Massachusetts Volunteers Guide for

Surveying a Lake Watershed and Preparing an Action Plan

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Lake Watershed Survey—Introduction

Section 1

What's Here?

Community volunteers are energizing efforts in Massachusetts to restore bodies of water to healthier conditions. By collecting information and educating themselves and others about water quality problems, volunteers are strengthening stewardship for the environment in the Commonwealth. Today, the number of volunteer groups taking on challenging water quality problems in lakes, streams, coastal waters, and wetlands is growing. Neighborhoods, businesses, organizations, and government are coming together to solve environmental problems in new and more effective ways. Local leaders and citizens like you are taking responsibility and working together with other communities to find and correct pollution problems that are damaging local waterbodies.

Designed for citizens and local leaders, this Lake Watershed Survey guidance empowers community volunteers and provides the tools to identify and alleviate common sources of pollution that are associated with different land uses. This guide includes basic information about water pollution and lakes, direction for working with a steering committee and volunteers, a step-by-step process for conducting a lake watershed survey, and considerations for recommending and implementing a lake management action plan.

Lake watershed surveys

Lake watershed surveys can help protect water quality and aquatic life. The primary objective of a survey is to locate as many potential pollution problems in the watershed as possible. By identifying sources of pollutants within the watersheds of Massachusetts lakes, volunteers will bring attention to issues that need to be corrected. A second, equally important objective is to help the watershed community understand how land use influences lake water quality. Once awareness is raised, people are more likely to change habits that are damaging to lakes.

Addressing a lake's water pollution problems on a watershed basis makes sense. A watershed is defined by the movement of water from the geographic high points to a common low point such as a river, lake, or bay. Thus, the flow of rain and snowmelt on and in the ground is along pathways that are defined by watersheds. Because of these flow patterns, surface and ground water transports pollutants within a watershed, rather than along municipal or other created boundaries. Consequently, neighboring communities are connected by the water within a watershed, and they share the responsibility to protect it.

Clean lakes are vital to Massachusetts' economic and ecological well-being. Massachusetts lakes are used for drinking water, recreation, and flood control. Lakes also provide wildlife habitat and irrigation for farmland. However, despite regulatory protection, such as the Rivers Protection Act, the Wetlands Protection Act, and Title 5, hundreds of Massachusetts lakes have pollution problems,

Bold italics indicates that there is related information in an Appendix.

including an overabundance of aquatic plants and algae, a buildup of sediment, infestation of nonnative plants, and mercury contamination in fish. Pollution impairs or reduces the ways in which Massachusetts lakes may be used. Pollution can make water unsafe or unhealthy to swim in and can cause restrictions or prohibitions of fish and shellfish consumption. It also can lead to expensive treatment of drinking water in reservoirs. As clean water becomes less plentiful, protecting lakes and eliminating pollution becomes critically important to all of us.

This Lake Watershed Survey guidance has been developed by the Massachusetts Department of Environmental Protection to support the state's Total Maximum Daily Load (TMDL) program for lakes.

Today, the federal and state governments are approaching water quality problems in a systematic way using the TMDL provision in the federal Clean Water Act. TMDLs are required for all waterbodies–such as lakes–which are impaired by pollution. The ultimate goal of the TMDL program is to assure that all waters in the nation can be used and protected, appropriately.

A TMDL is defined as the greatest amount of pollution a waterbody can accept without causing impairment and still meet the Clean Water Act standards.

In practical terms, developing a TMDL requires knowledge about the sources, types, and amounts of pollution that are causing damage to a lake or waterbody. Once the pollution problem is understood, a determination is made of the amount of pollution that can be tolerated by the waterbody. That amount is divided among all the sources of pollution, including piped groundwater and over land runoff that flow into the waterbody. In most cases, sources of pollution will need to be reduced or eliminated to attain acceptable pollution levels, and landowners will need to take greater

The Importance of Watershed Surveys

- **Raise awareness to protect lakes from nonpoint source pollution.**
- **Collect information to track changes in the watershed.**
- **Determine watershed problems, their location, and seriousness.**
- **Give landowners information on how to reduce nonpoint source pollution on their property.**
- **Provide information for a lake management action plan to protect and restore the lake.**

responsibility for watershed stewardship. This will require some changes in current land use activities, storm drain systems, and other practices with discharges to waterbodies.

The guide describes a simple and effective visual assessment method to identify existing and potential sources of problems in a lake watershed. Other lake assessment and monitoring techniques also are used to evaluate the environmental conditions of Massachusetts lakes and ponds. While separate from this survey, in-lake and shoreline studies can be used to supplement this lake watershed survey. Although soil erosion issues are emphasized in this survey, the guidance includes land use activities that also contribute to the phosphorus and sediment problem in lakes. Since much of this damaging lake pollution comes from private land, volunteers will need the cooperation of landowners to reduce pollutants at their sources. By participating in this important work, volunteers and landowners will gain a better understanding of land uses and their impacts.

Thank you for sharing your talents and giving your time. As you visit sites and gather information, there will be an opportunity to share knowledge with residents and landowners in the watershed. Take advantage of these opportunities; they will help improve decisions made at the local level, and your enthusiasm may inspire greater community involvement.

About the guide

Volunteers who are new to lake watershed surveys will have a lot of questions about the work they will be undertaking. This guide explains what is expected of volunteers before, during, and after the lake watershed survey. This guide is not an in-depth resource on topics, such as lake pollution and nonpoint pollution best management practices. However, there are references, a bibliography, Web sites, and funding sources in the appendices for those interested in pursuing lake resource issues beyond the scope of the guide.

The guidance is divided into five sections, and is organized as follows:

Section 1 - Introduction provides information on lake watershed surveys, discusses the purpose of the guidance, and outlines the structure of the document.

Section 2 - Understanding Lake Pollution introduces volunteers to the lake pollution problems that the survey is addressing.

Section 3 - Organizing a Lake Survey provides an organizational framework for steering committees.

Section 4 - Steps for a Lake Watershed Survey: Field Volunteers describes the step-by-step process for conducting a lake watershed survey. It is written for field volunteers, but the steering committee also will find it useful.

Section 5 - Getting Results from the Survey is for the steering committee, field volunteers, and others interested in interpreting the survey results and translating them into a work plan of objectives and recommended activities.

The guidance also can be used to support the training workshops for volunteers. Appendices contain frequently asked questions, references, sample survey forms, a glossary, case studies, guidance for reading topographic maps, and who to call for help. Lake associations, watershed and civic groups, and municipal officials are invited to organize and join a lake watershed survey. With many impaired lakes in Massachusetts, your volunteer support is needed to identify and address lake watershed water quality problems.

The document is based, in large part, on *A Citizen's Guide to Lake Watershed Surveys: How to Conduct a Nonpoint Source Phosphorus Survey,* April 1997, prepared by the Congress of Lake Associations and Maine Department of Environmental Protection (DEP). Inspired by the success of lake watershed surveys conducted in Maine, the Massachusetts DEP adapted Maine's survey process to encourage similar survey efforts by community volunteers in Massachusetts.

Understanding Lake Pollution—The Basics

Section 2

What's Here?

Why are lakes sensitive to pollution?

Lakes are constantly receiving environmental pollution and other substances from the air, land, and water around them. Lakes can be very susceptible to damage from this uninterrupted bombardment of airborne and waterborne pollution because water exchange can be very slow, compared with streams, rivers, and coastal waters. In general, pollutants tend to stay longer in lakes, which provides a greater opportunity for impairment. Lake water is a blend of incoming water, airborne materials, and resident lake water.

A lake's pollution problem reflects what is happening on the land surrounding the lake–***the lake watershed.*** A watershed (for any body of water) is the land area which defines and directs the downhill flow of water, from the highest elevations to the body of water at the lowest elevation. A lake's watershed includes all the surrounding land that captures and drains water–through streams, ditches, groundwater, or directly over the land's surface–into the lake. Even though a watershed may extend many miles away from the lake itself, the watershed is part of the ***lake ecosystem***, and the two cannot be separated. Whatever happens in a lake watershed affects the lake ecosystem.

The health of a lake is affected by a combination of physical, chemical, and biological factors that make up the lake's ecosystem. Physical characteristics, such as the size and depth of the lake, the size of the watershed relative to the lake area, steepness of terrain, and location of streams, have an effect on lake sensitivity to pollution. Lake sensitivity also is affected by chemical factors, which may be associated with climate, the types of soils in the watershed, soil fertility and erodibility, and nutrient enrichment. In addition, biological factors relating to lake habitat and the plants and animals in the watershed will influence the condition of a lake and its sensitivity to pollution.

Where does lake pollution come from?

Nonpoint source (NPS) pollution is the greatest threat to lake water quality because it exists in many forms that are often difficult to pinpoint and control. NPS occurs when rainwater, snowmelt, or water for irrigation flows over the land, picking up pollutants and depositing them into rivers, lakes, coastal waters, or groundwater. Until recently, the focus of water protection laws and regulations has been on direct or ***point source pollution***, which comes from a discrete source or single outlet such as a discharge pipe at an industrial plant or wastewater treatment plant.

Heightened public awareness, legislation, and improved control technologies have reduced point source pollution. A great deal of progress has been made in the past few decades to reduce pipe discharges to lakes, rivers, streams, and oceans.

NPS pollution, on the other hand, exists wherever there is human activity. Residential, commercial, urban development, roadways, parking lots, agriculture, forestry, and industry all contribute pollutants that degrade water quality. These land uses not only create pollution, they also cause it to reach the lakes more readily by increasing the amount of runoff from rain and snowmelt and channeling it more directly.

The decline of lake water quality as a result of human activity in the lake watershed is referred to as ***cultural eutrophication*** (over-enrichment of the lake from human actions). The result is an acceleration of a lake's "aging" process (called succession) that can have far-reaching consequences on watershed communities, including:

- Reduced swimming and boating appeal;
- Loss of habitat and changes in fishery as habitat disappears;
- Increased expense of treating drinking water;
- Loss of shorefront property value;
- Reduced community tax revenues; and
- Increased costs to communities for lake improvement or restoration.

The pollutants carried in stormwater runoff may include ***nutrients*** like ***phosphorus*** and nitrogen, biological matter (viruses and bacteria), and ***toxic*** substances like heavy metals. Materials may be dissolved in runoff or they may be attached to sediment particles. Lakes are particularly sensitive to phosphorus and ***sediment*** particles.

Many Massachusetts lakes have been seriously damaged, and many more are considered at risk from pollution. The 303(d) list of impaired waters, prepared by the Massachusetts Department of Environmental Protection (DEP), concludes that about 727 lakes do not meet water quality standards established by Massachusetts law. The deteriorating quality of these lakes is evident by problems such as dense growth of non-native and invasive plant species, nuisance ***algal blooms,*** and metals, particularly mercury in fish. Most of these problems are associated with excess nutrients and sediments in the water.

How does land development speed up the transport of pollution into lakes?

Stormwater runoff is one of the main pathways for pollutants, such as phosphorus, to travel from the upper elevations in a watershed to a lake. The volume of stormwater runoff and the amount of phosphorus in the runoff depends on how land throughout the watershed is being used.

Forest land in undeveloped lake watersheds acts like a large sponge. The irregular depressions and rich organic ***duff layer*** on the ground surface absorb runoff from heavy rains and snowmelt, trapping and filtering the water.

The forest's tree canopy breaks the ***velocity*** of rain, which reduces soil erosion and allows moisture to be absorbed into the ground. Smaller trees and woody shrubs provide additional protection against erosion by binding the soil with their dense root systems.

