City of Menasha

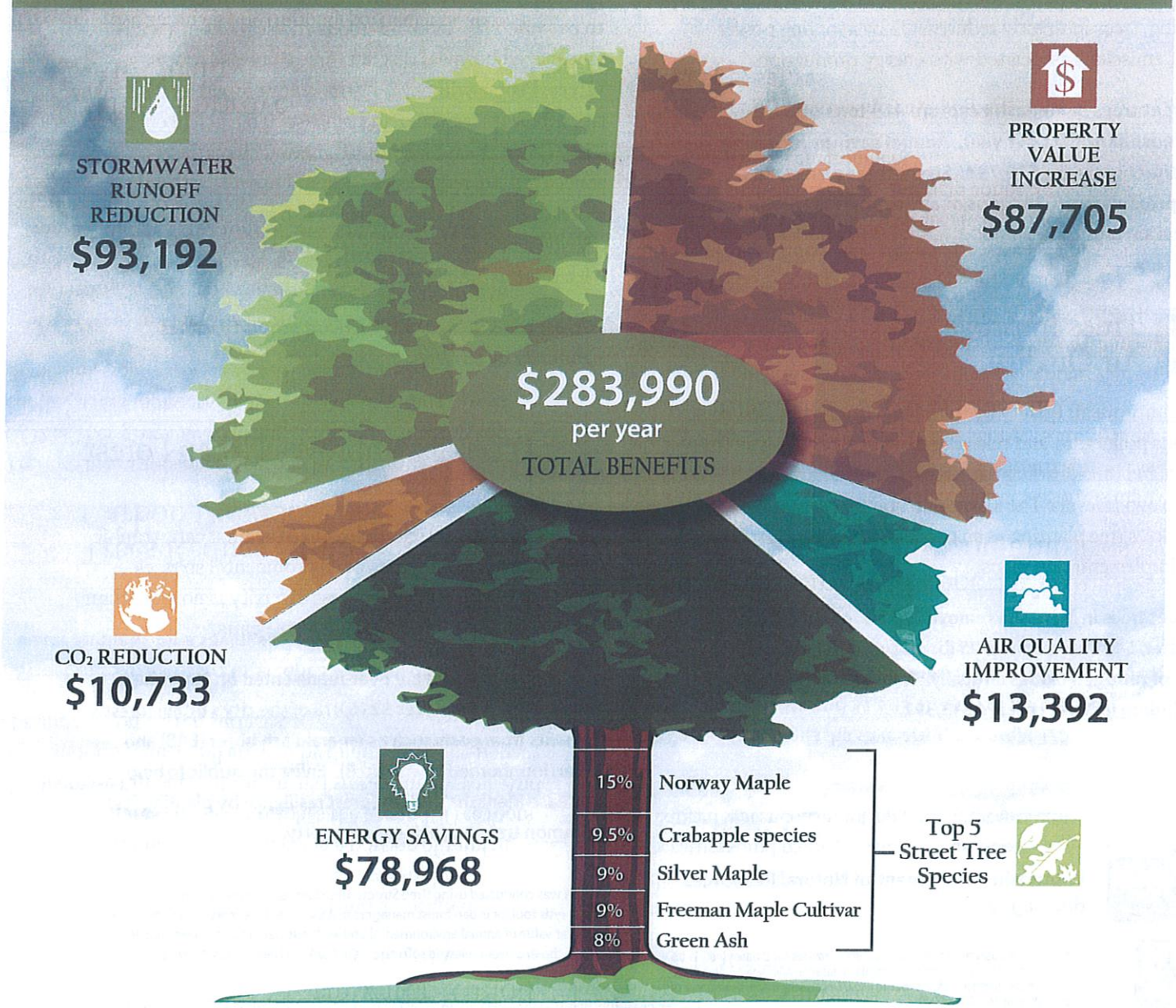
Street Tree Benefits

Menasha street trees provide thousands of dollars of environmental, economic and aesthetic benefits to the community. Over their lifetime, street tree benefits exceed the costs of planting and care, representing a 300 percent return on investment. Tree benefits increase over time highlighting the importance of not only planting trees, but of providing ongoing maintenance and protection. These benefits are a reminder of the worthwhile investment in our community forestry program.

Trees:

- **Reduce stormwater runoff**
- **Lower summer air temperatures**
- **Reduce air pollution**
- **Reduce heating and cooling costs**
- **Reduce atmospheric carbon dioxide (CO2)**
- **Enhance property values**
- **Provide wildlife habitat**
- **Improve health and wellbeing**
- **Improve learning and concentration**
- **Provide aesthetic benefits**

Annually **Menasha** public street trees provide[1]...



