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Landscape Design and Maintenance for Pollution Control

Urban and suburban landscapes are often the only green in a generally artificial environment, so it is difficult to view them as pollution sources. But they can be. With every rain or watering of lawn, shrubs, flowers, and garden, some water may run into the storm sewer or down the roadside ditch and enter nearby waterbodies. This runoff can carry lawn and garden chemicals, which on the land are resources but in runoff become pollutants. This runoff can also carry bacteria and nutrients from pet wastes or improperly functioning septic systems, sediment from eroding areas, and any oil, grease, or solvents that may have leaked or spilled on the ground. Pollutants from a lawn or driveway may not seem like much of a problem, but their cumulative impact can be significant.

A quick look at any creek or stream in an urban or suburban area often shows a waterbody that is physically, chemically, and biologically different from streams in less developed areas. Algae blooms are more common, water levels are more erratic, water is more turbid (sediment laden), and litter is often present. Not all of the water quality problems in urban and suburban streams and lakes result from landscape runoff; however, controlling or preventing polluted runoff is essential to restore these waterbodies.

An Overview

In 1983, the U.S. Environmental Protection Agency and cooperating state and local governments monitored 28 urban watersheds to determine the type and amount of pollution that originated in urban areas and to evaluate control practices. This study, called the National Urban Runoff Program, found that the annual average levels of nitrogen and phosphorus were lower in runoff from residential and commercial areas than in discharges from well-run wastewater treatment plants. Yet, single storm episodes can contribute extremely high loads of nutrients that can significantly shock the receiving waterbody.

A resource efficient landscape can include a gravel drive, brick and sand walkways, and native and resource efficient plant materials.

Most plants are chosen for urban and suburban landscapes because they are plentiful and inexpensive. Little consideration is given to site

adaptability or maintenance needs (water, fertilizer, and pest control). As a result, millions of homeowners spend millions of dollars and countless hours to maintain attractive, healthy landscapes, often at significant costs to the environment. By following simple design and maintenance practices, homeowners, landscape contractors, lawn care providers, developers, and cities can have attractive, easy to maintain landscapes that are also easy on the environment. Suitable plants, proper landscape design, soil preparation, and maintenance practices all contribute to trouble-free and environmentally friendly landscapes.

The Benefits of Resource Efficient Plants

Well-designed landscapes should use native and resource efficient plants (REPs). These plants are well-adapted to the natural conditions of an area and require few resources, such as water and fertilizers or pesticides, to remain attractive. They can also prevent runoff or nonpoint source pollution. The amount of chemicals needed, soil moisture content, plant irrigation requirements, and infiltration rate of water into the soil affect chemical runoff from landscapes. These factors offer the most opportunity to apply best management practices such as the selection of appropriate plant species.

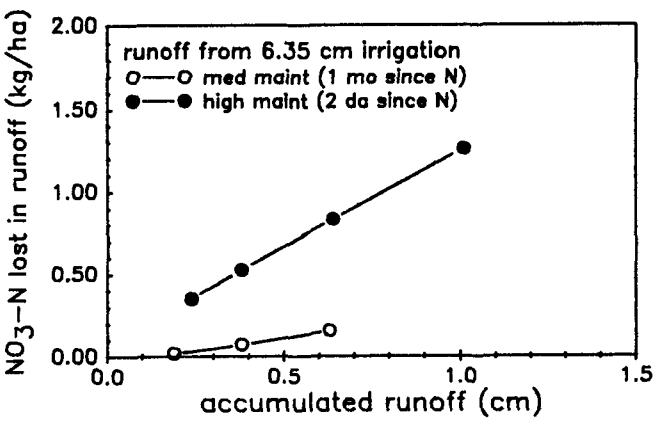
Table 1.—Landscape management systems.

