LAKEWOOD CITY COUNCIL
STUDY SESSION AGENDA

Monday, February 10, 2025
7:00 P.M.
City of Lakewood
Council Chambers
6000 Main Street SW
Lakewood, WA 98499

Residents can virtually attend City Council meetings by watching them live on the city's YouTube channel: https://www.youtube.com/user/cityoflakewoodwa

Those who do not have access to YouTube can call in to listen by telephone via Zoom: Dial +1(253) 215-8782 and enter meeting ID: 868 7263 2373

CALL TO ORDER

ITEMS FOR DISCUSSION:

(3) 1. Natural Environment and Climate Change (NECC) Program, Implementation Plan and Work Plan. – (Memorandum)

ITEMS TENTATIVELY SCHEDULED FOR FEBRUARY 18, 2025 CITY COUNCIL MEETING:

1. Business Showcase. – *State Farm Insurance, Juanita Lanier, Agent*

2. Authorizing the execution of an agreement for City Custodial Services. – (Motion – Consent Agenda)

3. Approval of donations for city events. – (Motion – Consent Agenda)

4. Approval of a Memorandum of Understanding with Partners for Parks for design services related to the H-Barn Project. – (Motion – Consent Agenda)

Persons requesting special accommodations or language interpreters should contact the City Clerk, 253-983-7705, as soon as possible in advance of the Council meeting so that an attempt to provide the special accommodations can be made.

5. Authorizing the execution of an agreement for design services related to the H-Barn Project. – (Motion – Consent Agenda)

REPORTS BY THE CITY MANAGER

CITY COUNCIL COMMENTS

ADJOURNMENT

Persons requesting special accommodations or language interpreters should contact the City Clerk, 253-983-7705, as soon as possible in advance of the Council meeting so that an attempt to provide the special accommodations can be made.

City of Lakewood

TO: City of Lakewood City Council

FROM: Tiffany Speir, Planning Division Manager

THROUGH: John Caulfield, City Manager
Jeff Rimack, PPW Director & Angie Silva, Assistant PPW Director

DATE: February 10, 2025

SUBJECT: Recommended Natural Environment and Climate Change (NECC) Program, Implementation Plan, and Work Plan

ATTACHMENTS: 2024 Lakewood Urban Forest Assessment Report (**Attachment A**); 2024 Pierce County Heat Watch Report (**Attachment B**); 2024 Pierce County Canopy Analysis Report (**Attachment C**); 2023 Establishing the Roots of Urban Forestry in Lakewood, WA: An Implementation Guide (**Attachment D**)

BACKGROUND

In recent years, Lakewood has taken a number of policy and regulatory steps to address various environmental concerns, including tree preservation, tree canopy increase, urban forestry, energy efficiency, and climate change preparation and resiliency (including hazard management planning.) State law was also recently updated to require local governments to make more specific climate change-related changes to their policies and regulations by 2029.

RECOMMENDATION

In order to integrate these efforts into an organized, resource-efficient, and cost-efficient body of work, the City is recommending a “Natural Environment and Climate Change” (“NECC”) Program, which would include policy direction, a 10+ year Implementation Plan, and a 3-5 year Work Plan. The NECC Program and Plans would replace the 2022 Three-Year Energy & Climate Change Work Plan adopted through Ordinance 776.

> ***Note***: The NECC Program as recommended would not propose new policies, strategies, or actions. Rather, it would incorporate items from existing initiatives and priorities previously approved by the City Council and/or required by state law.
>
> ***Note***: The recommended NECC Program would be cross-departmental, meaning not only PPW, but also PRCS, Communications, Legal, and even LPD would be involved in implementing different parts of it over time.

DISCUSSION

<u>2024 Lakewood Comprehensive Plan Goals and Policies</u>

During the 2024 Periodic Review, the City Council updated the Comprehensive Plan’s Energy & Climate Change (ECC) Element and added a new Natural Environment (NE) Element to the Plan. The NE and ECC Elements include goals for improving the tree canopy and creating and maintaining an Urban Forestry Program (UFP):

EC-5 Develop a Climate Resilient Community.

EC-5.5 Improve the Urban Tree Canopy. Enhance the quality and sustainability of the urban forest and urban tree canopy to mitigate urban heat island effects, address stormwater drainage concerns, and meet environmental quality goals.

NE-6 Maintain an urban forestry program to preserve significant trees, promote tree health, and increase tree coverage citywide.

NE-6.1 Maintain a comprehensive urban forestry program.

NE-6.2 Encourage the planting and regular maintenance of street trees to enhance urban greenery.

NE-6.3 Provide for the retention of significant trees and tree stands and the restoration of tree stands within the city.

NE-6.4 Maintain a city tree fund to preserve wooded areas, restore and enhance native trees, and provide for education and research.

NE-6.5 Work towards a citywide goal of 40% tree canopy cover by the year 2050.

NE-6.6 Consider opportunities to increase canopy and environmental equity when evaluating tree canopy distribution.

Status of Implementing the 2022 Three Year Energy & Climate Change Work Plan

Adopted through Ordinance 776, the 2022 Three Year Energy & Climate Change Work Plan included 15 items. It was noted at the time that "this is an aggressive climate change agenda." The status of each is depicted in the table below.

2022 ECCC 3 Year Work Plan Item #	Implementation Measure*	Status as of 2/18/25
1	**Establish (and regularly update) a new climate change chapter to the City's Comprehensive Plan.**	**Complete**. Updates to 2022 ECC Element and new Natural Environment Element adopted as part of 2024 Periodic Review
2	**Develop a five-year plan for reducing greenhouse gas emissions**.	**Not started.** City waiting for state and regional guidance documents.
3	**Update the City's Non-motorized Transportation Plan (also referred to as Active Transportation Plan.)**	**Complete**
4	**Clover Creek Floodplain Engineering Alternatives Analysis.**	**Complete**
5	**Review, and as appropriate, update Lakewood Municipal Code (LMC) Title 14, Environmental Protections.**	**Complete**. City's Shoreline Master Program also incorporated into the City Code in LMC Title 16 as part of 2024 Periodic Review.
6	**Work with Pierce County and Pierce County municipalities to develop a regional approach and best practices to address climate change. One strategy: adopt revised climate change Pierce Countywide Planning Policies (CPPs.)**	**Ongoing.** Updated CPPs adopted in 2022. Lakewood is a founding and ongoing member of the Pierce County Climate Conversation (PCCC.)
7	**Develop a public engagement plan for climate change (and Comprehensive Plan periodic update.)**	**Complete**. Conducted as part of the 2024 Periodic Review.
8	**Incorporate an environmental justice assessment into the Energy & Climate Change Chapter work plan.**	**Complete**

9	**Lakewood, as a member of the South Sound Military Communities Partnership (SSMCP), advocate for improvements to the I-5 corridor the Nisqually Delta at both the state and federal levels.**	**Ongoing**
10	**Revise the Lakewood's tree preservation code.**	**Complete**
11	**Explore the feasibility of reducing the City hall footprint from three floors to two floors. (Potentially reducing energy consumption.)**	**Complete**
12	**Every two years, or as otherwise dictated by Washington State, update LMC Title 15, Buildings and Construction Codes to address hazards resulting from climate change.**	**Ongoing**
13	**Support the implementation of the Tacoma-Pierce County Solid Waste Management Plan.**	**Complete**
14	**Coordinate a regional electric vehicle (EV) infrastructure strategy with neighboring cities, Pierce County and the State.**	**Not started**
15	**Develop/promote an urban forest management/ master reforestation plan.**	**Ongoing.** *Establishing the Roots of Urban Forestry in Lakewood, WA: An Implementation Guide* completed in 2023; Lakewood urban forest assessment, Pierce County Heat Watch Report, and Pierce County Canopy Analysis Report completed in 2024.

Funding for Individual Items proposed for NECC Program

- Urban Forestry Program: Through Motion 2023-55, the City Council approved the use of $340,000 of ARPA funds for the launch of an urban forestry program. $150,000 of the funds have been used to date for the 2024 .Lakewood Urban Forest Assessment Report (**Attachment A**.) Other uses of the ARPA funds will be determined as the urban forestry program is further developed now that foundational data has been collected. The remaining $190,000 must be expended (i.e., at least obligated through an executed contract) by 12/31/26.

  The City Council has also identified the Tree Fund (see LMC 18A.70.340(4)(b)) as an ongoing source of funds for:
  1. Acquiring, maintaining, and preserving wooded areas within the City;
  2. Planting and maintaining trees within the City;
  3. Restoration or enhancement of native trees like Oregon white oaks, such as on public lands, private tree tracts, critical area buffers, or lands with conservation easements;
  4. Establishment of a holding public tree nursery;
  5. Urban forestry education;
  6. Implementation of a tree canopy monitoring program;
  7. Scientific research;
  8. Resources to support the administration of this article; or
  9. Other purposes relating to trees as determined by the City Council.

  As of 2/4/25, the balance in the Tree Fund was $474,096.37.

- *Pending* - Energy Efficiency Community Development Block Grant (EECBG): The City applied for a non-competitive $123,080 federal EECBG in 2024; as of January 17, 2025, the application was still under review.
  - *Note*: It is unknown whether this grant will be awarded under the new federal administration. Information about the grant program has been taken off the website.

- *Pending* - 2ESHB 1181 Implementation Funding through WA Department of Commerce: Lakewood is eligible for a total of $700,000 in non-competitive grant funds through 2029 to implement the requirements adopted through 2ESHB 1181. Lakewood's rough schedule for implementation is as follows, assuming future state grant funding is awarded for the 2025-2027 and 2027-2029 biennia:

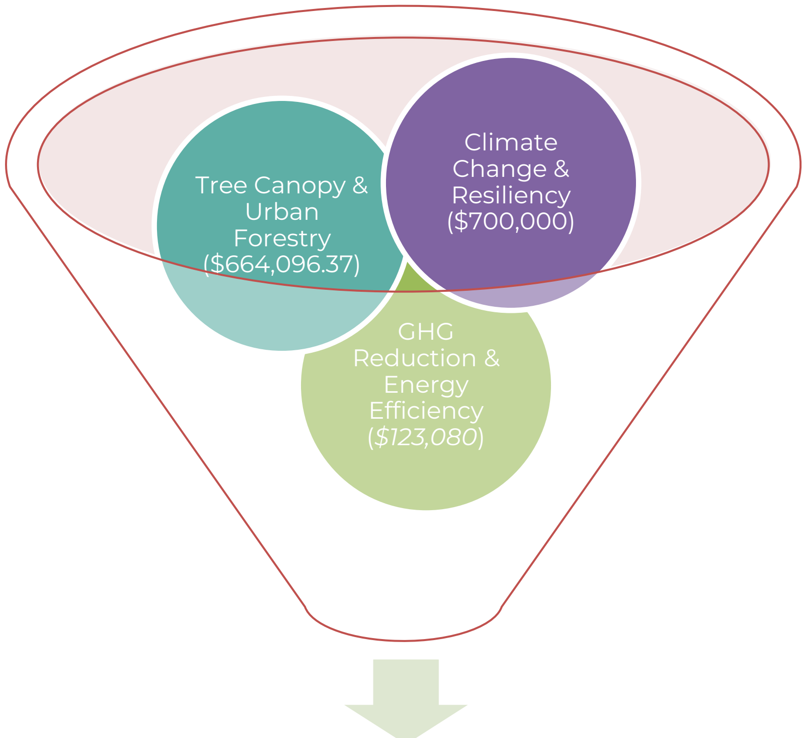
2ESHB 1181 Deliverables	Commerce Funds
Current Biennium (7/1/2023 – 6/15/2025)	
1. Initial updates to Energy & Climate Change Chapter (ECCC) to reflect intention to comply with 1181.	5,000
2. Draft Parks & Recreation Element per 1181.	5,000
3. Draft Utilities Element per 1181.	10,000
4. Draft Capital Facilities Element per 1181.	10,000
Subtotal	***$30,000***
Future Activities (7/1/2025 – 6/15/2029) – *dependent on state grant funding*	
5. Draft updated ECCC including Climate Resiliency and GHG Sub-elements	200,000
6. Draft updated Land Use Element.	25,000
7. Draft updated Transportation Element.	250,000
8. Draft Electric Vehicle Infrastructure Plan.	35,000
9. Draft Urban Heat Resilience Strategy.	35,000
10. Draft Native & Climate-resilient Planting Plans for Municipal Projects.	25,000
11. Draft updated Urban Forest Management/ Master Reforestation Plan.	100,000
Subtotal	***$670,000***
TOTAL	**$700,000**