Trees Reduce Stormwater Runoff and Improve Water Quality

Trees reduce peak stormwater runoff and associated pollutants entering local water bodies. Trees reduce stormwater volumes by intercepting a portion of rainfall, which evaporates and never reaches the ground. Tree roots also increase rainfall infiltration and storage in the soil. And tree canopies reduce soil erosion by diminishing the impact of raindrops on barren surfaces.

Street trees in Menasha intercept 3,438,580 gallons of water annually for a savings of $93,192.

Trees Reduce Atmospheric Carbon Dioxide

Trees reduce atmospheric carbon by capturing and storing CO2 as they grow. By reducing demand for heating and cooling, trees indirectly reduce CO2 by avoiding power plant emissions associated with energy production.

Street trees in Menasha capture 429 tons of atmospheric CO2 per year. Annual savings including indirect costs are $10,733. Street trees also store approximately 5,287 tons of atmospheric CO2 for a total savings of $79,304.

Trees Improve Air Quality

Trees improve air quality by trapping particulates, absorbing gaseous pollutants, and releasing oxygen. By cooling urban heat islands and shading parked cars, trees indirectly reduce ozone levels. The Environmental Protection Agency recognizes tree planting as an ozone reduction measure in state implementation plans.

Street trees in Menasha remove 276 lbs. of particulate matter, 549 lbs. of ozone, 25 lbs. of sulfur dioxide and 93 lbs. of nitrogen oxides annually. Total annual savings including indirect cost are $13,392.

Trees Save Energy

Trees reduce the demand for energy to heat and cool buildings by providing shade, lowering summertime temperatures, and reducing windspeeds. Secondary benefits are reduced water consumption and pollutants emissions by local power plants.

Street trees in Menasha save approximately 375 MWH of electricity and 51,543 Therms of natural gas annually for a savings of $78,968.

Trees Improve Property Values and Beautify Our Communities

Trees are the single strongest positive influence on scenic quality in our community! They increase the attractiveness of retail business areas. Studies found shoppers are willing to pay up to 11% more for goods and services in a well-landscaped business district. Trees increase property values. People will pay 3-7% more for properties with many trees. Trees foster safer and more sociable neighborhoods. Views of trees ease mental fatigue and stress, help concentration, reduce sickness, and provide settings for recreation and relaxation. Trees also help reduce noise, provide a refuge for wildlife, and help connect residents with their natural environment.

Street trees in Menasha increase property values annually by $87,705.

Diversity Improves Urban Forest Resilience

A diverse palette of trees helps guard against catastrophic loss to insects and diseases or environmental stresses. A general guideline for urban forest diversity is no more than 5% of any one species, 10% of any one genus.

Ash and maple trees are over-represented on Menasha's streets. This jeopardizes $216,818 of the city's urban forest's benefits from pests such as emerald ash borer (EAB) and Asian longhorned beetle (ALB). Enlist the public to help increase Menasha's urban forest resilience by planting less common trees on their own property.

[1] Analysis was conducted using iTree Streets. iTree Streets is a street tree management and analysis tool for urban forest managers that uses tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits. The iTree Suite is a free state-of-the-art, peer-reviewed software suite from the USDA Forest Service. www.itreetool.org.

Tree graphic concept courtesy of City of New York Department of Parks & Recreation.

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City of Menasha

Urban Tree Canopy (UTC) Analysis

What is the Urban Forest and Urban Tree Canopy?

The **Urban Forest** consists of all public and private trees and shrubs in our community. This includes trees in yards, parks, open spaces, along streets and other land where trees are present. One way to understand the value of urban forests is by envisioning the layer of leaves, branches and tree stems when viewed from above. This layer is called **Urban Tree Canopy (UTC)**.

Why is Urban Tree Canopy important?

While we may not think of city trees as a typical "forest," these trees provide valuable services and benefits.

Trees in our community:

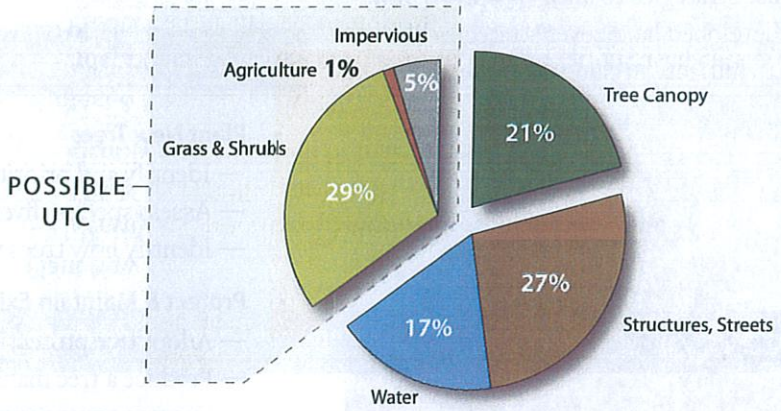
- **Reduce storm water runoff**
- **Lower summer air temperatures**
- **Reduce air pollution**
- **Reduce heating and cooling costs**
- **Enhance property values**
- **Provide wildlife habitat**
- **Improve health and wellbeing**
- **Improve learning and concentration**
- **Provide aesthetic benefits**

UTC benefits can be quantified. A single large tree can provide approximately $76 in average annual net benefits, $3,000 in benefits over a 40-year period. An increase in UTC brings an associated increase in benefits.

