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National Management Measures to Control Nonpoint Source Pollution from Urban Areas

Management Measure 3: Watershed Protection

November 2005

MANAGEMENT MEASURE 3
WATERSHED PROTECTION

3.1 Management Measure

Develop a watershed protection program to:

- Avoid development of areas that are particularly susceptible to erosion and sediment loss.
- Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian vegetation and aquatic biota.
- Site development projects, including roads, highways, and bridges, to protect the natural integrity of water bodies and natural drainage systems.

3.2 Management Measure Description and Selection

3.2.1 Description

The purpose of this management measure is to reduce the generation of nonpoint source pollutants and to mitigate the impacts of urban runoff and associated pollutants from new development and redevelopment, including the construction of new and relocated roads, highways, and bridges. It is intended to provide general goals for local agencies and urban communities in developing comprehensive programs for guiding future development and land use activities in a manner that will prevent and mitigate the effects of nonpoint source pollution.

Although the goals of this management measure and Management Measure 4 (Site Development) are similar, this measure is intended to apply to larger watersheds or regional drainage basins rather than individual sites. The watershed protection and site development management measures are intended to be complementary. They can be used together with the other management measures in a comprehensive framework to control runoff and reduce nonpoint source pollution. (See Chapter 1 for a description of the runoff management program framework.)

Comprehensive planning is an effective nonstructural tool to control nonpoint source pollution. Where possible, growth should be directed toward areas where it can be sustained with minimal impact on the natural environment (Meeks, 1990). Poorly planned growth and development have the potential to degrade and destroy natural drainage systems and surface waters (Mantel et al., 1990). By making proper planning and zoning decisions, water quality managers can direct development and land disturbance away from areas that drain to sensitive waters. Land use designations and zoning laws can also be used to protect environmentally sensitive areas such as riparian corridors and wetlands.

Riparian buffers and wetlands can have the benefit of providing long-term pollutant removal capabilities without the comparatively high costs usually associated with constructing and maintaining structural controls. Conservation or preservation of these areas is important to protect the water quality of streams, wetlands, lakes, and reservoirs. Land acquisition programs help to preserve areas considered critical to maintaining surface water quality. Adequate buffer strips along streambanks provide protection for stream ecosystems, help stabilize the stream, and can prevent streambank erosion (Holler, 1989). Buffer strips can also protect and maintain near-stream vegetation that attenuates the release of sediment into stream channels. Levels of suspended solids have been shown to increase at a slower rate in stream channel sections with well-developed riparian vegetation (Holler, 1989).

3.2.2 Management Measure Selection

This measure was selected for several reasons. First, watershed protection is a technique that provides long-term water quality benefits, and many states and local communities have adopted this practice. Numerous state and local governments have already legislated and implemented detailed watershed planning programs that are consistent with this management measure. For example, Oregon, New Jersey, Delaware, and Florida have passed legislation that requires county and municipal governments to adopt comprehensive plans, including requirements to direct future development away from sensitive areas. Many municipalities and regions have adopted land use and growth controls, including the towns of Amherst and Norwood and the Cape Cod region of Massachusetts; Narragansett, Rhode Island; King County, Washington; and many others.

Second, there is general recognition that the protection of sensitive areas and areas that provide water quality benefits is integral to maintaining or minimizing the impacts of development on receiving waters and associated habitat. Without a comprehensive planning approach that includes the use of riparian buffers, open space, bioretention, and structural controls to maintain the predevelopment hydrologic characteristics of the site, significant water quality and habitat impacts are likely. The experience of communities across the country has shown that the use of structural controls without adequate local land use planning and zoning often does not adequately protect water quality and might even cause detrimental effects such as increased temperature.

Third, this measure is effective in producing long-term water quality benefits without the high operation and maintenance costs associated with structural controls. The Michigan Department of Environmental Quality (no date) compared the costs of two nonpoint source projects. One involved preserving an urbanizing watershed, and the other entailed restoring an urban watershed. Table 3.1 is a side-by-side cost comparison demonstrating that it is generally less costly to protect high-quality streams than to restore them.

Table 3.1: Cost comparison of stream preservation vs. stream restoration (Michigan Department of Environmental Quality, no date).

	Bear Creek	York Creek
Type of nonpoint source project	Preservation	Restoration
Setting	Grand Rapids, MI, area stream	Grand Rapids, MI, area stream
Size	20,096 acres	2,110 acres
Level of urbanization	9.5% (1991)	19% (1993)
Stream category	High-quality trout stream	Former trout stream
Storm water ordinance	$10,000	$10,000
Decision-making GIS	$10,000	$10,000
Information/education program	$100,000	$80,000
Streambank stabilization	$15,000	$130,000
Storm water basin retrofits	–	$180,000
Additional storm water basins	–	$75,000
Other practices (habitat improvement, repairing road crossings, etc.)	$75,000	$190,000
Total cost	$210,000[a]	$675,000

[a] Total cost does not take into account the purchase cost or opportunity cost for not developing the land

3.3 Management Practices

A comprehensive watershed approach requires constant adjustments based on development patterns, population increases, changing land uses, the state of the resources, and the institutional capacity of the community to manage its resources. The practices listed below provide an overview of the approaches communities around the country are adopting or experimenting with to protect their water resources in a cost-effective way.

3.3.1 Resource Inventory and Information Analysis

Before a comprehensive program can be developed, communities should define the watershed boundaries, target areas, and pollutants of concern, and conduct resource inventory and information analysis. These activities can be done by using the best available information or collecting primary data, depending on funding availability and the quality of available data. Activities pursued under this process include assessment of ground water and surface water hydrology; evaluation of soil type and ground cover; identification of areas with water quality impairments; and identification of environmentally sensitive areas, such as steep or erodible uplands, wetlands, riparian areas, floodplains, aquifer recharge areas, drainageways, and unique geologic formations. Once environmentally sensitive areas are identified, those that are integral to the protection of surface waters and the prevention of nonpoint source pollution can be protected.

The City of Virginia Beach, Virginia, conducted a three-phase inventory of natural areas to help planners and public officials develop practices for resource protection. The data collection phase cost $13,867 (1991 dollars); the field inventory (Phase II), cost $54,624; and Phase III, preparation of a final report, cost $15,255 (Jenkins, 1991).

Richmond County, Virginia, developed the Richmond County Resource Information System (RIS) to provide a basis for responsible planning and development of shoreline areas. The

Watershed Approach to Storm Water and Flood Management

The Planning Department of Delaware County, New York, is leading the effort to develop long-term solutions to water quality impairment from urban runoff. The county's Stormwater and Flood Management program uses a two-phase approach: (1) inventorying and assessing sources of urban runoff and storm water infrastructure, and (2) local implementation and municipal plan development.

The inventory and assessment component involves a detailed evaluation of point and nonpoint sources of pollution in the Cannonsville Basin. Locations of potential sources were documented using a Global Positioning System and site characteristics such as soil type and land use were recorded. A GIS database was used to store this information along with existing infrastructure, topographic maps ,and planimetric maps.

The local implementation and municipal plan development component involves working with local municipalities as part of its Town Planning Advisory Service (TPAS) to develop local initiatives for water quality protection and to demonstrate the role of water quality in community economic development. The municipal plans help local officials integrate wellhead protection into water quality planning, prioritize management needs, establish maintenance programs, and incorporate runoff management into capital planning (Delaware County Departments of Planning and Public Works, 2003).

compilation and mapping of resource information are part of the county's planning and zoning program. In 1990, the program was supported by a $39,000 Federal Coastal Zone Management Grant, $45,000 from the Chesapeake Bay Foundation through a Virginia Environmental Endowment Grant, and $96,000 from the county's comprehensive plan budget (Jenkins, 1991).

3.3.1.1 Identify environmentally sensitive, critical conservation areas

The identification of environmentally sensitive areas, also referred to as critical conservation areas, is an essential component of a watershed protection program. These areas need to be identified to: (1) avoid developing areas susceptible to erosion and sediment loss; and (2) preserve areas that provide important water quality benefits, such as wetlands, permeable soils, forested buffers, and riparian areas. These types of lands are described in Table 3.2. Inventories of these areas can be developed using wetland inventories, soil maps, maps of critical habitat for endangered species, GIS tools, remote sensing, vegetative cover inventories/maps, and forest inventories, among other sources.

GIS Mapping for Open Space and Water Resource Protection

The towns of Westford, Littleton, Chelmsford, and Boxborough, located in the Merrimack River Watershed north of Boston, Massachusetts, are using GIS as a tool to guide efforts to protect critical open space lands and aquifers. The effort is part of Massachusetts' Community Preservation Initiative, which helps local officials address the tradeoff between environmental planning issues, such as habitat and watershed protection, and the growing needs of the community in terms of economic development, housing, and transportation. GIS provides local officials with the capability of identifying open space lands that are critical to protecting water resources and exploring the implications of various build-out scenarios, land preservation strategies, land uses, and densities (NALGEP, 2003).

Table 3.2: Types of lands that should be preserved for watershed protection (adapted from Caraco et al., 1998).

Conservation Area	Description	Examples
Critical habitat 	Essential spaces for plant and animal communities or populations	Tidal wetlands, freshwater wetlands, large forest clumps, springs, spawning areas in streams, habitat for rare or endangered species, potential restoration areas, native vegetation areas, coves
Aquatic corridor 	Areas where land and water interact	Floodplains, stream channels, springs and seeps, steep slopes, small estuarine coves, littoral areas, stream crossings, shorelines, riparian forest, caves, and sinkholes
Hydrologic reserve 	Undeveloped areas responsible for maintaining the predevelopment hydrologic response of a subwatershed	Forest, meadow, prairie, wetland, cropland, pasture, or managed forest
Water pollution hazard  Source: Stapleton, 1999.	Any land use or activity that is expected to create a relatively high risk of water pollution	Septic systems, landfills, hazardous water generators, aboveground or underground tanks, impervious cover, surface or subsurface discharge of wastewater effluent, land application sites, storm water "hot spots," pesticide application, industrial discharges, and road salt storage areas
Cultural and historic sites  Source: NPS, 2001.	Areas that provide a sense of place in the landscape and are important habitats for people	Historic or archaeological sites, trails, parkland, scenic views, water access, bridges, and recreational areas

3.3.1.2 Identify and protect drinking water sources

All drinking water sources, including surface and ground waters, should be considered for protection, and unfiltered sources will require the most stringent protection. More than 200 cities, towns, and tribes protect ground water public drinking water systems from contamination using a variety of local government tools such as zoning, subdivision controls, and transfer of development rights. The ordinances implementing these tools are varied and include measures

such as regulating onsite wastewater treatment systems and limiting nitrogen loading within wellhead protection areas (see section 1.3.1.2 in Management Measure 1, which describes different types of ordinances, including source water protection ordinances). This section introduces several tools to protect surface and ground water sources. Also, more information about identifying and protecting drinking water sources can be found at EPA's Office of Ground Water and Drinking Water Web site at http://www.epa.gov/ogwdw.

