Urban and Community Forestry – Policy and Law

Trees, Parking and Green Law: Strategies for Sustainability

February 2004

Prepared by:
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Project sponsors:
USDA Forest Service, Southern Region
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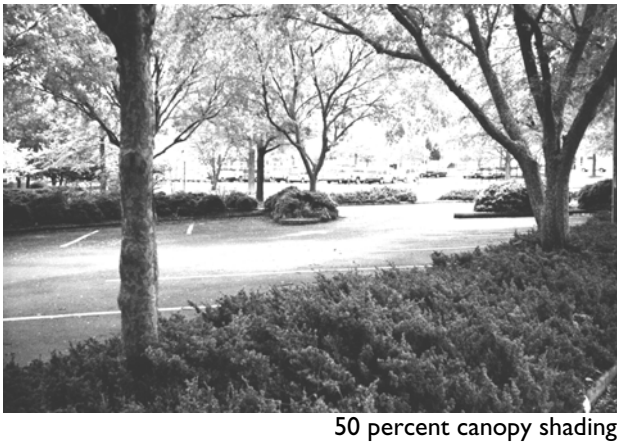
5 percent canopy shading

20 percent canopy shading


50 percent canopy shading

60 percent canopy shading

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1. INTRODUCTION

While the goal of sustainability is widely accepted, the ways and means of achieving sustainability in urban areas are still being debated, created and tested. Sustainability is defined in the urban context as practices that do not exceed the environment's capacity to support both human and natural communities, now and in the future – including issues of soil, air, water, vegetation and energy. Sustainability can be realized in part through the adoption of innovative legal code. In their efforts to achieve sustainability, many American cities have reviewed and revised urban forestry, parking construction and building practices.

Communities use sustainability strategies that include both comprehensive and detailed approaches to achieve their goals (Portney 2001). Sustainability initiatives vary in scale, depending on the jurisdictional boundaries of a city, county, or metropolitan area. Initiatives may also acknowledge landscape boundaries, such as a watersheds or ecosystems. At the landscape scale, for example, regional governments may team up to construct a transit system, reducing use of non-renewable energy sources. Site-scale practices, such as green building design, also affect energy use.

This report is intended to be a resource tool for concerned citizens and professionals in communities who are acting on one facet of sustainability - urban parking lots. The report contains scientific information about environmental impacts of paving in cities, and provides an overview of legal strategies to reduce those effects. Interested professionals may include planners, landscape architects, engineers and urban foresters. Community volunteers serving on planning commissions or urban forest councils may also find this information helpful.

Parking Areas & Sustainability

Parking areas are an integral part of the built landscape in American settlements of all scales, from the small town to major metropolitan centers. Parking areas are a landscape cover associated with all zoning and land-use types. Parking lots occupy about 10 percent overall of the land in U.S. cities, and can be as much as 20 to 30 percent of downtown core areas (Beatty 1989).

Parking lots can occupy as much as 20 to 30 percent of downtown areas

Parking areas serve primarily for vehicle storage while people spend time in spaces where they live, work and learn. But parking areas also reflect American lifestyle trends. For instance, universities now provide more parking than in the past because of increased numbers of evening and commuting students, and hospitals provide more parking because of increased short-term out patient care.

Parking Area Impacts

It is estimated that 80 to 90 percent of all U.S. parking demand is provided by surface parking lots (Stocks 1983). Typically, two or three times as much space for parking lots (usually surface lots) is created as there is floor space in the building being served by the parking. Lots for regional malls can take up more than 50 or 60 acres.

Trees and landscaping can reduce paved area impacts

Parking space is often viewed by developers as being essential to the market success of commercial buildings. Yet city planners must balance this commercial need for parking with other community desires such as a more compact urban form, a more pedestrian-oriented urban design and an improved environment.

Large surface parking lots can contribute to drainage and flooding problems, increase urban heat islands, become visual eyesores, and encourage people to abandon mass transit, thereby accentuating air quality problems (McPherson 2001).

LAW, DESIGN AND SUSTAINABILITY

Legal code, ordinances and regulations are important tools that communities can use to encourage, require and enforce sustainable practices. Historically, code has been motivated by aesthetic concerns, such as city beautification or urban renewal programs. Contemporary code should be guided by best available science so that law is based on sustainability goals, and reflects contemporary concerns about human health and welfare.

Green law in U.S. cities has existed for many decades, and can be thought of collectively as the codes and ordinances that address landscape, trees, green spaces, and how these elements are created, enhanced or protected during development. Early green law addressed aesthetic concerns, but recently code purposes and goals have become more comprehensive and explicitly address the environmental benefits of having nature and ecosystems in cities. Many of the

Definitions of Terms: Code, Ordinance and Green Law

The terms "code" and "ordinance" are used frequently in this report. A municipal or county code is the entire body of laws and regulations that defines legally accepted procedures, practices, responsibilities and built form within a community. It includes comprehensive legal description of community development practices. A city or county's code is usually organized hierarchically, as shown in this example:

GreenCity Municipal Code
- Title: Buildings and Construction (alternative heading is Article)
- Title: Zoning
- Title: Subdivisions
- Title: Environment
  - Chapter: Environmental Policy (alternative heading is Part)
  - Chapter: Noise Regulation
  - Chapter: Vegetation Management
    - Section: Findings and declaration of purpose
    - Section: Vegetation management permit
    - Section: Submittal requirements

Ordinances are new laws, passed by local legislative councils. Ordinances may be used to add a new Chapter, revise or amend an existing Title, establish a new requirement for a development permit, levy a new fee or amend a master plan. Some ordinances may address new community concerns (such as skateboard restrictions) and so function as general, stand-alone laws. Over time collections of ordinances may be reviewed and integrated to become new code chapters. Finally, "standards" are the regulatory benchmarks that clarify how the law will look on the ground, and are found within both code and ordinances, usually at the Section level.

"Green Law" is a phrase that generally refers to the entire collection of a city or county's local code and ordinances, and includes any site-specific law that addresses landscaping, trees, stormwater, and other environmental concerns in built or urbanized settings. The green law of one community may be limited in its applications, while other communities have extensive and comprehensive green law. Buck Abbey, a professor at Louisiana State University, has compiled information about Green Law: www.greenlaws.lsu.edu/

recommended practices of green law are associated with particular land uses or development actions.

Design is another aspect of sustainability and plays a dual role in green law. On one hand, designers can be very creative in developing new ideas about construction and materials that support sustainability goals. Successful small-scale experiments can become incorporated into code, then implemented throughout a community. Yet, not all site developers are as innovative as others. Much local green law has been written to encourage designers (architects, landscape architects and engineers) to achieve specific site planning and environmental goals that a community deems to be important. It is a combination of good design and legal documents (ranging from local master plans and zoning ordinances to federal regulations) that empower communities to become the places where people choose to live. While design is an important part of the code evolution process, this document will focus on the legal aspects of community design.

REPORT PURPOSE AND CONTENT

Unlike code about structural buildings or transportation, there is no national, standardized green law. Thus, some communities have made modest green law efforts, while others have developed quite innovative and comprehensive codes and ordinances. This variation reflects community differences in local climatic and natural conditions, local urban growth dynamics, and political acceptability of green law.

This report is a collection and analysis of code about one dynamic of sustainability – how trees and the urban forest can mitigate parking area impacts. The report has several goals:

- provide an overview of current scientific knowledge regarding trees and parking areas,
- consider the purpose of code and law given the best available scientific information,
- trace the history of urban green law regarding parking areas, including a summary of traditional code approaches,
- present the latest legal innovations that reduce and mitigate parking area impacts in cities.

Following this introduction, Chapter 2 provides an overview of current scientific information about paving, trees and urban environment effects. Chapter 3 provides an overview of urban forest policy and code purposes. A review of tree and parking code traditions is found in Chapter 4, and the next chapter presents emerging new practices and law. Chapter 6 considers some secondary components of ordinances, and describes best practices associated with creating and enforcing tree and parking area laws. Finally, appendices provide additional information sources and links to code examples.

PROJECT APPROACH

This report is a synthesis of legal requirements for trees and parking in the United States. It is not an exhaustive catalog of municipal code, but uses examples of green law to illustrate the array of traditional and emerging legal tools that can be used to improve environmental quality in and around parking areas.

Some code examples are provided as verbatim excerpts from municipal sources (*indicated by italics throughout the report*). Other examples are described in summary form. Most of the source text for municipal code is now available on-line. Generally, from within a city's web site, one follows links to the planning or community development departments. Additional links to the Zoning, Subdivision or Development code of ordinances will produce both parking and landscape regulations.

This initial review of parking lot code includes materials provided by the USDA Forest Service, Abbey (1998), Robinette (1992, 1993) and the International Society of Arboriculture (ISA 2003). The report has focused on cities of the southeastern United States, but also considers innovative code from throughout the entire country.

An image collection was also prepared, and will be used for follow-up research. Scientists at the Center for Urban Forest Research have studied the environmental consequences of the urban forest and paved areas. Canopy cover calculations (from aerial photographs) have been completed for parking areas in Davis and Sacramento, California. Photographs of these sites are an accurate representation of varied tree-to-pavement conditions and canopy cover ratios, and are used to illustrate some code examples.

2. PARKING AREAS, TREES & THE URBAN ENVIRONMENT

The greatest single impact of urbanization is the increase in the amount of impervious surface. Developed landscapes are covered with paving, buildings and other land treatments that alter the interaction of air, water, sunlight and living things with the land. In recognition of this problem, many cities are exploring new approaches to reducing impervious cover in new and existing urban areas.

The ubiquitous automobile, an expression of American independence and mobility, is at the center of environmental problems associated with urbanization. Aside from the other environmental consequences of the production and use of automobiles, roads and parking areas for vehicles pose a distinct set of concerns. In recent decades, scientific understanding of the effects of vehicular use areas in human environments has grown dramatically. Additional studies have begun to explore solutions and mitigations.

This chapter contains an overview of data about the impact of paved areas in cities. Some of the data will address all urban impervious surfaces, including roads and roofs. Vast land areas are needed to store cars when they are not in use at the places where people live, work, shop and learn. When possible, the research summaries will focus on data about the impacts of paved areas used to store cars.

URBAN LAND COVER AND FORESTS

Roofing and pavement generally cover large percentages of land in urban and highly developed suburban areas. Not surprisingly, as cities grow and expand their land base, the natural tree and vegetation cover is replaced by urban infrastructure. For instance, in the period from 1973 to 1997 Atlanta has expanded into its surrounding forested land, replacing about 65 percent of this forest with roads and buildings. As a result, average summer temperatures in Atlanta's urban area were elevated by about 6°F between 1970 and 1990 (American Forests 2001).

Healthy trees and vegetation generate many benefits. Environmental benefits include lower energy use, reduced air pollution and greenhouse gas reductions, decreased stormwater runoff and improved ecosystems. Community benefits, reported in scientific studies, are increased property values, improved mental health and functioning, and better quality of life for residents.

	Cities East of the Mississippi River and in the Pacific Northwest	Cities in the Southwest and Dry West
Suburban residential	50%	35%
Urban residential	25%	18%
Central business district	15%	9%
Overall	40%	25%

Recommended urban/suburban tree cover – American Forests

There is room for more vegetation and its potential benefits in all cities. American Forests (2002b), a nonprofit forest conservation organization, has prepared tree cover recommendations for urban land uses. It is estimated that planting approximately 634 million more trees in U.S. cities, or about 3 trees for each urban inhabitant, could bring significant benefits to urban areas.

Some cities, such as Chicago, have conducted Available Growing Space (AGS) analyses. The studies show that trees can potentially be planted in residential yards, highway rights-of-way, and on commercial, industrial and institutional lands. Plantings directly associated with paved and impervious surfaces can reduce environmental and human health impacts.

HEAT ISLAND EFFECTS

Scientists have long observed that urban and suburban areas have hotter air and surface temperatures than their rural surroundings. Studies of this heat island effect in the U.S. began in the early 1900s; the phenomenon has been detected in cities throughout the world. Continued expansion and development of urban and suburban areas is leading to more intense heat islands that affect larger areas.

Unshaded parking areas generate high near-ground temperatures

The hottest near-ground temperatures are generally found in areas with the least vegetation and the greatest urban development. Air in the canopy layer (below the tops of trees and buildings) can be as much as 10°F warmer than air in rural areas. Air in the boundary layer (from rooftop level extending up to about 6,500 feet above the earth's surface) also becomes warmer, and can cause temperature inversions that trap warm surface air. Summer inversions can increase human health problems and escalate energy bills.

Paving and High Temperatures

Paved surfaces contribute to heat islands in two ways. The first is through excessive accumulation of heat. Dark materials and the enclosed canyons created by city buildings trap more of the sun's energy. The reflection rate of paving compared to natural surfaces is important as higher reflectance means cooler temperatures. Black pavements, the hottest, have solar reflectances of 5 to 10 percent. Lighter pavements have solar reflectance rates of 25 percent or higher. Reflectance values for soils and various types of vegetation range from 5 to 45 percent.

The second cause of heat islands is the low moisture content of paving and building materials. Such materials are watertight, so no moisture is available to dissipate the sun's heat through evaporation.

In the peak of the summer season in warm climate areas, daytime temperatures of unshaded asphalt surfaces can reach as high as 160°F. In addition, paving materials act as thermal batteries, accumulating heat during the day and releasing it at night. As a result, there is daily fluctuation in temperatures ranging from 80˚F at night to highs at noon. Vegetated surfaces with moist soil typically reach daytime temperatures of 70°F, and the daily range is less extreme. Shading paved surfaces with well-irrigated plants can keep peak surface temperatures below 100°F.

The on-site effects of paving and heat are numerous. At high parking lot temperatures, paint, plastics and rubber deteriorate, and the value of automobiles depreciates accordingly. In summer, objects in cars are often damaged or destroyed. From time to time drivers underestimate the heat, leaving pets and children to suffer. The functional life of asphalt is shortened, as it thermally decomposes in repeated sessions of high heat, becoming friable and brittle.

Trees reduce such on-site heat buildup. NASA (2003) used an airborne scanner to collect data at the Madison Square Mall in Huntsville, Alabama in 1994. A spot check of daytime temperatures around the Mall found that in the middle of the parking lot, surface temperatures reach about 120°F. However, a tree island, a small planter containing a couple of trees, in the parking lot read at only 89°F. Even a small area of tree shade surrounded by a very hot parking lot reduced temperatures by 31°F!

Hotter Cities

The cumulative effect of acres of paved parking across a cityscape is detectable. During daylight hours paving surface temperatures rise. Hot pavement transfers heat to the air that flows over it – the hotter the pavement, the hotter the air will become. This heat exchange continues after sundown and heat island effects can be greatest at night, as urban surfaces continue to give off heat and slow the rate of nighttime cooling. Meanwhile, rural areas cool off quickly after sunset.