Why a Natural Environment and Climate change (NECC) Program?
The NECC program is intended coordinate and consolidate existing required and voluntary actions that the City will conduct over the next 10+ years. Priorities, policies, data and action items from existing sources are the basis of the NECC program and are listed here in chronological order:

- 2022 Lakewood Tree Canopy Cover Analysis;
- 2022 Three Year Energy & Climate Work Plan;
- 2023 E2SHB 1181 ("Improving the state's response to climate change by updating the state's planning framework");
- 2023 *Establishing the Roots of Urban Forestry in Lakewood, WA: An Implementation Guide* (**Attachment D**);
- 2024 Comprehensive Natural Environment (NE) and Energy & Climate Change (ECC) Elements;
- 2024 Energy Efficiency Community Block Grant (EECBG) Program;
- 2024 Lakewood Urban Forest Assessment Report (**Attachment A**);

- 2024 Pierce County Heat Watch Report (**Attachment B**); and
- 2024 Pierce County Canopy Analysis Report (**Attachment C**.)

The recommended NECC program is depicted graphically below, including currently identified funding, some of which is not completely secured and subject to changes in the federal administration:



Natural Environment & Climate Change Program (NECC) (*$1,487.176.37*)

Included below are draft Lakewood NECC Program Goals, Strategies, 10+ year Implementation Plan items, and 3-5 Year Work Plan items. The current scope of the NECC program would change if anticipated state or federal grant funding is not awarded.

There are other ongoing efforts related in some way to what the NECC program would encompass, such as the 2026 update to the Parks Legacy Plan and the development of the 2025-2029 Pierce County Hazard Mitigation Plan. Internal coordination will occur across departments to ensure consistency.

NATURAL ENVIRONMENT AND CLIMATE CHANGE PROGRAM (NECC)

The purpose of the Lakewood NECC Program is to address City priorities and goals related to urban forestry management, tree canopy improvement and maintenance, climate change and resiliency, energy efficiency, and greenhouse gas emission reduction.

Goals and Strategies

I. Tree Canopy Increase and Maintenance
- Achieve 40% citywide tree canopy cover by 2050
- Partner with agencies/organizations to promote voluntary tree planting on private property

II. Urban Forestry Program Launch and Maintenance
- Create administrative capacity within the exiting City organizational structure to handle program budget, implementation and monitoring.

III. Climate Change & Resiliency Goals and Regulations
- Comply with E2SHB 1181 by 12/31/2029

IV. Greenhouse Gas Emissions Reduction
- Meet PSRC 4-part GHG emissions goals
- Meet State of WA GHG emissions goals

V. Energy Efficiency Improvements in City Operations and Community
- Increase energy efficiency in City buildings and operations
- Educate, encourage, and incentivize/require residential and commercial/industrial energy efficiency improvements

Strategies for 10+ Year Implementation Plan and 3-5 Year Work Plan

From 2022 Three-Year Energy and Climate Work Plan
- Develop a five-year plan for reducing greenhouse gas emissions.
- Work with Pierce County and Pierce County municipalities to develop a regional approach and best practices to address climate change. One strategy: adopt revised climate change Pierce Countywide Planning Policies.
- Lakewood, as a member of the South Sound Military Communities Partnership (SSMCP), advocate for improvements to the I-5 corridor the Nisqually Delta at both the state and federal levels.
- Every two years, or as otherwise dictated by Washington State, update LMC Title 15, Buildings and Construction Codes to address hazards resulting from climate change.
- Coordinate a regional electric vehicle (EV) infrastructure strategy with neighboring cities, Pierce County and the State*
- Develop/promote an urban forest management/master reforestation plan.

\- Establish a Climate Policy Advisory Team (CPAT) to help guide the NECC implementation process by providing perspectives and recommendations relating to community development, the environment, transit, education, business, and more. CPAT members will be engaged periodically to review and comment on work products and guide public engagement.

From EECBG Award (if awarded)
2025-2027

- Energy data collection to assist in reducing fossil fuel emissions, reducing total energy use, or improving energy efficiency;
- Developing an energy vision, goals, and strategies;
- Conducting stakeholder outreach, engagement, and education; and
- Writing, adopting, and publicizing updated Comprehensive Plan element(s) and ECC Work Plan to reflect results.

From E2SHB 1181 Requirements

2024-2025

- Update the Parks & Recreation Element to include a tree canopy evaluation.

- Update the Utilities Element to include the general location, proposed location, and capacity of all existing and proposed utilities, including electrical, telecommunications, and natural gas systems.

- Update the Capital Facilities Element inventory of existing capital facilities owned by public entities to include green infrastructure.

2025-2027 (*E2SHB 1181 actions pending state funding approval*)

- Update the Lakewood Comprehensive Plan Climate Change and Resiliency Element to include a Greenhouse Gas (GHG) sub-element and climate resiliency sub-element consistent with E2SHB 1181:
  - develop a local emission inventory, conduct a Vehicle Miles Traveled Per Capita (VMT) study, and project emission reductions to inform the adopted Comprehensive Plan goals and policies; and
  - explore expected local climate impacts; audit existing plans and policies for climate resilience opportunities, gaps, and barriers; assess local assets' climate vulnerability and risk; and develop and prioritize science-based climate resilience goals and policies for Comprehensive Plans.

- Update the Land Use Element to:
  - include green spaces, urban and community forests. Give special consideration to achieving environmental justice in the element's goals and policies; and
  - reduce and mitigate the risk to lives and property posed by wildfires by using land use planning tools.

2027-2029 (*E2SHB 1181 actions pending state funding approval*)

- Update the Transportation Element traffic demand forecast to:

- address multimodal transportation demand forecasts and needs; and
- address forecasts of traffic demands and needs outside of the City to inform an element that balances transportation system safety and convenience to accommodate all users of the transportation system to safely, reliably, and efficiently provide access and mobility to people and goods.

- Update the Transportation Element to:
    - include estimated multimodal level of service impacts, giving priority to inclusion of transportation facilities and services providing the greatest multimodal safety benefit to each category of roadway users for the context and speed of the facility;
    - include an inventory of active transportation facilities and multimodal level of service standards for all locally owned arterials, locally and regionally operated transit routes that serve urban growth areas, state-owned or operated transit routes that serve urban areas, and active transportation facilities; and
    - include an Americans with Disabilities Act (ADA) Transition Plan.

- Develop an Urban Heat Resilience Strategy.

- Develop Native & Climate-Resilient Planting Plans for Municipal Projects.

- Update the City's Urban Forest Management/Master Reforestation Plan.

ATTACHMENT A

Return to Agenda

Urban Forest Assessment Report

CITY OF LAKEWOOD

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FACET

ACKNOWLEDGMENTS

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The information contained in this report is based on the application of technical guidelines currently accepted as the best available science and arboriculture industry standards. All discussions, conclusions, and recommendations reflect the best professional judgment of the author(s) and are based on information available at the time the study was conducted. All work was completed within the constraints of budget, scope, and timing. The findings of this report are subject to verification and agreement by the appropriate local, state, and federal regulatory authorities. No other warranty, expressed or implied, is made.

Executive Summary

Located in Pierce County in the southern Puget Sound region, Lakewood, Washington has a culturally diverse population of nearly 68,000 residents. Visitors and residents enjoy extensive parks, open spaces, and a thriving business community. Lakewood's collective natural resources and green assets directly contribute to the community's character and provide valuable ecological, economic, and public health benefits.

The City's 2025 Comprehensive Plan includes a goal to "[m]aintain an urban forestry program to preserve significant trees, promote tree health, and increase tree coverage citywide [as well as] work towards a citywide goal of 40% tree canopy cover by the year 2050." The primary objectives of the project were to gain a deeper understanding of the urban forest at various scales and across land ownership. Study elements included:

- geospatial analysis of canopy cover and plantable space using remote sensing;
- field inventory of publicly managed trees (e.g., rights-of-way, parks); and
- rapid field assessment of select large-acreage natural areas using the Forest Landscape Assessment Tool.

This report does not direct or recommend any actions to be taken by the City or the public. The intention is to use these data to guide the development of an urban forestry management plan and program and serve as a foundation for:

- conducting on-the-ground management of public trees;
- developing or updating the City's land use policies;
- future funding decisions for urban forestry and climate change & resiliency activities; and
- ongoing and future partnerships between the City, its agency and utility partners, and its residents and businesses.

The urban tree canopy assessment determined a citywide canopy cover estimate of 24.4% for the 2020 evaluation year. Canopy cover is reported for census block groups, land use zones, and select large individual properties. In addition to canopy cover, the assessment included an analysis of plantable area conducted at two scales, the contextual level (among census blocks and land use zones) and site level, providing operational support to Lakewood by assessing plantable areas on city-managed lands. Together they provide data to evaluate the opportunity for additional tree planting and tree canopy recovery.

The 2024 field tree inventory assessed 11,782 trees within public rights-of-way, city-owned parks, public schools, and other select public institutional grounds. Results show a public tree population that includes 161 species characterized by a mixture of ornamentally introduced tree varieties and trees native to the Pacific Northwest. The most abundant tree species are Douglas-fir (*Pseudotsuga menziesii*), Oregon white oak (*Quercus garryana*), Norway maple (*Acer platanoides*), cherry plum (*Prunus cerasifera*), and red maple (*Acer rubrum*), which together make up over half of all inventoried trees (54%). The study found that the population distribution is relatively even among size classes, and a majority of the trees were assessed to be in *good* condition (73%).

Natural sites assessed using FLAT included Fort Steilacoom Park, Seely Lake Park, Wards Lake Park, and the South Puget Sound Wildlife Area. Of the inventoried natural areas, 28% of these lands have been assessed to have an overstory composition well suited for the site and ecoregion. These include forests with an abundance of conifers, madrones, and Oregon white oak, as well as wetlands that have water regimes that would not support a forested ecosystem. Invasive species are prevalent across the City with 35% of natural areas having high levels of invasive species (defined as having greater than 50% cover).