LANDSCAPE	PLANT	FERTILIZATION	IRRIGATION
xeriscape	prairie buffalograss, autumn sage, wax myrtle	no fertilizer	no irrigation
low-maintenance	same plants as xeriscape	65.2 lbs N/acre (73 kg/ha) split between two applications	at 15 percent pan evaporation level (about 1.5 in/month during growing season)
medium-maintenance	tiffgreen bermuda grass, dwarf yaupon hollies, wax myrtle	130.5 lbs N/acre (146 kg N/ha) in three applications	to equal 40 percent pan evaporation (about 4 in/month during growing season)
high-maintenance	same plants as medium	261.6 lbs N/acre (293 kg N/ha) applied in 6 applications; 18 8 lbs P/acre (21 kg P/ha) and 32.1 lbs K/ha) application	to equal 60 percent pan evaporation (about 1.5 in each week)

Researchers at the Texas Agricultural Experiment Station in Dallas have begun to quantify the nutrient and pesticide reductions that can be achieved by landscapers who select resource efficient plants. Using 20 microwatersheds (each microwatershed was replicated five times), Professor Billy Hipp and colleagues are evaluating four different landscape management systems in clay soils: high-maintenance, medium maintenance, low-maintenance, and xeriscape (no maintenance). The researchers compared representative resource efficient plants to typical high-maintenance plants that require significant amounts of water and chemicals to remain attractive. Two-thirds of each microwatershed was planted to turfgrass, and the other third was planted to shrubs with a bark nugget cover. Table 1 shows the management systems and types of plants used in the microwatersheds.

Preliminary data from Texas show that during most rainfall and irrigation events, less runoff and more infiltration occur in landscapes with dry soils. Thus, landscapes containing resource efficient plants adapted to conditions of low soil moisture contribute less pollution to nearby waterbodies. The data also indicate that landscapes with limited inputs of fertilizers and pesticides contribute fewer nonpoint sources of pollution, and the concentration and amount of pollutants that do occur in the runoff are low. Figure 1 illustrates the differences in nitrate runoff between the high- and medium-maintenance systems.

Figure 1.—Differences in nitrate runoff between high- and medium-maintenance systems.



Source: B Hipp, Texas Agricultural Experiment Station, Dallas, TX

municipal mowing ordinances exist. U.S. Department of Agriculture soil scientists and range conservationists can advise homeowners, landscape designers, and contractors on how to indentify and plant various grass plants and forbs native to the area. Native grass plants have low nutrient requirements and can be effective in uptake or interception of nutrients.

- In many new subdivision developments, builders offer "landscape packages" as part of the purchase price of new homes. Polluted runoff from these landscapes can be prevented by requesting a resource efficient landscape design as the standard package.

■ **Group plants according to similar growing and resource requirements and match them with the existing site conditions.** Placing plants that require moist or saturated soil conditions in a wet area, instead of draining the area for less tolerant species, avoids the constant battle of keeping the site in an altered conditions so the plants can live.

- Landscape zoning or creating outdoor rooms based on the homeowner's desired use is an accepted concept in landscape design. This principle can be modified to include selecting uses according to the site's ecological zones.
- A high-maintenance turfgrass could be used as a specimen or accent area, with the remaining areas planted with resource efficient plants. One small but exquisite area of lawn has more visual appeal than a large area of difficult-to-maintain turf. Additionally, even though resource requirements are high, the smaller area of lawn will receive much lower total inputs than a larger area, thus reducing potential for pollution off site.

Water Quality Goals for Landscape Maintenance and Management

Resource efficient landscapes can be designed to require minimum maintenance to prevent pollution. Existing landscapes that do not have resource efficient plants can be managed more efficiently to provide some protection to water resources. Key management principles to observe include the following:

■ **Manage water efficiently.** Simple methods to conserve water and prevent runoff consider both irrigation quantity and timing. Use trickle irrigation systems, manually operate sprinklers (based on soil moisture conditions), and routinely test soil moisture to determine irrigation amount. Irrigate in the morning to allow plants to dry instead of the evening when low evaporation rates can lead to disease.

