This document is one chapter from the EPA "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," published in March 2008. The reference number is EPA 841-B-08-002. You can find the entire document **http://www.epa.gov/owow/nps/watershed_handbook**.

Handbook for Developing Watershed Plans to Restore and Protect Our Waters

Chapter 10. Identify Possible Management Strategies

March 2008

Handbook Road Map

10. Identify Possible Management Strategies

Chapter Highlights

- Overview of management techniques and measures
- Reviewing existing management efforts to determine gaps
- Identifying management opportunities and constraints
- Screening management options to determine the most promising types

Read this chapter if...

- You want to learn about common types of management measures
- You need information on how to focus management efforts in your watershed
- You want help with identifying possible management practices for your watershed
- You want to identify criteria for evaluating the appropriateness of management practices

10.1 How Do I Link My Management Strategies to My Goals?

Once you have analyzed the watershed conditions, quantified the pollutant loads, and determined the loading targets needed to meet your goals and objectives, you'll be ready to identify potential management measures and management practices to achieve your goals. You can then screen potential practices to narrow the options down to those which are the most promising and acceptable (figure 10-1). During this phase, it will be important for watershed planners and scientists to consult with engineers, technicians, and professional resource managers to ensure that the actions being considered are realistic and capable of meeting water quality objectives. The importance of this interaction cannot be overstated.

Key questions to address in your evaluation of candidate management measures and practices are these:

1. Are the site features suitable for incorporating the practice (i.e., is the practice feasible)?
2. How effective is the practice at achieving management goals and loading targets?
3. How much does it cost (and how do the costs compare between alternatives)?
3. Is it acceptable to stakeholders?

This chapter addresses the first step, identifying potential management measures and practices that might be feasible for addressing the particular problems in your watershed. Using screening criteria, you'll evaluate potential management strategies (a single management practice or multiple practices used in combination). The screening criteria are based on factors such as pollutant reduction efficiencies, legal requirements, and physical constraints. Once you have identified and screened various management options, chapter 11 will show you how to calculate the effectiveness of the management practices, compare the costs and benefits, and select the final management strategies that will be the most effective in achieving the load reductions needed to meet your watershed goals.

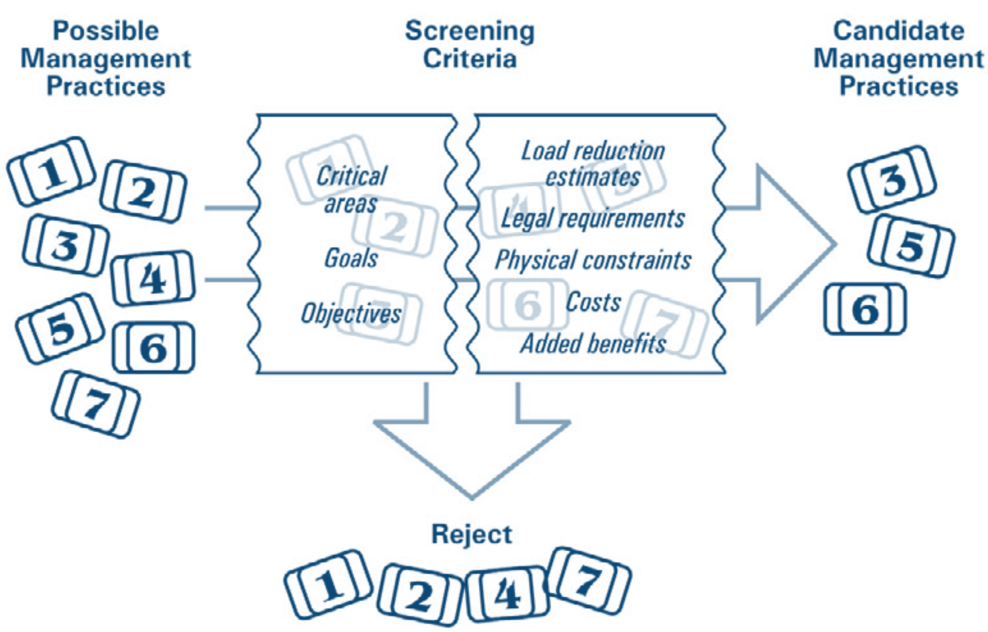


Figure 10-1. Process for Identifying Candidate Management Practices

9 The information presented in chapters 10 and 11 addresses element *c* of EPA's Nine Elements of Watershed Plans. Element *c* is *"A description of the nonpoint source management measures that will need to be implemented to achieve load reductions, and a description of the critical areas in which those measures will be needed to implement this plan."*

10.2 Overview of Management Approaches

A variety of management approaches are available to address water quality problems in the planning area. These include regulatory and nonregulatory approaches for dealing with point sources and nonpoint sources, e.g., management measures and management practices, terms that are sometimes used interchangeably. In general, management measures are groups or categories of cost-effective management practices that are implemented to achieve comprehensive goals, such as reducing the loads of sediment from a field to receiving waters. Individual management practices are specific and often site-based actions or structures for controlling pollutant sources.

Management measures and practices can be implemented for various purposes, such as

- Protecting water resources and downstream areas from increased pollution and flood risks
- Conserving, protecting, and restoring priority habitats
- Setting aside permanent aquatic and terrestrial buffers
- Establishing hydrologic reserve areas
- Acquiring ground water rights

Management measures can also help control the pollutant loads to receiving water resources by

- Reducing the availability of pollutants (e.g., reducing fertilizer, manure, and pesticide applications)
- Reducing the pollutants generated (source reduction such as erosion control)
- Slowing transport or delivery of pollutants by reducing the amount of water transported or by causing the pollutant to be deposited near the point of origin
- Causing deposition of the pollutant off-site before it reaches the waterbody
- Treating the pollutant before or after it is delivered to the water resource through chemical or biological transformation

Management measures can also be used to guide the implementation of your watershed management program. They are linked to performance expectations, and in many cases they specify actions that can be taken to prevent or minimize nonpoint source pollution or other negative impacts associated with uncontrolled and untreated runoff. The NRCS National Handbook of Conservation Practices (**www.nrcs.usda.gov/technical/standards/nhcp.html**) provides a list of practices applicable to rural and farming areas; consultation with NRCS staff when considering management actions in rural areas is highly recommended. Refer to EPA's National Management Measures guidance documents for information about controlling nonpoint source pollution (**www.epa.gov/owow/nps/pubs.html**).

EPA National Management Measures Guidance Documents

EPA maintains published guidance documents online for the following categories (see **www.epa.gov/owow/nps/categories.html**):

- Acid mine drainage
- Agriculture
- Forestry
- Hydromodification/habitat alteration
- Marinas/boating
- Roads, highways, and bridges
- Urban areas
- Wetland/riparian management

There are many types of individual management practices, from agricultural stream buffer setbacks to urban runoff control practice retrofits in developed areas to homeowner education programs for on-site septic system maintenance. Management practices can be categorized several different ways, such as source controls versus treatment controls, structural controls versus nonstructural controls, or point source controls versus nonpoint source controls. For the purposes of this handbook, management practices are grouped into structural controls and nonstructural controls. *Structural* controls are defined as built facilities that typically capture runoff; treat it through chemical, physical, or biological means; and discharge the treated effluent to receiving waters, ground water, or conveyance systems. *Nonstructural* practices usually involve changes in activities or behavior and focus on controlling pollutants at their source. Examples include developing and implementing erosion and sediment control plans, organizing public education campaigns, and practicing good housekeeping at commercial and industrial businesses. Regulatory mechanisms like ordinances and permits are discussed separately from structural and nonstructural controls.

