CHAPTER 1
PORTLAND'S URBAN FOREST

INTRODUCTION

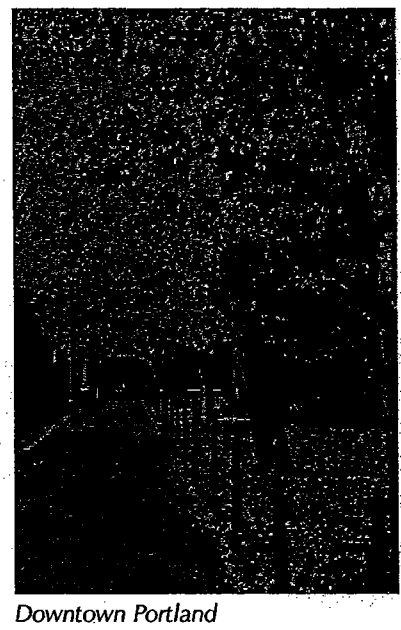
Portland's urban forest is a significant part of the environment and one that residents interact with directly and indirectly as part of their daily lives. This section describes Portland's setting, the urban forest and the many environmental, psychological and economic benefits that it provides to the community.

THE SETTING

Location. Portland is located in the northern portion of the Willamette Valley in Northwest Oregon near the confluence of the Willamette and Columbia Rivers. Tributaries of the Willamette course through the city above ground in streams and below ground in pipes. Lakes and wetlands associated with the Columbia River are located in the northern part of the city. Portland's physical landscape has been shaped by a spectacular geological history of volcanic activity involving massive basalt flows, the folding of the west hills, and catastrophic floods.

Downtown Portland is located on the Willamette River and is framed by the Tualatin Range to the west. To the east are forested terraces with low volcanic peaks rising out of the residential neighborhoods. On clear days, the Cascade Range and its foothills are seen in the distance. Mt. Hood and Mt. St. Helens ascend into the skyline. Neighborhood parks and open areas are scattered throughout the city.

Originally much of the area was heavily forested with Douglas firs, bigleaf maples and other species of deciduous trees. There were extensive wetlands associated with the streams and rivers, and large oak savannas. Most of these original habitats are gone or severely altered, but many natural areas have regenerated or been restored. These natural areas provide valuable habitat and important recreation resources for Portland's residents.



Downtown Portland

Climate. Portland climate is determined by its location between the Pacific Ocean and the high desert just above the 45th parallel. The Coast Range to the west buffers the effects of the marine air, and the Cascade Range to the east shelters the Willamette Valley from extreme summer and winter continental air masses.

Portland has a 'Mediterranean' climate with typically mild wet winters and clear dry summers. The average annual precipitation of 36.3 inches falls mostly as rain between October and May. The average January

mean temperature is 39.6 degrees F., while the average mean temperature for August, typically the warmest month, is only 68.5 degrees F.[6] The mild temperatures and moderate rainfall result in a long growing season that favors a diversity of vegetation and many Portland residents are avid gardeners.

This climate will change over time, although how much and when are unknown. According to the Climate Impacts Group at the University of Washington "nearly all the climate models show wetter winters and drier summers in the future." Possible impacts from climate change include reduced growth rates of the urban forest, greater fire risks, and changes in the kinds of species that thrive in the Northwest. If those models are correct, there will be more need for the moderating effects and increases to human comfort that the urban forest provides.[7]

Soils. Little information is available on urban soils in the central city's developed areas because most of the downtown area is covered by buildings and pavement and remaining areas have been graded, filled and compacted.[8] This downtown area is on the flood plain of the Willamette River where the slope is less than 3%. Street trees and other vegetation in these areas must be able to withstand poor or compacted soils.

Land east of the Willamette River is composed of several different soil complexes. Although much of the land has been disturbed, some areas retain the original qualities of a moderately well-drained loam soil. Elevations range from 50 to 400 feet. These soils can support a wide variety of vegetation although some species need summer irrigation to thrive in the dry summer conditions.

The soils in the West Hills are composed of deep silt mixed with volcanic ash deposits. A silty clay fragipan overlays basalt bedrock. Slopes are steep in many places and the potential for erosion and landslides is high. These soils underlie the mixed coniferous forest in the 5,000 acre Forest Park that serves as an impressive backdrop for the city and reminds Portlanders of the characteristic Northwest forest from which the city was carved.

Wetlands, Streams and Watersheds. The once numerous wetlands along the Willamette and Columbia Rivers have been greatly reduced but those that remain have great value for habitat, as well as some limited recreation. The sloughs along the Columbia and the Oaks Bottom area near the Willamette are being preserved and restored.