For other large-acreage properties and census tracts under 35% urban tree canopy, LiDAR analysis was utilized to determine site-specific canopy cover, tree count, and height distribution of trees on these sites. The information provided in tree demographics can be used to infer past management practices and evaluate needs or opportunities for future planting efforts.

The Lakewood Urban Forest Assessment Report synthesizes the results of this multi-faceted study and intends to serve as a guide for City staff, the Public Works Department, and Lakewood City Council, as they collaboratively develop programs and policies to steward a sustainable, climate-resilient, and equitably distributed urban and community forest.

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1. Purpose and Approach of the 2024 Lakewood Urban Forest Assessment

Urban forests include the trees and vegetation found in natural areas, formal parks, public spaces, private properties, and transportation corridors. Trees in heavily urbanized environments, especially right-of-way (ROW) and street trees, help to mitigate the effects of the built environment and provide numerous environmental and public health benefits, including stormwater mitigation; shade and urban cooling; improved air quality; noise abatement; economic advantages; human health and wellness; and traffic calming. To support the City's Comprehensive Plan goal to achieve 40% tree canopy by 2050, the City Council commissioned this study to obtain foundational information to support the development of an urban forestry program. This data will inform the development of urban forest policies and regulations and guide the maintenance of public trees. Overall, the City seeks to steward an urban forest that is climate-resilient and equitably distributed across various neighborhoods and land uses.

Several dimensions of urban forest metrics are evaluated including:

- field inventory of public trees and select public institutional grounds;
- forest health assessment in natural areas;
- canopy cover analysis; and
- evaluation of available plantable area.

This provides data that can be used to understand the baseline condition of the urban forest and aid in future planning and operations. Ultimately, the findings of this study will serve as a roadmap for strengthening Lakewood's urban forest and achieving its long-term vision of a greener, healthier, and more climate-resilient urban environment.

2. Methods

To meet the City's objectives, this urban forest assessment provides a three-tiered approach to provide a comprehensive evaluation compatible with Washington Department of Natural Resources (WADNR) Urban and Community Forestry data requirements and project budget constraints, including:

- geospatial analysis to assess canopy cover and plantable area;
- a field-based individual tree inventory; and
- a forest stand assessment of natural areas.

The individual tree inventory was conducted in the rights-of-way, public parks, and select public institutional grounds. All properties owned by state agencies and public institutions were completed with permission from the landowner. Although a complete tree census is not performed, a large sample is collected that is generally representative of the City's public tree infrastructure. This demographic information may be utilized to guide urban forest operations and maintenance and effectively plan and manage a forest composition and structure to meet the City's desired compositional objectives.

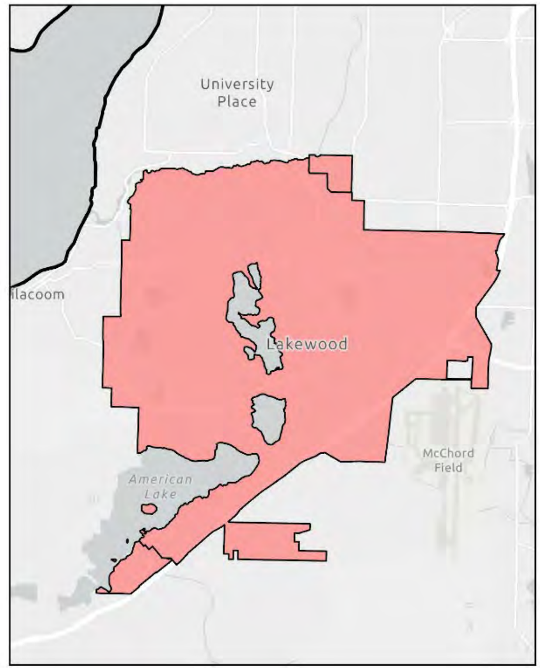

Figure 1. Urban forest assessment study area

Natural areas were assessed using the Forest Landscape Assessment Tool (FLAT) (see Section 2.4.1). FLAT provides information for forest and natural area management at the stand-level and considers ecosystem metrics beyond trees to systematically categorize and prioritize management actions. This allows for informed ecosystem-level forest management the city can leverage to plan and manage these natural areas.

The third component was a city-scale remote sensing analysis using LiDAR[1] and other data to analyze tree canopy cover and locate areas suitable for potential tree planting (i.e., plantable areas). This approach is well suited to evaluate progress in tree canopy and equity goals and provides city-scale data, including private properties, that are otherwise inaccessible to on-the-ground tree inventory methods. The plantable area analysis will allow the City to understand opportunities for additional tree planting and strategically plan future tree-planting efforts. All analyses were conducted within the city limits. LiDAR analyses were also completed for two locations outside of the city limits, Camp Murray and Meadowbrook Golf Course, to assist with future partnerships on interagency parks and open space improvements. Figure 1 shows the complete study area of the Lakewood Urban Forest Assessment.

[1] LiDAR (Light Detection and Ranging) is a remote sensing technology that generates a digital "point cloud" or 3D image of tree cover and the elevation of bare ground which can be used to evaluate canopy height among other forest assessment elements.

2.1 Tree Canopy Analysis

Tree canopy cover is one of the most encompassing metric to describe the overall condition of a city's urban forest and is commonly used to set policy goals and evaluate performance through time. This analysis is provided to determine overall canopy cover in Lakewood and geographically segmented areas including zoning districts and census block groups. These groups are selected to be useful for city planning and management and provide increased granularity compared to city-scale metrics. Large privately owned parcels are also evaluated due to their relative importance in the overall canopy.

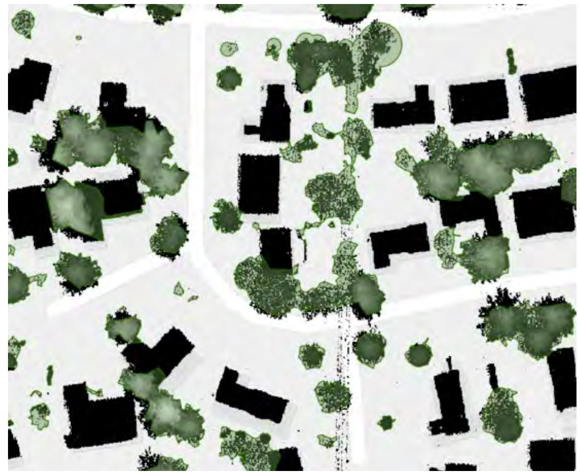

Figure 2. Image of Lidar-derived tree canopy layer.

The canopy cover layer was created using WADNR's latest LiDAR data for Pierce County (WADNR, 2020) and WADNR's landcover layer available for Pierce County (WADNR, 2022). The LiDAR data contains a bare earth digital elevation model (DEM) and a digital surface model (DSM) consisting of surface first-contact elevations, such as trees and buildings. An object height raster was created by calculating the elevation difference between the DSM and DEM, a layer that includes tree canopies in addition to buildings, utility lines, and other objects. All areas below 10 feet were removed to eliminate non-target objects below the height threshold. To eliminate non-target objects above the height threshold, impervious surfaces on the DNR Landcover Dataset were removed. Additionally, the canopy polygons were aggregated, and infrequent occurrences of utility lines and other non-tree objects were removed. The tree canopy layer was further refined with data from the tree inventory by adding individual canopy polygons using measured radii (see Section 2.3).

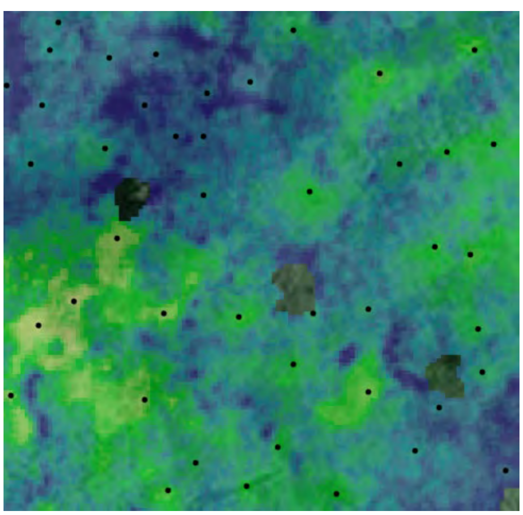

Figure 3. LiDAR-derived canopy height model and tree points making the canopy crown.

After creating the canopy layer, additional canopy height modeling was completed in select census block groups and large acreage properties to provide information on urban forest structure. The canopy height model (CHM) used the same LiDAR datasets as the canopy layer. The CHM was completed using 'LidR,' an open-source software package integrated into the R ecosystem for applications in forestry. Canopy height model and tree top identification algorithms were applied to identify tree heights. Tree height was used as a proxy for the overall tree since other common metrics (e.g., diameter-at-breast height (DBH) and age), cannot be directly measured with remote sensing technologies. This process yielded a tree population point layer with canopy height attribute values.

Both the canopy and tree population data were used to analyze canopy cover in Lakewood and among census block groups and zoning districts. Areas of open water greater than 10,000 square feet in the USGS National Hydrography Dataset (USGS 2024) were removed from the analysis for land area metrics. The canopy analysis study area includes numerous census block groups that straddle the boundaries of Lakewood and adjacent cities' boundaries. These groups were included in city-wide calculations for canopy cover, but because they are insignificant areas and provide no practical information for urban forest management, they were not separately reported.

2.2 Planting Site Assessment

Plantable area is defined as a permeable area without current tree cover that may be able to support a tree(s). This excludes areas that contain land cover that may be restored to a condition that may support trees, such as pavement. An analysis of plantable area was conducted at both a contextual level and a site level to evaluate the opportunity for additional tree planting and tree canopy recovery.

The goal of the contextual-level planting analysis was to assess plantable area among individual census block groups and zoning districts. This was completed through an overlay analysis to identify lands that are not:

- overlapped by incompatible infrastructure as indicated by impervious surfaces (PlanIT Geo 2022);
- National Hydrography Dataset (NHD) waters greater than 10,000 square feet (USGS 2024);
- landcover waters (PlanIT Geo 2022); or
- existing canopy generated in this study that approximates the current canopy conditions based on the latest and most accurate available data.

The objective of the site-level planting analysis was to assess plantable area on City-managed lands, such as public parks and ROW. A list of sites assessed for the site-level planting analysis is provided in Table 8. This analysis also incorporated the new GIS tree canopy layer (as described in Section 2.1) and the City of Lakewood's planimetric data (Lakewood, 1998). Lakewood's planimetric data was manually updated by Facet, using a visual observation method, and used as a proxy for impervious surfaces. The identified plantable areas were outside of both the planimetric (i.e., impervious) data and mapped areas of estimated tree canopy cover. The resultant planting assessment data approximately describes conditions in 2020 as that was the latest available LiDAR data. Data is presented at a resolution that reflects the accuracy of source information, approximately 1-10 feet.

Note: The accuracy of the planting analysis methodology relies on the accuracy and precision of the underlying source data. Limitations in both accuracy and resolution as well as temporal precision apply.

