New Britain's Urban Forest

A Report on the Status and Future of Trees in the City

Prepared for the City of New Britain

by the Central Connecticut Regional Planning Agency

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One of many mature trees in Walnut Hill Park.

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Executive Summary

This report examines the City of New Britain's tree canopy cover. Tree canopy cover, the percentage of a city that is covered by trees (as seen in an aerial view), provides many valuable economic, social, and ecological benefits.

Fig. 1 The services this young tree provides will increase as it matures.

Tree canopy cover services include[1]:

- Cleaner air
- Cleaner water
- Lower stormwater infrastructure costs
- Shade and subsequent lower cooling costs
- Higher property values
- Higher business revenues
- Better physical and mental health

Unfortunately the services tree canopies provide are often undervalued. As a result, many cities may not recognize the importance of proper tree canopy maintenance nor may they acknowledge the value of planting additional trees. In an effort to better understand the value of New Britain's current tree canopy cover, this report quantifies the current value of services provided by the canopy cover. The report also explores opportunities to increase the canopy cover and thus the value of the services.

An analysis of the City of New Britain reveals that the city currently has a tree canopy cover of 32%. The benefits are estimated to be valued at $18.6 million annually while the estimated costs are $1.9 million annually. This results in net benefits of $16.8 million annually. When compared to other urban communities across Connecticut, New Britain's canopy cover falls short of the average urban community canopy cover of 49%. A lower canopy cover also means New Britain is not receiving as many benefits as its counterparts. To determine how to enhance the tree canopy cover (and the benefits), this report identifies available locations throughout the city that may accommodate additional trees.

There are many locations throughout the city that may be appropriate for tree planting. These locations include parks, schools, streets, and residential properties. A total of 41,125 trees could be planted in these

locations across New Britain; this would increase the canopy cover to 40%. In terms of New Britain's street- and park-scape, this represents a 70% increase in tree cover. With an increase in canopy cover, the value of the benefits would also increase. The benefits of New Britain's suggested canopy cover are estimated to be valued at $23.1 million. While obtaining this level of cover would take an additional investment of $3.2 million, it would increase annual benefits of the city's canopy cover to $19.9 million, or an additional $3.2 million per year over what the city currently receives. That is, the benefits of increasing the city's canopy cover are projected to far outstrip the costs of additional tree planting and maintenance.

The report concludes by outlining a framework for New Britain to develop a tree planting program to increase its canopy cover. This framework is intended to serve as a guide, informing New Britain as to how a planting program can be developed and implemented city-wide. While more work will have to be done, this report seeks to demonstrate tree planting is economically feasible and will generate far more value than it demands in city resources.

Fig. 2 While downtown New Britain has some street trees, there is ample room for more.

Fig. 3 Some neighborhoods already have a dense canopy cover.

Why are trees good?

Trees are key to a healthy city. A flourishing urban tree canopy provides a host of benefits and services. These include: (1) environmental services – stormwater mitigation, air quality mitigation, ecological balance; (2) social enhancement – improved mental and physical health, a nurtured community, a sense of place; and, (3) economic growth – increased housing prices, amplified commercial income. These benefits give cities strong incentives to maintain a robust tree canopy. Understanding these positive outcomes of planting trees and embracing the importance of trees in the landscape can help improve the condition of urban places across the United States.

Fig. 4 Shade can reduce a building's heating and cooling costs.

Temperature and Microclimate

Cities tend to be hotter than suburbs and rural areas. This is partly because urban environments have a greater amount of impervious surfaces, which include paved roads, sidewalks, parking lots, and roofs. These sealed surfaces absorb sunlight. As the surfaces heat up, they also warm the surrounding air. This contributes, in part, to the urban heat island effect.

By shading buildings and streets, trees can reduce the amount of heat absorbed by impervious surfaces and mitigate the urban heat island effect. As a result, demand for air conditioning during warmer months decreases along with building cooling costs and energy use. The shade provided by trees can reduce air temperatures by up to 9°F. Through evaporation, a tree's release of water vapor further reduces air temperatures. Trees release excess water into the air as vapor through pores, or stomata, on leaf surfaces. As the vapor is released, it cools the surrounding air. This can reduce noon time peak temperatures by an additional 3.5 to 5.5°F. Thus, by providing shade and releasing water vapor, trees cool urban environments and reduce cooling costs.

Trees also reduce heating costs in the winter. Trees act as a wind barrier and can reduce wind speed by up to 60%. This prevents cool winter air from entering interior spaces, reducing heating costs. For instance, a 50% wind speed reduction yields a 7% reduction in heating energy.

To moderate building temperatures to reduce cooling and heating costs and save energy, it is best to plant deciduous trees on the east and west sides of buildings. Deciduous trees' loss of leaves in the fall allows more sunlight to reach building roofs when such heat can be the most beneficial. This allows trees to cast shade in the summer while enabling the sun

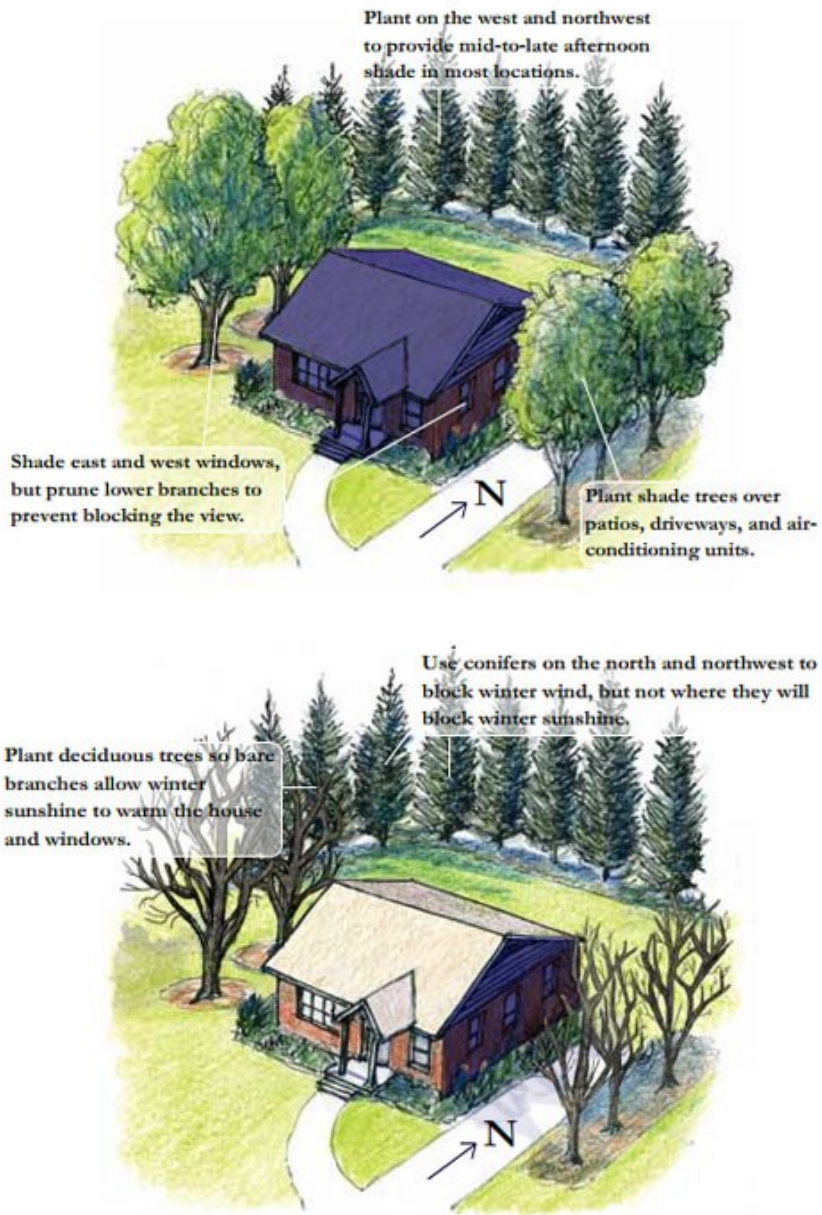


Fig. 5 Careful placement of deciduous and coniferous trees can significantly affect a landscape's microclimate.

to warm the building in the winter. To block wind and prevent cold air from penetrating interior spaces in the winter, evergreen trees should be planted on the north side of buildings (see Figure 5 for proper tree placement).

Carbon Storage

Cities with traffic congestion, industrial activities, power plants, and other carbon emission sources release large amounts of carbon dioxide. Many urban areas are recognized as carbon "hot spots" because of the release of large amounts of carbon. The increased carbon dioxide emissions form a dome over cities, increasing temperatures that in turn lead to increased concentrations of air pollutants which are harmful to human health.

As previously noted, trees can reduce the need for heating and cooling. As a result, power plants can decrease energy production and reduce the quantity of greenhouse gases released into the atmosphere. Planting an average of four shade trees per house is shown to decrease energy demands and lead to an annual carbon emissions reduction from power plants of 9,000 to 41,000 tons.

Trees also actively absorb carbon from the air. The term "carbon sequestration" is used to refer to the process in which carbon dioxide is removed from the atmosphere and stored. Using energy from the sun, trees react carbon dioxide with water to create sugar. While much of the sugar is used by the tree for energy, the rest (carbon included) is stored in the tree as structure. Sequestered carbon makes up 45% of the dry weight of the plant, with large healthy trees storing the greatest amount of carbon.

It is important to note in some cases, trees contribute to increased atmospheric carbon. This is because activities associated with tree mainte-

nance, including the use of chain saws, chippers, stump removers, and trucks used to transport the machinery, burn fossil fuels and emit carbon dioxide into the air.

Air Quality

Due to high concentrations of traffic and industry, air quality is often significantly worse in cities than in a state or county as a whole. As a consequence, pollution-related illnesses, which include upper and lower respiratory symptoms, bronchial asthma, lung function deficits, and air-pollution related cancers, are more prevalent in urban areas. The pollutants of greatest public health concern are particulate matter, carbon monoxide, ozone, nitrogen dioxide, and sulfur dioxide. Trees act as "green lungs," improving urban air quality by removing these harmful pollutants from the air and preventing their formation.

Trees remove air pollution in two ways, through uptake and interception. During uptake, stomata open during the day. This allows air, and airborne pollution, to move into the leaf. Once inside, some of the pollutants are trapped in the tree. The tree then releases oxygen into the atmosphere, further purifying the air. During interception, particulate matter, which includes soot, ash, and dust, adheres to the tree's surface. This reduces the local concentration of airborne particulate matter.

In addition to filtering out and trapping air pollutants, trees inhibit their formation altogether. As previously discussed, trees reduce air temperatures by providing shade and emitting water vapor. Some pollutants, such as ozone, require high temperatures to form. By lowering the air temperature, trees thus limit the formation of some pollutants. With fewer pollutants in the air, the air quality in urban areas improves, therefore reducing harmful impacts on human health.

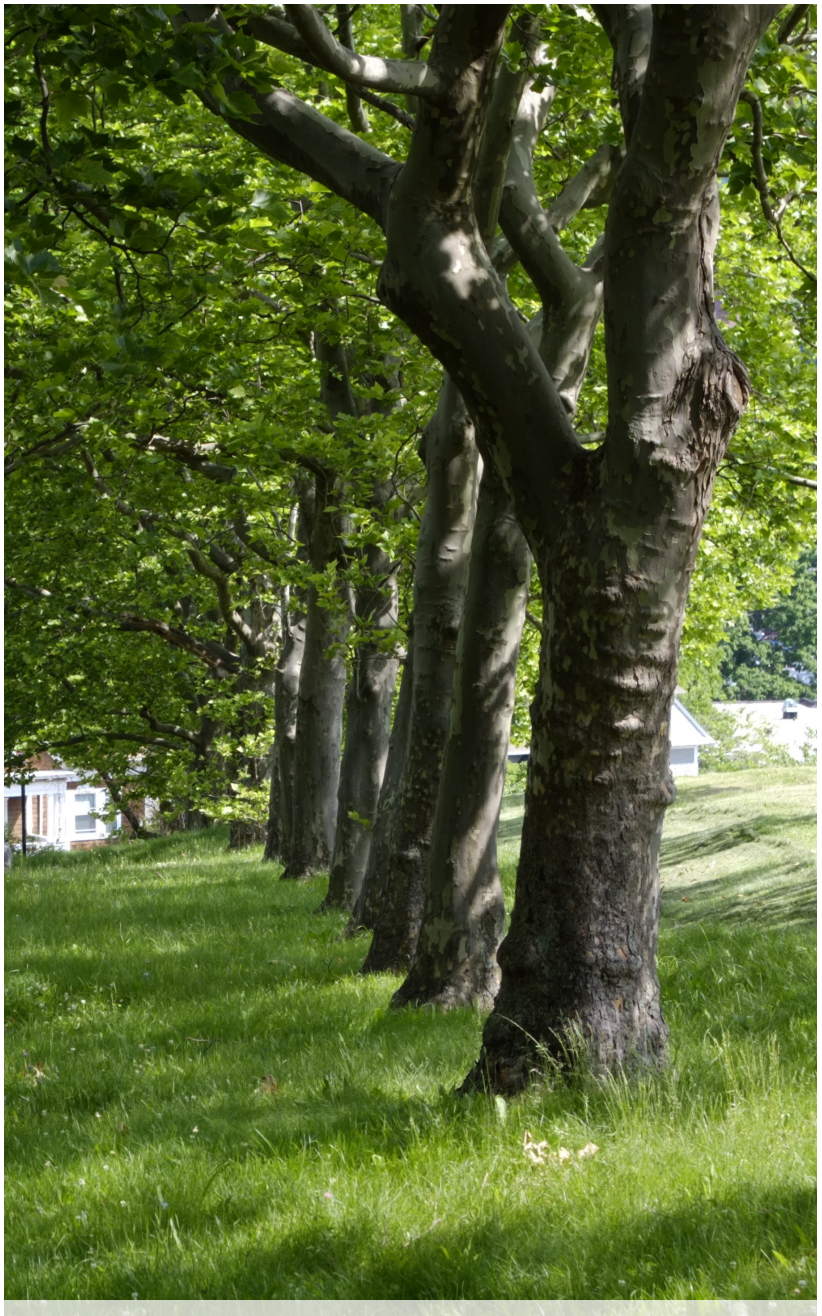


Fig. 6 These trees give ample shade in New Britain's Walnut Hill Park.