[6]*National Weather Service data (2002).*
[7]*University of Washington Climate Impacts Group (1999).*
[8]*According to the Soil Survey of Multnomah County (USDA Soil Conservation Service, 1983), most of the land in central Portland is classified only as "Urban Land." Original soils were gravelly loam, silt loam or silty clay loam with sandy materials.*

In addition to the Willamette River flowing through the heart of the city, there are numerous important tributaries. The most notable are Fanno, Johnson and Tryon Creeks. Development and activities in these streams and their watersheds have significant impacts on water quality and on fish and wildlife habitat. Smaller creeks and riparian corridors in the forested ravines of the West Hills provide additional habitat and environmental benefits. Watershed planning is being developed to preserve and restore the valuable functions of these areas.

Fish and Wildlife. Urbanization has had a dramatic impact on fish and wildlife through the loss of habitat. As wetlands are drained and filled, forests cleared and fertile valleys cultivated and built upon, habitat for many species has been and continues to be eliminated. Wetlands are especially critical for migrating waterfowl and shorebirds. They provide resting, breeding and feeding places for many bird species and for reptiles, amphibians and aquatic mammals, as well as fish. Coniferous forests provide important habitat for amphibians, mammals and many species of birds. Riparian trees and vegetation shade streams, providing important habitat for cool-water fish such as the federally-listed salmonids and other species.

Appropriate vegetation in parks, residential yards and community open spaces contributes to the food source and habitat of songbirds, butterflies and small animals. The quality and quantity of the urban forest also affects the fish and other aquatic species in our streams and rivers by cleaning and cooling water before it reaches the streams.

PORTLAND'S URBAN FOREST

Native Vegetation. At the time of European settlement, heavy forests covered most of the region. Stands of Douglas fir, western hemlock, and western red cedar dominated the landscape. Deciduous bigleaf maple and red alder were intermixed. Wetlands and flood plains along the river supported Oregon ash, willows, and black cottonwood. Oregon white oak and Pacific madrone grew in drier uplands. Understory upland vegetation included vine maple, western hazel, oceanspray, snowberry, thimbleberry, Oregon grape, salal, red huckleberry, ferns and forbs. Wetland species included elderberry, Douglas spirea, dogwood, sedges and rushes.[9]

As early settlers cleared the forest to build the city, the result was acres of stumps — and Portland's nickname of "Stump Town." Although most native trees and vegetation were removed, some native conifers still stand in small groups and as single specimens in parks and lawns. Native vegetation is being restored in many areas.

[9]*The "Portland Plant List," published by the Bureau of Planning, lists the trees, shrubs and ground covers native to the region. See Appendix for further information.*

"Trees reduce the temperatures of the heat islands that form in urban centers by shading pavement and structures. The larger the trees and the bigger the size of the green spaces, the greater the effect on climate."

Introduced Vegetation. In addition to supporting lush native forests, Portland's moderate climate nourishes vegetation from many other parts of the world including the Eastern United States, Europe and Asia. Early settlers to this area brought seeds and seedlings of plants native to their homelands. Nurserymen arrived soon after with stock to supply orchards and private pleasure gardens. By the turn of the century, a wide selection of ornamental plants was available.

While most introduced species fit well with the native landscape, some non-native species have very undesirable qualities. Plants such as Himalayan blackberry, Scot's broom, wild clematis and English ivy have invaded many natural areas and displaced more diverse and beneficial native plant communities. English ivy in particular is a problem in natural areas, as it smothers the native plants and creates a monoculture that has no value for wildlife. It has recently been listed as a Noxious Weed by the Oregon Department of Agriculture, and its transport, purchase, sale or propagation are prohibited.[10]

Most of the street trees in the city today are cultivars of introduced species.[11] Cultivars offer predictability in form and behavior for given situations. They are bred for certain features such as fall color, flower quality, disease resistance, or the ability to withstand difficult growing conditions.

In some areas, natives are appropriate for use as street trees, but they require adequate room and good growing conditions. The needs of different species must be carefully matched with the planting areas to ensure the success of each planting.

Urban Land Environments. As noted earlier, street trees are only one part of the urban forest. Five basic categories called Urban Land Environments (ULEs) make up Portland's urban forest. They are Residential; Commercial/Industrial/Institutional; Natural Areas and Stream Corridors; Transportation Corridors and Rights-of-Way; and Developed Parks and Open Spaces. The urban forest in each of these areas has similar characteristics and management needs. Chapter Four addresses these ULEs in detail.