2.3 Tree Inventory

Tree inventories are an essential component of urban streetscape management, similar to other city asset inventories. They are a foundational data source for tracking all related expenses, defining levels of service, and strategic planning. Public tree inventories help to inform budget forecasting based on tree attributes (e.g. size, age, condition, etc.) so that annual costs for tree care can be anticipated and then distributed strategically over many years.

Lakewood's green assets include individual and collective tree resources, street tree infrastructure (e.g., tree grates), landscape vegetation, and irrigation. In 2018, the City first invested in a field inventory of public trees through a WADNR Urban and Community Forestry grant. The 2018 study examined approximately 1,500 trees located along the ROW of select city arterial streets and city parks and included an estimation of the appraised value and identification of maintenance requirements (Community Forestry Consultants, 2018). This 2024 inventory reevaluated these sites and expanded the study to over 11,000 trees. Additionally, all associated GIS data was provided to the City to assist with future tree management and tracking and included geographically located tree points, attribute data, and photographs.

2.3.1 Field Inventory Methods

International Society of Arboriculture (ISA) Certified Arborists® from Facet collected data using Field Maps for ArcGIS, a mobile data collection app from Esri. A data point was added for each inventoried tree, using Esri aerial photography as well as the City's GIS right-of-way (ROW) boundary data as a reference. GPS data are believed reliable for general planning and most regulatory purposes. However, accuracy can be variable, and locations should not be considered equivalent to a professional land survey. Data was collected for all trees greater than two inches DBH between June and October 2024, using the attributes outlined below. The trees were fully leafed out at the time of the inventory.

2.3.2 Study Area and Tree Locations

The study area included a selection of City-owned ROW and developed parks and a selection of public institutional grounds. The ROW portion of this inventory focuses on principal arterials, minor arterials, and collector streets. Street trees include trees growing in planting strips, medians or tree wells between the street and sidewalk, or tree wells cut into the backside of the sidewalk. In areas of unimproved ROW, or where the ROW was incorporated into the adjacent private landowner landscaping, Facet arborists used the City ROW GIS boundary to delineate the public ROW. Table 1 provides a summary of all sites included in the individual tree inventory.

Table 1. Tree inventory study locations.

City of Lakewood	Public Institutional Grounds	Other
• Public rights-of-way (ROW) • Active Park • American Lake Park • Edgewater Park • Harry Todd Park • Kiwanis Park • Oakbrook Park • Ponders Park • Primley Park • Springbrook Park • Washington Park • Active Park • American Lake Park	• Clover Park High School • Custer Elementary School • Dower Elementary School • Dr. Claudia Thomas Middle School • Early Learning Sites • Hudtloff Middle School • Idlewild Elementary school • Lake Louise Elementary School • Lakes High School • Lakeview Hope Elementary School • Lochburn Middle School • Oakbrook Elementary School • Tillicum Elementary School • Tyee Park Elementary School • Clover Park Technical College Campus[1] • Pierce College Campus • Saint Clare Hospital Campus	• JBLM North Clear Zone[2] • Utility-owned properties

[1]*Clover Park Technical College has an existing tree inventory conducted by Monarch Tree Services. Facet did not re-inventory this site. The raw data was not available for integration into this study, however, the report was provided to the City by the college.*

[2] *The North Clear Zone (NCZ) is a federally designated 3,000 x 3,000-foot safety area adjacent to the north end of the McChord Field runway. It is located partly within Joint Base Lewis-McChord (JBLM) and partly within the City of Lakewood.*

2.3.3 Tree Attributes

Species

The arborists determined tree species by analyzing the characteristics of each tree, including canopy morphology and branch structure, bud shape and arrangement, bark texture, and leaves. Both botanical and common names were recorded. Where specific varieties and cultivars were identified, those were included as well.

Diameter

The diameter-at-breast height (DBH) was measured at 4.5 feet above the ground with a graduated logger's tape, except when codominant leaders bulged at 4.5 feet above the ground, in which case the diameter measurement was taken below the combined trunks. The total diameter of multi-stemmed trees was calculated by taking the square root of the sum of each diameter squared.

Condition

A Level 1 visual assessment was used to evaluate the health and condition of trees within the study area per International Society of Arboriculture (ISA) and Council of Tree and Landscape Appraisers (CTLA) standards. The condition determination was based on current conditions and considered the health, structural integrity, and form of the tree in addition to the characteristics of each species. Each tree was rated from *Excellent* to *Dead* condition, as defined in Table 2. Locations where previously inventoried trees had been removed were documented as *Gone*. Notes on large wounds, structural defects, or specific pruning and maintenance recommendations were recorded.

Table 2. Tree condition rating definitions (adapted from CTLA, 2020)

Rating Category	Condition Components		
	Health	Structure	Form
Excellent 1	High vigor and nearly perfect health with little or no twig dieback, discoloration, or defoliation.	Nearly ideal and free of defects.	Nearly ideal for the species. Generally symmetric. Consistent with the intended use.
Good 2	Vigor is normal for species. No significant damage due to diseases or pests. Any twig dieback, defoliation, or discoloration is minor.	Well-developed structure. Defects are minor and can be corrected.	Minor asymmetries/deviations from species norm. Mostly consistent with the intended use. Function and aesthetics are not compromised.
Fair 3	Reduced vigor. Damage due to insects or diseases may be significant and associated with defoliation but is not likely to be fatal. Twig dieback, defoliation, discoloration, and/or dead branches may compromise up to 50% of the crown.	A single defect of a significant nature or multiple moderate defects. Defects are not practical to correct or would require multiple treatments over several years.	Major asymmetries/deviations from species norm and/or intended use. Function and/or aesthetics are compromised.
Poor 4	Unhealthy and declining in appearance. Poor vigor. Low foliage density and poor foliage color are present. Potentially fatal pest infestation. Extensive twig and/or branch dieback.	A single serious defect or multiple significant defects. Recent change in tree orientation. Observed structural problems cannot be corrected. Failure may occur at any time.	Largely asymmetric/abnormal. Detracts from intended use and/or aesthetics to a significant degree.
Very Poor 5	Poor vigor. Appears dying and in the last stages of life. Little live foliage.	Single or multiple severe defects. Failure is probable or imminent.	Visually unappealing. Provides little or no function in the landscape.
Dead 6	N/A	N/A	N/A

Infrastructure Type & Noted Conflicts

The type of infrastructure surrounding the inventoried tree was documented as either a tree well, planter bed, median, or other as described in Table 3 below.

Table 3. Attributes: Infrastructure types

Type	Description
Tree Well	Enclosed tree pit with impermeable surface on four sides
Planter Bed[1]	Plater area with multiple trees in long strips
Median	Planter area in the center of the road
Unimproved ROW	Tree in ROW where no sidewalk or curb is present
Open space	Parks or wide-open planting areas

[1] *The size (in feet) of all planter beds was noted (for example: 4 feet by 6 feet).*

Where there were conflicts with tree parts and the adjacent infrastructure, a yes or no response was recorded for the following fields defined in Table 4 below.

Table 4. Observed infrastructure conflicts

Conflict	Description
Tree Grate Girdled	Contact between trunk and grate.
Tree Grate Lifted	The tree grate is lifted at least 0.5" above grade.
Sidewalk Lifted	The sidewalk is lifted at least 0.5" above grade.
Root Sidewalk Intrusion	Cracking was observed in the sidewalk, due to root growth.
Root Road Intrusion	Cracking observed in the street, due to root growth.
Overhead Utilities	Power lines within the expected mature canopy area.

2.4 Forest and Natural Area Health Assessment

This chapter covers the specific methodology used to assess the current conditions of open spaces and reviews the results of the field analysis. The forest health assessment was conducted using the Forest Landscape Assessment Tool (FLAT) in four selected parks and wildlife areas, including Fort Steilacoom Park, Seeley Lake Park, Wards Lake Park; and the South Puget Sound Wildlife Area (See Table 5).

Table 5. Forest Landscape Assessment Tool (FLAT) Properties

Site Name	Ownership	Acreage
Fort Steilacoom Park	City of Lakewood/Pierce College	340
Wards Lake Park	City of Lakewood	22
Seeley Lake Park	Pierce County	47
South Puget Sound Wildlife Area	WA Department of Natural Resources	100

Assessing the condition of undeveloped public open spaces, including forests, meadows, prairies, and wetlands allows land managers to establish restoration needs and priorities, develop site-specific restoration plans, and enable a quantitative evaluation of the effectiveness of future restoration actions. FLAT data attributes cover several metrics and indicators of ecosystem functions and processes, which capture additional information beyond what is gathered from an inventory of individual significant trees.

2.4.1 Forest Landscape Assessment Tool (FLAT)

The Forest Landscape Assessment Tool (FLAT) was developed by the Green Cities Research Alliance in coordination with the USDA Forest Service Pacific Northwest Research Station (Ciecko et al., 2016). The FLAT process is a standardized method for rapidly assessing and prioritizing forest health and restoration needs. The complete methodology is described in Ciecko et al. (2016) and the *FLAT Field Manual* by Green Cities Research Alliance (2013).

In this approach, discrete habitat management units (HMUs) are defined at a scale appropriate for site-specific management. Forest metrics are obtained by field researchers and units are assigned a ranked category based on the Tree-iage Matrix, a forest health rating from 1-9. The Tree-iage categories provide a forest health snapshot that can be used by managers to understand site conditions and prioritize maintenance and restoration.

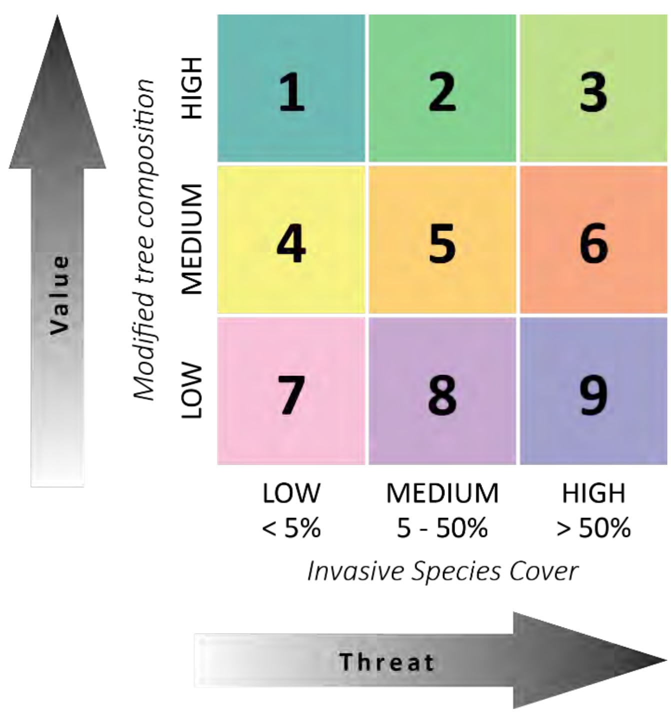

Figure 4. Tree-iage matrix, adapted from Green Cities Research Alliance

Table 6. Tree-iage category descriptions[2]

Category 1, High Canopy Composition – Low Invasive Cover

Forests have a high canopy cover and are composed of tree species that are well-suited to the site conditions and ecoregion. Forest canopies typically contain > 50% conifers or broadleaf evergreen trees. This category also includes wetlands and floodplains where deciduous forest, scrub-shrub, or emergent plant communities are supported under natural conditions. Invasive species cover is less than 5% and poses minimal threat.