Vegetation Condition	Compared to:	Air temperatures
Tree groves	Open terrain	9°F cooler
Irrigated agricultural fields	Bare ground	6° cooler
Suburb with trees	New suburb, no trees	4 to 6° cooler
Grass sport field	Parking lot	2 to 4° cooler

Vegetation cooling effects (from Maco & McPherson 2003, McPherson 1998)

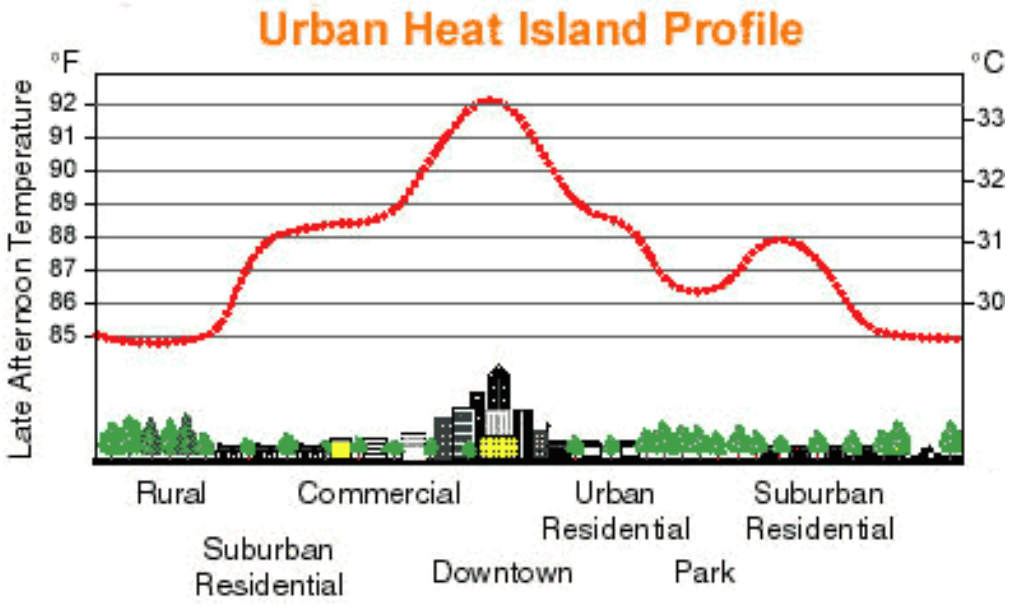
Because of heat-absorbing surfaces, parking lots can elevate air temperatures in sections of a city by as much as 20° to 40° F (NASA 2003). Conversely, trees, grass and other vegetation tend to stay cool in the summer sun, remaining at or below air temperature, and are less likely to elevate air temperatures.

One consequence of unshaded paving is that energy costs associated with air conditioning of adjacent buildings can be higher. Electricity demand in cities during periods of warm temperatures can push supply systems to, and even beyond, their capacity.

The heat island effect is also detected at higher altitudes, as thermal inversions (warm air over cool air). The natural air cycle starts with the sun heating air at the earth's surface. Warm air expands, becomes lighter and rises to higher altitudes, where it would normally cool. During clear, calm weather conditions, urban air is superheated at the surface, rises, but does not cool completely. This inversion will trap warm air and pollution near the ground. Unusually high temperatures and poor air quality can impact urbanites health.

The absorption and retention, then emittance of heat by urban materials can produce a dome of elevated air temperatures 5° to 15°F greater over the city, compared to adjacent rural areas (Brazel et al. 2000). Heat island effects have been detected in cities as small as 1,000 population.

Tree canopy cover reduces urban heat island effects (Akbari et al. 1992, Asaeda et al. 1996). Tree planting is one of the most cost-effective means of mitigating urban heat islands. Vegetation canopies can cool paving by direct shading of the ground surface. They also cool parking areas indirectly through transpiration of water through leaves (Oke 1987). Exposed soils also help through evaporation of water. Approximately 1°F of temperature reduction is associated with each additional 10 percent of tree canopy cover (Simpson, et al. 1994).



from EPA Heat Island Reduction Initiative

CLIMATE CHANGE

It is disputed whether climate change is the result of human activity or the natural long-term cycles of the earth. Nonetheless, the impacts on the atmosphere from human activity and resulting byproducts have increased dramatically in recent decades. Trees can buffer such effects.

Carbon Dioxide Reduction

Carbon dioxide is a greenhouse gas, thought to contribute to global climate change. It is released in any process where fossil and organic fuels are burned or combusted. CO_2 is a component of the emissions of industrial factories and power-generating plants, and is released as automobile exhaust. Both reduction of emissions and sequestration are proposed solutions to carbon dioxide build-up.

All plants take in carbon dioxide (CO_2) from the atmosphere during the process of photosynthesis. Oxygen is emitted back to the air, some carbon dioxide is released during respiration, and carbon is stored in new growth of a plant. Sequestration is the term for removal of carbon and its long-term storage.

A number of scientific studies suggest that urban trees can store significant amounts of carbon. A study of urban trees of central California cities found that annual sequestration rates ranged from 35 pounds of CO_2 for smaller, slower-growing trees, to 800 pounds for larger trees that were growing at their maximum rate (McPherson et al. 1999). The total amount of carbon stored in mature trees can be 1,000 times more than that stored in small, young trees.

Nonetheless, there is some disagreement about the net carbon sequestration of urban forests. The carbon budget is the calculation of all carbon sources and movement. Trees emit CO_2 and when they die their stored carbon is released back into the atmosphere when burnt or decomposing. Net carbon benefits depend on tree choices and local growing conditions.

Trees can also help reduce CO_2 emissions from power plants (McPherson 1998). Strategic tree planting near buildings can reduce energy needs for heating and cooling, resulting in lower overall energy demand from electricity providers.

Land-Use and Climate

Recently, atmospheric scientists have proposed that land-use changes are having at least as much, and perhaps an even greater, impact on climate change than CO_2. The scientifically controversial idea is that urbanization, agriculture and other human changes to U.S. landscapes account for more than 40 percent of the temperature rise over the past 40 years (Kalnay & Cai 2003).

As the scientific debate heats up complex studies will test this new outlook on large-scale temperature change. It is likely that surface temperature dynamics, now considered to be localized urban heat island effects, will be seen as a pervasive result of any landscape deforestation. While the extent of such change is uncertain, increased tree planting will probably be recommended as a solution.

AIR QUALITY

Various compounds and are the byproducts of urbanites' everyday activities. Some of these outputs, such as vehicle exhaust and the emissions from power plants, undergo chemical changes, and the processes can be influenced by air temperature. This section presents information on ozone and particulate pollutants, and how trees in cities can reduce their negative effects.

Ozone Mitigation

Ground-level ozone is "bad ozone" and occurs in the troposphere, the atmospheric layer that extends from the ground to about 6 miles in altitude, where it meets the stratosphere. "Good" ozone is found upward from about 6 to 30 miles, and protects living things on the Earth's surface from the sun's harmful ultraviolet rays. A helpful reminder about the two forms of ozone is, "bad nearby, good up high."

Bad ozone is created by chemical reactions between nitrogen oxides (NOx) and reactive organic gases (VOCs) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors and chemical solvents are all major sources of NOx and VOCs.

The effects of bad ozone on human health are extensive. Elevated levels of ozone in the air reduce lung function, particularly for people with asthma, bronchitis or

other lung disorders. It increases sensitivity to allergens, irritates the eyes and provokes dizziness and nausea (EPA 2003)

The strong sunlight and hot weather drive the creation of high concentrations of ozone, a main ingredient of urban smog. Reduction in urban air temperatures, and reduced emissions, are actions adopted by communities to reduce smog.

Trees can reduce surface temperatures by reducing the amount of solar radiation that is transmitted to dark paving surfaces. The amount of radiation transmitted through a tree canopy varies by type of tree, but ranges are 6 to 30 percent in the summer and 10 to 80 percent in the winter. Trees in Davis, California parking lots reduce surface asphalt temperatures by as much as 36°F, vehicle cabin temperatures by over 47°F and fuel tank temperatures by nearly 7°F (Litman 2002).

Automobiles are major sources of VOCs. While most vehicle emissions are in the form of tailpipe exhaust, it is estimated that approximately 16 percent are in the form of evaporative emissions when vehicles are not operating. Thus idle vehicle emissions may be more severe in locations where vehicles are concentrated, and where temperatures are high. The cooler the car, the lower the rate of gasoline evaporation from leaky fuel tanks and worn hoses. Trees cool air temperatures in parking lots, reducing ozone-forming hydrocarbons that are emitted by cars (Scott et al. 1999).

Studies in Sacramento, California suggest that 50 percent shading of paved areas would reduce hydrocarbon emissions city-wide 1to 2 percent, equivalent to about 0.84 metric tons per day. While this effect seems modest, these reductions are equivalent to agency emission reductions goals for non-transportation air quality improvement (such as waste burning and vehicle scrap practices) (McPherson 2001).

Pollutant Removal

Dry deposition refers to the removal of pollutants from the air, as trees absorb gases or particles become attached to leaves. This process takes place without the aid of precipitation. Removed pollutants can include nitrogen oxides, sulfur oxides, particulates (smaller than 10 microns in diameter) and ground-level ozone.

The level of atmospheric filtration varies based on climate, the types of trees present, in addition to tree age and growth rate trends. For instance, studies of Houston and Atlanta, two cities having similar canopy cover rates, found that annual removal of particulates by trees was 4.7 tons per square mile for the first and 3.2 tons per square mile for the latter. Generally, areas with the most large trees have higher rates of pollutant removal (American Forests 2000, 2001).

STORMWATER RUNOFF

The urban heat island effect can modify rainfall patterns. Mobile, Alabama is one example (Taylor, 1999). The city has expanded rapidly since the 1980s, replacing forests with impervious surfaces. The resulting heat island appears to intensify daily summer downpours. Sea breezes are laden with moisture and are the source of daily rainfall in the summer. Northeast Mobile has a concentration of mall parking and local annual rainfall can be 10 to 12 inches more than less paved areas. Consequently, nearby croplands receive less rain.

The second hydrological impact of parking lots is modification of surface water quality and quantity. Once paved, the ground is no longer able to absorb rainfall. A man-made surface will generate 2 to 6 times more runoff than a natural surface (USGS 2003). Stormwater drainage systems are built at considerable expense to handle peak flows of water over impervious surfaces. Adverse effects of increased runoff include increased flooding, erosion, sedimentation, water pollution, stream channel instability and loss of both in-stream and streamside habitat. A serious problem in some cities is overflow when sewage treatment facilities cannot accommodate peak stormwater runoff.

On individual properties, parking spaces associated with urban land uses significantly expand the impervious surface footprint associated with buildings. Acres and acres of such impervious surfaces cause stormwater management difficulties in many communities.

Trees can be used to reduce stormwater runoff. Trees intercept a significant amount of rainfall in their canopies, where it evaporates and does not contact the ground. Urban forest rain interception was studied (Xiao et al. 1998) in Sacramento, California. The utility department requires that the first 19 millimeters of runoff be retained on site for flood control and water-quality protection. A combination of vegetation and on-site infiltration basins proved to be an effective approach to reduce off-site transport of water. Approximately 50 percent of annual rainfall would be treated at reasonable cost ($ 0.83/m^3 of runoff).

In addition, if parking lots are made smaller to accommodate more trees, the reduced amount of impervious surface collects less water. Both conditions – reduction in impervious surface area and an increase in the area having vegetation – result in less polluted runoff being conveyed into engineered stormwater facilities. Parking lot runoff has relatively high concentrations of trace metals, oil and grease that adversely affect water quality in rivers and streams. Increasing the amount of vegetation results in an increase in canopy area and ground space for collecting and biologically treating urban stormwater.

TREES AND SOCIAL BENEFITS

Recent studies in urban environmental science report undeniable evidence that trees in cities improve the environment in many ways. Urban sustainability is a

blend of conditions of the physical environment and the well-being of the people who inhabit those environments. Another field of research, the investigations of the social benefits of trees, provide additional compelling data.

Social science research has helped us understand that visual contact with trees and greenery helps patients recover in hospitals more quickly, improves office worker productivity and job satisfaction, can have a positive effect in domestic violence situations, enhances creativity in children's play, and helps create a sense of community when people come together for greening projects.

Some social science findings are particularly relevant to business settings. High-quality landscaping is associated with higher residential land values (Anderson & Cordell 1988) and commercial building rental rates (LaVerne & Winson-Geideman 2003). A series of studies about nature and central business districts reports that a high-quality urban forest is associated with consumer reports of more frequent visits, greater length of visits, and willingness-to-pay more for products (Wolf 2003). Good landscaping and big trees extend a message of care and quality from merchants to their potential customers on the sidewalk.

BENEFITS ECONOMICS – THE SYNERGIES OF TREES

The environmental benefits of having trees in parking areas include reduced vehicle emissions, filtration of air pollutants, improved urban stormwater runoff management and mitigation of urban heat islands. Other benefits include potential prolonged pavement life due to shading, and reduced human exposure to ultraviolet radiation due to canopy interception. (Scott et al. 1999). When viewed parking space by parking space, or lot by lot, the benefits may seem modest. But cumulative benefits for an entire community or city are substantial.

The amenities of trees are perhaps less tangible, but are no less important to the quality of life of a community, and the well-being of each community resident.

At the landscape scale, the collective impacts of treeless paving generate significant costs. For instance, the engineered systems needed to meet regulations for air and water quality are expensive. Constructing infrastructure to collect and direct stormwater is costly. And scientists are just beginning to understand the medical costs to a community if citizens need treatment for respiratory and heat related ailments.

Several tools are available to assess urban forest costs and benefits. The Center for Urban Forest Research (CUFR 2003) has prepared a series of Tree Guide reports that analyze the benefits and costs of trees in western United States regions, and describe strategies for cost-effective tree planting and management.

Urban Forest Benefits Analysis Tools:

Urban Ecosystem Analysis, CITYgreen: http://www.americanforests.org/resources/rea

CUFR: http://cufr.ucdavis.edu/guides.asp?Action=search&SearchArea=products&ProductTypes=20

UFORE: http://www.fs.fed.us/ne/syracuse/Tools/UFORE.htm/

American Forests has conducted Urban Ecosystem Analyses, translating urban canopy cover comparisons to economic terms using CITYgreen software. A third tool, Urban Forest Effects (UFORE), developed by the USDA Forest Service, is software designed to model and quantify urban forest structure, air quality and community impacts.

Although the benefits of tree planting will vary by geographic region, these analytic tools conclude that trees generate substantial economic benefits. Having more trees in urban parking areas can expand such benefits.

Estimating the market value of a harvestable forest is a straightforward task. The "public goods" described here are less tangible, and not readily bought and sold on markets. Yet with each new study the economic implications of acres of impervious paving, combined with the absence of trees, are becoming obvious. Many strategies can be used to enhance environmental and community benefits, including incentives and voluntary projects. The rest of this report summarizes the legal tools that local communities can use to complement other approaches.

3. POLICY AND LAW

Scientific evidence justifies the adoption of comprehensive, well-constructed green law in a community. Admittedly, some individual property owners and developers may incur additional costs to meet green law requirements. Nonetheless, the latest evidence shows that there are dollar savings for those cities that pursue environmental benefits. Such public goods are a compelling argument to support green improvements, including trees in parking areas.

Policy is a mission statement of government, providing focus for a program of law and action to meet specific goals and objectives. Too often, local government staff will borrow snippets of code of other communities, only to find that there is no local consensus about how to adapt and apply the legal tools.

A definition of terms is helpful. In this document policy refers to the larger scope of intentions of a community and what it would like to achieve. Local law is created to address particular problems or issues associated with policy. Finally, standards provide regulatory benchmarks and clarify how the law will look on the ground. All of these elements are integrated and will probably change over time. For instance, agreement on policy may launch new green law, then the policy may be revised as the legal and landscape outcomes are reviewed.

Code and ordinance requirements are products of a community's desire to legislate, regulate and control minimum standards of landscape quality. Passage of new law is a political process that relies on a groundswell of local public will.

Developing policy statements about the need for trees and their benefits is the first step in authoring code for parking lots. Policy sets the stage for urban natural systems and vegetation to co-exist with built environments, creating more healthy, sustainable human environments.

TIME AND CHANGE

Code purpose and content has emerged and evolved in recent decades. Concerns about the effects of rapid urban development and its impacts on nature were first expressed in the 1950s. Pictures of the earth from space in the 1960s and 1970s enabled people to visualize the entire planet and begin to comprehend the interconnection of natural and built systems. This global view, combined with growing awareness of declining local environmental quality, induced communities to enact green law. Once committed to a policy of urban greening, code was written to address specific land uses and situations.