(1) *Delineate a Source Water Protection Area.* Delineation of a Source Water Protection Area requires identifying the boundaries of the area from which drinking water supplies are drawn. This information can be obtained from states, which are required to conduct an assessment of all public water systems. These assessments include a delineation, contaminant inventory, and susceptibility determination (see http://www.epa.gov/safewater/protect/swap.html for more information about state Source Water Assessment Programs). Local governments may choose to elaborate on the state's assessment before planning management activities.

(2) *Protect Sole Source Aquifers.* Sole Source Aquifer (SSA) designations are one tool to protect drinking water supplies in areas with few or no alternative sources. These areas are of special significance because if contamination occurred, using an alternative source would be prohibitively expensive. The designation protects an area's ground water resource by requiring EPA review of any proposed projects within the designated area that are receiving federal financial assistance. All proposed projects receiving federal funds are subject to a review to ensure they do not endanger the water source. Between January 1997 and January 1999, EPA reviewed 439 projects, 60 of which required modifications that were deemed necessary to protect the Sole Source Aquifers. Examples of federally funded projects that have been reviewed by EPA under the SSA protection program include highway improvements and new road construction, public water supply wells and transmission lines, wastewater treatment facilities, construction projects that involve disposal of storm water, agricultural projects that involve management of animal waste, and projects funded through Community Development Block Grants.

    EPA has developed Memoranda of Understanding (MOU) with other agencies to help establish review responsibilities under the Sole Source Aquifer Protection Program and to clarify what types of projects should or should not be referred to EPA. If you have questions about whether EPA needs to review a project in a particular Sole Source Aquifer, please contact the Sole Source Aquifer Coordinator for your state or territory (see http://www.epa.gov/safewater/swp/sumssa.html for lists and maps of Sole Source Aquifers in each of the EPA regions along with contact information for Sole Source Aquifer Coordinators).

(3) *Develop a local wellhead protection ordinance.* Wellhead protection refers to implementing pollution prevention and source controls to protect underground sources of drinking water. The Safe Drinking Water Act requires that State Wellhead Protection Programs be approved by EPA and incorporate delineation, contaminant source inventory, and source management. Local governments can also develop local wellhead protection ordinances to further protect drinking water supplies from contamination.

(4) *Purchase property or development rights*. This practice is meant to guarantee community control over the activities conducted on lands that contribute to aquifers or surface waters. This may involve outright purchase of the land or just surface-use rights (see section 3.3.5 for a discussion of land acquisition options). New funds from the Safe Drinking Water Act allow land trusts and other local organizations to work with state agencies and water suppliers to identify and acquire critical lands and conservation easements.

3.3.2 Development of Watershed Management Plan

The resource inventory and information analysis component provides the basis for a watershed management plan, which is a comprehensive approach to addressing the needs of a watershed, including land use, urban runoff control practices, pollutant reduction strategies, and pollution prevention techniques.

For a watershed management plan to be effective, it should have measurable goals describing desired outcomes and methods for achieving the goals. Goals, such as reducing pollutant loads to surface water by 25 percent, can be articulated in a watershed management plan. Development and implementation of urban runoff practices, both structural and nonstructural, can be incorporated as methods for achieving the goal. The following describes the general steps for developing a watershed management plan (Livingston and McCarron, 1992):

1. Delineate and map watershed boundaries and subbasins within the watershed.
2. Inventory and map natural runoff conveyance and storage systems.
3. Inventory and map the manmade storm water conveyance and storage system.
4. Inventory and map land use by subbasin.
5. Inventory and map detailed soils by subbasin.
6. Establish a clear understanding of water resources in the watershed. Analyze water quality, sediment, and biological data. Analyze subjective information on problems such as citizen complaints. Evaluate water body use impairment, including the frequency, timing, and seasonality of the problem. Conduct a water quantity assessment (e.g., low flows, seasonality).
7. Inventory pollution sources in the watershed, including point sources (location, pollutants, loadings, flow capacity, etc.) and nonpoint sources (type, location, pollutants, loading, etc.). Include a land use/loading rate analysis for storm water, a sanitary survey for septic tanks, and dry weather flow monitoring to locate illicit discharges.
8. Identify and map future land use by subbasin. Conduct land use loading rate analyses to assess potential effects of various land use scenarios.
9. Identify planned short-term (five years) and long-term (20 years) infrastructure improvements. Runoff management deficiencies should be coordinated and scheduled with other infrastructure or development projects.
10. Determine infrastructure and natural resource management needs within each watershed.

11. Set resource management goals and objectives. Before corrective actions can be taken, a resource management target must be set. The target can be defined in terms of water quality standards, attainment of beneficial uses, or other local resource management objectives.
12. Determine pollutant reduction for existing and future land uses needed to achieve water quality goals.
13. Select appropriate management practices for both point and nonpoint sources that can be used to achieve the goal. Evaluate pollutant removal effectiveness, landowner acceptance, financial incentives and costs, availability of land operation and maintenance needs, feasibility, and availability of technical assistance.
14. Develop a watershed management plan. Since the problems in each watershed will be unique, each watershed management plan will be specific. However, all watershed plans will include elements such as an existing and future land use plan; a master storm water management plan that addresses existing and future needs; a wastewater management plan, including septic tank maintenance programs; and an infrastructure and capital improvements plan.

Development of a watershed management plan may involve establishing general land use designations that define allowable activities on a parcel of land. For example, land designated for low-density residential use would be limited to a density of two houses per acre, provided that all other regulations and requirements are met. All development activities allowed in a use category should be defined. By guiding uses within the planning areas, impacts to surface waters from urban runoff can be controlled. Those areas identified in the resource inventory and information analysis phase as environmentally sensitive and important to maintaining water quality can be preserved through various measures supported by state or local goals, objectives, and policies.

In Florida, local governments (counties and incorporated municipalities) were required to develop comprehensive plans based on existing information to guide short-term (five years) and long-term (20 to 25 years) growth and development. Local plans were required to be consistent with the state plan and the state growth management law and needed to identify environmentally sensitive areas and areas with water quality problems.

The Environmental Quality Corridor (EQC) System was established in Fairfax County, Virginia, to preserve floodplains, wetlands, shoreline areas, and steep valley slopes. EQCs were defined in the county's comprehensive plan and identified on the county land use map. If a parcel of land subject to a zoning or land use designation change contained an EQC, it was required to be set aside by the developer as part of development approval. Since its initiation, tens of thousands of acres have been set aside through the EQC program. The cost of implementing the program is part of the operating budget of the county planning department.

Howard County, Maryland, developed a Land Preservation and Recreation Plan as part of the county comprehensive plan. Under this plan, open space resources are purchased for preservation and recreation. The annual cost to update the plan, $25,000 (in 1991 dollars), is funded by the state. In FY 1990, the county received $1.14 million in state funds to update the plan and acquire land (Jenkins, 1991).

3.3.3 Implement the Plan

Once critical areas have been identified, land use designations have been defined, and goals have been established to guide activities in the watershed, implementation strategies can be developed. At this point, the requirements of future development are defined. These requirements include, but are not limited to, permitted uses, construction techniques, and protective maintenance measures. Land development regulations may also prescribe natural performance standards, such as "rates of runoff or soil loss should be no greater than predevelopment conditions."

A useful planning tool is the Long-Term Hydrologic Impact Assessment (L-THIA), which was developed by Purdue University (2000) for land use planners to provide site-specific estimates of changes in runoff, recharge, and nonpoint source pollution resulting from past or proposed land use changes. The model uses regional climate data and user-provided location, land use, and soil group data for up to three different scenarios (past, present, and future). The results are in the form of tables, bar charts, and pie charts. The model is available at http://danpatch.ecn.purdue.edu/~sprawl/LTHIA7.

Listed below are examples of the types of development regulations and other implementation tools that have been successful at controlling nonpoint source pollution.

3.3.3.1 Develop ordinances or regulations requiring nonpoint source pollution controls for new development and redevelopment

These ordinances or regulations should address, at a minimum:

- Control of off-site urban runoff discharges (to control potential impacts of flooding);
- The use of source control BMPs and treatment BMPs;
- The performance expectations of BMPs, specifying design storm size, frequency, and minimum removal effectiveness, as specified by the state or local government;
- The protection of stream channels, natural drainageways, and wetlands;
- Erosion and sediment control requirements for new construction and redevelopment; and
- Treatment BMP operation and maintenance requirements and designation of responsible parties.

3.3.3.2 Plan infrastructure

Infrastructure planning is the multiyear scheduling and implementation of infrastructure improvements, such as roads, sewers, potable water delivery, landfills, public transportation, and urban runoff management facilities. Infrastructure planning can be an effective practice to help guide development patterns away from areas that provide water quality benefits, are susceptible to erosion, or are sensitive to disturbance or pollutant loadings. Where possible, long-term comprehensive plans to prevent the conversion of these areas to more intensive land uses should be drafted and adopted. Infrastructure should be planned for and sited in areas that have the capacity to sustain environmentally sound development. Development tends to occur in response to infrastructure availability, both existing and planned. New development should be targeted for areas that have adequate infrastructure to support growth in order to promote infill development,

prevent urban sprawl, and discourage the use of septic tanks where they are inappropriate (International City/County Management Association, 1979). Infill development may have the added advantage of municipal cost savings.