Inventories and Studies. A number of inventories and studies have been done for various parts of the urban forest, beginning with street tree inventories in 1938 and 1976. More extensive city and regional canopy cover inventories have been undertaken recently, including one in 2003 by PSU professor Dr. Joe Poracsky and Mike Lackner. Their

[10]*Oregon Department of Agriculture.*
[11]*Cultivar - Cultivated variety.*

study looked at the current state of Portland's urban forest canopy, the changes in the amount and composition of the canopy over time, and the relationship of canopy cover to geography (neighborhood and land-use).

Current total canopy cover in Portland is estimated to be 26.3% with Forest Park included and 23.6% with Forest Park excluded. This is an *increase* of 1.2% from 1972 when the first data was collected. The greatest increases in canopy occurred in inner-east Portland, which can be attributed to Friends of Trees tree-planting efforts, and the greatest loss occurred in Forest Heights where many wooded areas have been cleared for development.

This study and others are described in greater detail in the Appendix. Current efforts are to coordinate data collection and make it available to bureaus and groups throughout the city for a variety of inventory and analysis needs.

BENEFITS OF THE URBAN FOREST

The urban forest provides numerous environmental, psychological and economic benefits. It is critical in providing a healthy environment for people, fish and wildlife. It affects our health and sense of well-being. It provides economic benefits by reducing the need for power generating plants and for water treatment plants. Most benefits can be measured, some cannot, all are significant.

Bigleaf maple (Acer macrophyllum)

ENVIRONMENTAL BENEFITS

Water Quality. Clean water is vital to the health of our environment. In every area of the city, the urban forest helps to provide clean water. The urban forest intercepts rain — eliminating runoff before it can occur. It absorbs and stores water which reduces the impacts of stormwater pulses, especially in developed areas, along streets and highways and in parking lots. It helps remove pollution from the water and reduces excess sedimentation. Riparian vegetation shades and cools the water surface and the air in riparian areas, providing better habitat for fish and wildlife.

Erosion Control. The hard surfaces common to urban areas are impervious to water infiltration, thereby increasing stormwater runoff volume and flow rate. The rapidly moving water erodes the soil, increases siltation in vital urban waterways and creates serious water pollution problems. Trees and other plants play a vital role in stabilizing soils and preventing erosion. Their roots slow runoff by holding the soil in place and absorbing water. Leaves diminish the impact of raindrops on bare land and mitigate stormwater volume.[12]

[12]*McPherson, et al. (2002), p. 9.*

The USDA Forest Service states, "Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20-50 percent in energy used for heating," and the US Department of Agriculture states, "The net cooling effect of a young, healthy tree is equivalent to ten room-size air conditioners operating 20 hours a day." (The National Arbor Day Foundation).

Energy Efficiency and Temperature Control. The role of vegetation in temperature control may become more important as hotter summers are expected for the Northwest because of global warming.[13] Well-placed vegetation can significantly reduce energy needs and increase energy efficiency by reducing heat loss in winter and increasing cooling in summer.

In winter, evergreen vegetation can reduce wind velocity that pulls heat out of buildings and provide an insulating effect by trapping air close to buildings. Deciduous vegetation around buildings allows for solar gain in the winter months, reducing heating costs. In summer, well-placed trees can intercept up to 90% of the solar energy, reducing the need for air-conditioning.[14] Since different tree species provide different effects, local conditions must be known to obtain the best results.

Trees reduce the temperatures of the heat islands that form in urban centers by shading pavement and structures. The larger the trees and the bigger the size of the green spaces, the greater the effect on climate.[15]

Plants can be used to manipulate air movement by strategically placing them to block undesirable prevailing winds and to provide effective barriers. Walls of vegetation can be used to direct air to sites where cooling is wanted.