The purpose of early green law was improvement of the appearance of the town or city by shading, screening and softening of built elements. An early landscape

beautification movement promoted the visual benefits of vegetation and trees. As planners grappled with rapid urbanization in the post World War II era, plants (usually in rows) were regarded as the solution to screen unsightly views of mall parking lots containing hundreds of cars, trash receptacles and storage areas, industrial land uses and loading docks.

Green law varies widely in its content and approach, as documented in exhaustive books by Robinette (1993, 1992) and Abbey (1998). While professed environmental concerns motivated local green ordinances, in many instances the required planting was merely "parsley around the pig." Trees were used to cosmetically camouflage the greater damages being done to complex ecological systems (Robinette 1992).

Early, simplistic ordinances served as the first important steps toward green law, politically paving the way for later code review and revisions that contained more substantive remedies to environmental decline.

The earliest ordinances were usually passed in localities that had an environmentally sensitive constituency. Often drafted and promoted by concerned citizens, these ordinances reflected a desire to bring their communities into ecological balance. Later attempts have been implemented in a wide range of towns and cities of varying size, location and diversity.

While early efforts at green law focused on the amenity value of plants in the urban setting, many ordinances alluded to environmental benefits. Increasing concern in the late 1970s and 1980s about the quality of the environment prompted more serious study of urban ecological processes. In the past two decades urban forest and urban ecology research has provided information that broadens the purposes of green law, to include:

- specify design and installation practices that generate environmental benefits,
- create planting settings that are more suited to vegetation conservation and growth,
- specify performance standards that can be monitored over time, such as on-site vegetation densities or stormwater runoff quantities,
- consider vegetation on a single building site within the context of local and regional resource systems (such as a watershed).

PURPOSE STATEMENTS

The first, and perhaps most important, section of a green ordinance is the purpose statement. Well-written statements of purpose make the implicit values and of the community explicit and thus open to discussion. When articulated purpose statements can generate the political support needed for new legislation. The statement establishes the authority of local lawmakers to create new law. And it clarifies the goals that guide both current and future lawmaking.

The purpose statement is a statement of values that often includes (Mason 2002):

- broad references to benefits,
- list of community attributes that are served by the code,
- a philosophical perspective,
- language that sets the tone of the law.

Some purpose statements are expressed in basic, general terms while others are very specific and acknowledge local conditions. Many refer to the basic tenets of local government and planning and zoning departments, "the protection of human health, welfare and safety."

THE PAST – VISUAL ISSUES

Hundreds of cities have crafted purpose statements for green law. While some acknowledge specific regional conditions or needs, most address the general issues of urban landscapes and human welfare that are shared by many cities.

Many purpose statements refer to the amenity and beautification concerns that were the historic foundation of green law. Below are examples of how communities have addressed the value of vegetation to reduce annoyances among adjacent land uses:

> ***New Castle County, Delaware; Subdivision Ordinance***
>
> *(1) In general, it is County policy that adequate landscaping shall be provided to reduce intrusion into residential areas by glare, dust, noise and vibration caused by railroads, highways and industrial or commercial land uses, and to enhance the environmental and aesthetic value of all development in the County. When not provided by existing natural vegetation and earth-forms, such effects may be achieved by live planting or by grading, such as earthen berms, or by a combination of both.*

> ***City of Vero Beach, Florida; Office of Planning***
>
> *PURPOSE: The purpose of this ordinance is to improve the appearance of certain set-back and side yard areas, and including off-street vehicular parking and open lot sales and service areas, and to protect and preserve the appearance, character, and value of the surrounding neighborhoods, and thereby promote the general welfare by providing for installation and maintenance of landscaping and screening and aesthetic qualities. In this regard, this ordinance shall be considered a minimum standard and shall apply to all lands situated in the corporate limits of the City of Vero Beach.*

Beautification and Visual Quality	Mitigation of Annoyances
• *Improve the appearance of commercial, industrial, and residential areas and to perpetuate Orlando's image as "The City Beautiful"* • *To provide visual buffering and enhance the beautification of the City* • *Establish and enhance a pleasant visual character which recognizes aesthetics and safety issues* • *Enhance the overall appearance of a development* • *To complement the color, texture, scale and building materials used in a development*	• *Break the visual blight created by large expanses of vehicular surface areas* • *Filter and reduce the glare of headlight and reflected sunlight from parked automobiles onto the public street rights-of-way* • *Separate the public from the ill effects of fumes and dust* • *Create a transitional interface between uncomplimentary and incompatible land uses providing buffering and screening* • *To screen incompatible land uses* • *Promote compatibility between land uses by reducing the visual, noise, and lighting impacts of specific development on users of the site and abutting uses*
Property Value and Welfare	**Regional Character and Identity**
• *Create an aesthetically pleasing and functional living environment to protect and enhance property values by conserving trees and other vegetation and by requiring the planting of trees and other vegetation* • *Increase land values by providing landscaping as a capital asset* • *To protect and enhance property values* • *To safeguard and enhance property values and to protect public and private investment* • *To protect public health, safety, and general welfare through the reduction of noise, air, and visual pollution, light glare, and moderate air temperature* • *Mitigate for loss of natural resources values* • *Unify development, and enhance and define public and private spaces*	• *Maximize the retention of trees, a valuable natural resource of the community* • *Protect environmentally sensitive areas from activities which would alter their ecological integrity, balance or character* • *Conserve water by preserving existing native plants which are adapted to Central Florida seasonal precipitation rates, encouraging the use of plant materials specifically suited to the growing conditions of a particular location* • *To encourage the preservation of existing trees and desirable vegetation* • *To preserve, protect, and restore the unique identity and environment of the City of Virginia Beach and preserve the economic base attracted to the City by such factors* • *Restore natural communities through re-establishment of native plants*

Table 1: Purpose Statement Themes

Ecological Benefits	Ecological Functions or Services
• *Provide shade, noise attenuation, filtering the air of particulate and gaseous pollutants and other beneficial environmental effects to the microclimate* • *Aid in water conservation and water quality protection by requiring the use of native plant material in landscaping and the retention of existing natural vegetation, thereby reducing the need for irrigation, pesticides, herbicides and fertilizers* • *Improve environmental quality through the retention and installation of vegetation, including improved air and water quality through the removal of carbon dioxide and the generation of oxygen, facilitation of aquifer recharge and reduction of storm water runoff, decrease air and noise pollution, prevent soil erosion and sedimentation, mitigate heat and glare through shade and evapotranspiration.* • *To aid in stabilizing the environment's ecological balance by contributing to the processes of air purification, oxygen regeneration, groundwater recharge, and stormwater runoff retardation*	• *Modify the rate of stormwater runoff and increase the capability of groundwater recharge in urbanizing areas* • *Promote soil conservation by maintaining and controlling alterations of the natural terrain, and thereby reduce sedimentation and air and surface water pollution resulting from soil erosion* • *Minimize flooding by controlling filling activities and changes in drainage patterns* • *Promote energy conservation by maximizing the cooling and shading effects of trees* • *Aid in energy conservation by providing shade from the sun and shelter from the wind* • *To filter pollutants from the air and assist in the generation of oxygen*

Table 2: Purpose Statement Themes (continued)

EXPANDED PURPOSE STATEMENTS

The most far-reaching justification for good green law is environmental quality and sustainability. Recent scientific findings provide the evidence that concerned citizens and decision-makers need to act on their long-standing intuitions that plants in cities provide many functions and services. Consequently, in recent years the scope of purpose statements has expanded to acknowledge more extensive community needs and landscapes.

The format of purpose statements is typically a list of succinct phrases about conditions and benefits. The topics of the phrases can be generally categorized along several themes. Tables 1 and 2 contain verbatim examples from a variety of municipalities, but are rearranged by category.

A. Beautification and Visual Quality

One theme captures the origins of green law in many communities – concerns about beautification and other amenity values. A nice appearance is assumed to

correlate to the well-being of citizens, and the appeal of the community to both current and potential occupants.

B. Mitigation of Annoyances

This purpose reflects the historic land use and zoning trends of the United States. In the industrial growth era of the nation's history there was great concern about the community welfare impacts of industrial land uses on adjacent commercial and residential areas. Land uses were zoned and separated by function. Planting zones were seen as one technique to buffer or contain the effects of one land use on another. While direct harms of nearby land uses were not as great a public issue during urban expansion of the 1950s and 1960s, plants and landscaping continued to be regarded as suitable materials for screening views of cars or commercial use areas.

C. Property Value and Welfare

Government policy and regulation should serve diverse interests within a community. Many purpose statements imply that trees and landscape sustain market values of properties, appealing to business constituencies. This sentiment has been scientifically verified, for multiple studies of residential properties suggest that market values of homes with significant trees typically have market prices 3 to 7 percent greater than non-vegetated equivalent parcels.

D. Regional Character and Identity

Some statements acknowledge that ornamental landscapes can reflect local topography, climate and biological conditions. Such statements typically connect unique landscape features to a sense of community identity. Or they may establish that a distinctive landscape is a valuable asset to the community's commercial enterprises and economic vitality. Often such statements are followed by code that specifically conserves key green spaces or species that are identified as the markers of a singular landscape.

E. Ecological Benefits

Whether planted on public or private property, trees in cities generate many public goods. Benefits extend beyond the boundaries of single parcels, improving the well-being and welfare of people throughout the community. Such purpose statements reference current science about the potential of trees to mitigate citywide environmental concerns.

F. Ecological Functions or Services

Governments provide infrastructure systems in cities, such as transportation and utilities. The most recent environmental economics literature has concluded that nature can provide "green infrastructure" services that are comparable to those of "gray infrastructure." At one time concrete and steel were inexpensive options; now analysis suggests that working with nature is more cost effective, as

restoration of natural systems may be less expensive than the construction and maintenance costs of structural systems. Green infrastructure is becoming economically viable. For instance, some communities require on-site stormwater processing using a combination of engineered structures and natural materials, thereby saving money and improving the environment.

The City of Raleigh provides one example of how these diverse community values are combined in a purpose statement:

> ***Raleigh, North Carolina***
> ***Code of General Ordinances, Chapter 2: Zoning***
> ***Section 10-2082.6. Vehicular Surface Area Landscape Regulations***
>
> *(a) Intent, Purposes and Application.*
>
> *(1) It is the intent of this section to modify and reduce the deleterious visual, environmental, and aesthetic effects of existing and proposed vehicular surface areas. The landscape requirements herein have been developed to:*
>
> *a. filter and reduce the glare of headlight and reflected sunlight from parked automobiles onto the public street rights-of-way and;*
>
> *b. separate the public from the ill effects of fumes and dust and;*
>
> *c. visually modify the appearance of parking areas and vehicular surface areas, to encourage the construction of such necessary areas in a manner that more closely follows the existing natural contours of the land and;*
>
> *d. distribute planting areas around and within the parking area and;*
>
> *e. modify the rate of stormwater runoff and increase the capability of groundwater recharge in urbanizing areas and;*
>
> *f. provide shade, noise attenuation, filtering the air of particulate and gaseous pollutants and other beneficial environmental effects to the microclimate and;*
>
> *g. prevent the overcrowding of land and;*
>
> *h. break the visual blight created by large expanses of vehicular surface areas.*

Appendix A contains more examples of purpose statements from cities that have combined multiple themes to justify a comprehensive approach to green law. Multi-theme purpose statements generate a legal foundation for conserving existing vegetation, increasing plantings within new development and promoting urban sustainability.

This chapter has provided an overview of purpose statements. The next two chapters provide details about the specific legal approaches and language that can be used to increase the amount of vegetation associated with paved parking areas.

4. CODE TRADITIONS

A major complaint about parking areas is their poor appearance – their tendency to be big, hot, open expanses that have little spatial relationship to other activities or buildings around them. The size and scale of parking lots causes them to break the functional and visual links between buildings and can damage the continuity of community streets.

Aesthetic concerns were the earliest inspirations for code about vegetation and parking areas. Reactions to parking eyesores generated initial political support for parking landscape law. Regulations were needed because, in many cases, proposed landscaping was deleted from development plans due to construction cost overruns or lack of city oversight. When plants were installed they were often of questionable quality, or located and awkwardly and arbitrarily in a site.

This chapter provides an overview of parking lot code that emerged to address visual issues (and other contiguous properties concerns). The parking lot landscape code of many communities is meager, sometimes requiring only a strip of sod and a few small trees around the perimeter of a lot.

Other cities have drafted broader regulations that address aesthetically oriented vegetation requirements, probably also generating environmental improvements. Some of these examples may be a good starting point for communities that seek to start a process of code development, but may not yet have political backing for more stringent code that primarily addresses environmental purposes.

The sample code is sorted and presented as themes and categories of standards. The actual wording of landscape and tree code varies widely from place to place, and rarely is organized in the way you will find here. This document is intended to help code authors choose the basic elements of what their local code might contain. Examples of local code in Appendix B demonstrate how the elements are assembled into ordinances.

BUFFERING, SCREENING & PERIMETER PLANTING

Physical screening of unsightly parking expanses, those seas of cars and their associated annoyances, is the most prevalent vegetation requirement in municipal code. The following two topics, interior landscape and vegetation quantity, are additional strategies for reducing visual impacts of vehicular use areas.

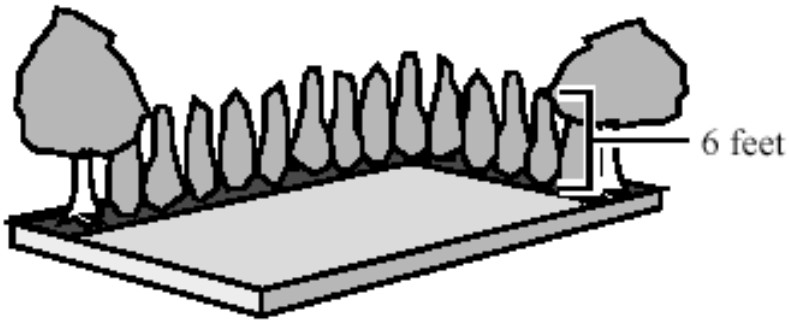
Physical screens and buffer zones are deemed especially necessary on lot lines:

- where commercial or industrial uses abut residential land uses
- around open storage areas and loading docks
- on parking area perimeters

- near on-grade and above-grade electrical or mechanical equipment such as heat pumps and transformers, and
- surrounding garbage pick-up or dumpster storage bays

The Orlando landscape ordinance describes the purposes of screens and bufferyards:

> ***City of Orlando, Florida***
> ***Chapter 60 - Subdivision and Landscaping Ordinance***
> ***Part 2: Landscaping and Vegetation Protection***
>
> ***2F. Bufferyards, Section 60.260. Purpose of Bufferyards***
>
> *. . . are intended to separate different land uses from each other and . . . to eliminate or minimize potential nuisances such as dirt, litter, noise, glare of lights, signs and unsightly buildings or parking areas, or to provide spacing to reduce adverse impact of noise, odor, or danger from fires or explosions. Plantings provided in connection with bufferyards also assist in reducing air pollution hazards.*
>
> *Both the amount of land and the type and amount of planting specified . . . are designed to reduce nuisances between adjacent land uses or between a land use and a public road.*



Vegetation screen of parking lot using trees and hedges

Screening is usually accomplished using vegetation, earthen mounds (known as berms), wood or masonry walls, or any combination thereof. Vegetation strategies include prescribed planting strip widths, evergreen plantings and densely planted hedges (Figure 3). Code may also include standards for the height, width, type and density of materials. Required opacity of vegetative screens may be a standard.