While trees play an important role in improving air quality, care must be taken to ensure low pollen producing and low volatile organic compound emitting trees are planted. This will minimize any potential negative effects and maximize the air purifying potential of trees.

Stormwater

While cities typically promote more efficient (and environmentally-friendly) use of land, energy, and materials than spatially-extensive suburban or rural developments, they also tend to have higher concentrations of impervious surfaces. Impervious surfaces, which are surfaces made of impenetrable materials such as concrete and asphalt, significantly impact the water cycle. Impervious surfaces prevent stormwater infiltration, diverting runoff directly into drainage infrastructure or surface waters. Not only does this increase in stormwater volume lead to severe flooding issues in many communities, it is also one of the top contributors to water quality degradation nationwide. As stormwater moves across surfaces such as roads, parking lots, and lawns, it picks up pollutants and carries them into rivers, streams, ponds, and lakes. Research indicates that the quality of surface water becomes significantly degraded with as little as 10% impervious cover in the drainage basin or watershed.

Healthy tree coverage can reduce stormwater runoff and peak flows in local waterways, resulting in substantial savings on drainage infrastructure, water treatment costs, and the need for flood controls. When it rains, foliage intercepts rainfall. The rainwater is temporarily held on leaves and bark where it may later evaporate directly from the tree, flow down the trunk to the ground, or drip off the leaves (see Figure 7). This interception slows the rate with which rainwater reaches the ground and reduces the volume of stormwater runoff. This reduces

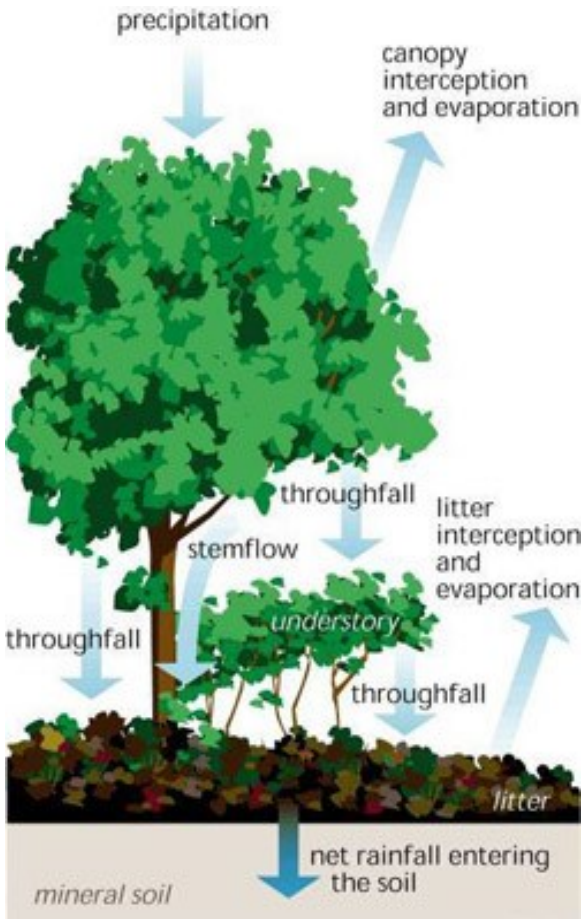


Fig. 7 How trees reduce stormwater runoff.

the volume of water being diverted into drainage infrastructure, easing the load placed on an aging infrastructure system and reducing the need for flood controls. With less stormwater entering the drainage system, less stormwater is treated at water treatment facilities. Trees, particularly larger ones (see Figure 8, previous page), are a cost effective way to manage stormwater and lessen infrastructure and water treatment expenses.

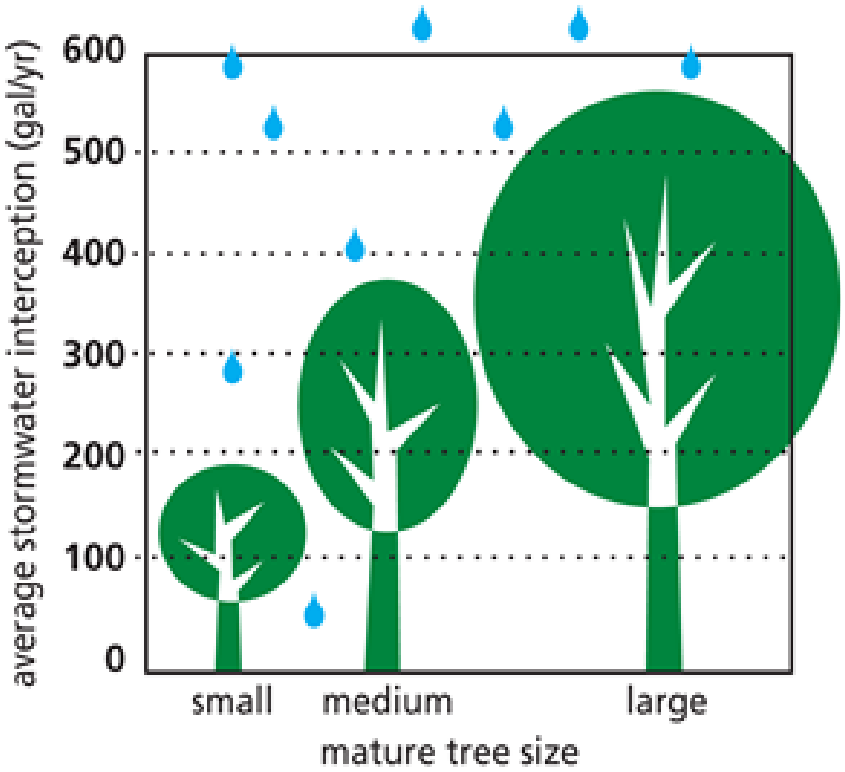


Fig. 8 The larger the tree, the more stormwater it can handle.

Trees also improve water quality. The area beneath trees is usually pervious and allows stormwater, along with any pollutants, to infiltrate the soil. Trees' roots take up degraded stormwater. Trees either store the pollutants or transform them into harmless chemicals. This on-site treatment of stormwater can reduce runoff and pollutant loads by 20% to 60%. Remaining stormwater that is not absorbed trees filters through the soil, recharging the groundwater below.

Even though trees play an important role in mitigating stormwater impacts in the urban environment, proper maintenance is required to ensure tree refuse does not clog pipes and outlets. Particular care must also be taken so that roots do not puncture underdrains and filter fabric or produce sidewalk heaves, leading to costly repairs. Tree placement should also be considered; trees must be planted in areas where they can most effectively absorb stormwater yet not obstruct utility lines. When properly planted and maintained, these concerns may be mitigated and trees can be used to effectively treat stormwater runoff.

Community Wellbeing

Livable cities are often identified as vibrant, walkable communities with a sense of place. While trees alone cannot make a city vibrant (that calls for people) and walkable (a function of urban form and amenities), or lend it a sense of place, they can and do play a key role in achieving all three goals. Many of the most livable cities in the world have extensive urban canopies; it is equally telling that images of urban blight and decay often lack trees altogether.

Street trees also buffer pedestrians from the road, making sidewalks safer and more comfortable. Comfort and safety result in more pedestrians using the sidewalks. As the number of people on the street grows, the safety—whether perceived or real—tends to rise, which in turn draws more people onto the street, producing a virtuous circle. By encouraging people to travel the streets at human speed, and to interact with them at a human scale, trees can foster the growth of social capital (through interactions on the street) and the development of a sense of identification with and pride in a place. This also benefits local business. With increased pedestrian traffic on streets, exposure for local businesses increases; businesses that are located in districts with street trees report higher revenue. Insofar as thriving businesses draw

Fig. 9 A mature tree canopy and additional landscaping can intercept, absorb and slow stormwater runoff.

additional traffic, such additional traffic may help other businesses thrive, again producing a virtuous circle.

Trees also make the city more appealing. Trees convert streets, parking, sidewalks, and alleyways into more pleasant environments by providing shade and screening or softening unattractive sights and, to a lesser extent, sounds and odors (see Figures 10 and 11 on the following page). Trees' organic shapes, colors, and textures add a natural, humanizing component to the built environment, which in many places consists largely of concrete and asphalt. Trees can also serve as visual markers. Trees can define a diversity of places, from play areas and parks to shopping areas and property lines. Similar to the way architecture can tie a neighborhood together, artistic tree choice or a particular landscape design can be used to provide cohesive aesthetics.

When an area is well landscaped, it is more attractive and people want to live there. This is best demonstrated by comparing the sale prices of houses. The difference in sale prices between homes with trees versus homes without them represents the willingness of the consumer to pay for the benefits (and shoulder the costs) associated with trees. In a study conducted in Manchester, Connecticut[2] (approximately 16 miles from the subject area), six to nine percent of the total sales price of a house could be attributed to good tree cover.

While trees can help make a city vibrant and walkable and lend it a sense of place, making cities more attractive for homebuyers, trees also make communities healthier places to live. Studies in a variety of locations have found a link between exposure to nature and wellbeing. Stress, for instance, is often a health concern in cities. Stress related to urban living, work practices, and hazardous environments contribute to poor mental and physical health, especially among vulnerable segments of the population (e.g., children). Exposure to nature can facilitate the recovery from stress or problems, make people more resilient against future stress, and enable people to concentrate and think more clearly. Trees play a key role in the urban environment, helping to make a vibrant, walkable, and healthy community.

Fig. 10 New Britain Residential Street Before: An open view of homes and sidewalks could be enhanced by the addition of street trees.

Fig. 11 New Britain Residential Street After: Densely planted street trees offer shade to pedestrians and surrounding homes and improve the overall aesthetic.

How many do we have?

Development in New Britain has had lasting impacts on the urban tree canopy. From the time New Britain was first settled in the 1600s to the beginning of urbanization in the mid-twentieth century to today, trees were cleared to first make way for farms, roads, and homes, and later factories. Past development focused on infrastructure with a secondary emphasis on greenery. These practices have produced New Britain's current tree canopy which covers approximately 32% of the city.

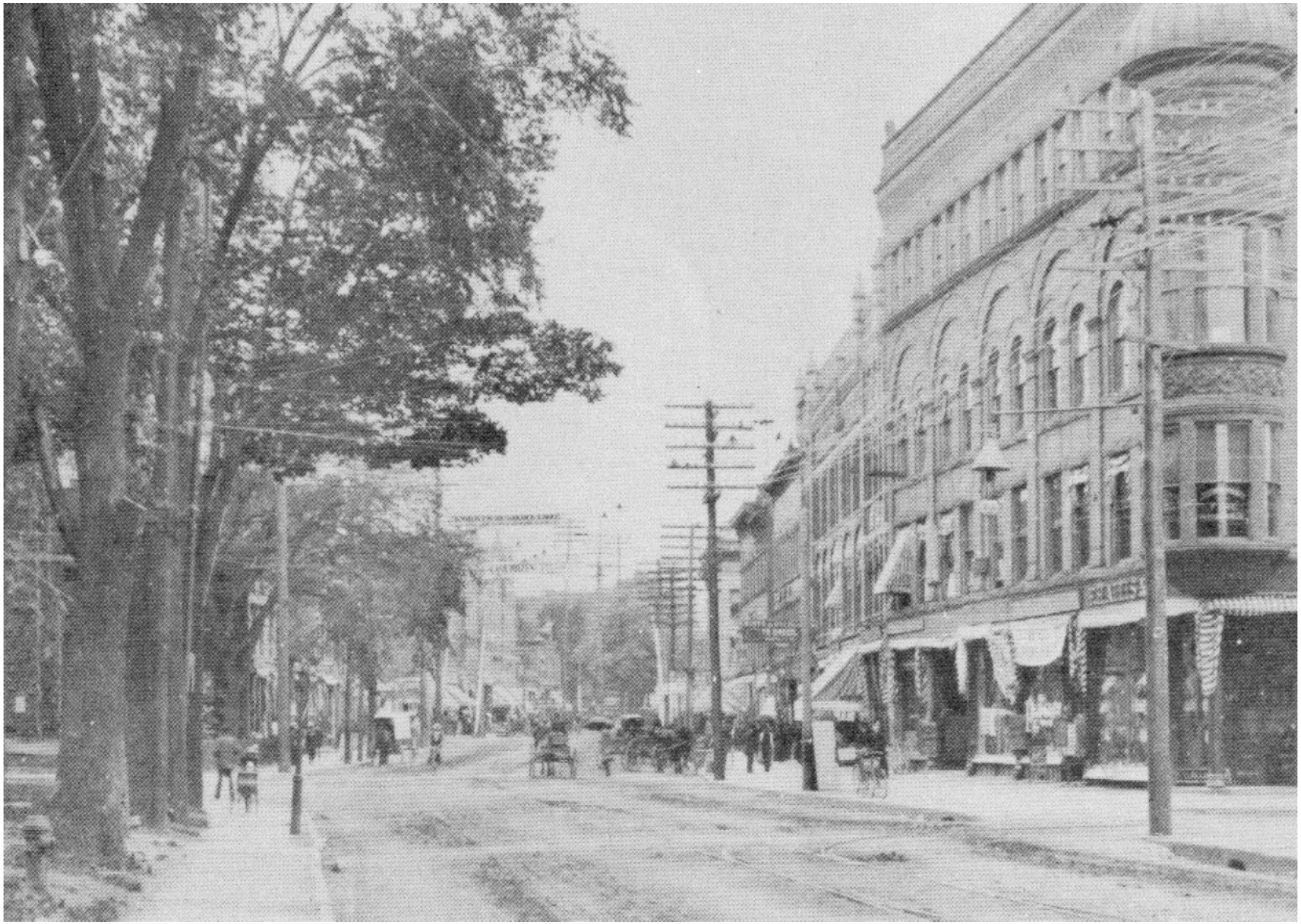


Fig. 12 Main Street, New Britain, 1899.