Much of the phosphorus trapped by the natural filtering action of soil particles and vegetation is then taken up by the forest vegetation. As a result, the water that flows to the lake contains relatively little phosphorus.

A lake's watershed consists of all the surrounding land that drains into the lake. Watersheds can extend for miles.

As a watershed is developed, trees and ground cover vegetation are removed. Soils are disturbed, compacted, and covered with pavement and structures. Natural ground surface irregularities are smoothed out to create lawns. Much of the rain and snowmelt that would have been absorbed into the ground runs off the surface of roads, parking lots, buildings' rooftops, fields, and lawns.

Ultimately when land is developed from its natural condition, and replaced with paved and impervious surfaces, the volume of stormwater runoff increases. Higher volumes increase the velocity at which the runoff moves through the watershed. With both increased volume and velocity, runoff travels greater distances toward streams and lakes. The added force of the runoff causes erosion of more soil from road surfaces, shoulders, ditches, stream channels, and shoreline areas.

A multitude of pollutants may be picked up and carried in runoff from developed areas. Soil particles, road salt, lawn fertilizers, herbicides, pesticides, animal excrement, oil, and gasoline residues from streets and parking lots are just a few of the potential pollutants in runoff from developed watersheds. Typically, phosphorus concentrations in runoff from developed areas are much higher than they are in runoff from an undisturbed forest.

Phosphorus — A Damaging Lake Pollutant

What is phosphorus?

Phosphorus is a natural substance found in nearly all plant and animal matter. It is an important building block for plant and animal cell ***metabolism***, and it is a nutrient (fertilizer) essential to all living organisms. Nearly all soils contain phosphorus. Fine soil particles like clays, silts, and rich organic soils contain very high concentrations of phosphorus. Septage, manure, and street runoff also contain high concentrations. Phosphorus is a common ingredient in lawn and garden fertilizers, and is found in gasoline and oil residues.

What are the effects of too much phosphorus on lakes?

Lakes are very sensitive to phosphorus and other nutrients. The amount of phosphorus influences biological growth in a lake. Even small increases of phosphorus can cause problems.

The amount of phosphorus in lake water determines the amount of vegetation–the more phosphorus that reaches the lake, the more ***algae*** and aquatic plants that can grow. Although algae are an important component of the lake ***food chain,*** too much algae growth causes the water to turn green and cloudy, and generally undesirable for most recreational uses, especially swimming, and balanced aquatic life.

Table 1: Land Use and Phosphorus

Land Use	Source of Phosphorus	Comments
Agriculture	• Tilled soil • Animal waste • Fertilizers • Diverted field runoff that flows into road ditches • Unstable stream banks, or shoreline areas from livestock grazing	Agriculture creates the potential for high phosphorus runoff. There may be large areas of exposed soil, concentrated water diversions, fields tilled too close to road ditches, and livestock grazing too close to streams or the lake. Runoff from manure storage areas can also be a serious problem.
Commercial/ Urban Development	• Exposed soil from construction sites • Gasoline and oil residues from road surfaces • Sand and gravel from roads • Large paved areas and parking lots without adequate stormwater controls	High runoff volumes from buildings and parking areas can erode streambanks. Urban runoff contains moderately high levels of phosphorus and many other pollutants that are potentially harmful to water resources. Sand spread on roads in winter is easily washed into storm drains, streams, and ultimately into the lake.
Residential Development	• Soil erosion from construction sites • Soil erosion from subdivision and camp roads • Runoff from fertilized lawns and gardens • Animal waste (pets) • Failing septic systems	The phosphorus pollution potential is high partly due to rapid growth of residential development in many watersheds. The cumulative phosphorus load from residential areas (including roads) throughout the watershed can easily exceed all other land uses in the watershed combined.
State and Town Roads	• Soil erosion from road surfaces, shoulders, and ditches • Erosion from unstable banks or bridge scour • Ditches discharging directly to streams • Inadequate stormwater controls (e.g., catchbasins, detention ponds)	A significant source of sediment in most watersheds is the extensive network of roads and inadequate construction and maintenance standards.
Forestry Operations	• Soil erosion from skidder trails,clear cuts, log yards, logging roads, and stream crossings	Forestry operations can be a high source of phosphorus due to soil exposure and erosion from logging trails. Streambank erosion may occur due to increased runoff from heavily logged sites.

Excess algae growth also can cause a decline of oxygen in the water. This can seriously impair aquatic ***habitat,*** resulting in the slow decline of some sensitive species such as trout and salmon. In extreme cases, algae "blooms" can cause thick, foul-smelling scums to form on the water surface, and large numbers of fish and other organisms may die from oxygen depletion. Left uncontrolled, the effects of cultural eutrophication will result in the lake's decline.

Measuring phosphorus — How much is too much?

Natural phosphorus levels in lake water are normally so low that they are measured in parts per billion. A part per billion (ppb), is equivalent to 1 grain of salt in about 35 gallons of water. Lakes that have phosphorus levels in the 3-5 ppb range are typically clear and have good water quality. Levels of only 15 ppb or more, however, can cause lake water to turn green from excess algae growth. Phosphorus concentrations in Massachusetts lakes range from approximately 3 to 100 ppb, with a relatively high average level of 18 ppb.

Soil erosion and phosphorus.

Fast-moving stormwater accelerates land ***erosion***. Eroded sediment is transported downstream into streams, rivers, and lakes, where it eventually settles out. When soil particles erode, they travel with the runoff. Dissolved phosphorus and very small soil particles can travel great distances in stormwater runoff. The erosion and sedimentation problem is enormous—it has been estimated that as much as 80 million tons of sediment a year are eroded from construction sites. Because phosphorus and sediment can affect lake water quality so negatively, this guide places emphasis on identifying and reducing sources of stormwater runoff and sediment enriched with phosphorus.

Detached soil particles (sediment) from eroded areas also can cause serious damage to the streams that feed a lake by smothering sensitive habitat for fish and aquatic insects. Sediment that travels to the lake causes similar damage.

You can actually see the difference.

The difference in runoff quality can be easily seen during a rainstorm. Look at the runoff from a residential or commercial area flowing through a road ditch or small stream. Compare it with that of a small brook in the forest. Runoff from forested areas does not begin to flow until the soil is saturated with water and natural depressions in the forest floor have filled.

A lake's watershed consists of all the surrounding land that drains into the lake. Watersheds can extend for miles.

In developed areas, runoff begins to flow almost immediately off the ***impervious surfaces,*** such as paved roads and roof tops. Also, the appearance of the water differs significantly. Runoff from developed areas is normally brownish-gray in color. But runoff from stable, forested areas is usually clear, except in severe storms where it may become cloudy due to soil erosion.

Collect water in a mason jar from a forested lake. Compare it with lake water from a residential neighborhood. Photos of the two jars are effective for public presentations.

Certain land uses release higher phosphorus levels in stormwater runoff.

Phosphorus contributions from different land uses vary significantly from one lake watershed to another. Studies have been done to estimate the approximate amount of phosphorus released by certain land uses. These study results can be used to roughly predict a lake's annual ***phosphorus load,*** based on the land uses and soil types in its watershed, and to estimate how much the lake may be degraded.

These studies and the predictive models developed from them do not specifically pinpoint the problems causing degradation, however. That information is best determined through a watershed survey. Locating the problems and describing their nature and severity provides valuable information about the extent of problems and the overall character of the lake watershed.

The degree to which pollutants threaten a lake depends on everything that's happening in the watershed–how the land is being used, the extent of development, and the way ***surface water*** travels down through the watershed to the lake. The location of streams, soil type, and variations in the slope of the land are all factors that affect the way NPS pollutants travel to lakes. A visual lake watershed survey like this one helps to determine what's happening in the watershed and how that affects the lake.

All of the land in a lake watershed contributes phosphorus to the lake, including the undeveloped land. Different land uses have the potential to contribute greater or lesser amounts of phosphorus, depending on a number of factors.

These factors include:

- Where the development is located in the watershed (i.e. is the developed area on steep slopes, poor soils, near streams or the shoreline);
- How large an area has been developed for each type of land use;
- Whether or not measures are being used to control soil erosion and stormwater runoff; and
- How long the developed area has existed.

For example, in a small watershed with moderate shoreline development, much of the phosphorus would probably be coming from the lakeshore development. But in a watershed with a large upland area away from the shoreline, general residential development, forestry operations, farms, and commercial development would probably all be contributing to the lake's phosphorus load.

By the time pollution effects are obvious, a lake can be difficult or impossible to restore.

A lake watershed survey helps determine *where*, and *what*, the problems are. It helps us understand whether or not particular *types* of land uses are problematic. For instance, new construction activities in a particular town may not have ***erosion controls*** installed to keep soil from eroding off the site. And most important, the survey nearly always confirms that the problems are not just the large, obvious ones. There are many small situations that are commonly overlooked. Small problems add up and can cause serious water quality problems.

A lake watershed survey identifies problems and educates the public about land use activities.

Can a lake's health be restored?

Efforts to restore a lake to a healthy state, once it has declined, take a long time and are very costly. The technology to manage watershed functions is complex, and the results are often uncertain. ***When it comes to caring for our lakes, an ounce of protection is worth many pounds of cure!***

During the past two decades, a number of Massachusetts lakes have undergone restoration efforts. Some lake restoration projects may cost hundreds of thousands, or even millions of dollars, and there is no guarantee of success. However, the potential for success is improved by reducing nutrients from the watershed.

Attempts to manipulate water quality through chemical treatment may only last for a few months, and usually no more than a few years. In the three year period from 1994 to 1997, the Department of Environmental Management (DEM) awarded nearly one million dollars from the Lake and Pond Grant Program for 127 projects at 113 Massachusetts lakes and ponds for improved best management practices. While there were improvements in water quality, this level of funding addressed only some of the lakes' problems.

Although many of Massachusetts lakes are impaired, it is more economical and ecologically responsible to prevent lakes from reaching the point where restoration is needed. Fortunately, many methods for preventing or alleviating NPS pollution are simple and inexpensive. These methods, however, must be accepted as an essential part of land-use planning and long- term management. Problems associated with existing development also must be addressed.

Landowners in lake watersheds need to become more aware of the sensitivity of lakes and accept greater responsibility for the stewardship of these fragile ecosystems. Watershed education will help. Many are still unaware that, cumulatively, landowners have the greatest impact on the health of a watershed. When municipal officials and landowners recognize the "cause and effect"of their activities on a lake's ecosystem, they will be more likely to change damaging practices. This is the first–and perhaps most important–step toward changing watershed behavior, in order to reduce water pollution and provide better lake and water resource protection.

Phosphorus from a lake watershed can be reduced, by identifying and eliminating the majority of soil erosion problems.

Organizing A Lake Watershed Survey

Section 3

What's Here?

Getting organized and establishing clear roles and responsibilities can ensure a successful lake watershed survey. The initial steps are organization of a steering committee and determining reasonable and acceptable goals for the survey to accomplish.

Organizers of the survey should begin by considering the benefits of conducting a lake watershed survey. An important benefit is raising public awareness of water quality problems in a watershed and the need to protect the lake's water quality. The survey becomes an effective tool for explaining watershed concepts. The survey also is a cost-effective way to gather land-use data, making it an important component in a comprehensive strategy for water quality protection. Landowners and community volunteers can become aware of erosion and runoff problems that may exist on their property and in their community.

The project schedule below shows a list of activities for a successful lake watershed survey. This schedule allows participants to set deadlines and structure certain activities for their specific lake watershed survey. Schedules can, and probably will, vary for each watershed.

