# An Analysis of Tree Canopy Cover

## and Strategies to Retain and Increase Trees

## in the City of *West Palm Beach*, Florida

APRIL 2025

WEST PALM BEACH

Prepared by the Green Infrastructure Center Inc.

Green Infrastructure Center

This report and analysis were funded by the City of West Palm Beach, Florida, under a contract to the Green Infrastructure Center Inc. (GIC)  The mention of trade names, commercial products, services or organizations does not imply endorsement by the City of West Palm Beach.



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## Project Overview and Findings

This report describes the City of West Palm Beach's (City) current tree canopy coverage and the benefits those trees provide for air quality, stormwater and shade. This report was provided by the Green Infrastructure Center (GIC) under a contract with the City. This report sets a goal to reverse the downward trend in canopy cover and increase current canopy by 1% to achieve 25% canopy cover by 2035. The GIC provided tree canopy cover data to the City to determine current tree cover and to track future progress. Strategies to maintain and increase canopy are found at the end of this report as well as on the City's website.

**Products created from this work include:**

- Analysis of the current extent of the urban forest through high-resolution tree canopy mapping.
- A Potential Planting Area analysis to determine where additional trees could be planted.
- Calculations of the environmental and social benefits provided by the City's trees.
- Strategies to expand canopy coverage over time.
- An online story map to visualize the data and show where new trees could be planted.

Tree Canopy



# West Palm Beach

## Fast Facts

**County: Palm Beach**
**Population: 124,130 people***
**Land area: 58 sq. miles**
**Area in tree cover: 7 sq. miles**
**Surface water & wetlands: 6.31 sq. miles**
**Total tree canopy cover: 34%**
**Total tree canopy in the City: 7,472 acres**
**Tree canopy in the urban areas (without grassy waters): 4,716 acres, covering 24%**

*(U.S. Census 2023 estimate)*

## Canopy Cover

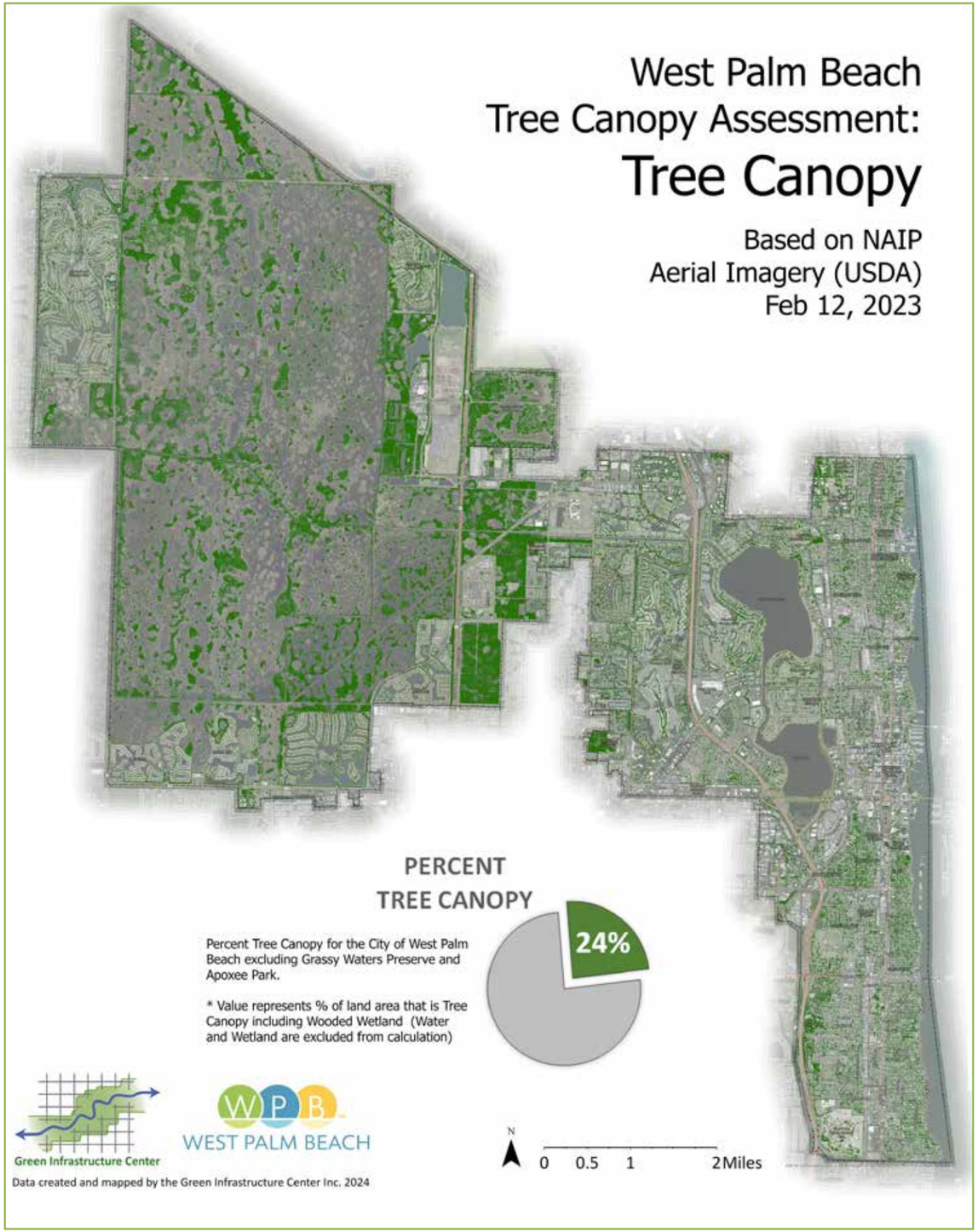
The City of West Palm Beach has a current tree canopy cover including Grassy Waters Preserve of 34%. However, in the urban areas of the City where everyone lives and works, the average canopy cover is 24%. Canopy cover varies across the City. For example, in the downtown area, canopy cover is just 13%. In addition, the City is losing canopy cover. In 2019, an analysis conducted by consultants found canopy cover for urban areas was 30%, meaning the City has lost 6% of its tree cover in the past 5 years. To stop this downward trend and recover some of the lost canopy cover the City proposes to increase canopy cover to 25% by 2035.

The City is actively planting new street trees.

To achieve this goal will take planting approximately 12,620 trees across the City. Most cities own/manage about 20% of city land (in this case referring to the urban area). **So, the City's share of the 1% increase goal is to plant about 2,524 trees or 252 trees per year, at a cost of $236,941.**

The rest of the goal (the other 80%) will be achieved through a community planting campaign to encourage private sector participation. It will cost the public less to participate and plant trees on private properties because people can buy smaller trees, water their own trees and provide ongoing tree care. The City currently provides free trees through giveaway events. In the past decade, the City has distributed 10,000 trees.

To meet the new goal to increase canopy by 1%, the public will need to plant just over 10,000 more trees over the next 10 years. Achieving this goal will require a robust planting campaign and partnerships to increase tree cover citywide. Expanding the canopy will allow the City of West Palm Beach to realize additional benefits for clean air, water, walkability, energy savings and economic benefits. The economic benefits include increased sales of goods and services in well treed business districts, lower vacancy rates and improved real estate values.






**The City of West Palm Beach can use the results of this report to:**

- Track progress toward achieving a recommended tree canopy goal of 25% by 2035 ("25 by 35!").
- Document the environmental and social benefits provided by City trees.
- Determine the most strategic locations to retain or plant trees.
- Inform urban forest management with strategic investments in tree care and planting.

A newly planted tree.

During a typical 2-year storm event, the City's trees capture
**42 million gallons of stormwater**
or the equivalent of 63 Olympic swimming pools of water!

## Canopy Benefits

An extensive tree canopy can provide a wide range of benefits to a community, such as improved air quality, the mitigation of stormwater runoff and associated water pollution, reduction of urban heating and significant savings in energy consumption.

Large trees provide more shade than palms.

While palms are native to Florida, they provide only minimal shade.

## Air Quality

Trees play a critical role, not only in providing oxygen, but also cleaning the air of particulate matter and ground level ozone ($O_3$ ), which can harm human health. Trees sequester greenhouse gases, such as sulfur dioxide and carbon dioxide. As these gasses are trapped by trees, the severity of climate change is reduced. Trees also store carbon and prevent its release, further ameliorating the impact of climate change. For example, the annual carbon storage by the City's trees is equivalent to taking 584 cars off the road annually!

## Stormwater and Water Pollution Uptake

The City's trees mitigate stormwater runoff impacts since they capture rainfall in their canopies, trunks, roots and surrounding soils. Some of that water is released back into the atmosphere through evapotranspiration. One mature, large tree can absorb thousands of gallons of water per year.

**The Trees and Stormwater (TSW) Calculator tool** created for this project can be used to model stormwater uptake for various storms that occur throughout the year. For example, the TSW tool shows that during a typical two-year storm event, the City's trees capture 42 million gallons of stormwater, or the equivalent of 63 Olympic swimming pools of water!

The City's trees also capture 26,116 lbs. Nitrogen (N), 2,092 lbs. Phosphorus (P), and 2,197 tons of sediment that would otherwise be carried by stormwater runoff to open waters including the Lake Worth Lagoon and the Atlantic Ocean. Sediment clogs fish gills and reduces light reaching underwater plants that produce oxygen and provide food for marine life while nitrogen and phosphorus are plant nutrients that can contribute to algal blooms and further reduce oxygen. Trees also perform an important "ecosystem service" by taking up stormwater, cleansing the water and reducing flooding.

In addition to providing shade in the future, these newly planted trees will contribute to the 42 million gallons of stormwater runoff captured by the City's trees.

## Reducing Urban Heating and Saving Energy

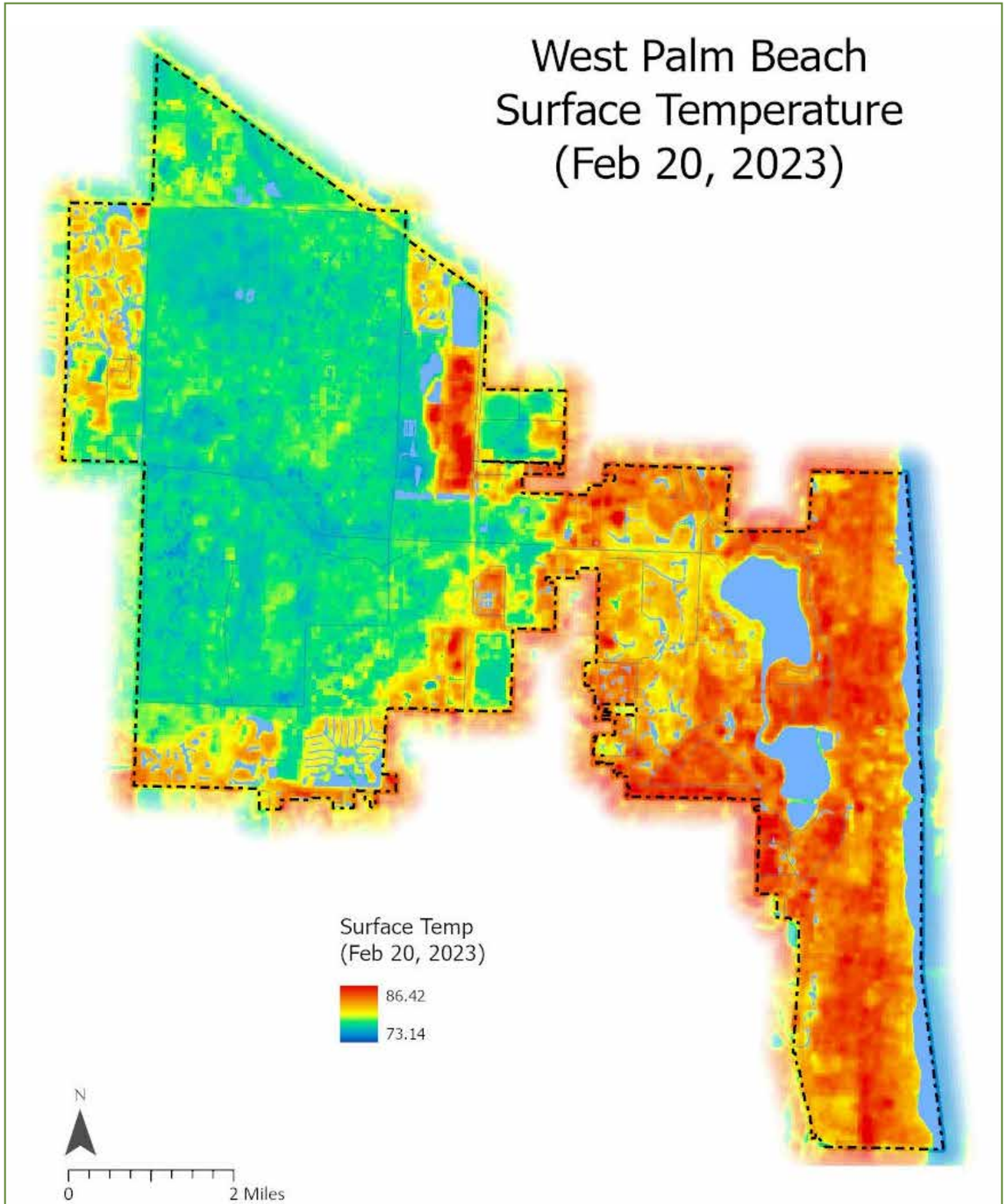
Like many southern cities, the City of West Palm Beach suffers from the effects of impervious surfaces, coupled with lack of adequate vegetative cover. Excessive pavement and lack of canopy shade lead to increased temperatures, forming pockets of very hot areas known as urban heat islands.

In West Palm Beach, higher temperatures were found in areas lacking tree cover. In lower income neighborhoods, people are often less able to afford to plant or care for trees. The City will promote new tree plantings in areas that are hotter, have lower income and a higher percentage of minority classes, in order to help residents who might not be able to afford a new tree. For more steps to increase equitable tree cover, see the strategies section of this report.

**Pounds of air pollution and greenhouse gases removed annually by Trees in the City of West Palm Beach**

| CO (carbon monoxide) | $NO_2$ (nitrogen dioxide) | $O_3$ (ozone) | $PM_{10}$* (particulate matter 10 microns) | $PM_{2.5}$ (particulate matter 2.5 microns) | $SO_2$ (sulphur dioxide) | C seq (carbon sequestered in metric tons) | C stored ** (carbon stored in metric tons) |
|---|---|---|---|---|---|---|---|
| 5,440 | 9,310 | 108,112 | 38,608 | 6,695 | 4,670 | 2,690 | 132,404 |

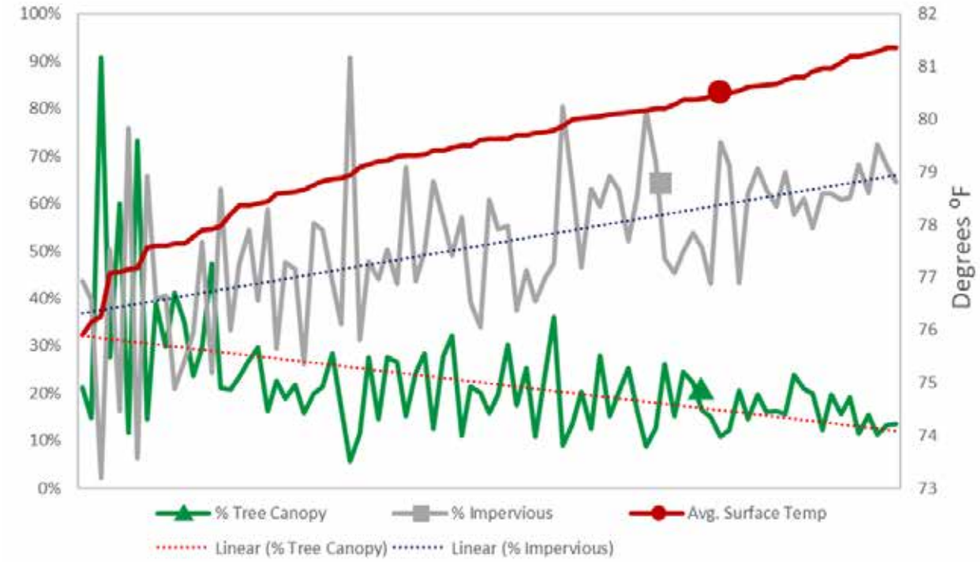
*PM = Particulate matter
**C stored is not an annual rate but a total amount of carbon stored.