To discourage development in the environmentally sensitive East Everglades area, Dade County, Florida, has developed an urban services boundary (USB). In areas outside the USB, the county will not provide infrastructure and has kept land use densities very low. This strategy was selected to prevent urban sprawl, protect the Everglades wetlands (outside of Everglades National Park), and minimize the costs of providing services countywide. The area is defined in the county comprehensive plan, and restrictions have been implemented through the land development regulations (Metro-Dade Planning Department, 1988).

Congress has enacted similar legislation for the protection of coastal barrier islands. In 1981, the availability of federal flood insurance for new construction on barrier islands was discontinued. In 1982, Congress passed the Coastal Barriers Resources Act, establishing the Coastal Barrier Resource System (CBRS), and terminated a variety of federal assistance programs for designated coastal barriers, including grants for new water, sewage, and transportation systems. In 1988, similar legislation was passed for the Great Lakes area, adding 112 Great Lakes barrier islands. Additions to the CBRS in 1990 included parts of the Florida Keys, the U.S. Virgin Islands, Puerto Rico, and the Great Lakes (Simmons, 1991).

The result of the legislation and subsequent additions to the CBRS has been the establishment of approximately 1,326,000 acres of barriers that are ineligible for federal assistance for infrastructure and flood insurance (U.S. Fish and Wildlife Service (USFWS), 2002). This act has helped to guide development away from these sensitive coastal areas to more suitable locations. USFWS (2002) estimates that more than a billion dollars may be saved between 1983 and 2010 due to reduction of disaster relief and infrastructure construction costs.

3.3.3.3 Revise local zoning ordinances

Zoning is the division of a municipality or county into districts for the purpose of regulating land use. Usually defined on a map, the allowable uses within each zone are described in an official document, such as a zoning ordinance. Zoning is enacted for a variety of reasons, including preservation of areas that are environmentally sensitive or necessary to maintain environmental integrity (International City/County Management Association, 1979).

Within zoning ordinances, subdivision regulations govern the process by which individual lots are created out of larger tracts of land. Subdivision regulations are intended to ensure that subdivisions are appropriately related to their surroundings. General site design standards, such as preservation of environmentally sensitive areas, are one example of subdivision regulations (International City/County Management Association, 1979).

There are specific types of zoning ordinances that can be particularly useful in protecting water resources, including performance-based zoning, overlay zones, bonus or incentive zoning, large-lot zoning, agricultural protection zoning, watershed-based zoning, and urban growth boundaries. The following provides an overview of each of these types of zoning:

3.3.3.3.1 Performance-based zoning

In performance-based zoning, developers are allowed flexibility in planning and designing the development as long as they meet minimum requirements set by the local government. These minimum requirements vary based on the particular resource protection objectives of the community but might include limiting the amount of impervious surfaces or preserving sensitive features such as wetlands or steep slopes with high erosion potential. Developers can choose lot sizes, building types, site layouts, and other development characteristics as long as they meet the minimum criteria. Performance-based zoning offers protection of natural resources for the community and increased flexibility for the developer. It requires greater effort on the part of the local government, however, to carefully tailor the language of the ordinance to ensure that resources are adequately protected, and to carefully review development proposals to ensure that performance criteria are met.

Officials in Columbia, Missouri, were interested in developing a uniform policy to deal with storm water pollution (Tritto, 2000). This effort was initiated in response to a recent back-and-forth battle between a developer and the Columbia City Council. Officials are reviewing a report developed by Missouri University researchers that evaluated the environmental sensitivity of 13 watersheds in the Columbia area using 12 criteria focused on human health and environmental protection. The report recommended limits on the percentage of impervious surfaces for developments based on categories of watershed sensitivity. Developers would be allowed to exceed these limits only by taking additional steps to control storm water pollution through the use of management practices. The approach recommended in the report would provide a financial incentive for developers to direct high-density developments to less-sensitive watersheds because tougher standards on impervious areas and the costs of storm water controls would make it more expensive to develop in environmentally sensitive watersheds. City officials are also reviewing storm water management policies in other cities to develop uniform guidelines so that developers are better-informed about what is expected of them.

3.3.3.3.2 Overlay zones

Overlay zones superimpose additional restrictions on existing zoning categories to provide extra protection for a particular natural resource. For example, if a wetland or endangered species habitat crosses the boundaries of several development zones, an overlay zone can be established to limit development in areas that affect the wetland. Overlay zones can also be used to limit development in areas with highly permeable soils to protect an underground drinking water source from contamination. The overlay zones would maintain the general land use category, such as residential or commercial, but would require additional protection, such as greater limits on impervious area or special vegetation protection requirements.

3.3.3.3.3 Bonus or incentive zoning

Bonus or incentive zoning is another method to allow developers greater flexibility in return for preservation of open space and sensitive or environmentally significant features. With incentive zoning, a developer might be allowed to develop at a higher density than normally allowed if in return he or she preserves additional open space, creates a wetland, or reduces the site's overall impervious area with underground parking, transportation modifications, or innovative site layouts. The success of bonus or incentive zoning is highly dependent on an individual developer's perception of the economic benefits of additional density credits; therefore, this type

of zoning cannot be relied upon to protect natural resources. However, bonus or incentive zoning can encourage voluntary and economically beneficial protection for open space and sensitive features.

3.3.3.3.4 Large-lot zoning

Large-lot zoning establishes a very low density of development; individual dwellings are built on lots of 5 acres or more. Large-lot zoning is most effective when lots are very large (5 to 20 acres) (Caraco et al., 1998). The purpose of large-lot zoning is to spread development thinly, thereby conserving a large proportion of open space on each lot and reducing impacts on water resources. This method can produce undesirable results, however, including

- Promoting sprawl;
- Fragmenting habitats with more extensive infrastructure and lawns;
- Increasing reliance on automobile transportation; and
- Excluding lower-income residents who cannot afford to purchase large parcels of land.

One approach to minimizing the negative impacts of large-lot zoning is to combine it with cluster zoning. In this way, a large area of open space can be protected, while accommodating new development in a more concentrated manner. Although used in many areas, large-lot zoning is not considered to be any more protective than other zoning tools.

3.3.3.3.5 Farmland preservation zoning

Farmland preservation ordinances are another type of measure to provide open space retention, habitat protection, and watershed protection. Farmland protection may be a less-costly means of controlling pollutant loadings than the implementation of urban runoff structural control practices. Much of the farmland currently being converted has soils that are stable and not highly erodible. Conversion of these farmlands often displaces farming activities to less-productive, more-erodible areas that may require increased nutrient and pesticide applications.

Many communities consider both agriculture and forestry to be an integral part of rural heritage and strive to preserve these industries and the open space associated with them. According to the 1997 National Resources Inventory, nearly 16 million acres of forest, cropland, and open space were converted to urban and other uses from 1992 to 1997. The average rate for those five years—3.2 million acres per year—is more than twice the conversion rate of 1.4 million acres per year recorded from 1982 to 1992 (USDA-NRCS, 2000).

Agricultural lands can be protected by implementing a modified large-lot zoning ordinance that makes residential development less economically attractive. Alternatively, a cluster development ordinance can be established that specifies a density for an agricultural development and also requires that dwellings be built on small lots, leaving the remainder of the site as agricultural open space. The ordinance can also specify that development must occur on the least-productive part of the lot so the richest soils can be reserved for cultivation.

Agricultural zoning ordinances can be combined with other initiatives to promote farming and forestry and to protect rural areas from being overtaken by urban sprawl (Sims, 2000b). The King County, Washington, executive official has undertaken several initiatives to promote diversity in lifestyle choices, encourage the continuation of farming and forestry, protect

environmental quality and wildlife habitat, and maintain a link to the county's heritage by preserving rural areas. So far the county has reduced its development rate in rural areas from 15 percent in 1980 to 6 percent at present. The target is to further reduce the development rate to 4 percent. The county issued orders to close loopholes in subdivision and land segregation regulations, and it tightened subdivision requirements for rural lands. These efforts will ensure that new development is consistent with current environmental and development standards.

The county's initiatives include maintaining an agricultural district as an "unincorporated urban area" to permanently protect this area from development pressures, establishing the Puget Sound Fresh program to promote locally grown and produced products, establishing a Farm Link program to connect farmers with land to sell or lease with those wishing to farm, and providing improved services for rural community centers. The county also established a Rural Forest Commission to encourage forestry and maintain the forest land base in the county's rural areas. The county implemented a Farmlands Preservation Program, which has preserved 12,793 acres of agricultural lands through purchase or donation of development rights. Additionally, the county is able to preserve hundreds more acres of rural land each year through incentive-based taxation programs. Finally, King County's 2000 Comprehensive Plan includes the following goals and initiatives:

- Ensure that zoning complies with goals to reduce the rate of growth and protect the environment;
- Ensure that the types and scale of development in the rural area blend with traditional rural development;
- Implement recommendations from the forest commission to bolster King County's forest and farming economies; and
- Consider alternative uses of agricultural land, such as for wetland mitigation or recreation, such that these uses will not harm the integrity of agriculture in the county.

More information about King County's growth management initiatives can be found on the SmartGrowth Rural Legacy Web site at http://www.metrokc.gov/smartgrowth/rural.htm.

3.3.3.3.6 Watershed-based zoning

Historically, zoning has been used to establish limits on building density and to separate uses believed to be inherently incompatible (Arendt, 1997). Watershed-based zoning, in contrast, uses watershed and subwatershed boundaries as the basis for making land use decisions. Typically, zoning objectives focus on maintaining or reducing impervious cover in sensitive subwatersheds and redirecting development to subwatersheds that are better able to absorb their influence (Caraco et al., 1998).

Local, state, and federal officials recently approved the Riverside County (California) Plan, which involved multi-agency cooperation in identifying where development may occur and where land should be preserved (Verden, 2000). Over the next 50 years, the Riverside County Plan will serve as a blueprint for building new roads, shopping centers, and homes, while also preserving rapidly disappearing habitat. The plan is designed to avoid costly delays and confrontations between regulators and developers. With the population of Riverside County

expected to double in 20 years, the plan will help developers accommodate growth while it also protects rare plants and animals. State and federal land, transportation, and wildlife managers hope the Riverside County Plan will be a model for other communities struggling to balance development and preservation.

