape work and construction is complete, both you and the homeowner should inspect the property. You should look for the following things:

- That all landscape treatments have been successfully implemented as per the scope of work agreed to during the design session.
- That, for each treatment measure, the landscaper has followed the detailed specifications defining exactly how the work should be done and what materials should be used.
- That the property has been left in a clean state. The homeowner must approve any material remaining on site after completion of the landscape work.

This process of approving the completed work can be as formal or informal as you want to make it. During Phases 1 and 2, the EMPACT LSYP approved each yard treatment during an informal visit between the outreach worker and the homeowner (the outreach worker also used these visits to reinforce the lead hazard education delivered during previous visits). On the other hand, Lead Safe Boston, a spinoff of the EMPACT LSYP run by the City of Boston, has developed a legally binding project completion certificate (PDF) to be signed by the homeowner and


A finished project.

the landscape contractor after the property has been inspected and all work approved. The certificate also serves as a lien waiver, in which both the homeowner and contractor discharge Lead Safe Boston from any legal claims that may arise in connection with the work performed under the program.

Lead Safe Boston has also created an additional form (PDF) for the contractor to sign upon receipt of final payment. The form certifies that the contractor:

- Has paid all debts associated with the work done on the property.
- Discharges the program and the homeowner from any claims made by subcontractors, material suppliers, or workers, in connection with the work performed under the program.
- Has completed all work on the property according to the terms of the contract.
- Warrants the completed work against workmanship and material defects for the period stipulated in the contract.
- Has been paid in full for all work complete.

7.8 Handing Over the Case File

At the conclusion of the yard treatment process, after all landscape work has been inspected and approved, you should present the homeowner with the case file that has been developed for his or her property. This file should be a binder containing all information related to the property, including copies of application and permission forms, testing results, treatments plans, and approval forms. The binder should also contain a copy of the maintenance manual that the landscape coordinator develops for the property (see Chapter 8). Keep a copy of each case file for your program's records.

7.9 For More Information

For information on U.S. EPA's proposed standards (TSCA 403) for lead-based paint hazards (including lead-contaminated residential soils), visit the Office of Pollution Prevention and Toxics.

The Department of Housing and Urban Development's Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally Owned Residential Property and Housing Receiving Federal Assistance (24 CAR Part 35) can be found online.

Click here for an information sheet on ACQ pressure-treated lumber.

Two excellent resources on lead in gardens are:

> *Lead in the Home Garden and Urban Soil Environment*,
> by Carl J. Rosen and Robert C. Munter,
>
> *Lead Contamination in the Garden*,
> a fact sheet by Terry Logan

The RSMeans Company publishes two reference books that can help with the process of estimating landscaping costs. The books, *Means Site Work & Landscape Cost Data 2000* (ISBN 0-87629-547-2) and *Landscape Estimating, 3rd Edition* by Sylvia H. Chattin (ISBN 0-87629-534-0), can be ordered online.

Information on OSHA's "lead in construction standard" (OSHA Regulation 1926.62) can be found online.

Sample Specifications for Yard Treatments

Suggested Plantings

Azalea evergreen hybrid (2 gallon)

Torch azalea (2 gallon)

Japanese boxwood (1 gallon)

Common boxwood (2 gallon)

American holly (2'-3')

Regal privet (18"-24")

Columbine (1 gallon)

Chrysanthemum (1 gallon)

Foxglove (1 gallon)

Day lily (1 gallon)

Black-eyed susan (1 gallon)

Hosta (1 gallon)

Drip Zone

Raised perimeter box filled with gravel (no plantings). Install 2" x 6" ACQ pressure-treated wood box 3' from foundation wall. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground to a minimum depth of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 3" of loam and 2" of ¾" crushed stone over filter fabric weed barrier.

Raised perimeter box filled with mulch and plantings. Install 2" x 6" ACQ pressure-treated wood box 3' from foundation wall. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground to a minimum depth of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 4" of loam and 3" of pine bark mulch over filter fabric weed barrier. Install a minimum of ten perennials per the list of plantings or approved equal.

Grassed Areas

Existing lawn improvement. Rake bare areas to loosen soil. Apply rye, fescue, and bluegrass seed mix at the rate specified by manufacturer. Apply ¼"of top soil over new seed and water thoroughly.

New lawn installation (at existing grade). Rototill existing lawn bed 6" deep. Apply water to contain dust during rototilling. Apply rye, fescue, and blue grass seed mixture at the rate specified by manufacturer. Spread ¼" loam on top of seed. Water thoroughly.

New lawn installation (raised bed). Install 2" x 6" ACQ pressure-treated wood box at owner-approved location. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 6" of loam over filter fabric weed barrier. Apply rye, fescue, and blue grass seed mixture at the rate specified by manufacturer.

Spread ¼" loam on top of seed. Water thoroughly. Raised mulch bed (with plantings). Install 2" x 6" ACQ pressure-treated wood box to completely cover bare soil area. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 4" of loam and 2" of pine bark mulch over filter fabric weed barrier. Install a minimum of ten perennials per the list of plantings or approved equal. Provide recessed egress stepping-stones from bed to walkway.

Parking Areas

Gravel parking areas. Install 6" of compacted gravel/crushed stone base to all areas designated as parking areas. Top of base shall be 2" to 3" below finish grade of surrounding area. Install a top layer of 1-1/2" to 2" of processed gravel or crushed stone (3/8" or ¾" size) over gravel/crushed stone base. Final grade is to have a minimum of 2% pitch across the surface to ensure that water will not puddle.

Asphalt parking areas. Level surface by preparing a 6" gravel base over a uniformly graded and compacted subgrade. Form, spread, and roll 2" of bituminous base coat and 1" topcoat to create a driveway 10' wide. Final grade is to have a minimum of 2% pitch across the surface to ensure that water will not puddle.

Walkways

Stone path. Install round or square red patio stepping stones at all egresses from front to rear yard. All stones shall protrude no more than ½" above the existing or new grade.

Recreation and Children's Play Areas

Raised play area. Install 2" x 6" ACQ pressure-treated wood box. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 4" of loam and 2" of pine bark mulch or woodchips over filter fabric weed barrier.

Wood platform. Install a 10' x 12' ACQ wood platform built from 2" x 6" stock, 16" on center with 5/4" x 6" radius edge decking. All decking and joints to be mechanically fastened with 3" galvanized screws. Platform shall be installed with a ¼" pitch to drain rainwater off of surface.

Garden Areas

Raised vegetable garden bed. Install 2" x 8" ACQ pressure-treated wood box at owner approved location. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 6" of loam over filter fabric weed barrier.

Pet Areas

Raised pet area filled with mulch or woodchips. Install 2" x 6" ACQ pressure-treated wood box to completely cover bare soil area. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 4" of loam and 2" of pine bark mulch or woodchips over filter fabric weed barrier.

Porches

Bare soil under porches (lattice and trim). All exposed soil under porches is to be barricaded by ACQ wood framing, lattice, and pine trim. Prep, prime, and paint pine trim or apply two coats of wood sealant. Install framed access door of like material. Include galvanized metal hasp and hinges.

Bare soil under porches (mulch bed). Install 2" x 6" ACQ pressure-treated wood box along footprint of porch. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 2" of loam and 3" of pine bark mulch over filter fabric weed barrier.

Bare soil under porches (gravel bed). Install 2" x 6" ACQ pressure-treated wood box along footprint of porch. All joints and corners shall be mechanically fastened with 3" galvanized wood screws to a 1-1/2" square stake driven into the ground a minimum of 12". All corners shall be braced with triangular exterior grade plywood keystones mechanically fastened directly to the wood box with 3" galvanized wood screws. Install 3" of loam and 2" of ¾" crushed stone over filter fabric weed barrier.

Sample Budget for Yard Treatments

House perimeter (drip zone)

Each house receives approximately 150 l.f. of perimeter raised boxes installed 3' from foundation wall where feasible. (Exceptions to perimeter boxes are existing asphalt/concrete paving, bulkhead, under rear porches, etc.). Fill perimeter boxes with homeowner’s choice of:

	Allowance
Option #1: 6" of pine bark mulch, filter fabric, and ten 1-gallon plantings (i.e., common boxwoods, azaleas, holly, or equal). Plantings to include compost/top soil/manure.	$1060.00
Or Option #2: 4" of gravel, filter fabric (no plantings).	$1060.00
Bare soil area under rear porch area (all areas matching this criterion to receive treatment)	
Option #1: Barricade exposed soil by wood framing and lattice secured to porch framing/supports. Install access door of like material with hasp.	$350.00
Or Option #2: Area under porch to received raised perimeter boxes, filter fabric, and installation of 6" of pine bark mulch or 4" of gravel.	$350.00
Back yard (homeowner to choose one option)	
Option #1: Each house shall receive a 10’ x 12’ wood platform built from 2" x 6" ACQ stock, 16" o.c. with 5/4" x 6" radius edge decking.	$780.00
Each house shall also receive approximately 10' x 12' area of lawn. Treatment to include rototilling soil 6" deep, installing filter fabric, adding 6" of conditioned top soil to be spread by hand, perimeter edging to be constructed of 2" x 6" ACQ stock, and a 6# shade mix to be installed by push spreader.	$250.00
Or Option #2: Each house shall receive a 10' x 12' wood platform built from 2" x 6" ACQ stock, 16" o.c. with 5/4" x 6" radius edge decking.	$780.00
Each house shall also receive approximately 10' x 12' garden area. Treatment to include rototilling soil 6" deep, installing filter fabric, adding 6" of conditioned top soil to be spread by hand, perimeter edging to be constructed of 2" x 6" ACQ stock.	$250.00
Or Option #3: Each house shall receive approximately 20' x 24' area of woodchips. Treatment to include installation of filter fabric, adding 2" of topsoil spread by hand and covered with 6" of woodchips, and installation of perimeter edging to be constructed of 2" x 8" ACQ stock.	$905.00
Each house shall also receive misc. treatments to adjoin mulched area to egresses. Misc. treatments to include up to 30 additional 12" x 12" red patio stepping stones, misc. plantings, additional mulching, etc.	$125.00
Walkways	
Each house shall receive up to 30 red patio stepping stones, 12" x 12", to be used at major egresses.	$60.00
SUBTOTAL (house perimeter, rear porch, back yard, and walkways)	$2500.00
CONSTRUCTION MANAGEMENT ALLOWANCE (general requirements; landscape design and site development; construction oversight; homeowner education and maintenance manual development)	$500.00
TOTAL (APPROXIMATE) COST PER LOT	$3000.00

Example Documents

All of these documents are PDFs; you will need Adobe's free Acrobat Reader to view them. Click here to download Acrobat Reader.

Cost Estimate Sheet
Treatment Plan
Homeowner's Approval of Treatment Plan
Consultant Contract
Sample Project Completion Certificate
Contractor's Affidavit of Payment of Debts, Release of Claims, Warranty of Workmanship and Receipt of Payment

NEXT CHAPTER

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Chapter 8: Yard Maintenance

8.1 | 8.2 | 8.3 | 8.4 | 8.5

Since the start of the EMPACT Lead-Safe Yard Project in 1998, the project's leaders have gained a heightened appreciation of the importance of yard maintenance to the project's overall success. It is safe to say that good maintenance is as critical as gathering accurate soil samples or selecting appropriate treatment measures.

This chapter explains the importance of yard maintenance (Section 8.1) and provides guidance on making maintenance an integral part of your lead-safe yard program. Section 8.2 presents specific maintenance guidelines for the landscape treatments found in Chapter 7. Section 8.3 describes the development of a property-specific maintenance manual and presents a sample manual used by the EMPACT Lead-Safe Yard Project. Section 8.4 provides tips on homeowner education, while Section 8.5 suggests creative ways of encouraging ongoing maintenance.

All of these sections will be useful to someone responsible for implementing a lead-safe yard program. Homeowners interested in applying landscape treatments to their own yards can focus on Sections 8.1, 8.2, and 8.3.

This chapter contains links to documents in PDF format. To view them, you will need Adobe's Acrobat Reader. Click here to download Acrobat Reader.

8.1 The Importance of Yard Maintenance

Why is yard maintenance such an important part of a successful lead-safe yard program? The answer is quite simple. All of the landscape measures used by the EMPACT LSYP are interim controls: that is, they are designed to protect children and other people from existing soil-lead hazards without permanently abating the hazards. These landscaping measures provide protection only so long as they are kept in good repair. Evergreen shrubs, for example, will discourage children from playing in the drip zone only if the shrubs are kept alive. Grass serves as a protective barrier only if it is healthy and well maintained. Likewise, a mulch-filled pet area must be raked regularly to maintain a 6-inch mulch barrier and keep pets from contacting lead-contaminated soil.

The good news is that all of these landscape measures can provide effective, continuing protection if well maintained. And most maintenance tasks are relatively simple—as easy as tightening a screw, watering a lawn, or raking a gravel drive.

8.2 Maintenance Requirements for EMPACT Treatment Measures

The table at the bottom of this page summarizes all maintenance tasks required for the landscape treatments described in Section 7.2 of this handbook. The table includes information on the optimum frequency of maintenance and the tools needed for each task.

8.3 Developing a Property-Specific Maintenance Manual

For each completed yard treatment, the landscape coordinator should prepare a property-specific maintenance manual that can be provided to the homeowner as part of the case file for his or her property (see Section 7.8). This maintenance manual should tell the homeowner what maintenance tasks need to be performed, when it is best to do them, and what tools (if any) are required for each job.

The maintenance manual (PDF) used by the EMPACT LSYP during its Phase 1 and 2 treatments has several features that make it effective and easy to use:

- It is easily customized for each yard treated. The landscape coordinator simply places a checkmark next to each treatment measure used in that particular yard.

- It is easy to read. The homeowner simply looks for the checkmarks identifying the treatments used, then follows the maintenance guidelines provided.
- It is keyed to correspond with the treatment plan developed during the design session. The letters identifying particular treatment measures match up with those shown on the site worksheet (PDF).
- It includes a list of materials used for yard maintenance, their typical costs, and places they can be obtained (including sources of free materials).

8.4 Educating Homeowners About Yard Maintenance

At the conclusion of each yard treatment, the landscape coordinator should meet with the homeowner to review all landscape work that has been completed in the yard, pass on the property-specific maintenance manual, and explain the information it contains.

This meeting provides a perfect opportunity to educate the homeowner about the importance of yard maintenance and to re-emphasize some of the key lessons of your program. The EMPACT LSYP has found that homeowners often don't retain the information on soil-lead hazards that was presented to them by the outreach coordinator (see Lessons Learned below). For this reason, the landscape coordinator should use this opportunity to review the following:

- The results of the soil-lead sampling and the areas of concern.
- Why lead-contaminated soil is harmful to children and other people.
- The landscape treatments that were employed and how they protect against harmful exposures.
- The homeowner's responsibility in maintaining the landscape installations.

Throughout the meeting, the landscape coordinator should emphasize that the landscape treatments will only be effective if well maintained. He or she should also emphasize that all involved maintenance is easy and inexpensive to perform.

8.5 Strategies for Encouraging Ongoing Maintenance

Once you have finished treating a yard, met with the homeowner one last time, thanked him or her for participating, and said goodbye, the success of that yard treatment is almost entirely in the homeowner's hands. If he or she completes all maintenance tasks as outlined in the maintenance manual, the treatments that have been installed can provide ongoing protection for many years. On the other hand, if the homeowner neglects all maintenance, the benefits of the yard treatment will be limited.

Lessons Learned: Re-Educating Homeowners About Soil-Lead Hazards

During Phases 1 and 2 of the EMPACT Lead-Safe Yard Project, the project team made focused efforts to educate homeowners about the need for maintaining the landscape treatments that were installed in their yards. These efforts included the creation of a homeowner packet for each completed property; the packet contained a record of the soil-lead sampling results, a color-coded plot plan showing treatments used, and a property-specific maintenance manual identifying maintenance tasks needed for that yard.