City planting strategies should first target areas of the City with the lowest tree cover.

## Canopy and Heat

This assessment included mapping areas where strategically placed trees can do the most good in reducing summer heating and associated cooling costs.




Grassy Waters Preserve provides a cooling effect and an escape from hotter temperatures.

## Meeting City Strategies

This assessment supports West Palm Beach's ***Rethink Paradise: Sustainability Action Plan*** and its efforts to become better prepared to face existing and future hazards in a changing environment and to become more resilient. The City met its prior goal to distribute 10,000 trees, and its new goal to plant and distribute more than 12,000 new trees over the coming decade is intended to reverse the downward trend in tree cover. For more on this initiative see https://www.wpb.org/Departments/Sustainability/City-Initiatives/10000-Trees-in-10-Years

Planting to increase shade tree cover on both public and private properties will occur through a variety of mechanisms, from tree giveaways and planting projects to new, city-wide policies, such as adopting a new tree ordinance to better protect trees during and after development.

The City of West Palm Beach has 15,596 acres of green space, made up of municipal parks, beaches and conservation lands, making the City rich in natural amenities that contribute to a high-quality lifestyle. The City's crowning jewel is the 23 square mile Grassy Waters Preserve that provides abundant fresh water for City residents. Its boardwalks and nature center also provide a wonderful escape to enjoy native Florida flora and fauna, protecting hundreds of species of plants, trees, birds, fish, amphibians and beneficial insects. The City is also home to Manatee Lagoon, adjacent to Florida Power & Light Company, where manatee sightings are common.

Art within the park along the Manatee Lagoon, along with newly planted trees, creates a wonderful oasis for people.

## West Palm Beach's Sustainability Focus

**The City's Comprehensive Plan – Conservation Element (2024) states that, West Palm Beach will "conserve, protect and appropriately manage the natural resources of the City to ensure the highest environmental quality possible." The *Rethink Paradise: Sustainability Action Plan* update is complete and will be taken to Commission for adoption in the near future. Protecting tree cover will assist this plan by ensuring greenhouse gases and carbon capture is addressed and will protect residents from an increasingly warming planet.**

**In 2021, the City completed a Climate Resilience Assessment and Plan which look at several climate threats, including extreme heat, water pollution, and rainfall-induced flooding, which all could be lessened and addressed by having health and vibrant tree canopy.**

**Assessing and enhancing the City's tree canopy supports the goals of a number of City boards, plans and policies:**

- **Comprehensive Plan (June 2024)**
- **Rethink Paradise: Sustainability Action Plan (2023) (first plan created in 2012, last updated 2023 draft). The update calls for the City to review current policies and ordinances, as well propose new additions, to ensure the protection of its green spaces and water systems.**
- **Tree City USA designation for 32 years and counting**
- **Keep West Palm Beach Beautiful Committee**
- **Community Rating System from FEMA**
- **Urban Forest Management Plan (2018)**

# A Primer on Tree Benefits

The trees of West Palm Beach benefit the City in many ways, including ecologically, economically and socially. This assessment allows the City to measure some of those benefits, and to increase them by planting more trees. The City's tree canopy can be used to maximize many environmental and social benefits in terms of:

- bird and wildlife habitat
- clean air and water
- walkability and fitness
- enhanced natural beauty
- lower vacancy rates
- lower heating and cooling costs
- increased revenues from sales and property taxes

A red bellied woodpecker forages amongst the canopy in Palm Beach County.

The City's trees provide essential shade for playgrounds. Children are more susceptible to heat-related stress.

## Trees Are Green Infrastructure

Trees and vegetation in a city can be considered as a city's "green infrastructure." Just as we manage our gray infrastructure (roads, sidewalks, bridges and pipes), we also need to manage our trees as green infrastructure. Trees are green infrastructure because they enhance sustainability by filtering stormwater and reducing runoff, cooling streets, cleaning the air, and capturing carbon emissions. Trees also support a vibrant, safe and healthful city while adding to the City's historic, coastal character. Trees also increase property values.

West Palm Beach has been designated as a "Tree City USA" for 32 years by the Arbor Day Foundation in recognition of its commitment to caring for its urban trees. As the City of West Palm Beach continues to redevelop, managing and expanding the urban forest will help the City achieve its vision of being both sustainable and resilient. See text box, "*West Palm Beach's Sustainability Focus*", on page 13.

### Gray vs Green Infrastrucure

The image on the left shows a Florida city's gray infrastructure, including buildings and roads. Classified high-resolution satellite imagery (on the right) adds to a city's green infrastructure data layer (trees and other vegetation). This green infrastructure provides cleaner air and water, energy savings and natural beauty.




Image by City of West Palm Beach

The City regularly donates trees to residents who are ready to help expand tree cover.

Trees filter and clean land runoff before it enters surface waters, ensuring healthy fisheries.

## Reducing Stormwater Runoff and Filtering Pollutants

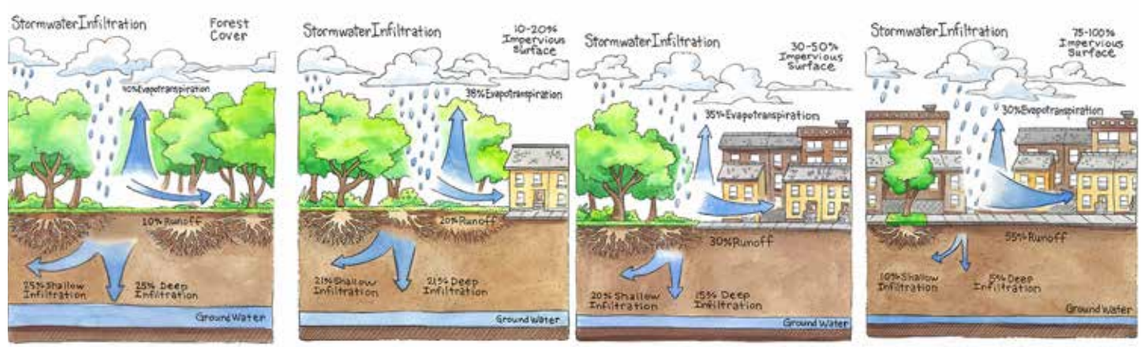
Trees protect cities from problems associated with stormwater runoff. As forested land is converted to impervious surfaces, runoff increases. Excess stormwater runoff can cause temperature spikes in receiving waters, increased pollution of surface and ground waters, and greater potential for flooding.

Trees reduce nitrogen, phosphorus and sediment in stormwater runoff by cleaning rainfall of these pollutants. Increased loads of nutrients in stormwater runoff reduce oxygen in surface water, causing harm to fish and other aquatic life. The presence of trees means fewer pollutants reach drainage canals, Lake Mangonia, Clear Lake, Lake Worth Lagoon and the Atlantic Ocean.

The average annual precipitation in West Palm Beach is 57.4 inches[1], which contributes stormwater runoff conveying surface pollutants from the land into canals and then to the Lake Worth Lagoon and eventually the Atlantic Ocean. Large, paved areas contribute significant stormwater volumes to this runoff. While stormwater ponds and other best management practices (BMPs) are designed to mimic rainfall release by detaining and filtering runoff, they do not fully replicate pre-development hydrology. In addition, older parts of the City may lack stormwater management practices that are required for new developments, so not all runoff is captured or treated before it flows into open waterways.

[1] https://www.weather-us.com/en/florida-usa/

### Water Infiltration Rates with Development



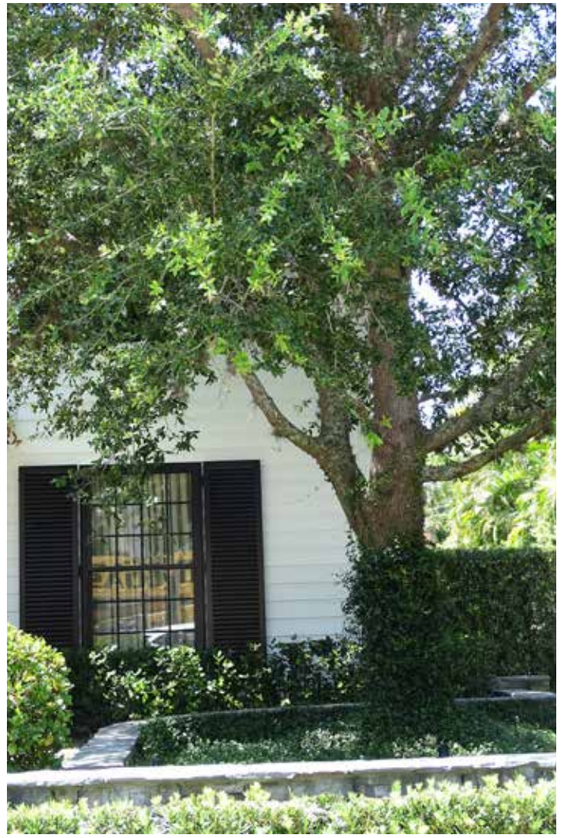

Runoff increases as land is developed. Data Source: Federal Stream Corridor Restoration Handbook (1998).

Excess impervious areas cause higher temperatures and runoff that often flows unfiltered into storm drains, to City canals, lakes and the Atlantic Ocean. This parking lot could be retrofitted to add more trees, bioswales and pervious surfaces.

Since trees filter stormwater and reduce overall flows, planting or conserving trees is a natural way to mitigate stormwater. Each tree plays a significant role in stormwater management. Based on the GIC's review of canopy rainfall interception studies, a typical street tree's crown can intercept between 760 and 3,000 gallons of water per year, depending on the tree's species and age.

As tree cover is lost and impervious areas expand, excessive urban runoff results in pollutants, such as oils, metals, lawn chemicals (e.g., fertilizer and herbicides), pet waste, trash and other contaminants reaching surface waters. Trees help capture and filter that urban runoff. Nitrogen and phosphorus are nutrients that cause harmful algal blooms, while sediment can clog fish gills, smother aquatic life and necessitate additional dredging of canals and waterways. Algal blooms can also reduce oxygen levels, further harming fish and other aquatic life.

An example of a tree planted in a recessed area to capture and treat stormwater.



Trees shade residences and improve property value too.



## Buffering Storms and Flooding

**Another benefit of conserving trees and forests is buffering against storms and losses from flooding. According to the U.S. Environmental Protection Agency (EPA), excessive stormwater causes increased flooding and property damage, as well as public safety hazards. The EPA recommends a number of ways to use trees to manage stormwater in its book *Stormwater to Street Trees*.**

**Retaining trees and forests along coasts provides a wind break and helps evaporate and reduce standing water. In addition, utilizing trees as green infrastructure provides a basis for reimbursement from FEMA for storm-damaged trees. To qualify, trees must be inventoried and specifically utilized for stormwater management, buffers or other "green infrastructure" functions.**

Shade trees added to this area could help soak up standing water.

Mangroves prevent coastal erosion and provide a buffer against wind. The City has planted mangrove islands in Lake Worth Lagoon to add habitat and filter the water.

**The City of West Palm Beach participates in the National Flood Insurance Program's Community Rating System (CRS). The CRS is a voluntary incentive system that allows local governments to earn flood insurance premium discounts for policyholders in the community. Local governments receive points, both for actions and for policies that reduce flooding and flood damage; these points earn premium discounts as high as 45%. The City of West Palm Beach is currently rated as Class 5 in the CRS program, earning its residents and businesses a 25% premium reduction in insurance rates within its special flood hazard areas.[2]**

**The lower the CRS rating, the higher the premium reductions for flood insurance. Communities can earn point reductions for adopted management plans that protect the critical natural functions of floodplains and native species, while restoring natural habitats.[3] This requires an inventory of all species in the plan's geographic purview, action items for protecting one or more of the identified species of interest, restoring natural floodplain functions, and the review and update of the plan every 10 years.**

[2] https://www.wpb.org/Departments/Development-Services/Flood-Information

[3] https://floodsciencecenter.org/products/crs-community-resilience/element-profiles/422-c-natural-functions-open-space/

# Improving Air Quality, Public Health and Economic Values

## Trees Pay Us Back

As the City considers the cost of planting and caring for more trees, it is important to note that studies have shown that "twenty years after planting, average annual benefits for all public trees exceed costs of tree planting and management" (Peper et al, 2010). And, of course, even a newly planted tree will immediately begin to sequester carbon, clean the air and soak up stormwater. So, while the City will need to expend more funds to increase and maintain its canopy coverage, those trees will more than pay their way. Trees planted in commercial shopping districts have been shown to increase peoples' time and spending in the district, which benefits the City in increased sales' revenues.

City investments in downtown canopy are paying dividends with new businesses and increased foot traffic supporting more shopping, dining, businesses and residences.

## Trees Cool the City

Increasing shade provides many benefits, especially during Florida's hot summers. Excessive heat can lead to heat stress, which especially affects infants and children up to four years of age, those 65 years of age and older, those with obesity issues and those on certain medications (CDC 2020).

As a result of their year-round cooling effects, trees in Florida provide energy savings for homes and businesses. For instance, a study of Miami's trees showed substantial cooling savings (McPherson et al. 1993). Individual trees can transpire hundreds of liters of water per day which represents a cooling power equivalent to the energy needed to power two average household central air-conditioning units per day (Ellison et al, 2017).

Tree cover shades streets, sidewalks, parking lots and homes, making urban locations cooler and more pleasant for walking or biking. Multiple studies have found significant cooling (2-7° F) and energy savings from having shade trees in cities (McPherson et al, 1997, Hashed et al, 2001).

Shaded pavement also has a longer lifespan, so maintenance costs associated with roadways and sidewalks are less (McPherson and Muchnick 2005). These benefits are particularly important in the southeastern United States where average temperatures are generally higher than other parts of the country.

Trees shading shopping districts have been shown to increase the amount of time that people spend in the district.

## Trees Clean the Air

In addition to cooling surfaces, trees absorb volatile organic compounds and particulate matter from the air, improving air quality. For example, trees clean the air of ground level ozone ($O_3$), and they filter out fine particulate matter, which can damage lungs and lead to respiratory distress and diseases such as asthma. Well treed neighborhoods have been found to have lower rates of respiratory illness (Rao et al, 2014). Trees also sequester carbon which forms greenhouse gases, such as carbon dioxide, that contribute to a warming planet and associated health problems from excessive heat. By storing carbon and preventing its release, trees mitigate the impacts of climate change.

This tree is cleaning the air while providing needed shade.



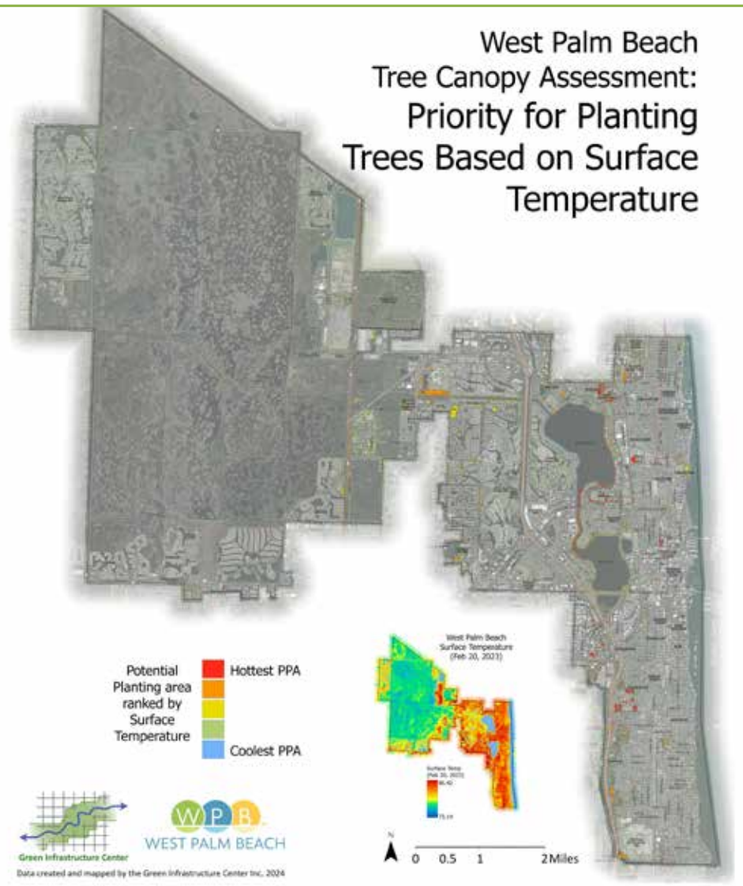
## Trees Improve Cognitive Function

Children who suffer from Attention Deficit Hyperactivity Disorder (ADHD) benefit from living near forests and other natural areas. One study showed that children who moved closer to green areas have improved cognitive function after the move, regardless of level of affluence (Wells 2000). Thus, communities with greener landscapes benefit children and reduce ADHD symptoms. Exposure to green spaces such as parks or treed landscapes for 20 minutes a day can also improve cognitive function – so providing natural areas on or near school grounds, as well as greening routes to school, can better prepare children to learn.