■ **Use mulch.** The infiltration rate in mulched areas is often more than double that of unmulched areas because the mulch intercepts the impact of raindrops and prevents the soil from developing a less permeable crust. Mulch also controls weeds, reducing the need for herbicides or labor to pull weeds. Mulched soil is cooler than bare ground and provides a favorable environment for earthworms and insects that increase infiltration and build soil. A healthy soil is the first step to a healthy plant and may prevent diseases or pests from attacking the plant. Consider composting as another way to build a better soil while eliminating nonmeat household food scraps and landscape clippings. The new composters are self-contained, unobtrusive, inexpensive, easy to use, and virtually odor free.

■ **Manage nutrients wisely.** All plants need nitrogen, phosphorus, potassium, and various micronutrients to grow. Even resource efficient landscapes sometimes need supplemental fertilizer. The key to water quality protection through proper nutrient management is to test the soil and plants to determine the missing nutrients, select the least mobile form of the nutrient available, and apply the nutrient to coincide with growth cycles. Avoid applying fertilizer just before rainfall, place fertilizer only when and where it is needed, and avoid overwatering. Research shows that a significant pollution load can wash off sidewalks to which fertilizer has been inadvertently applied. Figure 3 illustrates the high nitrogen pollution load that may result in runoff from a sidewalk.

■ **Begin pest management with plant selection.** Site-adapted and native plants may be more pest

intercepting and filtering pollution in runoff. Most small suburban lots (less than a quarter-acre) cannot accommodate a buffer designed to control pollution from the entire watershed but may be sufficient to control on-site runoff.

Critical areas to protect with buffer zones include creeks, drainage swales, storm sewer outlets, and wet areas. A mixture of trees, shrubs, and ground cover is a more effective design than a single species. If soil conditions are suitable, these buffer zones may operate like a seepage trench (a soil-covered, gravel-filled trench) or Dutch drain (a surface drain that consists of a shallow, gravel-lined trench with curbing and a grate) by improving infiltration and slowing runoff velocity. Water infiltration into forest soils is one-third to one-half higher than turf covered soils. Thus, using woody plants to retain water in the buffer can minimize runoff and increase infiltration.

■ **Limit impervious areas.** Research in urban and suburban watersheds shows that once a watershed exceeds 12 percent imperviousness, stormwater flow and pollutant loadings increase proportionally. On a typical 100 by 75-foot lot with a 2,000-square-foot home, a driveway, and a garage, the site is approximately 33 percent developed. Since roof area generally cannot be reduced, other methods to reduce site imperviousness will help control pollution. Replacing lawn areas with decks, paving, and mulched areas underlain with plastic is often recommended for a xeriscape system. Although these nonporous soil coverings are effective in reducing high-maintenance lawn areas and subsequent water needs, they can increase runoff velocity and amount and contribute to water pollution.

More efficient methods can limit impervious surfaces during landscape design and installation. For example, residential and commercial sites might use porous pavements, nonsolid decking without a plastic or nonpermeable liner, organic mulch, bricks and sand for walkways instead of concrete, and crushed gravel within curbing for driveways and utility areas.

■ **Manage runoff and pollution from impervious surfaces.** Driveways, sidewalks, and gutters need not drain to the pavement—they can drain to a well-vegetated area by appropriately sloping, crowning, or redirecting water flow.

- Direct the flow to infiltration trenches or Dutch surface drains as long as the runoff only comes in contact with normal home construction and landscape material and is not installed on a clay soil, an impervious claypan soil, or an area with a high water table.
- During home construction, use techniques that minimize soil compaction. Since heavy, compacted clay soils around existing homes usually cannot be replaced, planting materials with deep fibrous roots will help to improve infiltration.
- Improve existing soil infiltration capacity by incorporating organic material into planting beds, and where possible, into lawns.