How much Urban Tree Canopy does Menasha have?

UTC analysis for Menasha shows[1]:

- **An existing tree canopy of 21% (968 acres)**
- **Trees could potentially cover an additional 35% (1,622 acres) of the city's land surface. These "Possible UTC" areas include grass, agriculture land, and impervious surfaces (e.g., parking lots, paved playgrounds & ROW).**
- **The remaining 44% (2,019 acres) of the city 's area is buildings, streets, water and other permanent features and is generally unsuited to UTC improvement.**



Many factors determine where best to plant urban trees. UTC analysis shows where additional trees will have the greatest positive impact.

UTC analysis for the FOX VALLEY METROPOLITAN AREA shows[2]:

- **An overall tree canopy of 20%.**
- **Possible UTC is 55%. The remaining land area of buildings, streets, water and other permanent features is 25%.**

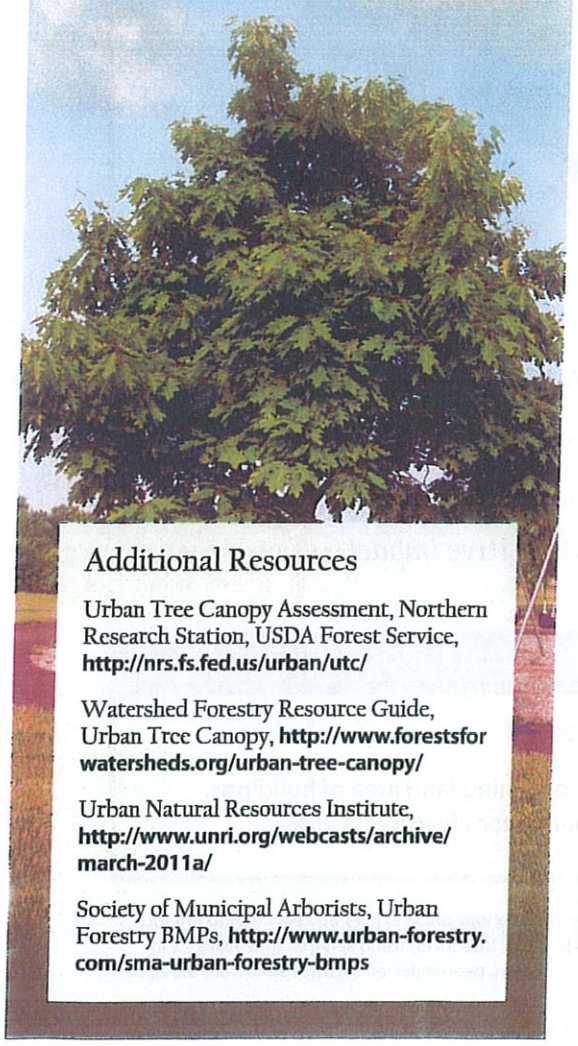
[1] Analysis was conducted using iTree Canopy. iTree Canopy offers a quick and easy way to produce a statistically valid estimate of land cover types (e.g., tree cover) using aerial images available in Google Maps. The iTree Suite is a free state-of-the-art, peer-reviewed software suite from the USDA Forest Service. www.itreetool.org

[2] Appleton, Greenville, Kaukauna, Kimberly, Little Chute, City of Menasha, Town of Menasha, Neenah

Why should Menasha set goals for UTC?

As urban development expands, it is increasingly important to balance growth with environmental wellbeing. To maximize UTC benefits, communities should set goals to protect, maintain and enhance their entire urban forest. Careful planning and goal setting are necessary to retain as much mature tree canopy as possible in areas with development pressure and to expand and sustain canopy in already urbanized areas. UTC goals can emphasize environmental quality (stormwater, air quality, carbon offsets), livability and economic vitality.

Though many communities have adopted land use strategies to mitigate sprawl, few have developed land cover strategies like UTC to mitigate urbanization effects.