Some code distinguishes between street frontage landscaping and other perimeter area landscaping, acknowledging community expectations of public appearance. It is more common to require screens along the street edge than other perimeter areas, except perhaps when an adjacent lot is zoned for residential use.

Screening regulations reflects historic zoning practices and presence of heavy industry. Certain commercial and industrial land uses were hazardous or unsightly and plants were introduced to mitigate adverse impacts.

Contemporary urban planning concepts and practices (such as New Urbanism) seek to mix zoning types in multi-functional urban villages where residents can gain access to commercial areas as pedestrians or by using transit.

In this emerging mixed-use urban environment, screening code is less relevant than other vegetation purposes. In addition, a concentration of vegetation around the edge of a property boundary may not generate many environmental services or benefits, as little paved surface is shaded.

Perimeter plantings can screen views of the paved area, but may not provide much parking lot shading

INTERIOR LANDSCAPE

Many local landscape ordinances include requirements for landscape development internal to parking lots. Often requirements for internal plantings were intended more for traffic routing and guidance than landscape benefits.

Standards for interior landscaping usually includes some combination of the following six options. For instance, one community might specify that planting area be calculated based on the number of parking spaces (B), while another might specify the percentage of the lot area that should be planted (C).

A. Minimum Size of Parking Lot to Which Regulations Apply

Most communities specify 20 parking spaces or more as a trigger for landscape improvement requirements. But a number of communities require landscaping in smaller lots: Colorado Springs, Colorado if 15 or more spaces; Salisbury, North Carolina if 12 spaces; Virginia Beach, VA if 10 spaces.

Portland, Oregon requires that interior landscaping must be provided for all sites having more than 3,000 square feet of parking and loading areas, and at least 10 percent of all such areas must be landscaped.

Ratio of one tree per twenty parking spaces

B. Planting Area Per Parking Space

Square footage of landscape development is proportional to the number of parking spaces. The requirements of local law range from 10 to 25 square feet of planter space per parking space, and may require a minimum planter area.

Ratio of one tree per four parking spaces

C. Minimum Percentage of Lot Devoted to Landscape Development

An alternative standard is to specify lot coverage, usually described as a ratio of planter surface area to paved area. Community law requirements range from 2 to 10 percent. Higher performance standards include 15 percent for Coral Springs, Florida and 20 percent for Dania, Florida.

D. Relationship Between the Number of Trees and the Parking Spaces

Communities commonly specify that there be one large canopy tree per 20 parking spaces. But Leesburg, Virginia requires one tree and three shrubs for every 16 spaces. Atlanta, Georgia requires one tree per 8 parking spaces. Raleigh, North Carolina has a formula that acknowledges the impact of approach roads, requiring one tree per 2,000 square feet of all paved surfaces. This roughly equates to one tree per 6 parking spaces. Portland, Oregon tops the list with one tree per 4 spaces, and requires that trees be dispersed to provide shade.

E. Maximum Distance From Any Parking Space to the Nearest Tree

Dallas, Texas specifies that no parking space may be more than 120 feet from a tree trunk, while Corpus Christi, Texas has a 70 foot requirement. Raleigh's standard is 50 feet. A long distance standard is probably not likely to generate environmental benefits as few trees, when mature, would be able to shade paving or cars within a space defined by a 240 foot diameter.

F. Protecting Vegetation From Vehicular Damage

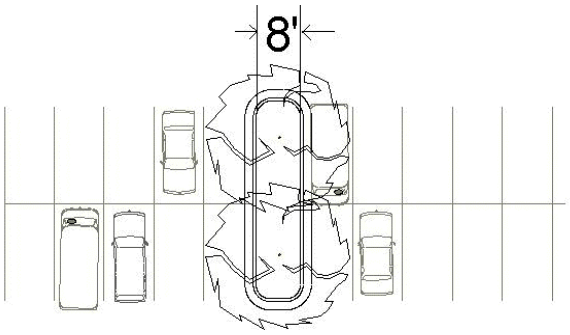
Tree protection may be addressed by specifying that no paving will be placed within a fixed distance from the tree center (15 feet for Carrboro, North Carolina), or that a minimum amount of growing area must be left unpaved around the base of a tree. Raleigh, North Carolina, for instance, requires a minimum of 350 square feet per planting area, with no dimension less than 7 feet. Curbing and car bumper blocks can be placed to accommodate a 30 inch car overhang, obviously the greater the distance the better.

Inadequate tree protection from vehicles (photo by Mike Sherwood, Bartlett Tree Labs)

Implementation of these six types of requirements varies widely. The landscape effect of the more modest versions of these requirements can be minimal, and not generate much environmental benefit across a community. Some communities use more stringent internal landscaping requirements to achieve sustainability goals.

In an effort to assure that plants are distributed throughout the paved area, some communities specify the in-lot planting options and include planting space dimensions so that trees and other plants have adequate growing space.

Tree islands are a common parking area feature. They may be placed intermittently within a bay of parking spaces. Or they can be placed at the ends of parking bays to ensure sight distances, provide adequate turning radii, and help delineate circulation.



Tree Island

Often island interiors are too small to accommodate the root systems of healthy trees. Planter islands, if adequate in size, can support large tree plantings and secondary vegetation. A draft of the Baton Rouge, Louisiana landscape code proposed a classification system for landscape islands. Large trees are to be planted in the largest of four island sizes; small island plantings are limited to shrubs and groundcover (but receive less credit in the total landscape plan review).

Landscape Strip

Landscape strips, also known as tree lawns or medians, are perhaps a more effective option for assuring that trees are placed within and throughout a parking area. The width of the strip must be wide enough to allow growing space for tree roots. Generally, required widths range from 5 to 10 feet, but may be as wide as 18 feet. Adequate space for car bumper overhang must be provided, so that tree trunks are not damaged. An example of the spacing of landscape medians is found in a Louisiana community code:

> ***St. Tammany Parish, Louisiana Landscape Code***
> ***5.16. Landscape and Tree Preservation Regulations***
>
> *Every fourth row of parking shall be separated by a median strip for landscaping of not less than ten (10) feet in width exclusive of curbs. One (1) Class A tree and one (1) Class B tree for every thirty (30) linear feet shall be planted in the required median between rows of parking. The surface of the landscaped medians shall be planted in living vegetative ground cover.*

VEGETATION QUANTITY

Vegetation quantity requirements are a component of about one-third of landscape ordinances. The assumption is that more vegetation is better than less, and that a generous amount of landscaping is the simplest method of improving the appearance of a parking lot.

As seen in the prior two sections, screening and interior planting requirements vary widely in vegetation quantity. Merely requiring that so much of a site be planted does not necessarily insure that environmentally oriented purposes and intentions are satisfied.

Requirements for parking landscaping are often imbedded within landscape requirements for an entire property. The quantity of vegetation is often specified by zoning district, with parking landscape being included in area calculations for the entire site. An Oregon community provides an example:

> ***Clackamas County, Oregon.***
> ***Title 12: Zoning and Development Ordinance.***
> ***Section 1000: Development Standards.***
>
> ***1009 Landscaping, 1009.02 Minimum Area Standard***
>
> *The minimum area requirements may include landscaping around buildings and in parking and loading areas, outdoor recreational use areas, and buffering as required under this section (1009).*
>
> *A. Medium and High Density Residential: A minimum of twenty-five (25) percent of the gross land areas shall be used for landscaping in medium and high density districts. This requirement may be reduced to a minimum of twenty (20) percent when the development qualifies for bonus density under subsection 1012.040 for Site Planning and Design Excellence.*
>
> *Redevelopment or additions to multifamily developments shall meet the minimum area requirements of this section.*
>
> *B. Special High Density Residential: The minimum area requirements shall be as specified under subsections 304.09D and E. Reductions in the forty (40) percent requirements may be allowed as provided under subsection 304.09E, for indoor recreation facilities over and above the minimum requirements.*
>
> *Other sections include minimum site area landscaping requirement for other zoning categories: General Commercial and Light Industrial: 15 percent of the developed site area, Office Commercial: 20 percent, Campus Industrial: 25 percent.*

Many communities boost the amount of vegetation by combining multiple planting quantity standards. Leesburg, Virginia requires that 10 to 20 percent of the parking lot be covered by tree canopy (within 20 years), depending on the land use, and also specifies 1 tree to be planted per 16 parking spaces. Another approach is to require a percentage of the parking lot area that is devoted to landscape, and then to specify plant types.

In other places a greater amount of planting is required as parking lots increase in size. Examples are in the next section.

Plant specification is another approach. A code may require amounts of certain classes of plants to guarantee that landscape requirements are not met by using turf and shrubs exclusively. Plant class lists often specify materials by category – canopy trees, screening trees, small trees, large to low shrubs, ground covers and other ornamentals (such as decorative grasses). Plant class requirements usually emphasize trees, to promote visual and environmental functions. Plant specifications can also include recommended species lists, often highlighting native species, generating plantings that are suited to regional climate and growing conditions.

VARIABLE LANDSCAPE REQUIREMENTS

Sliding-Scale Requirements

Some communities vary interior planting requirements based on parking lot size. Large lots that have significant visual and environmental impacts are often the targets of this type of code. Standards for large parking lots provide incentives that encourage builders to break up a lot into distinct segments.

Parking lot landscaping codes of Bellevue and Redmond, Washington; Palo Alto, California; the town of Waterford, Connecticut; and San Buenaventura, California use sliding scale standards.

In Palo Alto, 5 percent of the interior of parking lots smaller than 15,000 square feet must be landscaped. Lots between 15,000 and 29,999 square feet are required to have 7.5 percent, and 10 percent landscape is necessary for lots of 30,000 square feet or larger. If clearly divided into distinct parking lots by yards or buildings, a business' parking lot can be treated as several separate parking lots.

Bellevue, Washington has a similar sliding-scale approach but requirements are expressed in relation to the amount of landscaping per parking stall. Parking lots of 50 spaces or smaller must have 17.5 square feet of landscaping per stall. If there are between 50 and 99 spaces, the requirement ranges between 17.5 and 35 square feet per stall. Parking lots of more than 99 spaces must have 35 square feet of landscaping per stall.

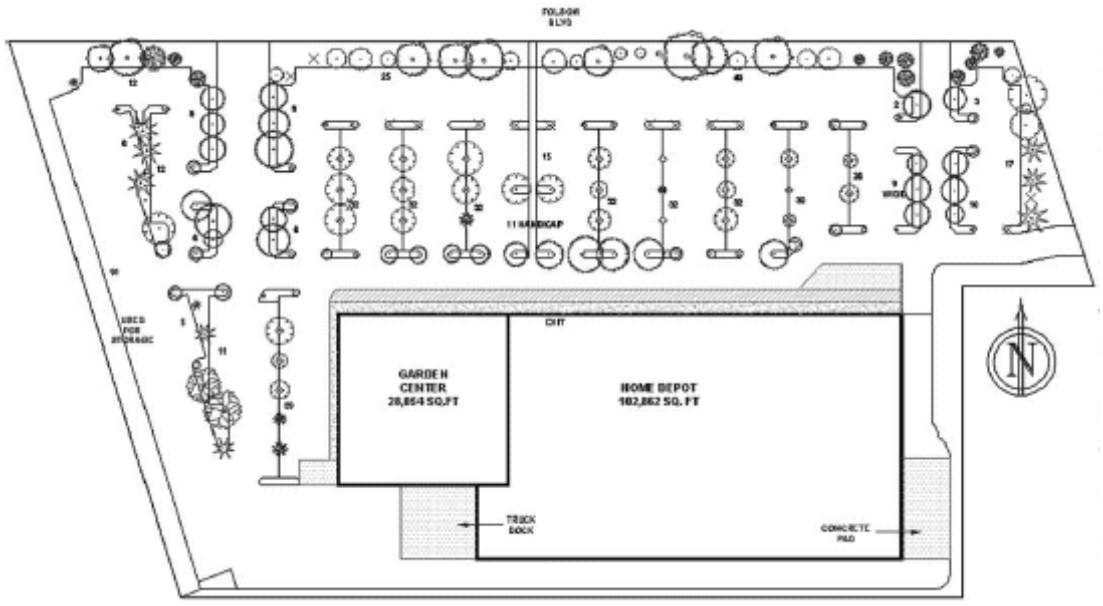
San Buenaventura is quite stringent in its requirements. The city requires that 10 percent of the interior of a lot with 22 or more parking spaces be landscaped. Five percent is required for 10 to 21 space lots, and there is no landscaping requirement for lots having 10 or fewer parking spaces.

Performance and Points Systems

Performance systems specify the functions that the landscape should serve, and most refer to the traditions of land use buffering and aesthetic standards. Plant species character and the land use where the vegetation is located are taken into account.

Performance based code may prescribe the density of required landscaping based on the degree of conflict between land uses. For instance, Queen Anne's County, Maryland uses a system of plant units with varying unit values required in different zoning situations. The "plant unit" concept counts a specified collection of vegetation as a unit, with six alternatives. For instance, one unit can be achieved by having one canopy tree, one understory tree, 10 shrubs and one evergreen tree. Plant units requirements for parking lots vary by land use. An Urban Commercial District must have 2.0 plant units and 648 square feet of planted space per 24 parking spaces. In most higher-density residential areas 2.5 plant units and 810 square feet are required.

Point systems have also been used to encourage preservation of existing trees and to encourage use of particular species. Corpus Christi, Texas has a point schedule that credits landscaping by trunk size. Preferred species (minimum 2 inch caliper size) are awarded 25 points compared to 8 points for other species. Also, large trees are favored; a 5 inch caliper size preferred tree receives 160 points.



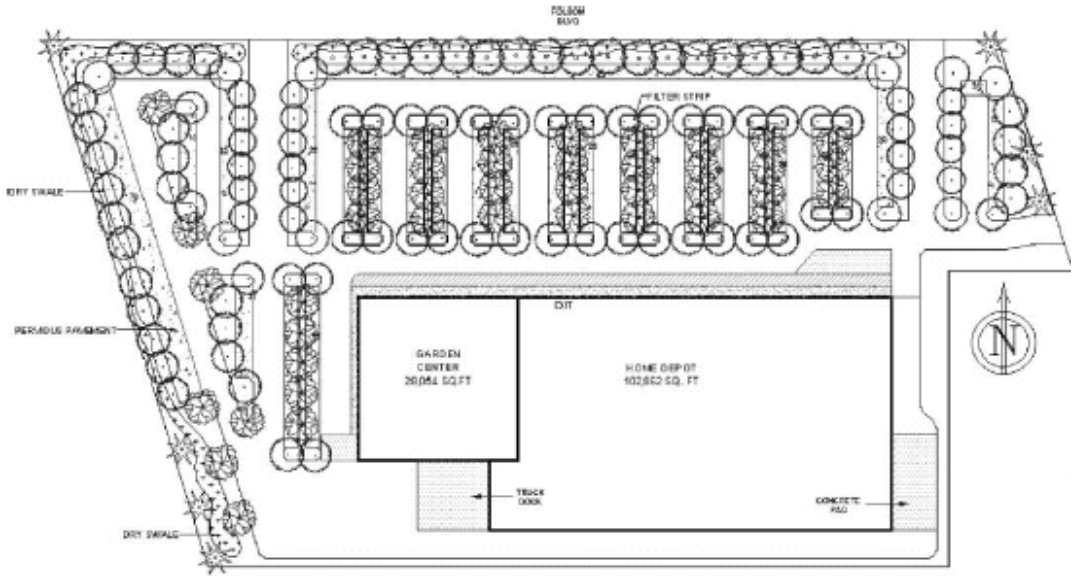
Existing Conditions – Parking lot landscaping analysis (from McPherson, 2001)

The development code of Orlando, Florida includes a point system for parking lot landscaping. Code requires trees and other landscaping to screen parking from adjacent land uses and to provide lot shading. The minimum requirements are expressed using points. The most effective way to generate the necessary points is to retain or install trees.