In the spring of 2000, less than two years after the first Phase 1 treatments were completed, members of the EMPACT team revisited several of the Phase 1 and 2 properties to evaluate the level of maintenance that had taken place. The results were disappointing. Their observations indicated that, at some properties, little or no maintenance had occurred. Many of the landscape installations (especially those requiring frequent attention from the homeowner, such as grassed areas and plantings) had degraded to the point where they no longer appeared to provide effective protection. Some homeowners were unable to locate their maintenance manuals when asked.

In assessing the reasons for these disappointing results, the project team found that many of the homeowners perceived the LSYP as a "yard beautification" project rather than as a risk-prevention program designed to protect children from

Organize a presentation on lead poisoning and soil-lead hazards to encourage ongoing yard maintenance within the community.

dangerous lead exposures. Though each homeowner had been given extensive information about soil-lead hazards and how landscape measures could help protect their family's health, the homeowners had not always retained this message. The project team concluded that they needed to find new strategies for emphasizing the lead hazard message during Phase 3 of the project, and for creating repeated opportunities for homeowner re-education. The strategies devised by the project team included sending out reminders about the need for yard maintenance, holding community-wide lead-safe yard maintenance days, and offering annual educational events about soil-lead hazards. These strategies are presented in Section 8.5. Additional strategies are described in Section 5.2, "Educating People About Lead and Lead in Soil."

Here are three strategies for encouraging ongoing maintenance over time:

- **Send out reminders.** Try developing a standard maintenance reminder that can be sent out annually to all homeowners who have participated in your program.
- **Hold community maintenance days.** Once or twice a year (perhaps in spring and/or fall), organize a community-wide "Lead-Safe Yard Maintenance Day." Such an event could be combined with community clean-up days.
- **Offer annual educational events within your community about soil-lead hazards.** For example, you might want to organize a presentation on lead poisoning and soil-lead hazards at a local community center or community college.

Above all, remember to be creative in communicating your message about soil-lead hazards, and repeat it at every opportunity.

Maintenance Required for EMPACT Landscape Treatments

Yard Area	Treatment Measure	Maintenance Tasks	Frequency	Tools Needed
Drip Zone	Raised perimeter box filled with mulch and plantings	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Three times a year	None
		Replenish mulch to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
		Water plantings	Regularly	Sprinkler, garden hose
	Raised perimeter box filled with gravel	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Annually	None
		Apply grass fertilizer	Twice a year (spring and	None

Grassed Areas	Existing lawn improvement OR New lawn installation (at existing grade)		fall)	
		Water lawn	Regularly	Sprinkler, garden hose
		Reseed bare spots	Annually (spring or early fall)	Rake, seed mixture
	New lawn installation (raised bed)	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Apply grass fertilizer	Twice a year (spring and fall)	None
		Water lawn	Regularly	Sprinkler, garden hose
		Reseed bare spots	Annually (spring or early fall)	Rake, seed mixture
	Raised mulch bed (with plantings)	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Three times a year	None
		Replenish mulch to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
		Water plantings	Regularly	Sprinkler, garden hose
Parking Areas	Gravel parking area	Remove weeds and debris	Twice a year (spring and fall)	None
		Rake to maintain evenly spread top layer of 1 ½ " to 2"	As needed	Rake
	Asphalt parking area	No maintenance needed	None	None
Recreation and children's play areas	Wood platform	Check that all screws and other connections are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Sweep to maintain cleanliness	As needed	Broom
	Raised bed filled with mulch or woodchips	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Three times a year	None

		Replenish mulch to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
Pet areas	Raised pet area filled with mulch or woodchips	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Twice a year	None
		Rake to maintain 6" depth	As needed	Rake
		Replenish mulch or woodchips to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
Bare soil under porches	Install lattice and trim	Check that all screws, nails, and other connections on installation are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Scrape, sand, and paint or apply additional coats of sealant	Annually	Scraper, sandpaper, paintbrush, paint or sealant
Bare soil under porches	Raised bed filled with mulch or gravel along footprint of porch	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Remove weeds and debris	Annually	None
		Rake to maintain evenly spread top layer	As needed	Rake
		For mulch beds, replenish mulch to 6" depth	Every two years	Mulch fork or rake, shovel, wheelbarrow
Garden areas	Raised vegetable garden bed	Check that all screws and other connections on box are secure	Annually	Screwdriver, hammer
		Look for and remove splinters	Annually	None
		Add additional loam (or compost)	Annually	Shovel, wheelbarrow
Walkways	Stone path	Sweep to maintain cleanliness	As needed	Broom

Example Document

This document is a PDF; you will need Adobe's free Acrobat Reader to view it. Click here to download Acrobat Reader.

Lead-Safe Yards: Maintenance Made Simple

NEXT CHAPTER

Chapter 9: Evaluating Your Lead-Safe Yard Program

9.1 | 9.2

This chapter provides guidance on evaluating the effectiveness of your lead-safe yard program. Section 9.1 suggests questions that you may want to focus on during your evaluation. Section 9.2 discusses the need for documenting your program's work at key evaluation points.

The information in this chapter is designed primarily for managers and organizers who are responsible for running lead-safe yard programs.

This chapter contains links to documents in PDF format. To view them, you will need Adobe's Acrobat Reader. Click here to download Acrobat Reader.

9.1 Focusing Your Evaluation

How effectively does your program reduce young children's exposure to lead? To answer this, you will need to evaluate your program.

As described in Section 1.2.2, EPA New England and the National Center for Lead Safe Housing are currently leading a HUD-funded research study to document the effectiveness of the low-cost interim soil control measures used by the EMPACT Lead-Safe Yard Project. The study will include a retrospective evaluation of the soil intervention work conducted during Phases 1 and 2 of the EMPACT LSYP. It also will examine data collected during the summer of 2000 by all three Boston-based lead-safe yard programs: the EMPACT project, the Lead Safe Boston demonstration project, and the Boston Public Health Commission project. Soil-lead data will be collected before, during, and after each yard intervention, mainly to document the effectiveness of the landscape treatment measures in reducing risk to residents.

In designing an approach to evaluating your own program, you can focus on any of a number of criteria. Some of these are easily measurable, others are not. Here are four questions you may want to look at in your evaluation:

- How effective were the yard treatments in reducing soil-lead levels?
- How well did the yard treatments hold up over time?
- What effect did the yard treatments have on children's blood lead levels?
- How well did your program educate residents about lead poisoning?

9.2 Documenting Evaluation Points

An effective strategy for evaluating mitigation work is to compare the yard at three points in time: pre-treatment, immediately after treatment, and one year after treatment. Key to conducting an evaluation is adequate documentation of the program's work. Throughout this handbook, tools for documenting lead-safe yard activities have been identified. The following documentation should be contained in the case file you began upon initial contact with the homeowner.

- Homeowner application materials (PDF) and consent form (PDF) (Chapter 5).
- Results of educational 'quiz' (Chapter 5).
- "Homeowner Yard Use/Treatment Options Interview" Form (PDF) (Chapter 5).
- "Before and after" photographs of the yard.
- Site worksheet (with monitoring results) (PDF) and color-coded plot plan (PDF) (Chapter 6).
- Treatment plan (PDF) (Chapter 7).
- Contract (PDF) (Chapter 7).
- Cost estimate sheet (PDF) (Chapter 7).
- "Homeowner's Approval of Treatment Plan" Form (PDF) (Chapter 7).
- Project Completion Certificate (PDF) (Chapter 7).
- Any information available about blood lead levels of children living in the home.

When you return a year later, you should again obtain the homeowner's permission for inspecting the yard and taking additional measurements and photographs. A sample form is shown here (PDF). Your photos and notes from the follow-up visit will help document how well the landscaping measures have been maintained. You should also get input from the owner on:

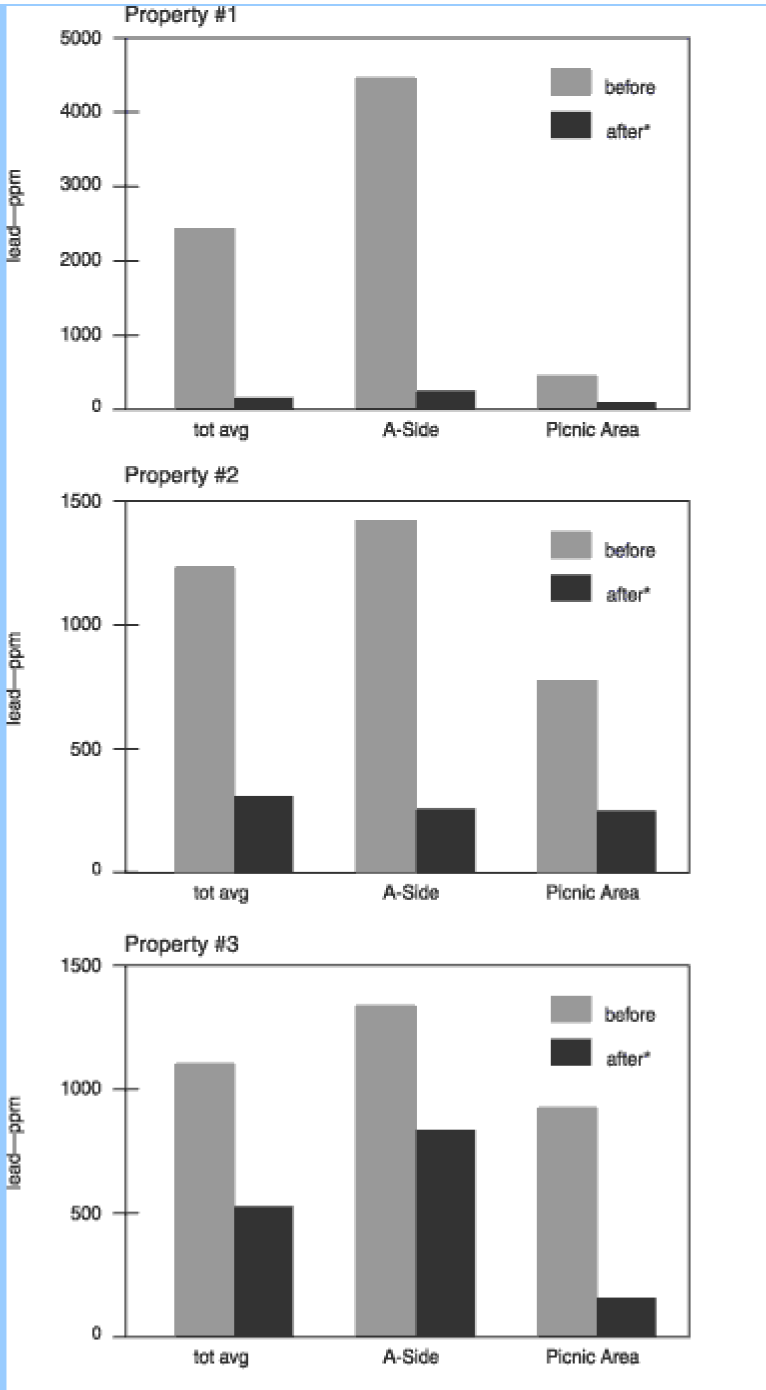
- His or her impressions of the benefits and/or drawbacks of the landscaping done at the home.
- How hard or easy it was for the homeowner (or another resident) to maintain the landscaping measures and whether the maintenance plan was clear and easy to follow.
- How your lead-safe yard program could be improved (e.g., through better treatment measures or better maintenance procedures).

You can also try to evaluate how well your educational efforts worked; the EMPACT outreach worker, for example, plans to readminister the quiz that she gives following the educational video, 'Lead Poisoning: The Thief of Childhood.' Finally, you can ask the residents if they are willing to give you the results of any lead testing done on children who live at the home.

All of this information will help you document and assess the various aspects of the program. This evaluation will be of value to your project team, your funders, the community, and each family involved in the program.

Assessing Reductions in Soil-Lead Levels

In the summer of 1999, the EMPACT Lead-Safe Yard Project returned to several residences in the Bowdoin Street neighborhood to assess changes in surface soil-lead levels. All of these residences had been treated one year earlier, during Phase 1 of the project. Retesting efforts focused on play areas and/or areas that had been found to have high soil-lead levels during the initial testing. As illustrated in the graphs below, the results of the retesting showed that lead concentrations in the yard surfaces were significantly lower at each site. This indicated to the project team that the landscape barriers installed at the sites during the yard treatments were effectively covering the contaminated soil below. In the year 2001, the EMPACT LSYP intends to do another round of retesting at 25 sites.



Lead Concentration Before and After Mitigation for Three Phase 1 Properties

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Example Document

This document is a PDF; you will need Adobe's free Acrobat Reader to view it. Click here to download Acrobat Reader.

Homeowner Permission Form: One Year Follow Up

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Chapter 10: Non-Residential Applications of Lead-Safe Yard Mitigation Strategies

Many of the mitigation strategies and approaches incorporated into a lead-safe yard program can be applied to non-residential properties as well. Properties such as tot lots, playgrounds, community gardens, and vacant lots where children play may contain high levels of lead in their soil. Also, while children should not be playing at abandoned industrial sites or commercial buildings, these properties can be sources of increased exposure if children have access to areas of lead-contaminated soil. Specific mitigation approaches that have proven successful in reducing lead exposure risk at residential properties can be just as effective when applied to certain non-residential properties.

At tot lots and playgrounds, for instance, raised sand boxes can be constructed. The bottoms of these boxes should be lined with perforated plastic, landscaping fabric, or even indoor-outdoor carpeting to create a barrier between the lead-contaminated soil and the clean sand in which the children play. Clean sand should be tested to ensure that it does not contain lead levels of concern (i.e., greater than 400 parts per million). Similar raised boxes can be built around playground equipment and play areas and filled with sand, gravel, or mulch. Another alternative is to lay down rubber matting in play areas, or even paving lots. Planting and maintaining healthy grass cover is yet another option for play areas. Planting evergreen shrubs in areas with especially high lead levels can also be effective in keeping children from playing in these areas.

Community gardens can also incorporate lead-safe yard principles to protect against lead exposure. Raised garden boxes can be constructed, lined with perforated plastic or landscaping fabric, and filled with clean loam and compost. Loam should be tested to ensure that it does not contain lead above the 400-ppm level. Clean compost should be added yearly to replenish nutrients and help control lead levels.

Vacant lots where children play can be made lead-safe by covering exposed areas of soil. Planting grass is one approach, but other materials such as woodchips, mulch, or even gravel could be used. To keep children from playing in areas with high levels of lead in the soil, plant evergreen bushes and shrubs.

For abandoned industrial sites and commercial buildings, construct barriers (such as fences or walls) to keep children out of these potentially dangerous areas.

APPENDIX A

Appendix A: Safer Soil Pilot Program of Cambridge, Massachusetts

About the Program

The Lead-Safe Cambridge (LSC) program works to make the homes of income-qualified people in Cambridge, Massachusetts, lead safe through interior and external lead hazard control. It began the Safer Soil Pilot Program in 1997 to build on this effort by making the yards of participants in its interior de-leading program lead safe as well.

After soil sampling was initiated for the Safer Soil Pilot Program, LSC found that over 95 percent of the yards it investigated contained soil with lead levels above 400 parts per million. Currently, all homeowners participating in LSC are eligible for additional assistance under the Safer Soil Pilot Program. However, after September 2000, participation in the Safer Soil Pilot Program will be required, in keeping with new federal regulations.