In 1992 Maryland enacted the Economic Growth, Resource Protection, and Planning Act to organize and direct comprehensive planning, regulating, and funding by state, county, and municipal governments in furtherance of a specific economic growth and resource protection policy (Maryland Department of Planning, no date). The policy is organized around seven statutory vision statements that must be pursued in county and municipal comprehensive plans where priorities for land use, economic growth, and resource protection are established. The seven statutory vision statements are:

- Development is concentrated in suitable areas.
- Sensitive areas are protected.
- In rural areas, growth is directed to existing population centers and resource areas are protected.
- Stewardship of the Chesapeake Bay and the land is a universal ethic.
- Conservation of resources, including a reduction in resource consumption, is practiced.
- To assure the achievement of the above, economic growth is encouraged and regulatory mechanisms are streamlined.
- Funding mechanisms are addressed to achieve these visions.

The visions must also be followed by the state in undertaking its various programs. Both state and local funding decisions on public construction projects must adhere to the visions. The Act also established an Economic Growth, Resource Protection, and Planning Commission to oversee, study, and report on progress towards implementation of the visions. More information about the act can be found at http://www.mdp.state.md.us/planningact.htm.

3.3.3.3.7 Urban growth boundaries

Urban growth boundaries are lines drawn around metropolitan areas to delineate where urban development can take place (inside the boundary) and where it may not (outside the boundary). Outside of urban growth boundaries, land use is restricted to agriculture, forestry, and open space (Nelson and Moore, 1993). The boundaries encourage more compact (i.e., infill) development, control urban sprawl, and help protect rural heritage. The approval process for new development can be streamlined within the growth boundary to further encourage development in these areas.

The duration or lifespan of growth boundaries is normally related to planning periods or cycles, typically 10 to 20 years. Boundaries should be examined at regular planning intervals, however, to assess whether conditions have changed since they were established.

Establishing the location of urban growth boundaries sometimes requires complex decision-making. Officials should be reasonably sure that there is sufficient land within the boundary to meet projected growth over the planning period and that public facilities and services can be

provided at reasonable cost in a timely fashion. The potential impact of growth within the boundary on existing natural resources also needs to be determined. In the context of watershed planning, it is advantageous to use watershed boundaries or other natural features as urban growth boundaries. In this manner, key or sensitive watersheds can be protected from the impacts of development.

In Arizona, the 1998 Growing Smarter Act and its 2000 addendum, Growing Smarter Plus, were signed into law by Governor Jane Hull (Morrison, 2000). This legislation addresses the issue of development by strengthening the ability of communities in Arizona to plan for growth and to acquire and preserve open space. The Growing Smarter legislation requires communities to address growth and growth-related pressures by mandating general plans that identify growth areas, establish policies and strategies for new growth, identify open space needs, regionally plan for interconnected open space, and analyze the environmental impacts of the development anticipated by the general plan (City of Tucson, no date).

3.3.3.4 Establish limits on impervious surfaces, encourage open space, and promote cluster development

As described earlier, urban runoff contains high concentrations of pollutants washed off impervious surfaces (roadways, parking lots, loading docks, etc.). By retaining the greatest area of pervious surface and maximizing open space, nonpoint source pollution due to runoff from impervious surfaces can be kept to a minimum. Refer to section 4.3.2 for a detailed discussion of site design practices to reduce impervious surfaces in new developments.

The following are examples of successful implementation of open space requirements and cluster development:

- Brunswick, Maine, recently adopted an allowable impervious area threshold of 5 percent of any site to be developed in the defined coastal protection zone. The remaining 95 percent is required to be left natural or landscaped. The threshold was developed and adopted using a $28,000 grant.

- Virginia provides general guidance with regard to minimum open space and maximum impervious areas to local governments within the Chesapeake Bay watershed. While specific requirements are not associated with the guidance, local plans are required to contain criteria and must be approved by the Chesapeake Bay Local Assistance Board.

- Carroll County, Maryland, is a community with substantial farmland and open space. Because it is located close to both Baltimore and Washington, DC, the county amended its zoning ordinance to encourage cluster development and preserve open space. This and land protection efforts by Carroll County have resulted in protection of 33,000 acres by agricultural easements (Maryland Environmental Trust Land Conservation Center, 2002).

- Maryland adopted the Forest Conservation Act of 1991, which requires all public agencies and private landowners submitting a subdivision plan or application for a sediment control permit for an area greater than 40,000 square feet to develop a plan for retention of existing forest cover on-site. The act allows clearing that is essential to site

development, and it established a forest conservation fund for reforestation projects. In the first five years of implementation, the Forest Conservation Act has produced 22,508 acres of retained forest and 4,313 planted acres, while 12,210 acres of existing forest have been cleared (Honeczy, 2000).

- Broward County, Florida, has an open space program and encourages cluster development to reduce impervious surface area, protect water quality, and enhance aquifer recharge (Broward County, Florida, 1990).

- New Hampshire has a model shoreland protection ordinance that encourages grouping of residential units, provided a minimum of 50 percent of the total parcel remains as open space.

One way to increase open space while allowing reasonable development of land is to encourage cluster development. Clustering entails decreasing the allowable lot size while maintaining the number of allowable units on a site. Such policies provide planners the flexibility to site buildings on more suitable areas of the property and leave environmentally sensitive areas, such as wetlands or steep slopes, undeveloped. Criteria can vary. Advantages of cluster development include:

- Reducing the costs of infrastructure;
- Preserving sensitive areas;
- Increasing property values with proximity to open space; and
- Preserving ecological, aesthetic, and recreational values.

Planned unit development is a type of zoning that encourages the use of cluster development but does not require it. For example, a set number of units could be spread across the site under typical residential zoning, but under cluster zoning, the same number of units could be concentrated on smaller lots on only a portion of the site, preserving the other portion for common open space to protect sensitive features or for use as a recreation area.

3.3.3.5 Revitalize existing developed areas

Redeveloping existing areas can alleviate water quality impacts by reducing the strain of development on open space land and minimizing the amount of impervious surface added to the watershed. Existing impervious surfaces, such as declining shopping malls and retail centers, can provide large tracts of developable land and are a prime opportunity for mixed-use infill development. For additional discussion of options for revitalizing urban areas, see Management Measure 10—Existing Development.

3.3.3.6 Establish setback (buffer zone) standards

In coastal areas, setbacks or buffer zones adjacent to surface water bodies, such as rivers, estuaries, or wetlands, provide a transition between upland development and these water bodies. The use of setbacks or buffer zones may prevent direct flow of urban runoff from impervious areas into adjoining surface waters and provide pollutant removal, sediment attenuation, and infiltration. Riparian forest buffers function as filters to remove sediment and attached pollutants,

as transformers that alter the chemical composition of compounds, as sinks that store nutrients for an extended period of time, and as a source of energy for aquatic life (USEPA, 1992). Setbacks or buffer zones are commonly used to protect coastal vegetation and wildlife corridors, reduce exposure to flood hazards, and protect surface waters by reducing and cleansing urban runoff (Mantel et al., 1990). The types of development allowed in these areas are usually limited to non-habitable structures and those necessary to allow reasonable use of the property, such as docks and unenclosed gazebos.

Factors for delineating setbacks and buffer zones vary with location and environment and include:

- Seasonal water levels;
- Nature and extent of wetlands and floodplains;
- Steepness of adjacent topography;
- Type of riparian vegetation;
- Quantity and velocity of runoff entering the buffer;
- Soil types and infiltration capacity;
- Density of development adjacent to the riparian corridor; and
- Wildlife values.

It is important that sheet flow, not concentrated flow, be directed to the buffer. High-velocity runoff from steeply sloped or highly impervious areas can promote excessive erosion and decreased pollutant removal. A flat, grassy area or a level spreader can be installed at the upland part of the buffer to slow the velocity of runoff and promote sheet flow. It is also important to consider that the pollutant removal capacity of a buffer is finite and can be exceeded in areas with high concentrations of pollutants in runoff.

Buffer width is an important measure of pollutant removal effectiveness. Buffers typically range from 20 to 200 feet wide and should include the 100-year floodplain, riparian areas including adjacent wetlands, steep slopes, or critical habitat areas (Schueler, 1995). A buffer at least 100 feet wide is recommended for water quality protection, and a 300-foot buffer is recommended to maintain a wildlife habitat corridor. Wider buffers offer increased detention times, infiltration rates, and diversity of soil, vegetation, and wildlife.

According to Herson-Jones et al. (1995), forested buffers achieve 50 percent TSS removal; 23 to 96 percent phosphorus removal depending on the extent of TSS removal; greater than 40 percent lead removal; more than 60 percent copper, zinc, aluminum, and iron removal; and more than 70 percent oil and grease removal.

Overall, aquatic buffers are highly effective at removing particulate pollutants, but less effective in removing soluble pollutants (such as nitrogen, for which documented removal rates range from -15 to 99 percent). Proper siting and design and regular maintenance enhance removal efficiency.

In general, EPA recommends that no habitat-disturbing activities should occur within tidal or non-tidal wetlands. In addition, a buffer area should be adequate to protect the identified wetland values. Minimum widths for buffers should be 50 feet for low-order headwater streams, with

expansion to as much as 200 feet or more for larger streams. In coastal areas, a 100-foot minimum buffer of natural vegetation landward from the mean high tide line helps to remove or reduce sediment, nutrients, and toxic substances entering surface waters.

3.3.3.6.1 Buffer ordinance

Buffer ordinances provide guidelines for buffer creation and maintenance. They should include the following provisions:

- Buffer boundaries to be clearly marked on local planning maps;
- Maintenance language that restricts vegetation and soil disturbance;
- Tables that illustrate buffer width adjustment by percent slope and type of stream; and
- Direction on allowable uses and public education.

A model ordinance and examples of buffer ordinances from across the country can be found at http://www.epa.gov/owow/nps/ordinance. Buffer ordinances and other water resource-related ordinances are also described in section 1.3.1.2.