History

Human activity has long impacted Connecticut's forests. As the population grew, impacts on the state's forests increased. Beginning in the 17th century, forests were cleared for agriculture and wood was harvested for heating, cooking, and building materials. By 1830, approximately 70% of Connecticut's forest had been cut down. New Britain followed the same trend that could be found taking place on a larger scale across the state. Located on land once covered by meadows and forests, as the city took shape, farms, homes, roads, and later factories took their place.

New Britain, located nine miles south of Hartford, was originally part of Farmington. Settlers to the area first arrived in the mid-1600s. Primarily farmers, the early residents settled on land that was previously used by Native Americans for hunting and fishing. As homes were constructed with timber from nearby forests and the land cleared to farm, an agricultural village was born. Over time, more people arrived in the area and began to settle to the southeast of what is now New Britain. Although these residents established homes and farms in New Britain, the area remained part of Farmington. Residents continued to travel to Farmington for business and worship; more trees were cleared and roads constructed to allow travel between the two communities.

New Britain continued to grow as original families expanded and more people moved to the area. More land was cleared to make way for more homes, farms, and connecting roads. Travel to the center of Farmington for civic life became increasingly inconvenient, so residents constructed their own meeting house in New Britain to serve as a gathering place. By the mid-1700s, New Britain had scattered farms, roads, a saw-mill, and a meeting house.

At the turn of the nineteenth century, New Britain remained a primarily agricultural village. However with a growing population, in the early part of the 1800s manufacturing industries began to take hold in New Britain, drawing more people to the community. Taverns, homes, and stores were built to support the growing workforce. At this time the railroad was constructed to connect New Britain to other communities. As the city began to take shape, forested land in the core became the home to industrial and civic buildings and homes, with many of the early farmhouses and farms located on the outskirts. By the time New Britain was incorporated as a city in 1871, it was home to numerous industrial companies, including Stanley Works, Landers and Smith Manufacturing, Russell & Erwin, P & F Corbin, Corbin Cabinet Lock, and North & Judd. Producing items including door and shutter hardware, coat and hat hooks, specialized locks, wire products, equestrian hardware, and suspender buckles, New Britain rose in prominence as a center of manufacturing and industry. These developments earned New Britain its nickname the 'Hardware City.'

As New Britain became widely recognized for its manufacturing, more and more people moved to the city for work. Additional homes were constructed to house workers. By this point much of the forested land had been cleared. As the built environment expanded in New Britain, the city began to recognize the importance of preserving the natural environment that remained. Just as other cities and towns began to plan for their environment, so did New Britain. Urban environmental regulations, such as laws to protect public trees from vandalism, were passed, trees were planted, and parks were created. Walnut Hill Park was designed as part of this movement.

Fig. 13 West Main Street, New Britain, 1899.

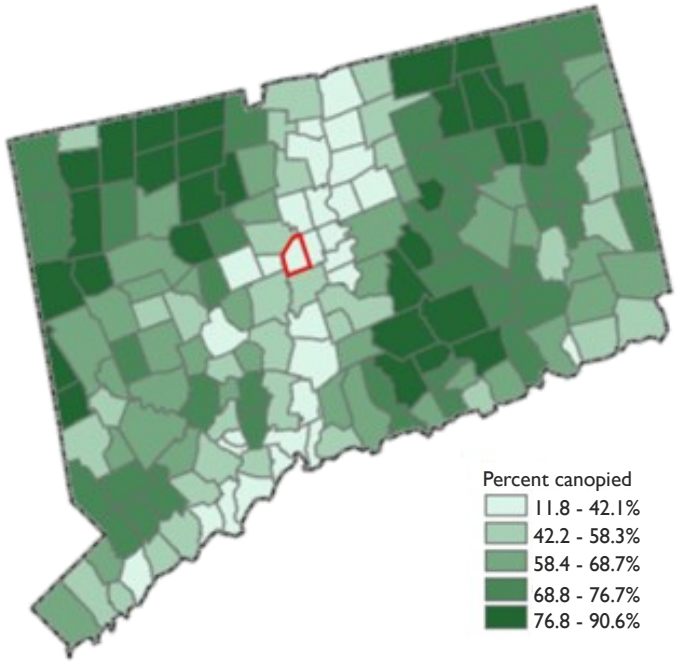


Fig. 14 Tree canopy coverage: New Britain (red) among the lowest.

Current Tree Canopy

Today, trees and shrubs are found throughout New Britain. Located in parks and green spaces, lining residential and commercial streets, and in private yards, the tree canopy covers approximately 32% of New Britain, or 2,782 acres. While vegetation is found throughout the city, certain areas have more vegetation, and thus canopy cover, than other areas.

Much of New Britain's tree cover is located in parks and on the edges of the city. Stanley Park, located in the northern part of New Britain, has swaths of forested land, and thus has particularly high tree canopy cover. The southwest corner of New Britain bordering Plainville, Southington, and Berlin, also has high canopy cover as the land is located on the edge of the Ragged Mountain Memorial Preserve and Shuttle Meadow Reservoir. Neighborhoods in this vicinity are also more likely to have tree-lined streets as well as trees planted on private, residential properties. While certain areas in New Britain have high canopy cover, the canopy cover in other areas is minimal to non-existent. The urban core in particular lacks canopy cover. The trees that do exist are often widely spaced. Trees can be planted in the urban core in parking lots, along streets, and in other available spaces, to mitigate stormwater runoff, increase the nearby property values, and help contribute to an overall enhanced and vibrant streetscape.

New Britain ranks low for tree canopy cover compared to other cities and towns in Connecticut. The average tree canopy cover in Connecticut in urban areas is 49.3% compared to New Britain's cover of 32%. The statewide average canopy cover is 64.5%, just about double that of New Britain. To see how New Britain compares to places around the state see Figure 14. The lack of canopy cover shows there is both a need and an opportunity to increase the canopy cover in New Britain.

Fig. 15 Historic view of New Britain from Walnut Hill Park, 1862. The reservoir (in the foreground) was eventually removed.

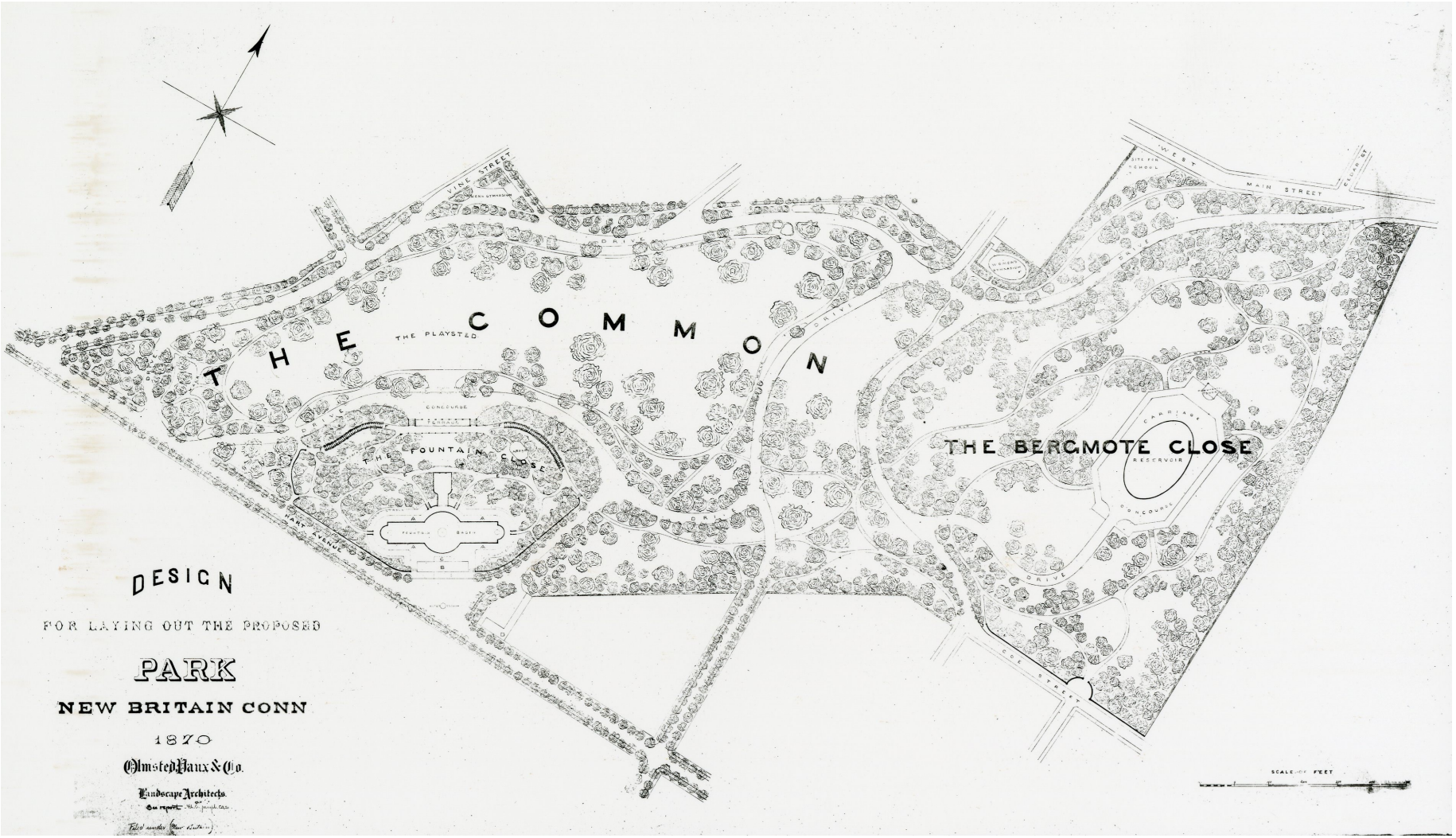


Fig. 16 The original design for Walnut Hill Park was done by landscape architect Frederick Law Olmstead.

Basic maintenance guidelines for urban trees

Forest trees may live for hundreds of years, but those in an urban environment, especially street trees, face special challenges (see table below). As a result many urban trees die well before maturity and thus are not able to provide the maximum benefit to the city. To ensure that trees live long, healthy lives, proper care and maintenance is required. General recommendations for maintaining a healthy urban tree canopy include:

Monitoring Trees

- Look for pests and diseases
- Remove dead or dying branches
- Clear away debris/weed accumulation at trunk base

Pruning

- Do not top trees
- Establish a pruning regular schedule
- Prune newly planted trees every other year for first 5 years
- Small trees: every 8 years
- Large trees: every 12 years

Watering

- Trees need 8 to 10 gallons of water per month
- Young trees need 10-20 gallons per month

Other

- Mulch should not contact the trunk
- Limit disturbance to the tree's surroundings
- Protect trees in construction zones
- Flush out street tree pits after winter to remove excess salt

Special Considerations for Urban Trees and Street Trees

Environmental Stressors	Urban Trees	Street Trees
Air pollution	X	X
Polluted runoff	X	X
Pests	X	X
Litter (including pet waste)		X
Salt and road maintenance		X
Drainage/passive watering		X
Light	X	X
Compacted soil		X
Soil erosion	X	X
Limited root space		X
Human impacts (maintenance, nearby construction, etc.)		X

What do they do for us?

Trees have proven their utility through the abundance of benefits they provide. These benefits can be quantified into monetary values to better understand the economic impact of planting trees. The benefits are separated into four categories: stormwater, property value, carbon storage and sequestration, and air quality. New Britain's tree canopy currently produces $18.6 million in benefits annually.