Under the pilot program, soil samples are taken from select areas of a home and tested to determine their lead content. If elevated lead levels are found, a landscape planner works with the homeowner and/or tenants to develop an appropriate landscape remediation plan. The Safer Soil Program provides homeowners free soil sampling and grant support to reimburse them for the cost of implementing LSC-recommended soil remediation and landscaping plans. Specifically, the program offers:

- Free soil testing.
- Training on the dangers of lead exposure.
- Free technical advice on preventing lead exposure.
- Grant support of up to $2,000 per unit and $6,000 for three or more units toward the cost of approved materials used to make the yard leadsafe.

Partner Organizations

LSC receives funding for its Safer Soil Pilot Program from the U.S. Department of Housing and Urban Development. LSC collaborates with a number of local non-profit housing groups, including Just-A-Start and Homeowner's Rehab, as well as with the U.S. Environmental Protection Agency and the Massachusetts Department of Environmental Protection.

Outreach Barriers and Strategies

Cambridge is a diverse community. Its residents come from many different cultural backgrounds—English is not always their primary language. Successful communication with homeowners and residents often requires close cooperation and coordination with their English-speaking relatives, as well as the help of multilingual LSC staff members.

Homeowners and tenants are recruited to participate in the program through newspaper ads, Web announcements, property owner workshops (such as Cambridge Homefair), and word of mouth.

As part of its soil education strategy, LSC distributes flyers to educate homeowners about the soil-lead problem and inform them about the program, disseminates fact sheets via the Internet, and presents lead-safety materials at public meetings throughout Cambridge. In addition, LSC offers two annual Safer Soil workshops, free and open to the public, at which people can learn why lead in soil is a problem, find out how to landscape a yard to make it safer, and get technical advice from a landscape planner. LSC also enlists the help of local garden centers, which sponsor the workshops and offer coupons to workshop participants.

Soil Sampling and Analysis

After their units have been de-leaded under the LSC program, homeowners interested in participating in the Safer Soil Pilot Program sign an agreement with LSC to have their soil tested for lead. LSC takes soil samples from different use areas in each yard—such as driplines, play areas, gardens, walkways, and other bare areas—and sends them to a state laboratory in Jamaica Plain for analysis.

All samples are analyzed using the atomic absorption method (microwave digestion followed by flame atomic absorption spectroscopy). LSC relies on laboratory analysis, as opposed to onsite analysis using field portable x-ray fluorescence technology, because of cost and liability issues. A new XRF costs $15,000 or more (see Section 6.2); because an XRF contains radioactive materials, only a trained technician can use it. Getting sample results back from the laboratory takes about 7 to 10 days, but this has not been a problem.

Once LSC receives the sample results, it reviews them and consolidates them in the form of hand-drawn plot diagrams. These are then presented to (and interpreted for) the homeowners and/or tenants. If the test results reveal that soil on a property exceeds EPA-recommended levels for lead, an LSC landscape planner works with the homeowner and/or tenants to design attractive, usable lead-safe urban yards, providing them with plans, product recommendations, and cost estimates. The landscape planner works with homeowners in the design and construction of these plans. LSC believes that close cooperation with homeowners helps to create a sense of ownership, community, and most importantly, safety for children. In addition, this cooperation makes for longer-term compliance and better maintenance.

Remedial Measures and Yard Treatments

The Safer Soils Pilot Program favors a combination of techniques for remediating lead-contaminated soil around a residence. These include selectively paving contaminated areas, using softer paving materials (such as gravel with brick edging), and incorporating plants and shrubs in the yard. The program often recommends placing plants and shrubs around house driplines to reduce access to these areas while making the yard more attractive.

The program also works to reduce lead toxicity in the soil by rototilling organic matter (such as composted cow manure) and rock phosphate, which bind with lead, into affected areas. Once organic material has been introduced, the Safer Soil Pilot Program recommends taking the additional step of putting down landscape fabric over the contaminated area and covering the fabric with 3 to 4 inches of bark mulch or pea gravel to create a natural barrier. Sodding is another effective option, although its drawbacks include its high cost relative to other treatments and the need for routine watering in its early stages of establishment.

In areas where lead levels in the soil are found to be greater or equal to 5,000 ppm, LSC follows current EPA recommendations for remediating high-lead-content soil by covering the area with an impermeable surface (such as concrete or pavement) or, in extreme cases, removing the soil altogether. However, the Safer Soil program generally tries to avoid complete soil removal, in large part because of its cost and the difficulty of disposing of lead-contaminated soil.

Participants in the Safer Soil program are offered grants to help them pay for the materials they need to remediate their properties. The standard grant is $2,000 per unit and up to $6,000 for three or more de-leaded units. In order to make full use of an available grant, the homeowner (or a landscape contractor) must implement the program’s recommendations for the property. Work must be done according to the landscape planner’s recommendations; soil must be kept damp in order to prevent unnecessary lead dust exposure. Homeowners can use landscape contractors to execute their Safer Soil landscape plans if they are unable to do the work themselves. If the homeowner chooses to use a landscape contractor, he or she takes the landscape plan and specifications developed by the landscape planner and obtains three estimates for the landscaping work. The landscape planner approves the selected contractor, who then begins work. Homeowners save all receipts for materials and labor and submit them to the landscape planner for reimbursement (up to the total grant amount) after work has been completed.

The Safer Soil program also offers homeowners and tenants guidance on preliminary steps they can take to mitigate children’s exposure to lead-contaminated soil. These tips include:

- Establishing a play area away from areas once exposed to old paint, such as the house or a fence.
- Covering leaded dirt with clean gravel or grass (preferably sod).
- Buying or creating a sandbox to cover leaded soil (making sure that the bottom is sealed away from the soil).

Results

To date, 27 yards have been landscaped through the Safer Soil Pilot Program, with 106 yards tested for lead. Landscaping plans and specifications have been developed for an additional 11 yards, and will be implemented in the near future.

Awards and Recognition

In 1999, LSC's Safer Soil Pilot Program was presented a National Merit Award from the American Society of Landscape Architects for its innovative approach to addressing lead in residential soil.

For More Information

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APPENDIX B

Appendix B: Some Proposed Models for Less-Resource-Intensive Approaches to Implementing Lead-Safe Yard Programs

To develop feasible working models that can be applied in other communities, the issues of cost-effectiveness and homeowner participation need to be addressed. In the absence of a HUD-funded municipal program, or for those homeowners or residents not eligible for grants or loans from such a program, less costly approaches can be considered. In Boston, the EMPACT Lead-Safe Yard Project is currently investigating the following possibilities, several of which could be drawn upon in carrying out a lead-safe yard program at the local level:

- Using a model based on the principles developed by Habitat for Humanity, in which the work involved in achieving a lead-safe yard is carried out by the homeowner with the help of community volunteers (possibly other residents in the area who would then receive help with their yards). Habitat for Humanity is a non-profit organization that builds and rehabilitates low-cost homes through volunteer labor and donations of money and materials, with the help of homeowner (partner) families.
- Offering courses/workshops for homeowners and for landscapers through a local community college or other adult education program. Such a course would include information on building and landscaping techniques and materials, as well as maintenance required to achieve lead-safe yards. This could be part of a longer course on home maintenance or a course for new homeowners.
- Training environmental science students at a local community college to carry out sampling of yards for lead contamination. Students would be trained in how to draw plot plans, how to take samples, and how to interpret and write up the results, as well as in health and safety issues surrounding the handling of lead-contaminated soil. This would substantially reduce sampling costs, while providing an educational experience for the students concerned.
- Involving youth volunteers from a program such as City Year in carrying out the construction and landscaping work for lead-safe yards. City Year, a program of AmeriCorps (the domestic Peace Corps), engages young people aged 17 to 24 in youth development, human services, public health, and environmental programs. Another option would be to contract with a training and construction program such as Youth Build. Youth Build is a youth and community development program that offers job training, education, counseling, and leadership development opportunities to unemployed and out-of-school young adults, aged 16 to 24, through the construction and rehabilitation of affordable housing in their own communities.

APPENDIX C

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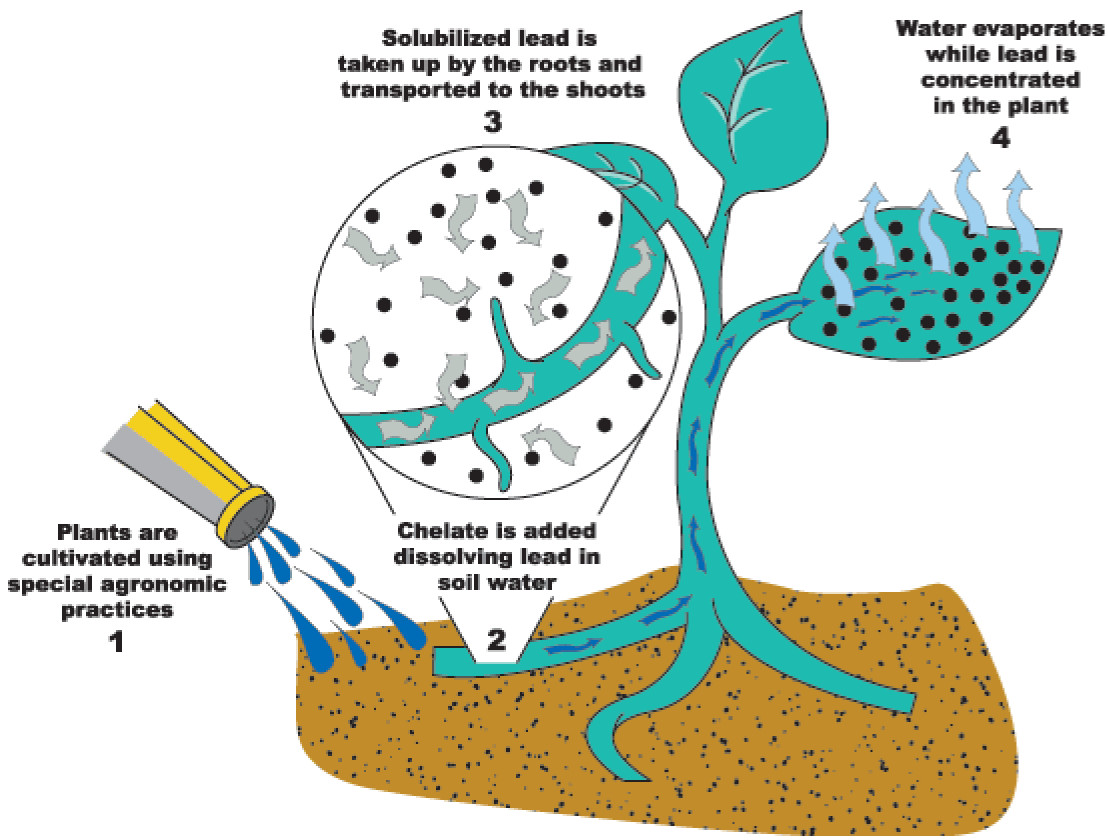
Appendix C: Future Options—Using Plants To Treat Lead-Contaminated Soils

This handbook focuses on measures that can keep children safe by reducing their risk of exposure to lead. The fact is, though, that unless the lead is permanently removed, exposure can reoccur (for example, if landscaping measures are not maintained).

The most frequently used method of removing the lead is to dig up the contaminated soil and haul it to a hazardous waste facility. This method is costly and requires intensive labor. However, some promising and innovative experiments explore how to minimize lead exposure by actually extracting it from the soil. This angle of research explores how nature itself, through a process called phytoextraction, might hold a potent solution for removing lead and other hazardous metals from contaminated soils.

Phytoextraction involves using living green plants for removing contaminants, such as lead, from soil and water. The term refers to the uptake of metal contaminants by the plant's roots and the subsequent transport of the contaminants to various parts of the plant. In general, plants do not absorb or accumulate lead.[19] But certain plants, such as the sunflower and Indian mustard, absorb remarkably large amounts of metals compared to other plants and actually survive. After the plants are allowed to grow on a contaminated site for a period of time with proper soil amendments to mobilize the metal, they are harvested. After this, they are either disposed of as a hazardous waste or incinerated (and the metals recycled). The schematic below illustrates phytoextraction processes (adapted from http://aspp.org/public_affairs/briefing/phytoremediation.htm).



Scientists have studied phytoremediation (the use of plants to recover contaminated soils and water) extensively. It is slowly becoming an acceptable, and even preferred, technology. Numerous demonstration projects have shown the promise of phytoremediation. For example:

- In Trenton, New Jersey, the Gould National Battery site was home to commercial lead-acid battery manufacturers from the 1930s to the 1980s. In those years, the land became heavily contaminated with lead. Under the Brownfields Initiative, the U.S. Environmental Protection Agency awarded Trenton a grant to restore the site. In 1995, Phytotech Inc. (now Edenspace Systems Corporation) approached the city about using "green technology" to clean up the site. Three crops of plants over a summer reduced lead levels on

75 percent of the treated area to below the New Jersey residential standard of 400 parts per million. Click here to see Edenspace's case study.
- In Chernobyl, a team of scientists from Rutgers University headed by plant biologist Ilya Raskin tested phytoextraction to remove radioactive cesium and strontium from a contaminated pond. Sunflowers were set floating on small polystyrene rafts so that their roots dangled in the water. Despite the poisons, the plants thrived. So far, Raskin has used phytoextraction techniques in sites in New Jersey, Massachusetts, and Connecticut.

Only a handful of demonstration projects focused on removal of lead from residential soils. Here's an example from the Boston metro area:

- The Boston Health Department sought a comprehensive strategy to remove lead from a small Dorchester neighborhood that hosted a cluster of childhood lead poisoning cases. Excavation and removal simply cost too much, so the department sought other methods. They teamed with Edenspace Systems Corporation to explore phytoextraction using Indian mustard plants on a 1,000-square-foot test site in the neighborhood. They spread a soil amendment that would loosen the lead so it dissolves in the moisture. They planted Indian mustard, which is well suited for metal removal because it accumulates the metal in its leaves rather than its roots. After six weeks, they harvested the plants and analyzed the soil. Lead concentrations decreased 47 percent, and after a second growing, the overall lead reduction was 63 percent (from 1,500 ppm to under 300 ppm). The harvested plants were incinerated, and the metals in the ash were recycled. Based on the results of the demonstration, Tom Plante of the Boston Health Department feels this method is very effective in reducing lead levels in soil and has the potential for a wide array of applications including brownfields—and now urban residences (if there is enough sunlight and moisture). For more information on this demonstration project, visit the Boston Childhood Lead Poisoning Prevention Program online.

Edenspace Systems Corporation is continuing research on residential soil-lead remediation. One of the challenges of lead remediation in residences is that the plantings can put an entire yard out of use and out of sight for months or even years. Therefore, the company is researching the potential of turf grasses to extract lead from the soil. Making the technology affordable, ensuring proper sunlight and irrigation, bringing heavy machinery into residential neighborhoods, and reaching lead that is too far for plant roots to reach might pose additional challenges. However, research will continue to build on existing knowledge of phytoextraction and help address the potential challenges.

For more information on phytoextraction and other forms of phytoremediation, see the following online resources:

Edenspace Systems Corporation
Edenspace now owns or licenses an array of proprietary techniques used in removing lead, arsenic and other metals from the environment. The resources page provides many useful links to articles on phytoremediation.

Phytoremediation: using plants to remove pollutants from the environment
An overview of phytoremediation written by Rutgers University plant biologist Ilya Raskin.

Rutgers University Center for Agriculture and Environmental Technology
One of the pioneer research institutions for phytoremediation.

U.S. EPA Citizen's Guide to Phytoremediation

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[19]Carl Rosen and Robert Munter. 1998. *Lead in the Home Garden and Urban Soil Environment.* University of Minnesota Extension Service. FO-2543-GO. Available online.