Category 2, High Canopy Composition – Medium Invasive Cover

Forests have a high canopy cover and are composed of tree species that are well-suited to the site conditions and ecoregion. Forest canopies typically contain > 50% conifers or broadleaf evergreen trees. This category also includes wetlands and floodplains where deciduous forest, scrub-shrub, or emergent plant communities are supported under natural conditions. Invasive species cover is between 5-50% and poses a moderate threat. If left untreated, invasive species may reduce the viability of native seedlings, compete for resources, and in severe cases impact the health of mature trees.

Category 3, High Canopy Composition – High Invasive Cover

Forests have a high canopy cover and are composed of tree species that are well-suited to the site conditions and ecoregion. Forest canopies typically contain > 50% conifers or broadleaf evergreen trees. This category also includes wetlands and floodplains where deciduous forest, scrub-shrub, or emergent plant communities are supported under natural conditions. Invasive species cover is extremely pervasive and ranges between 50-100%. If left untreated, native plant communities, mature trees, and habitats could be lost.

Category 4, Medium Canopy Composition – Low Invasive Cover

The forest canopy is dominated by native deciduous trees, but site conditions could support between 1-50% cover of conifers and broadleaf evergreen trees. This category also includes wetlands and floodplains that could support between 1-50% conifers or broadleaf evergreen trees. Invasive species cover is less than 5% and poses minimal threat.

Category 5, Medium Canopy Composition – Medium Invasive Cover

The forest canopy is dominated by native deciduous trees, but site conditions could support between 1-50% cover of conifers and broadleaf evergreen trees. This category also includes wetlands and floodplains that could support between 1-50% conifers or broadleaf evergreen trees. Invasive species cover is between 5-50% and poses a moderate threat. If left untreated, invasive species may reduce the viability of native seedlings, compete for resources, and in severe cases impact the health of mature trees. Competition with native seedlings may disrupt successional pathways and prevent the establishment of late-seral plant communities.

Category 6, Medium Canopy Composition – High Invasive Cover

The forest canopy is dominated by native deciduous trees, but site conditions could support between 1-50% cover of conifers and broadleaf evergreen trees. This category also includes wetlands and floodplains that could

[2] Green Cities Research Alliance, 2010

support between 1-50% conifers or broadleaf evergreen trees. Invasive species cover is extremely pervasive and ranges between 50-100%. If left untreated, native plant communities, mature trees, and habitat could be lost.

Category 7, Low Canopy Composition – Low Invasive Cover

Forests in this category have little to no conifers or broadleaf evergreen trees where they would otherwise dominate under natural conditions. Forests in this category are often a legacy of disturbance without assisted revegetation. Invasive species cover is less than 5% and poses minimal threat.

Category 8, Low Canopy Composition – Medium Invasive Cover

Forests in this category have little to no conifers or broadleaf evergreen trees where they would otherwise dominate under natural conditions. Forests in this category are often a legacy of disturbance without assisted revegetation. Invasive species cover is between 5-50% and poses a moderate threat. If left untreated, invasive species may reduce the viability of native seedlings, compete for resources, and in severe cases impact the health of mature trees. Competition with native seedlings may disrupt successional pathways and prevent the establishment of late-seral plant communities.

Category 9, Low Canopy Composition – High Invasive Cover

Forests in this category have little to no conifers or broadleaf evergreen trees where they would otherwise dominate under natural conditions. Forests in this category are often a legacy of disturbance without assisted revegetation. Invasive species cover is extremely pervasive and ranges between 50-100%. If left untreated, native plant communities, mature trees, and habitats could be lost.

Several adjustments to the FLAT methodology were applied to adapt the protocol for the conditions in Lakewood's forests and other natural areas, as summarized below:

1. HMUs are assigned to areas less than five acres, with a minimum recorded size of 0.8 acres.
2. The FLAT was not designed to be used in prairie-oak ecosystems. To account for this, the native Oregon white oak is considered in the category of "Conifer or Madrone Cover" in the canopy composition flow chart because it is a desired tree in local ecosystems.
3. HMUs that are managed intentionally as non-forested sites, such as prairies and some prairie-oak ecosystems, are included in the respective category of "Capability to Support Canopy" based on management objectives rather than biological limitations of the site.
4. Several instances were noted in public parks where a non-native tree was the dominant or a large canopy component of an HMU. When management objects do not intend to remove and replace these trees, these are not treated as invasive species for the purpose of the cover estimate.

3. Urban Tree Canopy Assessment

3.1 Landcover and Urban Tree Canopy

The City of Lakewood encompasses 19.0 square miles, with a land area of 17.2 square miles and 1.8 square miles of water. The citywide urban tree canopy is estimated to cover 2,660 acres, or 24.4% of the City during the 2020 analysis year (Figure 5). The following are some comparable urban canopy cover estimates in the Puget Sound region: Tacoma (20%), Seattle (28%), Kent (28%), Renton (29%), Maple Valley (31%), Bellevue (37%), and Kirkland (41%) (PlanIT Geo, 2018).

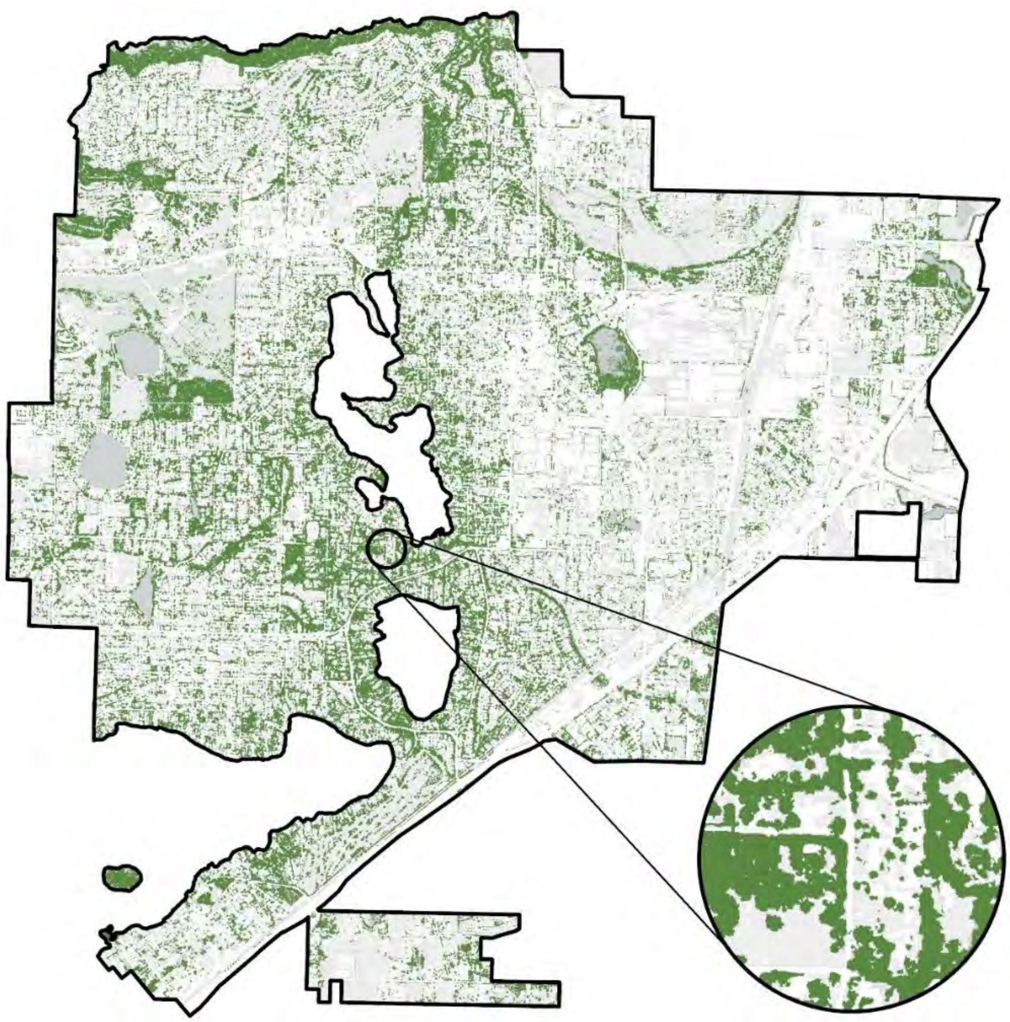

Figure 5. Tree canopy cover in Lakewood city limits.

3.2 Contextual-level Planting Site Assessment

The contextual-level planting site assessment revealed planting opportunities throughout Lakewood totaling approximately 3,400 acres of plantable area, or 31.4% of the City. Approximately half of all identified plantable areas would need to be covered in the tree canopy to provide the 15.6% increase necessary to achieve Lakewood's 40% canopy cover goal (See Figure 6). This result includes lands that are potentially environmentally suitable for trees to grow but may be constrained by other land uses, designations, and infrastructure.