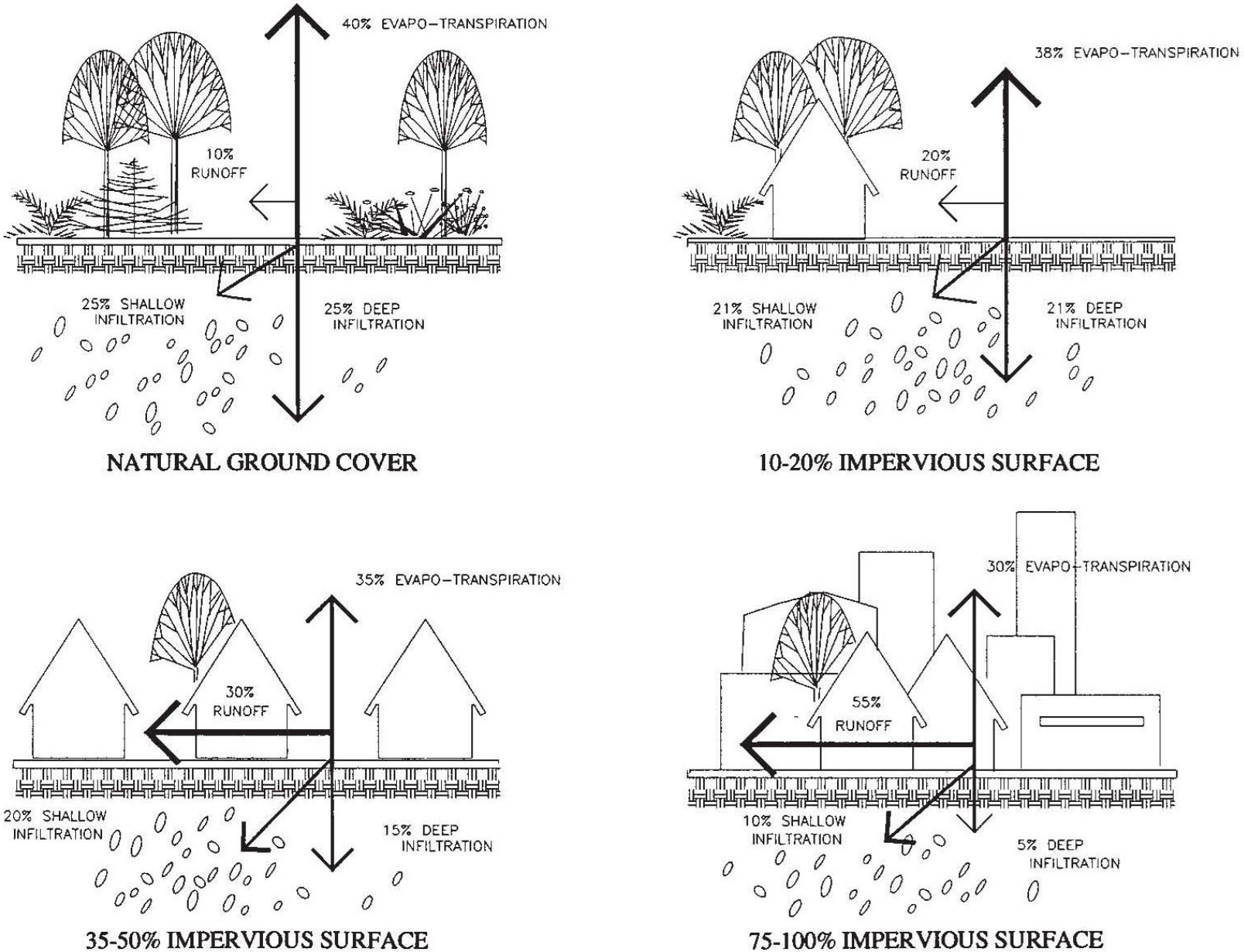


Fig. 17 Water cycle changes associated with urbanization: The greater the amount of impervious surface, the less stormwater

Tree Canopy Benefits

Figure 18 (right) outlines the annual dollar value provided by New Britain's tree canopy. The benefits to property value are the greatest, at an estimated $13 million annually. This category also incorporates benefits associated with improved aesthetics, community character, and the positive impact trees have on human health and well-being, all of which contribute to high property values (see Figures 20 and 21 on the following page). The second highest benefit is the value assigned to stormwater, estimated to be $2.4 million annually. New Britain trees intercept rainfall and subsequently reduce runoff, thereby reducing the volume of stormwater to be treated at water treatment facilities (see Figure 17, opposite). Stormwater is followed by benefits of carbon storage and sequestration. Citywide, reductions in carbon dioxide emissions due to reduced energy consumption and sequestration by trees is valued at $2.4 million annually. The fourth category of benefits is air quality. This includes reductions in particulate matter, nitrogen dioxide, ozone, and other harmful pollutants which is valued at approximately $640,000 annually.

Tree Canopy Costs and Net Benefits

While the benefits of New Britain's tree canopy are valued at $18.6 million annually, there are costs to plant and maintain the trees. Municipalities on average spend $34 per tree annually. This includes costs associated with planting, pruning, removal, infrastructure repair, and administration. Using the average cost per tree, this means the cost of New Britain's current tree canopy is estimated to be $1.9 million annually. When compared to the annual benefits valued at $18.6 million, the net benefits of New Britain's current tree canopy are $16.8 million (see Figure 19 to the right).

Benefits	**Value**
Air Quality	
Carbon	$2,600
Nitrogen dioxide	$124,000
Ozone	$365,500
Sulfur dioxide	$11,100
Particulate matter	$135,100
Carbon	
Carbon Storage	$2,336,100
Carbon Sequestration	$77,200
Miscellaneous	
Property Value	$13,148,200
Stormwater	$2,427,500
Total	**$18,627,300**

Fig. 18 Current Tree Canopy Benefits: the annual monetary savings provided by the current New Britain canopy.

	Value
Benefits	$18,627,300
Costs	$1,871,700
Net Benefits	**$16,755,600**

Fig. 19 Net Benefits of New Britain's Current Tree Canopy: the total benefits of the existing canopy less the costs.

Fig. 20 New Britain residential property before: A blank landscape does little to increase property values.

Fig. 21 New Britain residential property after: The addition of street trees not only increases property values but also increases shade and improves aesthetics.

How many could we have?

New Britain enjoys millions of dollars in savings annually from its current tree canopy. However, continuing without action, in other words not planting any trees nor maintaining the canopy, would result in a reduction in benefits received. It is in New Britain's interest to populate available land with trees to thicken and expand the canopy. The suggestions included in this report include planting locations on publicly owned properties. It is also recommended that residents become engaged in the tree planting project and encouraged to plant trees on their properties.

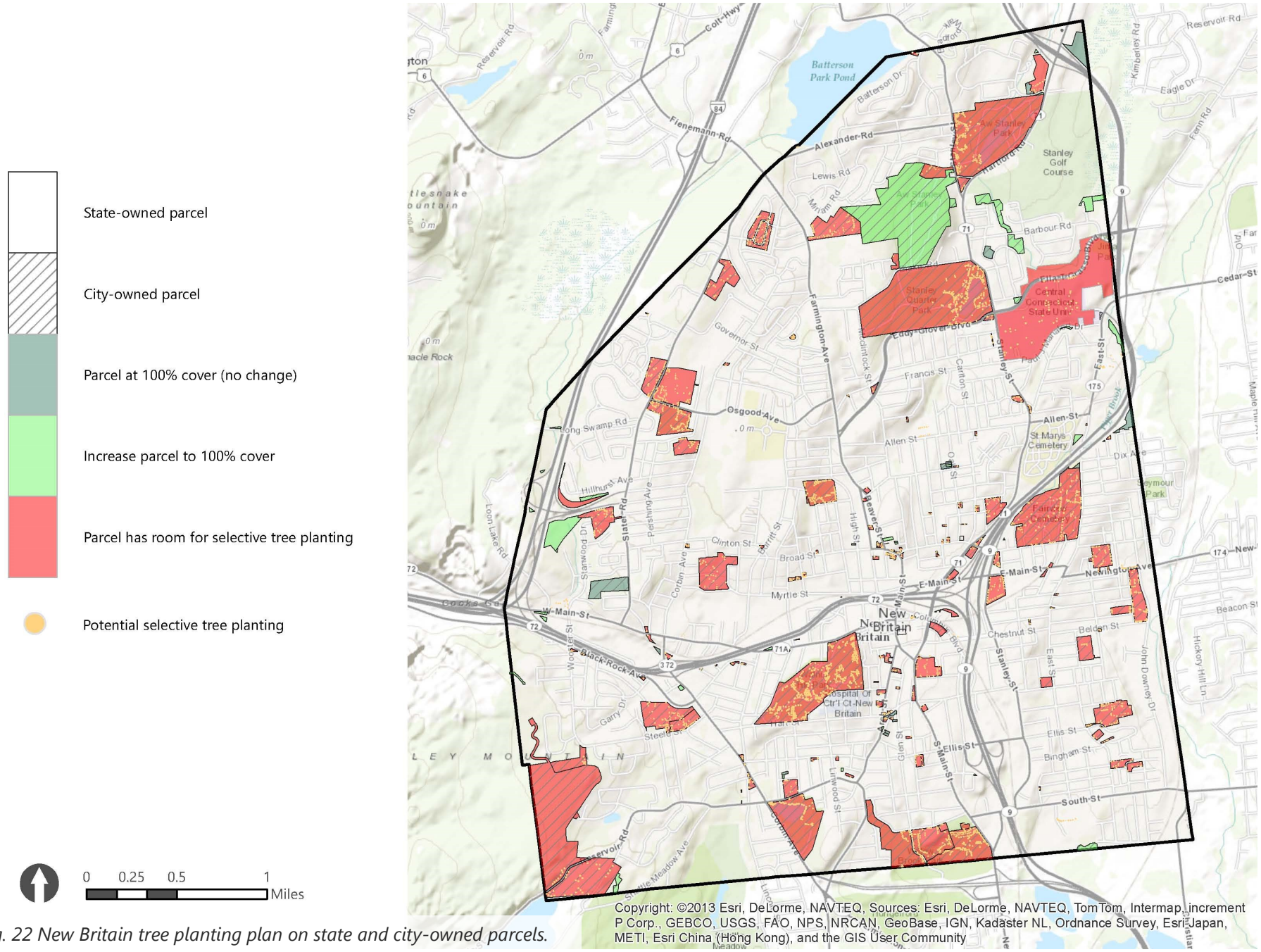


Fig. 22 New Britain tree planting plan on state and city-owned parcels.

Tree Planting Location Selection

To increase its tree canopy cover, New Britain should maximize protection and maintenance of its current trees while also pursuing a tree planting project throughout the city. From planting street trees in downtown to planting trees in city parks, there are many locations throughout New Britain that could accommodate additional trees. To achieve higher canopy coverage in a cost-effective manner, it is important to select areas where the installation and maintenance costs of trees will burden the city the least.

The first areas evaluated for tree planting were city and state-owned properties that are partially wooded (see Figure 22, opposite for parcel map). It was assumed trees could be planted in these locations without contributing to higher maintenance costs. There are currently 33 parcels in New Britain which have trees covering sections of the property. However, in many cases, the tree line on these properties ends abruptly and transitions to grass (see Figure 23). The grass area must then be maintained. Additional trees may be planted on these properties to extend the tree line. This has the benefit of reducing maintenance costs and increasing the tree canopy cover. Approximately 2200 trees could be planted in these areas adding 26.3 acres of canopy cover to the existing canopy.

Fig. 23 Site For Additional Trees: Grassy areas on wooded properties have the potential to be forested and add to New Britain's canopy.

Following an assessment of wooded city- and state-owned properties, the remaining city- and state-owned parcels were evaluated for suitability for tree planting (see Figure 22, opposite). Examples of these parcels include the campus of Central Connecticut State University, New Britain public schools such as Roosevelt Middle School, New Britain High School, and Gaffney Elementary School, and parks such as Walnut Hill Park. These properties can, in many cases, accommodate additional trees (beginning on page 38, see Figures 30 and 31 for planting locations in Walnut Hill Park and Figures 32 through 36 for Central Connecticut State University planting locations). Privately-owned properties greater than five acres were also included in the evaluation (see Figure 25, on page 33 for parcel map). These areas were selected because the city either currently oversees maintenance and landscaping efforts on the property or an agreement could be implemented with the state or property owner to permit tree planting on the land. There are a total of 366 parcels that are suitable for tree planting. An additional 3,900 trees could be planted on these parcels, adding 65.1 acres of canopy cover.

In addition to city- and state-owned properties and private properties greater than five acres, it was determined that land along New Britain streets may also accommodate additional trees (see Figures 28 and 29, page 36). There are approximately 810,000 linear feet of local roads and 174,000 linear feet of secondary roads in New Britain. Through an assessment of New Britain's roads, it was discovered that while some streets have trees, others have trees lining only one side of the street or lack trees altogether. Taking this into consideration, it was determined as a general guideline one tree may be planted every 50 feet

on one side of the road. This would add 19,680 trees to New Britain, resulting in an additional 138 acres of canopy cover.

While there is space available on city and state-owned properties (including land along local and secondary roads) and on larger private properties to accommodate an additional 28,780 trees resulting in a canopy cover increase of 230 acres, to fully realize the potential of New Britain's urban tree canopy, all parcels must be evaluated for tree planting. This includes 15,355 privately owned properties smaller than 5 acres throughout the city. Many cities have had success with programs that promote tree planting on private property. It is expected New Britain could have similar success as well. An assessment estimated that one tree could be accommodated on each property, leading to 445.3 acres of additional canopy cover (see Figures 37 and 38, page 44). When combined with the trees planted elsewhere, a total of 41,125 trees could be planted in New Britain.

In summary, New Britain can accommodate an additional 41,125 trees (see Figure 24, at right, for details). This would add 675 acres of canopy cover to the city, increasing the canopy cover from its current 2,782 acres to 3,457 acres (see Figures 26 and 27, page 34 for details). As a result, the percent canopy cover would increase from 32% to 40%. This measure includes trees from urban, suburban and forested areas. By focusing only on the non-forest trees, analysis reveals a 70% increase of tree cover in urban and suburban areas, which would have a dramatic impact on the look and feel of the city as a whole.

Tree Mortality and Canopy Decline

While New Britain would benefit from enhancing its tree canopy, if the city decides to take no further action with respect to the urban tree canopy, it is likely the tree canopy cover will decrease. Tree decline, which refers to deterioration in a tree's crown or overall reduction in health, and tree dieback, which indicates thinning of a tree canopy with healthy branches adjacent to dead or dying ones, can negatively impact the tree canopy. Affected trees are characterized by thinning crowns and dead branches and the affected trees may eventually die. While decline and dieback affects trees of all ages, it is most commonly observed in older and more mature trees. Tree decline and dieback may be caused by a number of stressors including, but not limited to, damage to the root system, bark damage, soil compaction, and drought. While some affected trees may survive, others may die within two years after the first symptoms of decline and dieback are noticed. The average annual mortality rate for mature trees (four to 30 years after planting) is 1%. Given that many trees in New Britain fit this description, a 1% mortality rate would reduce the tree canopy cover by approximately 38 acres, falling from 2,782 acres of canopy cover to 2,744 acres. Routine maintenance can help curb the stressors that cause tree decline and dieback which ultimately contribute to tree mortality. Therefore it is important New Britain continues to maintain

Property Type	# of trees planted	Canopy cover added (acres)
Wooded properties	2,192	26.3
City, state, large private properties	3,898	65.1
Local and secondary roads	19,680	137.8
Other private properties	15,355	445.3
Totals	**41,125**	**675**

Fig. 24 Number of trees planted and acres of canopy cover: suggested tree plantings by location.