The following are examples of setback or buffer requirements:

- Town commissioners in Apex and Cary, North Carolina, have agreed to set wider buffers between development and streams (Price, 2000). Under the new ordinance, buffers must be at least 50 feet wide along intermittent streams and must average 100 feet wide along perennial streams. The towns chose to use an average rather than a strict 100-foot minimum to allow landowners flexibility. In addition to the buffer ordinance, Apex and Cary halved the limit of impervious surfaces on a given tract of land over which retention ponds are required to control runoff (from 24 percent to 12 percent). Town officials will hold a public hearing to vote on the new regulations.

- Monroe County, Florida, requires a setback of 20 feet from high water on man-made or lawfully altered shorelines for all enclosed structures and 50 feet from the landward extent of mangroves or mean high tide line for natural water bodies with unaltered shorelines (Monroe County, Florida, Code, Section 9.5-286).

- Brunswick, Maine requires a buffer of 125 to 300 feet from mean high water within the Coastal Protection Zone (Section 315 of the Brunswick Zoning Ordinance), depending on the slope of the buffer, as designated on the town's land use map.

- Queen Anne's County, Maryland, established a standard shore buffer of 300 feet from the edge of tidal water or wetland, 50 percent of which must be forested.

- Maryland's Critical Area Act requires the establishment of a minimum buffer of 100 feet of natural vegetation landward from the mean high-water line of tidal waters or the edge of tidal wetlands and tributary streams. Unless a property owner can demonstrate unwarranted hardship and prove no negative impact to water quality, plant, fish or wildlife habitat, the local jurisdiction will not permit disturbance or new development within the buffer except for access or water-dependent facilities. Any clearing that occurs for access or water-dependent facilities must be mitigated through a buffer management

plan approved by the local jurisdiction (Critical Area Commission for the Chesapeake and Atlantic Coastal Bays, no date).

3.3.3.6.2 Vegetative and use strategies within management zones

Buffers can be divided into three zones—the streamside, middle, and upland zones (Herson-Jones et al., 1995). Dense vegetation in the streamside zone (recommended to be approximately 25 feet wide) prevents excessive activity in this sensitive area, maintains the physical integrity of the stream, and provides shade, litter, debris, and erosion protection. The width of a grassed or mostly forested middle zone (minimum of 50 feet) depends on the size of the stream and its floodplain and the location of protected areas such as wetlands or steep slopes. The upland zone, typically 25 feet wide, is an additional setback from the buffer and usually consists of lawn or turf. Zones in the buffer should be delineated to determine the types of vegetation that should be maintained or established.

Allowable land uses in the three zones vary. The streamside zone is limited to footpaths, runoff channels, and utility or roadway crossings. The middle zone may be used for recreation and runoff control practices. The upland zone may be used for many purposes, with the exception of septic systems, permanent structures, or impervious covers. A depression incorporated into the design of the upland zone can detain runoff during storms. This runoff is released slowly to the middle zone as sheet flow, which is then transferred to the dense streamside zone, designed to have minimal to no discharge of surface water to the stream.

3.3.3.6.3 Provisions for buffer crossings

Stream crossings should minimize impacts on buffer integrity while providing crossing points for linear forms of development such as roads, bridges, golf course fairways, underground utilities, enclosed storm drains, and outfall channels (Schueler, 1995). They should also be designed to provide fish passage and to withstand overbank flows from the 100-year storm event. Design considerations for buffer crossings include: minimizing the width of the crossing; orienting the crossing at a right angle to the stream; limiting the total number of crossings; ensuring that outfalls discharge at the invert elevation of the stream channel; and burying utility crossings at least 3 feet below the channel's invert elevation. An outfall should not be placed directly in the main channel. Energy-dissipating devices can be installed in outfalls to protect the streambed and adjacent banks.

3.3.3.6.4 Integration of structural runoff management practices where appropriate

Depressions can be incorporated into the upland part of a stream buffer to provide runoff detention during storms and to promote sheet flow over the middle zone of the buffer. A flat, grassed area or level spreader can also be used in the upland part of the buffer to create sheet flow and to promote infiltration over the rest of the buffer.

Storm water ponds and wetlands can be located inside or outside the buffer. According to Schueler (1995), ponds inside the buffer should be used only for runoff quantity control. Although ponds in the buffer treat the greatest possible drainage area, are more likely to maintain their water level during dry periods, provide a diversity of aquatic habitats, and can increase the total width of the buffer, they displace vegetation and might cause barriers to fish migration, modification of existing wetlands, and stream warming.

3.3.3.6.5 Development of buffer education and awareness programs

Buffer education efforts should foster community awareness and encourage stewardship. These objectives can be met by posting signs along the buffer boundaries that describe allowable activities in different parts of the buffer. Buffer owners can be educated by distributing pamphlets, hosting stream walks, and holding meetings. New owners should be made aware of buffer limits and allowable uses when the property is transferred. Buffer stewardship can be encouraged through reforestation and "bufferscaping" programs. Annual inspections can be done with "buffer walks" to determine the extent of encroachment, devegetation, erosion, or excessive sediment deposition.

3.3.3.7 Establish slope restrictions

Slope restrictions can be effective tools to control erosion and sediment transport. Erosion rates depend on several site-specific factors including soil type, vegetative cover, and rainfall intensity. In general, as slope increases, there is a corresponding increase in runoff water velocity, which may result in increased erosion and sediment transport to surface waters (Dunn and Leopold, 1978).

3.3.3.8 Promote urban forestry

Urban forestry is an effective tool for protecting watersheds because it can provide some of the storm water management required in urban areas. Trees decrease runoff by intercepting rain and promoting infiltration. This reduces the peak runoff flow and the total runoff volume that communities must manage, which can be financially beneficial to communities that have to build and maintain sewer and drainage systems (ENN, 2001). Also, trees provide shade, which lowers the temperature of urban heat islands and runoff. Erosion and leaf litter in forested areas can contribute sediment and nutrients to receiving waters; therefore, an effort should be made to establish and maintain stable vegetation and to keep leaf litter on-site.

Several organizations dedicated to promoting urban forestry can provide information and other resources to interested groups or individuals. For example, American Forests (http://www.americanforests.org) is a conservation organization that is working to improve the environment with trees and forests. The organization's Urban Forest Center offers tools to measure the environmental benefits of trees, such as pollution reduction and storm water management. These tools include the Regional Ecosystem Analysis (REA) and CITYgreen software packages. REA uses a combination of satellite data, field surveys, CITYgreen software, and other GIS technology to measure a region's or city's tree canopy and calculate its dollar value. CITYgreen allows users to compare the economic benefits of various planning scenarios by testing landscape ordinances, evaluating site plans, and modeling development scenarios that capture the benefits of trees. An application of this tool in Fayetteville, Arkansas, found that increasing the city's tree cover from 27 to 40 percent could result in cost savings from runoff reduction of up to $135 million (NALGEP, 2003). Information about the software is available at http://www.americanforests.org/productsandpubs/citygreen/.

TreePeople is another forestry organization. It works with the U.S. Forest Service and has enlisted the help of thousands of students and volunteers to plant seedlings in the mountains around Southern California. Its mission is to inspire people to take responsibility for improving their immediate environment. Information about TreePeople is available at http://www.treepeople.org/.

Houston's Urban Forests

American Forests conducted a study of a 3.2 million-acre area in Houston to document urban forest cover (ENN, 2001). They also analyzed 25 individual sites with aerial photography using CITYgreen to map and measure tree cover and to calculate the benefits of Houston's trees. Study results show that trees provide significant benefits in storm water runoff reduction, energy savings, and pollutant removal. The study found that Houston's tree cover reduces the need for storm water management by 2.4 billion cubic feet per peak storm event, saving $1.33 billion in one-time construction costs. As a result, American Forests made the following recommendations to the city of Houston:

- Improve green infrastructure by using tree cover data in land-use planning; growth management; and all transportation, public works, and development decision-making.
- Encourage the use of increased tree cover to met storm water needs.
- Work to increase tree cover in the metropolitan area.

3.3.3.9 Use site plan reviews and approval

A site plan review involves review of specific development proposals for consistency with the laws and regulations of the local government of jurisdiction. Potential development sites should be inspected to ensure that natural resources necessary for protecting surface water quality are preserved. Inspection ensures that the information presented in any application for development is accurate and that sensitive areas are noted for preservation. Inspections should also be conducted during and after development to ensure compliance with development conditions. Depending on the size of the local government and the amount of new development, this inspection could be incorporated into the duties of existing staff at minimal additional cost to the local government, or the inspection could require the addition of staff to conduct onsite inspections and monitoring. The effectiveness of such a program depends on the ability of the inspectors to evaluate property for its natural resource value and the practices used to protect areas necessary for the preservation of water quality.

Development approvals should contain conditions requiring maintenance of the area's environmental integrity and prevention of degradation from nonpoint source pollution, consistent with the goals, objectives, and policies of the comprehensive program and the requirements of the land development regulations. The criteria for new development are outlined as part of a development permit. Examples include the following:

– Areas for preservation or mitigation may be identified, similar to the Fairfax County Environmental Quality Corridor System (see section 3.3.2).

- The use of nonstructural and structural management practices described in this chapter for controlling nonpoint source pollution may be a condition of development approval.

- Setbacks and limits on impervious areas may be clearly defined in a condition for development approval, as is being done in the programs discussed above.

- Reduction in the use of pesticides and fertilizers on landscaped areas by encouraging the use of vegetation that is adaptable to the environment and requires minimal maintenance. (Xeriscaping techniques are described in Management Measure 4 and lawn and garden activities are described in Management Measure 9.)

3.3.3.10 Designate an entity or individual responsible for maintaining the infrastructure, including urban runoff management systems

The responsible party should be trained in the maintenance and management of urban runoff management systems. If desired, the local government could be designated to maintain urban runoff systems, with financial compensation from the developer. Because they are not usually trained in infrastructure maintenance, homeowners groups are not the best entity for monitoring infrastructure for adequacy, especially urban runoff management systems. This responsibility should belong to a responsible party that understands the complexity of urban runoff management systems, can determine when such systems are not functioning properly, and has the resources to correct the problem. Again, this is a duty that the local government can assume, with either existing staff or additional staff, depending on the size of the local government and the amount of new development occurring. The amount of funding needed depends on the size of the local government.