## Trees Improve Walkability

Trees result in people walking more and walking farther. When trees are not present, people perceive distances to be longer, hotter, and less pleasant, making pedestrians less inclined to walk than if streets are well treed (Tilt, Unfried and Roca 2007).

Well-treed areas encourage people to walk and cycle.




The hottest areas of the City are also those with the lowest tree canopy.

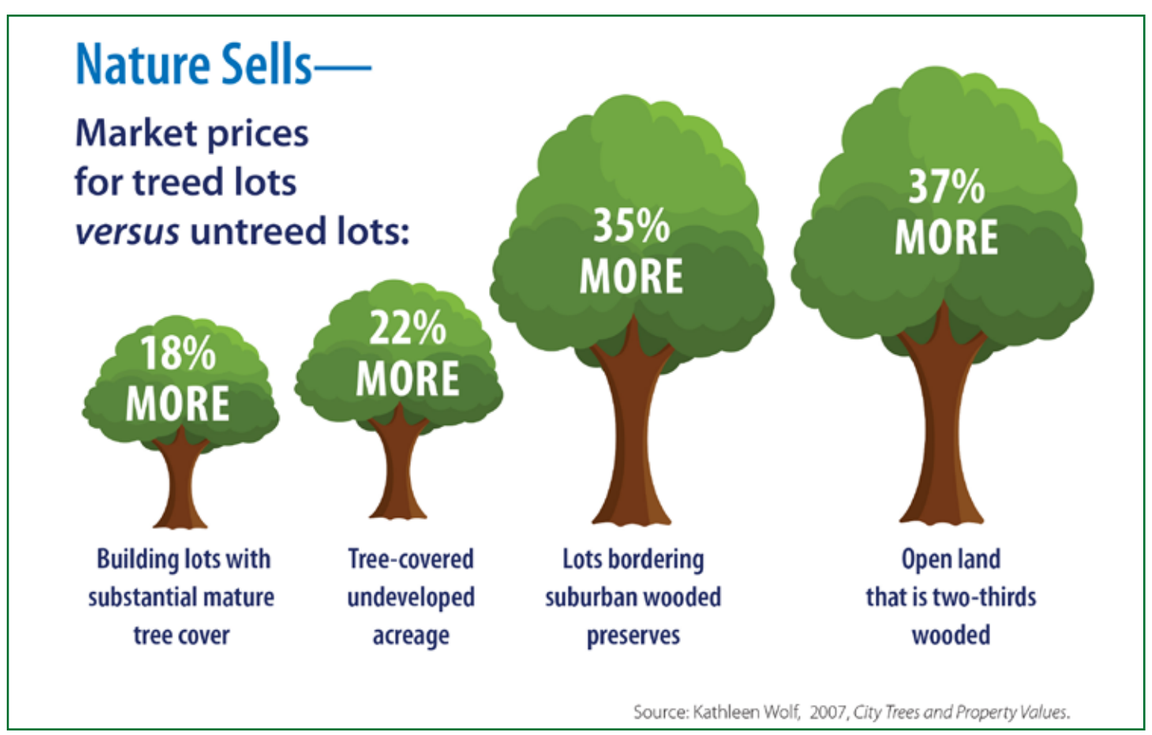
## Increasing Property Values

Developments that include green space or natural areas in their plans sell homes faster and for higher profits than those that take the more traditional approach of building over an entire area without providing community green space (Benedict and McMahon 2006). Individual trees on lots and forested open spaces also make lots more valuable.

A study by the National Association of Realtors found that 57% of those surveyed were more likely to purchase a home near green space, while 50% were willing to pay 10% more for a home located near a park or other protected area. Citizens also appreciate fruit trees for their nourishment and cultural significance to southern Florida.

**Home buyers are willing to pay more for homes located near a park or other natural area.**

Homes with shade trees are likely to have lower energy bills.






# Methods to Determine Current and Potential Tree Canopy Cover and Values

## Methods

This assessment determined the current and potential future tree canopy and quantified the ecosystem services it provided. First, a highly detailed land cover analysis was conducted to determine current and potential tree cover (See Appendix A for details). In addition to urban forest planning, this new land cover data can be used for other purposes, such as analyzing urban cooling, walkability and street tree plantings. This plan can also inform area plans and the City's Comprehensive Plan updates and the ***Rethink Paradise: Sustainability Action Plan***.

Satellite imagery from the National Agricultural Imagery Program (NAIP) distributed by the USDA Farm Service Agency was classified based on 4 infrared bands to determine the types and extent of different land covers in West Palm Beach. Additional data sets from the City of West Palm Beach, the National Wetlands Inventory, and the National Hydrography Dataset were used to classify the following:

1) Tree canopy (including both trees and mangroves), defined as woody vegetation over 10' in height.
2) Those wetlands that are indistinguishable using other spectral/feature-based image classification tools.
3) Forested open space: compact, continuous tree canopy greater than one acre that is not intersected by buildings or paved surfaces.

LiDAR (light detection and ranging) data were used to determine height, in order to distinguish between large shrubs and trees.[4] Note that newly planted trees such as those installed in the past few years may not yet show up on satellite images because they are not tall enough to register as a "tree."

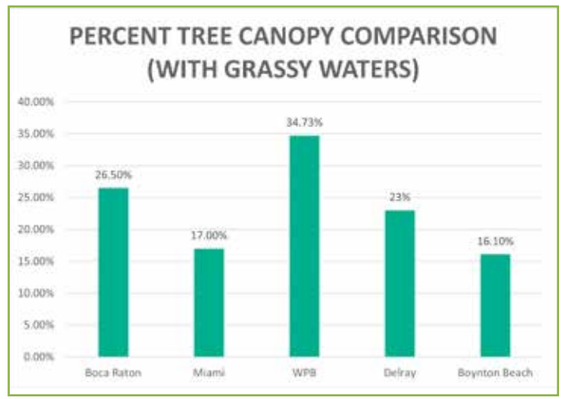
As West Palm Beach is a tropical city[5], palm trees make up part of its canopy. Technically, palms are not trees; they are grasses. This means that, while palms provide some shade, they have shallow, fibrous roots that do not absorb as much water or filter pollutants the same way as a mature shade tree. For more on this, see the box on page 22 Palm Trees: Costs *versus* Benefits.

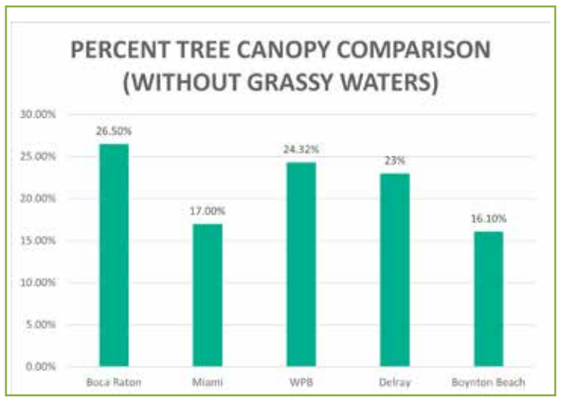
Since they make up a dense part of some of the City's canopy along Lake Worth Lagoon, mangroves were also included in canopy calculations. However, they present another challenge when calculating canopy cover, since they behave similarly to wetlands, rather than mature forest.

Cities often want to know how they compare to their neighbors. However, when comparing the tree canopy in the City of West Palm Beach to other local cities, there are some key distinctions in how tree canopy data have been analyzed between jurisdictions. In the City of Delray Beach, for example, its analysis did not utilize height data and thus its canopy results include a sizable percentage of shrubs and other low-lying vegetation that are not actually trees.

[4] LiDAR is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the top of the vegetation, compared to the underlying surface of the Earth. The farther the laser beam travels, the shorter the vegetation.

[5] Koppen classification system.




When including Grassy Waters in the percentage of tree canopy cover, West Palm Beach has the highest canopy coverage at just over 34%. However, excluding Grassy Waters Preserve shows that the urban areas of the City are lower than surrounding cities at just over 24% coverage.

## Palm Trees: Costs versus Benefits

Palm trees are a signature aesthetic element of Palm Beach County and its cities and towns. Palm trees, though, are not technically trees at all; they are "grasses." As such, palms are monocots – plants whose seeds contain only one leaf – and are in the Arecaceae botanical family of perennial flowering plants. Palm forms include climbers, shrubs and other tree-like and stemless plants. Those with a tree-like form are colloquially called "palm trees."

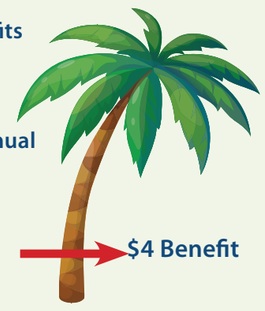
Larger palm trees barely function like actual trees; while they provide some shade, cooling, carbon sequestration and air pollution removal, it is relatively little compared to a large canopy tree. Although palms take up some stormwater, because of their shallow root structure, skinny trunks and narrow, thin canopy, they do not come close to matching the capabilities of a mature canopy tree, such as a live oak, for ecosystem benefits.

Furthermore, although "palm trees" are ubiquitous to Florida, they are expensive to maintain as a street "tree." In a study of Central Florida, the US Forest Service found that palms can be "very expensive to plant and maintain." Research shows that annual benefits and expenditures for a typical palm used as a street tree (sabal palm) were $4 and $30, respectively, resulting in a net annual loss of $26 per tree. Compare that to a large live oak in a yard 20 years after planting, for which the total value of environmental benefits alone ($80) is five times the total annual cost ($16) of maintaining it (Peper et al, 2010).

One reason palm trees are so expensive to maintain compared to typical trees is that many palms in Florida are "non-self-cleaning." They require every dead leaf to be manually removed because fallen palm fronds do not biodegrade into turf and soil, as do the leaves of many broadleaf tree species. Palms also require more nutrients than any other cultivated plant in Florida. Thus, in order to grow well and develop fully, they require routine treatment with expensive fertilizers (Broschat 2010a).

While palm trees are a significant aesthetic element of Palm Beach County's canopy, when hoping to realize the benefits of an abundant tree canopy for shade, stormwater, air quality and health, the City of West Palm Beach should consider planting large shade trees – both to save on costs and to realize their greater benefits.

The annual benefits of a typical street palm vs the expenditures result in a net annual loss of $26 per tree.



Cost $30 → $4 Benefit

Cost $16 → $80 Benefit

The environmental benefits of a large live oak in a yard 20 years after planting, is five times the total annual cost.



Including Grassy Waters in the canopy coverage calculation for West Palm Beach at 34% makes the City the clear "winner" in the unofficial canopy competition, but considering the urban areas where people live the average City canopy is 10% lower.

Because of these differences in methods and landscapes, comparisons between jurisdictions may not be useful. The City of West Palm Beach is best served by focusing on its own goal to expand and better manage its urban areas with respect to tree coverage.

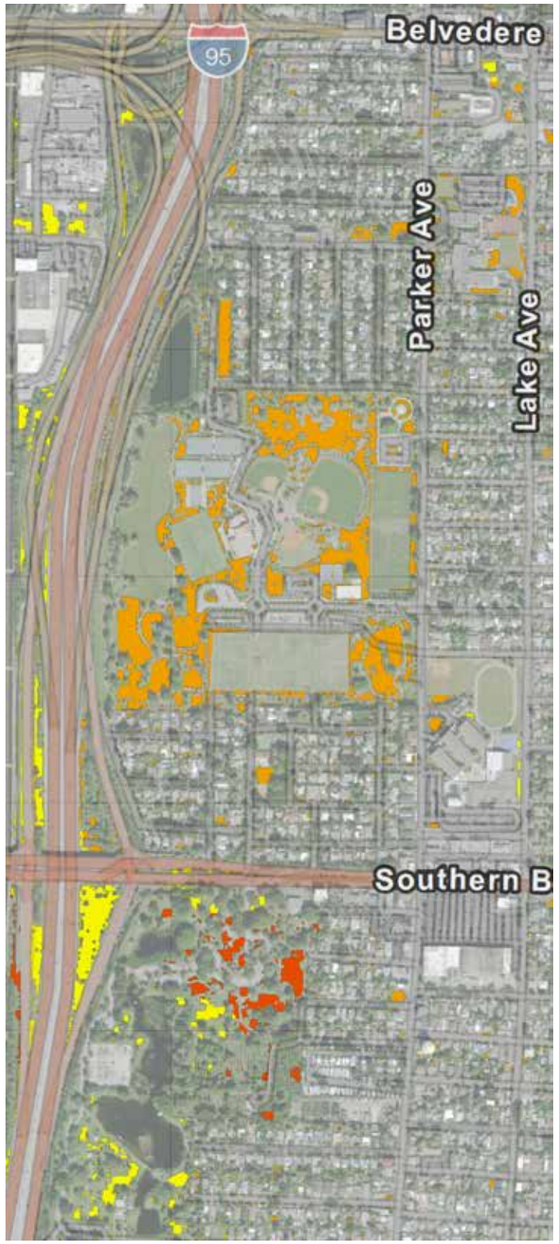
## Determining Plantable Acreage

### Possible Planting Areas

In urban areas, realistic goals for expanding urban canopy depend on an accurate assessment of plantable open acreage. A Potential Planting Area (PPA) map estimates areas where it may be feasible to plant trees. The PPA is estimated by selecting those land cover features that have space available for planting trees and accounts for the overlap of canopy (canopy that is intermingled, or a large canopy tree that partially covers an understory tree). It is important to note that West Palm Beach does not have many open space areas available to plant new trees since only about 3% of open space is available for planting. Note that this study did not include urban tree pits in calculating available planting area because the root volume available under the sidewalks is unknown. This study looked for planting widths of at least 6 feet to ensure enough room for a shade tree to grow and develop fully. One recommendation for the City is to continue its work to expand tree pits citywide, similar to City efforts in the downtown district.

Of the nine land cover classes mapped, only pervious and turf were considered for the PPA. However, some paved areas could be removed or reduced, soils conditioned and then used to plant new canopy. For example, a parking lot could be redesigned in order to accommodate more tree canopy to

There are many places in the City where new trees can be planted.




Potential Planting Area (PPA) shown by planting areas that can soak up the most rainwater with the redder areas soaking up the most water if trees were planted there, followed by orange and yellow zones. The City now has these data to analyze and prioritize tree planting within the hottest areas.

absorb and clean stormwater runoff. Some cities have lowered their parking minimums (number of required spaces) and others have also adopted a parking maximum (a cap on the number of spaces to avoid over paving). If less parking spaces are required, more space is available to plant trees.

Eligible planting areas are also limited by their proximity to features that interfere with a tree's natural growth (such as buildings) or where a tree might affect the feature (such as power lines, sidewalks or roads). City staff and the GIC reviewed the draft PPA map and removed playing fields, the cemetery and other known land uses, such as drainage swales along streets, where trees are not currently allowed. The resulting PPA represents the maximum potential places trees can be planted and grow to full size.

The GIC recommends no more than half the available PPA is realistic to plant, since many other uses, such as vegetable gardens or swimming pools, require full sun. Since the PPA is 3%, about half of that area could be practical to plant at most. The City has adopted a goal of a 1% increase in canopy cover in 10 years, equating to about 12,620 trees (about half of these would be large trees and the other half smaller trees). This number assumes that about 1,000 trees will be lost over the next 10 years due to old age, storms, disease or development.