Improved Air Quality. Many plants of the urban forest can reduce the effects of air pollution by removing pollution, both particulates and gases, from the air. This occurs because plants reduce winds, causing particulates to settle out of the atmosphere onto plants or the ground where precipitation washes the particulates into the soil below. Certain gases such as nitrogen oxides, carbon monoxide, chlorine and fluorine halogens, ammonia, and ozone are removed by absorption and stored in the leaves and needles of some woody vegetation. Trees also sequester and reduce atmospheric carbon dioxide (CO_2).[16] Portland's

[13] *Global warming refers to increased global temperatures resulting from increased carbon dioxide (CO_2) emissions produced by burning fossil fuels. The urban forest can reduce energy needs and consequently reduces CO_2 emissions.*
[14] *The USDA Forest Service states, "Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20-50 percent in energy used for heating," and the US Department of Agriculture states, "The net cooling effect of a young, healthy tree is equivalent to ten room-size air conditioners operating 20 hours a day." (The National Arbor Day Foundation).*
[15] *McPherson, et al. (2002), pp. 5-6.*
[16] *The US Department of Agriculture estimates that "one acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people." (The National Arbor Day Foundation).*

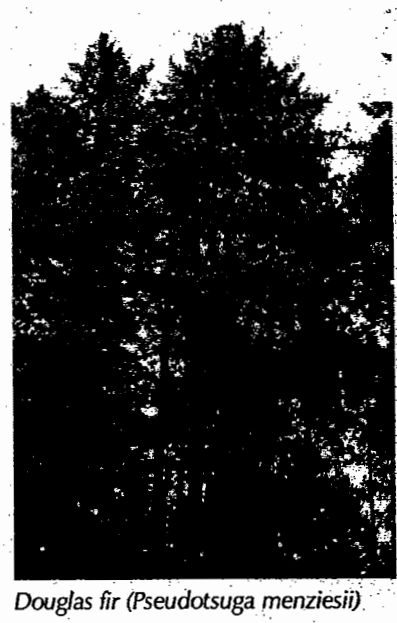
Friends of Trees estimates that a mature tree will sequester 223 pounds of CO_2 annually.[17] Trees improve air quality as they release oxygen through photosynthesis and they reduce ozone levels by reducing urban temperatures.[18]

While some plants in the urban forest can tolerate a degree of pollution, many others have a low tolerance for pollutants and suffer from its effects. Some trees take up and store pollutants while others can emit pollutants, so selection of appropriate trees is critical to maximizing air quality benefits.

Sound Control. The leaves, twigs and branches on vegetation absorb sound energy, as do grasses and other low growing plants, especially sounds in the higher frequencies which are the most bothersome to people. Plants dissipate sound energy by refraction that occurs when sound passes through vegetative barriers and bends around plant structures. Barriers of trees and vegetation in conjunction with walls and landforms can reduce highway noise by 6 to 15 decibels.[19]

Vegetation also masks unwanted sound by providing sounds of nature — rustling leaves and singing birds — to cover unwanted noise. People can focus on those natural sounds that are more pleasing than the noise of the city.

Fish and Wildlife Habitat. The urban forest provides habitat for many species of birds, mammals, fish, insects and amphibians that enrich urban life and offer opportunities for study. The larger the area, the greater the possibility for diversity of habitat and wildlife. While forested natural areas with native understory offer more biological diversity than other parts of the urban forest, all provide some habitat. Squirrels (mostly non-native) and chipmunks live in and around the trees; numerous species of birds abound in the vegetation; bats dwell in the secret places; fish inhabit the creeks, streams, and rivers. Wetlands, riparian areas, connected natural areas and urban landscapes provide important biodiversity.



Douglas fir (Pseudotsuga menziesii)

PSYCHOLOGICAL BENEFITS

Mental and Emotional Benefits. While people have always felt that the urban forest increases the enjoyment of everyday life and provides a meaningful connection between people and the natural environment, research now provides the scientific basis to support those feelings. Urban forests have a clear role to play in reducing stress-related im-

[17]*McPherson et al. (2002) pp. 7-8.*
[18]*McPherson et al. (2002) p. 8.*
[19]*McPherson et al. (2002) p.11.*

pacts on health such as lowering blood pressure, easing headaches and calming upset digestive systems.[20]

Studies show that exposure to nature and the urban forest reduces stress and provides significant restorative benefits. Various studies using slides of different subjects show that those of natural scenes and urban nature settings hold the viewer's attention more effectively than urban scenes without nature. Even slides of unspectacular natural scenes produce more positive emotional states than urban scenes without trees.

Significance and Symbolism. Trees have deep significance to people, especially in an urban setting that may offer little of the natural world. Trees and forests provide beauty and serenity that we can experience in the sensory realm. The constantly changing sights, sounds and smells of plants fascinate and delight us.

Following the devastation of Hurricane Hugo in Charleston, South Carolina, 185 residents talked about the special physical features of the city that were damaged by the storm. Thirty percent responded that some aspect of the urban forest was the most significant thing damaged. More than 10% of the respondents remarked that they had previously taken the urban forest for granted.