10.2.1 Nonpoint Source Management Practices

Structural Practices

Structural practices, such as stormwater basins, streambank fences, and grade and stabilization structures, might involve construction, installation, and maintenance. Structural practices can be vegetative, such as soil bioengineering techniques, or nonvegetative, such as riprap or gabions. Note that practices like streambank stabilization and riparian habitat restoration involve ecological restoration and an understanding of biological communities, individual species, natural history, and species' ability to repopulate a site. Such practices involve more than simply installing a structural control. Many vegetative practices can be considered "green infrastructure." The term green infrastructure has sometimes been used to describe an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure management approaches and technologies mimic natural processes by capturing rainfall and runoff and infiltrating it into the soil to maintain or restore natural hydrology and by using plants to help evaporate and transpire water. Green infrastructure site-level practices might include rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation. Green infrastructure practices also involve preserving and restoring natural landscape features (such as forests, floodplains and wetlands). By protecting these ecologically sensitive areas, communities can improve water quality while maintaining healthy ecosystems, providing wildlife habitat, and opportunities for outdoor recreation. Examples of structural practices for rural and urban scenarios are listed in table 10-1.

You can choose to use structural practices that are vegetative, nonvegetative, or a combination, depending on which practice is best suited for the particular site and objective. For example, if a site is unable to support plant growth (e.g., there are areas with climate or soils that are not conducive to plant growth, or areas of high water velocity or significant wave action), a nonvegetative practice can be used to dampen wave or stream flow energy to protect the vegetative practice.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) provides technical and other assistance to help land owners and managers conserve and protect soil, water, and other natural resources. Regional and often county-level staff are available to provide this assistance to land users, communities, units of state and local government, and other federal agencies in planning and implementing natural resource conservation systems. Technical resources include environmental, scientific, engineering, societal, and economic analysis services. State, local, and regional contact information for NRCS staff is posted at **www.nrcs.usda.gov/about/organization/regions.html**.

Table 10-1. Examples of Structural and Nonstructural Management Practices [a]

	Structural Practices	Nonstructural Practices
Agriculture	• Contour buffer strips • Grassed waterway • Herbaceous wind barriers • Mulching • Live fascines • Live staking • Livestock exclusion fence (prevents livestock from wading into streams) • Revetments • Riprap • Sediment basins • Terraces • Waste treatment lagoons	• Brush management • Conservation coverage • Conservation tillage • Educational materials • Erosion and sediment control plan • Nutrient management plan • Pesticide management • Prescribed grazing • Residue management • Requirement for minimum riparian buffer • Rotational grazing • Workshops/training for developing nutrient management plans
Forestry	• Broad-based dips • Culverts • Establishment of riparian buffer • Mulch • Revegetation of firelines with adapted herbaceous species • Temporary cover crops • Windrows	• Education campaign on forestry-related nonpoint source controls • Erosion and sediment control plans • Forest chemical management • Fire management • Operation of planting machines along the contour to avoid ditch formation • Planning and proper road layout and design • Preharvest planning • Training loggers and landowners about forest management practices, forest ecology, and silviculture
Urban	• Bioretention cells • Breakwaters • Brush layering • Infiltration basins • Green roofs • Live fascines • Marsh creation/restoration • Establishment of riparian buffers • Riprap • Stormwater ponds • Sand filters • Sediment basins • Tree revetments • Vegetated gabions • Water quality swales • Clustered wastewater treatment systems	• Planning for reduction of impervious surfaces (e.g., eliminating or reducing curb and gutter) • Management programs for onsite and clustered (decentralized) wastewater treatment systems • Educational materials • Erosion and sediment control plan • Fertilizer management • Ordinances • Pet waste programs • Pollution prevention plans • No-wake zones • Setbacks • Stormdrain stenciling • Workshops on proper installation of structural practices • Zoning overlay districts • Preservation of open space • Development of greenways in critical areas

[a] Note that practices listed under one land use category can be applied in other land use settings as well.

Nonstructural Practices

Nonstructural practices prevent or reduce runoff problems in receiving waters by reducing the generation of pollutants and managing runoff at the source. These practices can be included in a regulation (e.g., an open space or riparian stream buffer requirement), or they can involve voluntary pollution prevention practices. They can also include public education campaigns and outreach activities. Examples of nonstructural practices are listed in table 10-1. Nonstructural controls can be further subdivided into land use practices and source control practices. Land use practices are aimed at reducing impacts on receiving waters that result from runoff from development by controlling or preventing land use in sensitive areas of the watershed (e.g., critical habitat). Source control practices are aimed at preventing or reducing potential pollutants at their source before they come into contact with runoff or ground water. Some source controls are associated with new development, whereas others are implemented after development occurs. Source controls include pollution prevention activities that attempt to modify aspects of human behavior, such as educating citizens about the proper disposal of used motor oil and proper application of lawn fertilizers and pesticides (when needed).

10.2.2 Regulatory Approaches to Manage Pollutant Sources

The management practices you select can be implemented voluntarily or required under a regulatory program. Point sources are most often controlled using regulatory approaches. It's important to consider that regulatory approaches work well only when adequate mechanisms are in place to provide oversight and enforcement.

Regulatory Approaches for Nonpoint Sources

- **Local stormwater ordinances and permits.** Local stormwater ordinances may require development applicants to control stormwater peak flows, total runoff volume, or pollutant loading. Stormwater ordinances that apply these requirements to redevelopment projects (not just new development areas) can help mitigate current impacts from existing development. Developers could be required to implement stormwater practices such as bioretention cells, stormwater ponds, or constructed wetlands to meet performance standards for the development set forth in the ordinance.

- **Local development ordinances and permits.** Local development and subdivision ordinances may require development applicants to meet certain land use (e.g., commercial versus residential), development intensity, and site design requirements (e.g., impervious surface limits or open space, riparian buffer, or setback requirements). See section 5.5.2 for examples. Again, ordinances that apply these requirements to redevelopment projects (not just new development areas) can help mitigate current impacts from existing development. Although it might be difficult to add open space to the redevelopment plan of an already-developed area, equivalent off-site mitigation or payment in lieu might be required. Similarly, a riparian area might be revegetated and enhanced.

- **Federal or state forest land management plans.** Corporate, federal, and state owners of forest lands are often required to develop and implement forest management plans. These plans usually include management practices for logging, road construction, replanting, and other activities. A number of states also have forestry practice regulations that cover logging practices by individuals or private landowners. Such regulations may have requirements such as notification of intent to log, development of and compliance with a management plan that includes the use of management practices, and notification of termination of activities. Watershed planners can review recent or existing forest management plans in the watershed, discuss with managers which plans and practices are working well, and identify areas that could be strengthened.