Additional Resources

Urban Tree Canopy Assessment, Northern Research Station, USDA Forest Service, **http://nrs.fs.fed.us/urban/utc/**

Watershed Forestry Resource Guide, Urban Tree Canopy, **http://www.forestsforwatersheds.org/urban-tree-canopy/**

Urban Natural Resources Institute, **http://www.unri.org/webcasts/archive/march-2011a/**

Society of Municipal Arborists, Urban Forestry BMPs, **http://www.urban-forestry.com/sma-urban-forestry-bmps**

How to Set UTC Goals

Effective UTC goal setting requires involvement and commitment by municipal leaders and staff, local business community, neighborhood groups and citizens. The process generally includes four steps:

- **Assess Current UTC**
  - Can use iTree Canopy Analysis or GIS to arrive at UTC baseline.
- **Assess Possible UTC**
  - Identify opportunities on both public and private land.
- **Adopt Goals Based on Assessments**
  - If possible, institutionalize goals in appropriate ordinances, policies, or community master plan.
- **Develop Implementation Plan**
  - Identify strategies to meet goals based on available resources, political climate and stakeholder needs. Produce timeline and identify parties responsible for each strategy.

Potential Strategies to Implement UTC Goals

- **Plant New Trees**
  - Identify and prioritize planting sites community-wide.
  - Assess species diversity needs.
  - Identify how trees will be maintained.
- **Protect & Maintain Existing Trees**
  - Adopt tree protection ordinance and conservation easements.
  - Produce a tree management plan.
  - Ensure proper pruning in utility corridors.
- **Minimize & Restore UTC Lost to Age, Mortality & Land Conversion**
  - Specify strategies within Comprehensive Land Use Plan (e.g. Smart Growth).
  - Adopt subdivision, zoning, and landscaping ordinances.
  - Identify impact from EAB and potential management strategies.
- **Promote Public Education & Awareness**
  - Promote tree benefits (e.g., community website, newsletter, water bill insert)
  - Promote proper tree planting (e.g., Arbor Day, workshops)
  - Develop or participate in campaigns (e.g., First Downs for Trees, Taking Root in Oshkosh)

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TREE CITY USA®
BULLETIN
No. 55
Dr. James R. Fazio, Editor • $3.00

How Trees Can Retain Stormwater Runoff

Trees in our communities provide many services beyond the inherent beauty they lend to streets and properties. One of the most overlooked and underappreciated is their ability to reduce the volume of water rushing through gutters and pipes following a storm. This means less investment in expensive infrastructure and – importantly – cleaner water when the runoff reaches rivers and lakes.

© iStockphoto.com/Yougen

Drop by drop, rainwater is stored on the leaves of trees, slowing and reducing runoff. The collective effect of this simple action can make a huge difference in a community.

Have you ever stood under a tree that has served as an umbrella during a sudden downpour? Not a good idea when lightning is present, but otherwise the canopy offers welcome shelter.

The next time you experience the umbrella effect, consider the amazing service each tree provides to the quality of our environment. Aside from keeping you dry, the leaves and bark of a tree retain a huge amount of water, allowing some of it to evaporate and some to more slowly reach the ground. Depending on size and species, a single tree may store 100 gallons or more, at least until it reaches saturation after about one to two inches of rainfall. When multiplied by the number of trees in a community, this interception and redistribution can be significant. It is estimated that the urban forest can reduce annual runoff by 2 – 7 percent. This reduction can be converted into dollar savings due to the use of smaller drainage and artificial retention systems. When trees are combined with other natural landscaping, studies have shown that as much as 65 percent of storm runoff can be reduced in residential developments. In fact, sometimes even 100 percent of rainfall can be retained on site.

Through the collective action of leaves and the anchoring and absorbing effects of roots, trees also contribute to soil stabilization, cleaner water and the recharge of groundwater that serves as the drinking supply for over half the nation's population. The role of trees in stormwater retention and its resulting benefits to public health and municipal budgets deserves greater appreciation. It is one more reason why the planting and care of trees in our communities is of critical importance.

Published by
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Pioneering Research Leads to Useful Applications

For nearly a century scientists have been studying the influence of forests on rain and snow retention in the mountains. This is important for determining stream flows and making decisions about reservoir management and irrigation schedules. In 1996, scientists at UC-Davis and the USDA Forest Service took a new look at trees and rainfall retention. These studies focused on the potential of individual trees in urban settings.

The work continues today, but research scientist Dr. Qingfu Xiao explained some of the early work he undertook with Dr. E. Gregory McPherson and other colleagues at the Center for Urban Forest Research at Davis, California. The idea was to develop methodology and mathematical models that would explain and predict how much rainwater is intercepted by the leaves and bark of trees. Eventually, this would be refined and described on a species by species basis because retention potential varies with tree structure, bark characteristics and other physical features. The end result has been the inclusion of this information in the i-Tree suite of software programs. These programs, in turn, provide empirical assessment of the benefits of urban trees and offer research-based guidance for cost-effective planting and care.