## Possible Planting Spots

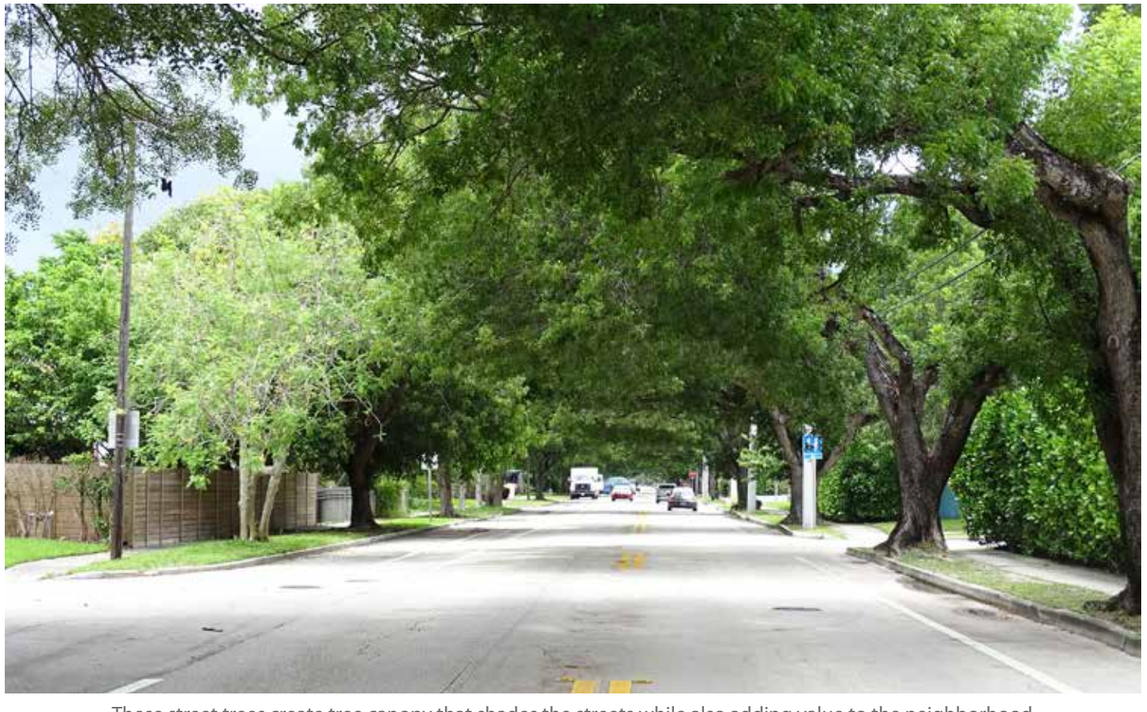
**Potential Planting Spots (PPS)** are created from the PPA. A GIS modeling process is applied to select spots where a tree can be planted, depending on the desired mature size. For this analysis, expected sizes of 20 ft. and 40 ft. diameter for individual mature canopy trees were used, with priority given to 40 ft. diameter trees, since larger trees provide more benefits.

## Potential Canopy Area

The **Potential Canopy Area (PCA)** is created from the PPS. Once possible planting spots are selected, a buffer around each point is created to represent the mature canopy spread. For this analysis, that buffer radius is either 10 ft. or 20 ft. which represents a 20 ft. or 40 ft. diameter canopy. These individual tree canopies are then merged to form a Potential Canopy Area.

Percent Street Trees is calculated using the Land Cover Tree Canopy and road centerlines, which are buffered to 50 ft. from each road segment's centerline. The percent value represented is the percentage of tree cover within that 50 ft. buffer.

View the tree cover maps in the Story Map online: https://arcg.is/1X8eH51 .



These street trees create tree canopy that shades the streets while also adding value to the neighborhood.



# Maps and Findings

The *Tree Canopy Map* will be used to plan for tree conservation and as a benchmark to gauge future progress in tree canopy gains. An ArcGIS geodatabase with all GIS shape files produced during the study has been provided to the City.

In addition, the City requested statistics for canopy in the following areas:

- census block groups
- parks
- waterways
- neighborhoods
- downtown
- parcels
- streets
- watersheds
- state opportunity area

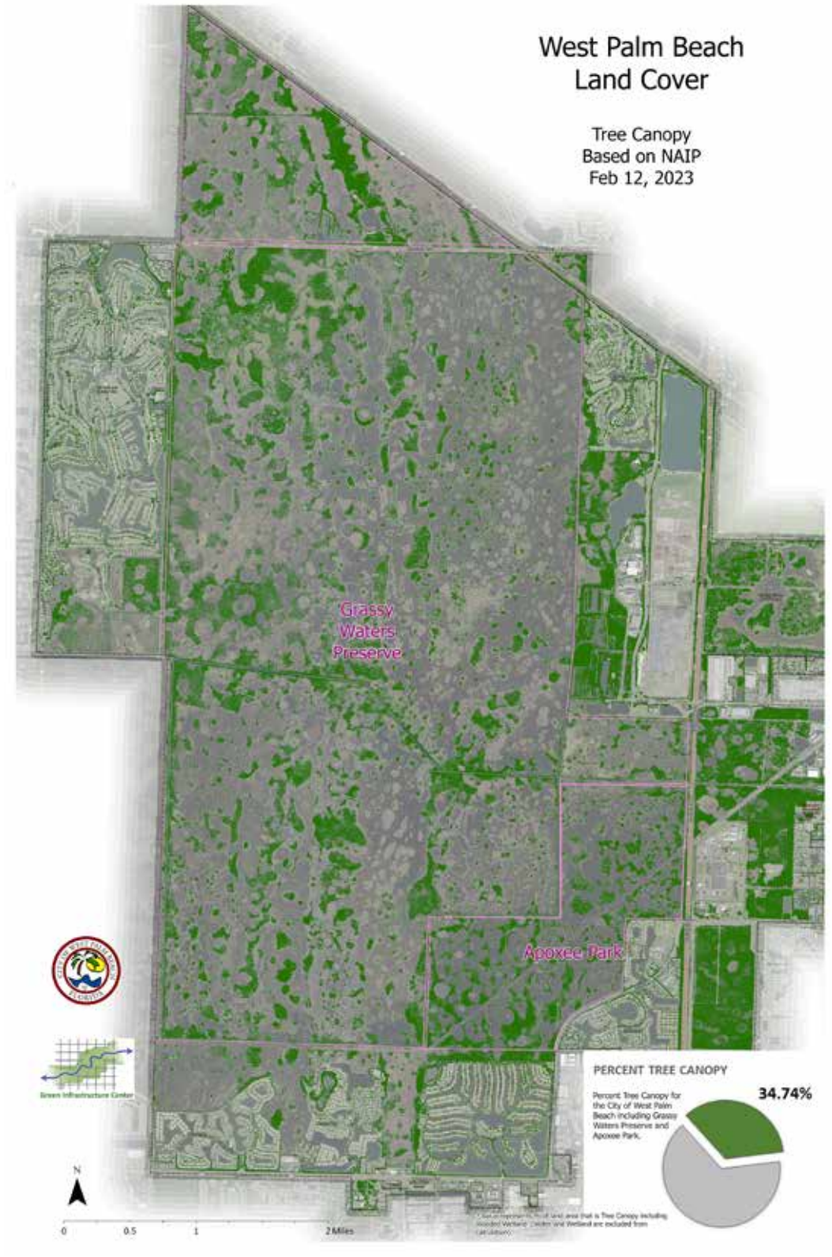
The canopy data and the Possible Planting Area Map can inform tree planting decisions to meet many goals, such as walkability, greenhouse gas emission reduction, energy savings, urban heat island reduction and economic revitalization. See the canopy maps on the following pages.

Tree canopy cover for parks were included in the canopy statistics provided to the City.

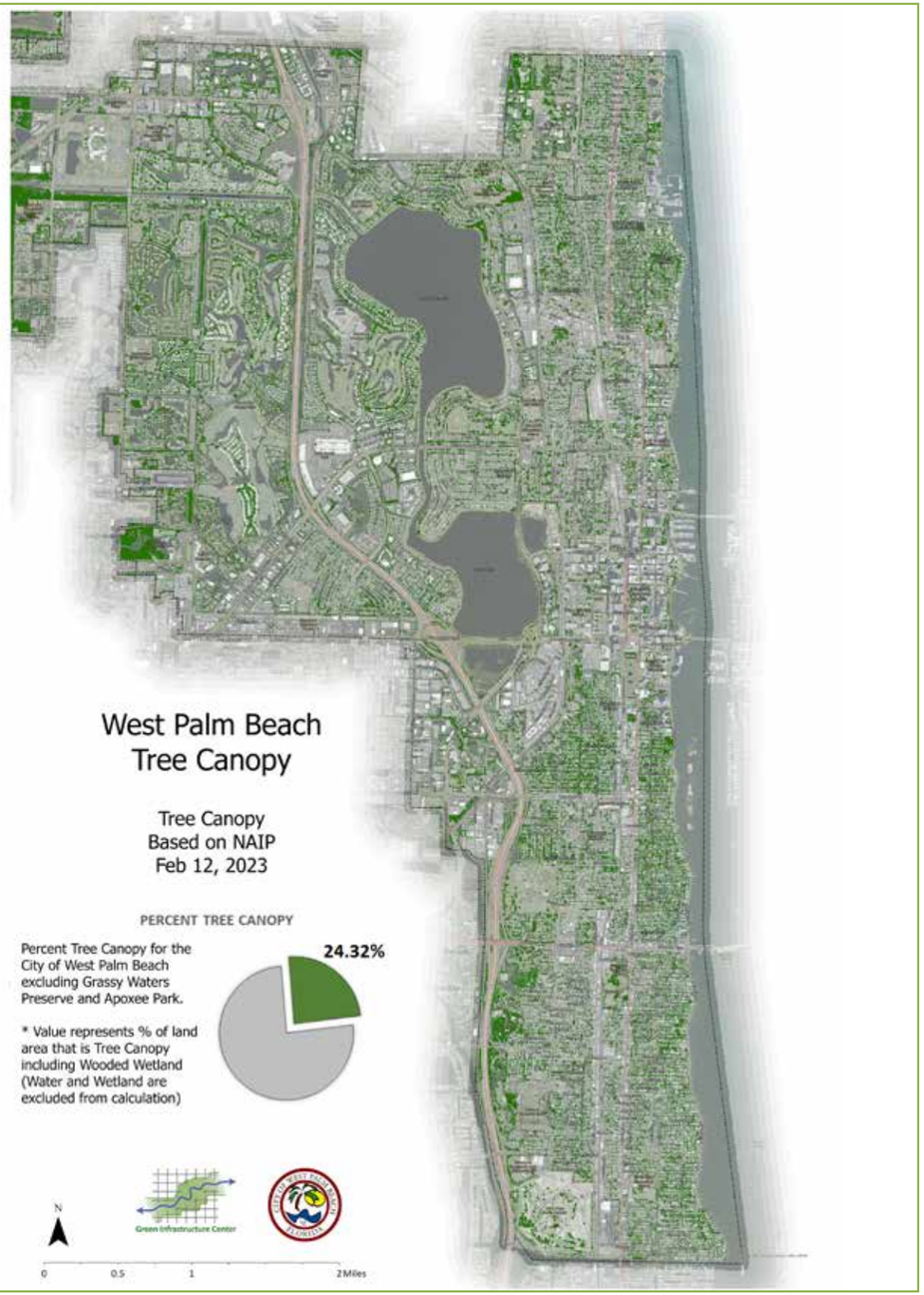
One mature tree, such as this magnificent Banyan Tree can absorb thousands of gallons of water per year.

# City Tree Canopy Cover

The two maps on these pages show the current tree canopy for the City of West Palm Beach split into the west and east. The total tree cover for the City, including Grassy Waters, is 34% of the total area, as shown in the pie chart on the left map. The pie chart showing 24% canopy refers only the urban areas where people live and work.



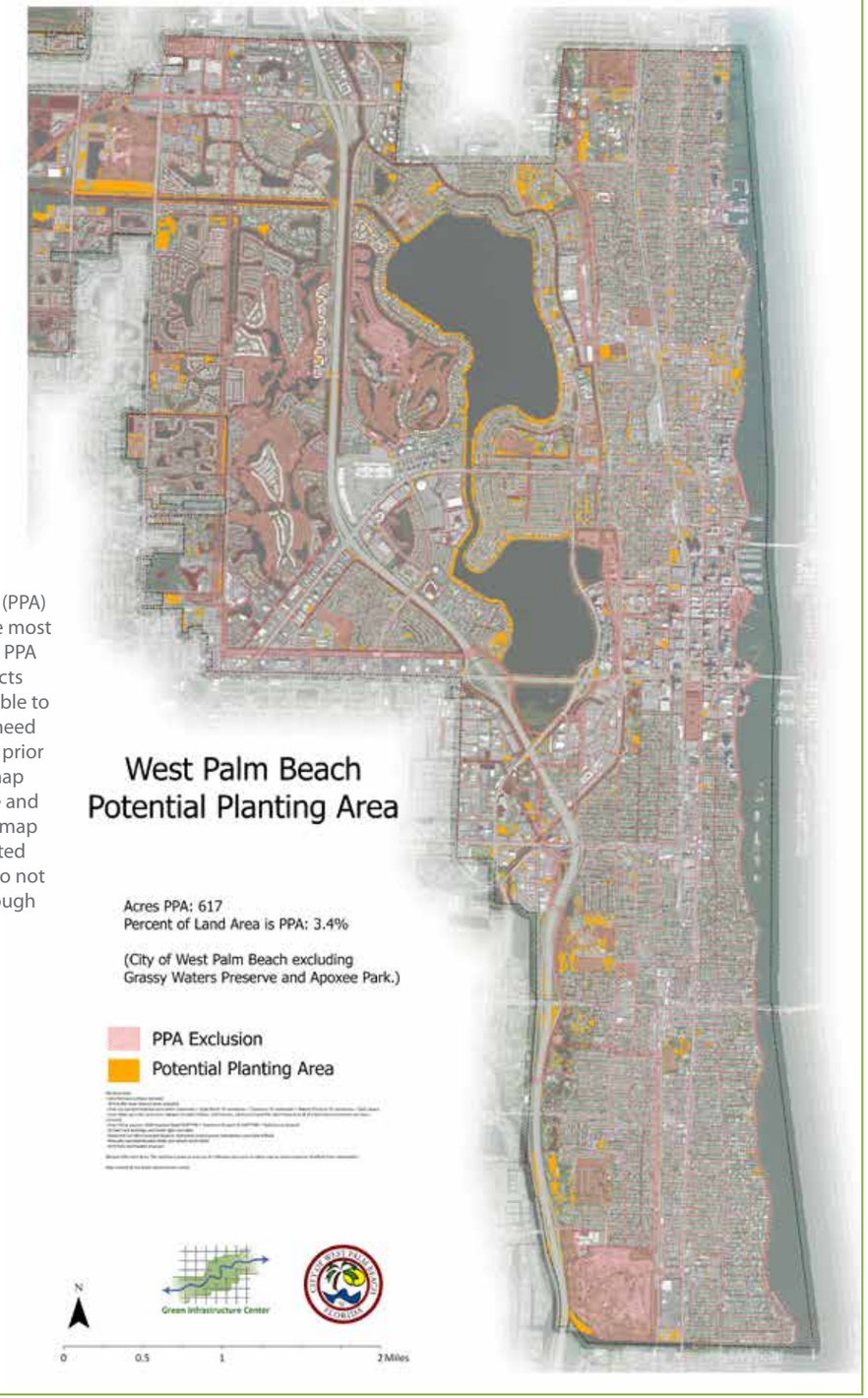

Tree canopy is reducing urban heating, cleansing the air, facilitating exercise, absorbing stormwater runoff and adding beauty, protecting property values and providing habitat.