- **Federal or state grazing permits.** Federal or state lands that are leased to individuals often require permits that specify conditions and management practices that must be adhered to for the term of the permit. These practices and conditions might include limiting the number of livestock allowed to graze, establishing off-stream watering or fencing in sensitive watershed areas, and other water quality protection measures. Again, watershed planners can review existing permits in the watershed, discuss with managers which practices are working well, and identify areas that could be improved.

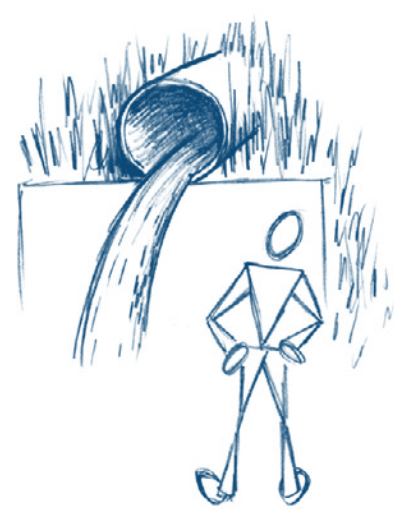
- **State regulatory authority.** Some states, such as California, have the authority to regulate nonpoint sources. California is beginning to issue waivers for traditional nonpoint sources, such as irrigated agriculture in the Central Valley. The waivers may require growers to implement management practices and develop farm plans, notice of which is submitted to the state's water board through a Notice of Intent (NOI). Irrigated agriculture facilities may be required to submit an NOI indicating that management practices have been implemented before irrigation return flows may be discharged to receiving waters.

  In 1990 Congress passed the Coastal Zone Act Reauthorization Amendments (CZARA) to address the nonpoint source pollution problem in coastal waters. Section 6217 of CZARA required the 29 coastal states and territories with approved Coastal Zone Management Programs to develop Coastal Nonpoint Pollution Control Programs. In its program, a state or territory describes how it will implement nonpoint source management measures to control nonpoint source pollution. States and territories ensure the implementation of the management measures through mechanisms like permit programs, zoning, bad actor laws, enforceable water quality standards, and other general environmental laws and regulations. Voluntary approaches like economic incentives can also be used if they are backed by appropriate regulations.

- **Decentralized wastewater management.** Many states and counties are developing or upgrading their management programs for onsite and clustered wastewater treatment systems. These programs usually include an inventory and analysis of existing systems; inspections; risk assessments; projections of future treatment needs; and development of standards for new system designs, operation and maintenance, inspections, corrective actions, and residuals management.

Regulatory Approaches for Point Sources

Point sources are regulated under the National Pollutant Discharge Elimination System (NPDES) permit program. Authorized by section 402 of Clean Water Act, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES program covers discharges from industrial facilities, municipal stormwater conveyances, concentrated animal feeding operations (CAFOs), construction sites, publicly owned treatment works (POTWs), combined sewer overflows (CSOs), and sanitary sewer overflows (SSOs). These categories are briefly described below.



- **Wastewater discharges from industrial sources.** Wastewater discharges from industrial facilities might contain pollutants at levels that could affect the quality of receiving waters. The NPDES permit program establishes specific requirements for discharges from industrial sources. Depending on the type of industrial or commercial facility, more than one NPDES program might apply. For example, runoff from an industrial facility or construction site might require an NPDES permit under the stormwater program. An industrial facility might also discharge wastewater to a municipal sewer system and be covered under the NPDES pretreatment program. If the industrial facility discharges wastewater directly to a surface water, it will require an individual or general NPDES permit. Finally, many industrial facilities, whether they discharge directly to a surface water or to a municipal sewer system, are covered by effluent limitation guidelines and standards.

- **Municipal stormwater discharges.** Stormwater discharges are generated by runoff from land and impervious areas like paved streets, parking lots, and building rooftops during rainfall and snow events. This runoff often contains pollutants in quantities large enough to adversely affect water quality. Most stormwater discharges from municipal separate storm sewer systems (MS4s) require authorization to discharge under an NPDES permit as part of the Phase I or Phase II (depending on the size of the population served) NPDES Stormwater Program. Operators of regulated MS4s must obtain coverage under an NPDES stormwater permit and must implement stormwater pollution prevention plans or stormwater management programs, both of which specify how management practices will be used to control pollutants in runoff and prevent their discharge to receiving waters. For example, regulated small MS4s (in general, cities and towns with populations between 10,000 and 100,000) must include the following six minimum control measures in their management programs:
  - Public education and outreach on stormwater impacts
  - Public involvement/participation
  - Illicit discharge detection and elimination
  - Construction site runoff control
  - Post-construction stormwater management in new development and redevelopment
  - Pollution prevention/good housekeeping for municipal operations

The NPDES stormwater program also requires operators of construction sites 1 acre or larger (including smaller sites that are part of a larger common plan of development) to obtain authorization to discharge stormwater under an NPDES construction stormwater permit.

Management practices appropriate for controlling stormwater discharges from MS4s, construction sites, and other areas are discussed in more detail under Nonpoint Source Management Practices.

- **Publicly owned treatment works (POTWs).** These facilities are wastewater treatment works owned by a state or municipality and include any devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature, as well as the sewers, pipes, and other conveyances that convey wastewater to a POTW treatment plant. Through NPDES permits, discharges from POTWs are required to meet secondary treatment standards established by EPA. These technology-based regulations apply to all municipal wastewater treatment plants and represent the minimum level of effluent quality attainable by secondary treatment for removal of biochemical oxygen demand (BOD) and total suspended solids (TSS). Discharges from POTWs may also be subject to water quality-based effluent limitations to reduce or eliminate other pollutants, if needed to achieve water quality standards.

- **Combined sewer overflows.** Combined sewer systems are designed to collect runoff, domestic sewage, and industrial wastewater in the same pipe system. In 1994 EPA issued its Combined Sewer Overflow Control Policy (**www.epa.gov/npdes/pubs/owm0111.pdf**), which is a national framework for controlling CSOs through the NPDES permitting program. The first milestone under the CSO Policy was the January 1, 1997, deadline for implementing minimum technology-based controls, commonly referred to as the "nine minimum controls." These controls are measures that can reduce the frequency of CSOs and minimize their impacts when they do occur. The controls are not expected to require significant engineering studies or major construction. Communities with combined sewer systems are also expected to develop long-term CSO control plans that will ultimately provide for full compliance with the Clean Water Act, including attainment of water quality standards.

- **Separate sanitary systems.** Separate sanitary collection systems collect and transport all sewage (domestic, industrial, and commercial wastewater) that flows through the system to a treatment works for treatment prior to discharge. However, occasional unintentional discharges of raw sewage from municipal separate sanitary sewers occur in almost every system. These types of discharges are called sanitary sewer overflows (SSOs). There are a variety of causes, including but not limited to severe weather, improper system operation and maintenance, and vandalism. Examples of management practices that can reduce or eliminate SSOs are:
    - Conducting sewer system cleaning and maintenance
    - Reducing infiltration and inflow by rehabilitating systems and repairing broken or leaking service lines
    - Enlarging or upgrading sewer, pump station, or sewage treatment plant capacity and reliability
    - Constructing storage and treatment facilities to treat excess wet weather flows.

Communities should also address SSOs during sewer system master planning and facilities planning or when extending the sewer system into unsewered areas.