Appendix D

Quality Assurance Project Plan for:

A Community Based Environmental
Lead Assessment and Remediation Program

Prepared for:

Lead Safe Yard Program
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Approved by:

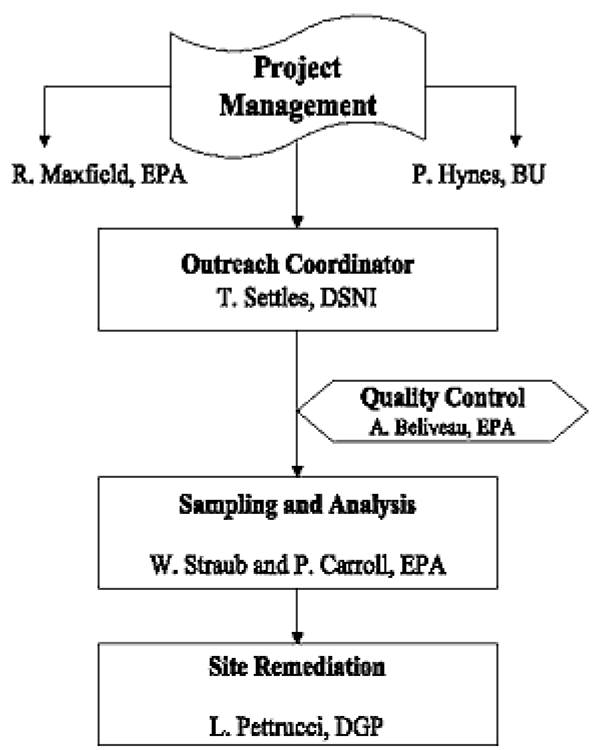
Robert Maxfield, Chief
Investigations and Analysis Unit, OEME

Approved by:

Andy Beliveau, QA Officer
Quality Assurance Unit, OEME

1.0 Scope and Application

This QAAP outlines procedures for the field analysis of lead in soil using the Niton 700 Series Field Portable X-Ray Fluorescence Spectrometer. These methods are designed as part of the sampling and analysis protocol for the Lead Safe Yard Program and are applicable to the measurement of lead in urban soils.



2. Project Organization and Responsibility

The Project Managers are in charge of coordinating, maintaining and monitoring all activities, including direction for preparation of work plans, sampling plans, and analytical procedures relative to the project. The Quality Assurance personnel will evaluate and approve QA/QC plans through the course of the project and oversee all data quality assurance aspects of the project. The Outreach Coordinator will be responsible for locating potential properties for sampling and analysis, contacting property owners and gaining consent to work on the property. The sampling and analysis team will be responsible for scheduling and conducting data collection and data reduction procedures, properly maintain samples, develop site sketches and other observations, generate required QA/QC records and implement corrective actions. The site remediation group will apply innovative and cost effective landscape techniques for site improvements.

3. Problem Definition

Lead poisoning continues to be an extremely serious environmental health issue for youth, particularly in poorer inner city neighborhoods with older wood framed housing. While considerable attention has been focused on the lead contaminated paint prevalent on the surfaces of homes in these neighborhoods, less attention has been paid to the lead contaminated soil that surrounds each home. The reasons for this lack of attention by regulators stems from a variety of concerns: perhaps foremost is the cost of soil removal and disposal.

4. Project Description

The overall objective of the proposed project is to produce a summary report documenting the effectiveness of low cost residential soil intervention. The project will incorporate two sampling plans to accomplish this goal. One sampling strategy will be to measure surface soil lead at residential properties in the Greater Boston area. Properties that exceed project specific action levels will be mitigated with simple, low cost methods that are designed to minimize the risk of human exposure to the contaminated soil. Soil surfaces will then be measured to evaluate the effectiveness and durability of the intervention measures over time. A second sampling strategy involves measuring tracked-in soil Pb (house dust) to compare pre and post intervention Pb levels inside the residence. This Quality Assurance Project Plan outlines protocol for the residential soil surface sampling program that will be used in this project.

4a. Project Timeline

Activity	Start	End
Review existing data	11/99	
Determine target community		2/00
Community Outreach	2/00	9/01
Site Investigations	3/00	11/01
Meet with property owners		
Site Remediation	3/00	11/01

5.0 Sampling Design

The sampling strategy is designed to assess the potential of excessive lead exposure to humans from soil on the property. Each property will be evaluated with focus on four areas of concern: the dripline along the house foundation, play areas in the yard, areas of exposed soil in the yard, and any other potential sources of soil lead contamination including those from abutting properties. Play areas found to contain greater than 400 parts per million (ppm), and other areas that are found to contain greater than 2000 ppm lead will be further characterized to determine the nature and extent of contamination (note Appendix 1, the Sampling Logic Tree). Two soil sampling strategies, in situ and bag sampling, will be used to determine lead content in these residential soils. Descriptions of each along with QA/QC protocol follow.

In-Situ Sampling. Samples will be analyzed with a Niton Model 702 XRF Spectrum Analyzer. The 702 is a field portable multi-element, multi-functional x-ray fluorescence analyzer (FPXRF) equipped with a 10mCi cadmium-109 source and a high resolution Silicon-Pin detector. The hand held, battery powered FPXRF is capable of in-situ analysis techniques. Based upon a minimum detection limit study (MDL), the detection limit for this method is approximately 100 ppm. These data are attached as Appendix 4. This instrument is factory calibrated, has been found to hold calibration quite well, and is software compensated for any deterioration of the source. In addition to the MDL, precision and accuracy studies (1998 and 2000) are attached as Appendix 5.

Soil lead measurements will be taken in-situ during the screening phase provided that the surface is not inundated with water. Large nonrepresentative debris, including rocks, pebbles, leaves and roots, will be removed from the soil surface prior to sampling. The area will be smooth enough to allow uniform contact between the FPXRF and the ground surface. The initial sample locations will depend upon the size and shape of the region of interest. A line pattern will be used when the area is linear (e.g. dripline). In-situ measurements will be taken at approximate 10 foot intervals along the line depending upon the length of the building. Additional lines are tested at 2 to 5 foot sampling intervals away from the original sampling area to characterize the extent of any lead contamination. Target patterns will be used for sampling larger, nonlinear areas of potential exposure (e.g. play areas). A large "X" will be superimposed upon the space to be analyzed. In- situ measurements will be taken at 5 to 10 foot intervals along each line of the "X" unless the samplers determine that additional (or less) resolution is required. Screening data and descriptive information about each site will be recorded on the Site Worksheet (Appendix 2).

Quality control checks will consist of replicate measurements, standard reference material (SRM) checks and confirmation samples as defined in Section 10, Acceptance Criteria for Soil Lead by XRF. Replicate measurements will be conducted over a minimum of 10% of the screen samples to indicate the precision of analysis and the homogeneity of the sample matrix. Three point SRM measurements and a blank measurement will be conducted at the beginning and end of each sampling day to ensure linearity over the expected sampling range (e.g. 400-5000 ppm) and to determine that the instrument is operating contaminant free. SRMs (NIST 2586 @ 432 ppm lead in soil) will be used as continuing calibration checks after every 10th screen sample. A minimum of one confirmation sample will be collected from each site. Approximately 4 tablespoons of surface soil, to no more than the approximate depth of 0.5 inches, will be collected into a soil sample container and thoroughly mixed for each confirmation sample. The sample will be properly labeled and returned to the laboratory for analysis by EPA Method 6010A.

Bag Sampling. If site conditions are such that in-situ sampling is not appropriate and sampling activities must continue, this bag sampling method will be used to evaluate soil lead conditions on the residential properties. The sampling strategy will be a scaled down version of the in-situ strategy. The focus will still be on the dripline of the building on the property, play areas, bare soil and other concerns such as sources from abutting properties. The bag approach involves collecting soil samples into a sampling container and returning them to the laboratory for preparation, XRF analysis and ICP confirmation.

Typically, a minimum of 4 discreet soil samples will be collected from each side of the building perimeter within 1 to 3 feet of the foundation (dripline). These samples will be collected at the very minimum of 2 feet from each other. Bare soil areas are the preference (vs. covered areas).

Composite samples from play areas will consist of aliquots collected along an X shaped grid. These subsamples will be collected at a minimum of 1 foot from each other. Bare soil areas are preferred. This method will also apply to bare areas of soil, vegetable gardens and high use areas noted on the subject property.

The decision to sample along the property boundary will be determined by the samplers at the time of the site visit. If conditions exist on an abutting property that would appear to present a risk of soil lead contamination to the subject property, the following protocol will be followed. Aliquots of surface soil will be collected along the property line(s) of interest. These subsamples will be collected no closer than 1 foot apart and will be located within 1 to 5 of the property line. Subsamples will only be collected on the subject property.

Quality control for the composite method measurements will be identical to QA/QC for the in situ method. Three point SRM measurements and a blank measurement will be conducted at the beginning and end of each sampling day to ensure linearity over the expected sampling range (e.g. 400-5000 ppm). SRMs will be used as continuing calibration checks after every 10th screen sample. A minimum of one confirmation sample will be collected from each site.

All bag samples will be collected according to protocol outlined in Section 7 (*Sample Handling and Chain of Custody Requirements*). The samples will be returned to the EPA laboratory where they will be dried, screened to remove nonrepresentative debris, and analyzed using XRF technology. Select samples will be designated for confirmation analysis by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP).

Confirmation Samples. Confirmation samples are collected during sampling activities to be analyzed at the University of Cincinnati, Hematology and Environmental Laboratory by Atomic Absorption Spectrometry. These samples are collected in selected intervals around the house perimeter (designated HC for house composite), any play areas (PC), from any on-site vegatable gardens (GC) and from any high use areas (HUC).

Typically, 12 subsamples are collected for each perimeter composite sample (3 from each side of the house). If possible, 5 subsamples are collected for each play area composite, garden composite and/or each high use area composite using the target pattern approach. The samples are returned to the EPA laboratory, sieved with a number 10 sieve (U.S.A. Standard Sieve Series) to removed any coarse debris, rebagged and analyzed for lead content using the Niton XRF. Each sample is then labeled (street number and name and composite designation), recorded on a chain of custody form and sent to the U. of C. Lab for the extraction and AA analysis for lead content.

6. Sampling and Analytical Methods Requirements

Parameter	Matrix	# of Samples	Analytical	Containers	Preservation	Hold Time
Lead (XRF) insitu	Soil	TBD	EPA 6200	N/A	N/A	N/A
Lead (XRF) confirmation	Soil	TBD	-	ziplock bags	4°C	1 year
Lead (ICP) confirmation	Soil	TBD	EPA 6010A	ziplock bags	4°C	1 year

7. Sample Handling and Chain of Custody Requirements

The majority of the soil lead measurements will be taken in situ during the site characterization phase. Sample handling and chain of custody requirements will not apply to these procedures. Soil will be collected as confirmation samples and as discreet bag samples. Chain-of-custody (COC) procedures will be followed for these samples to maintain and document possession from the time they are collected until they are delivered to the laboratory for analysis. A sample COC form is attached. The sample handling and COC predator will include:

- sample information on the jar/bag with sample ID, time and date of collection and technician ID, all written in unerasable ink.
- a sample seal attached firmly to the sample cover as soon as possible after collection when using sample jars.
- a chain of custody record containing the project name and number, the sampling station ID, date and time of collection, a brief description of the type of sample collected, parameters for analysis, the samplers name and signature, adequate space for any transferee's name and signature and a comment section to describe any special conditions associated with the samples.

All sample sets will be accompanied by a COC document. Any time the samples are transferred, both the sample custodian and the receiver shall sign and date the COC document. COC documentation will be maintained in the project folder.

8. Quality Control Requirements

Analyte	Analytical Method	Detection Limit*	Quantitation Limit**	Precision***	Accuracy****
Lead	EPA 6200	~ 75 ppm	~225	±50	±25
Lead	EPA 6010A	42 ppb	~120	±10	±20
Lead	Kevex XRF	50 ppm	~150	±20	±20

**Typically 3 times the MDL
***Precision determined by replicate sample analyses
****Accuracy determined by analysis of SRMs

9. Data Management and Documentation

A field log book, dedicated to the project, and field data sheets will be maintained during sampling events. There will be separate field sheets for the screening and additional site characterization phases. Each sheet will include the date, time, property name and address, sample locations, a site sketch that includes sampling locations, sample description, important details about how the sample was collected, analyst(s) names, along with the respective measurement data, and any additional comments that would accurately and inclusively describe the sampling activities. Care will be taken to maintain the logbook and field data sheets neatly with factual, objective language that is free of personal feelings and other terminology that may be deemed inappropriate.

These field data sheets, along with confirmation sample data received from the laboratory will be kept on file at the EPA Region 1 Lab. The confirmation information will include results of sample analyses, method blanks, matrix spike/spike duplicates and acceptance criteria. Copies of the field data sheets and validation information from the confirmation samples will be distributed to members of the remediation team to help determine where remediation activity will take place.

10. Assessment and Response Actions

Acceptance Criteria for Soil Lead by XRF(in-situ)

Audit	Frequency	Limits	Corrective Action
Initial Calibration			

(SRM) @ 50, 500, 5000 ppm	Run prior to daily sampling events	%RSD=30	Investigate problem and re-run initial calibration until an acceptable calibration is obtained
Continuing Calibration	Sample data must be bracketed every 10th sample (or less) using SRM	%D < ±25%	Re-analyze CC and if passes continue sample analysis. If fails investigate problem and re-analyze all samples following the last acceptable CC starting with a new initial calibration.
Field Blank	Varies by site	<100 ppm	Corrective action determined by end user.
Replicate Analysis (Accuracy)	Varies by site	%D < ±50%	
Confirmation Samples	Site Dependent, minimum 1/site	Variable	Intrusive sample for conformation and/or confirmation analysis
MDL	When there is a change in the method or instrument.	Instrument Specific	Action taken at data validation level.
IDC	When there is a change in sampling method or instrument	± 30% recovery*	Investigate problem and correct. Re-run.

Appendices

All of these documents are PDFs; you will need Adobe's free Acrobat Reader to view them. Click here to download Acrobat Reader.