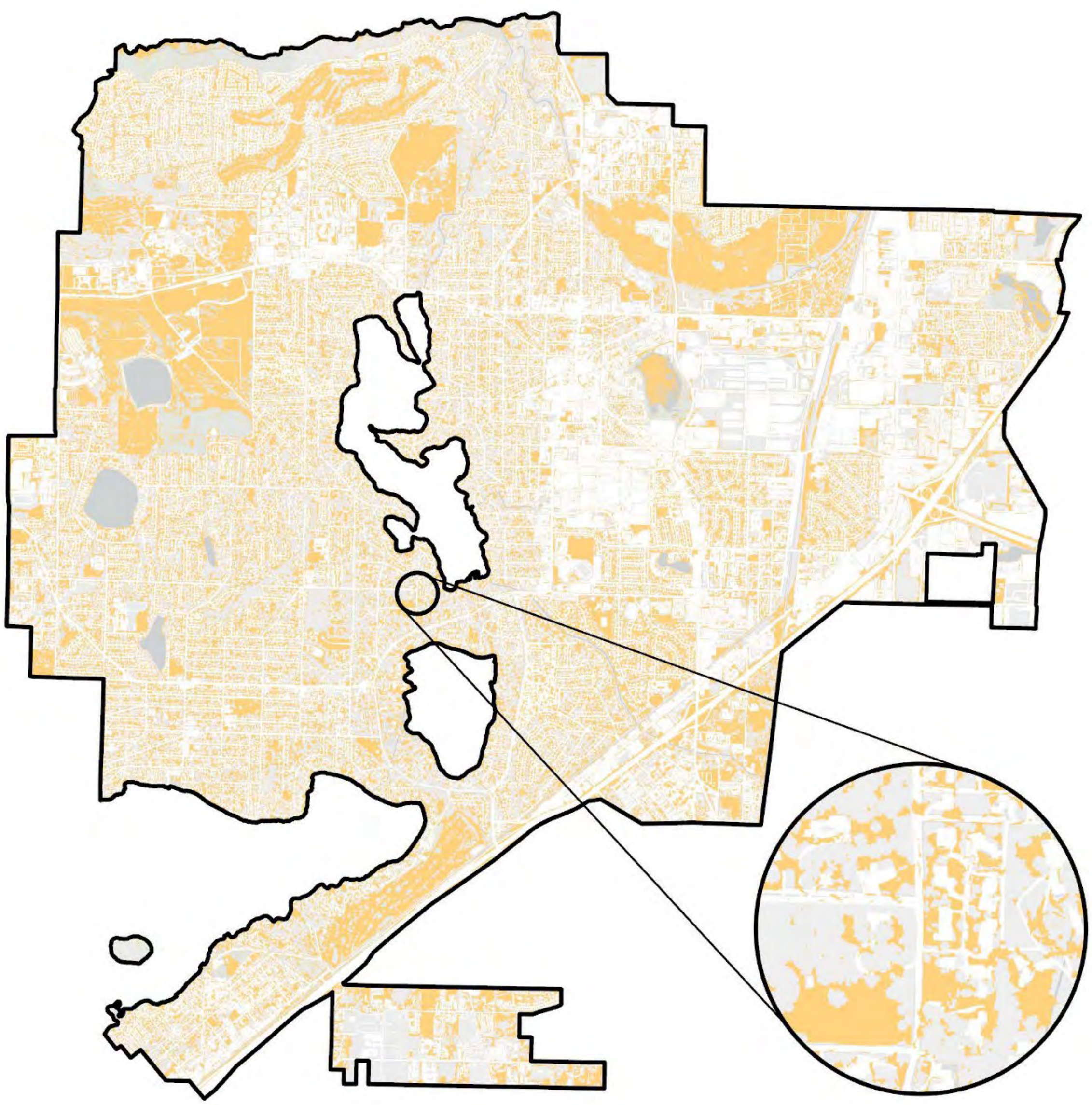

Figure 6. Contextual-level planting area analysis within Lakewood city limits

3.3 Census Block Groups

Generally speaking, the relationship between urban forest canopy distribution and income and racial inequities is well documented (Fan et al., 2019; Watkins & Gerrish, 2018). Studies show that people with lower incomes do not enjoy the same urban forest and ecological benefits as higher-income neighborhoods (Greene et al., 2018). Affluent, primarily white communities typically have higher canopy cover and larger investments in tree-planting activities (Myers et al., 2023; Watkins et al., 2017). Regional studies indicate that socioeconomic tree inequity trends also exist in Puget Sound (Puget Sound Regional Council, 2024).

Lakewood requested an evaluation of census block groups with relatively low canopy cover (less than 35%) to seek opportunities to improve tree equity. Tree canopy was examined at the census tract and block group level. Of Lakewood's 53 evaluated census block groups, 42 have less than 35% canopy cover. See Appendix A for associated metrics at the census block group level.

The data reveals a positive correlation between canopy cover and income in Lakewood, indicating that areas with higher income levels tend to have greater existing canopy cover (see Figure 7) and areas with lower income have less plantable areas (see Figure 8). Many factors influence urban tree canopy patterns and distribution; for instance, affluent areas typically have larger lot sizes and better access to public parks, translating to proportionately greater opportunities for canopy recovery (R^2=0.14). Scatter plot and linear regression showing positive correlation between annual median household income from the 2023 ACS and canopy cover by census block groups (R^2 = 0.14). Income data was not available for all evaluated census block groups.

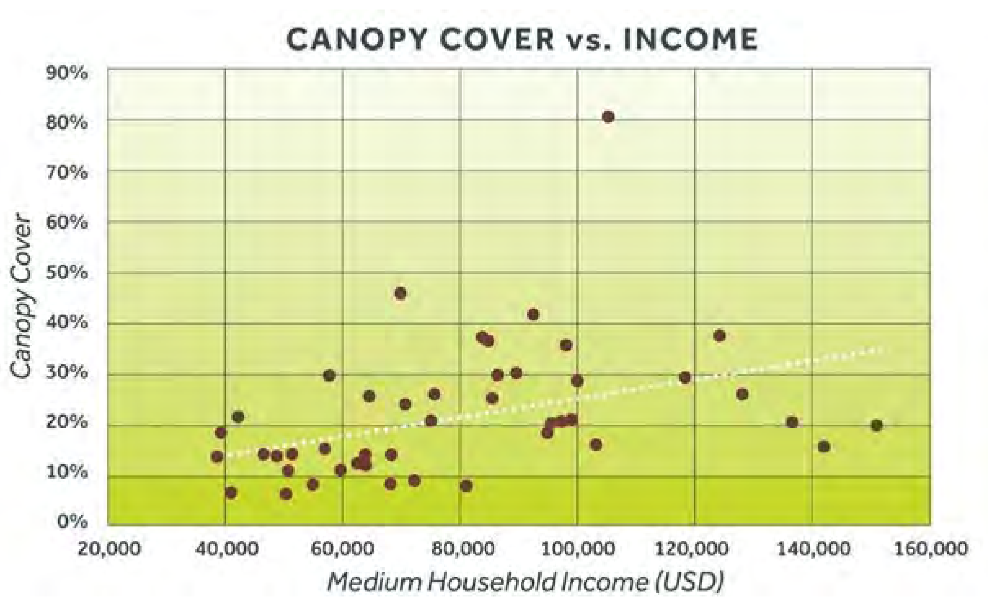

Figure 7. Scatter plot and linear regression showing positive correlation between annual median household income from the 2023 ACS and canopy cover by census block groups (R^2 = 0.14). Income data was not available for all evaluated census block groups.

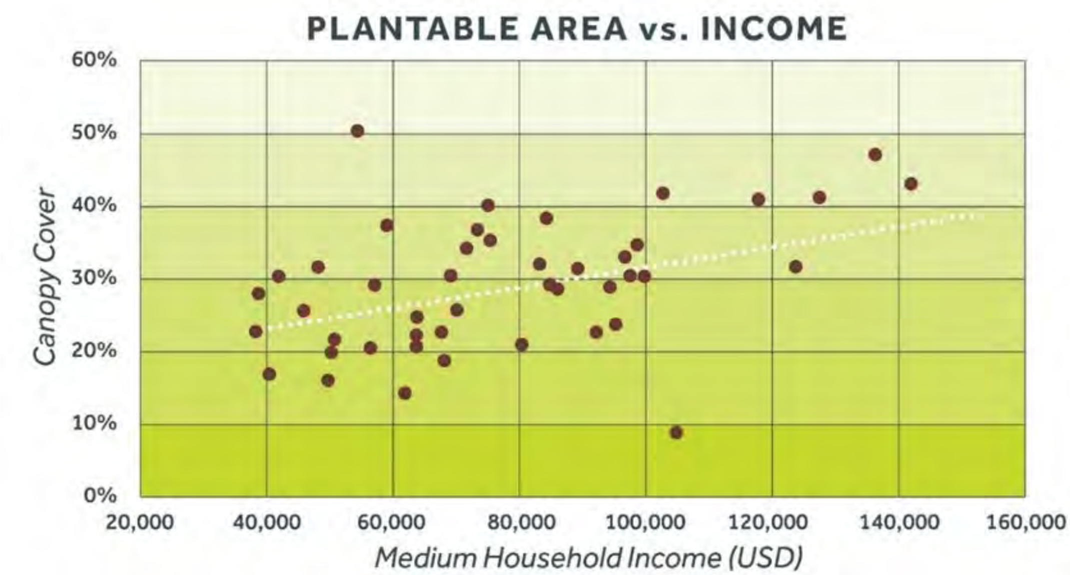

Figure 8. Scatter plot and linear regression showing positive correlation between annual median household income from the 2023 ACS and plantable area by census block groups (R2 = 0.18). Income data was not available for all evaluated census block groups.

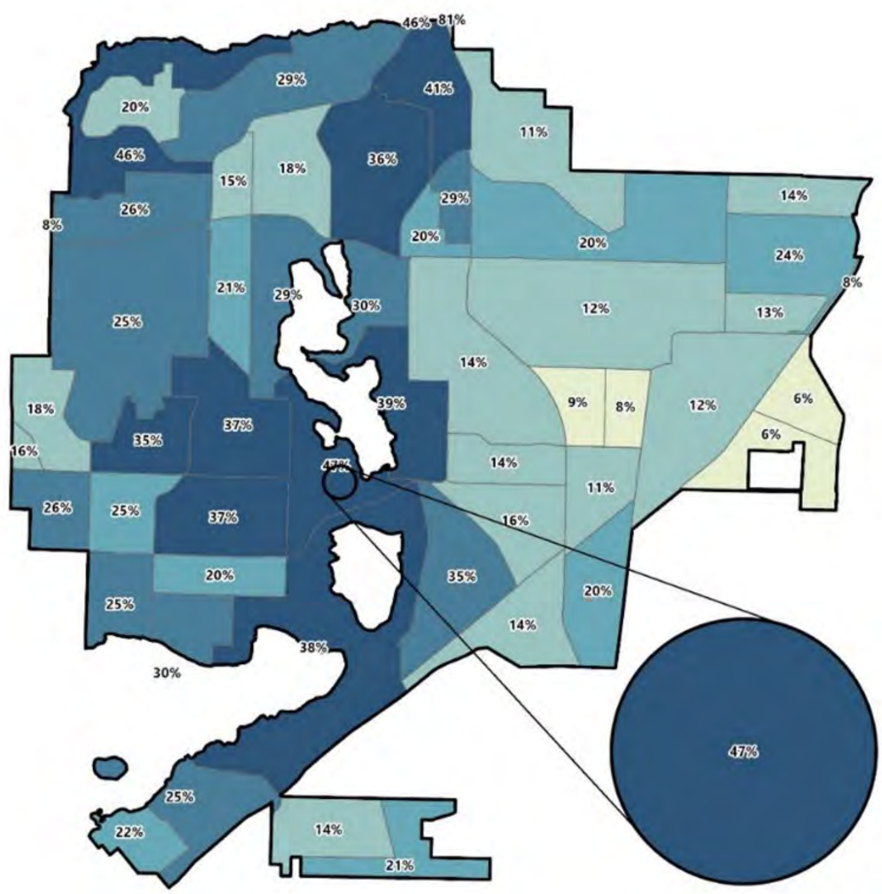

Figure 9. Urban tree canopy percentage by census block groups

3.4 Land Use Zoning and Tree Canopy

Urban land use plays an important role in the distribution and structure of urban forest canopy (Mincey et al., 2013). Understanding the distribution of existing and potential canopy within various land use zones, as well as the statutory, regulatory, and environmental restrictions beyond the control of the City, provides useful data that can inform policies and regulations governing urban forest management practices. This is of particular importance for tree removal and retention regulations on private development sites.

Tree canopy cover is relatively high in Lakewood's residential zones, ranging from 23.3%-48.1%. These zones also make up a large proportion of the total city area and collectively account for 59% of Lakewood's total tree canopy area. The open space and recreation zones include 17% of the total canopy. Commercial and industrial zones have low canopy cover values, ranging between 5.4% and 11.3%.