The initial research was complicated. It went far beyond simply measuring the amount of water reaching the ground under a tree vs. on open land. Instead, it considered seasonal conditions, the 'architecture' of the tree, and the angle, intensity and duration of rain storms. It even considered the size of raindrops! Importantly, leaf sizes, quantities and angles of attachment had to be evaluated, as well as the texture and amount of bark on limbs and trunk. Finally, apparatus was installed to help with measurements each time it rained. Eventually, rather than waiting for rain storms, the researchers constructed simulators and used computer modeling to allow for as many test variations as desired.

Helpful Tools in the i-Tree Suite

In 2007, a series of software programs began being released to help quantify the contributions of urban trees and serve as a modern guide in their management. Several of these aids clarify the value of trees in reducing rain runoff and helping to keep waterways clean.

i-Tree Streets (formerly STRATUM) focuses on the benefits provided by a municipality's street trees. It makes use of a sample or complete inventory to quantify and put a dollar value on the street trees' annual environmental and aesthetic benefits.

i-Tree Hydro simulates the effects of changes in tree cover and impervious surface areas on stream flow levels and water quality. One use of this tool may help communities incorporate urban vegetation into meeting standards of the Clean Water Act.

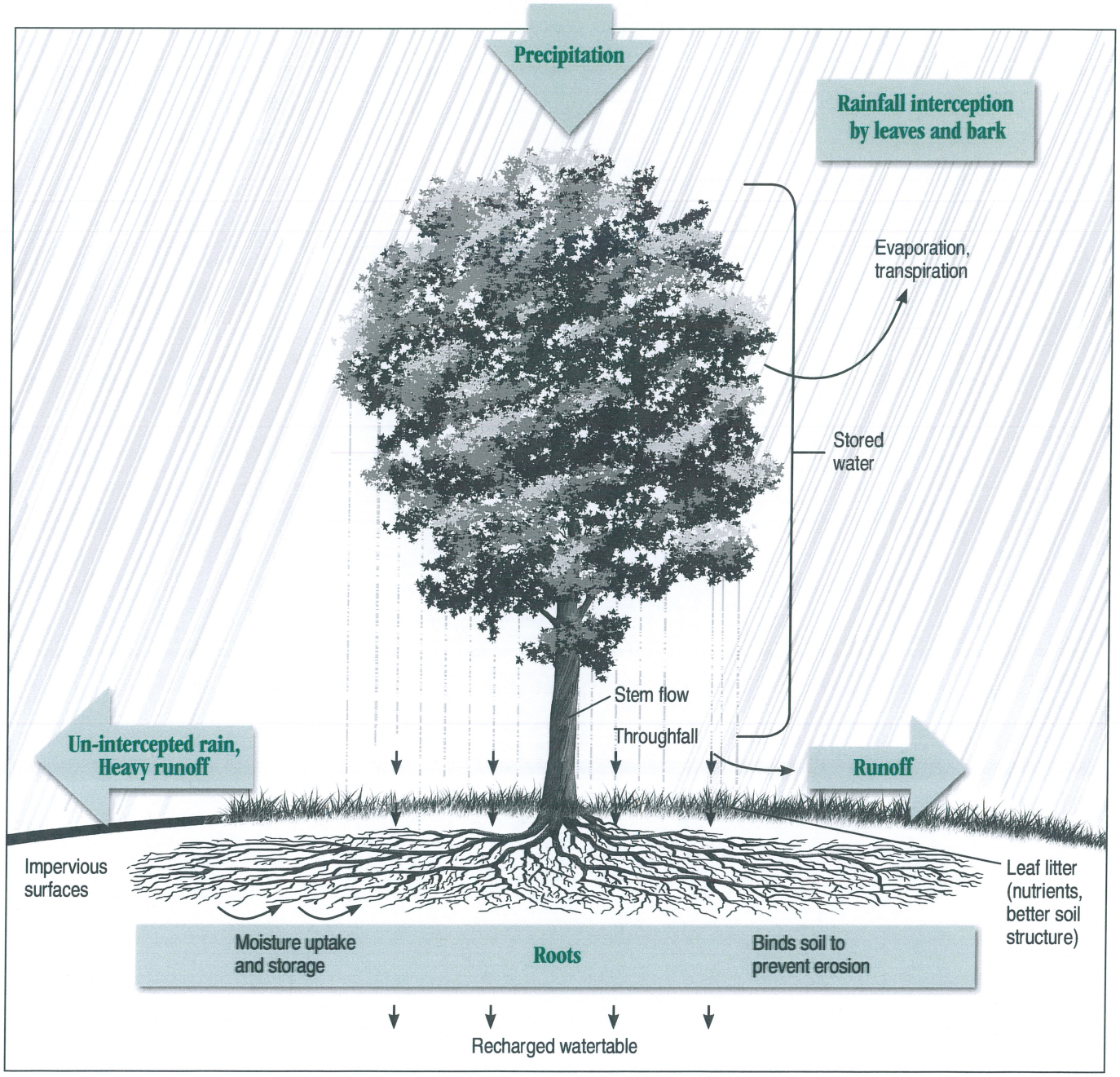
i-Tree Species is designed to help urban foresters select the most appropriate tree species to plant or maintain based on environmental function and geographic area.

i-Tree Vue uses national land cover data maps to assess a community's land cover, including tree canopy, and some of the ecosystem services provided by the existing urban forest. The effects of different planting scenarios on future benefits can also be modeled.