Appendix 1: Sampling Logic Tree
Appendix 2: Site Worksheet
Appendix 3: IDC Study
Appendix 4: MDL Studies
Appendix 5: Accuracy Studies
Appendix 6: Results of Confirmation Samples

United States
Environmental Protection
Agency

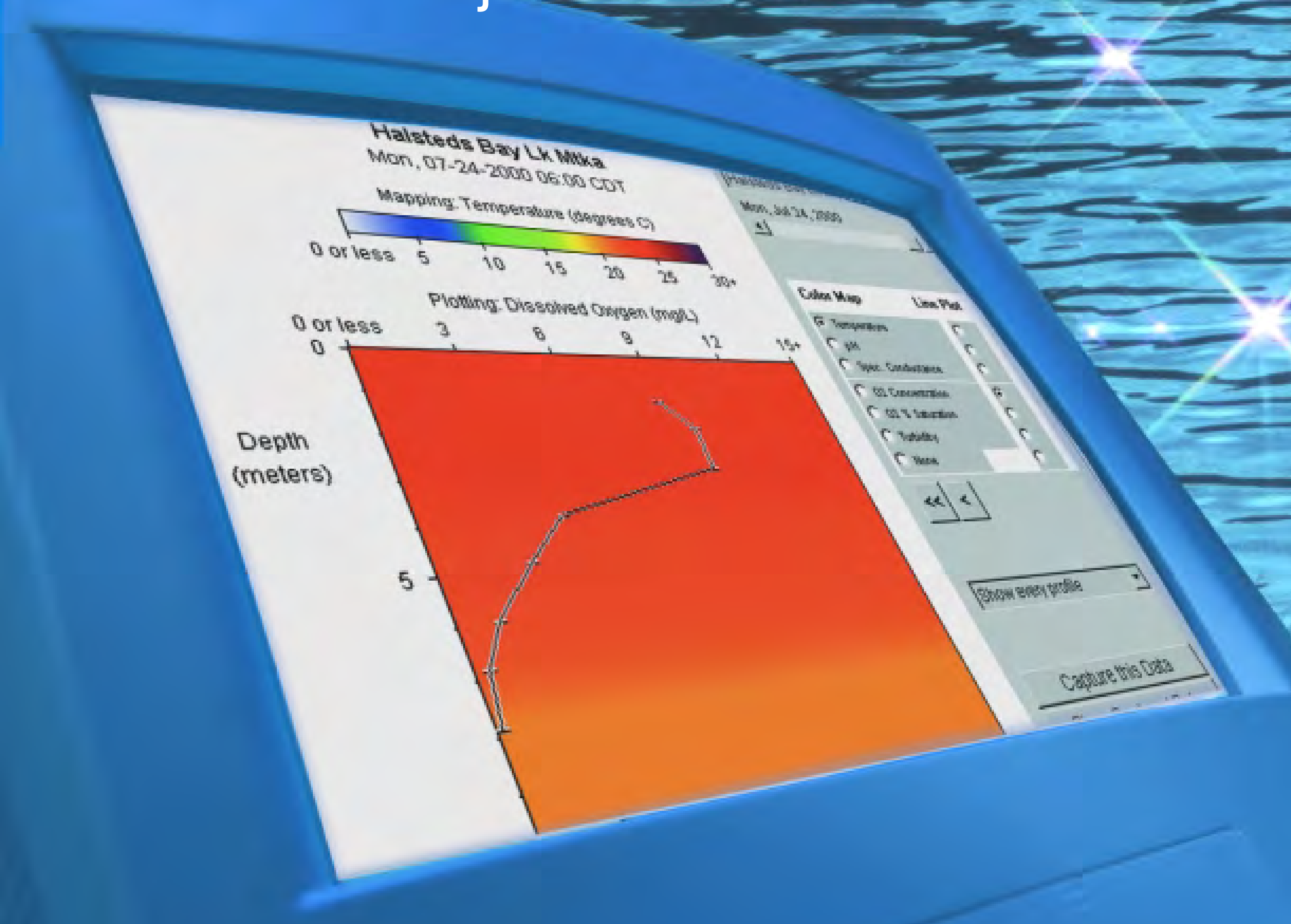
Office of Research and Development
Office of Environmental Information
Washington, DC 20460

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



EMPACT

Environmental Monitoring for Public Access & Community Tracking

Disclaimer

EPA/625/R-00/013
September 2000

Delivering Timely Water Quality Information to Your Community

The Lake Access–Minneapolis Project

United States Environmental Protection Agency
National Risk Management Research Laboratory
Office of Research and Development
Cincinnati, OH 45268

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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 U.S. 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:

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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
Rochester, NY
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

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.

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 U.S. 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 U.S. 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 U.S. 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™) 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.

The diagram on page 10 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.

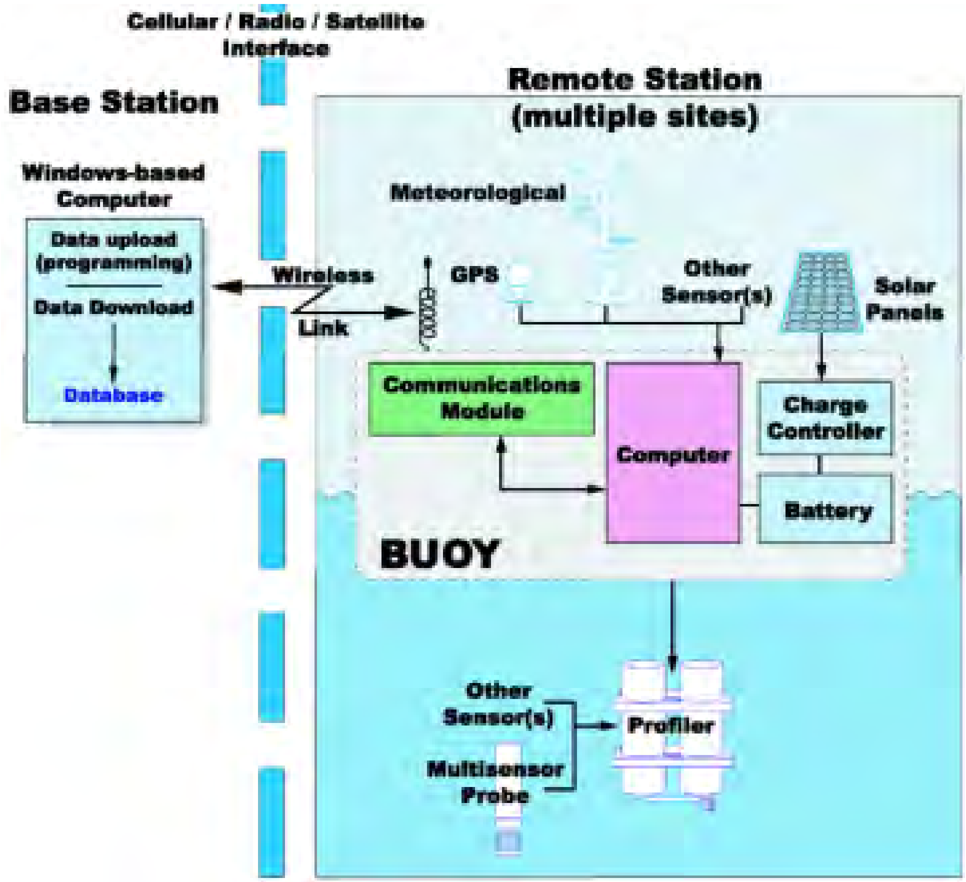


Diagram showing some of the RUSS unit components and illustrating the communication between the RUSS unit and the land-base station. (Taken from the RUSS System Manual, available from Apprise Technologies at http://www.apprisetech.com.)

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.)

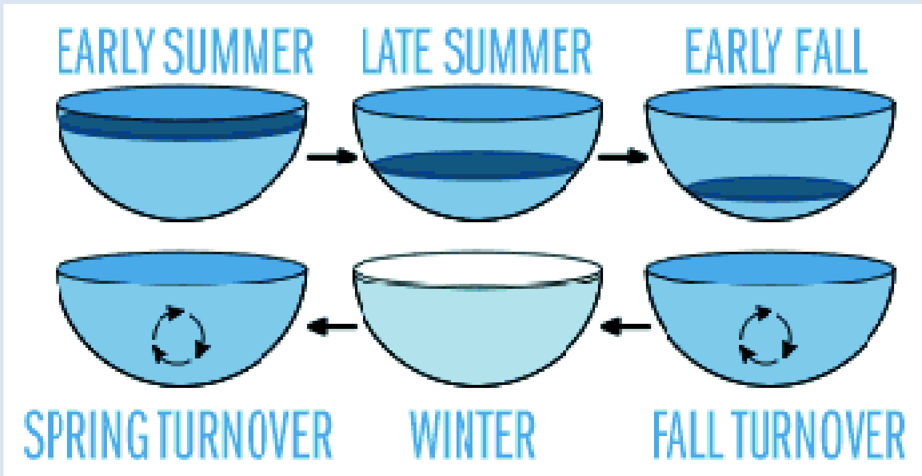


Figure showing the activities and characteristics of the types of lakes studied through the Lake Access Project. (Taken from the Lake Access Web site at http://www.lakeaccess.org/ecology/lakeecologyprim4.html).

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 on page 12 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.

(continued on next page)

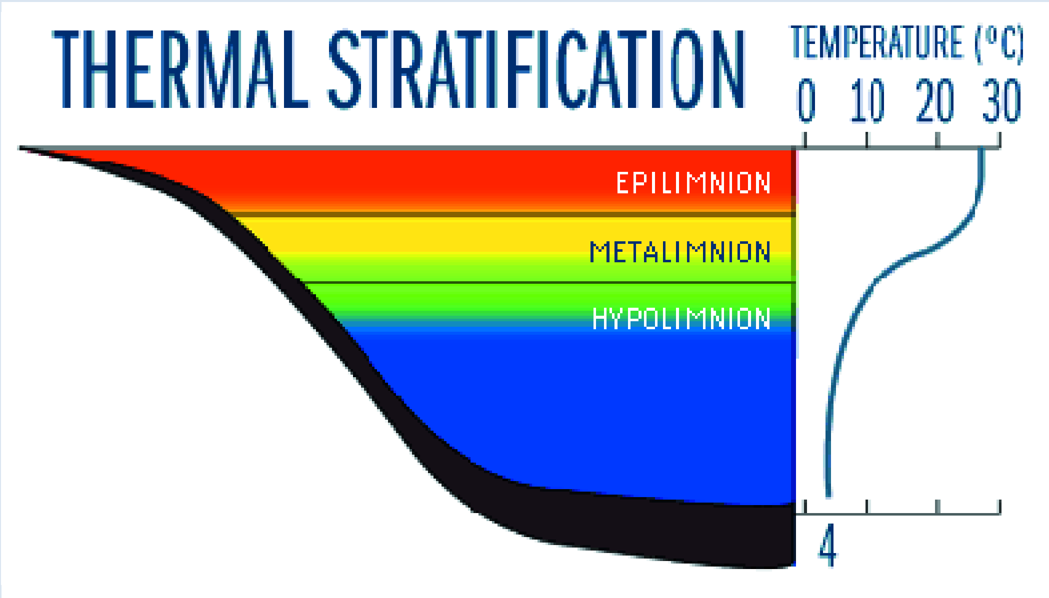


Figure showing the three distinct layers of a typical stratified lake.
(Taken from the Lake Access Web site at http://www.lakeaccess.org/ecology/lakeecologyprim4.html).

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 on page 14 provides more information on the design of the Lake Access Project.

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 on page 15 for more information.

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

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.

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.

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

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 U.S. 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.**

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 on page 17.

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).

3.5 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.

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.

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

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.

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 on page 19. 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.

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.

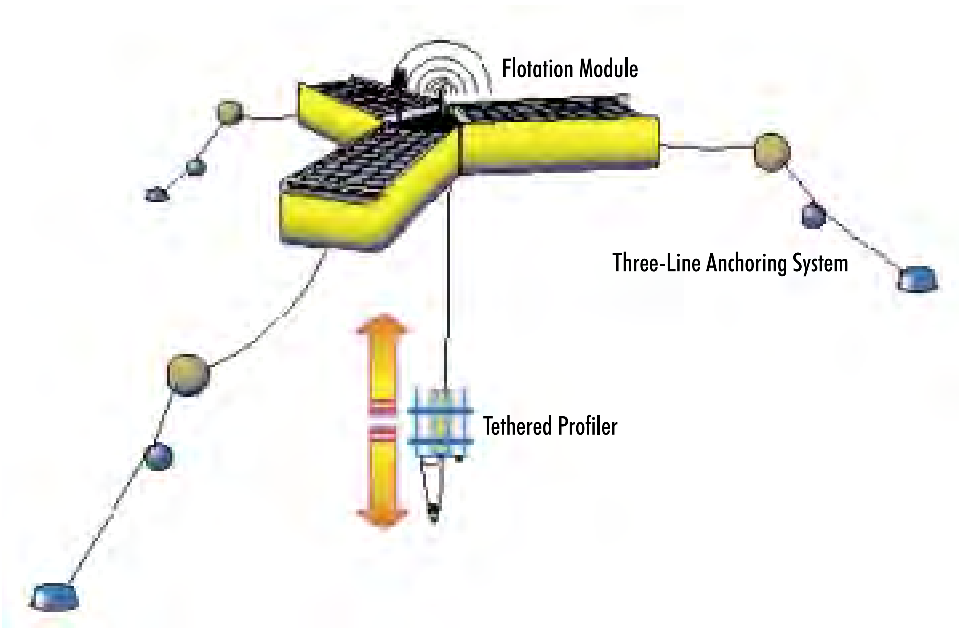


Diagram of RUSS unit, showing the flotation module, tethered profiler, and three-line anchoring system. (Taken from the RUSS System Manual, available from Apprise Technologies at http://www.apprisetech.com.)

Flotation module. The flotation module is a yellow, three-armed, floating buoy.

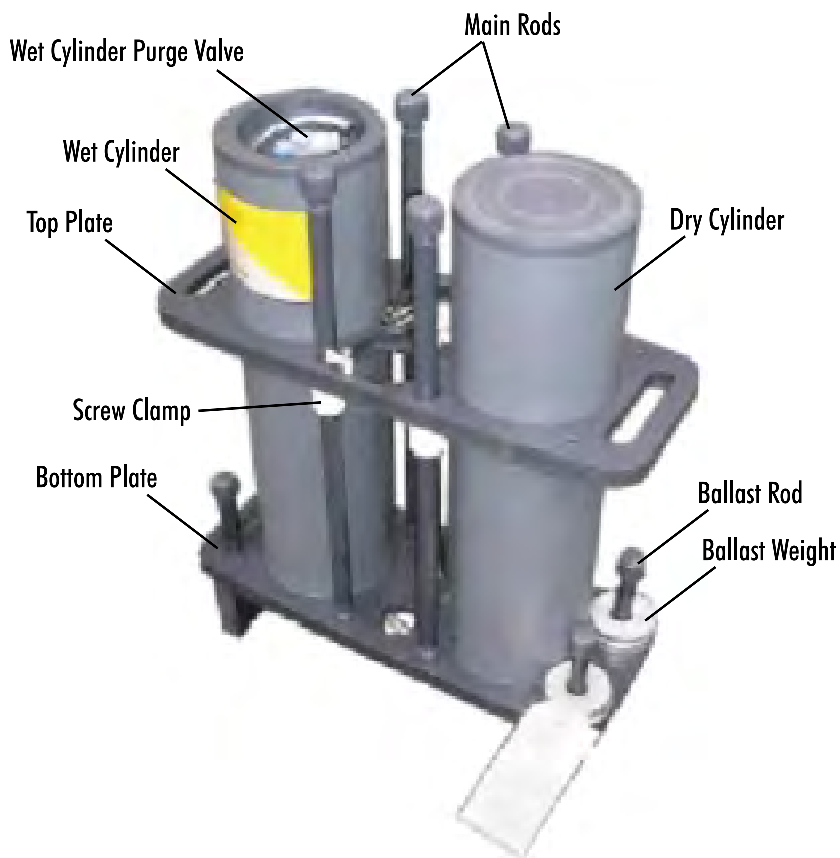
Profiler. The RUSS unit profiler is controlled by the RePDAR unit. The profiler carries the water quality monitoring sensor to multiple depths within the water column beneath the flotation module. A special profiler cable transmits power and buoyancy-control protocols from the RePDAR unit to the profiler and transmits data from the water quality monitoring sensor to the RePDAR unit.

An illustration of the profiler is presented on page 20.

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 on page 21 when choosing your location:

Siting the Lake Access Project Monitoring Locations

The Lake Access Project team selected three locations for siting RUSS units:

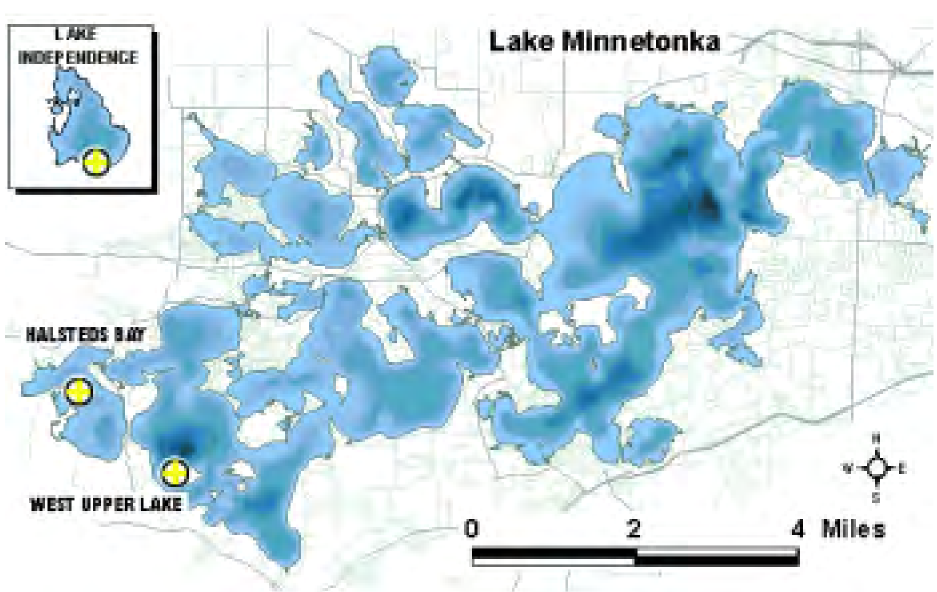
- Halsteds Bay in Lake Minnetonka, which receives runoff from a large watershed of both agricultural and urban residential land use. Because of nutrient loading from the runoff, the water quality in Halsteds Bay is poor. Halsteds Bay is subject to rapid weather-related mixing during the summer because 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.