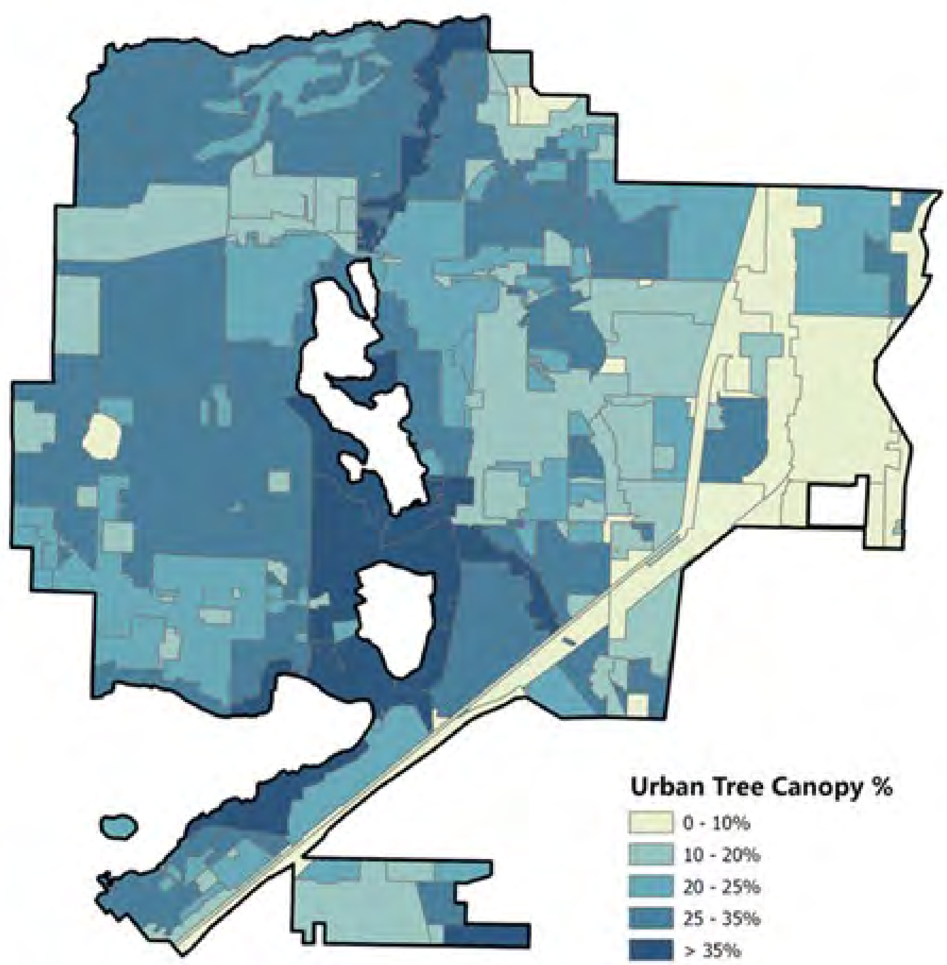

Figure 10. Urban tree canopy percentage by land use zones.

Due to larger lot sizes and lower impervious surface coverage, the availability of plantable area is greatest in the residential and parks & open space land use zones (see Table 7).

- Parks and open space zones have between 57%-66% potential plantable area where trees could be grown if planting aligns with management objectives.
- Residential zones have between 30%-32% potential plantable area, since many properties have yards that can support trees.

Table 7. Urban tree canopy and plantable area summary for each zoning district in Lakewood.

Zone	Land Area		Urban Tree Canopy			Plantable Area		
	Acres	*A%*	*Acres*	*A%*	*UTC%*	*Acres*	*A%*	*PA%*
Air Corridor 1	340.5	3%	33.4	9.8%	1.3%	70.4	21%	2.1%
Air Corridor 2	233.5	2%	49.7	21.3%	1.9%	63.3	27%	1.8%
Arterial Residential/Commercial	21.1	0%	5.1	24.3%	0.2%	5.2	25%	0.2%
Central Business District	336.7	3%	37.2	11.1%	1.4%	32.1	10%	0.9%
Clear Zone	56.8	1%	1.6	2.9%	0.1%	8.0	14%	0.2%
Commercial 1	90.2	1%	4.9	5.4%	0.2%	12.0	13%	0.4%
Commercial 2	302.9	3%	17.0	5.6%	0.6%	36.0	12%	1.0%
Commercial 3	26.2	0%	2.7	10.3%	0.1%	4.9	19%	0.1%
Industrial 1	294.9	3%	18.7	6.3%	0.7%	53.6	18%	1.6%
Industrial 2	31.8	0%	2.5	7.9%	0.1%	3.2	10%	0.1%
Industrial Business Park	436.0	4%	48.0	11.0%	1.8%	84.5	19%	2.5%
Military Lands	25.4	0%	6.1	23.9%	0.2%	9.4	37%	0.3%
Mixed Residential 1	135.5	1%	14.9	11.0%	0.6%	53.5	39%	1.6%
Mixed Residential 2	198.1	2%	46.2	23.3%	1.7%	55.4	28%	1.6%
Multifamily 1	275.6	3%	64.6	23.4%	2.4%	69.6	25%	2.0%
Multifamily 2	273.3	3%	68.9	25.2%	2.6%	72.3	26%	2.1%
Multifamily 3	185.9	2%	29.2	15.7%	1.1%	44.8	24%	1.3%
Neighborhood Commercial 1	19.4	0%	2.2	11.1%	0.1%	3.4	18%	0.1%
Neighborhood Commercial 2	268.5	2%	30.4	11.3%	1.1%	40.5	15%	1.2%
Open Space & Recreation 1	997.4	9%	344.4	34.5%	13.0%	571.0	57%	16.6%
Open Space & Recreation 2	462.4	4%	116.1	25.1%	4.4%	306.4	66%	8.9%
Public Institutional	759.1	7%	134.3	17.7%	5.1%	253.3	33%	7.4%
Residential 1	441.1	4%	212.1	48.1%	8.0%	131.1	30%	3.8%
Residential 2	576.4	5%	258.9	44.9%	9.7%	178.3	31%	5.2%
Residential 3	2,758.3	25%	833.8	30.2%	31.4%	852.3	31%	24.8%
Residential 4	1,131.2	10%	263.2	23.3%	9.9%	362.2	32%	10.6%
Right-of-Way	81.7	1%	3.6	4.4%	0.1%	15.8	19%	0.5%
Transit Oriented Commercial	148.7	1%	9.8	6.6%	0.4%	30.3	20%	0.9%
Water / Open Space/Recreation 1	11.8	0%	0.2	1.5%	0.0%	0.0	0%	0.0%
Totals	**10,920.5**	**100%**	**2,659.6**	**24.4%**	**100%**	**3431.4**	**31.4%**	**100%**

A%: Percent land, urban forest canopy area, or plantable area within each census block group.

UTC%: Percent urban forest canopy cover relative to the City total.

PA%: Percent plantable area relative to the City total.

3.5 Site-Level Planting Analysis

This planting analysis is intended to provide a map of specific actionable plantable areas in rights-of-way and public properties that Lakewood can use to assist in operations. It also provides a site-level evaluation for select properties. These highlight significant opportunities for tree planting in all evaluated areas. The plantable area layer is provided to Lakewood in GIS format for city management, and an example is shown in Figure 11.

This UFAR's plantable area calculations likely overestimate actual opportunity because no comprehensive dataset exists that can fully predict the extent of current or planned infrastructure conflicts. The accuracy of all planting analysis methodologies also rely on the accuracy of the underlying source data, which may contain limitations in both accuracy and resolution. Additionally, areas identified as physically plantable do not necessarily mean that a site is free of current or future infrastructure conflicts from sources that are not present in available databases.

Certain areas are physically plantable but have incompatible management objectives, such as golf courses and sports fields. However, there may still be opportunities to strategically increase canopy cover in select locations on or around these facilities; therefore, these areas were not removed from the analysis. Further evaluation is needed to determine plantable locations in such situations. Paved areas may also be restored for tree planting opportunities that are not represented in the plantable area analysis.

There is a considerable opportunity for tree planting across the UFAR study area, ranging from approximately 6%-100% of the evaluated sites. If planted strategically and successfully, new trees could significantly increase city-wide canopy and alleviate canopy deserts by 2050.

Public rights-of-way (ROW) were also analyzed for potential plantable areas. A total of 33% of the public ROW is identified as theoretically suitable for planting trees, but the analysis did not account for planned future City's infrastructure improvements and needs (i.e., sidewalk installation, motorized and non-motorized travelway improvements. More analysis must be done to determine a realistic percentage.

As discussed above, this UFAR did not consider the use of current or planned land use when calculating potential plantable areas. However, parks are often the most compatible area for additional tree canopy cover and can be designed to meet multi-benefit objectives. Lakewood's parks have substantial areas of open space suitable for tree planting, with some as high as 89% of plantable area. Fort Steilacoom Park was the largest evaluated park and was estimated to have 71% plantable area, providing a significant opportunity for increasing overall canopy cover.

The public institutional grounds, primarily schools, and medical facilities, were also evaluated to have high levels of potential plantable area given the size of land parcels. However, a large portion of the plantable area on school property was dedicated to sports fields and would not be compatible with tree planting.

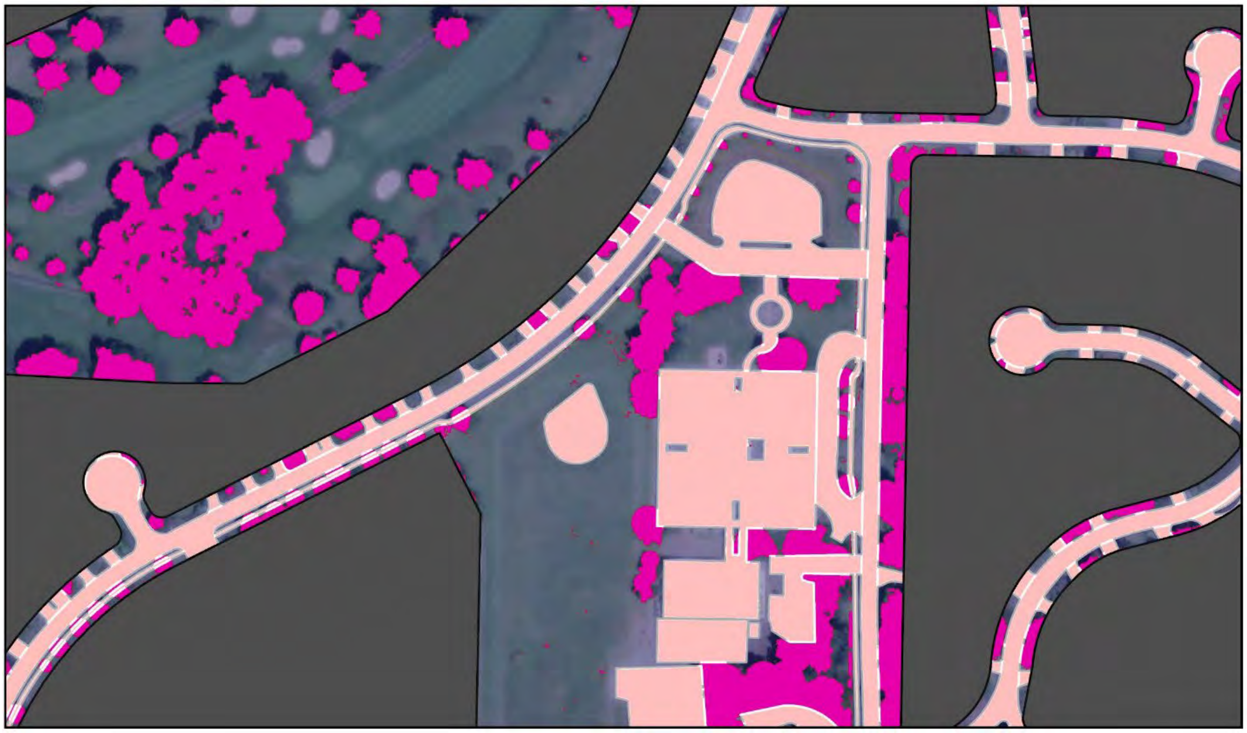

Figure 11. Example of site-level planting analysis. Dark gray areas were excluded from the analysis (e.g. private parcels). Planimetric data (light pink) and tree canopy (bright pink) were excluded as possible planting locations.