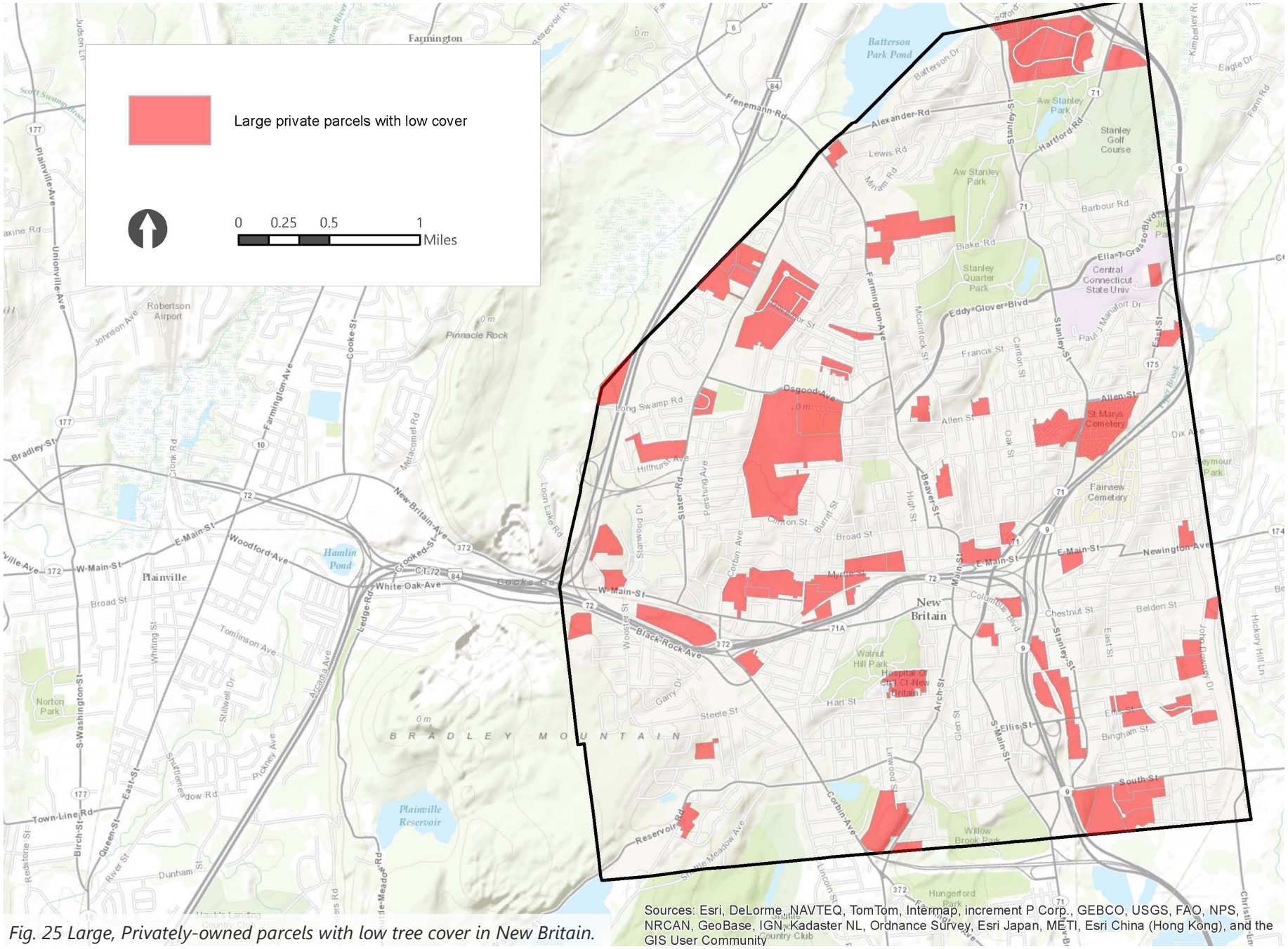
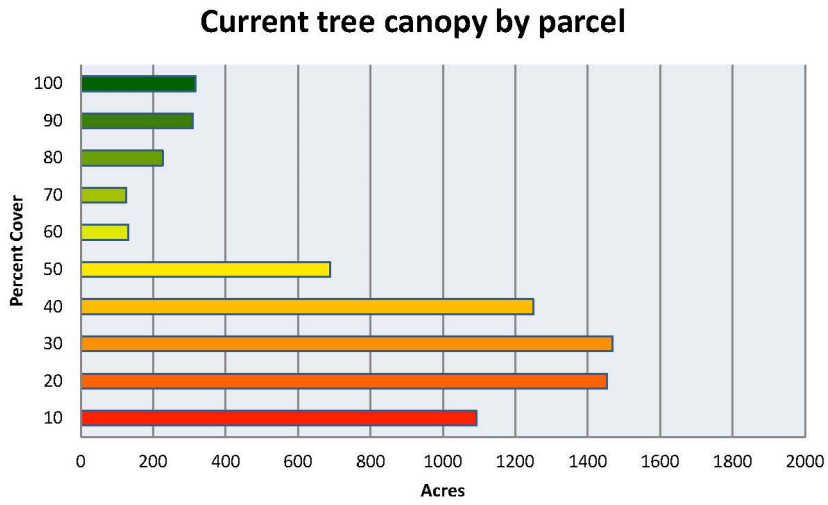
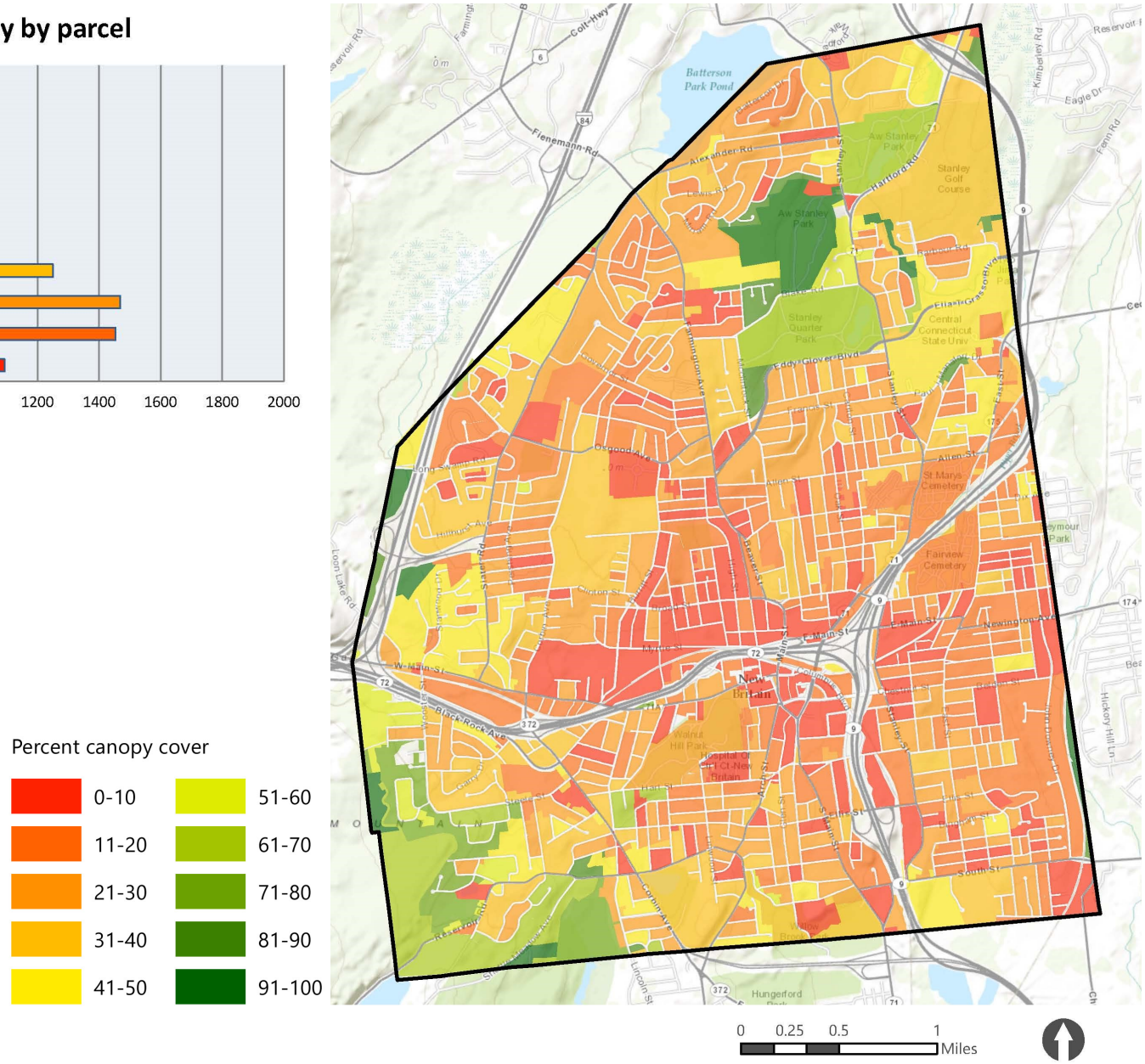


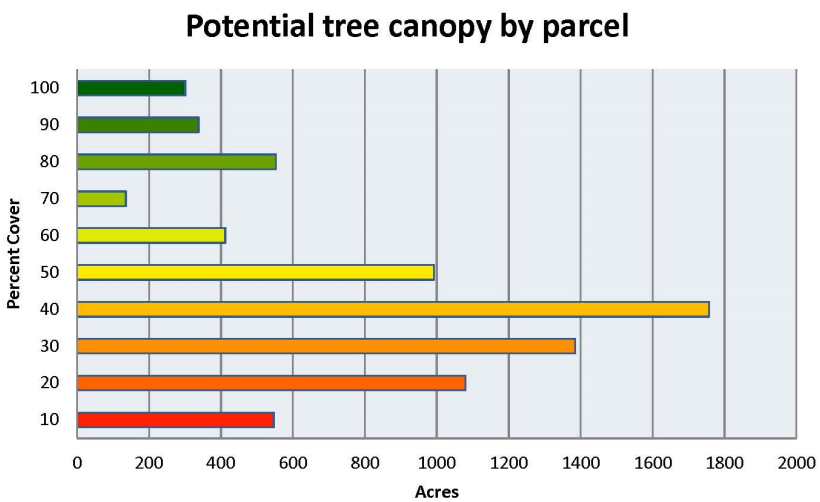
Fig. 25 Large, Privately-owned parcels with low tree cover in New Britain.





Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., CEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community.

Fig. 26 Before: Current percent canopy cover in New Britain.



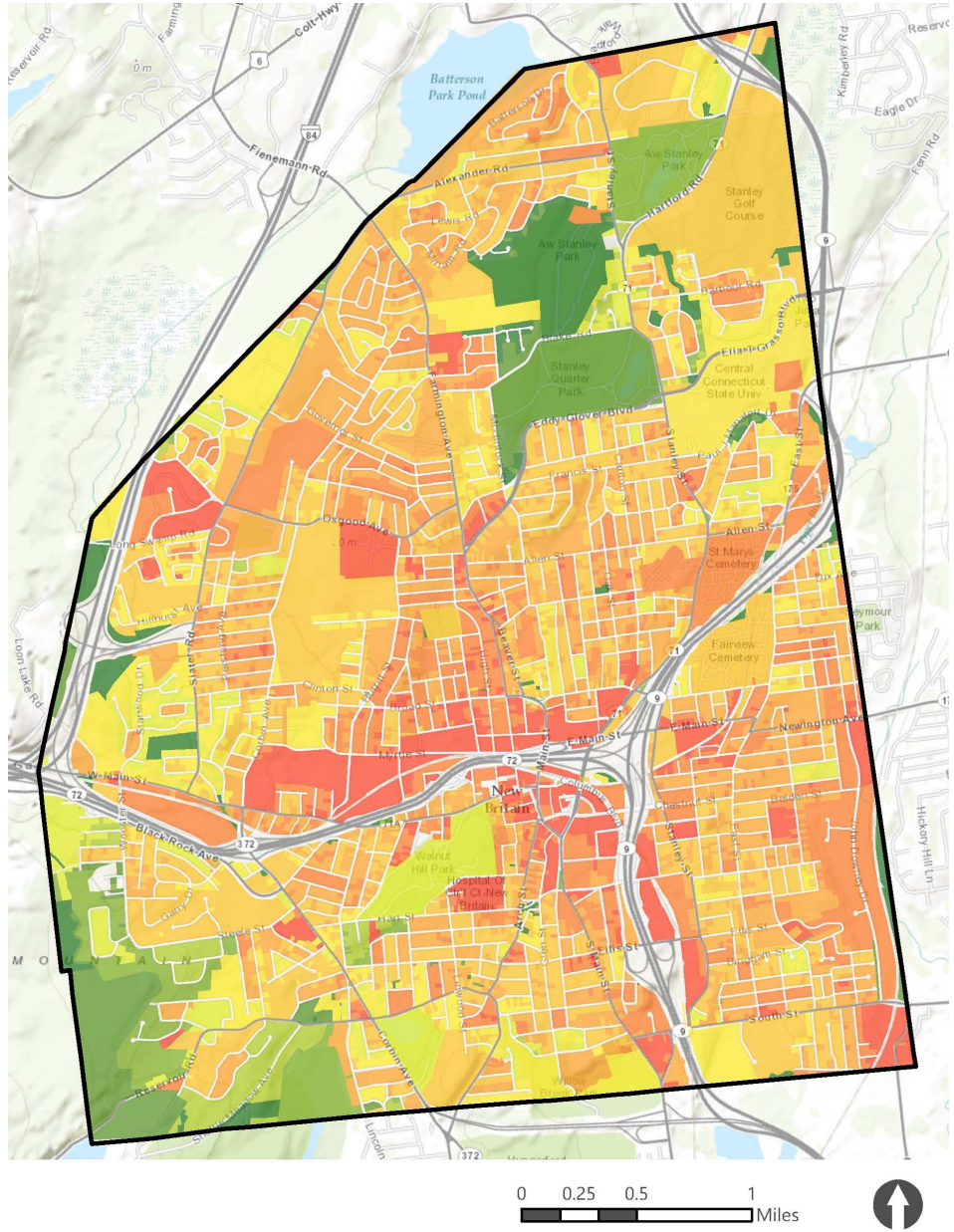


Fig. 27 After: Percent canopy cover with planting plan Implemented.