Project Schedule

Target Date	Actual Date	Activity
		◆Organize steering committee and gather information about the watershed.
		◆Run article/notice in local newspaper. ◆Hold public information meetings. ◆Conduct training sessions for volunteers.
		◆Project advisors check ground conditions and decide on start date. ◆Begin the survey. ◆Trainers schedule a day in the field to help volunteers get started.
		◆Volunteers complete and return survey forms to volunteer coordinator. ◆Volunteer coordinator checks with each team to be sure work has been completed.
		◆The team reviews data and reports findings to discuss and resolve questions concerning field data.
		◆Prepare preliminary summary of findings. ◆Address problems with the group and consider contacting landowners. ◆Hold public meetings to present findings. ◆Prepare final report. ◆Seek funding and develop watershed protection strategies.

Steps in Organizing the Lake Watershed Survey

1. Form a steering committee to guide the survey.

A steering committee will be the guiding force behind the lake watershed survey. The committee is comprised of committed individuals who are aware of the problems in the surrounding watershed. The diversity of this committee can be seen by the representation of its members. Committee members should have the ability to facilitate group interactions and the ability to build and strengthen new and existing relationships within the watershed community. People from local lake associations, property owners' groups, business groups, and educators should be on the steering committee. Local, state, and federal representatives should be asked to participate. Members can include town selectmen, managers, planning board members, and boards of health. Steering committee members also might be found in watershed teams, conservation commissions, and state and federal environmental agencies.

Steering committee members will play a number of important roles throughout the survey. Committee members need to set project goals according to the needs of the community. They will develop a long-term comprehensive strategy for lake protection based on information gathered during and following the lake watershed survey. The steering committee will communicate with town officials, resource agencies, and the local media, as well as plan community information meetings. Another responsibility of the steering committee is recruiting volunteers and support personnel. Members of the group will be responsible for ensuring that field volunteers get the necessary training, checking identified sites, and preparing the final report.

Key roles in the lake watershed survey project are:

Survey Coordinator: Responsible for coordination of the specific projects, including overseeing the activities of the steering committee.

Volunteer Coordinators: Responsible for coordinating activities of the volunteers, including distribution of materials and the collection and preliminary review of data. These individuals will assist volunteers on technical issues, training, conducting follow-up work in the field, and writing the final report.

Documentation of organizational time may prove valuable in demonstrating the level of commitment that a group of individuals, an organization, or town has made to the project. This may be very useful if additional assistance is needed for a follow-up project that may have been identified in the survey. The amount of time will depend on the size of the watershed and the level of detail in the Lake Watershed Action plans.

2. Identifying concerns and issues.

Why conduct a lake watershed survey? Be prepared to answer this question. Is there a specific problem with the lake that justifies the survey? If not, does the watershed community recognize the value and sensitivity of the lake, and want to protect and maintain that value? These questions should be answered early in the organizing process.

Each town in the watershed should be represented on the steering committee, regardless of whether the lake itself is in those towns.

Before enlisting help from the public and agencies or organizations, project organizers should be able to define the concerns and basic issues. Much of the background information needed to discuss the issues is included in *"Understanding Lake Pollution,"* Section 2 of this manual. Often, additional information about the lake can be obtained by contacting the Massachusetts Department of Environmental Protection ; Bureau of Resource Protection; Watershed Planning Program; the Department of Fisheries and Wildlife's Riverways Program; the Executive Office of Environmental Affairs (EOEA) watershed team leader; or the Department of Environmental Management (DEM) Lakes and Ponds Program.

There may be a great deal of information already available about the lake and its watershed. Watershed maps are available from DEP and EOEA watershed team leaders. Soil and aerial survey maps are available from the Massachusetts Geographic Information System (MASS GIS) and Natural Resource Conservation Service (NRCS). Towns may have drainage maps available. Conservation commissions also may have information concerning land use problem areas in the watershed and examples of ***Best Management Practices*** (BMPs) that are in use. Finding information about the watershed and lake before volunteers begin will prevent repetition of information about problem areas that have been identified through other agency research.

3. Communicate and involve the watershed community.

Community support is critical to the success of a lake watershed survey. Before beginning the survey, talk with community ***stakeholders*** (area business people, lakefront property owners, and town officials) to let them know what is planned and to get their support. This also would be a great time to recruit volunteers for the survey!

Communication early in the process will educate and inform citizens about the project well in advance of the field survey. Community members may point out problem areas in the watershed before field volunteers do their work. Key members of the steering committee should work with landowners to identify sites and sources of technical assistance. Early awareness helps address citizens' questions and concerns. Landowner involvement should be emphasized when the project is discussed with members of the community. Misunderstanding about the survey objectives can be avoided when landowners are fully knowledgeable of the project.

Publicizing the survey process in advance, and holding public information meetings, will help ensure that the public understands the nature of the project and the need to access private land. Watershed association newsletters and Web sites can be used to publish information about the lake watershed survey. Regular communication with the public is the most effective way to avoid misconceptions about the project's purpose, findings, and recommendations.

Send a letter of explanation to landowners before the survey

Develop or obtain a mailing list for landowners in the lake watershed, and mail a letter explaining the survey. A one-page explanation of the survey objectives and the name and telephone number of contacts (e.g., a survey coordinator or watershed team leader) provides every landowner with an opportunity to ask questions about the project. These letters also provide another opportunity to ask for volunteer participation!

Organize public information meetings

Ideally, public meetings should be scheduled throughout the life of the project, and information about the survey should be available at town meetings.

Hold public information meetings to explain the purpose and procedures of the project to interested members of the watershed community. Invite the press to *all* public meetings and to attend volunteer training sessions. Send press releases to the local newspaper with progress summaries as the project proceeds. Local television reporters should be invited to attend public meetings. Make use of community bulletin boards in churches, schools, supermarkets, and public libraries to help raise awareness of the survey and its progress.

Speak with property owners during the survey

As a general rule, permission must be obtained before volunteer surveyors enter private land. Steering committee members should make every effort to make landowners aware of the project before volunteers begin the survey. Surveyors also should speak to property owners before entering their land to avoid potential conflicts or misunderstandings. This contact gives volunteers an excellent opportunity to explain the survey and educate the property owner. Information about how to approach landowners should be included in the training for field volunteers.

Landowners who do not wish to participate in the survey can notify the committee so their property will not be surveyed. However, not everyone will be aware of the project, and property lines are not always easy to determine. Town assessors maps can be checked, copied, and carried in the field to determine property ownership.

Leave information with property owners

If owners are not home when the survey is conducted, field volunteers should have a prepared statement about the survey along with a contact name and phone number. Volunteers should leave this information at the house and recontact the landowner another time. Do not survey any property without permission.

4. Involving agencies and organizations.

A number of local, state, and federal agencies and organizations can provide technical experience, guidance, and direction. Many of the members of these organizations become involved in their local lake associations and are willing to contribute their technical expertise for the lake watershed survey. The following are examples of the resources provided by organizations and groups that can assist in the survey process, both technically and financially. ***(See also Appendix D for contacts and Web sites for the following groups.)***

The Executive Office of Environmental Affairs watershed teams and local watershed associations can provide valuable help in all phases of the project. Technical expertise and materials, such as watershed maps, may be acquired through these groups. They should be among the first contacted.

Municipal governments should not only be informed about the survey but encouraged to participate. Clean lakes benefit communities in many ways. High property valuation around clean lakes result in higher tax revenues for cities and towns. Tourists, who are more likely to visit clean lakes and patronize local businesses, can increase local revenues substantially. Municipalities may be willing to cover the cost of materials required for the survey and expenses for professional oversight. It is essential that municipal officials be kept fully informed of the progress and findings of the project. They are likely to field questions from the public and they need to provide accurate information.

Conservation commissions can be an excellent source of information about the lake watershed. The commission may have already identified or mapped sensitive areas. Commissioners may be interested in participating on survey teams. They also may have aerial photos. Coordination with a local conservation commission in preparing the final project report may add credibility to the findings and recommendations of the survey team.

Regional Planning Commissions (RPCs) may be able to identify problem areas in the watershed and help organize information. RPCs may be willing to direct organizers to key people in the watershed towns. They may know of grants for the survey work and be willing to assist with the development of grant proposals for restoring problem sites identified during the survey.

The University of Massachusetts Cooperative Extension should be made aware of the project and approached for help. They work with agricultural producers in improving nutrient management and pesticide reduction. They also work to solve wellwater problems and conduct environmental education projects.

The Massachusetts Water Watch Partnership provides training and technical assistance to organizations that conduct water quality monitoring programs in Massachusetts. The partnership also can be a resource for finding funding opportunities. This group is affiliated with the University of Massachusetts at Amherst Water Resources Research Center.

The Watershed Planning Program in the Division of Watershed Management, Massachusetts DEP maintains water quality files for many Massachusetts lakes. They may have useful information on land use activities in your lake watershed, as well as extensive historical data about the watershed.

The Drinking Water Program in the Division of Watershed Management, Massachusetts DEP will have information on lakes and reservoirs that are active drinking water sources. DWP is conducting the ***Source Water Assessment Program*** to identify and map potential contaminant sources in Massachusetts drinking water sources. ***(see appendix E for more information)***

The North American Lake Management Society (NALMS) is a nationwide organization that creates partnerships among citizens, scientists, and professionals to further the protection and management of lakes. NALMS Web site at www.nalms.org has links to the New England chapter. Contact the New England chapter for information on workshops.

The Massachusetts Congress of Lakes and Ponds (MACOLAP) and ***LAPA-West*** promote and support the formation of lake and pond associations. Their objective is to preserve, protect, maintain, and enhance the environmental, aesthetic, recreational, and economic values of Massachusetts waterbodies.

The Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE) is a good resource for fish and wildlife habitat information. ***The Riverways Program*** assists with the organization of local watchdog and advocacy groups to protect waterbodies in Massachusetts.

The ***Natural Resource Conservation Service (NRCS)*** is a federal agency under the U.S. Department of Agriculture with regional offices in Massachusetts. The NRCS is familiar with erosion problems in many lake watersheds. Limited technical review and assistance in recommending BMPs may be available through NRCS, depending on staff availability and funding for other projects.

Lastly, qualified ***private consultants*** are available to assist with watershed survey projects. If a consultant is hired to work with the steering committee, the individual or firm should be thoroughly familiar with nonpoint source pollution issues, lake water quality issues, watershed land-use relationships, and the use of BMPs to mitigate nonpoint source problems. Hiring a consultant will add expense to the project, depending on the level of involvement.

5. Determine the survey schedule.

Establish a time frame for the survey. This ensures that surveyors are in the field during the best time of the year for seeing ***runoff***-related NPS problems. A schedule also provides volunteers with a deadline for returning field forms.

6. Find field volunteers to survey the watershed.

Field volunteers participate because they are concerned about protecting their lake and are willing to give their personal time to that effort. Volunteers reduce project costs and help educate and inform the community about the effects of watershed development on lake water quality. Because volunteers live in and represent the community, they are able to continue educating the public for years after the survey has been completed.

There are many ways to find people who are interested in being field volunteers. Many of the organizations listed below can be found in the yellow pages of a local phone directory, and on Web sites.