3.3.3.11 Use official mapping

Official maps can be used to designate and/or protect environmentally sensitive areas, zoning districts, identified land uses, or other areas that provide water quality benefits. When approved by the local governing body, these maps can be used as legal instruments to make land use decisions related to nonpoint source pollution.

3.3.3.12 Require environmental impact assessment statements

To evaluate the impact that proposed development may have on the natural resources of an area, some counties and municipalities require an environmental assessment as part of the development approval processes. These assessments can be incorporated into the land development regulation process. Areas to be covered include geology, slopes, vegetation, historical features, wildlife, and infrastructure needs (International City/County Management Association, 1979).

3.3.4 Cost of Planning Programs

The cost of planning programs depends on a variety of factors, including the level of effort needed to complete and implement a program. Many of the practices described in this section can be incorporated into ongoing activities of a state or local government.

The Florida legislature funded the development of comprehensive programs and land development regulations required by the Local Government Comprehensive Planning and Land Development Regulation Act (1985). Distribution of funds was based on population according to formulas used for determining funding for the plan and land development regulations. A base amount was given to all counties that requested it. The balance of the monies was allocated to each county in an amount proportionate to its share of the total unincorporated population of all the counties. A similar distribution process was used for local governments. A total of $2.1 million was allocated for plan development; however, not all components of the plans address nonpoint source issues.

The effect of planning programs depends on many variables, including implementation of programs and monitoring of conformance with conditions of development approval.

3.3.5 Land or Development Rights Acquisition Practices

An effective way to preserve land necessary for protecting the environmental integrity of an area is to acquire it outright or to limit development rights. Land conservation includes more than simply preserving land in its current state. It also means taking responsibility for restoration of areas of the property that might already have been affected by urban runoff. Stewardship activities for land conservation might include:

- Resource monitoring
- General maintenance
- Control of exotic species
- Installation of structural runoff management practices

A government agency or a nonprofit organization, such as a land trust, often has a greater capacity to take on the responsibility of stewardship than do private owners. Consequently, many of the practices discussed below focus on how conservation lands, or at least property rights to those lands, can be transferred to such entities. In many instances, however, private owners successfully accomplish stewardship without any formal or binding relationship with a public or private conservation agency or organization.

Several organizations provide educational materials and training to help landowners learn to manage conservation areas for the benefit of water quality, wildlife, and other purposes. For example, the Land Trust Alliance, an organization that "promotes voluntary land conservation and strengthens the land trust movement by providing the leadership, information, skills, and resources land trusts need to conserve land for the benefit of communities and natural systems," has compiled a list of links to local land trust organizations. This list can be accessed at http://www.lta.org/resources/links (Land Trust Alliance, 2001). Other information on land conservation policy, news, success stories, training opportunities, and technical guidance is provided on the Land Trust Alliance's Web site at http://www.lta.org.

Additionally, The Conservation Fund Web site, at http://www.conservationfund.org, provides information on land acquisition, community initiatives, leadership training, and sustainable conservation solutions emphasizing the integration of economic and environmental goals.

Another resource is the Natural Lands Trust whose Web site, at http://www.natlands.org, provides information and resources pertaining to land preservation and land use planning.

The practices described below can be used to protect beneficial uses.

3.3.5.1 Fee simple acquisition/conservation easements

The most direct way to protect land for preservation purposes and associated nonpoint source control functions is fee simple acquisition, through either purchase or donation. Once a suitable area is identified for preservation, the area may be acquired along with the development rights. The more development rights that are associated with a piece of property, the more expensive it will be. Many state and local governments and private organizations have programs for purchasing land.

Conservation easements are legal restrictions on the present and future use of land. For preservation purposes, the easement holder, who is usually not the owner of the property, is able to control the rights of the property when the landowner might adversely impact resources on the property. In effect, the property owner gives up development rights within the easement while retaining fee ownership of the property (Mantel et al., 1990; Barrett and Livermore, 1983). The agreement between the easement holder and property owner is permanent, legally enforceable, and not subject to alteration unless permission is received in writing by the easement holder and all other cosigners (Arendt, 1997).

A conservation easement is a flexible tool that can be customized to set different levels of restrictions among different types of conservation areas in a parcel. In addition to protecting and maintaining environmental benefits in perpetuity, landowners who donate conservation easements to a government agency or nonprofit group typically realize substantial income, property, and estate tax benefits resulting from the charitable donations. Their property value might be lowered, however, because the development rights were removed. Consequently, tax and estate planning professionals need to be consulted when a conservation easement is being contemplated.

As an alternative, agricultural and forestry easements are specific types of conservation easements that allow continued use of land as farms or forests and prevent the land from being sold for commercial or residential development. The USDA Natural Resource Conservation Service currently manages the Farm and Ranch Lands Protection Program (FRPP), a voluntary program that provides matching funds to state, tribal, or local governments and non-governmental organizations with existing farm and ranch land protection programs to purchase conservation easements. FRPP is reauthorized in the Farm Security and Rural Investment Act of 2002, also known as the Farm Bill (NRCS, 2003).

3.3.5.2 Leases, deed restrictions, and covenants

Even though government agencies, land trusts, and other nonprofit organizations would prefer that conservation lands be acquired by donation or that conservation easements be placed on the property, some lands hold so much value as conservation areas that leasing is worth the expense and effort. Leasing a property allows the agency, trust, or organization to actively manage the land for conservation.

Deed restrictions are included in deeds for the purpose of constraining use of the land. In theory, deed restrictions are designed to perform functions similar to those of conservation easements. In practice, however, deed restrictions have proven to be much weaker substitutes because unlike conservation easements, they do not necessarily designate or convey oversight responsibilities to a particular agency or organization to enforce protection and maintenance provisions. Also, deed restrictions can be relatively easy to modify or vacate through litigation. Modifying or nullifying an easement is difficult, especially if tax benefits have already been realized. For these reasons, conservation easements are generally preferred over deed restrictions.

A covenant is similar to a deed restriction in that it restricts activities on a property, but it is in the form of a contract between the landowner and another party. The term *mutual covenants* is used to describe a situation where one or more nearby or adjacent landowners are contracted and covered by the same restrictions.

3.3.5.3 Transfer of development rights

The principle of transfer of development rights (TDR) is based on the concept that ownership of real property includes the ownership of a bundle of rights that goes with it. These rights may include densities granted by a certain use designation, environmental permits, zoning approvals, and others. Certain properties have a bigger bundle of rights than others, depending on what approvals have been received by the owner. The TDR system takes all or some of the rights on one piece of property and moves them to another parcel. The purpose of TDRs is to shift future development potential from an area that is determined to be unsuitable for development (sending site) to an area deemed more suitable (receiving site). The development potential can be measured in a variety of ways, including number of dwelling units, square footage, acres, or number of parking spaces. Most TDR systems require a legal restriction for future development on the sending site. TDR programs can be either fixed so that there are only a certain number of sending and receiving sites in an area, or flexible so that a sender and receiver can be matched as the situation allows (Mantel et al., 1990; Barrett and Livermore, 1983).

This system is useful for the preservation of those areas considered necessary for maintaining the quality of surface waters, in that development rights associated with the environmentally sensitive areas can be transferred to less-sensitive areas. There are several examples of TDR use in the United States. The more successful projects include preservation of the New Jersey Pine Barrens and the Santa Monica Mountains in California. For the TDR concept to work, receiving and sending sites should be identified and evaluated, a simple, flexible program should be developed, and the use of the program should be promoted and facilitated (Mantel et al., 1990).

In contrast to a conventional down-zoning approach, which withholds from landowners the value associated with the right to develop, TDR systems allow a landowner to be compensated for that value by developing at another site.

Most TDR systems require a legal restriction to ensure that future development will not occur on the “sending” site. Also, TDR programs can be fixed so that there are only a certain number of sending and receiving sites in an area, or they can be flexible so that a sender and receiver can be matched as the situation allows. The following are general steps for setting up a TDR program (Redman/Johnston Associates, 1997):

- *Provide education and outreach*. The public should be familiar with the overall objectives of the program. Landowners and developers also need to be educated on how they will be affected.

- *Conduct an analysis of market conditions*. A successful program requires a market for TDR transfers.

- *Identify and designate TDR "receiving areas."* Receiving areas should be capable of supporting growth. Factors include adequate land area, infrastructure, public services, and consideration of environmental constraints.

- *Identify and designate TDR "sending areas."* Sending areas should support preservation and protection goals. Specific areas should be delineated to the parcel level.

- *Determine the nature of program*. Programs can be voluntary or mandatory. If mandatory, sending areas should be down-zoned to control growth.

- *Determine development potential and allocate TDRs*. Compute current allowable densities in both receiving and sending areas, and then allocate TDRs from sending areas based on desired densities. For example, down-zoning from a yield of 1 lot per 5 acres to 1 lot per 25 acres equates to 4 TDRs.

- *Consider a TDR Bank*. A TDR bank buys, holds, and sells TDRs. The bank can be either a government organization or a quasi-governmental entity.

Transfer of Development Credits Pilot Program, King County, Washington

King County, Washington's Transfer of Development Credits (TDC) Pilot Program is a voluntary initiative that allows residential densities to be transferred from rural areas to urban areas better suited to absorb additional density (King County Office of Regional Policy and Planning, 2001). The following provisions were made:

- A $1.5 million TDC bank was established to purchase and sell density credits.

- $500,000 was appropriated for urban amenities to improve neighborhoods that will receive increased density.

- An extensive outreach effort has been launched to inform stakeholders about the program and identify potential receiving sites.

- The Rural Forest Commission has reviewed and approved sending site criteria to be used by the TDC bank.

The first successful TDC was finalized in 2000 (Sims, 2000a). Forest land totaling 313 acres was protected from development. The density credits were transferred to a developer to add 500,000 square feet of commercial space in the nearby city of Issaquah.