Courtesy of Qingfu Xiao

Using unique field apparatus, scientists were able to study what happens to rainwater as it is intercepted by urban trees.

Important Ways a Tree Helps with Stormwater Management



Trees help reduce stormwater runoff in several ways. One is to intercept falling rain and hold a portion of it on the leaves and bark. Part of this intercepted water will evaporate and part will be gradually released into the soil below. At the surface of the soil, fallen tree leaves help form a spongy layer that moderates soil temperature, helps retain soil moisture, and harbors organisms that break down organic matter and recycle elements for use in plant growth. This important layer also allows rain water to percolate into the soil rather than rushing off carrying with it oil, metal particles and other pollutants. Below ground, roots hold the soil in place and absorb water that will eventually be released into the atmosphere by transpiration.

More Ways That Trees Can Help

Whether standing alone to intercept rain or working in conjunction with water-retention facilities, trees can make significant contributions. Their benefits are practical and can save money for the community, but they also add beauty and that counts, too.

Vegetative Swales

As impervious surfaces spread with the increase of paved roads, parking lots, driveways and even former lawn areas, the use of swales is more important than ever. The potential of this facility was well demonstrated by the Center for Urban Forest Research in a Davis, California, parking lot. Using a control area for comparison and after 50 storm events and 22 inches of rain, the researchers credited the swale with reducing surface runoff by 89 percent and reducing pollutants by 95 percent.

While some communities require swales in new developments, the vegetated aspect is sometimes overlooked. Designing with plant materials appropriate to the climate and site is important, as is a plan for occasional maintenance, but the effort is most worthwhile. Not only can trees and other vegetation provide the benefits described on page 3, they add to the beauty of the area, help 'calm' traffic, and offer the welcome cooling effect of shade in the summer. A swale with only rock or sod is depriving the neighborhood of a full return on its investment.

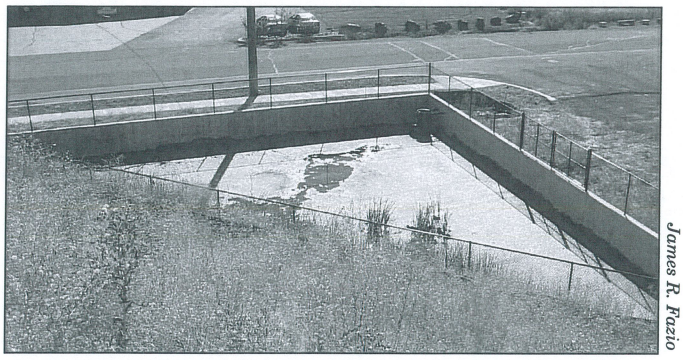
© Seattle Housing Authority

A streetside swale can be attractive as well as useful in retaining and cleaning stormwater runoff.

Stormwater Basins

A stormwater basin is similar to a swale but is generally not linear. Basins are often used in housing developments, especially if the streets and lots do not lend themselves to swales. Designs of basins vary widely. Some are simply concrete boxes that look like fenced, un-peopled swimming pools. They are often eyesores and reduce the space to a single use that contributes little else than the retention of water. On the other hand, stormwater basins can be built to serve as picnic grounds or free play areas during dry weather. Others appear as natural areas, providing open space, wildlife habitat and a touch of beauty.

> *Fencing or hiding stormwater facilities out of view not only loses the opportunity to create an aesthetically pleasing site design, but also sends the message that stormwater is an attractive nuisance. While there are legitimate concerns for safety and liability, these concerns can usually be resolved with careful design consideration, such as specifying shallow facility depths with gentle side slopes.*
>
> **– From: Portland Stormwater Management Manual**



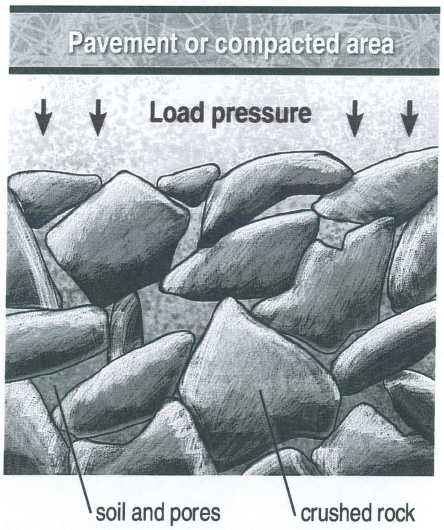
James R. Fazio

James R. Fazio

Community policy can make the difference between ugly, single-use stormwater basins and those that provide not only function but open space, a refuge for wildlife, and a touch of beauty.