- Lake associations or shoreline property owner groups
- Conservation commissions
- Planning committees
- Youth conservation groups
- Student interns from college environmental studies programs
- Local community service organizations such as the American Association of Retired Persons
- Fish and game clubs
- Garden clubs
- High school students

Identifying financial and moral support for the volunteer network should always remain a priority for the steering committee. Financial needs for the volunteers can vary greatly, and there are a number of funding sources that can provide money for project materials and expenses. The most common expenses are telephone charges, mileage, photocopying of documents (topo maps and survey forms, for example), and buying and developing film.

Volunteers may need support beyond what they receive during initial training sessions. Interest and enthusiasm are critical to a survey project's success! Hard work and long hours devoted to the lake watershed survey deserve recognition. Events, small and large, should be planned to mark accomplishments and milestones of the volunteer team.

Consider the size of the watershed when gathering volunteer support

A **minimum** of 10 volunteers is needed for a lake watershed survey. The size of the watershed and the development density of the watershed will determine how many volunteer surveyors are needed. For large, densely developed watersheds, it may not be feasible to survey the entire watershed in one year. Try to estimate how much area can be covered, based on the size of the watershed and the number of volunteers available. Involve enough volunteers to visit all developed property, roads, and undeveloped areas.

Tell field volunteers what to expect

Each volunteer should make a **minimum** time commitment of one day for training and two days in the field. They should expect to provide carefully written, photographed, and illustrated documentation of the problem sites found. Volunteers should understand the importance of accurate and consistent reporting of information.

Volunteers should be made aware that it may be necessary to visit certain sites during inclement weather conditions. Specific site problems that will be found in different weather conditions should be covered during the field volunteer training. Following a review of the volunteers' field data, they may be asked to revisit sites to verify observations, particularly if vital information is missing from the survey forms. Revisiting sites also is useful as a quality assurance and control measure. One or two volunteers should be designated as group coordinators. They should be responsible for relaying information from the steering committee to the field volunteers.

Part of the process of identifying sources of phosphorus and sediment should be done during runoff-producing storms, if possible. Volunteers should be aware that "windshield surveys" (surveys done from the seat of a car) will not produce the detailed information needed. They may have to track runoff for considerable distances from the lake to locate the sources of pollution.

7. Arrange for training sessions.

Who should train volunteers?

Training sessions should include a presentation on the goals and objectives of the project. The reasons for monitoring, the history of the watershed and lake, uses of data collected, and how the project will benefit the volunteers, the community, and the state should be covered in the first meeting. There should be an overview of the survey procedures, preferably with a slide presentation. A trial run of proper methods of surveying should be done by the trainer while in a classroom setting. The training session also should include the distribution of any equipment and an explanation on how to use the equipment. Volunteers should be encouraged to provide an evaluation of the training session to the training team.

The second part of the training involves a field assessment of actual problem areas in the watershed. This training should emphasize detailed and accurate documentation. Joint visits to a few sites will promote consistency in field data collection and reporting. Volunteers will be given an opportunity to practice what they have learned.

Fundamentals that volunteers should learn

Volunteers should know that there are two basic questions that need to be answered in reporting each problem: Where is the problem? What is the problem? Field survey forms that do not answer these two questions can slow the process and add expense to the survey.

Volunteer training is essential to the success of the lake watershed survey. Become a dynamic lake surveyor through training! Enthusiasm is catching!

Prepare topographic maps for use in the training session

The lake watershed should be outlined on USGS 7.5-minute topographic maps. Copies of USGS topographic quad maps are available from MASS GIS on-line ***(see Appendix C)*** or call 800/USA-MAPS. Another good source of topo maps can be found at www.topozone.com. Many copy centers now have map copiers that will reproduce a USGS map, but the copy will not be in color. If time and cost allow, copy or trace watershed boundaries directly onto original USGS maps to have color-coded topographic information. General guidance for reading topographic maps can be found in Appendix C. Distribute and review this guidance with the volunteers during training.

Divide the watershed into sections

Prior to the training session, divide the watershed into clearly defined areas. Each area should be small enough so that two or three volunteers can cover it in approximately two days,

Volunteer Training Issues to Cover:

- What is a watershed and how does it work?
- The goals of the survey.
- Tools for watershed management.
- What are stormwater runoff and nonpoint source pollution? How do they affect lake water quality?
- How soil erosion and phosphorus affect lake water quality.
- Lake ecology and how changes to the lake's ecology reduce recreational enjoyment.
- How changes in water quality affect the local economy.
- Safety in the field.
- How to read topographic maps.
- How to fill out survey forms.
- Methods for keeping accurate and detailed documentation.
- Examples of typical erosion problems (photos and slides as well as visits to actual sites).
- How to discuss the survey with landowners (i.e., public property rights or trespassing issues.)

or 7-8 hours. Establish area boundaries along features that are easy to locate, like roads and streams. ***(See next page for an example map.)***

Establish teams of two for each area

Volunteers should work in teams of two for several reasons: safety, to share ideas about site evaluations, and to help each other fill out data sheets consistently and accurately. It is also easier to obtain follow-up information on a specific site when more than one person can be contacted.

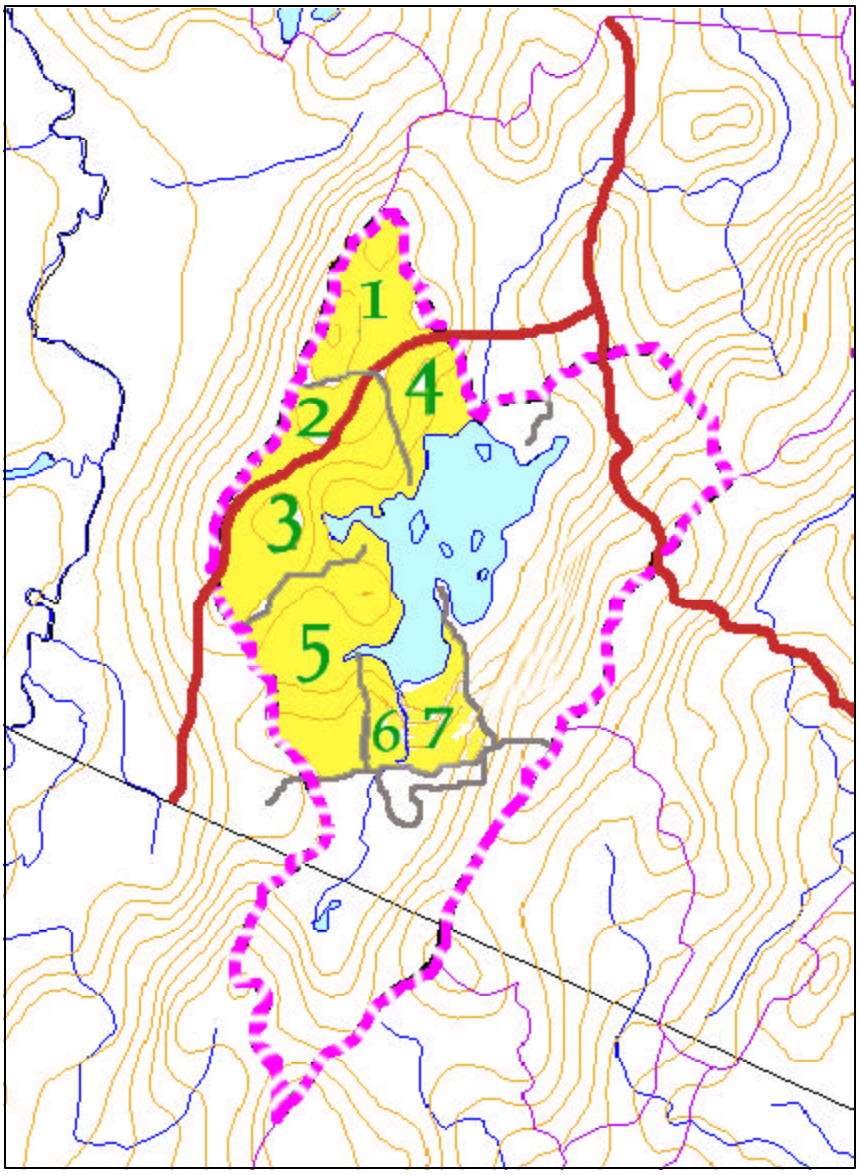
Give volunteers lake watershed survey data collection forms

Appendix A contains a sample watershed survey data collection form used by the Massachusetts WaterWatch Partnership. There are data collection forms designed for use with this survey and will be part of the lake watershed survey training for volunteers.

Give the volunteers practice

Volunteers should be taken into the field during training. Representative sites should clearly illustrate types of problems volunteers need to recognize, as well as good practices that can be found, such as existing buffers and landscaping with native plants. Sites can be defined as any problem area that can reasonably be described on the survey form. Include a variety of land uses such as open space, forest, water and marsh, agricultural (cultivated and pasture), and developed (urban and residential). Visit sites where BMPs are being used to emphasize the difference between stable and unstable land uses. Contact property owners to inform them that their sites provide good examples, ask permission to access their property, and encourage their participation in the training.

In addition to seeing typical NPS problems, have the survey volunteers participate in a problem-solving exercise. Ask them to locate and identify different land-use sites within a specific area.



Assigning Areas in the Watershed

The watershed should be divided into areas that are clearly defined by boundaries, such as roads or streams. The areas should be small enough that volunteers can cover the majority of the area in approximately two days.

This example shows clearly delineated boundaries using major highways, minor connecting roads, and existing waterbodies. Field volunteers can easily navigate through their area by using the boundary lines that are created naturally.

More information on reading and finding your way through topo maps can be found in Appendix C.

Legend

- ***Sub-Basin***
- ***Major Road***
- ***Minor Connectors***
- ***Waterbody***
- ***Assigned areas***

8. Send volunteers out to conduct the survey.

Plan ahead

Even if articles about the project have previously been published, print a reminder before the survey begins. Issue a brief press release to the local papers describing the project and the schedule for the survey just before volunteers go into the field.

Stay on schedule

The survey should be conducted according to a schedule set by the survey team. The public will be expecting volunteers to be surveying the watershed within the period of time discussed in newspaper articles. Staying on schedule also allows time for follow-up if there are questions concerning the volunteer findings.

Provide support for volunteers in the field

If the trainers and volunteers feel additional help is needed, consider meeting with the volunteers at a predetermined location on the first day of the survey. This allows volunteers to check back with the advisors during the day with questions, and it allows the team to review survey forms to ensure that information is being properly documented. This can save a lot of time after the volunteers have finished and are less available.

9. Review field data for preliminary summary.

Immediately after the lake watershed survey is finished, all survey information should be reviewed by members of the survey group to verify that the survey forms have been properly completed and all sectors evaluated.

The team will evaluate the accuracy and thoroughness of the documentation. Individual problems that have been identified will be prioritized. This process can take a few days or several weeks, depending on the number of problems that are identified.

If the survey information is incomplete, the volunteer coordinator should contact the volunteers *immediately* to ask for the missing information, which might require another field visit. Sites also may be checked with aerial photographs, where feasible. Contacting the volunteers soon after they have completed their work may save time that could be needed to locate poorly defined problems.

Throughout the lake watershed survey, the data being collected should be monitored as it comes in. Volunteers should be encouraged to ask questions about the process as they fill out the survey forms.

The data should be compiled from the field survey forms. A review of this data will help prepare a strategy to address specific site problems, which will need to be prioritized. High priority sites will not always be the focus of the strategy. The cumulative effect of correcting many lower priority sites may have greater benefits and be easier to address. These sites may be repaired at lower costs. In Section 5, a method is laid out for setting objectives and recommending activities to correct erosion and sedimentation problems.