More information about this TDC is presented at ww.metrokc.gov/exec/news/2000/032800.htm. More information about the King County TDC Pilot Program can be obtained from the program's Web site at http://www.metrokc.gov/exec/orpp/tdc or by contacting Mark Sollitto at 206-205-0705.

– *Provide adequate resources*. A TDR program does not run itself. It needs staff and resources to administer and manage the program.

3.3.5.4 Purchase of development rights

In this process, the rights of development are purchased while the remaining rights remain with the fee title holder. Restrictions in the deed make it clear that the land cannot be developed based on the rights that have been purchased (Mantel et al., 1990).

Howard County, Maryland, has the goal of preserving 20,000 acres of farmland. Development rights are acquired in perpetuity with ¼th of 1 percent of the local land transfer tax used as funding. There is no cap on the percentage of assessed value that may be considered development value, and payment for development rights may be spread over 30 years to ease the capital gains tax burden on the landowner (Jenkins, 1991).

3.3.5.5 Land trusts

Land trusts may be established as publicly or privately sponsored nonprofit organizations with the goal of holding lands or conservation easements for the protection of habitat, water quality, recreation, or scenic value, or for agricultural preservation. A land trust may also pre-acquire properties that are conservation priorities if it enters the development market when government funds are not immediately available by securing bank funding with the government as guarantor (Jenkins, 1991).

3.3.5.6 Agricultural and forest districts

Agricultural or forest districting is an alternative to acquisition of land or development rights. Jurisdictions may choose to allow landowners to apply for designation of land as an agricultural or forest district. Tax benefits are received in exchange for a commitment to maintain the land in agriculture, forest, or open space.

Fairfax County, Virginia, taxes land designated as an agricultural or forest district based on the present use valuation rather than the usual potential use valuation. A commitment to agricultural or forestry activities must be shown, and sound land management practices must be used. The districts are established and renewed for eight-year periods (Jenkins, 1991).

3.3.5.7 Cost and effectiveness of land acquisition programs

The costs associated with land acquisition programs vary depending on the desired outcome. If land is to be purchased, the cost depend on the value of the land. An additional cost to be considered is the maintenance of the property once it is in public ownership. Easements and development rights are less expensive, and maintenance responsibility is retained by the owner. Depending on the size of the local government, implementation of these programs is usually part of the operating budget of the appropriate agency (planning department or parks and recreation department, for example).

The effectiveness of a land acquisition program is determined by the size of the parcel and the difference between predevelopment and potential postdevelopment pollutant loading rates. In

addition, wetlands and riparian areas have been shown to reduce pollutant loadings. The acquisition and preservation of these areas can be extremely important to water quality protection and decrease the cost of implementing structural BMPs. However, the use of wetlands for urban runoff treatment, in general, should be discouraged. Where no other alternative exists, states and local governments can target upland areas for acquisition to minimize the impacts to and preserve the function of wetlands. One option for acquiring land is a public/private partnership. For example, Harford County, Maryland, has targeted areas for purchase of conservation easements. The county staff is working jointly with a local land trust to acquire conservation easements and to educate people in environmentally sound land-use practices. The estimated cost for the program is $60,000 per year (Jenkins, 1991). To aid in the establishment of two local land trusts, Anne Arundel County, Maryland, provided $350,000 in seed money for capital expenditures such as land and easement procurement. The county also gives staff assistance to volunteers; additional support comes from contributions of money or land, grants, and fundraisers (Jenkins 1991).

3.4 Information Resources

The Center for Watershed Protection's *Rapid Watershed Planning Handbook*, published in 1998, describes techniques communities can use to more effectively protect and restore water resources. This document is available for purchase from the Center for Watershed Protection's Web site (http://www.cwp.org).

The Chesapeake Bay Program's (1997) *Protecting Wetlands: Tools for Local Governments in the Chesapeake Bay Region* is available from the Chesapeake Bay Program's Web site at http://www.chesapeakebay.net.

The Conservation Fund's Web site, located at http://www.conservationfund.org, provides information on land acquisition, community initiatives, leadership training, and sustainable conservation solutions emphasizing the integration of economic and environmental goals.

Correll's (2000) Web site, entitled *Vegetated Stream Riparian Zones: Their Effects on Stream Nutrients, Sediments, and Toxic Substances*, presents an annotated and indexed bibliography of buffer strip literature. See http://www.unl.edu/nac/ripzone03.htm.

Eco-Compass (Island Press, 2000) is an information resource for urban sprawl issues. Developed by Island Press, Eco-Compass is an Internet guide to a wide range of environmental information, including ecosystems, communities, global change, and economics. The urban sprawl feature of Eco-Compass provides a summary of the major issues relating to sprawl as well as an examination of the lessons that can be learned from Atlanta, a city that has experienced tremendous growth in the past decade. The site also includes links to more than 50 of the best sprawl-related Web sites and publications. More information about Eco-Compass is available at http://www.islandpress.org/.

The Natural Lands Trust's 1997 publication, *Growing Greener: Putting Conservation into Local Codes,* is available from Natural Land Trust, 1031 Palmers Mill Road, Media, PA 19063; telephone 610-353-5587; e-mail planning@natlands.org. Other information and resources pertaining to land preservation and land use planning can be found at the Natural Lands Trust's Web site at http://www.natlands.org.

Schueler's (1995) manual, *Site Planning for Urban Stream Protection*, is available for download from the Center for Watershed Protection's Web site at http://www.cwp.org/SPSP/TOC.htm.

Based on the Local Government Commission's research of more than 150 "smart growth" zoning codes from across the nation, *Smart Growth Zoning Codes: A Resource Guide* will help planners design a zoning code that encourages the construction of walkable, mixed use neighborhoods and the revitalization of existing places. Each chapter analyzes a critical issue, such as design, streets, and parking, and highlights exemplary codes from across the country. The guidebook comes with a CD-ROM that contains copies of some of the best zoning codes in the United States and other resources. The guide is available for purchase ($25) from the LGC bookstore at http://www2.lgc.org/bookstore/detail.cfm?itemId=34.

The Smart Growth Network is a nationwide effort coordinated by EPA's Urban and Economic Development Division (International City/County Management Association, 2000). Through cooperative partnerships with a diverse network of organizations, EPA is working to encourage development that better serves the economic, environmental, and social needs of communities. The network provides a forum for information sharing, education, tool development and application, and collaboration on smart growth issues. Smart growth approaches focus on flexible zoning, preventive planning, intelligent management of natural resources and water quality, and implementation of treatment and control technologies at multiple scales from development sites to watershed planning. For more information about the Smart Growth Network, visit http://www.smartgrowth.org or contact ICMA—Smart Growth Network, 777 North Capitol St., NE, Suite 500, Washington, DC 20002-4201; telephone 202-962-3591; e-mail nsimon@icma.org.

The Mid-America Regional Council (MARC) initiated a project to raise awareness of the relationship between land development and transportation systems. In *Principles of Transit Supportive Development*, MARC (no date) presents alternative approaches to land development that encourage a more sustainable and balanced transportation system. The organization promotes community designs that enable citizens to walk, bike, ride transit, and drive from home to shops, schools, and services. For more information about the potential of transit supportive development, contact MARC at 816-474-4240 or visit their Web site at http://www.marc.org/transportation.

The Local Government Commission (http://www.lgc.org) is a nonprofit organization that provides peer networking opportunities, acts as an interface between city and county officials, and provides practical policy ideas for addressing serious environmental and social problems. The commission provides guidelines and resources for communities to improve their design, transportation, economic development, environment, energy, and waste prevention. A list of publications can be found at http://www2.lgc.org/bookstore/list.cfm?categoryId=1.

The Northeastern Illinois Planning Commission published *Model Stream and Wetland Protection Ordinance for the Creation of a Lowland Conservancy Overlay District: A Guide for Local Officials*, which can be ordered from its Web site at http://www.nipc.org/pubs-services/.

The National Association of Conservation Districts' Web site (http://www.nacdnet.org) contains a list of conservation districts across the country as well as conservation resources for districts, educators, and the public.

In July 2001 the National Governors' Association Center for Best Practices published *New Community Design to the Rescue: Fulfilling Another American Dream* (Hirschhorn and Souza, 2001), which provides alternatives to sprawl through "new community design." The book includes a checklist for local governments to evaluate communities and development projects for consistency with smart growth principles and provides examples of infill, suburban redevelopment, and greenfields projects that have successfully incorporated new community design principles. Innovative policies and actions taken by states to encourage new community design are also included. This publication can be purchased at the National Governors' Association Web site at http://www.nga.org or downloaded in PDF format at http://www.nga.org/cda/files/072001NCDFull.pdf.

"Protecting Water Resources with Smart Growth" is intended for audiences such as communities, local governments, state and regional planners already familiar with smart growth who are now seeking additional ideas on how to protect their water resources. The document is a compilation of 75 policies designed to protect water resources and implement smart growth. The majority of these policies (46) are oriented to the watershed, or regional level; the other 29 are targeted for specific development sites. The document is available for download in PDF format at http://www.epa.gov/smartgrowth/water_resource.htm.

Getting to Smart Growth: 100 Policies for Implementation was produced by the Smart Growth Network. The document highlights and describes techniques to help policymakers put smart growth principles into practice. The policies and guidelines, which have proven successful in communities across the U.S., range from formal legislative or regulatory efforts to informal approaches, plans, and programs. The primer describes 10 smart growth principles, specific policies for each principle, illustrations of their application in a community, and additional resources to aid communities in implementation. The document is available online in PDF format at http://www.smartgrowth.org/pdf/gettosg.pdf.

The concept of creating and maintaining an interconnected network of protected land and water, called "Green Infrastructure," is presented at http://www.greeninfrastructure.net. Green Infrastructure supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to health and quality of life. This Web site, developed by The Conservation Fund with support from USDA Cooperative Forestry, contains information to aid in implementing a comprehensive conservation program and includes resources such as searchable profiles, training information, events, and references databases.