- **Concentrated animal feeding operations.** AFOs are agricultural operations in which animals are kept and raised in a confined setting. Certain AFOs that meet a minimum threshold for number of animals are defined as concentrated AFOs (CAFOs). CAFOs require NPDES permits. The permits set waste discharge requirements that need to be met by implementing animal waste management practices such as reducing nutrients in feed; improving storage, handling, and treatment of waste; and implementing feedlot runoff controls.

- **Industrial stormwater permits.** Activities that take place at industrial facilities such as material handling and storage are often exposed to the weather. As runoff from rain or snowmelt comes into contact with these materials, it picks up pollutants and transports them to nearby storm sewer systems, rivers, lakes, or coastal waters. Stormwater pollution is a significant source of water quality problems for the nation's waters. Of the 11 pollution source categories listed in EPA's *National Water Quality Inventory: 2000 Report to Congress*, urban runoff/storm sewers was ranked as the fourth leading source of impairment in rivers, third in lakes, and second in estuaries.

  In order to minimize the impact of stormwater discharges from industrial facilities, the NPDES program includes an industrial stormwater permitting component. Operators of industrial facilities included in one of the 11 categories of stormwater discharges associated with industrial activity that discharge or have the potential to discharge stormwater to an MS4 or directly to waters of the United States require authorization under a NPDES industrial stormwater permit.

Most of the management practices listed in the following section could be required through regulations or encouraged through training and education programs. Your watershed management plan might include both regulatory and nonregulatory methods to get landowners, citizens, and businesses to adopt the practices needed.

10.3 Steps to Select Management Practices

This section describes a process for selecting management practices that might be feasible to implement in the critical areas identified in your watershed. The first step in the process is to inventory what has been or is being accomplished in the watershed. Future projects and management practices should augment efforts already under way. This analysis will allow you to determine where modifications are needed to existing programs, practices, or ordinances and where new practices are needed.

Steps to Select Management Practices

1. Inventory existing management efforts in the watershed
2. Quantify the effectiveness of current management measures
3. Identify new management opportunities
4. Identify critical areas in the watershed where additional management efforts are needed
5. Identify possible management practices
6. Identify relative pollutant reduction efficiencies
7. Develop screening criteria to identify opportunities and constraints
8. Rank alternatives and develop candidate management opportunities

The next step involves quantifying the effectiveness of existing management efforts. This step will allow you to establish a baseline level of pollutant load reductions that are already occurring and will help guide the selection of additional management practices to meet target load reductions.

The third step entails identifying new opportunities for implementing management measures. Based on the identification of pollutant sources from chapter 7, you can locate critical areas where management measures will likely achieve the greatest pollutant load reductions.

Once opportunities for pollutant load reductions are identified, you can match them with candidate management practices, alone or in combination, that could effectively reduce pollutant loads. This step will involve research into management practice specifications to help you determine which practices will be most feasible (considering site constraints), which practices are most acceptable to landowners, and which have the greatest pollutant removal effectiveness under similar conditions. For example, EPA lists management measures for urban areas and cost/benefit and other information at **www.epa.gov/owow/nps/urbanmm/index.html**.

Managing Onsite and Clustered Wastewater Treatment Systems

EPA has developed several tools designed to help local communities manage decentralized (distributed) wastewater treatment systems. The tools include a handbook for developing or improving existing management programs, a set of guidelines that describe five generalized management models, a design guide, technology fact sheets, case studies of successful programs, a homeowners' guide, and more. To access these tools, visit **http://cfpub.epa.gov/owm/septic/index.cfm**.

After researching candidate management measures and practices, you should have enough information to analyze each management opportunity using screening criteria that you develop. The screening criteria are based on various factors, such as your critical areas, site conditions, and constraints. The criteria will help you sort through the different attributes of each practice so you can select the practices worthy of more detailed analysis. Then you can quantify their effectiveness and conduct the associated cost versus benefit analysis. You'll conduct these more detailed analyses in chapter 11.

10.3.1 Identify Existing Management Efforts in the Watershed

Before you identify the additional management measures needed to achieve management objectives, you should identify the programs, management strategies, and ordinances already being implemented in the watershed. In some cases, the existing management practices themselves might be adequate to meet water quality goals, but they might not be maintained correctly or there might not be enough of them in place. Perhaps, for example, NRCS conservation practices on farmland are effective for the farms using them, but not enough farmers have adopted the practices to meet the goals in the watershed. In other cases, you might want to modify an existing practice, for example, by increasing stream setback requirements from 25 feet to 100 feet. When identifying the existing programs and management efforts, be sure to record the responsible party, such as an agency or landowner, and the pollutants the efforts address.

Tip Remember to incorporate the existing management efforts into your implementation plan in addition to any new management measures you identify. Often, existing management efforts have already incorporated complex site-specific social and economic factors, as well as considerable local knowledge of regional environmental constraints. Understanding why existing management measures were selected and choosing options for new ones is important business. This points to the need to make sure those entities that will be asked to implement practices are part of the team developing your plan.

Communities in the Mill Creek watershed in Michigan first evaluated existing local regulations and programs to help identify ways to strengthen local policies to help meet multiple watershed objectives. These programs and policies are described in table 10-2. Appendix A includes references of example watershed plans.

Low-Impact Development and Watershed Protection

Stormwater management programs and antidegradation implementation procedures have embraced low-impact development as a preferred management measure for minimizing water resource impacts from new areas of development. Low-impact development is based on preserving the existing hydrology (drainage system) of the development site, including vegetation growing along the drainage features; minimizing overall disturbance by carefully siting buildings, roads, and other design elements; promoting infiltration of rain and snowmelt by routing runoff from impervious surfaces to nearby rain gardens, swales, and other infiltration areas; and reducing the total amount of impervious surface area by minimizing the footprint of structures built on the site. For more information, visit **www.epa.gov/owow/nps/lid**.

Table 10-2. Existing Programs and Policies Identified in the Mill Creek Subwatershed Communities

Stakeholder	Existing Program or Policy	Pollutant Addressed
USDA, Natural Resources Conservation Service	Wetland restoration (Wetlands Reserve Program)	Hydrologic flow
	Controlling erosion/soil information	Sediment
	Streambank stabilization expertise	Sediment
	Riparian revegetation (Conservation Reserve Program)	
	Forested revegetation/filter strips	
	Agricultural waste management (Environmental Quality Incentives Program)	Nutrients
	Soil testing	
	Cross wind strips	Wind erosion

Table 10-2. Existing Programs and Policies Identified in the Mill Creek Subwatershed Communities (continued)