For example, the standard for perimeter landscaping is "sufficient canopy trees to receive at least three tree points per 100 lineal feet of frontage." Interior planting must include "sufficient canopy trees to receive at least one tree point per 100 square feet of gross landscaped area." Trees deliver points as defined by their height and trunk diameter. Small native canopy trees are worth between 1.0 and 2.5 tree points; medium-size native trees are worth up to 4.0 points. Large or specimen-size native trees are worth 5.0 points.

Orlando planners observe that the point system strongly discourages clear-cutting of trees for parking lots and creates incentives for preserving patches of existing forest. Developers are given points for saving a tree, and additional points are awarded for protecting large trees or clusters of trees.

Performance and point systems give developers design flexibility in achieving landscaping standards. Unit or point systems can be a way to encourage site design proposals that optimize the environmental benefits of trees in parking areas. But these approaches require a commitment on the part of planning departments and development review staff to adequately understand and apply the requirements.



Redesigned – Parking lot landscaping analysis (from McPherson, 2001)

COMBINING TRADITIONS AND INNOVATIONS

This chapter has briefly presented the legal strategies that have evolved as local communities have responded to the need for vegetation in and around built environments. As seen from the examples, legal requirements of screening, interior planting and vegetation planting area can range from the negligible to the substantial.

In the next chapter, more contemporary code approaches that specifically address environmental purposes will be described. Nonetheless, within the traditional approaches of this chapter there is opportunity to mitigate the heat island and environmental effects of large paved areas quite effectively.

For instance, scientists have been studying the parking lot shading ordinance of Sacramento, California. One site was chosen for detailed analysis, the parking lot of a building supply retailer. Full and complete plantings on the property perimeter, use of full sized trees at the street screening edge, and infill of all required lot interior landscaping areas did much to reduce the heat island potential of the large lot (McPherson, 2001). Two site plans (on prior pages) show the redesign.

The scientists noted that, based on growth and condition at time of the survey, trees in the parking lot were projected to shade only 29 percent of the parking area after 15 years. At the time of the site survey 28 trees were stunted or dead, 83 required staking, removal or adjustment, and 22 needed pruning (lifting or thinning). In addition, there were 24 more parking spaces than are required in the site development proposal, creating significant additional impervious surface.

The redesigned parking lot increases planned tree shade to 58 percent. Pervious cover is reduced by 18 percent, by eliminating 20 percent of parking spaces (found to be consistently unused in a parking analysis). The redesign includes new perimeter swales and changes to tree wells in the planting islands to reduce stormwater run-off. Tree species that have proven to grow well in the region's parking lots are featured in the redesign.

More information about code addressing parking lot shading, parking spaces needs, and stormwater practices is found in Chapter 6. These innovations can be used in combination with legal traditions to address the environmental impacts of urban parking lots.

5. GREEN LAW INNOVATIONS

Reflecting public concerns about environmental degradation, much legislation regarding the environment (such as water quality, air quality and wetlands) has been generated at federal and state levels. Legal requirements for local environmental quality are outlined within state or national law, and municipalities or counties may add more stringent requirements.

Local green law, on the other hand, has few national or regional exemplars. The consequence is that each municipality must create its own code. Across the nation, local green law is a diverse collection of purposes, requirements and standards. Each community has a different mix of constraints, opportunities and politics that shapes the content of local law and regulation regarding landscape.

An advantage of this local code diversity is that each ordinance can reflect unique local circumstances and context, responding to regional variations of climate and ecology. The disadvantage of this code evolution is that there are no universal models that provide consistency of landscape quality or quantity from one U.S. community to another (Abbey 1998).

This is particularly true of code that is focused on environmental or ecological purposes. Scientific understanding of the benefits of the urban forest is relatively new, and the translation of the science into a legal framework happens slowly. Nonetheless, a few communities have written code and regulations that are responsive to this new knowledge.

This chapter presents three primary themes of innovations, each including several legal strategies. Some researchers would argue that the root of many problems is simply the amount of impervious surface required for development. Thus, reconsideration of parking lot size and geometry are perhaps the most important issues, followed by requirements specifying the amount of tree canopy cover and stormwater performance of a vehicular use area.

Innovation Theme	Legal Strategies
Reducing Parking Surface Area	*Parking demand and parking space counts* *Flexible parking geometry*
Trees and Vegetation	*Tree preservation and retention* *Tree canopy cover and shading* *Plant specification (permitted & prohibited)*
Stormwater Management	*Runoff reduction (using pervious paving and biofiltration)*

Code flexibility can provide some leeway for creative planning that responds to our evolving understanding of the urban environment. With an eye toward the future, the following chapter presents some of the more innovative approaches, ones not yet widely accepted but showing promise.

PARKING DEMAND & PARKING SPACE COUNTS

To size parking lots, planners use parking demand ratios that specify the minimum and, in some cases, the maximum number of spaces per gross square foot of leaseable floor area (GFA) or dwelling unit (DU) (Bergman 1991). Parking ratios have been based on surveys of parking rates (ITE 1987) and result in parking built to handle peak demand, for example, the number of cars that will be at a shopping mall on weekends between Thanksgiving and Christmas. Parking lot standards specify minimum stall and aisle dimensions, landscaping, lighting, and signage requirements (ULI-NPA 2000).

The American Planning Association (APA) notes that no land use has a natural or ideal parking standard. Conditions affecting parking requirements change from community to community. A city's size, age, character, relative mobility of residents, and political climate all contribute to acceptability of local parking standards. For instance, APA, in a review of 138 communities found that the required parking for shopping centers ranged from one space per 100 to 250 square feet of usable floor area. Office building parking ranged from one space per 200 to 750 square feet of floor space. In more personal terms this means that about 300 square feet of aisle and stall space is required to store a car; in comparison, a person's typical office space is 100-200 square feet.

Parking demand analysis helps communities tailor national standards to local realities. The APA has published methods and examples of parking demand studies (Smith 1983). Childs (1999, p. 203) also provides recommendations for local studies, including demand predictions, elasticity studies, cost contours and occupancy maps.

In regard to urban forestry, a study in Sacramento, California examined 15 parking lots to evaluate parking capacity and compliance with a tree canopy cover ordinance (McPherson 2001). Parking lots account for 13 percent of urban impervious surface and occupy 5.6 percent of the city's total land area. The total number of existing parking spaces was 6 percent more than required by law. When surveyed at peak occupancy periods, 36 percent of the spaces were empty. The investigators suggested that a conservative amount (just 2 to 5 percent) of the empty spaces are excess parking that could be converted to non-impervious surfaces. These excess spaces occupy more than 10 percent of the land covered by parking lots.

The APA (Smith, 1983) offers ideas for flexible parking requirements. Some communities use fees in lieu of parking; reduced surface parking requirements are combined with fee payments that are used to construct centrally located parking

structures. Some planning departments have reduced parking space requirements to promote use of public transit or ridesharing.

The shared parking concept has become important as urban planners encourage mixed-use development (ITE 1995). Land uses having different occupancy patterns are combined. For instance, day use parking for office workers can be used by theatergoers at night. Or there may be reciprocal weekend to weekday demand patterns, for example, adjacent schools and churches that could share parking space.

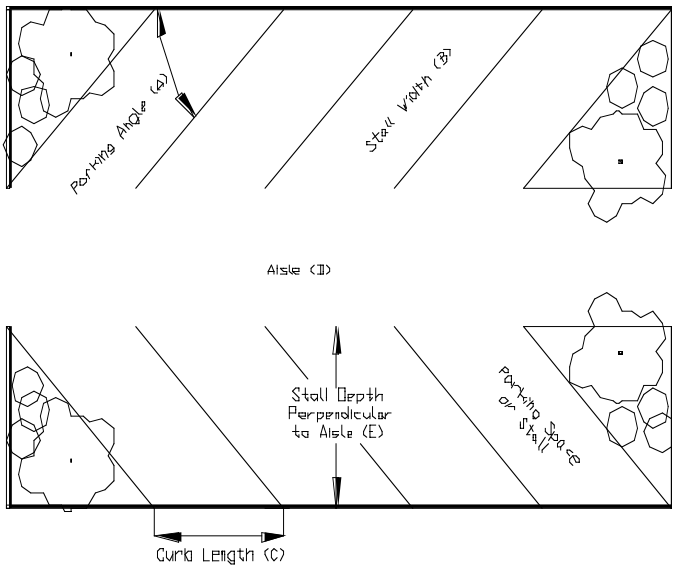
Childs (1999) also lists strategies of land release, phased-in parking, standard waivers, and cash-outs to potential parking space users. To illustrate one of these options, in lieu of constructing more parking spaces a business pays some of its employees cash to not park at work, encouraging use of alternative transportation modes.

Another innovation is to use district parking. Parking is supplied not to individual buildings, but to commercial streets, campus or downtown districts (Childs 1999). Santa Monica and Los Gatos California have district parking programs. In 1977 Boulder, Colorado used district parking for a downtown revitalization program. City planners waived on-site parking requirements and formed a district-wide general improvements organization that included thorough consideration of the supply of parking facilities in its goals. Increased building sites and a pedestrian-supportive environment offset a resulting tight parking supply.

FLEXIBLE PARKING GEOMETRY

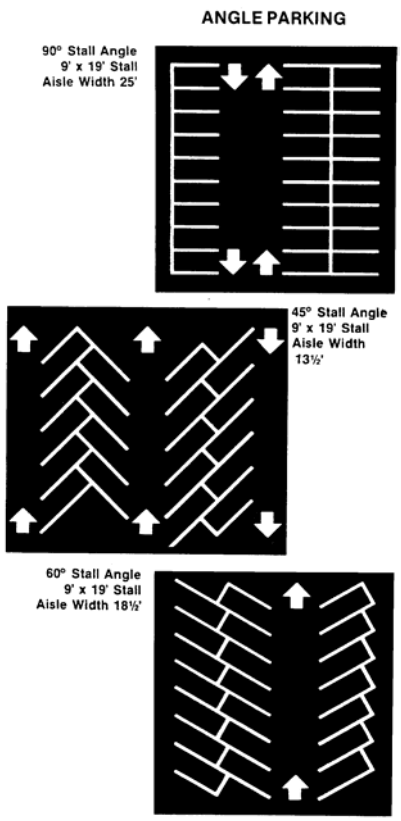
Impervious surface area can also be reduced through attention to parking space dimensions and circulation. Some of the principal factors in developing conventional parking designs are traffic circulation, ease of maneuvering, and safety for pedestrians and drivers. Standards have been prepared for lot interior dimensions.

Historically, parking stall dimensions have been increasing in size to accommodate the largest vehicles. The standard parking lot geometry now being used in cities across the United States was developed in the 1960s and 1970s, when average car sizes were substantially larger than they are today.



Parking lot interior dimensions

In 1929 recommended stall widths were 7 feet and under. Today less than 7 feet is prohibited; a width of 9 feet is common. Increasing width of stall circulation lanes has caused gradual expansion of the space needed for equal numbers of vehicles. In addition, wide aisles and stalls have become standard, providing convenience and plenty of maneuvering space.



Parking stalls can be laid out at various angles, changing the required width of aisles (from Smith 1988)

While good standards represent experience about what makes something safe and convenient, they are meant to be only generally applicable. Analysis of local circumstances should guide the acceptance and use of standards. In addition, recent studies suggest that it is time to reconsider surface parking lot geometry.

Childs (1999) recommends a service approach to parking bay and stall dimensions. Variability in dimensions is based on three conditions: 1) the expected turnover rate of the lot, with greater width used for high turnover situations such as parking for grocery stores, 2) how many small car stalls are provided (as determined by a demand survey), and 3) the parking stall angle.

The goal of circulation is to create a simple, legible route that allows drivers to circulate easily near available stalls. Yet this convenience should be considered in light of other priorities in the parking area, such as planting spaces.

A common parking layout is the two-way aisle with 90-degree stalls. This is perhaps the most driver-friendly layout, for it permits easy recirculation and prevents back-ups by slow vehicles. In response to environmental concerns, Portland, Oregon has reduced the standard 90-degree angle parking space from 9 feet wide by 19 feet long to 8.5 feet wide by 16 feet long.

Revisiting 90-degree parking is a good approach to reducing paved surface. Most communities (such as Leesburg, Virginia) vary aisle widths by parking angle. Parking areas using 45-degree double-parking bays and one-way driving aisles can fit easily in a space as narrow as 40 to 45 feet. Right angle (or 90-degree) parking typically has two-way traffic aisles so the layout width can be as wide as 60 to 65 feet.

For some drivers, reduced size parking spaces and narrower aisles may be less convenient than larger ones. Larger vehicles may require a three-point maneuver to back out of a parking space. Yet studies of reduced dimension lots suggest that safety is not compromised. Drivers tend to slow down in lots having tighter spaces (City of Portland 2000). Environmental gains are the tradeoff for minor driver inconvenience.

Minimum Aisle Widths Adjacent to Parking					
Parking Angle (degrees)					
	0	30	45	60	90
1-Way Traffic	13 ft	13 ft	13 ft	18 ft	22 ft
2-Way Traffic	19 ft	20 ft	21 ft	24 ft	24 ft
Aisle with no Adjacent Parking					
1-Way Traffic	12 ft				
2-Way Traffic	18 ft				

Parking geometry – Leesburg, Virginia Zoning Ordinance

TREE PRESERVATION AND RETENTION

Tree preservation ordinances generally promote the retention of individual trees and tree stands during development review and site construction. Using tree trunk and canopy cover specifications, as well as designations of significant species, the benefits of mature trees are promoted over the delayed gains of planting small saplings. Many cities and counties require permits to remove a tree or build, excavate or construct within a given distance of designated protected trees.

In some locales, removal or destruction of existing, healthy natural vegetation is strongly prohibited, and significant plants are given extra attention. In an early effort at landscape related ordinances the State of California passed a tree preservation act in 1931. Florida laws generally protect palms and mangroves, and Texas and California protect native oaks.

Wide driveways reduce benefits of trees in planting strips or trees lawns

Tree protection must be connected with good tree health and condition, and expected life cycle. Saving unhealthy, declining trees will only contribute to insufficiently planted sites, and make replacement enforcement difficult.

A protection ordinance may include several of the following elements:

1. Unlawful to remove a tree without a permit,
2. Replacement of all removed trees that are larger than 24 inches dbh,
3. No tree over 4 inches caliper may be removed,
4. Special consideration granted for plants of significant rarity, beauty, historic background, landmark character or cultural value,
5. No impervious material may be placed within the dripline of preserved trees,
6. Protection from grade changes during clearing and grading operations
7. Protection practices are required during site construction (such as the placement of temporary fencing around trees, and the prohibition of materials storage within the tree root zone),
8. Replacement of trees that die due to damage or disease caused during construction,
9. If code includes a point system, extra points may be awarded for preserved vegetation.

Using existing trees to meet landscape requirements encourages the retention of older, larger trees. Communities use strategies of measures, points, special lists and mitigation to preserve trees. For instance, Portland, Oregon allows each 6 inches of existing tree trunk diameter to eliminate the requirement for one proposed tree; an 18 inch trunk tree corresponds to 3 such trees. In addition to a protected trees list, Myrtle Beach, South Carolina also uses a stem caliper measurement system to assess quantities of replacement trees for trees removed during permitted development. Using a point system in its landscape code, Orlando, Florida awards retained trees up to 5 points, with specimen trees getting a 7 point credit, compared to a maximum of 4 points for installed ornamentals. Carborro, North Carolina protects all existing trees of DBH greater than 18 inches, and all trees that are on the city's very rare species list.