Monitoring Site-Selection Checklist

- ☐ 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?
- ☐ Will people in your community support equipment installation and remote time-relevant monitoring at your locations?
- ☐ 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?
- ☐ Will monitoring equipment be safe at your locations? In other words, will equipment be especially susceptible to vandalism, tampering, or damage?
- ☐ What local, state, or federal regulations will you need to consider when choosing your locations?
- ☐ 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?
- ☐ 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?
- ☐ Can you adequately survey and assess your locations? What equipment-specific considerations will you need to make?

- 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.

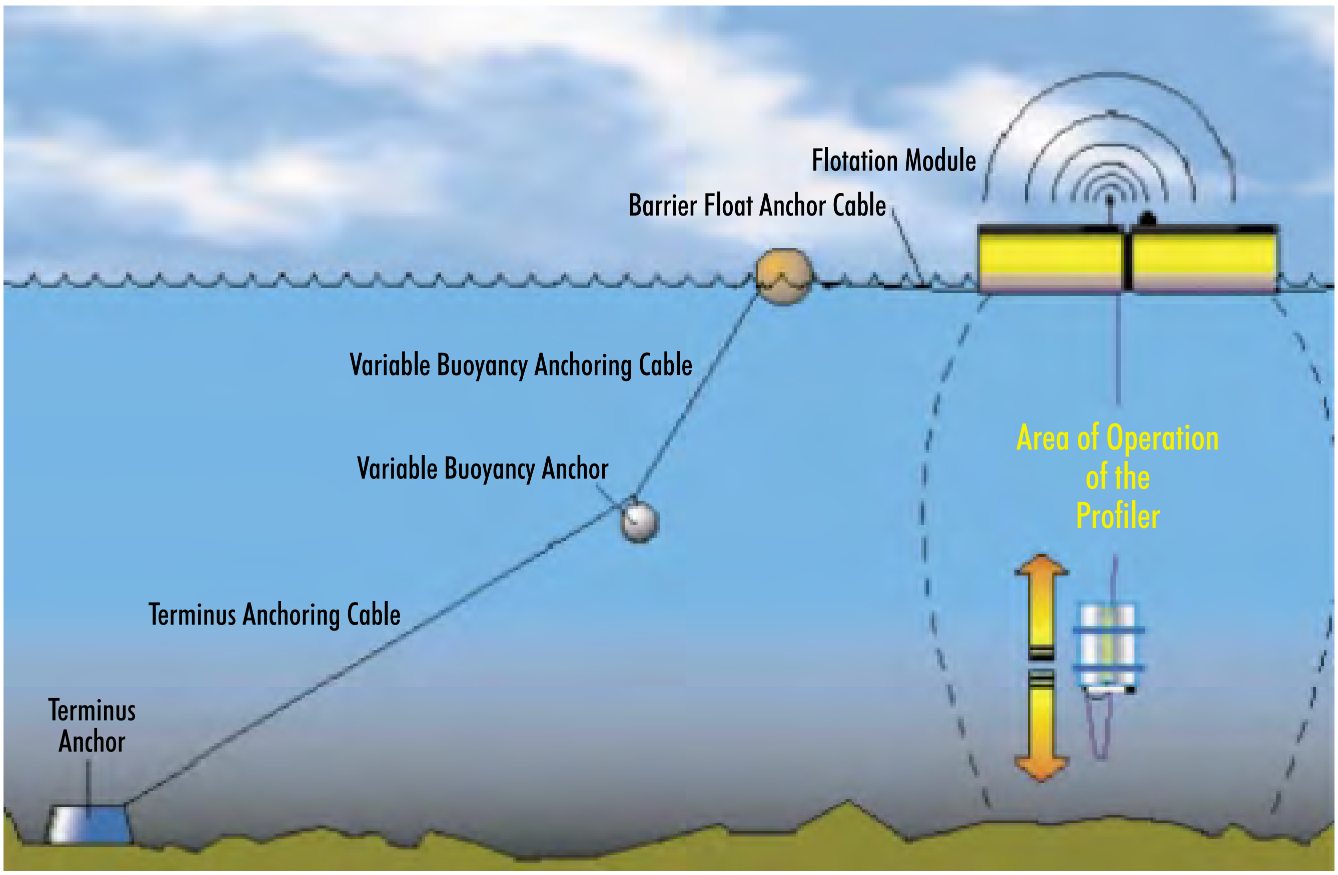


Diagram of the recommended anchoring system components (only one of the three lines is illustrated). (Taken from the RUSS System Manual, available from Apprise Technologies at http://www.apprisetech.com.)

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.

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:

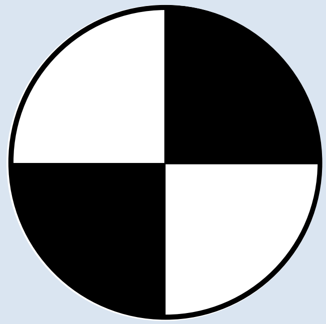
- Chlorophyll-a measurements show how much algae is present in the water.
- Total and soluble reactive (i.e., dissolved) phosphorus measurements indicate the amount of phosphorus available for algae growth. Very little phosphorus is needed to dramatically change lake water quality; one pound of phosphorus 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 on page 34) 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.

(continued on next page)

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.

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.

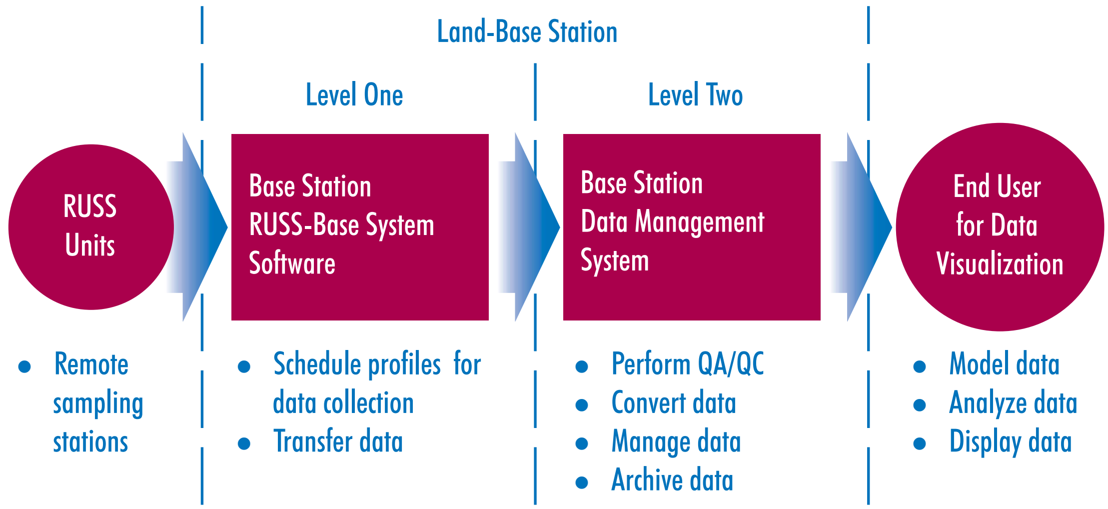
4.1 System Overview

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 on the following page):

- *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, section 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.

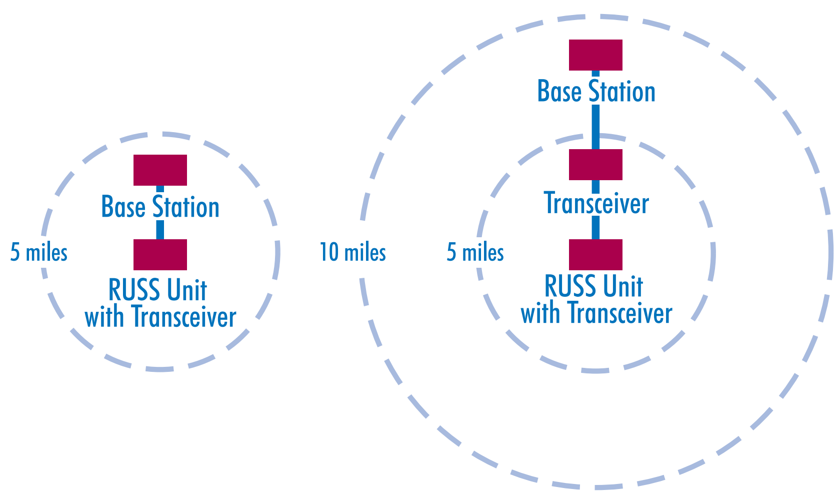
Tip. To test the connection between a CTM unit and a RUSS unit, you can call the test line maintained by Apprise Technologies, which is usually pre-programmed into the CTM. (Before you dial, be sure to switch the unit to the proper pre-programmed number by using the key pad.) On certain CTMs, you can 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 c*lk2403.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.

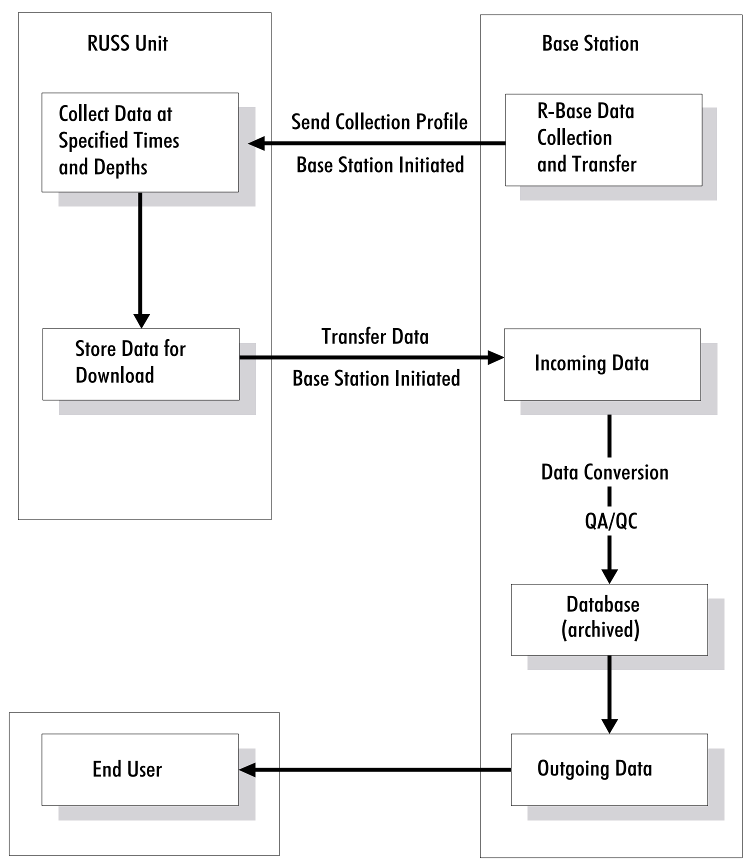
4.3 Programming Your System for Scheduled Transfers of Data

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.

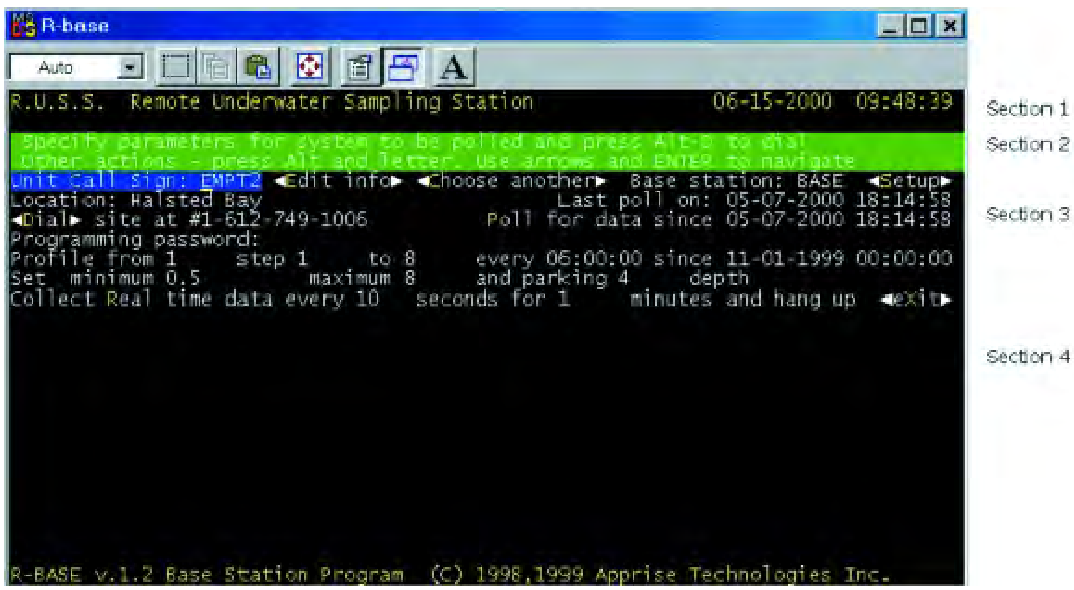


The following instructions provide an orientation to the system using a combination of screen shots and descriptive information.

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.



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:

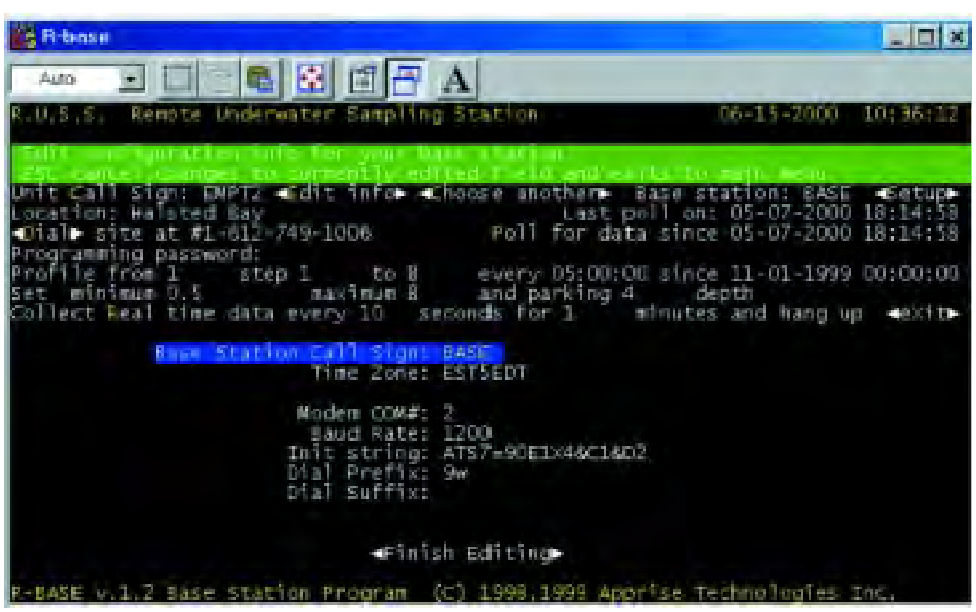
Function	Short Cut Key	Screen Name	Description
Setup	Alt-S	RUSS-Base Setup	Enter base station call sign, time zone, parameters of your modem, and data collection information
Real-time data	Alt-R	RUSS-Base Setup	Enter "real-time data" parameters
Poll for data since	Alt-P	RUSS-Base Setup	Enter "poll for 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 List	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 Display dialing status
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.