■ **Select resource efficient plants.** A resource efficient landscape should have attractive plants that are suited to the site but require minimal levels of fertilizer, pesticides, and irrigation to thrive. Each area of the country has a wealth of attractive native plants—trees, shrubs, ground cover, grasses, and flowers—as well as many well-adapted introduced species that the homeowner, landscape designer, or contractor can choose from. Most local county extension specialists have lists of resource efficient plants adapted to each region and will provide the names of recommended plants suited to local soils, climate, and landscape needs.

■ **Replace large areas of high-maintenance landscapes with adapted or native plants.** The largest consumer of water, time, fertilizers, and other resources is a high-maintenance landscape area. Research at Texas A&M University in Dallas shows that selecting reduced-input and low-maintenance plants results in significantly reduced nutrient concentrations in runoff when compared to typical landscape materials.

- Portions of the high-maintenance landscape can be replaced with resource efficient ground cover, shrubs, and trees that generally have lower resource requirements. For example, in the north Texas area, native tree seedlings require a weekly one-inch watering for their first three years but only supplemental irrigation during especially dry summers or early falls thereafter.
- Establishing native grass and herbaceous flowering plants in a meadow-like setting is an excellent alternative for high-maintenance landscapes unsuited for shrubs or ground cover. This includes suburban areas where homes are sited on a few acres and no

Resource Efficient Landscapes

A properly designed landscape not only adds beauty to a residential or commercial site, but it can also increase property values, decrease heating and cooling expenses, provide security, buffer noise, screen unsightly views, preserve water supplies, mask or remove objectionable odors, and control nonpoint source water pollution.

Some of the factors that influence the selection of resource efficient plants also guide the development of a resource efficient landscape design. In particular, the site's soils and drainage and the area's climate must be carefully considered to design a landscape that prevents pollution. Any existing vegetation, prevailing wind direction, slope, available water, existing or desired impervious surfaces, and proximity to street must also be considered.

Design Principles for Pollution Prevention

The key to a landscape design that prevents nonpoint source pollution is understanding the site to be designed and the resources to be protected. Basic landscape design principles that reduce potential nonpoint source pollution include the following:

■ **Work with the hydrology instead of altering it.** The first consideration in landscape design is generally how to alter a site's hydrology to meet the landowner's objectives. A resource-intensive approach is usually taken—wet areas are drained, water flow patterns are altered, and dry areas are irrigated. However, incorporating the existing hydrology into the landscape design can meet the objectives while still effectively controlling pollution and saving money as well.

As shown in Figure 2, the landscape design for a residential property should allow off-site runoff to move across the property without damaging the site or adding pollution to the runoff. Using the areas that carry the runoff as part of the landscape design integrates the hydrology of the area into the landscape plan.

- If the site must be significantly modified, ensure that all areas drain to well-vegetated zones—never directly to a stream or storm sewer—to minimize pollution. Small on-site detention or retention basins and gravel-filled seepage pits can hold water to increase infiltration or slow rapid runoff to a nonerosive rate. Small berms or terraces can also increase infiltration. Take care to protect groundwater resources with these installations.
- Siting recreation and other high-use areas in stable and dry zones in the yard help prevent unnecessary site alteration. New developments offer expanded possibilities for pollution prevention and control. Developers should set aside wet or streamside areas for community green space. Porous pavement and detention and retention basins can also improve the management of water or site.

■ **Use buffer zones.** Design buffer zones and riparian protection areas for individuals or the entire development. Properly designed and vegetated buffer zones are highly effective in

Figure 2.—A resource efficient landscape design.