# Potential Planting Areas

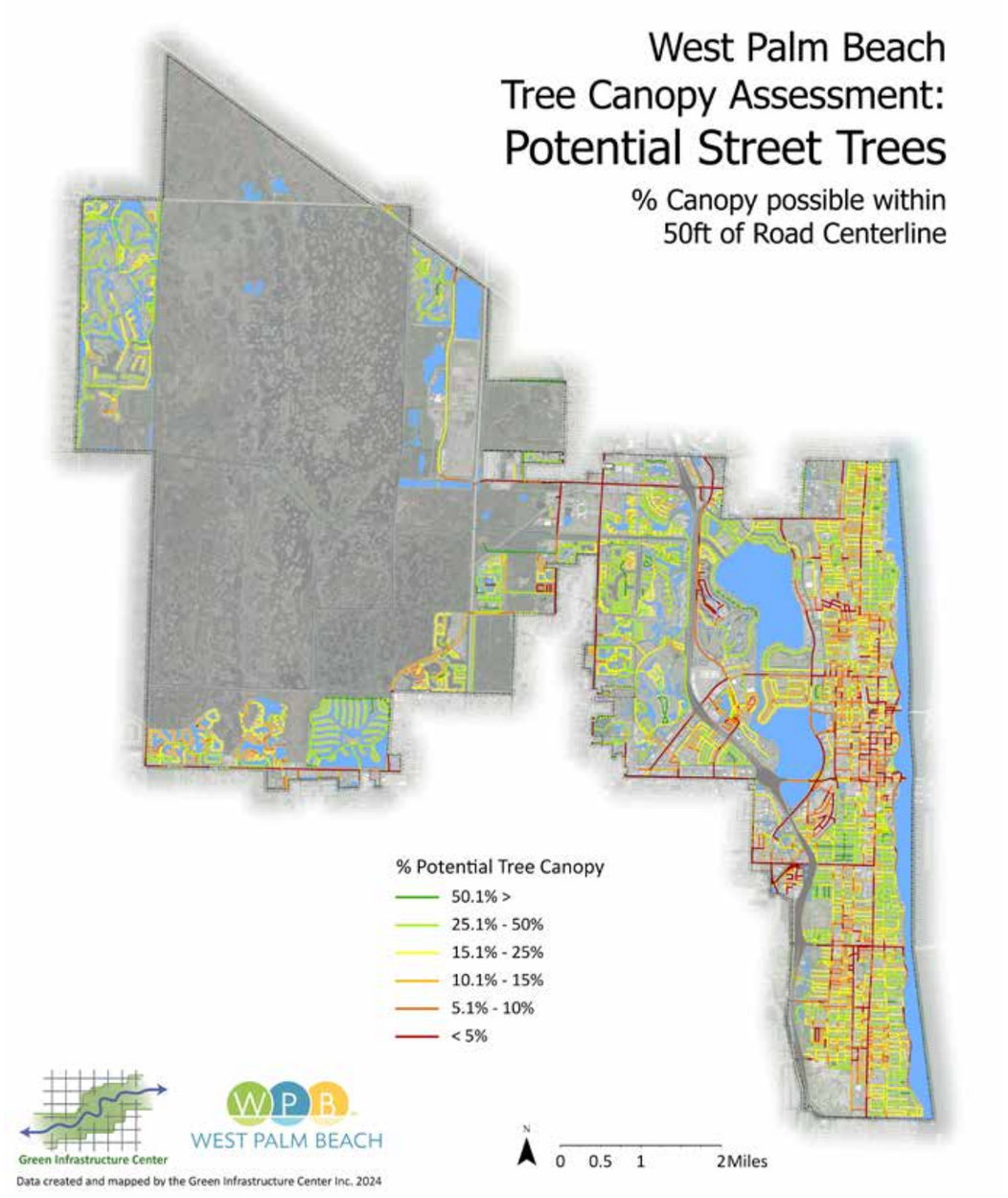

The Potential Planting Area (PPA), shown here in orange, depicts areas where it may be possible to plant trees. All sites would need to be confirmed in the field prior to planning planting. The map shows PPAs on both private and public lands. Grassy Waters makes up the majority of the western side of the City providing tremendous benefits for drinking water storage and cleansing as well as recreation and wildlife habitat. Trees regenerate naturally in the large wetlands of Grassy Waters so it is not necessary to plant trees within (except to shade the parking lot or picnic areas).






The Potential Planting Area (PPA) on the eastern side is where most of the development occurs. PPA shown here in orange, depicts areas where it may be possible to plant trees. All sites would need to be confirmed in the field prior to planning planting. The map shows PPAs on both private and public lands. Note that this map does not include trees planted in street tree pits as those do not show up as open space, though they may also be planted.

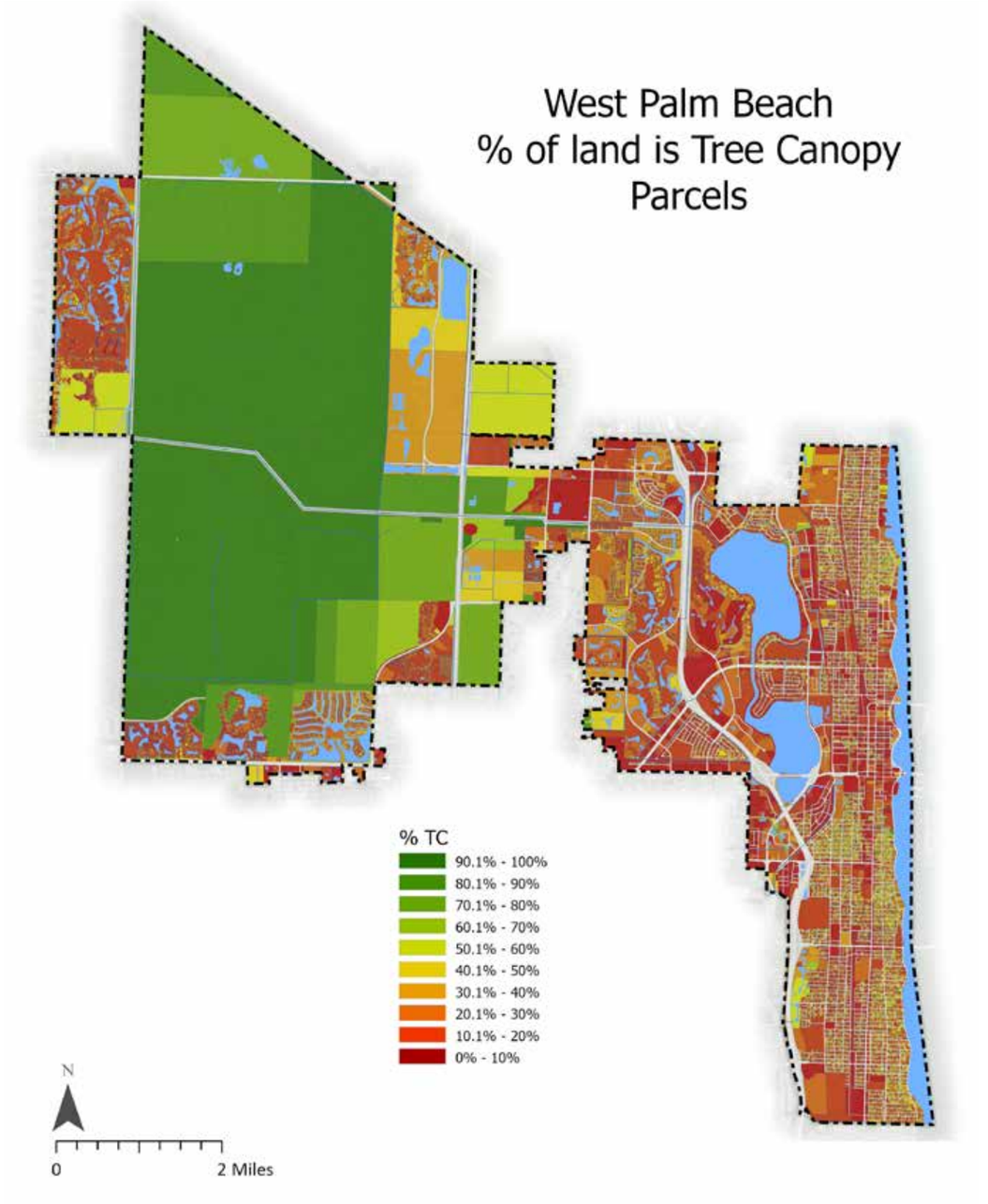
## Street Tree Coverage




The Street Trees Map shows those streets that have the most canopy (dark green) and those that have the least (red). Streets that lack good coverage can be targeted as appropriate for planting to facilitate specific City goals, such as safe routes to school or beautifying a shopping district. As noted, people walk longer and farther in well- treed landscapes. Trees also add a traffic calming effect by adding visual stimuli to the streetscape, causing people to drive more slowly.



## City Parcels and Canopy




This map shows relative tree canopy by parcel. The redder the parcel the lower the tree cover.

# Methods to Calculate Environmental Benefits

## Stormwater Uptake

Trees and forests are the best land cover for taking up urban stormwater as recognized by many forestry scientists and civil engineers (Kuehler 2017, 2016). Trees intercept, uptake, and slow the rate of stormwater runoff. Canopy interception varies from 100% at the beginning of a rainfall event and slowing to about 3% at maximum rain intensity (Xiao et al, 2000).

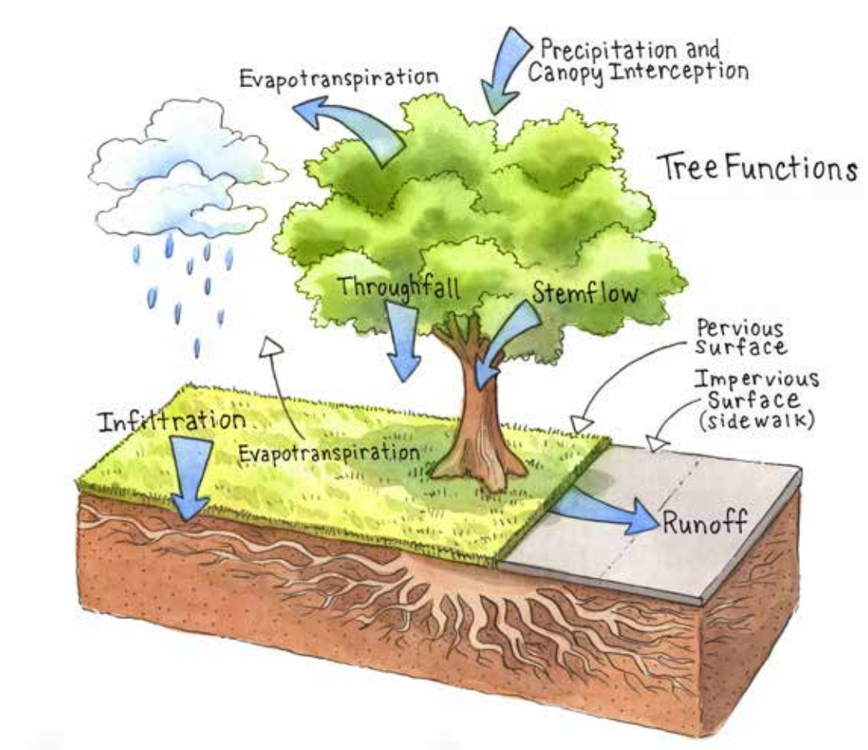
Stormwater runoff and uptake by the City's tree canopy was evaluated using GIC's Trees and Stormwater Calculator (TSC) tool. This estimates the capture of precipitation by tree canopies and the resulting reductions in runoff yield. It considers the interaction of land cover and hydrologic conditions of the soil. It can also be used to run 'what-if' scenarios, specifically losses of tree canopy from development or storms, and increases in tree canopy from tree planting programs.

See the diagram below of tree water flow for more details.

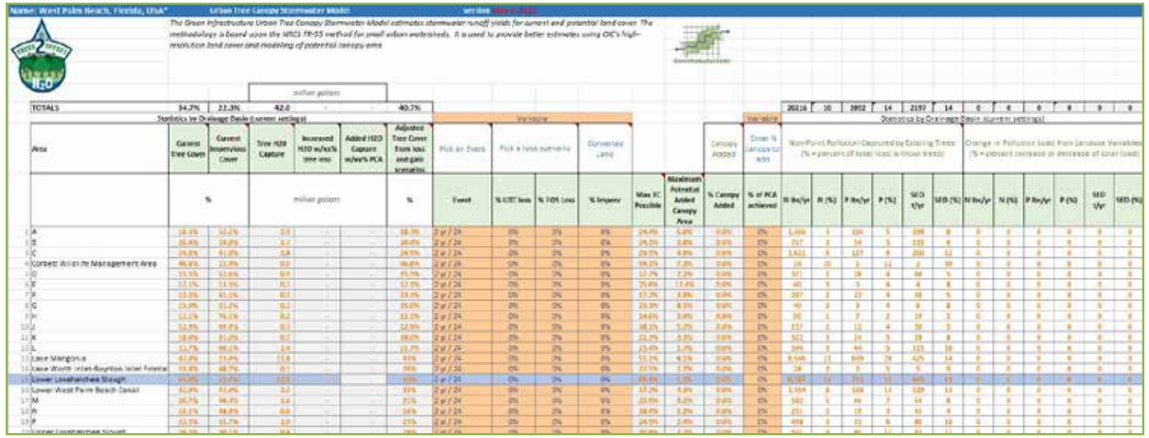
**The TSC model is a tool for seeing the stormwater impacts of adding or losing tree canopy and the resulting pollution increases or decreases.**

The amount and type of open space under and around a tree and the condition of its surrounding surface soils affect the infiltration of water. The GIC's TSC tool includes a data field to hypothetically add trees to calculate outcomes for stormwater uptake from new tree plantings. The TSC tool uses PPA data to determine how many more trees could be planted. The tool also calculates the amount of nitrogen, phosphorus and sediment the trees and their surrounding soils take up. For more about the stormwater calculator tool, see Appendix B.

As an example of how the TSC tool works, if the City had a 5% loss of tree canopy, during a typical small storm (a 2-year storm event), there would be an additional 1 million gallons of stormwater runoff. The tool also can be used to model benefits of adding tree canopy, as well as resultant increases or decreases in nitrogen, phosphorus and sediment pollution.





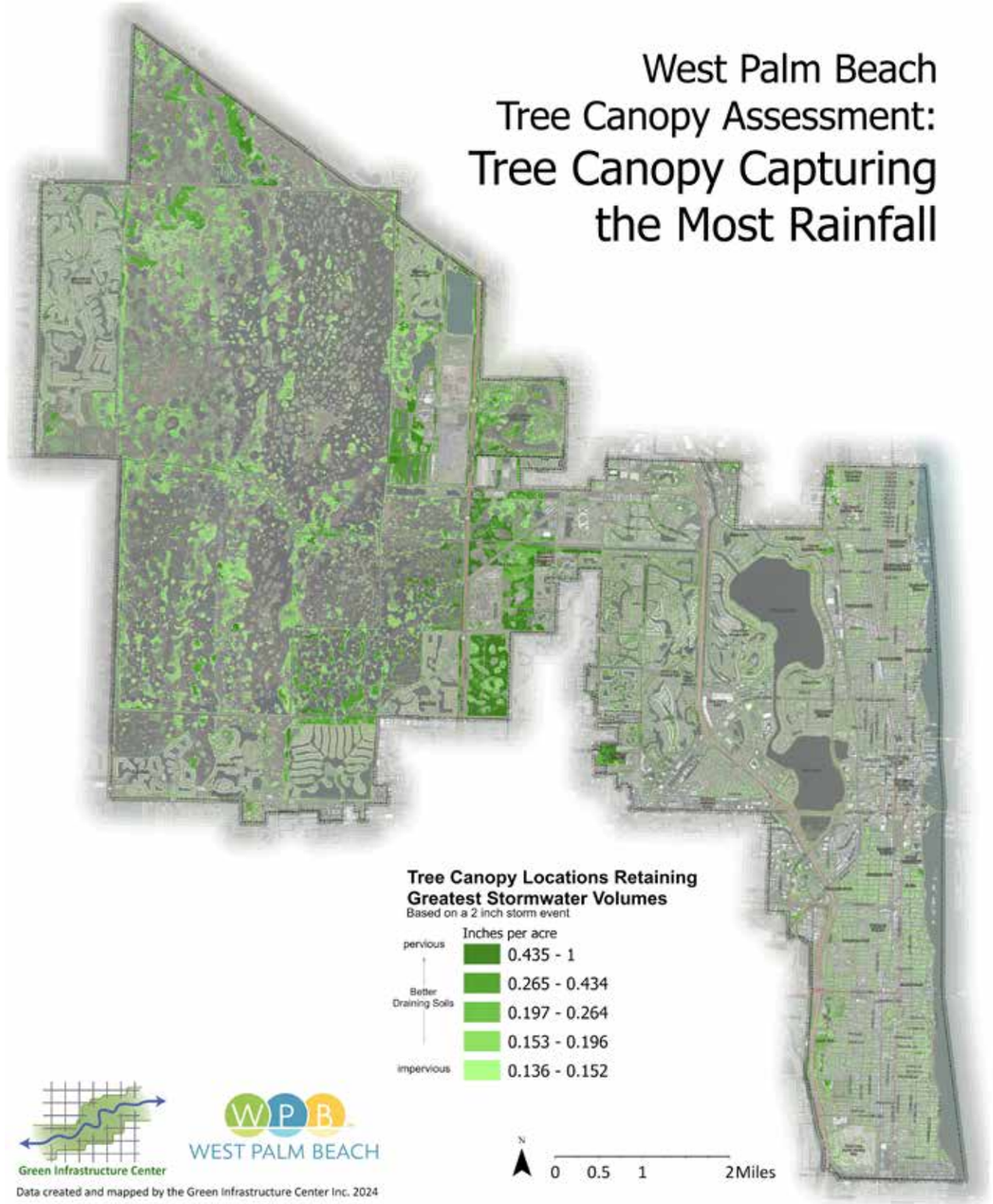
The Trees and Stormwater Calculator Tool, (TSC) allows the City to model water uptake by the existing canopy and impacts from changes, whether positive (adding trees) or negative (removing trees).