Protection of the lake is an ongoing process. The steering committee's plan should develop long-range goals and recommendations for the future to sustain the interest and involvement of the watershed community.

Steps for a Lake Watershed Survey—Field Volunteers

Section **4**

What's Here?

Decide When to Survey
Plan to Talk to Landowners
Conducting the Survey
FillingOut the Survey Form

1. Decide when to survey.

At this point, field volunteers have training, topographic watershed maps, and blank survey forms. Volunteers are ready to begin surveying the watershed. Begin surveying the assigned section of the watershed as soon after the training as possible. Ideally, the survey should be conducted within a week or two of training.

A watershed survey can be conducted at any time. However, there are advantages to conducting a watershed survey in the spring, between March and May, because:

- The ground is likely to be ***saturated*** with water due to spring snowmelt. Under these conditions, ***stormwater runoff*** from rainstorms will be at a maximum (phosphorus and sediment in runoff from spring storms often represents a large percentage of the total annual phosphorus load to a lake).
- Eroded areas will be more visible due to the absence of vegetation.
- No spring maintenance on roads will have taken place, so problems will be more obvious than after roads have been regraded and repaired.
- Time will remain for the follow-up team to complete the project during the summer months.

Because about 90 % of erosion occurs during heavy storms, it will be easier to see runoff associated with erosion when a survey is done during or just after a storm. However, it will be more convenient to plan and conduct the first survey on a day that has been scheduled in advance. During the survey, look for brown or ***turbid*** (cloudy) water in road ditches, swales, brooks, and streams. This is an indication that silt and other phosphorus-bearing soil particles are present. Severe erosion problems, such as gully erosion, ditch and road washouts, and undercutting of streambank slopes from running water or in areas of heavy shoreline wave action, are obvious in dry weather.

2. Decide where to start.

Before going into the field, become familiar with the assigned section of the watershed on the topographic map of the watershed. Locate roads and watershed boundaries, and decide where to begin. The ability to read maps is a skill necessary for locating and documenting sites. Practice reading topographic maps before doing fieldwork. ***(A guide for reading topographic maps is in Appendix C.)***

This section is set up as a series of checklists that volunteers can use to prepare and conduct the survey.

Starting at the low point—the lake itself—and working up the watershed is usually most efficient. **The most environmentally sensitive area is within 1000 feet of the lake and its tributaries.** Access the watershed via roads. Begin near the lake at one end of the road; work within the assigned area of the watershed. An orderly progression through the watershed works well for documenting and recalling sites.

3. Gather materials for the field.

- ☐ Clothing for foul weather, including rain gear, hat or hood, gloves, comfortable boots, warm sweater, and socks.
- ☐ Survey forms, topographic maps of the watershed, clipboard and pencils; if possible, stored in a sealed plastic bag or a field clipboard designed to shield contents from the weather.
- ☐ Camera, film, and fresh batteries—the saying "a picture is worth a thousand words" is especially true when documenting watershed problems.
- ☐ A 50-foot tape measure to measure areas of the site and distances from landmarks (or measure your pace so you can estimate distances by "pacing" it out).
- ☐ Life vest, in case you work around large streams with high-velocities.
- ☐ Flashlight with fresh batteries (useful for checking ***culverts*** and as a safety precaution).

4. Prepare to be safe in the field.

- ☐ Always work in teams of two or more.
- ☐ Be sure someone at home knows where you are.
- ☐ Dress appropriately.
- ☐ Have a first-aid kit, and tick and insect repellent available.
- ☐ Always use a map.
- ☐ Bring a cell phone.
- ☐ Walk only where footing is safe — do not compromise your safety to gain access to a difficult area.
- ☐ Use caution walking near roads, a rocky or steep shoreline, or on slippery rocks.
- ☐ Know how to recognize poison ivy.
- ☐ Bring water and snacks.
- ☐ Heed "beware of dog" signs.
- ☐ When working around large streams with high velocities, wear a life jacket.
- ☐ After field visit is over, check for ticks.

5. Talk with landowners.

- ☐ Knock on the door, introduce yourself, and explain the survey. This is an excellent opportunity to educate the community.
- ☐ Take along handouts to give to landowners. Handouts explain the watershed survey work *(see Appendix A.)* If no one is at home, leave a handout explaining the project.
- ☐ Be clear about the purpose of the survey:

➢Volunteers are trying to identify problems that may be impacting the lake.
➢Volunteers are finding the pathways in which stormwater carries soil and pollutants to the lake or tributary streams.
➢Volunteers and technical teams are developing solutions to the problems identified and are creating an action plan detailing solutions.
➢Volunteers are raising public awareness about the effects of polluted runoff on the lake and building support in the community for local watershed management.

- ☐ Be prepared to respond to uncooperative people. If the property owners do not wish to have their property surveyed, leave them literature and move on to the next site. Confrontations are unnecessary.

- ☐ Always respect the property owner's wishes, regardless of the situation. If a volunteer suspects a serious problem exists on an inaccessible site, note it on the survey form and notify the DEP Regional Office (Appendix D), so that the site can be visited later.

6. Who should be contacted for questions?

Even with training, questions will come up throughout the survey. Look for answers in Appendix B, Frequently Asked Questions, and contact the following people:

- ☐ Your partner.
- ☐ Steering committee chair.
- ☐ DEP Nonpoint Source (NPS) Coordinators (Appendix D) are available to answer questions — just a phone call away.

7. Conducting the survey— What to look for in the field.

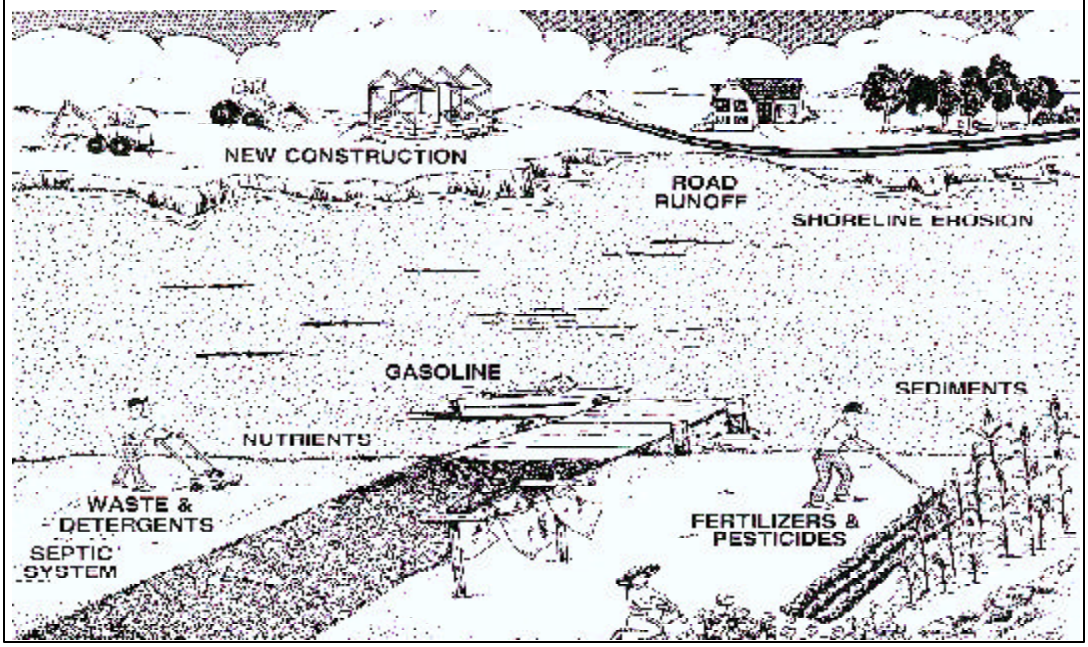
Regardless of land use type, volunteers will be looking primarily at the pathway for stormwater runoff. Is the runoff flowing directly to a stream or lake? How close is the erosion problem to the lake or stream? Is it entering a channel or ditch that flows to a stream or lake? Does runoff flow to a vegetated buffer before it reaches a stream or the lake? How well is runoff distributed throughout the buffer? Does the runoff spread over the ground, or does it flow through the buffer in a channel? Are there steep slopes at and below the site that might cause runoff to pick up speed and erode channels?

Volunteers should look for, and record, the approximate distance from the site to a lake tributary, an ***intermittent stream,*** a road ditch, or the lake. Road ditches often transport contaminated runoff for hundreds of feet before flowing into a brook. It may be necessary to follow runoff for a considerable distance before determining whether runoff from the problem site reaches the lake.

The volunteers' presence will generate interest. People may question what volunteers are doing, and why they are going onto private property.

Remember, during a storm or right after, it's easier to see evidence of erosion such as turbid water. However, clear runoff may still be a concern. Therefore, document any runoff to a ditch, stream, lake, or wetland. Also learn to recognize sediment deposits, which accumulate or mound near stream channels and shorelines, downstream of areas with eroding soil. Look for activities that alter or remove streambank, shoreline, and natural vegetation. These activities cause open areas to be more vulnerable to erosion.

Typical Sources of Nonpoint Source



Look closely for land disturbances that may be causing changes in lake water quality or increasing sediment transport, such as:

Land Disturbances–Examples:

- ☐ Bare soil, uncovered/unfenced piles of soil.
- ☐ Erosion, such as ***gullies and rills.***
- ☐ Undercut or slumping banks or slopes.
- ☐ Cloudy or discolored water or runoff.
- ☐ Green scum, oily sheen, or floatables on water.
- ☐ Sediment deposits/build up in waterbodies or pipes.
- ☐ A defined pathway of runoff from the site.
- ☐ Pipes/culverts with runoff, stains, or odors.
- ☐ Animal manure, trash, vehicles, or waste storage near waterbodies.
- ☐ Altered and paved areas near waterbodies–absence of ***vegetated buffers.***
- ☐ Slopes of 7% or more on topographic maps (***See Appendix C***).
- ☐ Absence of erosion and sediment barriers around disturbed areas, such as hay bales and ***silt fences.***
- ☐ Absence of check dams in ditches or swales.

Look closely at all land uses in the survey area, particularly the following:

More information on land uses follows the list.

Land Uses–Examples:

- ☐ Construction sites: disturbed areas and waterbodies.
- ☐ Residential areas: driveways, shoreline, paths to shoreline, and lawns, (especially very green lawns).
- ☐ Roads (town, state, and private): ditches, shoulders, banks, stream crossings.
- ☐ Agricultural areas: cultivated fields, pasture/open land, manure storage areas, animal stream crossing, animal grazing.
- ☐ Urban, commercial, and industrial areas: parking and vehicle maintenance areas, dumpsters and waste storage areas near waterbodies; piped drainage ways to streams and wetlands.
- ☐ Logging operations: trails, roads, stream crossings, logging yards, cut areas.

Field volunteers will find other land uses, such as landfills, parkland and open space, and gravel pits. Although these are not the primary land uses described in the guide, discuss these sites and how to proceed with the DEP NPS Coordinator.

Construction Sites

Soil can erode from excavated or filled areas during and after construction of new buildings, additions to existing structures, foundations or footings, and during landscaping projects. Soil erosion from construction sites is usually obvious. Small gullies or channels, called rills, appear on the surface of bare soil where soil particles have been carried away by rain or snowmelt. These channels do not have to be very wide or very deep to cause downstream problems. The larger the exposed area and the steeper the slope, the greater the potential for soil erosion. Areas that are not replanted following construction can be ongoing sources of phosphorus and sediment to a lake.