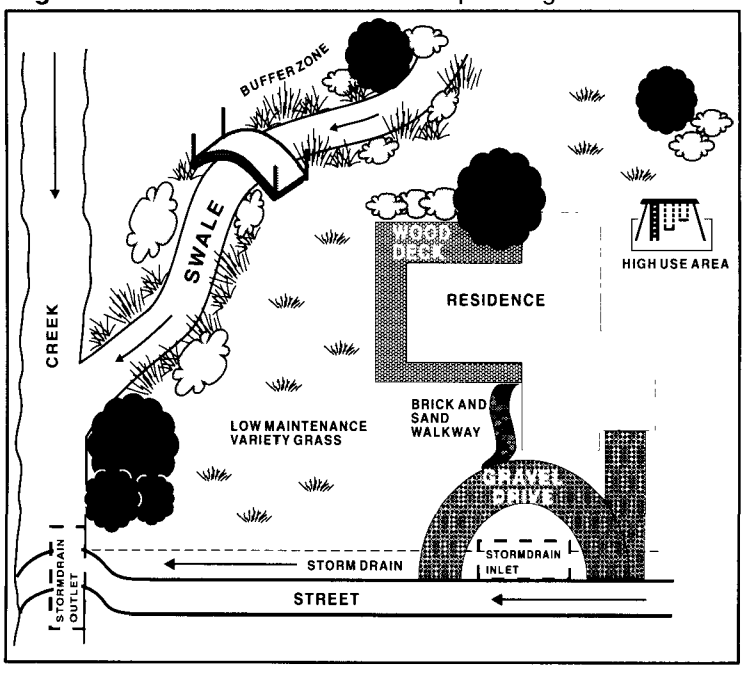
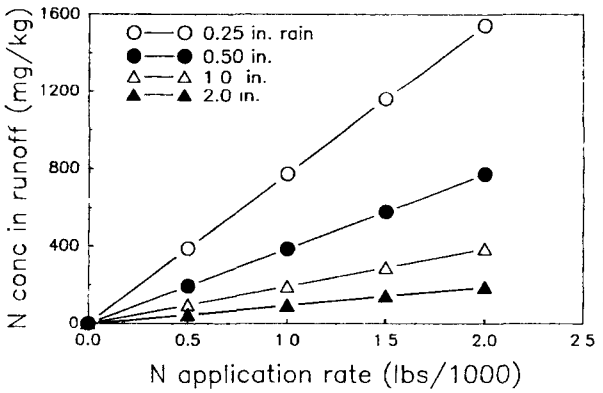


Figure 3.—Calculated nitrogen concentration in runoff from sidewalk.



Source: B. Hipp, Texas Agricultural Experiment Station, Dallas, TX.

resistant than many introduced species because plants established in suitable soils are less prone to disease and attack by insects. If a problem does occur, identify the cause to determine if it warrants treatment. If a disease or insect problem reaches an intolerable level, choose the least toxic but most effective pesticide for the specific pest. Select the least mobile pesticide with the shortest residual time in the environment, and apply it according to label directions. Some label directions can be confusing or misread—take care to dilute and apply correctly. Always dispose of containers properly.

■ **Influence others.** Many suburban homeowners engage lawn care companies. As with any business, these companies respond to consumer demand. Encourage companies to expand their services to promote the use of low-maintenance, low-impact landscapes, and include more customized assistance instead of routinely scheduled care.

■ **Incorporate new lawn care knowledge into routine practices.** Many extension service agents promote resource efficient use of grass clippings through simple but effective programs such as composting or "Don't Bag It." Reduced mowing and increasing the mowing height of the blade are simple conservation practices that can improve water quality. Some grasses do poorly if mowing height is increased. In some instances, evenness of cutting is more important in reducing lawn water loss.

Help is Available

Many groups and agencies can provide written materials, services, and on-site assistance with resource efficient landscaping. For specific help, contact the following:

- American Society of Landscape Contractors, state chapters
- American Society of Landscape Architects
- Cooperative Extension Service
- Local nurseries
- Local Environmental Protection Agency offices
- State Water Quality agencies
- U.S. Department of Agriculture Soil Conservation Service
- Native plant societies

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