Removal of mature trees and existing forest generates the greatest impact for stormwater runoff. As more land is developed or re-developed, the City should seek to maximize tree conservation, in order to maintain its surface water quality and groundwater recharge. The City currently requires that removed canopy be replaced, either through retention or relocation. If onsite tree planting is not possible, individuals can pay into the Tree Mitigation Fund that can be used for future tree plantings. The following maps show those areas where it is most important to retain trees for stormwater uptake and those where tree planting will have the most benefits for stormwater uptake. It is based on the types of soils present.

The City currently requires that removed canopy be replaced, either through retention or relocation.
If not possible, individuals can pay into the Tree Mitigation Fund that can be used for future tree plantings

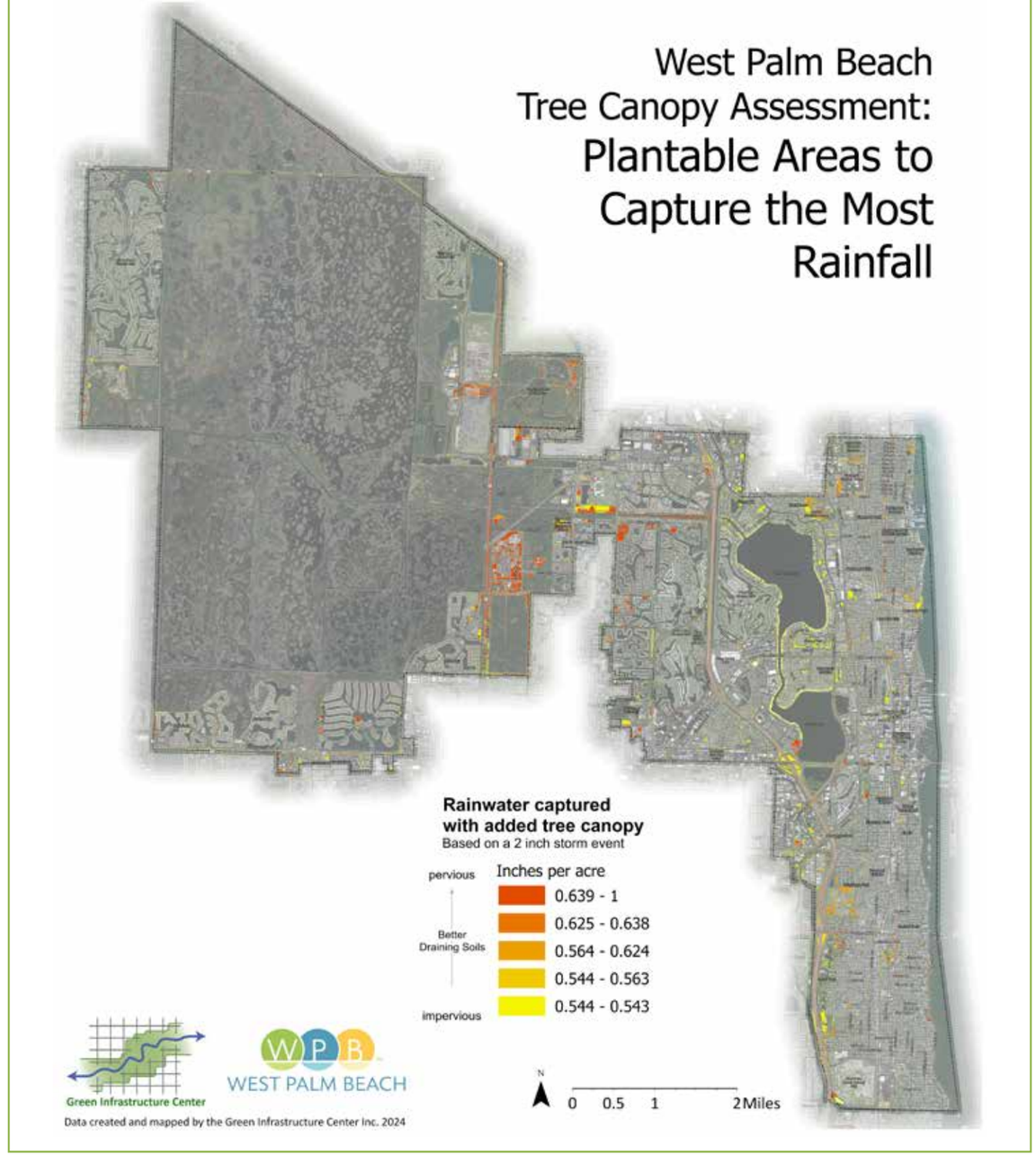
## Capturing Rainfall With Current Trees

The Trees and Stormwater Calculator model was used to map the locations where tree loss will result in the greatest stormwater runoff. These areas of tree cover (darkest green) capture the most stormwater runoff and should be retained.




## Capturing Rainfall With New Planting

The Trees and Stormwater Calculator model was used to map locations where adding trees will result in the greatest stormwater capture.



## Air quality multipliers

| Pollutant (Abbrev.) | Benefit Description | Removal rate (lbs/acres/year) | Removal rate (lbs/year) |
|---|---|---|---|
| CO | Carbon monoxide removed annually | 0.728 | 5,440 |
| NO2 | Nitrogen dioxide removed annually | 1.246 | 9,310 |
| O3 | Ozone removed annually | 14.469 | 108,112 |
| PM10 | Particulate matter greater than 2.5 microns and less than 10 microns removed annually | 5.167 | 38,608 |
| PM2.5 | Particulate matter less than 2.5 microns removed annually | 0.896 | 6,695 |
| SO2 | Sulfur dioxide removed annually | 0.625 | 4,670 |

| Pollutant (Abbrev.) | Benefit Description | Removal rate (mT/acres/year) | Removal rate (mT/year) |
|---|---|---|---|
| C sequester | Carbon sequestered annually in trees | 0.36 | 2,690 |
| C storage | Carbon stored in trees (note: this benefit is not an annual rate) | 17.72 | 132,404 |

### Air Quality

The benefits of trees for air quality were calculated by applying the multipliers used by the i-Tree models. i-Tree is a peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefit assessment tools. The i-Tree researchers developed standard pollution removal values per acre for various air pollutants. In the table above i-Tree model values for urban areas were used to multiply acres of canopy to calculate the pollution removal values.

Carbon, a greenhouse gas, contributes to climate change. Trees help to mitigate climate change by sequestering carbon from carbon dioxide ($CO_2$) in their leaves, trunk, and roots, and prevent it being released into the atmosphere. As trees die they either release that carbon back into the atmosphere, or it enters the duff layer (the layer of soil, leaves and other organic matter on a forest floor) to form a reservoir of carbon within the soil. As the science shows, excess carbon is being produced from the burning of fossil fuels and other sources causing the Earth's temperature to rise, leading to sea level rise, wetter and more severe storms and more extreme heat days, which can have wider health impacts than just poor air quality. Planting trees helps absorb and trap this excess carbon.

Ground level ozone, $O_3$, is another air pollutant of concern because it can cause severe respiratory problems in humans. It can make lung muscles constrict, trapping air in the alveoli, leading to wheezing and shortness of breath, which is particularly harmful to those with respiratory diseases or chronic conditions, such as asthma. Trees absorb ozone, particularly the polluting ground-level ozone as well as other nitrogen oxides (NOx), which contribute to ozone formation.

Nitrogen dioxide and sulfur dioxide also irritate airways in the respiratory system and aggravate respiratory conditions such as asthma. Trees help capture these pollutants too.

Particulate Matter (PM) is another air pollutant of concern. PM10 is particulate matter measuring 10 micrometers or less in diameter and PM2.5 is particulate matter 2.5 micrometers or less in diameter (a human hair is about 100 micrometers = about 40 fine particles). PM2.5 is generally described as "fine particles." Finer particles have the potential for greater harm since they may lodge deeper in the lungs. Trees are able to filter and clean such particles from the air.



# Urban Tree Loss – Reversing the Trend

While the City has lost 6% of its canopy cover in the past five years, West Palm Beach is not unique in having had tree losses from storms, development and old age. Widespread loss of tree canopy is occurring in urban areas throughout the world. Fortunately, this loss can be reversed. The first step – having an accurate assessment of the community's tree cover – has now been achieved. The second step is to expand tree planting to overcome losses and eventually to increase overall canopy coverage by at least 1%.

There is room to plant trees at schools, parks, homes and along roadways.

Many streets and public properties, such as this school, private yard and road frontage have room for more trees to add shade, beauty and improve air quality.

## Current Status

West Palm Beach now has updated baseline data to monitor progress on canopy protection or expansion, and to measure the stormwater and water quality benefits of its urban forest. The City can also use the data to prioritize canopy restoration in specific areas where it is most needed. A regular planting program will be needed just to maintain the City's canopy coverage at 24%, as it ages or is lost to storms. The City's goal to plant more than 12,000 trees over 10 years will allow an increase to 25% canopy cover.

This tree has died and needs replacement.

## Why Are Urban Trees Declining?

**Tree loss is not a unique problem to any city in Palm Beach County. A 2007 study found a decline of 38% in forest cover in the county's urbanized areas from 2004 to 2006, primarily from hurricanes (American Forests). Development and growth are also a significant cause of tree loss in southern Florida. As a mostly built out city, tree loss in West Palm Beach comes from redevelopment when larger houses replace smaller structures and the entire parcel is cleared. In other instances, newly planted trees are not planted correctly, are not maintained or are poorly pruned, causing trees to decline and die. One strategy the City hopes to pursue is to strengthen standards for tree planting, care and protection during and after development. For more see the strategies section on page 41.**

Tree pruning for power line safety can make trees unstable, so planting large trees under power lines should be avoided. In this example, the branches on the left have died and should be removed for public safety.

## Increasing Canopy Cover

Each year, trees in West Palm Beach are lost to storms, development and old age, as well as removals by individuals. Choosing the wrong tree for a site or climate, planting it incorrectly or caring for it poorly can also lead to tree canopy loss. For every 100 street trees planted, only 50 will survive 13-20 years, largely because of poor planting conditions and care (Roman et al, 2014). So, a well-treed neighborhood of today may not have good coverage in the future unless young trees – the next generation – are planted now. Expanding the size and structure of underground street tree pits over time will also ensure the longevity of street trees.

To change the downward trajectory of tree cover in south Florida and realize the tremendous ecosystem services trees provide, the City of West Palm Beach should plant trees to increase its canopy cover. The City hosts tree planting and giveaway events (*see text box*) and partners with nonprofit organizations, such as Community Greening, and this outreach


Image credit: City of West Palm Beach

The City gave away 10,000 trees over the past decade, but many more will be needed to stem the losses and increase canopy by 1%.

### West Palm Beach Supports Community Tree Planting

The City of West Palm Beach's Office of Sustainability routinely provides free trees for residents and businesses to plant.

image credit: City of West Palm Beach

Local tree giveaways helps residents and businesses get suitable trees to plant in their yards.

can be expanded. This plan recommends hiring a community urban forester to oversee new plantings, expanding community outreach to meet the new tree goal.

Volunteer programs that involve the community in widespread tree planting can also have a significant effect. While the City has given away 10,000 trees over the past decade, expanding efforts to increase canopy cover will help the City achieve its new canopy cover of 25% cover for its urban areas. Private property owners are a key partner since much of the land in the City is privately owned, including most of the 3% of the City's geography identified as plantable.

Expanding the City's canopy can meet several objectives:

- Reduce urban heat island effect
- Beautify neighborhoods and improve property values
- Improve community health and equity
- Mitigate stormwater to reduce flooding risks
- Help meet the City's ***Rethink Paradise: Sustainability Action Plan*** goals and actions

For more strategies from the plan related to urban trees see: https://www.wpb.org/files/assets/city/v/1/sustainability/documents/draft-rethink-paradise-plan-2023.pdf



## Community Review

The City of West Palm Beach held community input sessions around the City in fall 2024 to present this study's findings and elicit community response. The City also provided a survey for residents to provide their comments and a linked map to drop points on places where more trees are desired.[6]

Two thirds of survey respondents "strongly" agreed that the City should actively plant trees on public spaces with the remaining third agreeing. About half of the respondents also strongly agreed that the City should help residents plant trees on their properties, with about another half agreeing, and one respondent disagreeing. All respondents but two, requested that canopy be increased by 3% or more and all respondents supported spending city dollars to increase canopy coverage. Two thirds of respondents also offered to plant a new tree on their property too and those without land to plant on are ready to volunteer!

For a list of additional comments see Appendix D.


[6] The survey link was distributed by the City and made available on its website. The survey was kept open for two weeks . It is not a scientific survey and respondents do not necessarily represent the population or views of the public at-large.

Image credit: City of West Palm Beach

The City is committed to outreach and needs even more citizens to accept and plant a tree.

**Investments in canopy at the neighborhood level can improve the respiratory health of residents.**

## Sustainability Action Plan

**Increasing tree canopy plays a role in numerous actions within the City's *Rethink Paradise: Sustainability Action Plan*. They include actions to:**

- **Encourage the use of multimodal transportation while improving access | and safety**
- **Preserve historical, cultural, natural and archaeological assets**
- **Reducing extreme heat exposure and other climate-related health risks**
- **Protect Grassy Waters, our waterways, and other green spaces**

## Community Participation

To meet the recommended canopy cover of 25%, the City of West Palm Beach will need to expand its tree planting campaign and engage developers, residents, businesses, gardening groups, environmental organizations and other stakeholders in doing their part to reach the planting goal. The campaign may include ways to donate trees to the City and to recognize citizens, companies and sponsors who contribute to a cleaner, greener and more sustainable city. As the City works to meet the canopy goal, they can document progress by tracking trees planted by location and species.

The next step is for the City to select and prioritize target areas for implementation of the tree planting goal, such as neighborhoods with the highest mean temperatures, parks, schools and specific streets, such as entrance corridors and downtown areas. The City should, as much as possible, promote the planting of tree species with a high ecological value, such as native and drought-tolerant species, hurricane-resistant species and those that support biodiversity.

As part of this project, the City has been provided with a *Tree Planting Cost Calculator* to determine the numbers of trees to plant within the Possible Planting Areas across specific target geographies. The City used the calculator to determine city costs (about 20% of the total) and costs for the private sector (the remaining 80%). Note that City costs are higher because contractors are typically retained to do plantings on city lands whereas planting on private lands can often be maintained by homeowners or HOAs at a fraction of the cost. Following are strategies intended to grow and sustain tree cover across the City's urban areas. City staff developed these strategies to meet established goals and community interest and input.

Image credit: City of West Palm Beach

New tree planting is key to the City's success in both retaining and expanding canopy.



# City Strategies to Maintain and Increase Tree Canopy Cover

All strategies relate to either increasing tree cover or ensuring longevity of current trees.

## City canopy goal: 25% cover in 10 years

The City has lost 6% of its canopy cover since 2017 to development, storms, disease, old age and landowner removals. If this trend continues the City will be hotter, wetter and less habitable. The new goal is a modest one to bring up the canopy by 1% to get to 25% canopy cover in the urban areas where people live.

The new goal for urban areas in the City of West Palm Beach is to plant about 12,620 trees to achieve 25% canopy cover. Most cities own or manage about 20% of city land (in this case referring to the urban area). So, the City's share of the 1% increase goal is to plant about 2,524 trees or 252 trees per year, at a cost of $236,941. In should be noted, this is the high end calculation on cost per year, however, the City continuously seeks grants for tree plantings as well as partnerships and donations, so annual costs could fluctuate from the amount provided in this document but the City will still need to provide some dollars to achieve this goal.