Erosion of soil from construction projects can be greatly reduced by stabilizing the soil surface with erosion controls. Erosion controls can preserve topsoil, which reduces landscaping costs. A wide range of erosion controls are available, such as mulch, blankets, plastic sheeting, and sod. These ***erosion controls*** must be installed properly and maintained in order to be effective.

Construction Sites - Examples:

- ☐ Exposed soil and erosion.
- ☐ Alteration to drainage pathways or alteration near waterbodies.
- ☐ Absence of erosion controls.
- ☐ Evidence of erosion, such as gullies or rills on the surface of the soil.
- ☐ Cloudy or discolored water in ditches, streams, wetlands, or lake.
- ☐ Sediment build up in ditches, streams, wetlands, or lake.
- ☐ Construction on steep slopes.
- ☐ Check local permits for an erosion and sediment control (ESC) plan.
- ☐ Erosion controls such as silt fences and hay bales that are not working (not holding the soil on site, or not anchored into the ground).

Residential Areas

Residential areas are a source of runoff pollutants. Of concern are eroding soils, shorelines, or streambanks; poorly vegetated lots and improper use of fertilizer and pesticide in landscaping practices; effluent from poorly maintained or failing septic systems; illicit sanitary connections to storm drains; pet waste; and concentrated runoff from roofs, driveways, lawns, and other hard or impervious surface areas.

Lakes can benefit greatly by keeping a vegetated buffer area between structures and the lake, or along pathways to the lake (ditch, stream, and wetlands). Vegetated buffers filter out pollutants from runoff before they reach the lake. Vegetation also provides habitat and shade for animals that depend on the lake for survival.

Residential areas - Examples:

- ☐ Areas of bare soil.
- ☐ Turbid (cloudy) water.
- ☐ Evidence of erosion on driveways or other areas, such as gullies or rills on the surface of the soil, or sediment accumulation in ditches and streams.
- ☐ Bank instability—bare soil, slumping, or undercut banks.
- ☐ Removal of vegetation near shoreline, resulting in increased vulnerability to erosion.
- ☐ Unstable, eroding access points or paths to the lake.
- ☐ A direct pathway for runoff to reach the lake.
- ☐ Absence of vegetation or vegetated buffer.
- ☐ Evidence of septic system problems— lawn with green patch, soggy or wet lawn, and/or sewage odor.
- ☐ Lush lawns.
- ☐ Petwaste.
- ☐ Improperly stored trash (e.g., trash barrels or dumpsters) or organic debris (grass clippings, leaves, compost) near a waterbody.

Roads

In many watersheds, roads represent a significant percentage of impervious areas and problem sites. Poor design, location, and maintenance of paved and unpaved roads can contribute to chronic erosion problems. Steep slopes and unstable banks adjacent to roadways are prone to erosion. Without routine grading and the addition of new gravel on gravel road surfaces, these surfaces tend to erode. In addition, road erosion problems occur in areas of increased development, which contributes runoff in excess of the design capacity of the road drainage system.

Road drainage ditches erode when designed improperly, when not stabilized after construction, and when not maintained. Erosion also can occur around culverts that are undersized or installed without sidewall or ground stabilization measures at inlets and outlets. When ditches and culverts are not working properly, a road surface can wash away.

During dry weather, pollutants from cars and trucks accumulate on roads. Sediment, metals, oil and gas residues, and other materials, including phosphorus are picked up by stormwater from roads. Gravel and paved roads are designed to shed stormwater. Stormwater runoff from roadways concentrates in ditches, which often discharge directly into streams and waterbodies.

Roads - Examples:

- ☐ Roads located close to streams, lakes, or wetlands.
- ☐ Absence of vegetation or buffer between road and waterbody.
- ☐ Roads located on steep slopes.
- ☐ Washouts and crumbling pavement.
- ☐ Ditch, culvert, or pipe washouts, undercutting, or gullies and rills along sides and bottom of road or ditch.
- ☐ Exposed soil in ditch channel.
- ☐ Ditches that are long without discharge points into vegetated areas.
- ☐ Ditches, culverts, or pipes that empty runoff into streams, wetland, or lake.
- ☐ Erosion around inlets and outlets of culverts.
- ☐ Sediment buildup in lake or stream channel below culvert.
- ☐ Washed out or damaged culvert.

Agricultural areas

Agricultural land uses, while not prevalent, can be significant sources of phosphorus and sediment, as well as other pollutants that are transported by stormwater. Most tilled fields experience at least some erosion problems, particularly in spring. Drainage alterations to fields and yards are very common, and can concentrate the runoff into ditches or streams. Eroded soil from cropland may contain very high levels of phosphorus, pesticides, and herbicides.

Manure spread on frozen fields during late fall, winter, and early spring is easily washed away to a ditch, tributary, or lake by rain and snowmelt. Manure-handling systems, if not properly designed and used, leak liquid wastes containing high concentrations of phosphorus and bacteria.

When livestock graze close to a lake shoreline or stream, animal waste, which includes ***nutrients*** and ***biological contaminants*** such as bacteria and viruses, may wash toward the water during wet periods. Streambanks and shoreline areas also may break down and erode if animals are not fenced, and overgrazing can increase soil loss.

Agricultural areas - Examples:

- ☐ Bare soil.
- ☐ Tilled fields where no buffer exists between area and stream, lake, or wetland.
- ☐ Fields close to road ditches.
- ☐ Turbid water in ditch, stream, wetland, or lake.
- ☐ Farm animals grazing in or directly adjacent to streams, lakes, or wetlands: broken down stream banks and/or shoreline, stream widening, disturbed soil adjacent to stream.
- ☐ Manure spreading during periods when the ground is frozen, or where runoff can reach the stream or lake.
- ☐ Leaking storage areas and storage areas that are not enclosed or covered.

Urban areas

Urban areas typically have a mosaic of land uses to support thriving communities. In addition to homes, businesses, and commercial development, urban areas are defined by a wide variety of land uses such as parkland, gas stations, cemeteries, roads, railroads, and utilities.

Urban stormwater runoff is characterized by increased volume and velocity**,** which can cause severe erosion and flooding damage downstream. More stormwater runs off urban areas because there is more ***impervious pavement.*** Generally, natural drainageways are not large enough to handle increased runoff associated with urbanization. Consequently, urban runoff, which may contain high concentrations of phosphorus and other pollutants, causes streambanks to erode, while depositing sediment, phosphorus, and other pollutants into lakes.

In urban areas, much of the runoff also is conveyed underground by a storm drain system, which may consist of street gutters, storm drains or catchbasins and sometimes detention ponds, treatment structures, or constructed wetlands. Typically, the ultimate discharge of stormwater is to a surface waterbody, but this may not be obvious. Thus, the watershed survey work in an urban area should start with a visit to the municipal department of public works in order to learn more about the storm drain system, and to review storm drain maps, if available, to locate discharge points in the watershed. The town or city engineer also may be able to identify private land uses that discharge stormwater to the municipal drainage system, and explain the maintenance schedule for cleaning the municipal drainage system and street sweeping.

Urban areas - Examples:

- ☐ Street drains, storm sewers, and pipes that discharge directly to streams, lake, or wetland.
- ☐ Street drains and catch basins with sediment or waste material.
- ☐ Eroded or undercut banks due to increased stormwater volumes and flows.
- ☐ Green scum, oily sheen, or floatables on water.
- ☐ Cloudy, discolored, or smelly water in ditches, streams, wetland, or lake.
- ☐ A defined or eroded pathway of runoff from the site.
- ☐ Sediment buildup in stream channel below pipe or along roadside.
- ☐ Damaged or eroded pipe or culvert outlets.
- ☐ Absence of vegetation or vegetated buffer near waterbody.
- ☐ Altered and paved areas near waterbodies.
- ☐ Lush lawns.
- ☐ Petwaste.
- ☐ Improperly stored trash (e.g., trash barrels or dumpsters) or organic debris (grass clippings, leaves, compost) near a waterbody.
- ☐ Manure, trash, vehicles or waste storage near waterbodies.

Forestry operations

Some of the problems typically associated with logging operations, like logging yard erosion and runoff from skidder trails, are easy to detect. More subtle problems, such as stream bank scouring from increased runoff may be overlooked. Poorly located and constructed logging roads, improperly designed stream crossings, heavily cut woodland buffers along streambanks, areas of exposed soils in logging yards, and brush and slash placed in streams can all harm stream and lake water quality.

Runoff from a heavily logged site can increase in a very short time, producing severe soil erosion in the area that has been cut, and along streambanks and downstream property. Skidder trails are often deep enough to redirect the course of small streams. If this occurs, soil can erode from the new stream course for several months or longer, until the new stream bed has stabilized.

Forestry operations- Examples:

- ☐ Road surface and ditch erosion.
- ☐ Ditches that empty runoff to streams or channelized flow.
- ☐ Unstable culverts, roads close to streams.

- ☐ Areas where skidder trails cross streams, causing erosion of stream bank and redirecting runoff.
- ☐ Erosion of culvert inlets and outlets.
- ☐ Turbid water or sediment in stream.
- ☐ Heavily cut woodland buffers along streams.
- ☐ Bare soil.
- ☐ Gullies and rills.
- ☐ Poor design of logging roads.

8. Filling out the Lake Watershed Survey Form—Checklist:

- ☐ **Fill out the survey form completely. Be sure to put the same number on the corresponding site map, form, photographs, and drawings.** *(See Appendix A for a sample watershed survey form. Survey forms will vary from watershed to watershed, and the information within the form will reflect the conditions found in your watershed.)*

- ☐ Fill out one survey form for each site within the assigned area. If the entire site is not surveyed, explain why and estimate the percent of the area that was not covered.

- ☐ Fill out all forms in the field, as work is done. Do not rely on an after-the-fact memory.

- ☐ Mark the site on your topographic map using the site number. Take one or two pictures and label them with the site number and surveyor's name. As photographs are taken, write the exposure number from the camera and the site description on the survey form. When the film is developed, this will ensure that the corresponding photos will be submitted with the forms.

- ☐ Draw a site diagram. Use easily identifiable landmarks in the drawings and provide information on distances and estimated slope. Sketch an area map to show where the problem is.

- ☐ Provide details, such as road names, telephone pole numbers, and house numbers. In large watersheds or remote areas, use a global positioning system (GPS), if available.

- ☐ Record weather information from the last 48 hours on the survey form. For instance, was there a recent heavy rain storm or has it been very dry? Weather is an important factor in the way pollutants move from the watershed to the lake.

- ☐ Estimate the dimensions of the problem area. The approximate width and depth of runoff channels and exposed soil areas are important in assessing the severity of a problem site.

- ☐ Note whether the problem is connected to a stream or lake. During the initial survey, carefully assess the cause or causes of the erosion or sediment problems. This is essential to correcting problems and setting attainable goals.

- ☐ Document why you identified a particular site. This information will help in the follow-up analysis and provide insight into the nature of (and solution to) the problem.

- ☐ Proper documentation is critical to the watershed survey's usefulness and success. Any follow-up work may take place during another season when the ground may look dramatically different from the original survey date.

In addition to differences in appearance, the runoff that attracted attention to the site in the spring is likely to be nonexistent during the summer and fall. If the information on the form is insufficient, the technical team may need to ask volunteers to revisit the problem area.

9. Document the time spent on the project.

Documentation of volunteers' time may prove valuable in demonstrating the level of commitment that a group of individuals, an organization, or the town has made to the project. This information may be useful if additional assistance is needed for a follow-up project to fix problems that have been identified in the survey. Therefore, keep track of how much time is spent on the survey. This includes time spent in training, preparation for going out in the field, actual surveying, and organizing the forms and pictures for delivery to the volunteer coordinator.