Structural Soil

One of the most significant urban forestry developments in recent decades has been the design and use of structural soil. Pioneered by Dr. Nina Bassuk at Cornell University, structural soil can be used beneath sidewalks and parking lots to provide both the strength needed for paving or compaction and a livable environment for tree roots.



In some cases, the use of structural soil can result in zero runoff from a site. Silva Cells, crate-like structures filled with soil, have much the same engineering attributes as structural soil and provide even more growing space for roots. Either way, the result is healthier, more robust urban trees and more water retained onsite.

There are several research-tested benefits provided by structural soil:

- It provides a reservoir for runoff that can then percolate deeper into the subsoil and eventually groundwater.
- It allows deeper, better root development. In turn, this means larger tree canopies, more intercepted precipitation and more uptake by roots for transpiration.
- It can be used under paved areas where space for swales is not available.
- Normal amounts of surface pollutants are intercepted before reaching waterways. Immobilized contaminants can then be transformed by soil microbes or taken up by roots.
- Utilities can share the space.

Notes: Type of soil will affect infiltration. Where soils do not accommodate a reasonable rate of percolation, drain pipes may be necessary. Too much pooling of water will cause tree damage or death. Also, where limestone gravel is used in the structural soil mix, pH may become higher than in the native soil. In this case, plant species that can tolerate more alkaline soil.

Tree Pits

Even traditional tree pits can contribute to retaining stormwater runoff. If engineered for water to drain into the pits (sloping pavement, curbs with inlets, etc.), these are called 'stormwater-capturing tree pits.' Their usefulness is enhanced with greater soil volume and by connecting individual pits with trenches. Of course, as with structural soil, it is important for the subsoil to be able to receive percolating water or a drain system is necessary to prevent drowning the root system.

Riparian Buffers

Trees along the shores of lakes and the banks of rivers and streams are more than decorations. Not only do their canopies intercept some of the rain and reduce its impact, their roots anchor the soil and help take up leached chemicals before they reach the body of water. Shrubs in the riparian zone also help slow flood water. Where banks are washed away or heavily impacted, a range of bioengineering techniques are available using natural materials for restoration.

Kestrel Design Group, Inc.

Development and the spread of impervious surfaces produced more stormwater runoff than could be absorbed by the banks of Pine Creek in the City of Maple Grove, Minnesota. The creek has now been restored using a combination of gradient control, rock 'armor,' and planting native vegetation that will eventually include restored tree cover. Bioengineering techniques result in living, self-repairing systems that grow stronger with age.

Cities Putting Trees to Work for Stormwater

There is untapped potential in utilizing trees to address stormwater runoff in urban areas. Traditional approaches used by most municipalities to manage urban trees have focused on short-term aesthetic goals often to the detriment of tree health and full realization of ecosystem services provided by trees. Many municipalities are reluctant to expand tree programs due to budget, staffing, and liability issues. However trees are useful and valuable components of city stormwater infrastructure and provide measurable reductions in runoff volume and pollutant loads. Municipalities should explore opportunities to expand tree planting programs and incorporate trees into engineered stormwater systems. Trees are not just landscaping placed on top of city infrastructure, they are city infrastructure.

– Shirley Trier, Davey Resource Group

Throughout the nation, communities of all sizes are beginning to include trees in their plans to meet federal standards for water quality. Many, however, are slow to see the relationship between trees and stormwater management. Local tree boards need to embrace the challenge of educating engineers, city officials and the general public about the potential of green infrastructure.

The Portland Example

Portland has perhaps the most comprehensive stormwater management program in the nation. With over 37 inches of precipitation annually and important rivers and streams for recreation and fish habitat running right through the city, it is little wonder that Portland places high priority on managing stormwater runoff. As new development occurs, city officials view sustainable stormwater management as the preferred alternative to the traditional piped approach, and mandate onsite stormwater management to the degree possible. According to Portland's Stormwater Management Manual, "Vegetation may be one of the most cost effective and ecologically efficient means available to improve water quality."

The city's guidelines and strict regulations apply to:

- Properties where new offsite discharges will occur or new connections to the public system are required.
- Any project that develops or redevelops over 500 square feet of impervious surface.