Stakeholder	Existing Program or Policy	Pollutant Addressed
Washtenaw County Road Commission	Leave buffers when grading gravel roads	Sediment
	Assess and manage erosion at stream crossings	
	Follow soil erosion and sediment control practices	
Village of Chelsea	Soil erosion and sediment controls and stormwater retention requirements on new developments	Sediment
	Stormwater calculations must account for roads in new development in addition to the other development	Hydrologic flow
	Large detention on wastewater treatment plant site	
	Stormwater collectors, proprietary treatment devices	
	Oil and grease separators installed; add outlet devices to existing development	Sediment, oil and grease
Daimler Chrysler Chelsea Proving Grounds	Leave buffers (of minimal width) along creek	Nutrients
	Switching products to no- or low-phosphorus alternatives	
	Ongoing monitoring of phosphorus levels in Letts Creek for NPDES permit	
	Pursuing alternative treatment chemical to reduce phosphorus	
	Soil erosion and sediment control permits and practices	Sediment
	Oil-grease separators installed	Oil and grease
	Devices in manholes checked monthly	
Washtenaw County Drain Commissioner's Office	Planning incentives or requirements for infiltration	Hydrologic flow
	Require first flush and wet ponds	
	Implementation of Phase II NPDES stormwater permits	All
	Work to balance drain maintenance and channel protection	
	Drains are being entered into a GIS for enhanced use	
	Community Partners for Clean Streams program encourages business and community partners to improve operations to protect streams	
	Stormwater BMP Demonstration Park nearly complete	
Scio Township	Adopted Drain Office standards	Hydrologic flow
	Follows county Soil Erosion and Sediment Control rules	Sediment
Sylvan Township	Part of regional plan to limit sprawl	All
	Lake communities connecting to sanitary sewer	Nutrients

Note: GIS = geographic information system; BMP = best management practice.

Worksheet 10-1 is an excerpt of a worksheet that can be used to begin identifying and evaluating existing efforts. A blank worksheet 10-1 is provided in appendix B.

Excerpt of Worksheet 10-1 *Identifying Existing Management Efforts*

Wastewater Discharges

- Where are the wastewater discharges located in the watershed? If possible, map the locations.
- What volume of wastewater is being discharged?
- What are the parameters of concern in the effluent?

Onsite Wastewater Treatment Systems

- Where are onsite systems located? If possible, map the locations and identify system type, age, and performance.
- Are there known malfunctioning onsite systems? If so, where?

Urban Stormwater Runoff

- Are cities and counties in the watershed covered by an NPDES stormwater permit? If so, what are the conditions of the permit?
- Do local governments in the watershed have stormwater ordinances? If so, what are the requirements?

Agricultural and Forestry Practices

- Are there areas with active farming or logging in the watershed? If so, map them if possible.
- Are management plans in place where these activities are occurring?
- What percentage of the area uses management practices for controlling sediment and other pollutants? Are these practices effective? If not, why? Are monitoring data available?

Wetlands and Critical Habitat Protection

- Have wetlands been identified and evaluated for the habitat value, water quality benefits, and flood control contributions?
- To what extent do natural buffers and floodplains remain in the watershed?
- To what extent are critical habitats such as headwater streams, seeps, and springs that provide many critical functions (e.g., habitat for aquatic organisms) being protected?
- Has the natural hydrologic connectivity been mapped? If so, are there management practices in place to restore any fragmentation of stream networks?

10.3.2 Quantify the Effectiveness of Current Management Measures

After you've identified existing management efforts in the watershed, you'll determine the effectiveness of the measures in terms of achieving desired load reductions or meeting other management goals and objectives. The difference between the levels of pollutant load reductions achieved by existing practices and the targeted reductions you identified in chapter 9 will help determine the additional practices needed.

Quantifying the effectiveness of existing programs and measures can be a challenging task. First, take a look at whether the source quantification analyses performed earlier (Chapter 8) reflect existing programs adequately so that you can determine the gap. For example, if you don't expect the programs to achieve more than what was represented in earlier modeling analyses and a gap exists between the current level of loading and the target, additional measures will need to be added to fill that gap. In addition, if the existing management measures are not aimed at controlling the stressors of greatest concern, a gap is clearly evident and new management measures are needed. On the other hand, if the existing programs are evolving and greater participation or improved performance is expected with respect to the parameters of concern, you can estimate how much that gap will be further reduced by programs already in place. Additional measures would be needed only to the extent that a gap is expected to remain.

If the modeling tools previously applied to conduct the loading analysis can't be used to predict the future performance of existing management programs, you can approximate the additional reductions expected based on best professional judgment or you can develop additional modeling tools to estimate effectiveness. Chapter 11 discusses methods for evaluating the effectiveness of new management measures, from the relatively simple to the complex; some of the methods could be used to evaluate existing measures as well.

10.3.3 Identify New Management Opportunities

Now that you've identified the existing management efforts in the watershed and their relative effectiveness in reducing pollutant loads, you can begin to identify potential new management measures that could be used to achieve the additional load reductions required. At this stage you'll conduct a preliminary screening of these management measures to determine their potential usefulness. Once this screening is complete, you'll conduct more rigorous evaluations in chapter 11.

> NRCS published *National Catalog of Erosion and Sediment Control and Storm Water Management Guidelines for Community Assistance* (**www.info.usda.gov/CED/ftp/CED/Natl-Catalog-Erosion-and-Sed-Guidelines.pdf**). This document contains a comprehensive list of urban and development management practices from every state, as well as representative standards and specifications for each type of management practice.

This section provides a process for screening management opportunities and identifying good candidate options, which will be subjected to a more detailed evaluation. The process includes

- Identifying critical areas where additional management is needed
- Identifying candidate management practices
- Identifying relative pollutant loading reductions
- Identifying opportunities and constraints for each management measure
- Documenting good candidate opportunities

10.3.4 Identify Critical Areas in the Watershed Where Additional Management Efforts Are Needed

In general, management practices are implemented immediately adjacent to the waterbody or upland to address the sources of pollutant loads. Streamside practices include streambank protection and riparian habitat enhancement to address the channel, floodplain, and riparian corridor of the waterbody. Upland management practices are typically divided into practices for agricultural lands, forestry, and urban or developed lands. Related to these upland practices, and important to the ecological integrity of watersheds, is the management of surface water flow and groundwater pumping.

As part of your screening process, you'll want to identify which management practices can be implemented in the critical areas that you have identified. Using the location of the pollutant sources you identified in chapter 7, you'll start to identify possible opportunities for installing additional management practices.

You can use a geographic information system (GIS) or hand-drafted maps to conduct an analysis of management opportunities. A simple mapping analysis for a rural residential and farming area that has nutrient problems might include the following geographic information: location of section 303(d)-listed waterbodies, existing agricultural areas (using a GIS coverage of existing land use or land cover data that indicates grazing versus cropland if possible), areas where existing management practices are being employed (if any), and the degree of riparian buffer disturbance. These maps can often be generated using the land use/land cover databases and watershed tools from the scoping and watershed analysis.

Figure 10-2 shows a map that was generated to help identify the critical areas where management practices were needed in the rural Troublesome Creek watershed. The map shows the impaired waters, along with the percentage of buffer area disturbed in the Troublesome Creek subwatersheds. The subwatersheds that have buffers more than 15 percent disturbed indicate the potential for riparian area restoration efforts to limit sediment loading. Maps for an urban or suburban area might include waters on the section 303(d) list with an overlay of subwatersheds that have impervious area greater than 10 percent and greater than 25 percent, indicating the medium and high potential for stream degradation, degree of riparian buffer disturbance, and industrial sites.