Trees have deep symbolic meaning. Many cultures associate trees with strength and wisdom, and we remember loved ones with memorial tree plantings.[21] Planting trees shows a commitment to the future and a desire to improve the places where we live. While the economic benefits of the urban forest are important to the well-being of the city, to many people they are insignificant compared to the positive experiences that trees and natural areas offer.

Aesthetics. Positive emotional states are also associated with being in or looking at things that are pleasing. Trees and vegetation provide much of the color, variety, texture, shape and sound that are pleasing in all seasons of the year. The Visual Preference Survey, conducted in Portland in 1993, showed that small parks and open spaces were uniformly desirable in all settings of the city. Other studies have shown that people prefer scenes that show well-maintained trees and vegetation. Research substantiates what people have known intuitively — trees and natural areas bring pleasure and provide benefits beyond their economic values.[22]

[20]*Examination of acutely stressed patients in pre-surgical holding rooms indicates that patients exposed to "serene" views (primarily displaying trees, water or other natural elements) have systolic blood pressure levels 10-15 points lower than patients exposed either to "exciting" pictures (e.g., a sail boarder leaning into the wind) or to no picture at all. Prison research suggests that views of nature from cell windows are associated with lower frequencies of prisoner stress symptoms, such as digestive illness and headaches (Hull and Ulrich, 1991).*
[21]*Dwyer (1994), pp.143-144.*
[22]*McPherson et al. (2002), p. 12.*

BENEFITS AND COSTS

As shown above, a healthy urban forest improves water quality, prevents erosion, reduces heating and cooling costs, converts carbon dioxide into oxygen and has positive effects on our health and well-being.

Trees provide benefits in their immediate location and to the surrounding community. From the individual property owner who has a more comfortable environment and increased resale value to community members who have better water and air quality to the fish and wildlife who have better habitats — all benefit from healthy trees and vegetation.

Cost Benefit Ratios. For all sizes of trees, the total benefits greatly outweigh the total costs. Generally, the larger the tree, the greater the benefits, but both benefits and costs increase with the size of the tree. A large tree, such as a red oak, is estimated to provide $50 worth of benefits annually for the first 20 years of its life and around $100 per year for the next 30 years — effectively producing around $4,000 worth of benefits over a 50-year life span.[23]

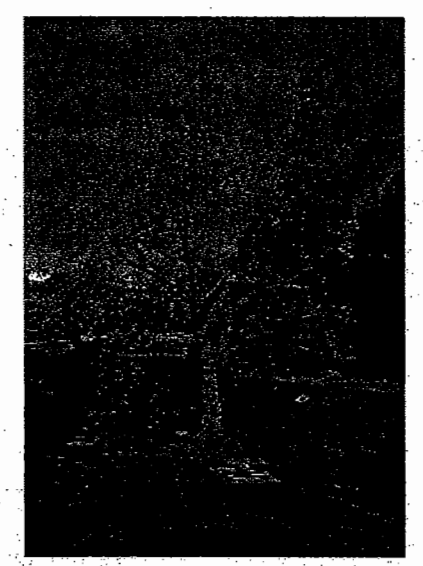
Northern red oaks (Quercus rubra)

It is critical to note that maximum benefits are gained from planting the right trees in the right places. Many conflicts can be reduced or avoided by careful planning and by matching tree characteristics to site conditions.

Increased Resale Values. Studies have shown that landscaping with trees is associated with an increase of 6 to 9%[24] in the sales price of residential properties. A study done in 1988 showed that a 1% increase in sales price was associated with each large front yard tree.[25] Intermediate and large sized trees, regardless of species, have a greater effect on resale values than small trees.[26] Typically, properties with trees show better and sell faster. Increased property values increase the community's tax base.

Stormwater Benefits. In addition to increased resale value, trees and vegetation provide cost savings to developers and property owners. Trees and vegetation mitigate stormwater runoff from new construction, reducing or eliminating the need for more costly piped systems. Reduced stormwater volume allows the City to address water quality regulations and infrastructure needs more effectively.