The city's goal is to have developments or other projects contain enough runoff onsite to handle the 3.4 inches of rain expected in a '10-year storm.' The following three steps keep trees in the picture while helping developers understand the city's goals and guide them through the application and permit processes:

1. Create an informed project team.

The project team must go "beyond traditional civil engineering expertise." It should include diverse disciplines, all prepared to integrate sustainable stormwater solutions early in the design process. Examples of such team participants include: landscape architects, geologists, geotechnical engineers, planners and licensed design professionals.

2. Maximize permeability, minimize offsite discharge.

Maximize the site's permeability by retaining existing trees and greenspace and by using strategies like pervious pavement and ecoroofs. Minimize offsite discharge by creating a site design that limits pavement and building footprints. These strategies require integration of decisions at all levels of the project, from site planning to materials selection.

3. Use stormwater as a design element.

Instead of pipes that hide water beneath the surface, green systems can work with natural land forms and land uses to become a major site design element. Starting in the conceptual design phase and with an evaluation of a site's infiltration potential and drainage patterns, designers can create a more aesthetically pleasing relationship to the natural features of the site and provide multiple benefits. This, in turn, can result in:

- Recreational opportunities
- Maximized land values
- Improved project marketability
- Landscape and screening requirements being met
- Providing wildlife habitat
- Providing environmental education

Control

'Grey to Green Initiative' Projects

In many established neighborhoods, Portland's infrastructure – like that in many American cities – is aging and needs to be repaired or replaced. Instead of traditional renovations, the 'Grey to Green' approach implements the kind of techniques described in this bulletin. Incentives for going green include a reduction in stormwater user fees. To encourage tree planting, one incentive is that the city helps residents by paying a portion of new tree costs in addition to reducing fees. The larger the species at maturity, the larger the incentive! The city also promotes tree planting through the use of volunteers and by working with contractors on various projects. In all cases, the city's policy is to focus on green street improvements and private stormwater investments first, followed by traditional pipe replacement and upgrades where required and financially appropriate.

Is it working? In one creek basin alone, the program:

- Anticipates saving more than $58 million by integrating green infrastructure and pipe replacement and repairs, 40 percent less than the cost of traditional solutions.
- Sewer backups and overflows are being reduced.
- Potentially more than 20,000 residents and hundreds of small businesses will be engaged in stormwater initiatives.

Throughout the city:

- More than 900 green street facilities are being constructed and incentives were provided or are available for 150 targeted private improvement projects.
- Over 10,000 new street trees and 60,000 seedlings in natural areas have been planted.
- Habitat in environmentally sensitive areas is being restored, including the removal of invasive species and the planting of native tree and shrub species.

Naomi Tsurumi

Through partnerships with Friends of Trees and volunteers, street trees are being planted to help with stormwater management in Portland, Oregon. The results of using incentives for homeowners exceeded expectations with more than 1,000 new yard trees planted in the first years of the 'Grey to Green' initiative.

Other Blue Ribbon Cities

The Environmental Protection Agency cites several other cities as leaders in the use of trees and other vegetation for stormwater management. These include:

Chicago – Its green roof demonstration on the top of City Hall resulted in numerous others throughout the city, as well as heightened awareness about green infrastructure.

Lenexa, Kansas – Using both regulatory and non-regulatory approaches, Lenexa has created riparian greenways through a stream setback ordinance, protecting natural areas and implementing other green infrastructure practices.

Philadelphia – Demonstration projects and green infrastructure used in planning and development has saved the city approximately $170,000.

Pittsburgh – In addition to having the first ever LEED certified convention center, Pittsburgh is using natural systems to help absorb, infiltrate, reuse and evaporate runoff.

Seattle – Rain gardens, rain barrels, downspout disconnection, swales, green roofs and other green infrastructure techniques are being used along with a campaign to reduce impervious surfaces.

Milwaukee – City funding is paying off in reduced runoff and improved water quality through downspout disconnects and several greening programs.

City of Chicago

Trees, shrubs and other vegetation atop the city hall building in Chicago help slow and retain stormwater runoff as well as reduce the urban heat island effect. The site has served as a demonstration of what can be done with beneficial results elsewhere in the city.

EPA is the Source of Regulations and Help

The Environmental Protection Agency was an outgrowth of the original Earth Day in 1970. It was created to establish and enforce environmental standards that "protect human health and safeguard the natural environment." Today the EPA is challenged to provide federal leadership in the area of stormwater management and other sustainable practices. The agency recognizes trees and other vegetation as part of the 'best management practices' that can help it attain its goal of protecting the quality of our nation's water.

For More Information

Due to the technical nature of much of the material in this issue, its thorough treatment is well beyond the page limits of a bulletin. To find links and other sources that will provide more details, please visit arborday.org/bulletins and click on No. 55.

James R. Fazio

Conifers have even more rainwater interception potential than deciduous broadleaf trees, but both can have a significant impact on the volume and purity of storm runoff.

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Published for the *Friends of Tree City* USA by

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