FIGURE 1. TREE POINTS

		Retained Native	Installed Native	Non-Native
Small Tree:				
	1.5" Caliper, 10' Height	1.0	1.0	0.5
	2.0" Caliper, 12' Height	1.5	1.5	1.0
	3.0" Caliper, 14' Height	2.5	2.5	1.5
Medium Tree:				
	4.0" Caliper, 15' Height	3.0	3.0	2.0
	25' Height	3.5	3.5	2.5
	30' Height	4.0	4.0	3.0
	35' Height	4.5	4.0	3.5
Large Tree:				
	40' Height+	5.0	5.0	
Specimen Tree or Historic Tree		7.0	n.a.	5.0

Orlando, Florida credits tree points in a landscape plan for preserved and installed vegetation

Retained trees in a parking lot will require special attention if they are to survive and thrive after construction work is completed (Austin 1997). Grade changes, by either excavation or removal, of as little as three inches of soil can kill a tree. Soil retaining structures or aeration and drainage systems may be needed to preserve tree health. Care must be taken not to damage either tree trunk or roots during construction. Physically preventing materials and equipment from being placed near the tree prevents physical damage and soil compaction.

In some communities a particular tree species is part of the visual identity of the local landscape. Mandeville, Louisiana is an example and its code acknowledges the cultural importance of live oaks:

Mandeville, Louisiana Landscape Code
Article 9, Landscaping
7.6.2 Gateway Overlay District Ordinance

The vegetation protection zone is an area extending at least fifteen (15) feet in all directions from the trunk of any tree proposed to be preserved to meet the requirements of this section or encompassing a minimum of two thirds (2/3) of the entire canopy area of the tree or which ever is greater shall be required to be maintained undisturbed with the exception of live oaks. The vegetation protection zone for live oaks will be a circle with a radius which is

eighty-two (82) percent of the canopy of the tree measured from the trunk to the drip line. A barrier shall be erected and maintained around the vegetation protection zone at all times during construction.

TREE CANOPY COVER

Tree canopy cover, scientifically assessed as the amount and distribution of tree leaf area, is directly associated with the urban forest's capacity to produce community benefits. Increasing a city's canopy cover is a direct way to increase benefits afforded by trees: climate control and energy savings; improvement of air, soil and water quality; mitigation of stormwater runoff; reduction of the greenhouse gas carbon dioxide; provision of wildlife habitat; and increased real estate values and human psychological well-being (Maco & McPherson 2002).

American Forests (2002) has identified canopy cover targets by urban land use: 15 percent in downtown and industrial areas, 25 percent in residential and light commercial, and 50 percent in suburban residential settings. Some communities have adopted site canopy cover requirements. Fairfax County, Virginia requires that trees be retained or planted in new development to meet variable tree canopy cover goals within ten years, ranging from 10 percent in commercial and industrial areas to 20 percent in low density residential areas.

Canopy cover regulations applying specifically to parking lots have come into use. The standards typically require that shade trees be placed in adequate number and location so that a certain percentage of the total parking area is shaded within a predetermined number of years following issuance of all development permits. In the 1980s scientists in Florida drafted a model energy conservation landscape ordinance that required 50 percent canopy cover of parking lot area after a 10-year growth period (Parker 1989).

Parking lot having 50 percent tree canopy cover

Cities in the warm climate areas of the southeastern states and California have taken the lead in adopting cover recommendations. Examples are Agoura Hills, Sacramento, Woodland, Sacramento County, Modesto and Los Angeles, all in California. Sacramento's ordinance, adopted in 1983, requires 50 percent shading coverage of total paved area within 15 years. In Sacramento County, trees in parking lots of 5 to 24 spaces must provide 30 percent lot shading; lots having 25 to 49 spaces must have 40 percent shading; and 50 percent shading must be attained in lots of 50 spaces or more. Woodland specifies that shade trees must be distributed so that 40 percent of the parking stalls are shaded at high noon when trees are in full foliage.

Both the quantity of trees, and their distribution are important for achieving greater canopy cover. Some parking canopy ordinances specify one tree per a certain number of parking spaces or a certain amount of landscaped area per space. However, under such ordinances trees can be clustered in islands or along the lot perimeter, potentially leaving large areas of pavement unshaded. Sacramento's ordinance contains a performance standard that ensures distribution of shade throughout the lot.

PLANT SPECIFICATION

Tree lists are often a component of canopy and other landscape code. They typically list plants that are permitted in planting proposals, or species that are prohibited due to disease or invasive tendencies. For instance, to attain desired canopy cover planners use Recommended Tree Lists containing the 15-year crown diameter and crown projection area of recommended species to calculate shaded area.

Specifying shrubs (and other companion plants) in parking area planting spaces may enhance tree canopy benefits

Lists may simply contain botanical and common names, or they may provide information on height, shape, spread, growth rate, drought tolerance and possible pest problems.

Care is needed to generate good lists. Climate and soil conditions should be considered. Different plant species have different innate growth characteristics. It is better to select a plant that will naturally fit a space or situation than to plant something that needs constant tending. For instance, some trees are better suited to canopy pruning to enhance visibility, thus improving sight lines and security in the lot.

In addition to compatibility with the growing environment, good fit with other parking lot conditions is important. When choosing trees for parking lots, the primary concerns are longevity, crown size (for shading purposes), aesthetics, and nuisance factors. Trees that drop sap should be avoided, and trees that drop large amounts of blossoms, seeds, and pods that might clog drains should also be avoided. Deciduous trees that drop leaves can be used if parking lots are periodically cleaned. Hearty trees – those resistant to motor exhaust fumes, dirt and soot – should be used. Trees with expansive roots that could disrupt paving and underground lines should be discouraged. In cold climates, the use of trees that are tolerant of road salt and de-icing compounds must be encouraged.

Other lists specify acceptable and unacceptable plants for a local region or jurisdiction. Increasingly, communities are listing prohibited plants. Certain species may be diseased or damage prone, possess certain unfavorable growth characteristics (such as brittle wood) or be a host for disease and pests. More

recently, attention has focused on plants that may pose a risk of becoming invasive in greenbelts and native reserves.

The composition of a planting design is also important. Using a diversity of species can reduce both the spread of tree disease and the effect of a disease on the overall tree cover. The International Society of Arboriculture recommends the following diversification formula: no planting plan should contain more than 10 percent of one family or 5 percent of one species (Phillips 1993). Some communities (such as Portland, Oregon) also specify a deciduous (60 percent) to evergreen (40 percent) ratio.

STORMWATER MANAGEMENT

Many cities, in response to peaked out stormwater systems and regulatory mandates, are reviewing their development code for stormwater management. Urbanization results in the removal of vegetation, installation of impervious roofs and pavement, and installation of storm sewers to carry away stormwater – all conditions that increase runoff rates.

Runoff from parking lots commonly is directed to a drain that leads to a trap, catch basin or other device that removes oils and sediment. The water is then discharged to a storm sewer or to the city's combined storm and sanitary sewer system. In addition, discharge generally must pass through a device to control the rate of flow. These devices are usually underground and can be expensive.

The best way to achieve reduced runoff is to integrate stormwater management into site and facility design from the beginning of a development project. Parking lots offer significant opportunities for improvements. A number of cities, such as Portland, Oregon, have reviewed and amended their Zoning and Landscape Codes to include Best Management Practices, such as interception, shading, infiltration filtering and detention, as new elements in existing code.

Pervious Paving

Most parking lot paving materials are impervious, that is, water cannot soak through them and into underlying soils. Thus precipitation collects on the paved surface, moves downhill, and must be dispersed or will cause local flooding in low spots. Vegetation-based strategies are the focus of this report. But pervious pavings are an equally important innovation, and their use is being drafted into local code.

Pervious materials permit water to enter the ground because they are porous or have void spaces. Various materials and technologies are being explored. An important consideration is whether the choice of paving material is consistent with the use intensity and traffic load of the vehicular use area.

Paving	Description
Pervious concrete	Special structural concrete having no fine particles (appearance is like a rice cake), and having a void content of 15 to 25 percent. Will support traffic and allow water to pass through (3 to 5 gallons per minute) to gravel bed beneath. Strength is about 85 percent of conventional concrete.
Pervious pavers	System composed of interlocking paving blocks placed on a bed of fine gravel. The configuration of the pavement blocks creates small voids that allow stormwater to infiltrate.
Structural grass pavers	Lattice of open-cell, interlocking grid blocks are placed, and hollows are filled with soil and planted with grass (or wildflowers). Pavers may be made of concrete, metal or recycled plastic. Vehicles can use a reinforced lawn occasionally.
Crushed rock and gravel	These materials are compacted, and may consist of multiple layers. Finest textured rock is placed at the top and most coarse is placed near the native soil. Can be used with confinement cells or structures for long term and horizontal stability.

Pervious pavings options

For example, pervious concrete can be used in place of traditional concrete or asphalt in parking lots, while areas that have a lighter amount of traffic (such as bays of parking spaces farthest from building entrances) may be suited for crushed gravel or pervious pavers.

Parking lot rain garden (from PSAT 2003)

Bioretention and Biofiltration

Increasingly, stormwater management code expects that new and redeveloped parking lots must be managed to produce stormwater runoff similar in quantity and quality to runoff from the same property in an undeveloped state. Low Impact Development is the term being used to describe stormwater oriented development practices

Not all runoff can be eliminated using pervious pavings. Using landscaping to treat and manage stormwater has several important advantages over the usual collection-and-drainpipe systems: landscaping cools the runoff; pollutants are filtered and trapped in soils; and landscaping increases evaporation, transpiration and infiltration.

Prince George's County, Maryland has been an innovative leader in urban runoff control. Bioretention approaches that are endorsed by the county provide on-site water infiltration and storage spaces for water uptake by vegetation. An example

is the use of "rain gardens." These gardens make use of small, shallow pools, as vegetated landscape features, to both retain stormwater and remove pollutants. Rain gardens can be placed in parking lot tree islands and landscape strips. They can be installed in new development, or used to retrofit older parking lots.

Additional local code recommendations regarding runoff include some of the topics already described (such as increased interior landscaping, reduction of parking space and aisle dimensions, and plant specifications), but are oriented to stormwater quantity standards.

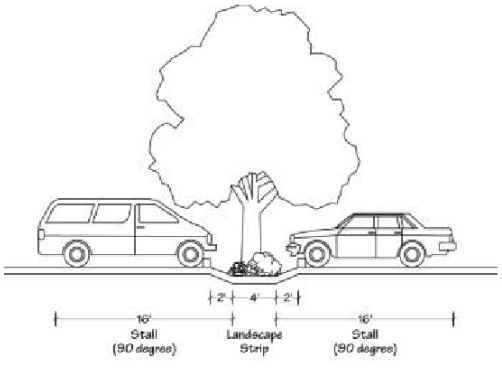
One example is the use of landscape strips, the planting areas that run the length of a row of parking spaces. Strips can provide small areas to collect and hold water. A 4-foot minimum width is needed, with added car bumper overhangs.

Portland's code specifies "permeable" curbs to permit water flow into bioswale landscape areas:

> ***Portland, Oregon. Zoning Code.***
> ***Chapter 33.266 Parking and Loading***
>
> ***33.266.130 D. Improvements***
>
> *3. Protective curbs around landscaping. All perimeter and interior landscaped areas must have protective curbs along the edges. Curbs separating landscaped areas from parking areas may allow stormwater runoff to pass through them. Tire stops, bollards, or other protective barriers may be used at the front ends of parking spaces. Curbs may be perforated or have gaps or breaks. Trees must have adequate protection from car doors as well as car bumpers.*

And the code encourages certain landscape materials so that the car overhang area of parking spaces aid in stormwater management.

> ***Portland, Oregon. Zoning Code.***
> ***Chapter 33.266 Parking and Loading***
>
> ***33.266.130 F. Parking Area Layouts***
>
> *4. A portion of a parking space may be landscaped instead of paved, as follows:*
>
> *a. The landscaped area may be up to 2 feet of the front of the space as measured from a line parallel to the direction of the bumper of a vehicle using the space.*
>
> *b. Landscaping must be ground cover plants.*
>
> *c. The landscaped area counts toward parking lot interior landscaping requirements and toward any*



Landscape strip with parking space overhang

overall site landscaping requirements. However, the landscaped area does not count toward perimeter landscaping requirements.

Wider planting areas, specified at up to 10 or 20 feet in width, serve as bioswales, or infiltration areas. These spaces optimize growing conditions for trees, and water management effectiveness. The planting bed is depressed 2 to 3 feet and planted with water tolerant shrubs, such as red-twig dogwood and trees such as red maple, willow, alder or poplar. Water is directed across pavement into the infiltration area, which is equipped with an over-flow pipe connected to the storm sewer to accommodate excess water in major storms. Total size of infiltration area for any parking lot is calculated based on local flood control requirements and soil permeability.

Bioswale planting strip is slightly depressed and richly planted

Multiple performance and design standards (including porous paving, bioretention and underground recharge beds) can be used in conjunction with tree planting to reduce stormwater runoff from vehicular use areas. Prince Georges County, Maryland (2000) has published good guidelines. Other publications on Low Impact Development (such as Puget Sound Action Team 2003) list a variety of construction and legal strategies for managing stormwater. Some communities are adopting regulatory code and others use incentives, such as reductions in utility fees, to promote these innovations.

6. ADDITIONAL STRATEGIES & OPPORTUNITIES

Landscape and tree code must address many situations, land uses and development site conditions. In Chapters 3, 4 and 5 a variety of legal strategies were presented that can help communities minimize the environmental and human impacts of parking areas. These strategies generally translate community values into desired levels of impervious surface and vegetation, and surface water quality in urban landscapes.

Policy	Traditional Code	Innovative Code
Statement of purpose (connecting community goals & values with best available science)	• Buffering, screening & perimeter planting • Parking lot interior landscaping • Vegetation quantity • Variable landscape requirements	• Parking demand & parking space counts • Flexible geometry of parking lots • Tree preservation & retention • Canopy cover & shading • Plant specification • Stormwater management
Implementation		
• Development plan review	• Trees & construction	• Vegetation maintenance

This final chapter presents some aspects of the *process* of code implementation and monitoring. These issues may be set up as procedures that are recommended during parking lot planning and construction, or may be incorporated more formally into code.

Several final considerations close out both this chapter and this report. Because there is no standardized green law for local government, there is wide latitude in how communities address site landscaping in general, and parking lot greening in particular. Non-regulatory options can supplement regulations and guide site designers to the best achievement of community goals.

DEVELOPMENT PLAN REVIEW

Developing and adopting code is but the first step; effective implementation and enforcement may be an equal challenge. Effective site plan review for adherence

to code can happen only if planning staff have the proper technical knowledge and commitment to the purposes of the code.

Many localities list requirements for content of development plans that are submitted for review and permitting, as in the table below. Plan reviewers should first check that all required content pertaining to vegetation and parking has been submitted.