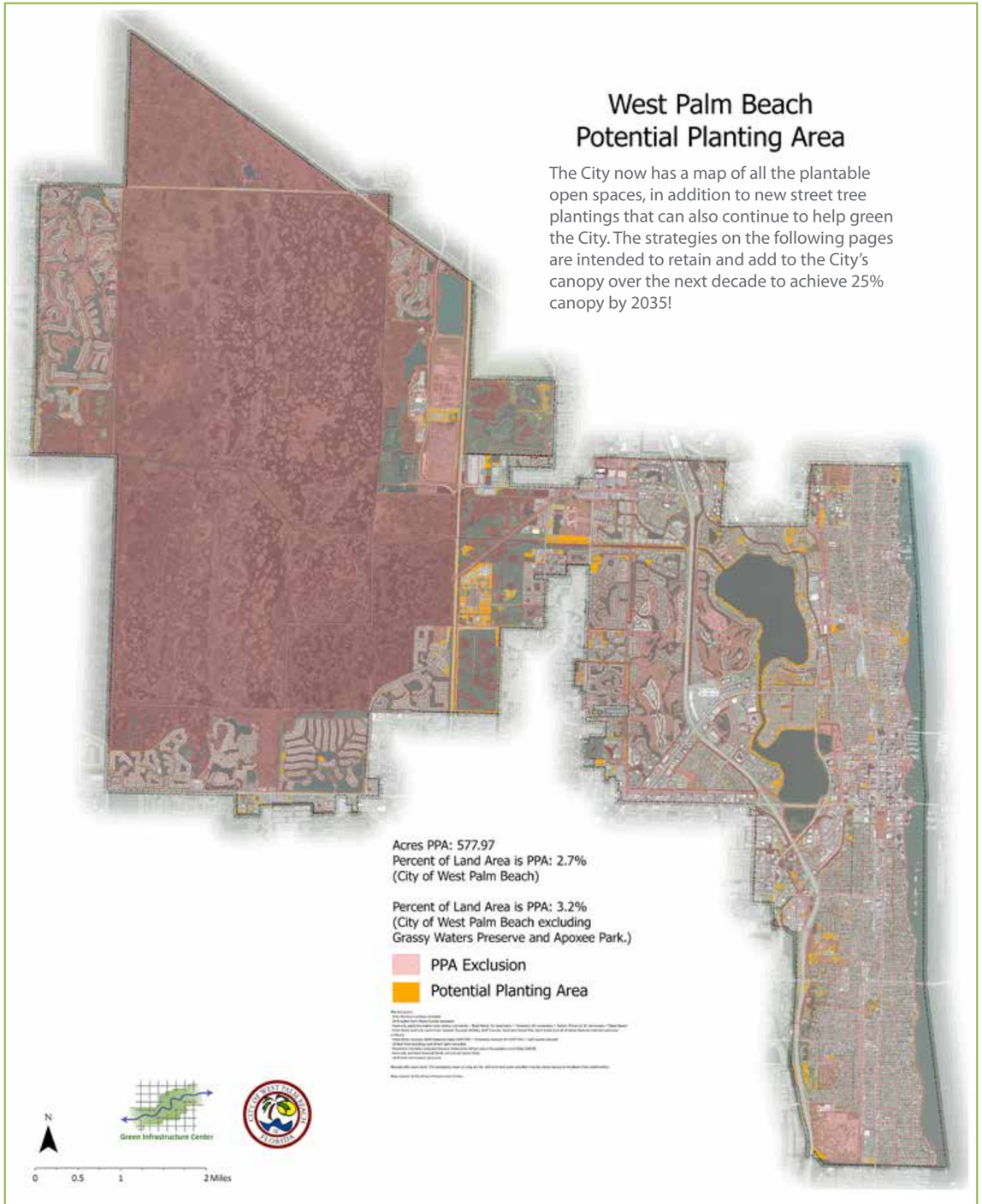
Image credit: City of West Palm Beach

The rest of the goal (the other 80%) will be achieved through a community planting campaign to encourage private sector participation. It will cost the public less to participate and plant trees on private properties because people can buy smaller trees, water their own trees and provide ongoing tree care. The City currently provides free trees through tree giveaways and has distributed 10,000 trees to residents and businesses over the past decade. To meet the new goal, the public will need to plant just over 10,000 additional trees on private lands over the coming 10 years – this will require a robust planting campaign and partnerships to increase tree cover citywide. In short the goal, is to achieve 25% cover by 2035 or "25 by 35!".

**Goal: 25% by 35!**

Permeable brick pavers around trees allow more water to reach roots. More of these strategies can help trees survive and thrive.

Curb bumpouts are a way to provide more room for trees.






# Strategies

**KEY: In the strategies below, the timeframes to achieve each objective are denoted as:**

**ST = 1 year, MT = 2-3 years, LT = 4 years plus**

## GOAL:

## Protect and expand tree canopy cover from 24% to 25% for better shade, air quality, stormwater uptake, carbon capture and beautification of the City.

### Objective A

**Plant trees on municipal lands and streets with the aim of achieving a total of 12,620 trees over a period of 10 years. The city's responsibility would be to plant 2,524 trees.**

**A1 Action:** Use the Tree Mitigation Fund and the Citywide Tree Program Fund to support planting of 252 trees annually in parks, right of ways and parkways at an estimated annual cost of $236,941.

- **Responsible Parties**: Tree Team[7]
- **Timeframe**: ST

**A2 Action**: Target tree plantings on public lands in areas shown as the hottest, least treed based on map (See Urban heat map, page 11).

- **Responsible Parties**: Tree Team
- **Timeframe**: ST

**A3 Action**: Track city tree plantings in TreePlotter to monitor annual achievements towards meeting the goal. City tree team to determine new actions if annual goals are not met.

- **Responsible Parties**: Tree Team
- **Timeframe**: ST

**A4 Action**: Hire a Community Forester to manage the City's tree planting and maintenance program and to oversee the achievement of goals on public and private lands. (a * on other actions denotes strategies that also would rely on this position to carry them out.)

- **Responsible Parties**: Development Services
- **Timeframe**: ST

[7] Internal team consisting of Development Services, Parks & Recreation, Public Utilities/Sustainability, and Public Works/Keep West Palm Beach Beautiful.

New trees downtown will grow to provide much needed shade.

## Objective B

**Encourage the private sector to plant and care for trees by planting approximately 1,000 trees annually for total trees planted of more than 10,000 on private property. (Note that the City's past campaign reached 10,000 trees given to the public.)**

**B1* Action:** Start a nature-scaping program to incentivize native habitats and provide more healthy vegetation such as shrubs or other ground covers for areas where a tree will not fit.
- **Responsible Parties**: Community Forester, Public Utilities/Sustainability, Public Works/Keep West Palm Beach Beautiful
- **Timeframe**: MT

**B2* Action:** Expand community plantings by creating a homeowner assistance program to deliver and plant larger trees (15-gallon trees).
- **Responsible Parties**: Community Forester, Public Utilities/Sustainability
- **Timeframe**: MT

**B3* Action**: Create partnerships with neighborhood/homeowner associations and nonprofit organizations to identify open spaces and plant trees together.
- **Responsible Parties**: Community Forester, Public Utilities/Sustainability, Public Works/Keep West Palm Beach Beautiful
- **Timeframe**: MT

**B4* Action:** Work with HOAs to develop creative solutions for tree replacement using a comprehensive plan (mini-master plan for trees in a subdivision and creation of mini-forests).
- **Responsible Parties**: Community Forester, Development Services
- **Timeframe**: LT

Understory plants add stormwater storage too.

**B5* Action:** Create a promotional plan to encourage businesses, churches, and other commercial entities to plant trees at their properties.
- **Responsible Parties**: Community Forester, Public Utilities/Sustainability, Public Works/Keep West Palm Beach Beautiful
- **Timeframe**: ST

**B6* Action:** Continue tree giveaways to distribute trees and develop tools to incentivize confirmation of tree location plantings and longevity (e.g. Proof of life = coupon to a retail establishment).
- **Responsible Parties**: Community Forester, Public Utilities/Sustainability
- Timeframe: ST

**B7* Action:** Co-locate giveaways with events and other promotions, such as fruit trees giveaway with jam making class encouraging participants to stay longer to learn about proper tree planting and care.
- **Responsible Parties**: Community Forester, Public Utilities/Sustainability, Public Works/Keep West Palm Beach Beautiful
- **Timeframe**: MT

* A Community Forester needed for this strategy.



## Objective C

**Increase the lifespan of existing trees on public lands by strengthening the City's ordinances and development codes and management practices.**

**C1 Action:** Adopt new standards to provide adequate soil volume in street tree pits.
- **Responsible Parties**: Development Services, Parks & Recreation, Engineering Services
- **Timeframe**: ST

**C2 Action:** Utilize new technologies such as underground structural cells or structural soils and best practices for tree siting to ensure long-lived trees.
- **Responsible Parties**: Development Services, Parks & Recreation, Engineering Services
- **Timeframe**: MT

**C3* Action:** Adopt standards for tree planting, care and maintenance on city properties and ensure all planting contracts follow such standards.
- **Responsible Parties**: Parks & Recreation, Community Forester
- **Timeframe**: ST

**C4* Action:** Utilize volunteers to assist with public tree health surveys and care activities.
- **Responsible Parties**: Community Forester, Parks & Recreation, Public Utilities/Sustainability
- **Timeframe**: MT

**C5* Action:** Launch an active "re-treet" program to address trees lost to public storms, floods, or other impacts. (re-treet is a program of Keep America Beautiful).
- **Responsible Parties**: Community Forester, Public Works/Keep West Palm Beach Beautiful, Parks & Recreation
- **Timeframe**: LT

This tree has ample root space.

**C6* Action:** Use the existing tree inventory to address those public trees already flagged as needing follow up care to reduce risk of failure and ensure clear evacuation routes for storms.
- **Responsible Parties**: Community Forester, Public Works, Parks & Recreation
- **Timeframe**: LT

Hazardous trees are subject to failure and should be removed.

## Objective D

**Increase community awareness and stewardship for trees to foster a healthy forest cover.**

**D1* Action:** Create a Tree Advisory Board to provide insight and assistance with community engagement, ensure City planting goals are being met, and to meet the City's standards for its designation as an Arbor Day Foundation's Tree City USA.
- **Responsible Parties**: Community Forester, Development Services
- **Timeframe**: ST

**D2* Action:** Hire a Community Forester to provide education, coordinate programs and respond to public concerns. (also see multiple actions noted with * that require this position to manage.)
- **Responsible Parties**: Development Services
- **Timeframe**: ST

**D3* Action:** Ensure existing trees remain healthy by expanding tree care for those unable to afford to care for trees. Consider utilizing the Tree Mitigation Fund to provide additional support for street tree maintenance in low-income neighborhoods. Develop a program for residents to qualify and apply for such assistance.
- **Responsible Parties**: Tree Team
- **Timeframe**: MT

**D4 Action:** Increase penalties for lack of compliance with the City's tree ordinance <Sec. 94-9> to ensure that fees for replacements of removed trees are high enough to pay to replace the same square footage of trees.
- **Responsible Parties**: Development Services
- **Timeframe**: MT

**D5* Action:** Launch a community planting campaign centered around Florida friendly landscaping (also known as nature-scaping) https://ffl.ifas.ufl.edu/ to incorporate native plants into residential landscapes.
- **Responsible Parties**: Community Forester, Public Utilities/Sustainability, Public Works/Keep West Palm Beach Beautiful
- **Timeframe**: MT

**D6* Action:** Provide the public with training and teaching around what makes a healthy tree, how to ensure longevity, planting the right tree in the right place and the benefits trees provide.
- **Responsible Parties**: Community Forester, Public Utilities/Sustainability
- **Timeframe**: ST

* A Community Forester needed for this strategy.

Trees make downtown more lively.

## Objective E

**Increase tree retention and conservation before, during and after new development.**

**E1 Action:** Adopt standards for tree care and planting following the American Society of Arboriculture and best practices for tree canopy, trunk and root protection.
- **Responsible Parties**: Development Services, Parks & Recreation
- **Timeframe**: MT

**E2 Action:** Establish a survival bond for protected or newly planted trees on construction sites, similar to bonds for stormwater structures and facilities, to ensure trees are retained and surviving post construction.
- **Responsible Parties**: Development Services, Engineering Services
- **Timeframe**: MT

**E3* Action:** Provide in-house training to code enforcement staff and inspection staff on what to look for on site plans and on field visits.
- **Responsible Parties**: Community Forester, Development Services
- **Timeframe**: ST



Everybody appreciates shade.

**E4* Action:** Engage City's Community fForester (see Obj. D, A2. hiring new position) in site plan review to determine tree conservation opportunities and requirements for all sites containing significant trees or tree cover.
- **Responsible Parties**: Development Services, Community Forester
- **Timeframe**: MT

**E5 Action:** Require grade/elevation changes that will affect tree survival to be shown on development plans and develop a tree relocation program for trees that could be moved and replanted.
- **Responsible Parties**: Development Services
- **Timeframe**: ST

**E6 Action:** Develop standards for conserving/minimizing root damage during construction for buildings, facilities, sidewalks, driveways or utility installation or repair and train staff in these best practices.
- **Responsible Parties**: Development Services, Parks & Recreation, Engineering Services
- **Timeframe**: MT

Roots were damaged by road and utility work.

Without using caution, utility work can damage tree roots.

## Objective F

**Monitor achievement of City canopy goal of 25% canopy cover by 2035.**

**F1 Action:** Enlist a consultant to create a new landcover map using NAIP imagery and determine if canopy is being lost or gained.
- **Responsible Parties**: Tree Team
- **Timeframe**: LT

**F2* Action:** If canopy decline is occurring, determine the causes and target new plantings to areas of loss.
- **Responsible Parties**: Tree Team
- **Timeframe**: LT

**F3 Action:** If major storms have impacted canopy, adopt replanting plans to initiate within one year of the storm or following declaration of a major disaster if such funds will be used for recovery efforts.
- **Responsible Parties**: Tree Team
- **Timeframe**: LT

## Measuring Success

All successful plans include benchmarks and monitoring. The City has a Tree Team made up of the City departments that affect tree planting, care and cover. They meet monthly to work on shared goals and projects. In addition, a new Tree Advisory Board and hiring the recommended new position of Community Forester will be central to efforts to meet this plan's modest 1% increase goal and to stem the downward trend in tree cover (a 6% loss in just the past 5 years). The Tree Team – working with the new board and the hoped for Community Forester – will develop a work plan to meet years 1-, 2-3- and 4-years onward goals.

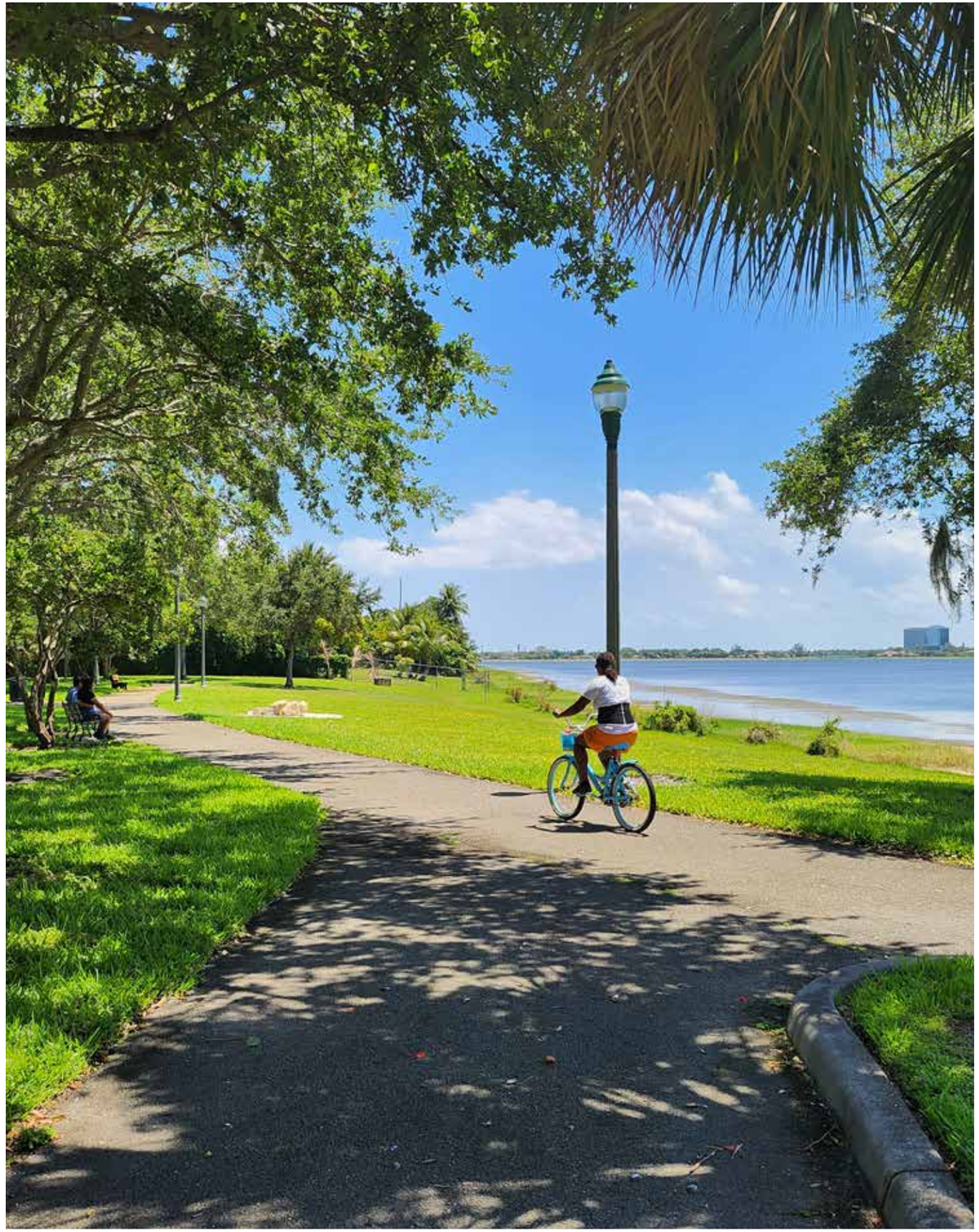
In 4 years, the City should re-do the canopy cover mapping to determine whether the City is meeting its goal and should repeat this effort every 4 years. If the canopy cover goal is not being met, the Tree Team should determine the reasons and create new actions to ensure it is met. They may also develop additional strategies to meet emerging challenges. Additional city funding will be necessary for new staff, to purchase trees and to ensure that city infrastructure is updated to allow for long-lived urban trees.