[23] *McPherson et al. (2002), p. 28, and personal communication with McPherson, 8/13/2002.*
[24] *Morales (1980), p. 308. The International City/County Management Association states, "landscaping, especially with trees, can increase property values as much as 20 percent," and the USDA Forest Service states, "Healthy, mature trees add an average of 10 percent to a property's value." (The National Arbor Day Foundation).*
[25] *McPherson et al. (2002), p. 10.*
[26] *Average annual benefits associated with property values range from $8 to $10 for a small tree, $20 to 23 for an average tree and $35 to 41 for a large tree. (McPherson et al. (2002), p. 31.*



Specimen tree in park

Economic Stimulus. Trees make the city more attractive to both residents and businesses. The National Arbor Day Foundation explains that "trees can be a stimulus to economic development, attracting new business and tourism. Commercial retail areas are more attractive to shoppers, apartments rent more quickly, tenants stay longer, and space in a wooded setting is more valuable to sell or rent."[27] In a survey conducted by the University of Washington, consumers indicated that they would be willing to pay 12% more for goods purchased in well-landscaped districts. The study also indicated 15% higher interaction between consumers and merchants, and tree-lined sidewalks were rated 80% higher for amenities and comfort.[28]

Recreational Value. Portland's urban forest includes wonderful recreation areas, ranging from the urban wilderness of Forest Park to the cool and refreshing local parks found in most of our neighborhoods. While it is important to provide ample open areas for active recreation, it is equally important to provide places for passive recreation. The urban forest provides places to observe wildlife, commune with nature and escape the stresses of daily life. Having recreation areas nearby reduces the need to drive fuel-consuming and carbon dioxide-producing vehicles to reach recreation areas.

Traffic Management. Trees function as "traffic calming" devices — effectively slowing speeding drivers while also adding to the aesthetics of the urban landscape. Vertical elements, including trees, reduce the "optical width" of a narrowed street, thereby discouraging speeding.[29] Trees and other plants may be used to direct not only vehicular traffic, but pedestrian traffic as well.[30]

Having a healthy urban forest has some costs, including establishing and maintaining trees and vegetation, repairing parts of the built infrastructure (sidewalks and utilities) due to conflicts with tree roots and canopies and replacing the urban forest as it ages.

The following information is based on average costs for the open-grown trees found in residential yards, along the streets and in developed parks, not the trees and vegetation in our natural areas.[31]

Establishment and Maintenance Costs. All plants need some level of care, especially to get established. Survival is greatly enhanced by selecting the right plants for the right places and by watering.[32] For resi-

[27] *Cool Communities.*
[28] *Wolf (1999), p.4.*
[29] *Project for Public Spaces.*
[30] *Grey & Deneke (1992) p.91.*
[31] *See Appendix for cost and benefit estimates for various elements of the urban forest.*

dential trees, that cost averages less than a $1/year.[33] After the trees are established, the largest single cost is for pruning. Property owners may need to prune or remove trees and vegetation as wildfire prevention measures, as well as for regular maintenance of trees on private property and in street rights-of-way.

There are clean-up costs after storms, and there are costs to remove and dispose of trees when they die. Other costs come from regular street cleaning of leaf litter and other debris from trees that can clog drain inlets and, on occasion, cause localized flooding.

Trees function as "traffic calming" devices — effectively slowing speeding drivers while also adding to the aesthetics of the urban landscape.

Urban Interface Costs. Trees in urban environments often occupy the same areas as sidewalks, streets and utilities, with resultant conflicts in some cases. Sidewalks and streets occasionally need to repair because of damage from street trees. Additional costs can come from repairs to sewer lines, building foundations and other built infrastructure elements. Costs to maintain trees in and around power lines are reflected in electric rates.

ESTIMATING THE VALUE OF THE URBAN FOREST

Recent studies provide some information about the value of the urban forest on a regional basis. It is estimated that by reducing the amount of water that needs to be treated, the stormwater retention value of the trees in the Willamette/Lower Columbia region is $20.2 billion.[34] Tree shade saves $1.8 million annually in residential energy savings, and reduced energy needs results in lower pollutant emissions. Trees in this region remove 178 million pounds of pollutants annually, saving $419 million.[35]

As noted earlier, inventories of the numbers of trees in Portland are incomplete. While we believe that Portland is comparatively well-treed compared to other cities, we don't know the exact number of trees in the city. The Appendix includes a description of the inventories that have been done to date. The following values are based on estimated replacement costs in areas where we have good estimates of the quantity of trees.

Street Trees. Using the general rule of thumb that a typical tree in good condition is worth $150 per inch of trunk diameter, measured at 4.5' from the ground, and assuming that an average street tree is 5" in diameter, Portland's estimated 200,000 street trees are worth $150 million.

[32]*The best time to establish trees is in the fall, when the soil is warm and the rains are soon to come.*

[33]*McPherson et al. (2002), p. 12*
[34]*American Forests (2001) p. 7*
[35]*This is estimated replacement cost.*