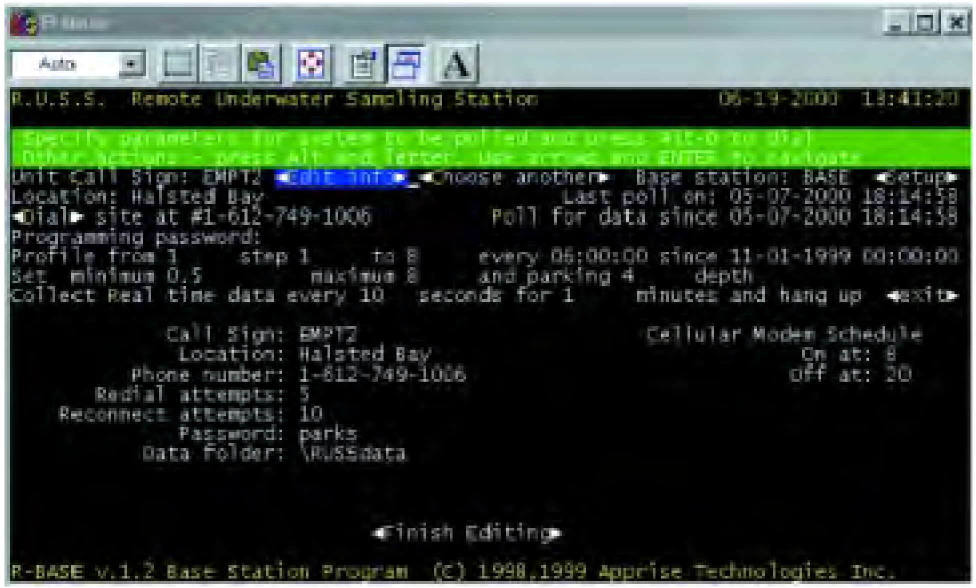
On the Setup screen, enter the information requested for various parameters, explained in the table below:

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	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 on page 48 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 on page 48 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 on page 48 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 the profiler will remain when inactive. The screen shot on page 48 shows the following parameters: *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 programming 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.



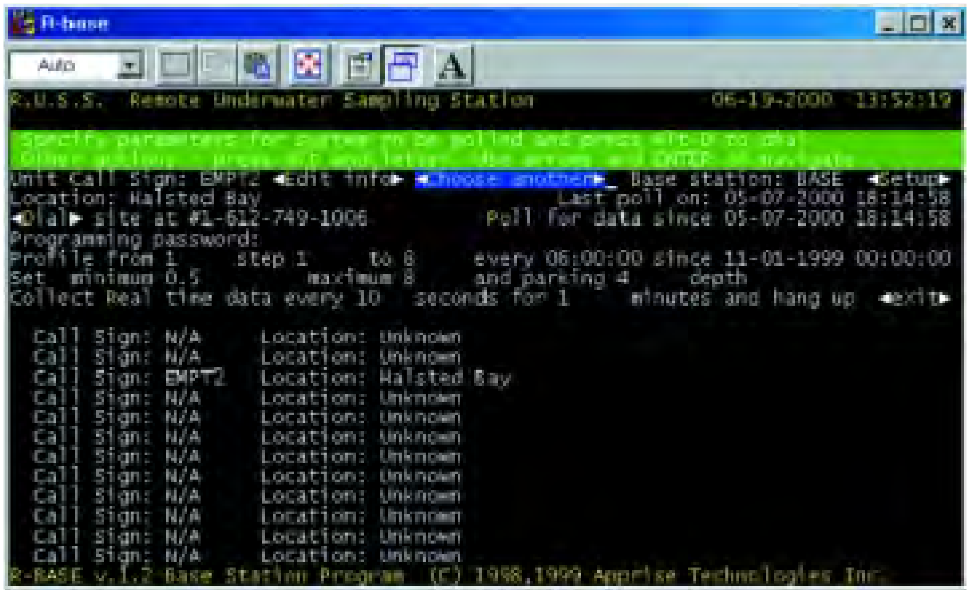
Using this RUSS unit Setup screen, enter information about the various RUSS unit parameters:

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.

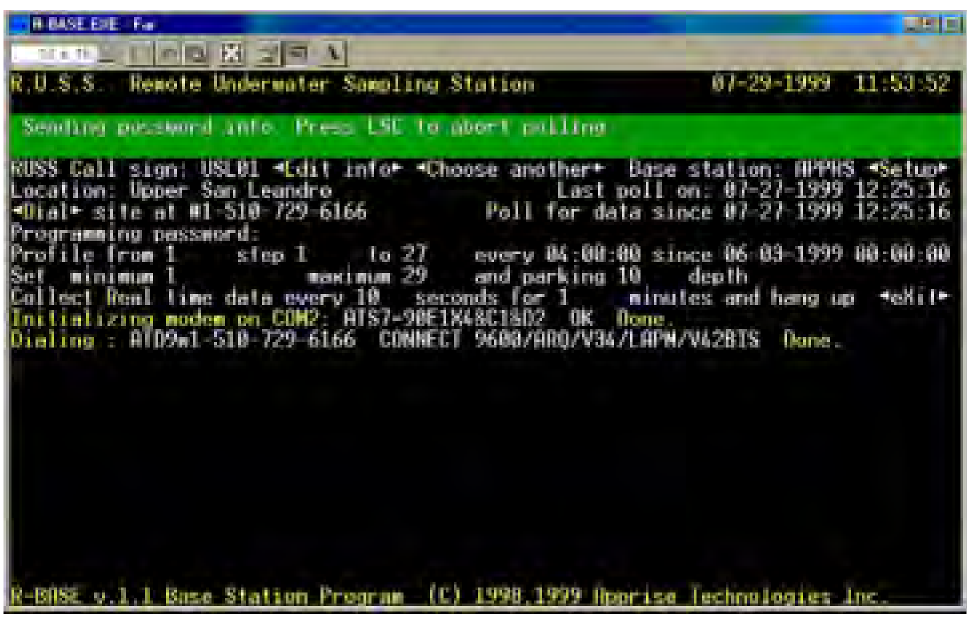
You have now set up your system with profile schedules and RUSS unit information—so that you can control your RUSS unit data collection activities. You are now ready to direct your RUSS units to collect data according to the profile schedules and to transfer back the collected data.

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.



To call the unit, select dial (Alt-D), which initiates the call and accesses the screen shown below.



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.

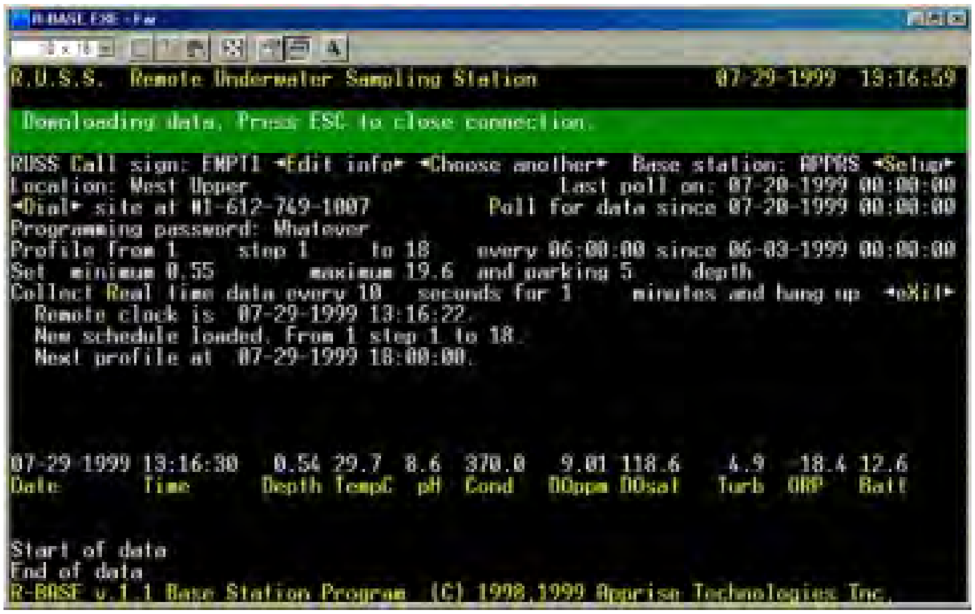
Once a connection is established, the RUSS unit will first validate the programming password if you are loading a new profile schedule. If the programming password is valid, the RUSS unit will report back the time of the next scheduled sample collection and data transmission, as well as profile parameters.

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, RUSS-Base 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 on page 53). An "End of data" message will be displayed when the transmission is complete.



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	07:32:07	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	< 0.2°C
Dissolved Oxygen	< 10 percent	< 0.5 mgO_2/L
EC (25° C)	< 10 percent	< 5 uS/cm
pH	< 10 percent	< 0.2 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° Celsius
pH	< 5 or > 10
EC at 25° C	< 1 or > 600 uS/cm
Dissolved Oxygen (DO)	< -1 or > 20 mgO_2/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.

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 Visualization Tools	Lake Access Live: Near Real-Time Display of Numeric Data; Profile Plotter; Color Mapper; Depth versus Time (DxT) Profiler	• Explore lake data as it varies 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.

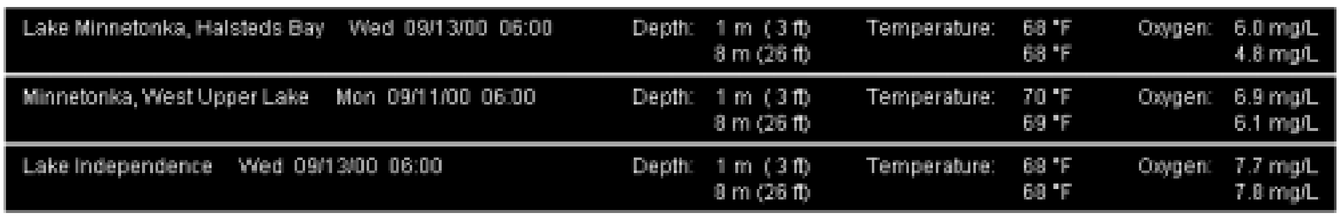
You can obtain the DVT tools by contacting Apprise Technologies at 218-720-4341. They are available individually, or as a package called the DVToolkit. The tools are easy to install and are appropriate for a wide variety of platforms, including Windows 95/98/NT, Unix/Linux, and Macintosh. You can run 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).

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.



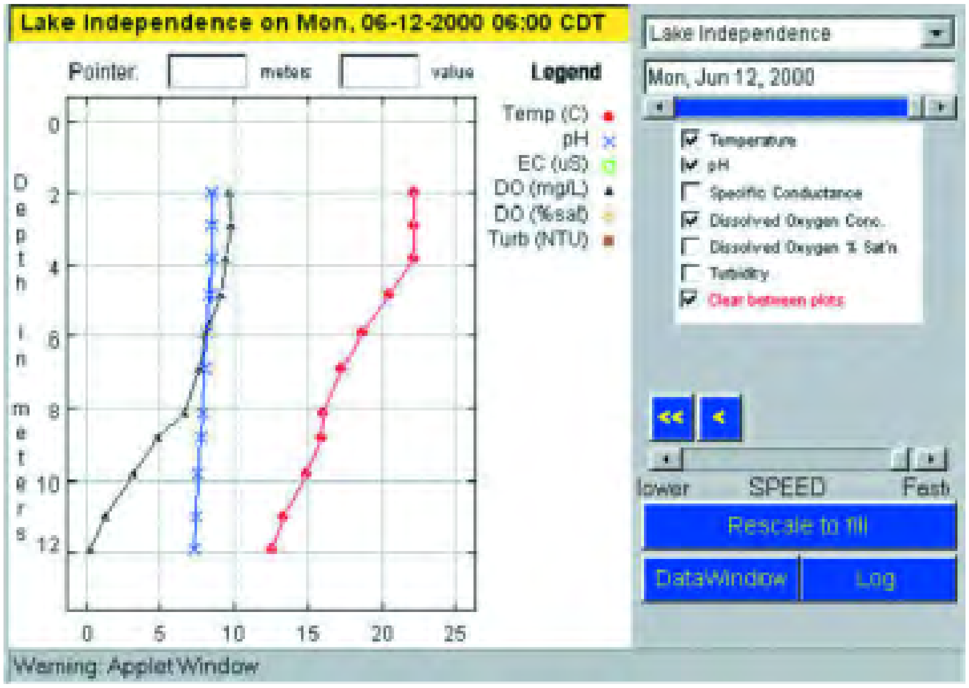
Profile Plotter

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 at the top of page 63 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.

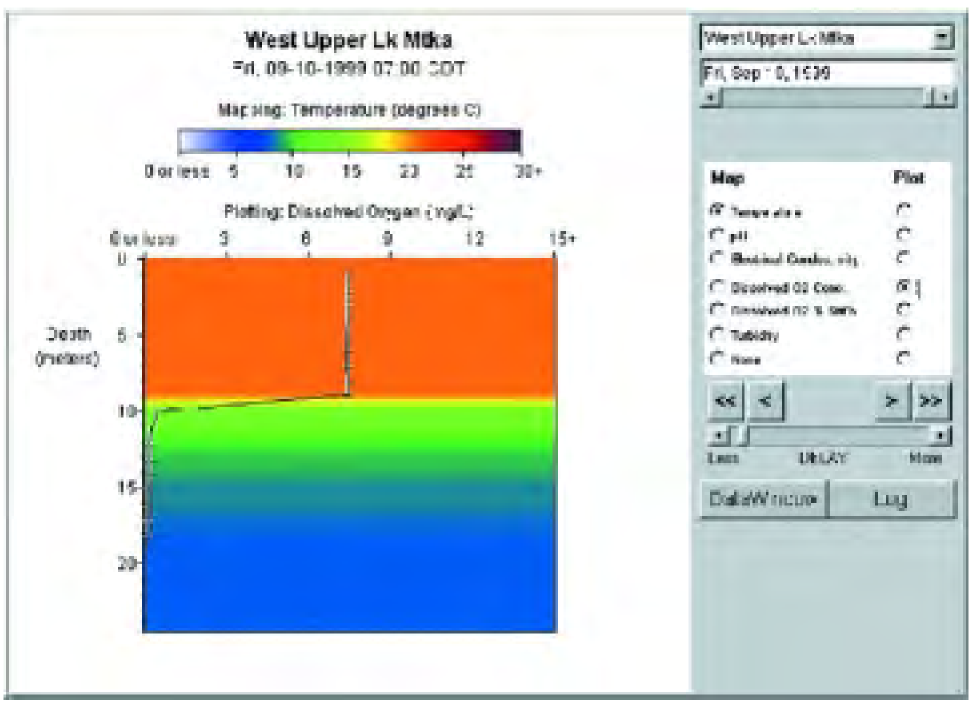
Color Mapper

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.