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., CEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community.

Fig. 28 Broad Street Before: There are currently very few trees along this busy city street.

Fig. 29 Broad Street After : The addition of trees along city streets would greatly increase the overall canopy and the benefits it offers.

Fig. 30 Walnut Hill Park currently: Large expanses of athletic fields and open landscapes are found throughout the park.

Fig. 31 Increased Tree Canopy at Walnut Hill Park: There are several areas throughout the park where dense groves of trees could be planted.

Fig. 32 New York City's Central Park (above and below) offers a densely forested retreat from the urban surroundings.

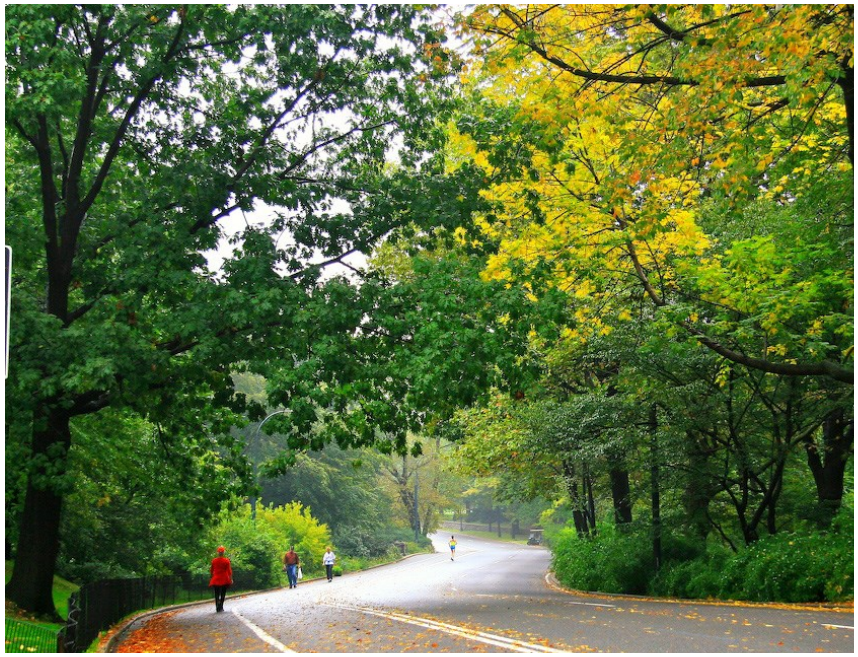


Fig. 33 Aerial View of Harvard University's dense urban tree canopy.

Fig. 34 Aerial View of CCSU: Much of the CCSU campus is lacking trees. Areas for potential trees (in green) are numerous.

Fig. 35 CCSU campus before: This blank landscape is a prime spot to plant trees.

Fig. 36 CCSU campus after: The addition of deciduous trees along this corridor offers shade to the building and walkway.

Fig. 37 New Britain residential neighborhood before: expanses of lawn offers no shade and allows a high volume of stormwater to run off.

Fig. 38 New Britain residential neighborhood after: there is ample space in this neighborhood for additional trees.

Urban Greening Strategies

How does New Britain's canopy compare?

New Britain's tree canopy cover of 32% is comparable to other communities in Connecticut that are also classified as urban. For example, New Haven has a slightly higher percent tree cover, with 38% tree canopy cover while Hartford has slightly lower tree cover, with 26% canopy cover. However, when compared to the 49.3% tree canopy cover average of urban communities across the state, the tree canopy cover in New Britain is much lower. As shown in the figure below, this places New Britain, along with New Haven and Hartford, in a higher priority index for planting.

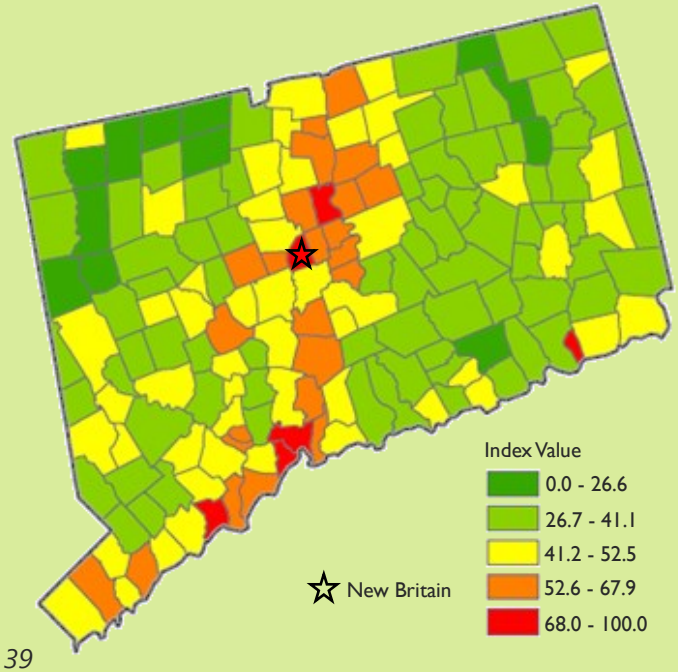


Fig. 39

Urban Greening Strategies

Getting citizens involved

There are many benefits to involving the public in a citywide greening initiative. It can provide residents with a personal connection to the project, increase support for the initiative, reduce planting costs, and help to get more trees planted on privately-owned properties. Some ways to involve the community include:

- Create a green infrastructure demonstration site on municipal or public property
- Organize volunteer tree planting days
- Offer free training programs on planting and maintaining urban trees
- Provide free trees to property owners on request
- Involve local schools

Fig. 40 Citizen involvement is a critical part of a tree campaign.

Urban Greening Strategies

How are other cities growing their urban tree canopy?

New York City

MillionTreesNYC is a public-private initiative to plant and care for one million new trees throughout New York City over a decade. The purpose of the project is to maximize the benefits that trees provide to help make New York a better place to live for its growing population. MillionTreesNYC actively seeks involvement from its residents to participate in the program through training initiatives, volunteer events, and by providing free trees.

http://www.milliontreesnyc.org

Philadelphia

introduced a program called Green City, Green Waters to better manage its stormwater through the installation of green infrastructure. The program is currently focused on planning, design, and implementation of projects within the combined sewer service area of Philadelphia. The Philadelphia Water Department's projects use stormwater tree trenches, green roofs, stormwater street bump-outs, flow-through planters, stormwater planters, and rain gardens to help manage its stormwater.

http://www.phillywatersheds.org/what_were_doing/green_infrastructure/programs/green_streets

Springfield, Massachusetts

has implemented a program called 'ReGreen Springfield'. The program provides free trees to city homeowners each spring in an effort to 'regreen' the city and help reduce energy usage and costs to residents.

http://regreenspringfield.com/

Chicago

launched its Sustainable Backyards program in 2011 to encourage environmental stewardship and action by its residents. Through this program, the City provides educational workshops and financial assistance for fifty percent of the cost for residents to install green infrastructure such as trees, native plants, compost bins and/or rain barrels on their property. Intercepting and reducing runoff from private property is a large part of lowering the City's stormwater costs and improving community health.

http://www.cityofchicago.org/dam/city/depts/doe/general/NaturalResourcesAndWaterConservation_PDFs/Sustainable%20Backyards/TreeRebate72111.pdf

How impervious surfaces affect stormwater runoff

Figure 41 at right illustrates the impacts of impervious surfaces on the water cycle. The water cycle in a landscape with natural ground cover allows 50% of stormwater to infiltrate the ground. In a highly developed urban environment, only 15% of stormwater gets into the ground. As a result, there is a 35% increase in runoff in urbanized areas. Many areas in New Britain have high amounts of impervious surfaces which reduces the amount of water that can infiltrate the ground. Increasing the tree cover in these areas will help reduce the amount of runoff and increase infiltration rates.

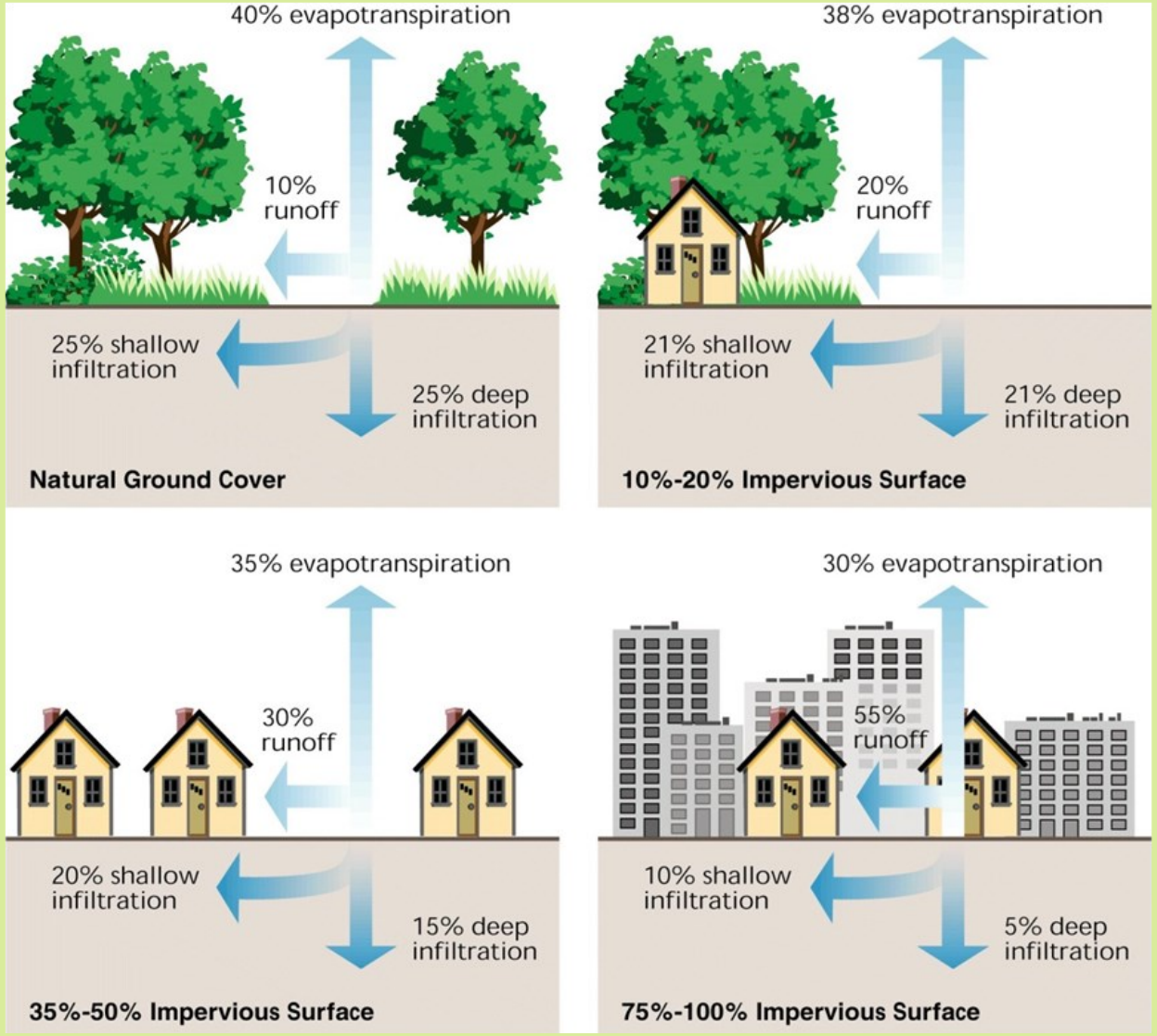


Fig. 41

Chicago

The City of Chicago has invested billions of dollars in climate change adaptation strategies to address the urban heat island effect throughout the city. One initiative completed in 2001 created a green roof on top of Chicago's City Hall building. It has over 150 species of plants, including grasses, shrubs, and two tree species. The City Hall green roof provides a demonstration site for research and educational outreach for Chicago and outlying areas. On average its roof is 7° F lower than nearby roofs and during summer months it often stays 30° F cooler.

http://www.asla.org/meetings/awards/awds02/chicagocityhall.html

http://www.cityofchicago.org/city/en/depts/dgs/supp_info/city_hall_green_roof.html

Washington D.C.

The U.S. Tax Court Building is a grayfield site and government complex on the National Register of Historic Places in Washington, D.C. Designers will convert a fountain in the building's landscaped plaza into a demonstration green roof to allow the public to experience a green roof at ground level. The green roof will mitigate stormwater runoff, lower the building's heating and cooling costs, and reduce the urban heat island effect.

http://www.sustainablesites.org/pilot_projects/

Fig. 42 Chicago's City Hall has covered their portion of the building with an extensive green roof.

Fig. 43 In Chicago, a green landscape stands out in a sea of concrete and steel.

How Trees Reduce Energy Consumption

Trees in urban and rural environments can greatly reduce energy consumption for commercial, residential and municipal properties. Trees modify climate and conserve energy in three principal ways: shade, transpiration and wind-reduction.