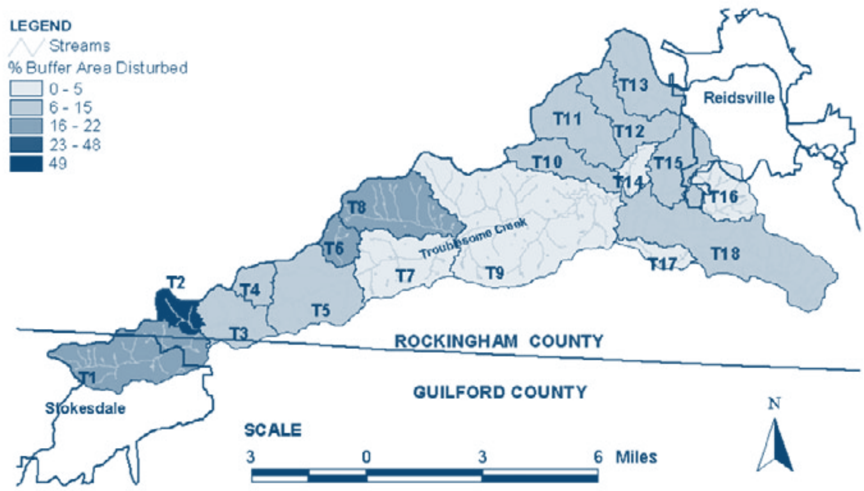


Figure 10-2. Percentage of Buffer Area Disturbed and Impaired Waters in the Troublesome Creek Watershed

10.3.5 Identify Possible Management Practices

Dozens of resources are available to help provide a sound basis for your research and preliminary screening of management practices. The resources you select should depend on the pollutant sources and causes in your watershed and the land use characteristics (chapter 7). For example, some resources focus on practices to control urban stormwater runoff, some focus on agricultural practices to manage farm runoff, and some concentrate on forestry practices to control impacts from logging. These resources provide information on the practice, such as description, cost, and planning considerations. Although data on management practice effectiveness and program-related load reductions can be very limited, the resources provide insight on relative performance. For example, NRCS's (2005) *National Conservation Practice Standards* allows you to identify the level of technical expertise necessary to successfully design, install, and maintain specific activities: passive management, active management, mild engineering, moderate engineering, and intensive engineering. Appendix A provides several resources that can be used to begin identifying possible management practices.

As you conduct your research, it's helpful to develop a one- or two-page summary of each promising management option. (These can be included in an appendix to your management plan.) Each summary should eventually include, at minimum, the information listed in Worksheet 10-2. As you move through the screening process you'll add information to the worksheet, such as the pollutant reduction effectiveness, planning considerations, legal requirements, and opportunities and constraints. Full-size, blank worksheets are provided in appendix B.

Excerpt of Worksheet 10-2 Documenting Management Measure Opportunities and Constraints

Sources (e.g., streambanks, urban stormwater, malfunctioning septic systems, livestock in stream)

Causes (e.g., eroding streambanks, unlimited access of livestock, undersized culverts)

Name of management measure or program (NRCS code if applicable)

Data source (i.e., where you obtained your information on the management measure)

Description (what it is and what it does)

Approximate unit cost (including installation and operation and maintenance costs; may be expressed as a range)

Approximate or relative load reduction for each parameter of concern (could be high, moderate, low, or unit reduction per acre per year)

Planning considerations (e.g., project factors such as site size and contributing watershed area; physical factors such as slope, depth of water table, and soil type limitations or considerations; operation and maintenance requirements)

Skill needed to implement the management measures (e.g., engineering, landscape design, construction)

Permitting considerations

Other (e.g., stakeholders' willingness to use the measure)

The *National Conservation Practice Standards* provides a one-page summary of each of 50 management practices. Drawing from this manual, Table 10-3 lists some commonly used practices for reducing sediment, total dissolved solids (TDS), and salinity, along with the pollution sources they address and the expected level of load reduction. The load reduction potential qualitatively describes the potential reduction of loading achieved by implementing the practice. The actual load reduction depends on the extent of the practice, existing loading levels, and local features like soils and hydrology.

This handbook and others like it can provide a good basis for screening, with some adaptation to local circumstances. For example, because *National Conservation Practice Standards* was developed in the West, if you're developing a plan for an eastern watershed, you might need to consult your local NRCS office or local engineering department staff regarding the potential load reductions and cost of selected practices in your area.

Although dozens of management practices can be implemented, you should identify those practices that will have the greatest likelihood of achieving your watershed goals. You should relate the management practices back to the sources of pollutants in the watershed, the types of impairments found, and the amount of load reduction needed. In addition, it is also useful to consider complementary or overlapping benefits or issues. For example, regional sediment management plans might be developed to provide an inventory and budget for local sediment resources. Excess instream sediment might be used for beach or wetland restoration, highway construction, landfill cover, or other uses.

The management practices selected should be targeted to the sources of a particular stressor. For example, full-scale channel restoration can be pursued along reaches where channel incision and streambank failure result from historical channelization, whereas exclusion fencing of cattle might be more appropriate when the sediment source is streambank trampling along cobble bed reaches. In cases where instream habitat is degraded, the components of the

Table 10-3. Commonly Used Management Practices for Salinity, Sediment, and Total Dissolved Solids

Pollution Sources (✓ = Management practice applies)							
AFO	Ag Practices	Industry Runoff	Urban Runoff	Disturbed Areas	Stream Erosion	Management Practice	Load Reduction (H, M, or L)
		✓		✓		Construction site mgt	L
	✓			✓	✓	Grazing mgt	M
✓	✓					Nutrient mgt	M
	✓			✓		Cover crop	H
✓	✓			✓	✓	Fencing	H
✓	✓			✓	✓	Filter strip	H
	✓			✓		Mulching	L
	✓	✓	✓	✓	✓	Riparian buffer	M
	✓			✓	✓	Seeding	M
				✓	✓	Tree planting	L
					✓	Brush layer	H
✓	✓				✓	Brush trench	H
✓	✓			✓	✓	Erosion control fabric	H
✓	✓			✓	✓	Silt fence	M
✓				✓		Straw bale barrier	M
	✓				✓	Watering facility	M
✓	✓	✓	✓		✓	Constructed wetland	M
✓	✓	✓		✓		Detention basin	M
	✓	✓		✓		Road stabilization	L–M
	✓	✓		✓	✓	Grade stabilization	H
					✓	Willow fascines	H
	✓	✓	✓			Water quality pond	M
	✓			✓	✓	Rock riprap	H
	✓			✓	✓	Stream channel stabilization	H
				✓	✓	Brush mattress	M
	✓			✓	✓	Pole/post plantings	M
✓	✓					Residue mgt	M
	✓				✓	Rock vane	H
	✓				✓	Rock weir	H
	✓	✓	✓	✓		Sloped drain	M
✓	✓			✓	✓	Terrace	H
	✓					Pest mgt	H

Resources on Management Practices

Select appropriate sources of management practice information on the basis of the pollutant type and land use characteristics. The following are examples:

Urban Sources

The International Stormwater Best Management Practice Database at **www.bmpdatabase.org** provides access to performance data for more than 200 management practice studies.

Agricultural Sources

NRCS offers a *National Handbook of Conservation Practices* at **www.nrcs.usda.gov/technical/standards/nhcp.html**.