10. Organize and give survey information to the volunteer coordinator.

After surveying your area, review the documentation. Do this while the information is still fresh in your mind. Make sure the survey sheets are complete and legible. Photographs should be labeled and attached to the corresponding watershed survey. Problem sites should be clearly numbered on the area map. Submit all the materials to the volunteer coordinator.

The steering committee and volunteer coordinator should arrange any follow-up work, such as revisiting the sites identified to determine how severe the problems are and making recommendations to correct them. Once the follow-up is done, a draft report (Section 5) will be prepared and sent to all volunteers. The report will present an overview of the extent of sediment problems, and associated phosphorus problems, in the lake watershed and should summarize the problems observed by category. A meeting also may be helpful before or after drafting the report to share the results with the volunteers and involve them actively in discussions about the results and how to use them in an action plan.

11. Volunteer involvement does not need to end.

In many ways, the report is another beginning, and it presents new opportunities for volunteer involvement. All participants of the survey—field volunteers and steering committee members—should participate in the discussions of a Watershed Action Plan to address the problems identified in the survey. The DEP Regional NPS Coordinators can assist with technical issues. The lake watershed survey results can be used to reach out to non-traditional groups, such as schools, churches, businesses, and community organizations, as well as landowners. This is an ideal time to create stewardship teams of volunteers and landowners. Working together, stewardship teams can seek practical ways to implement the action plan.

Getting Results from the Survey—Steering Committee & Volunteers

Section 5

What's Here?

Prepare a Draft Report
Develop a Lake Watershed Action Plan
Best Management Practices
Preparing the Final Report and Recommendations

Prepare a draft report.

The draft report does not have to be lengthy—it should be clear, complete, and concise. Survey information must be assessed carefully and presented accurately. Convey information on the extent of problems in the lake watershed as clearly as possible. Include information about the number of problems and where they were found. The draft report should summarize the important findings and lay the foundation for the Action Plan that will be built around the results in the report.

Tally the number of sites identified and categorize them by land use. This table is an example:

Land Use:	Number of Sites
Urban	16
Town Roads	21
State Road	2
Residential	18
Residential shoreline	12
Construction	5
Commercial	3
Forestry	1

Briefly discuss the most frequent problems found for each major land use. In preparing the report, consider your target audience and the most appropriate format to reach them. Consider the level of detail needed for the audience and the balance of text, data, graphics, and pictures. Highlight some particularly significant problems with graphs, illustrations, and photographs.

Publicize survey findings on the extent of point and nonpoint source runoff problems in the watershed. This information should be made available to the towns in the watershed as soon as it is available. If a town official (planning board member, selectman, or town manager) is not on the steering committee, one should be contacted to determine where the report should be sent. Copies of the draft report should be given to local libraries. Landowners also should be notified of the report's availability. If possible, a presentation of the information should be given for landowners and others interested in the survey.

The press also may be interested in preliminary findings. Remember to keep communication open during the entire process to maintain good public relations within the watershed community.

Include the field volunteers and be sure to let them know that survey data are being used. To maintain interest in the project, it is necessary for the volunteers to see the draft report in a timely manner and to know that their efforts are showing results. With the draft lake watershed survey report in hand, the steering committee, field volunteers, and others are ready to move into the next phase of the lake tershed survey project.

Action Plan activities can have regulatory requirements. Local, state, and federal agencies should be contacted and involved early in the work plan development process.

ROADS - Example of Observations and Best Management Practices

Site ID#	Type of Problem	Type of Solution (BMP)	Priority	Level Technical Asst. Needed	Cost	Identify Landowner Cooperation
1	Severe, road surface erosion into lake	Divert water away from road to vegetated areas. Use more culverts, if needed	high	high	med	possibly
2	Clogged culvert	Reshape road, add a berm and a box culvert. Maintenance, clean out, or possibly replace culvert	med	low	low	yes
3	Large area of exposed soil in ditch, drains to stream	Reshape, seed, and mulch	high	low	low	yes
4	Moderate shoulder erosion	Determine cause, add new material	low	low	low	yes

Develop a lake watershed management action plan.

Using the survey report as a foundation, the next step is to develop a Lake Watershed Management Action Plan. In the Action Plan, the problem sites from the lake watershed survey will be redefined into a list of realistic objectives and activities that can be accomplished within the watershed. The Action Plan objectives and activities need to be designed to advance the desired outcome or main goals of the survey, including the following:

- Minimize and eliminate existing and future sources of erosion to decrease the amounts of phosphorus and sediment entering the lake.

- Help educate the community of homeowners, businesses, and nonprofit and government agencies about the lake watershed survey and enlist their support for lake watershed management work activities.

To acquire widespread acceptance and support for the Lake Watershed Management Action Plan, the steering committee will need to collaborate with others to ensure that the survey results are integrated with the political, economic, social, and cultural values of the communities in the watershed. The Lake Watershed Management Action Plan should incorporate input from landowners, the steering committee, field volunteers, and all other interested watershed partners so that the objectives and activities reflect a common vision for the future of the lake.

The key steps in developing a Lake Watershed Management Action Plan are 1) to recognize that the objectives of the Action Plan need to be reasonable, 2) to rank and prioritize problem sites documented in the survey, and 3) to make recommendations on lake watershed management activities. This section of the guide outlines some considerations for accomplishing these key steps.

1. Understand lake watershed management constraints

Recognizing that all the problem sites cannot be addressed simultaneously is the first step toward developing a realistic Action Plan for a lake watershed. Other factors to consider are financial, political, institutional, legal and regulatory, social, cultural, and land and water use conflicts. Any of these can affect the feasibility and outcome of a management effort.

To determine the feasibility of correcting problem sites from the survey list, the steering committee should evaluate the challenges and issues affecting management and restoration efforts. This can be done by considering some potentially significant limitations, such as cost, landowner willingness, and availability of technical resources. Survey results will be adequate to identify lake watershed management needs in many situations, and may show that a more thorough assessment of the lake and the problem is advisable and necessary.

The matrix of road-related problems is a tool that can be used to determine which problems in a lake watershed can most readily be addressed, all factors considered. A matrix should be developed for each land use. When developing the matrix, ask questions such as: What sites can be corrected easily without spending significant resources? What are the most significant sources of pollution? Does this activity have support or opposition?

2. Rank and prioritize sites

The next step is to rank the problems based on their seriousness and make recommendations for corrective actions. A priority ranking of the sites can be done on a simple, low-medium-high scale, and the following criteria should be considered in site rating and ranking:

➢**Site conditions assessment score**—An average score for the site can be computed and interpreted as low, medium, or high for the purposes of ranking and prioritizing sites.

➢**Size of the area affected by the problem**—How large is the problem area? Is it a few square feet, half an acre, 10 acres? This factor is especially important where soil erosion is the problem. Generally, the larger the area, the more significant the problem.

➢**Slope**— Steeper slopes cause greater soil erosion. Runoff tends to concentrate in channels more quickly, and does not filter through the soil where it would be treated.

➢**Type of soil**— Generally, soil type is important in ranking a site for phosphorus loading. Loam contains more phosphorus than sand, and clay contains more phosphorus than loam.

➢ **Distance between the problem site and a ditch, stream, or the lake itself**—Generally, sites closer to the lake should receive higher priority ranking than those farther away, when the problems are equivalent or similar.

➢**Land use considerations**—Changes in land use patterns and increased development increase stormwater runoff, which affects sediment and nutrient transport. Trends toward increased watershed development will make the lake watershed more vulnerable to further impairment.

➢**Site capacity for management (e.g., adding a vegetated buffer)**— As a practical matter, sites that have a greater potential to be managed or restored should be rated higher. For example, there may be community consensus that the recreational value of a swimming beach is more important. Accordingly, it would be easier to plan management activities in response to a beach-related problem.

(NOTE: The scale of the problem will affect the scale of the Action Plan activities required. Therefore, a high rating for size, may be offset by a low rating for site management capacity. Priority rating systems need to be interpreted with caution. There is a danger that the public or whoever is reviewing the list of sites will be drawn only to sites with a relatively high rating. However, the ***cumulative impact*** to water quality of many low priority sites can outweigh a few high priority sites. Low priority sites also may be easier to correct than large-scale problems.)

3. Recommend realistic objectives for the Lake Watershed Management Action Plan

The Action Plan objectives may be considered secondary goals in that they directly or indirectly support the main goals for the survey and lake watershed management project. Realistic Action Plan objectives reflect community needs and significant lake watershed issues. They give direction for development and implementation of management activities. Realistic objectives also are measurable, in order to provide a basis for monitoring project success. The following are examples of measurable objectives:

- Decrease erosion,
- Reduce sediment entering a lake, and
- Install BMPs to reduce sediment.

4. Recommend realistic activities for the Lake Watershed Management Action Plan

Once objectives are established, a list of corresponding activities can be developed. Action Plan activities are based on a site's potential for management, which is not necessarily a plan for restoration to an unaltered or entirely natural state. This ideal situation may not be achievable, given the constraints that have been identified.

In this step, general solutions or overall strategies are being recommended to address the objectives. The steering committee and technical team should be familiar with technically feasible alternatives. Some of the concepts for management and restoration are outlined briefly, later in this section.

Realistic activities also should be measurable, in order to provide a basis for monitoring project success. For example, management activities could propose planting 20% of unvegetated lakeshore each year for five years, and that native vegetation planted along the lakeshore would show a 50% survival rate after 3 years. A landowner's agreement for survey-related work also would be a measurable success.

Best Management Practices (BMPs)

Making recommendations for Action Plan objectives and activities requires an understanding of the options available to improve water quality of the lake. Options range from simple solutions, such as lake cleanup days, to constructed BMPs. Knowing what BMPs are available and appropriate for typical lake watershed problems is basic to recommending management work.

BMPs are specific practices that have been designed to protect water quality from the effects of development. Mitigation with BMPs is less costly when it's incorporated into long-range land use planning. Adding BMPs after a problem exists may be difficult, or even impossible, due to site limitations. But just as every problem site in a watershed contributes to the cumulative damage to lake water quality, even a limited amount of mitigation can lead to improvements in water quality. Therefore, BMPs should be considered for developed sites, despite site limitations.

Information on BMPs is readily available through all search engines on the Internet. Some suggested Web site references are listed in Appendix D. BMPs to protect lakes from phosphorus and sediment in stormwater runoff should have one or more of the following capabilities:

- **Reduce soil erosion by stabilizing exposed soils.** Soil erosion is a major source of phosphorus and sediment to lakes. Many erosion problems can be eliminated easily by seeding and ***mulching*** exposed areas. Some problems have complex causes and may require evaluation by professionals. By reducing the number of erosion problems in a lake watershed, phosphorus and ***sediment loading*** to the lake can be reduced significantly.

- **Minimize vegetation loss, or replace vegetation that has been removed.** As the natural forest cover is removed, stormwater runoff increases. In addition, the

natural sediment and phosphorus filtering (buffering) capability of the vegetation is lost. By minimizing vegetation loss, erosion problems also are minimized. Generally, native trees, shrubs, and ground cover vegetation are preferable to lawns. Replacement vegetation should mimic natural forest conditions in the area, if possible. However, many property owners may prefer the appearance of a landscaped buffer, which can be effective, when designed properly. Vegetated buffers, greater than 100 feet wide, along streambanks greatly reduce nutrients and sediments; cool water; and provide critical habitat.