Requirements for Development Site Plan Review

Built Elements	Vegetation Elements
• *Title; north arrow; scale, names of owner, developer and person responsible for plan preparation; and the date that the plan was drawn, including subsequent revision dates* • *A notation stating, "This landscape plan has been reviewed and approved by the owner/responsible agent who understands that any changes, substitutions, or deletions may require review and approval by the responsible reviewing authority."* • *Scaled drawings of the property at a scale of one-inch equals to 20 feet* • *Property lines, dimensions and acreage of each lot or plot or portion thereof to be built upon or otherwise used* • *Existing and proposed buildings and accessory structures to include existing and proposed signs* • *Location and dimensions of existing and proposed streets and highways* • *Layout of all off-street parking and loading areas, including the location of entry and exit points, the internal vehicular circulation pattern and the location and dimension of required parking and loading spaces* • *Location of walls, fences and railings and an indication of their height and construction materials* • *All site lighting will be shown.* • *All easements and their designation will be shown*	• *Plant materials list that includes: Common and botanical names of all species being planted, a key that denotes the appropriate symbol, minimum installation size, quantity and appropriate remarks* • *Description, to include dbh (diameter at breast height), canopy and species name, of each existing tree to be retained.* • *Location and appropriate symbol that corresponds to each proposed and retained tree and shrub. Any special height or shape requests for trees or shrubs must be clearly indicated for each request* • *Details illustrating landscaping installation* • *Additional remarks required: The amount, depth and type of mulch required; statement regarding the type of irrigation system to be installed; any other remarks deemed appropriate by the designer*

Closer inspection of a site proposal can assure that the greatest benefit is derived from the development design. The Center for Urban Forest Research and Education has prepared a list of actions to specifically increase effectiveness of parking lot planning (Litman 2002). As planners and project designers prepare and review a new project plan, these recommendations will help create greener parking lots:

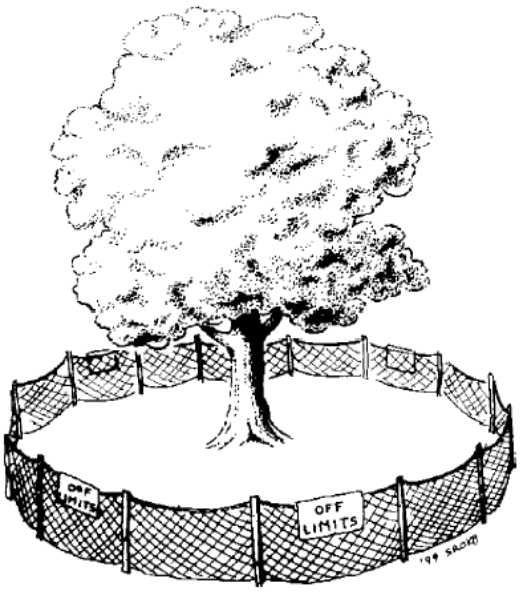
- *Do not allow parking lot ratios to exceed those stipulated in the ordinance;*
- *Do not allow smaller sized plant substitutions after the plans have been approved;*
- *Follow up to ensure that trees are actually planted, as well as not removed shortly after planting, especially at sites near store fronts where trees could obstruct signs;*
- *Do not allow planting of trees not on the ordinance's Recommended Tree List. Update the List periodically based on tree performance after installations;*
- *Regarding canopy cover calculations, avoid double counting tree shade where tree canopy areas overlap. Be sure crown diameters for both initial plantings and mature trees are not overstated (thus suggesting more shade area than will be achieved).*

TREES AND CONSTRUCTION

Following plan review and approval, landscaping is usually installed as one of the last phases of site construction. Soils underneath parking lots are usually very compact, offering parking lot trees limited root space. This can compromise the ability of parking lot trees to survive and thrive. Innovative parking lot construction methods can provide parking lot trees with a larger rooting area without compromising the structural integrity of the paved surfaces.

While beyond the scope of this work, structural soil mixes are a new technology offering an alternative to standard aggregate base, and could be specified in guidelines. Structural soil mix provides the compaction needed below parking lot paving surfaces to bear the weight of vehicles, while providing an accessible, extensive root environment for trees. Developed at Cornell University (Grabosky & Bassuk 1996), structural soils are being tested in field conditions around the United States.

Retained and protected trees in a parking lot need special attention during the construction process. Physical barriers are needed to prevent damage to both tree trunks and root zones. At times protective materials may need to be placed on the ground in the root zone to reduce impacts and root compaction. More common,



A highly visible fence and signs should be used to protect the root zone of conserved trees during construction (from MI DNR 2000)

and probably more effective, is complete exclusion of materials and equipment from the area within the tree dripline. Temporary fencing will prevent vehicles from passing beneath the trees and eliminate the temptation to store materials in the clear space. If equipment must be operated near tree trunks, then protective wraps of lumber or other materials will reduce the chance of trunk scraping and skinning.

VEGETATION MAINTENANCE

Once a landscape plan is approved and planted, its ultimate success in generating environmental benefits depends on tree maintenance. Specification of plant quantity and installation requirements is not enough. The methods and responsibilities for maintenance and on-going management should also be clear.

Responsibility for maintenance is usually legally assigned to the property owner or manager. The City of Rochester, New York requires that a landscape maintenance plan accompany every site plan, and that the property owner has responsibility for maintenance. Pima County, Arizona requires covenants that guarantee maintenance by property owners or their agents as a condition of building permit approval.

The Coral Gables, Florida, code states that "the owner, tenant, and their agent, if any, shall be jointly and severally responsible for the maintenance of all landscaping in good condition so as to present a healthy, neat and orderly appearance and shall be kept free from refuse and debris."

The Vista, California zoning code once spelled out detailed standards for maintenance:

- *All plant growth in landscaped areas be controlled by pruning, trimming, or other suitable methods so that plant materials do not interfere with public utilities, restrict pedestrian or vehicular access, or otherwise constitute a traffic hazard;*
- *All planted areas be maintained in a relatively weed-free condition and clear of undergrowth;*
- *All plantings be fertilized and irrigated at such intervals as are necessary to promote optimum growth;*
- *All trees, shrubs, ground covers, and other plant materials must be replaced if they die or become unhealthy because of accidents, drainage problems, disease or other causes.*

Adequate enforcement of maintenance requirements is a challenge. The problem is the cost of inspection programs for ensuring compliance. Few municipalities have staff available for enforcement. Some municipalities are exploring the possibility of using community partners (such as members of an urban forest non-profit organization) in enforcement efforts.

FINAL CONSIDERATIONS

Code Location and Placement

This report has presented a variety of legal approaches to parking lot landscaping and urban forestry. The placement of the code that prescribes requirements or performance criteria within the local regulatory framework varies a great deal from one city to another. Code location is an important consideration when drafting new law to introduce more trees into parking areas.

Code about trees and landscaping specific to parking on private property is often found in municipal Development or Zoning Ordinances. In some instances a single chapter or section of code will be the primary location of most vegetation law, perhaps including a number of subthemes such as landscape requirements, tree protection and permit review procedures.

On the other hand, code regarding trees in public places, such as street rights-of-way, is often located separately from the zoning, development or subdivision code. It may be a separate chapter or, as was done in Portland, Oregon, included in a Parks and Public Spaces chapter.

In other instances, the code is distributed throughout numerous sections or chapters. It may be found within sections on landscape, parking requirements, screening and buffering, associated with specific land uses, or located in an environmental section. Review for landscape requirements then becomes tied to permit review for various land use changes or zoning requirements.

Requirements, Performance or Guidelines?

Different communities convey different levels of regulatory expectation in their code approach. Some code and ordinances contain detailed specifications, expressing landscape in basic numeric requirements (such as planting distances in buffer zones). These tend to be laws that pursue functionally simple purposes.

As communities choose to promote more diversified or elaborate purposes, they find that it is difficult to anticipate and legally describe all possible landscape situations and design approaches. The use of performance standards is a solution. Code is written that describes required outcomes, such as the percentage of canopy cover or the acceptable amount of lot runoff, and the property developer makes choices about how to achieve the standards. Incentives may be provided that reward for exceeding minimum conditions.

Another approach is to use variable requirements that provide flexibility within ranges. This style of code states purposes, and is specific in describing the materials or conditions that will meet requirements. But various strategies are used to provide choices within the requirements. For instance, point systems permit flexibility of plant choices to meet landscape code, and often favor retention of existing vegetation.

Another alternative is to utilize companion guidelines or a manual. For example, tree lists, if written directly into code, can be unnecessarily restrictive, as the entire document must be amended to add or delete plants in the future. Companion documents that are referenced within code are easier to review and revise as additional study or observation suggests changes. Also, manuals can provide supplemental information, such as tree planting practices that are not appropriate in code but will improve the vitality of installed landscapes. The cities of Palo Alto (2001) and Sacramento (2002), California provide good examples of companion documents.

Finally, some communities may not be politically committed to having extensive regulatory requirements for trees and landscape. Another form of guidelines document is a Best Management Practices handbook, as created by Athens-Clarke County, Georgia (2001). The handbook guide provides technical references for desired practices, presented in an informative style. Property owners and developers, and city agency staff are encouraged to follow the recommendations, and some incentives are provided.

Importance of Good Design

Codes and ordinances of some cities can be quite specific in prescribing the spacing, locations and counts of plant materials. Some of the more recent or innovative ordinances provide more flexibility. In this way a site design professional is able to optimize parking space count, the use of native vegetation, layouts of new plantings and other contingencies to achieve legal and community goals.

For instance, Charleston, South Carolina provides a minimum to maximum range of required parking spaces for some nonresidential land uses. Site designers are motivated to consider the number of parking spaces carefully in major new developments, as a stormwater management plan is a required element of the proposal and permitting process. Charleston's Department of Public Service bills every property for stormwater services annually, based on the amount of impervious surface. Unused parking spaces generate unnecessary costs for property owners each and every year!

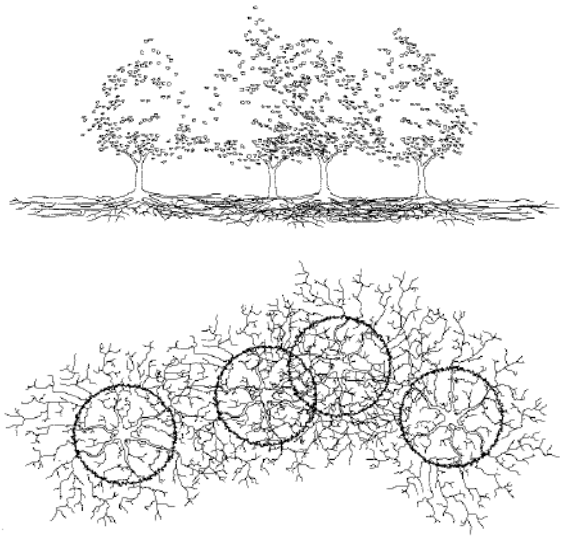
Another example is Orlando's tree point system. It establishes landscaping standards, but promotes design flexibility as a developer can make choices about the location, and sizes of both native and plant material to achieve a unique project character or identity.

The 50 percent canopy cover law for parking lots in Sacramento was described in Chapter 5. A recent review of Sacramento parking areas noted that few have attained the required canopy rate. Tree choice based on growth data may help. Some communities, such as Athens-Clarke County (Georgia) and Leesburg, Virginia, have rated tree species for expected square footage of canopy coverage, creating canopy size categories that can be used by designers and plan reviewers. A city would still need to monitor for adequate maintenance, but be relieved of the task of measuring cover rates for code compliance. The lists inform lot designers about how to achieve shading goals, and provide enough flexibility so that a distinctive landscape design can be created for each site or project.

Large Canopy Trees 2 inch minimum caliper; Square Footage of Canopy Credit = 1,000				
Common Name	**Botanical Name**	**Cultivars***	**Function**	**Height & Spread**
Ginkgo (Male)	Ginkgo biloba		B,PP,S,SB	50 × 30
Sugar Maple	Acer saccharinum	Commemoration	B,PP,S	50 × 35
Sugar Maple	Acer saccharinum	Legacy	B,PP,S	50 × 35
Red Maple	Acer rubrum	Red Sunset	B,IN,PP,S	50 × 40
Red Maple	Acer rubrum	October Glory	B,IN,PP,S	50 × 50
Red Maple	Acer rubrum		B,IN,PP,S	60 × 50
River Birch	Betula nigra	Heritage	B,IN,PP,S	50 × 50
Bald Cypress	Taxodium distichum		B,SB	60 × 25
Hackberry	Celtis occidentalis	Prairie Pride	B,SB	50 × 50
Kentucky Coffeetree	Gymnociadus dioicus		B	60 × 45
Japanese Pagodatree	Sophora japonica		B	60 × 40
Silver Linden	Tilia tomentosa	Brabant	B,IN,PP,S,SB	60 × 30

Canopy Categories – Leesburg, Virginia Zoning Ordinance
(functions: B=buffer, PP=perimeter planting, IN=interior planting, S=street, SB=street buffer)

"Signature Landscapes" is a concept promoted in the City of Colorado Springs code and a landscape manual (2002). In an effort to respond to the ecological context of the city, site planting designs are encouraged to make use of 60 percent of signature plants (mostly native species) to promote water conservation and the unique aesthetic qualities of the region. In and around parking lots, designers can create an "oasis" through conservation of existing vegetation or concentration of xeriscape (meaning low water use) plantings. The oasis can become a mark of distinction for the business or commercial property owner.



Diagrams of tree root growth
More root space = better tree health
(drawings from Fayetteville, Arkansas Landscape Manual)

And finally, new science about both trees and their growth situations in cities will promote new code development. Often, good design serves as a testing ground for emerging ideas, which are later codified. An example is recent research in urban forestry about both plant specification and planting densities in parking areas, in relationship to soil space and tree root zones. Past requirements and practices have often underestimated the amount of root space needed by trees for healthy growth. New scientific studies about soil space requirements for urban

Green Parking Lot Design

As this document evolved, it became obvious that few other planning publications have addressed the environmental implications of paved parking areas in cities. The basics of parking lot design have not been significantly rethought since the 1950s. Parking lot technology has been handed down over the decades by transportation engineers, and the concrete and asphalt industries. One looks out the window at a rain soaked parking lot and asks, "Is there a better way? A more environmentally friendly way? Why doesn't that parking lot do more than store cars?"

One possible incentive for change is to create a rating system that relates parking to development impact. A model is the LEED (Leadership in Energy and Environmental Design) national rating system. Commercial building projects can achieve a Silver, Gold or Platinum rating based on the number of points achieved in five different categories (sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality). The LEED awards are promoting and recognizing voluntary innovations in Green Building Design, and are highly regarded by architects and interior designers.

The current LEED system (version 2.1), sponsored by the U.S. Green Building Council, doesn't require performance targets for outdoor elements of the rating categories. Certification of "Green Parking Lot Design" could include measurable achievement of any of these elements: pavement shading and cooling, vehicle screening, pedestrian management, habitat protection, irrigation management and tree preservation, as well as on-site stormwater management practices (such as permeable paving, micro-detention of water, and pollution interception).

As planners and designers re-invent parking lots, vehicle storage areas will not look like the places we park cars today. Design and incentives will play an important role in future changes.

plantings will probably influence future recommendations for parking lot design (such as number of spaces and use of semipervious surfaces), and planting concerns, including tree island width, length, and species selection.

PARKING AREAS – NECESSITY AND NUISANCE!

The automobile is an integral part of American society. While more transportation options are becoming available (such as public transit or ridesharing) many people have no viable alternative to the personal car for their transportation needs. Large expanses of parking space are needed to store these vehicles at their destinations. Most of the time, private cars are not transporting us down the road, but are parked somewhere.

Land development practices and urbanization trends have become part of major public debates and national policy. Imbedded within the larger questions of land use are concerns about the specific design and implementation of vehicular use areas. American society has become more informed about the environmental

consequences of individual parking lots, as well as the cumulative paved surfaces of entire cities or towns.

Scientific study has revealed that parking lots have many environmental effects. Acres of pavement can increase the severity of flooding, destabilize streambeds, reduce groundwater recharge, degrade water quality, raise local air temperatures, contribute to urban heat island effects, fragment natural habitat, and increase air pollution.