All Sources

EPA has developed several guidance documents broken out by type of management measure. Draft and final manuals are available for agriculture, forestry, urban areas, marinas and recreational boating, hydromodification, and wetlands. These manuals can be downloaded from **www.epa.gov/owow/nps**.

Note: In addition to the resources mentioned above, many states have published BMP handbooks or guidance documents for in-state use. For example, the California Stormwater Quality Task Force published the California Stormwater Best Management Practice Handbooks to provide information on current practices, standards, and knowledge gained about the effectiveness of management practices. These documents can be downloaded from **www.cabmphandbooks.com**.

habitat that are most affected can be used to guide management actions. Slightly degraded habitat due to limited microhabitat (e.g., leaf packs, sticks, undercut banks), poor cover (e.g., logs and overhanging vegetation), and a thin canopy could be improved through revegetation of the riparian area; habitat degraded by poorly defined and embedded riffles, pools filled with sediment, and unstable streambanks might better be addressed through natural channel design. In the case of excessive nutrients from upland areas, passive actions such as designating conservation easements and limiting development might be the most prudent choices.

It's important to look at how the management practice being considered addresses the stressor of concern because that factor can considerably affect performance. Thus, in cases where sediment is identified as a stressor, stabilizing streambanks and limiting incision will be of little value if poor erosion and sediment control practices in a developing watershed are the overwhelming source of sediment contributed to the reach.

When you're screening management practices, selecting two or more practices will usually be more effective than choosing a single practice to achieve the needed load reductions. When you combine multiple practices, the result is called a *management practice system* or *treatment train*. Multiple practices are usually more effective in controlling a pollutant because they can be used at two or more points in the pollutant delivery process. For example, the objective of many agricultural nonpoint source pollution projects is to reduce the delivery of soil from cropland to waterbodies. A system of multiple practices can be designed to reduce soil detachment (e.g., soil additives to make soils less erodible), erosion potential (e.g., turf reinforcement mats), and off-site transport of eroded soil (e.g., vegetated buffer strips).

When reviewing multiple practices, consider spatial and temporal factors. For example, if you're trying to reduce impacts from an agricultural area, you should review management practices that might address upland agricultural activities as well as management practices that might address stream erosion (if both impacts exist). Complementary practices also have a time dimension. For example, streambank erosion is often caused by a reduction of woody vegetation along the stream due to intensive cattle grazing. Before the streambank can be successfully revegetated, the grazing issue should be addressed through fencing or other controls that protect the riparian zone from grazing and trampling. You should also screen for management practices that do not conflict with each other or with other management objectives in the watershed.

In addition to selecting management practices focused on pollutant reductions, you should also select practices for protecting, conserving, and restoring aquatic ecosystems. Those practices include, but are not limited to, the following:

- Ordinances for protecting habitats
- Aquatic buffers

- Fee simple land purchase
- Conservation easements (landowner grants recipient responsibility for protection and management)
- Conservation tax credits
- Transfer development rights (TDRs)
- Purchase development rights (PDRs)
- Landowner and public sector stewardship
- Greenways (ecologically significant natural corridors)
- Greenprinting
- Open space preservation
- Conservation or biodiversity banking
- Reserving or reclaiming flow (legal)
- Adoption of regulatory floodways
- Floodplain and riparian zoning
- Dam removal
- Conservation education
- Monitoring

There are resources available to help you weigh the pros and cons of these types of practices and select the practices that are most appropriate for your watershed planning goals. For example, every state wildlife action plan (refer to section 5.4.7) has a section that describes the conservation actions proposed to conserve the species and habitats identified in the plan. Many times, these plans provide pros and cons of the proposed actions or practices. Some questions to ask when selecting these practices include:

- What are the highest priorities for land conservation?
- Does a land trust exist to accept and manage conservation areas?
- How should conservation areas be delineated?
- What fraction of the watershed needs to be conserved, protected, or restored?
- How much pollutant removal might be gained from the buffer or conservation area?

10.3.6 Identify Relative Pollutant Reduction Efficiencies

Once you've selected potential management practices based on the pollutant type addressed, you should identify the relative effectiveness of each practice in reducing pollutant loading. At the screening stage, this means using or developing simple scales indicating high, medium, or low reduction potential (see table 10-3). The actual load reduction will depend on the extent of the practice and the existing loading levels, which will be addressed in more detail in chapter 11. Many of the resources and references mentioned previously also identify the relative load reduction potential of various practices.

Keep in mind that in addition to reducing pollutant loads, you might also want to evaluate management practices to reduce hydrologic impacts like high peak flows and volume through infiltration or interception. The ability of management practices to address these hydrologic impacts should be documented using a scale of high, medium, or low potential for peak flow or volume reduction.

Table 10-4 shows how a community can screen management practices for their relative performance in addressing pollutant loading and hydrologic issues. The table also shows the multiple and complementary benefits of the management practices.

Table 10-4. Example Management Practice Screening Matrix

Structural Management Practice	Hydrologic Factor				Pollutant Factor				
	Interception	Infiltration	Evaporation	Reduced Peak Flow	Total Suspended Solids	Nutrients	Fecal Coliform Bacteria	Metals	Temperature
Bioretention	●	◗	◗	◗	●	●	●	●	●
Conventional dry detention	○	○	◗	●	○	○	●	◗	◗
Extended dry detention	○	○	◗	●	◗	◗	●	◗	○
Grass swale	◗	◗	○	○	◗	○	○	●	◗
Green roof	●	○	●	◗	○	○	○	○	●
Infiltration trench	○	●	○	◗	●	●	●	●	●
Parking lot underground storage	◗	◗	○	●	●	●	◗	●	●
Permeable pavement	◗	◗	◗	◗	◗	○	◗	○	◗
Sand filter	○	○	○	○	●	●	◗	●	●
Stormwater wetland	●	○	◗	●	●	●	●	●	◗
Vegetated filter strip with level spreader	◗	◗	○	○	◗	◗	○	◗	◗
Water quality swale	◗	◗	◗	◗	●	●	○	●	●
Wet pond	○	○	●	●	●	●	●	●	○

○ Poor, low, or no influence ◗ Moderate ● Good, high

10.3.7 Develop Screening Criteria to Identify Opportunities and Constraints

Once you've identified general areas in the watershed that might benefit from management practices that address the sources of pollutants, you can apply additional screening to further hone in on feasible sites, for which you will conduct your more detailed evaluation and final selection (chapter 11).

Which screening criteria you select depends on where the practice is to be implemented and the nature of the practice. At this stage you can use the following screening criteria to help identify candidate management measures:

- **Location of management practice within the critical area.** Check to see if the candidate management practice will help achieve the load reductions that were identified in one of the critical areas of the watershed.