- Shading reduces the amount of radiant energy absorbed and stored by built surfaces.
- Transpiration converts moisture to water vapor and thus cools the air by using solar energy that would otherwise result in heating of the air.
- Wind-speed reduction reduces the movement of outside air into interior spaces and heat loss where thermal conductivity is relatively high (e.g., glass windows).

Energy Savings and Urban Areas

Trees and other vegetation in built-up areas may lower air temperatures by 5°F (3°C). At the larger scale of a city-wide climate (6 square miles), temperature differences of more than 9°F (5°C) have been observed between city centers and more vegetated suburban areas. The relative importance of these effects depends on the size and configuration of trees and other landscape elements. Tree spacing, crown spread, and vertical distribution of leaf area influence the transport of warm air and pollutants along streets and out of urban canyons.

The New York State Energy and Regulatory Authority recently completed a study with scientists at Columbia University and the National Oceanic and Atmospheric Administration on the heat island in New York City and mitigation scenarios, in which trees are one of the most effective measures to reduce air temperatures and resulting energy demand.

Fig. 49 Urban canyons, like this one in New York City, are a trap for warm air.

Fig. 50 Mature trees offer significant shade to this New Britain

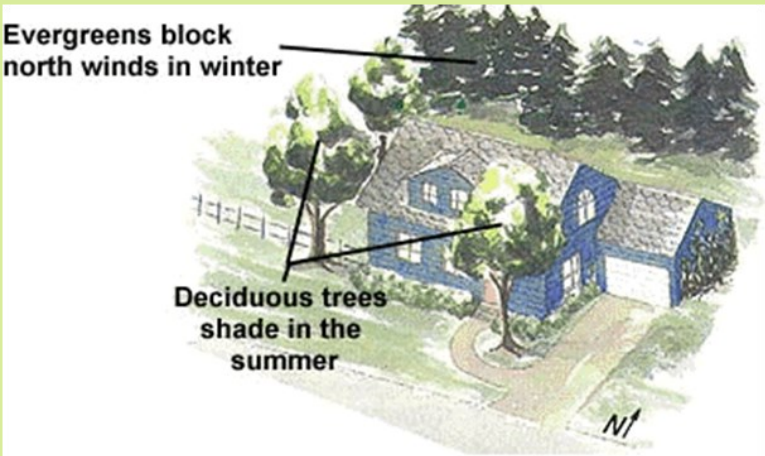


Fig. 51 Properly placed vegetation can lead to energy savings.

Energy Savings and Residential Properties

The proper placement of trees can reduce cooling costs for residential homes, leading to energy savings. In a study of residential energy savings in Sacramento, California, researchers monitored two houses and measured energy consumption for a one month period. Following the one month, sixteen trees were planted along the houses so that they cast shade on the south and west-facing walls and windows, and on all air conditioner units. Researchers once again gathered data on energy consumption and found that the shade trees resulted in energy savings of thirty percent.

Figure 51 at left illustrates the different ways that vegetation, and trees in particular, can lead to energy savings on a residential property.

What would they do for us?

Adding trees to the urban forest of New Britain would result in savings. Resources that would otherwise be used for infrastructure, pollution control, and health care in the absence of trees can be reallocated to meet other needs. While there would be costs associated with the planting of new trees and their maintenance, the benefits received from an expanded, healthy tree canopy would be more than quadruple the costs.

Tree Canopy Increase

Planting an additional 41,125 trees (as discussed in Chapter 4) would increase the total benefits of the tree canopy cover to New Britain by an estimated $3.2 million. (See Figure 45, right.) Most of this increase is attributable to higher property values, stormwater management, and carbon storage.

While less in dollar value, benefits to air quality are also expected as a consequence of planting of new trees. These benefits may be direct, e.g. through uptake and breakdown of air pollutants by trees themselves, and indirect. For instance, by reducing ambient air temperatures, the shade trees cast can reduce energy use for cooling and thus emissions from power plants (see Figures 47 through 48, page 54).

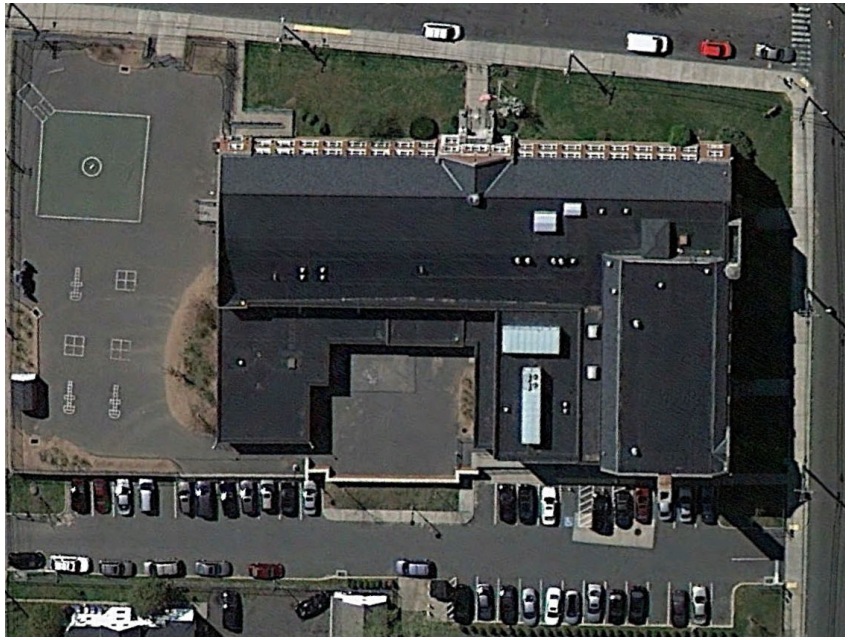


Fig. 44 Northend Elementary School: There are very few mature trees on this school property.

While the benefits, and subsequent value to New Britain would increase throughout the planting project, there would be some costs. The planting project would require funding for tree purchase, planting, and maintenance. Despite an increase in New Britain's budget for this project, the value of the benefits exceeds the costs. The net benefits of the current tree canopy are estimated at $16.9 million. Following tree planting, these are projected to rise to $19.9 million (see Figure 46, right).

Tree Canopy Decline

Should New Britain plant an additional 41,125 trees, the city will receive $19.9 million in net benefits. On the other hand, if the city does not plant any new trees nor conduct proper maintenance, benefits will decline, with the city receiving only $16.7 million in net benefits. This is because the average tree mortality rate is approximately 1% per year. This means the canopy cover will decline annually by 38 acres. As a result, there will be fewer trees and thus the value of benefits trees contribute to the urban environment will decrease. As shown in Figure 45, the benefits in each of the four categories property value, stormwater, carbon storage and sequestration, and air quality will decrease. To maximize the benefits of urban trees, it is important New Britain plants additional trees throughout the urban core and surrounding area and conducts routine maintenance to ensure their survival.

Benefits	Current Tree Canopy	Tree Canopy Increase	Tree Canopy Decline
Carbon			
Carbon Storage	$2,336,100	$2,902,800	$2,312,700
Carbon Sequestration	$77,200	$95,900	$76,400
Air Quality			
Carbon	$2,600	$3,200	$2,600
Nitrogen dioxide	$124,000	$154,100	$122,800
Ozone	$365,500	$454,100	$361,800
Sulfur dioxide	$11,100	$13,800	$11,000
Particulate matter	$135,100	$167,900	$133,800
Miscellaneous			
Property Value	$13,148,200	$16,337,800	$13,016,700
Stormwater	$2,427,500	$3,016,500	$2,403,300
Total	**$18,627,300**	**$23,146,100**	**$18,441,100**

Fig. 45 Benefits of New Britain's Tree Canopy: The monetary benefits of the current canopy, suggested canopy and canopy if it is left alone.

	Current Tree Canopy	Tree Canopy Increase	Tree Canopy Decline
Benefits	$18,627,300	$23,146,100	$18,441,100
Costs	$1,871,700	$3,214,100	$1,852,900
Net Benefits	**$16,755,600**	**$19,932,000**	**$16,588,100**

Fig. 46 Net Benefits of New Britain's Tree Canopy: The net benefits of the current canopy, the suggested canopy and the canopy if left alone.

Fig. 47 Northend Elementary School before.

Fig. 48 Northend Elementary School After: The addition of street trees offers much needed shade to the playground and school building.

How do we get there?

Pursuing an increase in canopy cover provides the opportunity to foster a healthy, vibrant community and has the benefit of also establishing New Britain as a leader in environmental stewardship. While the task of expanding the urban forest might seem daunting, there are basic steps to be taken that will ease the burden on one single participant. Creating an organized approach that includes outlining the project goals, tasks, and schedule is essential to executing the project.

Set Project Goals

As discussed in Chapter 4, there are numerous areas of the City that could accommodate more trees. Beginning with properties that have easily identifiable owners would lead to a greater chance of initial success. This would include state and city owned land and large private parcels that can accommodate additional trees. Next, local and secondary roads could be planted with thousands of trees. Finally, developing a tree planting campaign targeted at private property owners would allow for even more trees to be planted. The following are project goals previously discussed in Chapter 4.

1. Allow 2,192 trees to regenerate on partially wooded state and city owned parcels.
2. Plant 3,898 trees on remaining city and state owned parcels and private properties greater than 5 acres.
3. Plant 19,680 trees along local and secondary city roads (1 tree every 50 feet).
4. Develop a tree campaign to plant 15,355 trees on remaining private parcels (1 tree per parcel).

The accomplishment of these goals would result in 41,125 trees planted (675 acres) and an overall canopy increase of 8%.

Establish Project Lead

From the onset of the project, New Britain should establish a project lead. The project lead for New Britain may be the Park and Recreation Commission. The Commission is appointed the tree warden of the City of New Britain. As such, the Commission is responsible for overseeing all tree-related activities throughout the city including planting, removal, trimming, and tree maintenance. Given this role, it is likely that the Commission is well positioned to lead the tree planting effort. While the Commission may be the project lead, they should work closely with the Parks and Recreation Department staff to help see the project through. In addition to the Parks and Recreation Department, the Commission should work with other departments as well, including Public Works, the Health Department, and the Board of Education. This will help ensure that the project has widespread support and will also allow the different departments to assist with tree planting depending on the planting location.

Identify Project Tasks

Once the project lead has identified contacts in the various city departments, together the lead and department contacts should identify project tasks that must be completed. For timely completion, each task should be assigned a deadline. The following list identifies tasks that are commonly incorporated into a tree planting project.

Select Tree Planting Locations

The selection of tree planting locations is an important task in the planting project. In New Britain, tree planting locations may include wooded land, city and state-owned properties, and private properties greater than five acres, as discussed in Chapter 4. For tree planting targeted for state and private properties, New Britain will have to consult the specific owner of the property to coordinate tree planting. If the owner is not agreeable to tree planting, the trees may be reallocated to other available spaces on city-owned properties.

Planting locations may also include local and secondary roads. There are approximately 810,000 linear feet of local roads and 174,000 linear feet of secondary roads. With a guideline of planting one tree every 50 feet, additional assessment and evaluation will be required to deter-

mine specific locations of trees along the local and secondary roads. New Britain may decide to first target street tree planting in the downtown area as part of its streetscape plan.

Determine Tree Species

Depending on the tree planting location, New Britain will have to decide which tree species are most suitable for the area. For instance, a street tree will need to have a smaller root system to minimize impact on the infrastructure than a tree planted in a park, which has the space available to accommodate larger trees. Other factors to consider when selecting tree species include whether the tree is flower or fruiting, its mature height and spread, zone hardiness, tolerance to urban conditions, and the soil type required for optimal growth. It is important to plant trees that are best suited to the climate to help maximize the potential for survival. The University of Connecticut has a database that assists in the informed selection of tree species. Additionally, the Connecticut Urban Forest Council, and the Connecticut Department of Energy and Environmental Protection serve as local references for tree species. Dirr's Hardy Trees and Shrubs: An Illustrated Encyclopedia, written by Michael Dirr, includes more general recommendations for tree plantings. Species included in Dirr's book that would be suitable for planting in New Britain are shown below.

Select Tree Supplier and Determine Funding

Deciding where the trees will be purchased will involve careful consideration. There are various nurseries located in the area that can be contacted to source the trees. In selecting a nursery, it is important to consider the availability of the tree species desired and the price. It is currently estimated that approximately $34 per tree will be needed to purchase, plant, and maintain the tree canopy annually. However, depending on the exact cost of the trees purchased, the actual expenditure may differ slightly. Once the cost is determined, there are several funding sources New Britain can use for the purchase of trees. Possible funding opportunities include grants from the federal and state governments, business foundations, and private charitable foundations.

Begin Tree Planting

Tree planting will most likely begin during the spring months. When New Britain begins the tree planting phase, it is important the public is included in planting events. Therefore planting events should be scheduled during times when residents will be able to attend. For example, tree planting events can be held in May and June before summer break at the local schools. Students can be invited to participate in the planting. The events can also serve as an educational opportunity

Selected tree species

- Trident Maple
- Hedge Maple
- Sugar Maple
- Purple Blow Maple
- European Hornbeam "columnaris"
- European Hornbeam "fastigiata"
- Chinese Fringetree
- Corneliancherry Dogwood
- Gingko
- Common Bald Cypress
- Littleleaf Linden
- Chinese or Lacebark Elm
- Pawpaw
- Thornless Honeylocust
- Panicled Golden Rain Tree "September"
- Sargent Cherry
- Callery Pear
- Oak (various species)

to teach students about the benefits of trees. Other planting events, such as tree planting in Walnut Hill Park, should be scheduled for weekends so residents and volunteers can attend. This has the benefit of not only promoting the project and fostering stewardship of the trees, but it also reduces planting costs shouldered by the city. Throughout the planting process, it is important that New Britain keeps detailed records of the number of trees planted and their location so they will be able to monitor and maintain the new trees as needed.