Profile Plotter



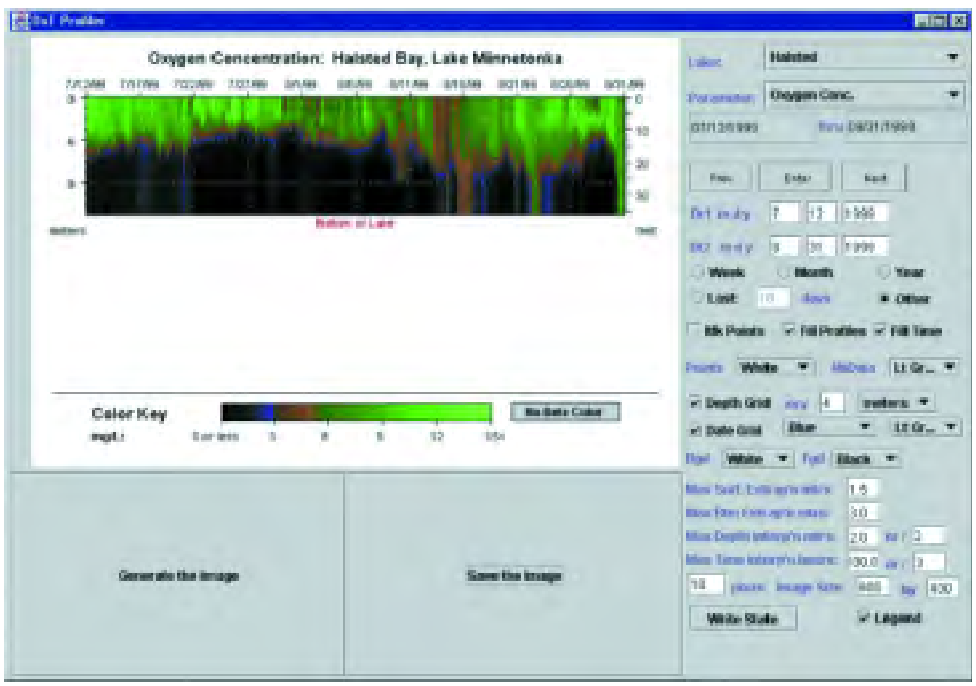
Color Mapper

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.

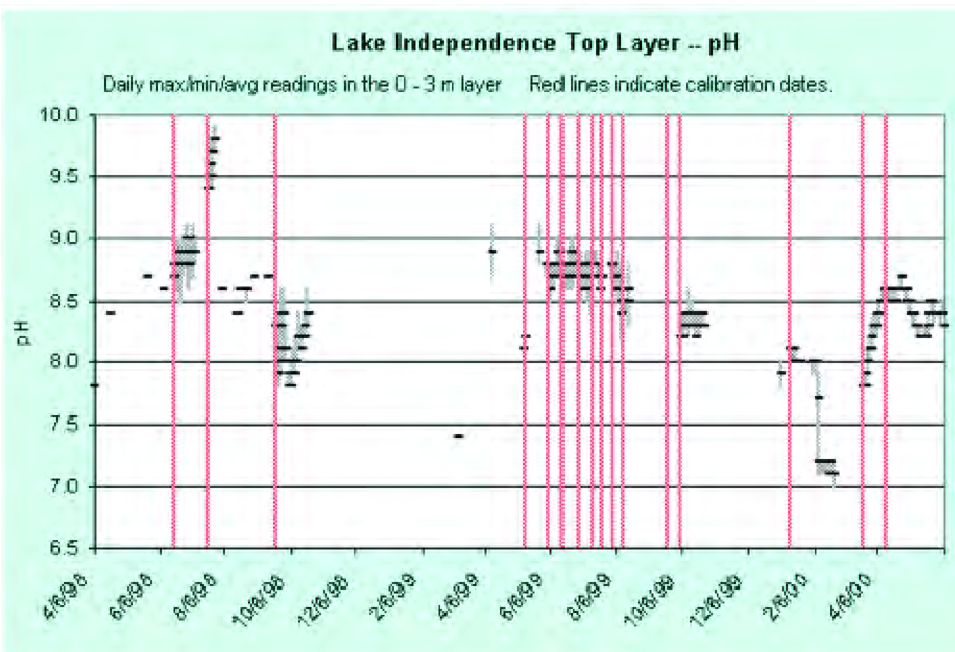


The screen above shows the changes in oxygen concentrations over time in Halsteds Bay, which is highly eutrophic. The color contours used to display oxygen are based on biological breakpoints that are important to fisheries management. The green colors represent acceptable oxygen levels for fish populations. 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

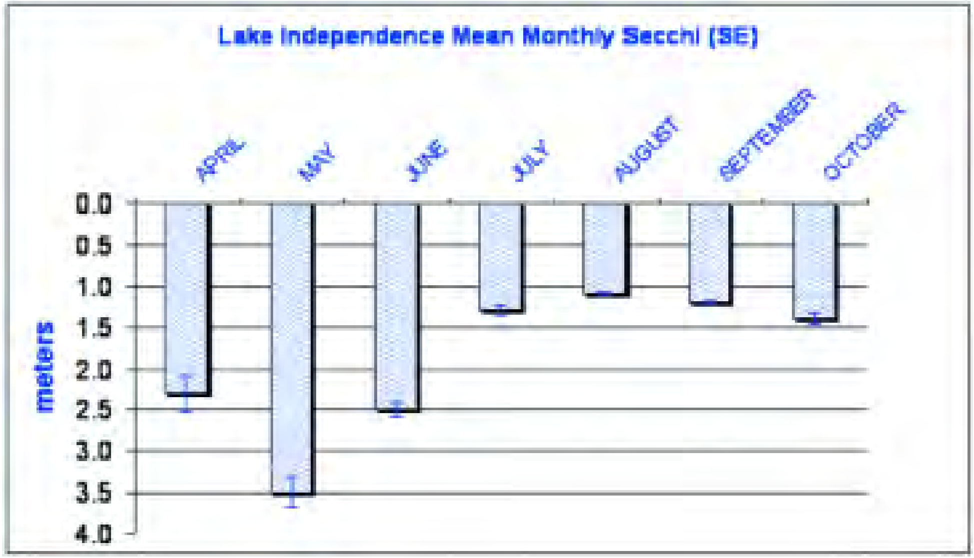
Simple spreadsheet programs such as Microsoft Excel and Lotus 123 can also be used to visually characterize lake data. These programs can be used to create graphs and tabular summaries of various water quality parameters plotted over time or versus depth. The resulting graphs and tables can be used to 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 page 34 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:

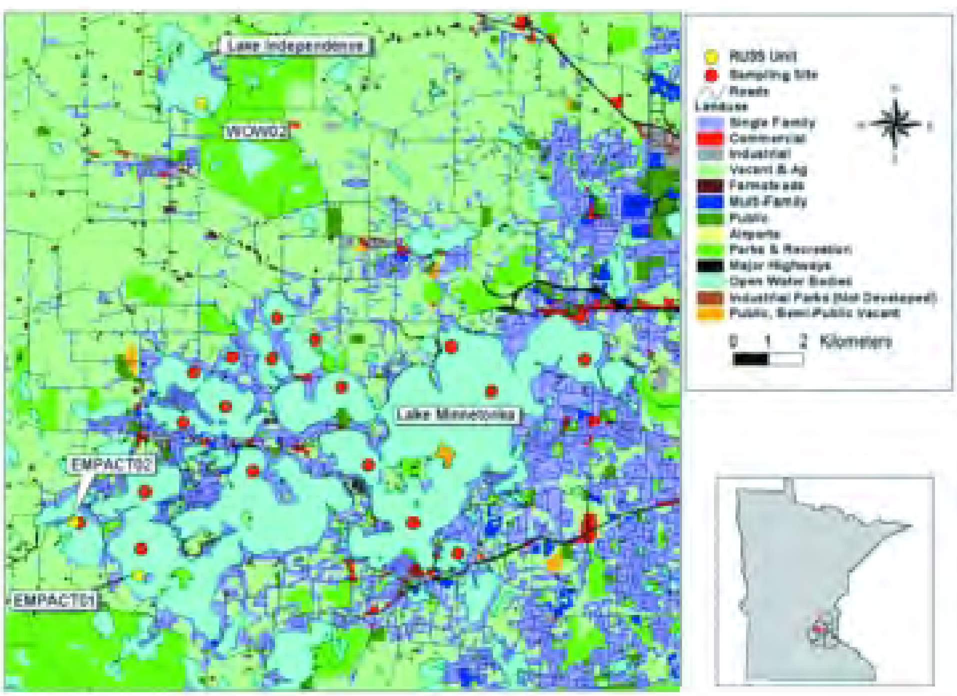
- ESRI (http://www.esri.com), whose suite of tools includes ArcInfo, ArcView, and ArcIMS internet mapping software

- 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).



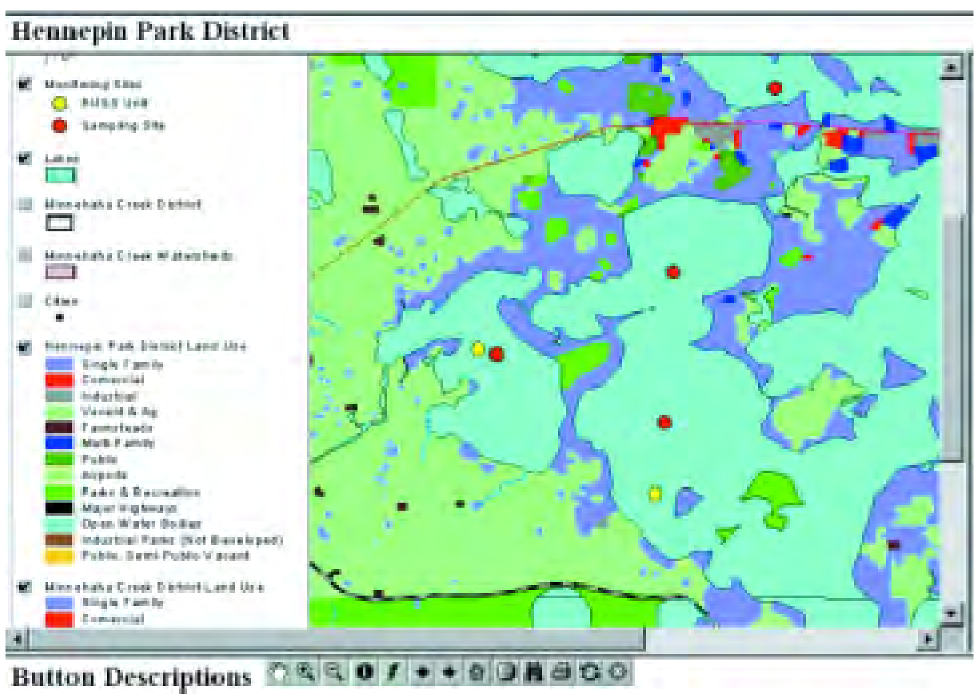
Maps of this type can help inform the public and local officials about connections between local water conditions and current land uses in their communities.

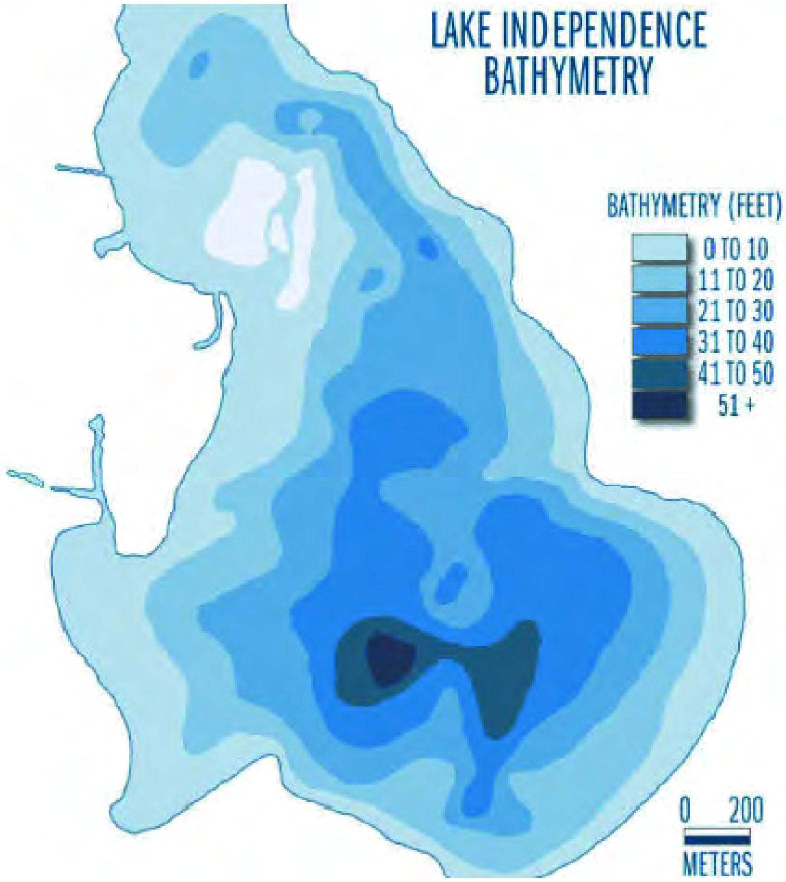
GIS Features on the Lake Access Web site. The Lake Access team has developed a user-friendly and engaging map-based product for the land use page of its Web site at http://www.lakeaccess.org/landuse.html. This Web-based capability is a powerful way to distribute GIS data, allowing thousands of interested 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.





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.

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 (For example, a goal might be to encourage the public to improve its shoreline management practices.) Once you have established your goals, every other element of the plan should relate to those goals.

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, Section 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/quailty/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/resources

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.

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™): 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

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:

- 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

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, graphics, and text.

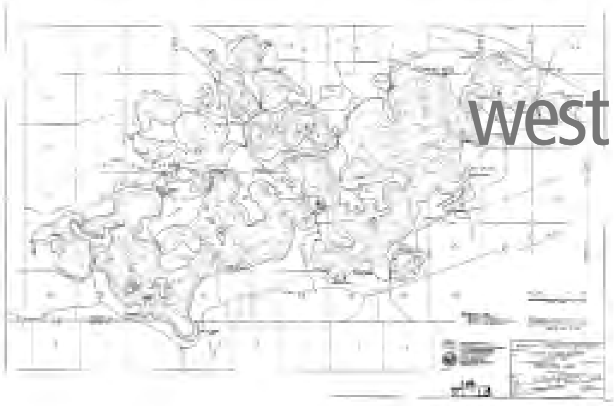
Making a Difference

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.

Please check out the Web site at:

www.nrri.umn.edu/empact

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

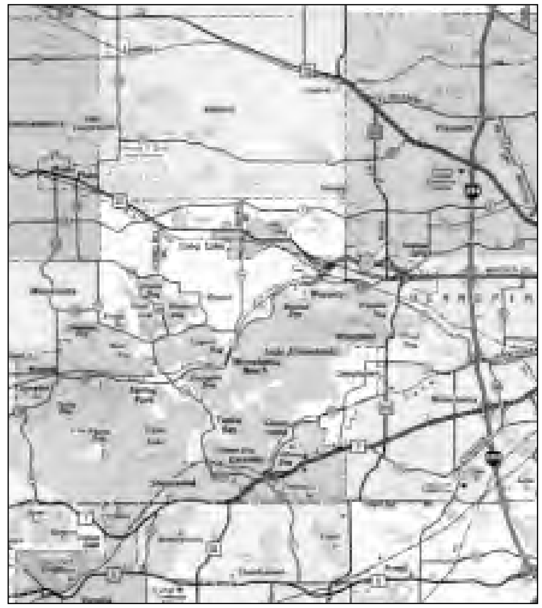
See the enclosed brochure and browse our Web site at: **http://www.nrri.umn.edu/empact**.

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/ HOMES				

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 AROUND THE WORLD.

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

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FIRST-CLASS MAIL PERMIT NO. 692 DULUTH, MN

POSTAGE WILL BE PAID BY ADDRESSEE

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