Native Flordians enjoy abundant shade.

The City also can use the rich data provided to determine the most strategic areas for planting and integrate tree protection into an updated ordinance. These, and other practices, implemented to provide long-term care, protection and best planting practices for the urban forest will ensure that investments in City trees pay dividends long into the future. These "dividends" include reducing stormwater runoff, as well as cleaning the air and water, lowering energy bills, raising property values, and providing natural beauty and a resilient West Palm Beach long into the future.

The City's trees are part of its history and culture and critical to a sustainable and resilient future.





# Appendixes

## Appendix A:
## Land Cover Analysis and Quality Assurance

This section provides technical documentation for the methodology used to classify land cover and create Potential Planting Spots and Possible Canopy Area scenarios for the City. Land cover classifications are an affordable way to use aerial or satellite images to obtain information about large geographic areas. Algorithms are trained to recognize distinct types of land cover based on color and shape. In this process, the pixels in the raw image are converted to one of several types of pre-selected land cover types. In this way, the raw data (images) are turned into information about land cover types of interest, such as what is pavement and what is vegetation. This land cover information can be used to gain knowledge about certain issues; for example: What is the tree canopy percentage in a specific neighborhood?

### Method

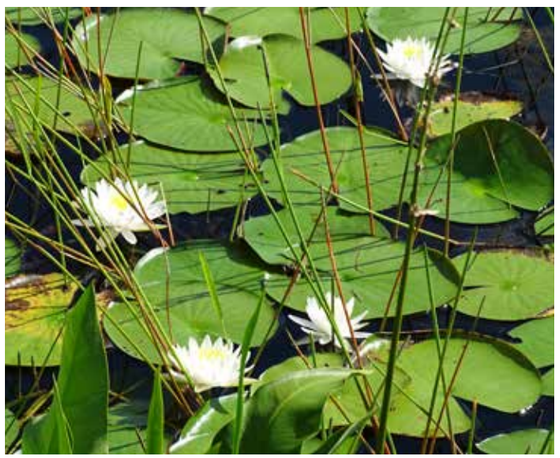
Satellite imagery from the National Agricultural Imagery Program (NAIP) distributed by the USDA Farm Service Agency was classified to determine the types and extent of different land covers in West Palm Beach.

The land cover map was created at 0.6-meter resolution using NAIP imagery from February 2023. In addition, various available vector data not uniform across the City were used where possible (for example, sidewalks, driveways and other impervious surfaces). Features such as "Tree Canopy over Impervious" were created/estimated using buffers from road centerlines.

The procedures were as follows: 1) An NDVI was created using the NAIP imagery 2) Feature Height layer created using the LiDAR. Areas reflecting green (0 to 1) in the NDVI and above 10' from the Feature Height were classified as Tree Canopy – the remaining green features where classified as pervious surfaces. Impervious surfaces where then added where available including existing data and additional image classification. Bare earth was selected from the pervious surfaces class where NDVI was -0.1. Some artifacts were produced where tree canopy was lost between acquisition date of LiDAR and NAIP.

The NAIP February 2023 image was originally used as the primary input. These data sets were used to determine the following nine feature classes:

1. Tree Canopy: These are features identified as "'green'" or typically above 0 in NDVI (Normalized Differential Vegetation index), and that have a feature height above 10'.
2. Tree Canopy over impervious: These are features that overlap Impervious surfaces and are primarily created from existing vector data, where available.
3. Tree Canopy over Water: Where Tree Canopy classified from NDVI/LiDAR intersects the vector dataset from city representing water.
4. Water: Water class created from city datasets representing canals and lakes and other inland water.
5. Mangroves: These were created from visual inspection of imagery, local knowledge and on-the ground verification
6. Scrub/Shrub: Spectrally, these features appear similar to tree canopy but do not meet the height requirement to be considered as trees but are above 1 meter in height.
7. Turf/Pervious: These are features identified as "'green'" or typically above 0 in NDVI but have a feature height less than 1 meter.
8. Impervious surfaces: These were created using an object-based recognition tool ArcGIS add-on called Feature Analyst, as well as existing vector data, such as road edge and building polygons. These features are typically below 0 on an NDVI.
9. Bare earth and Sand: These can be easily confused with impervious surfaces but have a NDVI value closer to 0.





### Potential Planting Area Dataset

The Potential Planting Area dataset has 3 components:

- **Potential Planting Area (PPA)**
- **Potential Planting Spots (PPS)**
- **Potential Canopy Area (PCA)**

These three data layers were created using the land cover layer and relevant data, in order to exclude unsuitable tree planting locations or where they would interfere with existing infrastructure.

The **Potential Planting Area (PPA**) is created by selecting the land cover features that have space available for planting trees, then eliminating areas that would interfere with existing infrastructure. Initial Inclusion selected from GIC-created land cover pervious surfaces class.

*Exclusion Features*:

- The pervious surfaces were buffered in 10' from all impervious surfaces, including buildings and roads.
- Playing fields were identified from NAIP imagery to be excluded. (Digitized by GIC.)
- Once this initial phase was completed, the Potential Planting Area data were reviewed by the City and manually edited to best represent City expectations of where planting was allowed (e.g., not along road swales or play fields). In addition, areas that were known to be planned for development were removed.

This additional work to exclude known areas that could not be planted resulted in a more accurate and realistic calculation of plantable areas and the number of new trees that could be added.

**Potential Planting Spots**. The Potential Planting Spots (PPS) were created from the PPA.

- They were run through a GIS model that selected those spots where a tree can be planted, depending on the size of the tree.
- Tree planting scenarios were based on a 20' and 40' mature tree canopy with a 30% overlap. Therefore, the planting spots are 16' and 32' apart, respectively.

**Potential Canopy Area**. The Potential Canopy Area (PCA) is created from the PPS. The possible planting spots are given a buffer around each point that represents a tree's mature canopy. First, larger canopy trees are digitally added, followed by smaller trees in the remaining spaces. Planting spots are then assigned a buffer of 10' or 20', to result in 20' and 40' tree canopy that overlaps by 30%. This reduces gaps that would be found at the corners of adjacent circles and reflects the reality that trees overhang and intermingle with adjacent trees.

# Appendix B:
# Trees to Offset Stormwater Calculator

The Trees and Stormwater Calculator (TSC) tool developed by the GIC uses modified TR-55 curve numbers to calculate stormwater uptake for different land covers, since they are widely recognized and understood by stormwater engineers. A canopy interception factor is added to account for the role trees play in the interception of rainfall, based on location and planting conditions (e.g., trees over pavement versus trees over a lawn, or in a forest).

Cities usually use TR-55 curve numbers developed by the Natural Resources Conservation Service (NRCS) to generate expected runoff amounts. The modified TR55 curve numbers (CN) provided by GIC includes a factor for canopy interception. Cities can use the stormwater calculator tool for setting goals at the watershed scale for planting trees and for evaluating consequences of tree loss as it pertains to stormwater runoff. Curve numbers produced for this study can be utilized in the City's modeling and design reviews.

Tree canopy reduces the proportion of precipitation that becomes stream and surface flow, also known as water yield. A study by Hynicka and Divers (2016) modified the water yield equation of the NRCS model by adding a canopy interception term (Ci) to account for the role that canopy plays in capturing stormwater, resulting in:

$$\mathbf{R} = \frac{(P - C_i - I_a)^2}{(P - C_i - I_a) + S}$$

Where **R** is runoff, **P** is precipitation, $\mathbf{I_a}$ is the initial abstraction (the fraction of the storm depth after which runoff begins), and **S** is the potential maximum retention after runoff begins for the subject land cover **(S = 1000/CN – 10)**.

Major factors determining **CN** are:

- The hydrologic soil group (defined by surface infiltration rates and transmission rates of water through the soil profile, when thoroughly wetted)
- Land cover types
- Hydrologic condition – density of vegetative cover, surface texture, seasonal variations
- Treatment – design or management practices that affect runoff

This new approach allows for more detailed assessments of stormwater uptake based on the landscape conditions of the City's forests. It distinguishes whether the trees are within a forest, a lawn setting, a forested wetland or over pavement, such as streets or sidewalks. This is because the conditions and the soils in which the tree is living affect the amount of water the tree can intercept.

The analysis can be used to create plans for where adding trees, or better protecting them, can reduce stormwater runoff impacts and improve water quality. This methodology was developed and tested in 13 communities in the southern US including in Florida, under a grant from the Southern Region of the USDA Forest Service.

For more about the project, please visit:
https://gicinc.org/projects/resiliency/trees-and-stormwater/



Tree over street

Trees over forest

Tree over lawn

Tree over parking lot

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# Appendix D:
# Community Survey[8]

Any other comments to share about city tree canopy?

2 years ago I contacted the City to plant  a few trees by the sidewalk west of my home. I even offered to split the cost. I did not have a response. You are welcome to visit my yard. There was nothing but one palm tree in the back when I bought. I have planted many kinds of palms, tropical plants etc. A few trees to shade them  from the harsh west sun would be great. Many pedestrian walkways & bike paths are not covered by tree canopies which makes them uncomfortable and unsafe to use, particularly in the summer. Areas that do have tree canopy are frequented more often by bikers & walkers, especially those who want to walk with their pets. If the City were to focus on adding trees to neighborhood streets and city parks, I believe we would see an increase in healthy recreational activities in those areas.

West of Broadway desperately needs more trees. The wealthy leave on the east side with mature trees reduces their electric bill whereas the middle to low income in the left side most likely rents and have little trees and high electric bills.

1. Require more trees of greater size on properties under development in the private sector. Provide no landscape waivers!
2. Do not further reduce green space in the City which are the obvious places where trees can be planted.
3. Do NOT allow more concrete in public parks by either Parks and Rec. or not for profit groups seeking long term leases to build on our park land.
4. Do not provide development waivers to reduce setbacks around new development thus minimizing opportunities for places for trees.
4. Support lower income neighbors in the planting and care for trees when they are newly planted. Many low income areas are riddled by absentee owners who must be required to .properly maintain street trees and existing trees on their property as a condition of holding a license their properties for rental in this City.
5. The City should play an active role in maintaining street trees to minimize improper pruning and care so that we don't lose the trees in place already.

Shade trees and natives please.  No more palm trees - they provide zero shade.

The city needs to add trees to the SOSO neighborhood. South olive is in desperate need of a tree canopy. Northwood, ElCid, Flamingo Park all have wonderful tree lined streets. Lining Olive Ave. with live oaks would certainly bring up the percent needed to reach the goal on increasing shade trees in the City. I would be willing to help plant and care for trees planted as part of this mission to increase the tree canopy.

On Flagler there should be a shade tree between the palms. Reconstruct roads and sidewalks to make sure trees are covering all sidewalks and many roads. Perhaps having some "model properties" throughout the City that showcase a beautiful landscape WITH shade trees, native trees, and little to no grass to inspire folks to do the same.

Aggressive planting of Oaks and Mahogany trees on swales and medians are low-hanging fruit that pay big dividends.  I live in Northwood and am germinating Southern Mahogany seeds in order to plant them where older trees have been lost and not replaced by reg City.  The difference in temperature and road noise between canopied streets and non-canopied streets is amazing.

In historic communities like Flamingo Park they are cutting down trees (including on tree-lined streets) and not replacing them. The main reason for this is that the City makes owners responsible for any newly planted tree along roads, including ones that replace old ones. One my street in Flamingo park we have lost 6-8 streets in the last 5-7 years for this reason.

I'm in a condo so can't plant my own but would def. help.

The mayor needs to listen to what the citizens of WPB want! Less high-rises, more green spaces.

Palm trees are beautiful and Florida but we also need trees that provide a beautiful canopy/shade and produce oxygen. Replace the trees lost along Olive Avenue south of Southern Blvd.

More more shade.


Image credit: City of West Palm Beach

Hello, there are very few trees currently on the north city right of way on 31st Street between South Terrance Dr and Greenwood Ave.  Can the City please plant some trees there? I live in northwood hills neighborhood and desperately would like to plant street trees on my property. It would do a lot for the neighborhood.

I have a giant Banyan tree in the rear corner of my small property that is causing problems with the sidewalk, street, and electric which would look beautiful in a park or large area providing tons of shade. If you're interested and have a spot for it you can have it and I'll plant new smaller shade trees!

Thank you,
We should invest directly into solar trees with retractable canopies. Similar to what European states are currently implementing. These should be reserved for higher traffic areas with heavy heat issues.

Additional trees in downtown areas, especially in areas like large parking lots and other concrete areas would make downtown significantly more tolerable.

Without trees heat increases, especially in urban areas and along roadways (city owned land). By planting trees, cooling areas through shade, we have a chance to reduce the public health of increasing heat in our area due to climate change. Private developers must be required to include and maintain shade trees in all projects. When mature trees are removed for construction, they should be replaced with mature trees with an equal canopy size and coverage before a certificate of occupancy is awarded.

Require high rise commercial and residential buildings to plant and maintain more trees on their property.

Have wider setbacks from the street to allow for pocket parks and tree-lined streets.

Change parking lot/garage requirements for new buildings to minimize size of the buildings and their garages - give over some of that space to trees.

Does every empty lot in WPB need to be a new high rise?  Why not allow more tree-filled areas?

Encourage planting trees with denser canopies, not just palm trees.

Plant street medians on larger roads to help absorb vehicle emissions and beautify and shade at the same time.

I have gotten 6ish trees from the City and have not been able to keep any alive. Perhaps it will be better to get residents to sign up for and volunteer for a tree planting day? Perhaps along a highway or street somewhere?

Add more large flowering trees where space allows... Jacaranda, appleblossom and rainbow cassia, verawood, etc.

Add more tree cover to parks, and along waterfront on Flagler.

Team up with city's arborist and landscape architect.
I work downtown and there is no shade! The palm trees do not cast shade, there is no canopy. Parking lots are brutal everywhere, all Publix parking lots are so barren. All lots, not one bit of shade to park in. So much wasted, paved space. Please don't plant trees that damage property "cars" with their seeds during storms like Mahogany trees!

We should have "kissing canopies" on every street and road in the City, without exception.

we need more trees all over the City: street Swales parks, etc. Let's think outside the box about how we can increase a tree coverage in the City. Especially in those areas of the City where private tree, planting and maintenance maybe a lower priority there are no downside trees, we should be planting them literally everywhere. It's hot, trees are one of the easiest and best way to reduce the temperature of the City.

Please allow removal of coconut palm from parkways and add shade trees instead.

Plan trees on 15th street where there are only a few planted in the last 40 yrs.

Recently I spent a week in Weston FL. It was so lovely driving around the town due to the tree lined streets. It would be nice if West Palm could look more like Weston.

[8] Conducted in Fall 2024.