The Southeast Michigan Council of Governments (SEMCOG) published *Opportunities for Water Resource Protection in Local Plans, Ordinances and Programs: A Workbook for Local Governments*, which is a guide for local communities to protect water resources. The workbook provides checklists that guide users through the process of establishing a water resource protection program. It covers a wide range of topics, including land conservation, erosion and sediment control, public education, and pollution prevention. For each of these topics, case studies and checklists guide users through basic tools available for master planning, regulatory controls, and design standards. The document can be downloaded from http://www.semcog.org or ordered by calling 313-961-4266.

EPA's Green Communities Program encourages successful community-based environmental protection and sustainable community development. The Green Communities Assistance Kit provides technical assistance and training for planning green communities. Information about the Green Communities Program can be found at http://www.epa.gov/greenkit.

Other useful EPA publications:

> U.S. Environmental Protection Agency (USEPA). 1996. *Green Development: Literature Summary and Benefits Associated with Alternative Development Approaches*. EPA841-B-97-001. U.S. Environmental Protection Agency, Washington, DC. Available through EPA's National Service Center for Environmental Publications (NSCEP) at http://www.epa.gov/ncepihom or by calling 800-490-9198.

U.S. Environmental Protection Agency (USEPA). 1998. *The Volunteer Monitor*. U.S. Environmental Protection Agency, Washington DC. Available in HTML format at http://www.epa.gov/owow/monitoring/volunteer/vm_index.html.

U.S. Environmental Protection Agency (USEPA). 1999. *Model Ordinances to Protect Local Resources*. U.S. Environmental Protection Agency, Washington DC. Available in HTML format at http://www.epa.gov/owow/nps/ordinance.

U.S. Environmental Protection Agency (USEPA). 2001. *Monitoring Water Quality: Volunteer Monitoring*. U.S. Environmental Protection Agency, Washington DC. Available in HTML format at http://www.epa.gov/volunteer.

3.5 References

Arendt, R.G. 1997. *Growing Greener: Putting Conservation into Local Codes*. Natural Lands Trust, Inc., Media, PA.

Barrett, T.S., and P. Livermore. 1983. *The Conservation Easement in California*. Island Press, Covelo, CA.

Broward County, Florida. 1990. Land Development Code. Ft. Lauderdale, FL.

Caraco, D., R. Claytor, P. Hinkle, H.Y. Kwon, T. Schueler, C. Swann, S. Vysotsky, and J. Zielinski. 1998. *Rapid Watershed Planning Handbook.* Center for Watershed Protection, Ellicott City, MD.

City of Tucson. No date. *Summary of Growing Smarter and Growing Smarter Plus Legislation.* http://www.ci.tucson.az.us/planning/grosmart/gsovervu.pdf. Accessed August 21, 2003.

Correll, D. 2000. *Vegetated Stream Riparian Zones: Their Effects on Stream Nutrients, Sediments, and Toxic Substances*. http://www.unl.edu/nac/ripzone03.htm. Last updated September 2001. Accessed May 28, 2002.

Critical Area Commission for the Chesapeake and Atlantic Coastal Bays. No date. *Frequently Asked Questions*. http://www.dnr.state.md.us/criticalarea/faq.html#14. Accessed March 3, 2005.

Delaware County Departments of Planning and Public Works. 2003. *Stormwater Management: Delaware County Action Plan.* Version 1.

Dunn, T., and L.B. Leopold. 1978. *Water in Environmental Planning*. W.H. Freeman and Company, San Francisco, CA.

Environmental News Network (ENN). 2001, January 10. *Calculating the Benefits of Houston's Urban Trees*. http://www.dnr.state.md.us/criticalarea/faq.html. Last updated January 10, 2001. Accessed April 6, 2001.

Herson-Jones, L.M., M. Hearty, and B. Jordan. 1995. *Riparian Buffer Strategies for Urban Watersheds.* Metropolitan Washington Council of Governments, Washington, DC.

Hirschhorn, J.S., and P. Souza. 2001. *New Community Design to the Rescue: Fulfilling Another American Dream*. National Governors' Association, Washington, DC.

Holler, S. 1989. Buffer Strips in Watershed Management. In *Watershed Management Strategies for New Jersey*, Cook College Department of Environmental Resources and New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, NJ, pp. 69–116.

Honeczy, M.R. 2000. *The Maryland Forest Conservation Act—A 5-Year Review*. Presented at the 2000 APA National Planning Conference, New York, New York, April 16, 2000.

http://www.asu.edu/caed/proceedings00/FOREST3/honeczy.htm. Accessed March 3, 2005.

International City/County Management Association. 1979. *The Practice of Local Government Planning.* American Planning Association, Chicago, IL.

International City/County Management Association. 2000. *Smart Growth Network*. www.smartgrowth.org. Last updated June 17, 2000. Accessed June 21, 2000.

Island Press. 2000. *Eco-Compass: Sprawl Cities*. www.islandpress.org/ecocompass/community/sprawl.html. Accessed April 4, 2001.

Jenkins. 1991. *Chesapeake Bay Restoration: Innovations at the Local Level. A Compilation of Local Government Programs*. The Chesapeake Bay Local Government Advisory Committee and the U.S. Environmental Protection Agency, Annapolis, MD.

King County Office of Regional Policy and Planning. 2001. *Transfer of Development Credits (TDC) Program.* Last updated April 23, 2001. Accessed May 1, 2001.

Land Trust Alliance. 2001. Links to Web Sites of Sponsor Members of the Land Trust Alliance. www.lta.org/resources/links. Last updated February 16, 2001. Accessed May 1, 2001

Livingston, E.H., and E. McCarron. 1992. *Stormwater Management: A Guide for Floridians*. Florida Department of Environmental Regulation, Tallahassee, FL.

Mantel, M.A., S.F. Harper, and L. Propst. 1990. *Creating Successful Communities: A Guidebook to Growth Management Strategies*. Island Press, Washington, DC.

Maryland Department of Planning. No date. *The Economic Growth, Resource Protection, and Planning Act of 1992*. http://www.mdp.state.md.us/planningact.htm. Accessed March 3, 2005.

Maryland Environmental Trust Land Conservation Center. 2002. *Local County Purchase of Development Rights (PDR) Programs*. http://www.conservemd.org/purchased/pdr. Accessed March 3, 2005.

Meeks, G. 1990. *State Land Conservation and Growth Management Policy: A Legislator's Guide*. National Conference of State Legislators, Washington, DC.

Metro-Dade Planning Department. 1988. *Comprehensive Development Master Plan.* Miami, FL.

Michigan Department of Environmental Quality. No date. *Into Every Life a Little Rain Must Fall.* Michigan Department of Environmental Quality, Madison, WI.

Mid-America Regional Council (MARC). No date. *Principles of Transit Supportive Development.* Mid-America Regional Council, Kansas City, MO.

Morrison, M. 2000, June 5. A sudden oasis, or just sprawl? Phoenix exurb sharpens growth debate. *The Washington Post*, p. A3.

National Association of Local Government Environmental Professionals (NALGEP). 2003. *Smart Growth for Clean Water: Helping Communities Address the Water Quality Impacts of Sprawl.* National Association of Local Government Environmental Professionals, Trust for Public Land, ERG. http://www.resourcesaver.com/file/toolmanager/CustomO93C337F42157.pdf. Accessed June 30, 2003.

National Park Service (NPS). 2001. *Colonial National Historical Park.* http://www.nps.gov/colo/. Last updated May 2, 2001. Accessed May 2, 2001.

Natural Resource Conservation Service (NRCS). 2003. *Farm Bill 2002: Farm and Ranch Lands Protection Program.* Natural Resource Conservation Service, U.S. Department of Agriculture. http://www.nrcs.usda.gov/programs/farmbill/2002/pdf/FRPPFct.pdf.

Nelson, A.C. and T. Moore. 1993. Assessing urban growth management: The case of Portland, Oregon, the USA's largest urban growth boundary. *Land Use Policy* 10(4): 293-302.

Price, J. 2000, December 7. Apex leaders agree to beef up their stream-protection measures: New rules call for larger buffers. *The Raleigh News and Observer*.

Redman/Johnson Associates. 1997. *Beyond Sprawl—Land Management Techniques for the Chesapeake Bay: A Handbook for Local Governments*. EPA 903-B-97-005. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.

Schueler, T. 1995. *Site Planning for Urban Stream Protection.* Metropolitan Washington Council of Governments, Washington, DC.

Simmons, M.M. 1991. *Coastal Barriers Protection Issues in the 101st Congress*. Congressional Reporting Service, Environment and Natural Resource Policy Division, Washington, DC.

Sims, R. 2000a. *First Transfer of Development Credits in NW Celebrated.* www.metrokc.gov/exec/news/2000/032800.htm. Last updated March 28, 2000. Accessed May 4, 2001.

Sims, R. 2000b. *SmartGrowth: Rural Legacy.* www.metrokc.gov/smartgrowth/rural.htm. Last updated May 31, 2000. Accessed May 1, 2001.

Stapleton, B. 1999. Old B/A Gas Station Finds New Life. http://www.oldgas.com/info/banewtonville.html. Last updated September 11, 1999. Accessed February 21, 2000.

Tritto, C. 2000, November 13. City seeks policy on storm water. *Missourian*, p. 9.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2000. *1997 National Resources Inventory*. http://www.nrcs.usda.gov/technical/NRI/1997/index.html. Accessed June 5, 2000.

U.S. Environmental Protection Agency (USEPA). 1992. Notes of Riparian and Forestry Management. In *U.S. EPA, Nonpoint Source News Notes.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. March 1992, pp. 10–11.

U.S. Fish and Wildlife Service. 2002. *The Coastal Barrier Resources Act: Harnessing the Power of Market Forces to Conserve America's Coasts and Save Taxpayers' Money*. http://www.fws.gov/habitatconservation/TaxpayerSavingsfromCBRA.pdf. Last updated August 2002. Accessed March 3, 2005.

University of Oregon. 1995. *What is an Urban Growth Boundary?* darkwing.uoregon.edu/~pppm/landuse/UGB.html. Last updated May 10, 1995. Accessed April 5, 2001.

Verden, T. 2000, September 25. Officials sign pact to balance development with preservation. *The Sacramento Bee*, p. N10.