Parking lots are critical to the future of modern cities. While multi-level parking structures are becoming more common, real estate dynamics in the United States makes surface level parking the most common option. Are there ways to mitigate the negative effects of barren stretches of asphalt?

A single use approach must be replaced by creative, multi-functional practices that enhance environmental conditions and improve the quality of life for urban residents. Green code and law is one of a variety of strategies for improving the sustainability of cities and communities. Statements of purpose, followed by code that addresses parking lot geometry, vegetation densities and covers, and environmental performance will improve human and welfare, as the environment of urban areas is made more sustainable.

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APPENDIX A: SAMPLE PURPOSE STATEMENTS

Chapter 3 discussed how community values influence local land use policy, and how such policy is expressed in code as purpose statements. This appendix contains examples of purpose statements from various communities. The examples demonstrate the diversity of values and functions that are associated with urban trees and landscaping

City of Myrtle Beach, South Carolina
Code of Ordinances

Appendix A. Zoning
Article IX. Supplemental Development Provisions

Section 903. Tree Protection.
903.1. Intent.

Pursuant to authority conferred by the South Carolina Code of Laws, to promote the public health, safety and general welfare; to reduce noise, heat and glare; to reduce air pollution; to prevent soil erosion; to improve surface drainage and minimize flooding; to ensure that noise, glare and other distractions of movement on one area not adversely affect activity within other adjacent areas; to beautify and enhance improved and undeveloped land; to provide a protective physical and psychological barrier between pedestrians and traffic; to create special places that are inviting; to create a civic identity; to counteract the heat island effect; to encourage energy and water conservation; to protect the wildlife habitat and sensitive ecosystems; to enhance real estate and economic values; to ensure that excessive tree cutting does not reduce property values; to minimize the cost of construction and maintenance of drainage systems necessitated by the increased flow and diversion of surface waters; to encourage the proliferation and replacement of trees on public and private property; and to allow trees to attain their natural shape and size while growing to maturity, the city council does hereby ordain and enact into law this tree protection chapter. The provisions herein shall not be interpreted to prohibit or unduly inhibit development of private property.

Hillsborough County, Florida (Tampa)
Land Development Code

Article IV: Natural Resources and Adequate Public Facilities

Part 4.01.00 Natural Resources
Section 4.01.02

A. The purpose of the Natural Resources Regulations is to set forth regulations regarding land alteration, the protection of soil and water, the protection of trees and other vegetation, and the protection of environmentally sensitive areas, in order to maintain the quality of life in Hillsborough County and protect the health, safety and general well being of the citizens of Hillsborough County.

B. Intent

It is intended that the implementation of these regulations accomplish the following objectives:

1. *Promote soil conservation by minimizing and controlling alterations of the natural terrain, and thereby reduce sedimentation and air and surface water pollution resulting from soil erosion.*

2. *Maximize the retention of trees, a valuable natural resource of the community.*

3. *Create an aesthetically pleasing and functional living environment to protect and enhance property values by conserving trees and other vegetation.*

4. *Protect environmentally sensitive areas from activities which would alter their ecological integrity, balance or character.*

5. *Ensure that the activities associated with excavating and the resulting excavation itself do not adversely impact the quantity or quality of surface water or ground water.*

6. *Ensure that the hauling of excavated material does not adversely impact public roads or bridges or public health, safety or welfare.*

7. *Protect surface water flow by controlling filling activities and changes in drainage patterns.*

City of Orlando, Florida
Chapter 60. Subdivision and Landscaping Ordinance

Part 2: Landscaping and Vegetation Protection
2A. General Requirements.

Section 60.201. Purpose of Landscape Regulations

The purpose of the landscape regulations is to protect the general welfare of Orlando citizens and visitors by establishing minimum standards for the protection of trees and native plant communities, to promote water conservation, to enhance the city's appearance, and to provide for the proper installation and maintenance of landscapes. The landscape standards are intended to eventually result in an urban environment which is in harmony with the surrounding natural environment. The landscape regulations are to achieve these objectives:

- *Conserve water by preserving existing native plants which are adapted to Central Florida seasonal precipitation rates, encouraging the use of plant materials specifically suited to the growing conditions of a particular location, and establishing standards for installation and maintenance of landscape plants and irrigation systems.*
- *Improve the appearance of commercial, industrial, and residential areas and to perpetuate Orlando's image as "The City Beautiful."*
- *Improve environmental quality through the retention and installation of vegetation, including improved air and water quality through the removal of carbon dioxide and the generation of oxygen, facilitation of aquifer recharge and reduction of storm water runoff, decrease air and noise pollution, prevent soil erosion and sedimentation, mitigate heat and glare through shade and evapotranspiration.*
- *Increase land values by providing landscaping as a capital asset.*
- *Provide human psychological and physical benefits through the use and arrangement of landscape materials to break up and moderate the monotonous and harsh urban built environment.*
- *Provide a haven for urban wildlife.*
- *To assist in the Protection of endangered or threatened plant species, habitats, and of rare or endangered ecosystems as regulated by Chapter 63, Part 2, Environmental Protection.*

Fayetteville, Arkansas
Title XV. Unified Development Code

Chapter 167: Tree Preservation and Protection
Section 167.01. Purpose

(1) It is the intent of this chapter to protect and promote the health, safety and general welfare and preserve and enhance the natural beauty of Fayetteville by providing for regulation of the preservation, planting, maintenance, and removal of trees within the city, in order to accomplish the following objectives:

A. Objectives.

1. To preserve existing tree canopy.

2. To create a healthful environment for Fayetteville residents, businesses and industries.

3. To moderate the harmful effects of sun, wind and temperature changes.

4. To buffer noise, air and visual pollution.

5. To filter pollutants from the air and assist in the generation of oxygen.

6. To reduce stormwater runoff and the potential damage it may create.

7. To stabilize soil and prevent erosion, with an emphasis on maintaining tree canopy on hillsides defined as Canopied Slopes in Chapter 151.

8. To provide habitat for birds and other wildlife.

9. To preserve riparian banks and beds, and prevent sedimentation.

10. To screen incompatible land uses.

11. To promote energy conservation.

12. To protect and enhance property values.

Objectives are immediately followed by B. Principles. The principles establish, using a list of statements, vegetation action priorities of preservation, on-site mitigation, off-site preservation, off-site forestation and lastly fines.

Virginia Beach, Virginia
Code of Ordinances

Appendix C: Site Plan Ordinance

Section 5A: Parking Lot and Foundation Landscaping
5A.1. Intent and Purposes.

The city council of Virginia Beach finds that Virginia Beach is blessed with a diverse and abundant cover of trees and vegetation and that such cover is of general aesthetic value to the city and that the ecological diversity and richness of the city makes it a desirable place for residents, owners, and visitors alike; and that the appearance of Virginia Beach from the public ways contributes ecologically and aesthetically to the growth and economic prosperity of the city; and also that the growth and development attracted to the City of Virginia Beach, because of its natural beauty, often times requires the removal of trees and other plant material, thereby contributing to the depletion of a most valuable natural resource, therefore, it is necessary to protect, preserve and restore this valuable asset. The city council declares the intent and purposes of this ordinance to be as follows:

a. To aid in stabilizing the environment's ecological balance by contributing to the processes of air purification, oxygen regeneration, groundwater recharge, and stormwater runoff retardation, while at the same time aiding in noise, glare and heat abatement;

b. To encourage the preservation of existing trees and desirable vegetation;

c. To assist in providing clean air;

d. To provide visual buffering and enhance the beautification of the city;

e. To safeguard and enhance property values and to protect public and private investment;

f. To preserve, protect, and restore the unique identity and environment of the City of Virginia Beach and preserve the economic base attracted to the City by such factors;

g. To conserve energy; and to protect public health, safety, and general welfare through the reduction of noise, air, and visual pollution, light glare, and moderate air temperature;

h. To provide habitat for living things that might not otherwise occur or be found in urban and suburban environments.

City of Portland, Oregon
Title 33: Planning and Zoning Code

Chapter 33.248 Landscaping & Screening
33.248.010. Purpose

The City recognizes the aesthetic, ecological and economic value of landscaping and requires its use to:

- *Preserve and enhance Portland's urban forest;*
- *Promote the reestablishment of vegetation in urban areas for aesthetic, health and urban wildlife reasons;*
- *Reduce stormwater runoff pollution, temperature, and rate and volume of flow;*
- *Establish and enhance a pleasant visual character which recognizes aesthetics and safety issues;*
- *Promote compatibility between land uses by reducing the visual, noise, and lighting impacts of specific development on users of the site and abutting uses;*
- *Unify development, and enhance and define public and private spaces;*
- *Promote the retention and use of existing vegetation;*
- *Aid in energy conservation by providing shade from the sun and shelter from the wind;*
- *Restore natural communities through re-establishment of native plants; and*
- *Mitigate for loss of natural resource values*

This chapter consists of a set of landscaping and screening standards and regulations for use throughout the City. The regulations address materials, placement, layout, and timing of installation.

APPENDIX B: CODE EXAMPLES

This appendix contains examples of development code that include landscape and tree requirements. These examples demonstrate a variety of ways in which green law about vehicular use areas can be integrated with building and development code. For instance, some communities have placed all vegetation code into one chapter, others have distributed the vegetation requirements in association with land use chapters, and in some instances minimal legal requirements within the code or ordinances are supplemented by a companion manual. Presentation of these examples does not imply any endorsement or assessment of the quality of the code, as compared to other communities, but rather, the entire collection provides an overview of the diversity of regulatory strategies municipalities have adopted.

Web links are provided for each code example (accessed January 2004).

CODE TRADITIONS

Myrtle Beach, South Carolina

http://www.cityofmyrtlebeach.com/laws.html
Then use link: "Complete Code of City Ordinances"

Code of Ordinances
Appendix A. Zoning

Article IX. Supplemental Development Provisions
Section 903. Tree Protection.
Section 910. Landscaping Regulations

Section 903 of the Code of Ordinances addresses protected trees, landmark trees, and tree protection during clearing and development, including mitigation replacements. Section 910 contains exhaustive code regarding landscaping and trees and integrates some tree protection provisions, such as perimeter undisturbed areas, credit for undisturbed areas, and credits for existing trees saved – including those in vehicular use areas.

Orlando, Florida

http://www.cityoforlando.net/permits/default.htm
Then use link: "City Code"

Code of the City of Orlando, Florida
Chapter 60. Subdivision and Landscaping
Part 2. Landscaping and Vegetation Protection

Chapter 60 of Orlando's Code uses a point system to promote compliance with landscape requirements and to promote and protect native vegetation. Tree points are awarded based on tree size, approved native versus non-native species and whether vegetation is installed or retained. The greatest number of points is awarded for retained specimen native trees. The code specifies required point attainment levels for various land cover types. Procedures for identifying tree health and plant material quality are described. Maintenance expectations and restrictions (such as no topping) are laid out for protected vegetation.

Tree points apply to landscape requirements for vehicular use areas, including bufferyards, areas adjacent to streets and site interior areas. Site designers can appeal to the city for a reduction of up to 15 percent of the number of required parking spaces for a new development, with the space retained as unimproved reserve areas, to boost tree points. Street design modifications are also allowed in order to protect native plant communities.

Fayetteville, Arkansas

http://www.accessfayetteville.org/city_government/city_code/
Then use link: Title XV: Unified Development Code

Title XV: Unified Development Code
Chapter 166. Development.
Chapter 167. Tree Preservation and Protection.
Chapter 172. Parking and Loading.

Chapter 172 contains the core of the city's parking lot design and construction requirements. Standards for the number of spaces, organized by land use, include minimum and maximum numbers; shared parking is permitted. Section F specifies *Parking Lot Landscaping Requirements*. Included are provisions for timing of installation, irrigation, maintenance and replacement of failed materials. Perimeter and interior landscaping is given thorough treatment. Additional requirements are contained in a section of the Development chapter, 166.10, *Buffer Strips and Screening*.

In some cities code regarding trees and landscape has been consolidated into one chapter. In other cities, such as Fayetteville, landscape requirements are distributed among several chapters. References to the city's companion

Landscape Manual are found in many code locations. The 150 page manual is a tool to assure consistency of landscape planning and design, tree protection practices and plant installation and maintenance. The manual establishes the purposes of landscape through description of urban forest benefits. It also clarifies basic principles of tree physiology, and the space and growth needs for healthy trees. The manual is available at:
http://accessfayetteville.org/planning_development_and_building_safety/planning/planning_documents/

Leesburg, Virginia

http://www.leesburgva.org/departments/planning/
Then use link: "Zoning Ordinance (PDF Format)"

Zoning Ordinance
Article 12: Landscaping, Screening, Open Space and Lighting

The Zoning Ordinance of Leesburg was adopted in February 2003 and the Landscaping Article is a model of a straightforward code containing traditional requirements that are enhanced by innovative practices. Buffers, screening, perimeter plantings and plant materials specifications are the foundation of the Article. Allowances for tree preservation credits are provided. Twenty-year canopy goals range from 10 to 20 percent of paved areas, depending on land use zoning.

Coral Springs, Florida

http://www.ci.coral-springs.fl.us/
Then use link: Codes

Land Development Code
Chapter 25. Zoning

Article VIII. Off-Street Parking, Loading, And Other Vehicular Use Areas
Article IX. Minimum Landscape Requirements

The minimum standards article briefly specifies the critical aspects of landscape and tree standards, including: plant material installation, maintenance, specimen and historic trees, credits for existing plant material, plan approval. An associated 31 page *Landscape Manual* provides an "illustrative interpretation" of landscape standards contained within the code. The parking article has a provision that allows certain land uses to provide from 20 to 80 percent of parking area as alternate surface, including vegetation. The manual is available at:
http:www.ci.coral-springs.fl.us/neighborhoods/code/landscaping/landscape.pdf

CODE INNOVATIONS

Sacramento, California

http://www.cityofsacramento.org/clerk/General/codes.htm
Then use link: "Sacramento City Codes"

Title 17 Zoning
Division III. Development Standards
Chapter 17.64 Parking Regulations
Section 17.64.030 Development Standards For Parking Facilities.

Section 17.64.030 contains standards for parking lot shading. Attainment of at least 50 percent cover of the entire parking area (including parking stalls, drives and maneuvering areas) is required within 15 years after establishment of the parking lot. The code is supplemented by the document, *Parking Lot Tree Shading Design And Maintenance Guidelines*:
http://www.cityofsacramento.org/planning/longrange/curproj.html

Portland, Oregon

http://www.portlandonline.com/auditor/index.cfm?c=26811
Then use link: "Title 33 Planning and Zoning "

Title 33 Planning and Zoning
Chapter 33.248 Landscaping And Screening
Chapter 33.266 Parking And Loading

Chapter 33.248 provides basic landscaping and screening standards. Other chapters in the city's code may contain more stringent requirements in particular situations. A modest tree preservation requirement is included, as well as construction protection actions. The code references the *Portland Plant List* which includes prohibited plants that are known to be noxious or invasive.

Chapter 33.266 includes several important elements pertaining to parking lot design and environment. First it addresses parking space area by defining a range of minimum to maximum number of required parking spaces. Additional flexibility options include joint use of nonresidential parking areas, and the provision that bicycle parking space can be substituted for up to 25 percent of the required vehicular spaces. Second, landscaping requirements for parking spaces are found in the chapter, including lot perimeters, interiors and buffers. Lastly, landscape requirements include strategies to reduce the amount and rate of stormwater runoff from vehicle areas, including "perforated" curbs and the use of landscape strips to capture runoff. These and other management practices are expanded in a *Stormwater Management Manual:*
http://www.portlandonline.com/index.cfm?&a=12548&c=28044&x=6&y=7