- **Estimated load reductions.** Using the information you collected in section 10.3.5, record whether the anticipated load reduction is low, medium, or high.
- **Legal and regulatory requirements.** Identify legal or regulatory requirements for projects, and determine whether any pose significant constraints. For example, if the restoration project involves working in the stream channel, a section 404 dredge and fill permit might be required. You should also check for the presence of wetlands because disturbance of wetland resources might be prohibited. Also, if the project is adjacent to a stream, make sure local stream buffer ordinances do not prohibit disturbance of the buffer for restoration purposes. Are there other resource conservation constraints (e.g., endangered species)? Federal Emergency Management Agency (FEMA) floodplain regulations also might affect the project. If the project is adjacent to a stream, make sure local stream buffer ordinances allow management practices within the buffer.
- **Property ownership.** Determine the number of property owners that need to agree to the restoration project. It's often easier to obtain easements on lands in public ownership.
- **Site access.** Consider whether you will be able to physically access the site, and identify a contact to obtain permission if private property must be traversed to access the site. Consider whether maintenance equipment (e.g., front-end loaders, vacuum trucks) will be able to reach the site safely. Design and costs might be affected if a structural control requires hand-cleaning because of maintenance access constraints.
- **Added benefits.** In addition to management practices fulfilling their intended purpose, they can provide secondary benefits by controlling other pollutants, depending on how the pollutants are generated or transported. For example, practices that reduce erosion and sediment delivery often reduce phosphorus losses because phosphorus is strongly adsorbed to silt and clay particles. Therefore, a practice like conservation tillage not only reduces erosion but also reduces transport of particulate phosphorus. In some cases, a management practice might provide environmental benefits beyond those linked to water quality. For example, riparian buffers, which reduce phosphorus and sediment delivery to waterbodies, also serve as habitat for many species of birds and plants.
- **Unintended impacts.** In some cases management practices used to control one pollutant might inadvertently increase the generation, transport, or delivery of another pollutant. Conservation tillage, because it creates increased soil porosity (large pore spaces), can increase nitrate leaching through the soil, particularly when the amount and timing of nitrogen application are not part of the management plan.

Sources of Cost Information

A list of currently available cost references is given below. Most of these references are available for free download, but some might be available only at a university library or by purchase. You should look for local costs before using these references because construction costs and designs vary between states. A more detailed list of resources on costing information is included in appendix A.

EPA Management Practice Fact Sheets

This comprehensive list of BMP fact sheets contains information on construction and maintenance costs, as well as other monetary considerations. Information is provided on both structural and non-structural management practices. Go to **http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm**.

National Management Measures to Control Nonpoint Source Pollution from Agriculture

This EPA document provides cost information on a number of management options for agricultural land. Go to **www.epa.gov/owow/nps/agmm**.

USDA Natural Resources Conservation Service

Some state NRCS offices publish cost information on agricultural practices. Some cost data are published to support the Environmental Quality Incentives Program (EQIP). For an example of this cost information, go to the "cost lists" section of the following Web site: **www.nc.nrcs.usda.gov/programs/EQIP/2005Signup.html**.

Center for Watershed Protection

The Center for Watershed Protection has published numerous support documents for watershed and management practice planning. The Web site has documents available for free download and purchase. Go to **www.cwp.org**.

- **Physical factors.** Many physical factors will determine whether you'll be able to install management practices. Look for constraints like steep slopes, wetlands, high water tables, and poorly drained areas. Also look for opportunities such as open space, existing management practices that can be upgraded, outfalls where management practices could be added, and well-drained areas. For example, a site proposed for a stormwater wetland that has steeply sloping topography might not be feasible for a wetland.
- **Infrastructure.** Look for sites that don't have utilities, road crossings, buried cables, pipelines, parking areas, or other significant physical constraints that could preclude installation or cause safety hazards.
- **Costs.** The appropriateness of a management practice for a particular site can be affected by economic feasibility considerations, which encompass short- and long-term costs. Short-term costs include installation costs, while long-term costs include the cost of continued operation and maintenance. Most of the guidance manuals referenced earlier in the chapter also provide cost information for each of the management practices discussed. In section 11.5 you'll consider more detailed cost elements associated with the management practices, such as construction, design and engineering, and operation and maintenance costs, as well as adjustment for inflation.
- **Social acceptance.** Consider how nearby landowners will perceive the management practice. Will it cause nuisances such as localized ponding of water, unsightly weed growth, or vector control problems? Can these issues be addressed in the siting and design of the practice? How can you involve nearby residents in selecting and designing the practice to address their concerns?

The optimal method for evaluating site feasibility for riparian and upland management practices is a site visit, preferably with staff from permitting or extension agencies. Actual constraints and opportunities can be identified, and input from the agencies can be incorporated to expedite the permitting process. When a site visit is not practical, however, many physical constraints can be evaluated remotely using a GIS. When the GIS approach is used, it's important to recognize that the input data might not be entirely accurate (e.g., land cover data from 1999 might have changed by now).

10.3.8 Rank Alternatives and Develop Candidate Management Opportunities

Now that you've identified various management practices that you could install in the watershed to achieve your goals and objectives, you should screen them to document the candidate management opportunities. At this stage, you're working with the stakeholders to identify which management options should go through a more rigorous evaluation to determine the actual pollutant reduction that can be achieved through combined management measures, as well as the costs and feasibility of the measures.

Using the worksheets from your research, develop a summary chart and map, along with a ranking of alternatives, to present and discuss with the stakeholders. Summarize and weigh such factors as

- Relative load reduction expected
- Added benefits
- Costs

- Public acceptance
- Ease of construction and maintenance

When developing your summary worksheets, it's helpful to group similar types of practices. Once you have collected all the information on the various practices, you can rate practices according to the screening criteria you've selected (table 10-5). You can create a basic rating system from 1 to 4, with 1 the lowest rating and 4 the highest. For example, practices receive higher ratings for high pollutant removal effectiveness, lower cost, lower required maintenance, high likelihood of public acceptance, and added benefits.

Table 10-5. Example Ranking Table to Identify Candidate Management Practices

Management Practice	Pollutant Reduction Effectiveness	Cost	Added Benefits	Public Acceptance	Maintenance	Average Score
Gradient terraces	2	3	1	2	4	2.4
Grassed swales	3	4	3	4	4	3.2
Wet extended detention ponds	2	3	2	3	3	2.6
Model ordinances	4	3	2	4	4	3.4

Before you rate each practice, you might want to develop some assumptions like the following:

- The management practices will be installed and maintained properly.
- Although public involvement activities will not directly reduce pollutant loads, they will contribute to an increase in awareness that might lead to people's adopting pollutant-reducing behaviors.
- The management practice is rated for reducing a specific pollutant of concern, not a suite of pollutants.

When you have rated all the practices, average the values in each row. Comparing the averages will give you a general idea of which management practices might be good candidates for implementation. Next, present the summaries to your stakeholders and ask them to review the information and agree or disagree. If they disagree with the ratings, review the criteria used, provide them with more information, or change the rating based on their input. Once you've narrowed down the candidate practices, you're ready to move on to chapter 11 and conduct more detailed analyses.

When developing good candidate options for watersheds with multiple sources, make sure you've identified management options for each source and that the options are complementary. Finally, map out upstream-to-downstream management options, making sure that you begin work on the upstream projects first. Working on upstream projects first, if possible, will aid in determining BMP effectiveness because water quality improvements can be measured without interference caused by multiple upstream pollutant sources that might not be addressed initially. As implementation proceeds, BMPs can be selected, installed, and adapted as needed to ensure that water quality is improving from upstream to downstream locations. Chapter 11 provides more detail on evaluating multiple projects in a watershed or subwatershed.