➢ **Reduce stormwater runoff volumes and velocities by minimizing the amount of impervious area.** Road and driveway lengths should be minimized, where possible. Parking lots and building areas also should be minimized. Runoff from small paved areas should be diverted directly to the shoulder and into vegetation. Avoid use of curbs and gutters, which collect water, where possible. By reducing impervious area, less runoff is generated during storm events. This means less phosphorus, sediment, and other pollutants in the runoff. It also means the runoff is less likely to find its way to a stream or the lake.

➢ **Divert runoff from developed or disturbed areas to vegetated buffers or areas where runoff can filter into the ground.** This practice reduces the amount of phosphorus and sediment in stormwater runoff. Runoff from buildings, parking lots, driveways, roads, construction areas, farmlands, and logging areas should not discharge directly into streams or the lake without first receiving some level of treatment to reduce pollutants. Natural woodland buffers are very effective at reducing phosphorus and sediment from stormwater runoff. Grassed areas, while less effective than woodland areas, can provide some treatment. For buffers to work, they must be located between disturbed areas and the lake, or any ***channel*** (road ditches, ***swales,*** and streams) that could carry runoff to the lake. The effectiveness of a vegetated buffer depends on the width of the buffer, the slope of the land, soil type, and the types and densities of vegetation growing in the buffer.

➢ **Control phosphorus by limiting opportunities for transport with sediment and stormwater runoff.** It has recently been found that residential lawns contribute significantly to the total load of many pollutants, especially phosphorus. Reduced fertilization, application of only the amount recommended, and use of organic or slow-release fertilizers will limit nutrient release. Lakeshore areas and tender young grasses also are attractive to Canada geese, with feces that are another source of nutrients. Maintaining and planting dense natural stands of trees with shrubby undergrowth and tall, unmowed grasses will provide natural obstructions to goose movement through the area.

➢ **Redirect surface runoff that is sediment free and clean away from areas prone to erosion.** This practice may be adaptable to many of the land uses. It will reduce sediment loads to waterbodies. For example, in a residential area, rooftop runoff could be discharged to a dry well where it will be absorbed by the ground, instead of being discharged to a sloping lawn which directs runoff into a brook.

Non-structural and structural BMPs

For both non-structural and structural BMPs, the design should control the pattern of sediment transport. Non-structural best management practices are activities that landowners can undertake to control sediment and phosphorus before they are released into the environment, where pollutants can be transported to the lake. Examples on non-structural BMPs are reduced fertilizer use, changes in application of fertilizers, street sweeping, and regular inspection of septic systems.

When non-structural measures are insufficient or infeasible, it may be possible to use structural BMPs for a point or non-point pollution problem in the lake. Structural measures include vegetative stabilization of shoreline and streambank areas, grassed swales or ditches with checkdams to slow the velocity of runoff, lakeshore buffers and management areas, and stormwater BMPs for control of sediments. The bibliography (Appendix G) provides references to Massachusetts publications for structural BMPs.

Land use and BMPs

■ Construction sites

Erosion rates from construction sites are much greater than other land uses. Even though most new construction sites are required by federal, state, or local regulations to have erosion and sedimentation plans, field surveys may reveal the use of inadequate or poor best management practices on construction sites. Unmanaged construction sites can contribute 7 to 1000 tons of sediment per acre during a year to a lake. Generally, erosion control methods should effectively hold soil in place so that it cannot be washed away by stormwater runoff.

Construction site BMP checklist

- ☐ Use nonvegetative soil stabilization.
- ☐ Use barriers such as silt fences and hay bales.
- ☐ Seeding and mulching exposed soil.
- ☐ Limit disturbed area.
- ☐ Project phasing to minimize bare soil.
- ☐ Use sedimentation basins and clean out sediment frequently.
- ☐ Stabilize construction roads.
- ☐ Cover and immobilize stockpiled soil.
- ☐ Remove excess soil as soon as possible.
- ☐ Use measures (e.g., checkdams and swales) to dissipate flow and velocity.

■ Residential areas

There is a direct link between water quality and chemicals used to maintain lawns and gardens. Although more research is needed, the types, quantity, and timing of chemical applications make a significant difference. Landowners need to be educated about the use of fertilizers and the impact of lawns on lake water quality.

In residential areas, look for low maintenance, long-term BMPs that can be implemented readily and inexpensively by homeowners. Use of aesthetically pleasing landscape materials to divert runoff from eroding slopes, planting vegetation, adding berms to driveways or use of porous pavers in driveways, and minor regrading are examples of achievable activities. Homeowners also should be educated about the use of fertilizers and the impact of lawns on lake water quality.

Residential BMP checklist

- ☐ Plant vegetation for soil stabilization.
- ☐ Add vegetated buffers along lakeshore.
- ☐ Limit and stabilize the number of lakeshore access points.
- ☐ Use porous pavement for driveways.
- ☐ Divert stormwater runoff (e.g. to grassed swale).
- ☐ Dry wells to capture and infiltrate rooftop runoff.
- ☐ Minimize and control use of fertilizers and pesticides/herbicides on gardens, lawns, and landscape plants.
- ☐ Minimize lawn areas–plant perennials–particularly along lakeshore (for geese control).
- ☐ Use non-phosphorus fertilizers on lawns.

■ Roads

In many areas, road systems will be the greatest source of imperious cover. When stormwater comes in contact with roads, accumulated sediment, oil and gas residue, and pollutants are washed off at higher velocities. Sediment and road salt accumulation are higher in early spring, after a winter season of storm de-icing. Look for solutions that address poor design, location of roads, and inadequate drainage systems, as well as road maintenance options to correct erosion and sedimentation problems.

Road BMP checklist

- ☐ Reshape road or add berms to redirect stormwater runoff away from lake or stream.
- ☐ Use pavement materials that are not susceptible to erosion.
- ☐ Reposition culvert inverts.
- ☐ Stabilize culvert inlets and outlets.
- ☐ Vegetate slopes and road ditches.

- ☐ Add ditch turnouts.
- ☐ Street sweeping.
- ☐ Clean out catch basins.

■ Agricultural areas

Because of extensive areas of exposed soil, agricultural land uses can be significant sources of phosphorus, sediment, and other pollutants. Well managed farms that use conservation practices can reduce water quality impacts to lakes and other waterbodies. Many resources that address agricultural BMPs are available.

Agricultural BMP checklist

- ☐ Plant vegetative buffers along lakes, streams, and wetlands.
- ☐ Use winter cover crop, rotation.
- ☐ Leave vegetation along ditches to capture field runoff.
- ☐ Fence animals out of streams and waterbodies.
- ☐ Create adequate stream crossings.
- ☐ Spread manure on unfrozen, dry ground.
- ☐ Properly design and maintain manure storage areas.
- ☐ Fertilizer management, based on soil testing.
- ☐ Integrated Pest Management

■ Urban

Urban environments are heavily impacted by development. Paved and impervious cover accumulates pollutants, reduces infiltration of rainwater into the groundwater, and accelerates the rate of runoff. Rivers rarely resemble a natural state. Most are culverted, dammed, straightened, or flow underground. Urban land use is a significant contributor to water quality problems. Waste from domestic animals and birds, such as pigeons, geese, and gulls also can be a problem for urban lakes and ponds. Consequently, urban areas pose significant problems that will require nonstructural and structural best management practices, long range watershed planning, and possibly local ordinances and bylaws to manage phosphorus, sediment, and pollutant loadings. BMPs need to address high levels of metals, nutrients, and contaminants from urban areas.

Urban BMP checklist

- ☐ Reduce impervious surfaces.
- ☐ Use porous pavement for parking lots.
- ☐ Direct roof top runoff to groundwater.
- ☐ Provide flood storage.
- ☐ Routine street sweeping.
- ☐ Nonstructural practices (e.g., spill prevention and containment, material storage, and housekeeping) to limit the release of pollutants.
- ☐ Use and maintain stormwater controls (BMPs).
- ☐ Check BMPs for damage and build up.
- ☐ Monitoring BMPs periodically to ensure that the schedule for maintenance is adequate.

■ Forestry (logging)

Harvesting forest products requires the use of heavy equipment, which disturbs soil and causes the release of sediments. Phosphorus and sediment concentrations in runoff from actively forested areas can be very high. Forestry is heavily regulated in Massachusetts; forest cutting practices regulations required the use of BMPs to prevent or minimize water pollution impacts. These regulations are supported by other state and federal regulations and funding programs. Use the *Massachusetts Forestry Best Management Practices Manual* to address forestry -related problems. Required BMPs are highlighted and differentiated from recommended practices and activities in that guide.

Forestry BMP checklist

- ☐ Regrade, smooth, and repair ruts and shoreline or streambank landings.
- ☐ Vegetate or stabilize and smooth roads and skid trails that are no longer used.
- ☐ Limit skid trails and locate where stream bed is firm and avoid steep or undercut banks.
- ☐ Maintain stream and shoreline buffers and filter strips.
- ☐ Clear culverts and stabilize inlets and outlets.
- ☐ Use barriers such as hay bales and silt fences.
- ☐ Maintain ditches, waterbars, and culverts.
- ☐ Use barriers such as hay bales and silt fences.
- ☐ Avoid stream crossings wherever possible.
- ☐ Use Integrated Pest Management (IPM) and best management practices for pesticide and herbicide use.

Prepare the final report and recommendations.

The final report is more comprehensive than the draft report. Input from all participants in the survey should be solicited in preparing the report. Shared ideas from the steering committee members, technical team, and volunteer surveyors will help to create a thorough and balanced report.

The final report may be used and referenced for many years in the future. If the lake should experience a change in water quality, the report may be valuable for providing historical perspective on the types of problems that have existed in the watershed. The documentation of watershed protection efforts by the community may also help to get funding for mitigating future problems.

The final report should include the following:

- A discussion of types of problems identified for each land use.
- General recommendations for fixing each site.
- For sites where technical assistance would be required in designing and implementing BMPs, (conservation measures) the appropriate resource agencies should be identified.
- Identification of potential sources of funding to fix problems.
- A description of the overall level of development in the watershed relative to the number, type, and severity of problems.
- Information that provides precise information about the location of sites, but does not make specific reference to the name of the landowner.
- To avoid alienating landowners, do not include landowners' names in reports that are available to the public.
- A map(s) depicting the lake watershed, survey area, and the general location of the sites.
- A priority ranking of the sites based on their level of severity.
- While fixing the problems documented in the survey is generally beyond the scope of the project, ranking the problems based on their seriousness and making recommendations for corrective efforts is not.

If certain types of problems are recurrent throughout the watershed, recommendations could be made for developing local ordinance standards to prevent similar problems from occurring in the future. For example, if the road ditches in residential subdivisions are consistently found to be unstable and eroding into streams, a standard could be added to the local subdivision ordinance. Such a standard might require developers to stabilize ditches with vegetation or stone and to direct runoff from ditches to well-vegetated wooded areas, so that phosphorus and sediment would be filtered out.

If development has taken place on land with severe limitations such as very steep slopes, highly erodable soils, high water table, or any other factor that would increase the likelihood of soil erosion, this information should be included in the report. Town comprehensive planning committees and conservation commissions may find this information helpful in establishing long-term lake protection programs.

Survey information can help to identify areas of the watershed where existing land uses have resulted in significant NPS problems due to poor soils, steep slopes, or other natural limiting factors to development. This information also may highlight the need for comprehensive lake water quality protection and serve as a basis for recommending that a town adopt a phosphorus control policy that can be used when reviewing new land use applications.