Conduct Planting Workshops for Residents

After trees are planted on city and state-owned properties, wooded land, and along local and secondary streets, the remaining trees will be available to be planted on private property. While planting on private property will be optional, New Britain can encourage participation by conducting tree workshops. These workshops will educate residents about the benefits of trees, including energy savings. The workshops should also focus on proper tree planting techniques and care to help maximize tree survival. New Britain can partner with neighborhood leaders or environmental non-profit organizations to conduct the workshops. Following the workshops, neighborhood leaders can hold tree planting events where neighbors help each other plant trees.

Maintain and Assess Tree Canopy

Tree maintenance will be critical to ensure all trees, both newly planted and existing, survive to maturity, thus maximizing their benefits. While city departments may shoulder many of the tree maintenance tasks, private property owners and residents should also be involved as stewards of the environment. Workshops should be held periodically, educating residents about how to maintain trees on their property. Residents should also be educated so that they can notify New Britain when a tree requires care.

Fig. 52 Roses in bloom at Walnut Hill Park.

Tree City USA

The Tree City USA Program is a national program that works to green communities throughout the United States by planting trees. To be designated a Tree City USA community, a municipality must apply for the program and meet the following four standards established by The Arbor Day Foundation and the National Association of State Foresters:

- Form a tree board or department
- Develop a tree care ordinance
- Establish a community forestry program with an annual budget of at least $2 per capita
- Have an Arbor Day Observance and Proclamation

Fig. 53 Programs like Tree City USA can help establish a lush canopy cover throughout a city, such as this beautiful tree-lined street.

There are many benefits to being designated a Tree City USA community including: access to education programs to improve current urban forestry practices; a potential preference over other communities when allocations of grant funds are made for trees and forestry programs; an increase in community pride; and enhancement of the community's public image. There are a total of 19 designated Tree City USA communities in Connecticut including Bridgeport, East Hartford, Hartford, and West Haven.

For more information, please visit http://www.arborday.org/programs/treeCityUSA/index.cfm.

Community involvement in planting trees

Seattle has a current tree canopy cover of twenty three percent and is striving to reach thirty percent canopy coverage by 2037. With the majority of available tree planting plots located on private land (two thirds of the land in Seattle is residential property), Seattle knew the community would be instrumental in attaining the thirty percent canopy coverage goal. To get residents involved, the City created a Tree Ambassador program. Tree Ambassadors are Seattle residents who are trained in the basics of urban forestry, leadership, and community organizing. Once trained, the Ambassadors work in teams to develop projects in neighborhoods throughout Seattle. Projects include tree planting events and invasive species removal workdays. Seattle also created the Trees for Neighborhoods program. The program is intended to help residents plant trees around their home, providing up to four trees per household and training on proper planting and care. Not only have the Tree Ambassador and Trees for Neighborhoods programs helped Seattle move closer to achieving its tree canopy goal, but they have also helped residents become stewards of the urban forest; this will be essential to the long term success of the project.

Fig. 54 Getting the community involved in planting trees is critical to achieving a municipality's canopy goal.

For more information, please visit http://www.seattle.gov/trees/getInvolved.htm.

Urban Greening Strategies

Funding resources and opportunities

There are many financial resources that can be used to fund an urban tree planting project. Sources for grants and additional information include the US Department of Agriculture's Urban & Community Forestry Challenge Cost Share Grants, US Department of Transportation's grant program, US Department of Housing and Urban Development's Community Development Block Grant, The Foundation Center, and the Alliance for Community Trees. In addition to grants, some cities have created innovative programs to support tree planting. The Chicago Park District has a Green Deed Tree Dedication Program. This program allows donors to select the type of tree planted and planting location. Once planted, donors receive a certificate detailing the person or event being honored, the tree type planted, and the location. The Green Deed Tree Dedication Program has proven to be an innovative way of planting additional trees as part of the Chicago Trees Initiative.

For more information, please visit http://www.chicagoparkdistrict.com/departments/operations/green-deed-tree-dedication-program/.

Spotlight on New Britain

Connecticut Tree Warden Program

The Connecticut General Statutes, Chapter 451, Section 23-58, requires municipalities that do not have a city forester on staff (or someone with similar duties) to appoint a tree warden. Tree wardens may pursue certification through the Tree Warden Association of Connecticut in cooperation with the UConn Extension System. To maintain tree warden certification, an individual must complete regular classes and workshops. Tree wardens are responsible for overseeing the care of all trees and shrubs, ensuring that public trees are properly maintained and removed if hazardous. In New Britain, the Board of the Park and Recreation Commission is the appointed tree warden for the City.

For more information, please visit http://www.canr.uconn.edu/ces/forest/fact5.htm http://ww2.newbritainct.gov/PDF/NB_ORDINANCES17.PDF.

Conclusion

Trees are essential to the city. They provide a host of valuable economic, social, and ecological benefits. These benefits include cleaner air and water, lower stormwater infrastructure costs, lower summer temperatures and lower cooling costs, higher property values and higher business revenues, and better physical and mental health. However, these benefits are often underappreciated or altogether ignored. The failure to consider the benefits of trees fully has led to the neglect and subsequent decline of urban trees. Unfortunately, the savings obtained through neglect and loss of trees pales in comparison to the benefits that those trees have produced.

Fig. 55 Mature trees surround the rose garden at Walnut Hill Park.

This report has quantified tree canopy cover in New Britain, both existing and potential. In particular, it has estimated both the costs and the benefits trees currently do and, under a planting plan, could provide the city. The current tree canopy provides an estimated $18.6 million annually in benefits at a cost of $1.9 million. Should additional trees be planted in available locations throughout the city, canopy cover could increase from 32% to 40%. The expanded tree canopy would provide an estimated $23.1 million annually in benefits at a cost of $3.2 million. Following the tree planting project, the net benefits of the canopy would increase from $16.8 million to $19.9 million annually.

While the report assesses available locations for tree planting and outlines suggested tasks to include in a tree planting program, the report is not a planting plan. Rather it is intended to be a rough framework for the development of a tree planting and reforestation program. While more work will have to be done, this report has demonstrated that tree planting is economically feasible and, indeed, will generate far more value than it demands in city resources.

The addition of 41,125 trees to New Britain will not occur overnight; it will require concerted action over the long term. However, trees are not just a short term investment: as they grow, they create value for generations. Thus in return for the time, effort, and funds required for tree planting and care, trees will contribute to a healthier, more vibrant community for years to come.

Fig. 56 Sun and shadows create an interesting scene along a path in Walnut Hill Park.

Endnotes, references, and sources

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Figure 7 http://www.patrees.org/trees-reduce-stormwater

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Figure 10 base photo from Google Maps

Figure 11 sketch by Kristin Thomas, base photo from Google Maps

Figure 12 http://nbrephoto.home.comcast.net/~nbrephoto/ThenAndNow/Tryptich/MainStNorth.htm

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Appendices

Tree Canopy Assessment Data Inputs May 2013

A. Background statistics and parameters

Statistics	Value	Source
City Name	New Britain	
Total Estimated Current Budget	$1,871,700	Based on average annual cost $34.48 per tree (Peper et al., 2007; McPherson et al., 2005; McPherson et al., 2007)
Population	73,206	U.S. Census Bureau, Census 2010
Urban/Street Tree Canopy Cover	.007 acres per tree	Athens-Clarke County, Georgia, Best Management Practices for Community Trees https://athensclarkecounty.com/DocumentCenter/Home/View/280
Park/Residential Tree	.029 acres per tree	Athens-Clarke County, Georgia, Best Management Practices for Community Trees https://athensclarkecounty.com/DocumentCenter/Home/View/280
Forest Tree	.012 acres per tree	Based off of the measurement of average number of trees per one acre of land that has 100 percent canopy coverage using aerial images and ArcGIS.
Total Urban Tree Canopy Cover	2782.45 acres	Based off of the measurement of the canopy coverage in each 2010 census block in the whole study area using ArcGIS and aerial imagery.

B. Estimated annual per-tree costs

Statistics	Value	Source
Planting	$5.14/tree	Average of values presented in Peper et al., 2007; McPherson et al., 2005;
Tree Removal	$3.63/tree	Average of values presented in Peper et al., 2007; McPherson et al., 2005;
Pruning	$9.13/tree	Average of values presented in Peper et al., 2007; McPherson et al., 2005
Infrastructure Repair	$8.97/tree	Average of values presented in Peper et al., 2007; McPherson et al., 2005;
Administration/Other	$7.61/tree	Average of values presented in Peper et al., 2007; McPherson et al., 2005;
Combined annual cost per tree	**$34.48/tree**	

C. Estimated annual per-acre benefits

Statistics	Value per acre of canopy	Source
CO2 Storage	$839.57	Derived from i-Tree Canopy software from the USDA Forest Service. http://www.itreetools.org/.
C Sequestration	$27.75	Derived from i-Tree Canopy software from the USDA Forest Service. http://www.itreetools.org/
CO removal	$0.93	Derived from i-Tree Canopy software from the USDA Forest Service. http://www.itreetools.org/
NO2 removal	$44.56	Derived from i-Tree Canopy software from the USDA Forest Service. http://www.itreetools.org/
O3	$131.35	Derived from i-Tree Canopy software from the USDA Forest Service. http://www.itreetools.org/
SO2	$3.99	Derived from i-Tree Canopy software from the USDA Forest Service. http://www.itreetools.org/
PM 10	$48.56	Derived from i-Tree Canopy software from the USDA Forest Service. http://www.itreetools.org/
Stormwater	$872.67	$0.04/gallon multiplied by 358 gallons/tree (McPherson et al., 2007) multiplied by 41,125 trees per 675 acres (measured using ArcGIS and aerial imagery)
Property Value	$4725.40	$52.5 million in aesthetics, property value, and other less tangible benefits from street trees divided by 11,110 acres of street tree canopy (Peper et al., 2007).

Tree Canopy Methodology

D. The analysis conducted in this study was as follows.

Total canopy cover

New Britain's existing tree canopy cover was estimated on a 2010 Census block level. The percent canopy cover in each block was estimated visually using leaf-off, 3-band RGB orthophotography with a resolution of 3 inches (captured in 2009). The percent coverage in each block was multiplied by the respective area of the block; the results were aggregated to give the total canopy area for the city. Tree canopy coverage was calculated by dividing this by the area of the city.

These results were verified using a LIDAR-derived line layer containing the outlines of all trees in the city. Both freestanding and grouped trees (e.g., in a grove or forest) were included. The lines were converted to polygons, and their total area was taken. This technique yielded the same total canopy cover result as visual classification.

Estimation of tree counts

As it was infeasible to count every tree, the number of trees in the city was imputed from the total canopy cover. Because where a tree is planted affects its growth (e.g. crown diameter) and hence the benefits it can provide, the canopy was broken into three classes: forest, park/residential, and street trees. Areas predominantly characterized by impervious surface were categorized as street trees; those where trees grew surrounded by grasses and loosely scattered trees were deemed park/residential; and all interior or core forestland beyond a 20-foot transitional fringe where tree density was greatest was designated as forest. This classification of park/residential and core forest trees was performed using an inverse buffer analysis. All forestland polygons identified in the LIDAR-derived line layer with an area less than 0.007 acres were classified as street trees. The remaining areas greater than 0.007 acres had a reverse buffer of 20ft was applied to identify fringe forest trees (that were then grouped as park/residential). The remaining core area was designated as forest.

Literature review indicated that typical crown diameters for street trees and trees in park/residential settings were 20 and 40 feet, respectively. Based on trunk counts in several representative one-acre transects, core forest tees in New Britain were found to have an average canopy of 522 square feet (a 26-foot diameter). To calculate the total number of trees in New Britain, the total acreages for street trees, forest, and park/residential canopy classes were divided by the average ground areas for a tree in the respective class and summed.

Scenario development

Three future scenarios were identified. These are current (maintenance of existing trees, with replacement of dead trees), decline (maintenance of existing trees with no replacement planting), and increase (maintenance of existing trees, with replacement of dead trees, and targeted planting of new trees). For replacement, literature review indicated that 1% of urban trees can be expected to die every year. The current scenario assumed the existing number of trees in New Britain would stay constant. Decline reduced it by 1%. Increase added 675 acres of new canopy cover, or 41,125 trees. (For the details on how this figure was arrived at, see p. 29-35.)

Estimation of Costs and Benefits of Each Scenario

Planting and maintenance costs reported in McPherson et al. (2005) and Peper et al. (2007) were averaged and then adjusted for inflation and the cost of living in New Britain. This produced an estimated cost of $34.48 per tree per year. This was verified against other sources, including Peper et al. (2007), which reported a cost of $37 and McPherson et al. (2005) which reported a range from $20 to $40. To

determine the costs for each scenario, this figure ($34.48) was multiplied by the number of trees under each scenario. As landowners would be responsible for the cost of new plantings and yearly maintenance, the same cost structure was used for private parcels. Forest land was assumed to have no cost as regeneration would happen naturally.

Per-acre values were derived from iTree Vue for all benefits (except for stormwater and property value). These values were multiplied by the total acreage of canopy cover under each scenario to determine total benefits. For stormwater, it was assumed that each tree provides $14.32 in benefits. This derives from McPherson et. al (2007), which reported small, mature trees process an average of 358 gallons of stormwater per year (gallons of stormwater processed varies by tree type, ranging from 358 gallons to 1,901 per year. For a conservative estimate, 358 gallons was used in the calculation), and Greeley & Hansen (2002), which found $0.04 in value per gallon of stormwater processed. For property value, it was assumed that each tree provides approximately $72 in benefits. This derives from Peper et al. (2007). For stormwater and property value, the per-tree benefits were multiplied by the number of trees under each scenario to determine total benefits.

Net benefits were calculated by subtracting total costs from total benefits for each scenario.

He who plants a tree plants a hope.

-Lucy Larcom