Figure 12. Comparison of plantable area available on St. Claire Hospital property (left, 18%) and in the JBLM North Clear Zone (right, 100%).

Table 8. Plantable area according to site-level analysis.

Site Name	Type	Total Area (Ac)	Plantable Area (Ac)	Percent Plantable
ROW	ROW	1,673.9	554.8	33%
Active Park	Public Parks	2.3	1.7	76%
American Lake Park	Public Parks	5.5	1.6	29%
Edgewater Park	Public Parks	2.8	2.5	89%
Fort Steilacoom Disc Golf Parcels	Public Parks	86.3	41.6	48%
Fort Steilacoom Park	Public Parks	418.7	296.8	71%
Harry Todd Park	Public Parks	16.8	5.3	31%
Kiwanis Park	Public Parks	2.9	1.4	48%
Oakbrook Park	Public Parks	1.5	0.9	59%
Ponders Park	Public Parks	0.4	0.1	33%
Primley Park	Public Parks	0.2	0.0	6%
Seeley Lake Park	Public Parks	46.8	21.4	46%
South Puget Sound Wildlife Area	Public Parks	90.6	75.6	84%
Springbrook Park	Public Parks	6.9	3.7	53%
Wards Lake Park	Public Parks	38.3	16.3	43%
Washington Park	Public Parks	3.6	2.2	61%
Clover Park High School	Public Inst. Grounds	41.2	15.1	37%
Clover Park Technical College	Public Inst. Grounds	70.7	25.2	36%
Custer Elem. & Hudtloff Mid. School	Public Inst. Grounds	36.9	23.5	64%
Dower Elementary School	Public Inst. Grounds	8.5	3.6	42%
Dr. Claudia Thomas Middle School	Public Inst. Grounds	21.5	8.5	40%
Early Learning School	Public Inst. Grounds	8.2	3.2	39%
Idlewild Elementary School	Public Inst. Grounds	9.2	4.5	49%
Lake Louise Elementary School	Public Inst. Grounds	9.0	3.8	42%
Lakes High School	Public Inst. Grounds	38.7	20.6	53%
Lakeview Hope Elementary School	Public Inst. Grounds	9.5	2.9	30%
Lochburn Middle School	Public Inst. Grounds	22.0	10.9	49%
Oakbrook Elementary School	Public Inst. Grounds	9.9	4.9	50%
Pierce College Campus	Public Inst. Grounds	40.5	14.2	35%
St. Clare Hospital Campus	Public Inst. Grounds	24.3	4.3	18%
Tillicum Elementary School	Public Inst. Grounds	5.5	2.3	43%
Tyee Park Elementary School	Public Inst. Grounds	9.9	5.9	60%
Western State Hospital	Public Inst. Grounds	214.6	94.3	44%
Lakewold Gardens	Large Ac. Private Property	9.1	3.2	35%
Oakbrook Golf Course	Large Ac. Private Property	126.9	97.4	77%
Tacoma Golf and Country Club	Large Ac. Private Property	135.4	96.7	71%
JBLM North Clear Zone	Lakewood Clear Zone JBLM	55.5	55.5	100%

3.6 Census Tracts with Less than 35% Urban Tree Canopy

Census block groups with less than 35% urban tree canopy cover were evaluated with remote sensing data for urban tree cover and other attributes including population estimates and height distribution. Of the 53 census block groups in Lakewood, 42 have urban tree canopy cover less than 35%. The average canopy cover of these groups is 19.2%, or 5.2% less than the citywide average. Data for each specified census block group in this category is provided in Appendix B. A graphic depiction of the CHM results is shown in Figure 13, indicating the center point and canopy area of each detected tree.

The relatively high abundance of small trees is indicative of a youthful population. Assuming that these trees are young rather than small-stature species, this demographic information highlights an opportunity for canopy growth over time and the presence of regeneration which can provide resilience to aging portions of the urban forest population. Note that this model excludes understory trees as well as all trees less than 10 feet in height, and therefore, is less comprehensive than information from complete tree inventories.

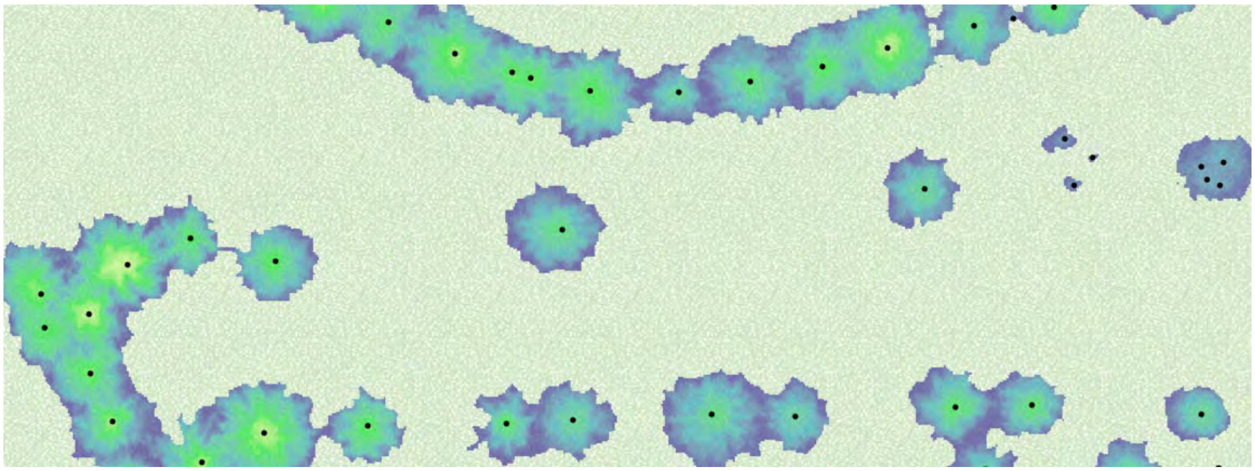

Figure 13. Canopy height model (CHM) overlayed with modeled tree top locations.

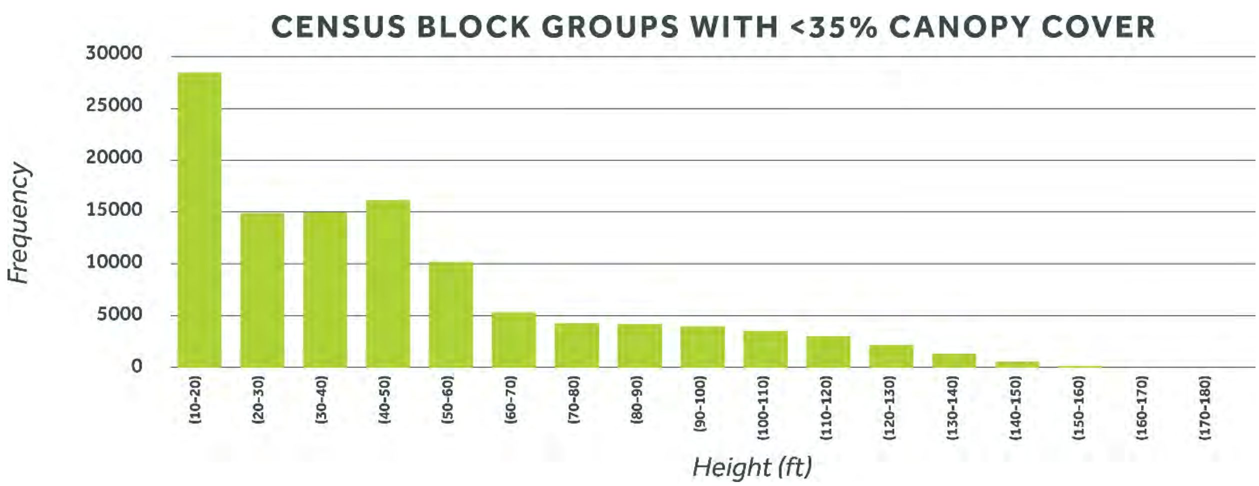

Figure 14. Tree height histogram for all census block groups with canopy cover less than 35%

3.7 Large Acreage Properties

Tree canopy cover on the evaluated large acreage public and private sites was generally greater than the City as a whole (Table 9). Lakewold Gardens, the Fort Steilacoom Disc Golf Course, and Camp Murray have notably high canopy cover because they include areas of forest and gardens. Many of these properties also have an opportunity for additional tree planting.

Table 9. Canopy cover and tree population estimate in large acreage public and private sites.

Site Name	Ownership Type	Area (ac)	Canopy Cover	Tree Count
Camp Murray	Private	211	43.1%	4,854
Fort Steilacoom Disc Golf Course	Public Park	86	49.3%	2,425
Lakewold Gardens	Private	9	57.5%	220
Meadow Park Golf Course	Private	145	28.6%	2,068
Oakbrook Golf Course	Private	127	22.9%	2,121
Tacoma Golf and Country Club	Private	135	25.1%	2,166
Western State Hospital	Public Institutional Grounds	215	28.2%	4,399

Each of the seven large-acreage parcels has a unique tree height distribution, highlighting variability in past management approaches. Tree height histograms are shown for each property in Figure 15, displaying tree height frequency in bins set at 10-foot intervals. As urban forests reach maturity, the distribution tends to flatten out over time (Morgenroth et al., 2020). Models for ideal urban forest tree distribution typically have a high proportion of smaller trees that gradually decrease relative to size (Morgenroth et al., 2020). Many of the sites have a relatively high proportion of trees between 30-60 feet in height, decline in heights between 70-100 feet, and again increase amongst the tallest trees. Site-specific management recommendations would benefit from field investigation to better understand the species composition and other tree height covariates. Some sites have a relatively small population of younger and smaller trees, which would indicate lower regenerative capacity and resilience to aging forests. Continuous planting over time also aids in increasing age diversity and urban forest resilience, in addition to regeneration.

As urban forests reach maturity, the distribution tends to flatten out over time (Morgenroth et al., 2020). Models for ideal urban forest tree distribution typically have a high proportion of smaller trees that gradually decrease relative to size (Morgenroth et al., 2020). These tree height distribution charts show a relatively small population of younger and smaller trees, which if present, would provide additional stability and resilience. As urban forest tree populations mature, Lakewood may consider replenishing young trees.

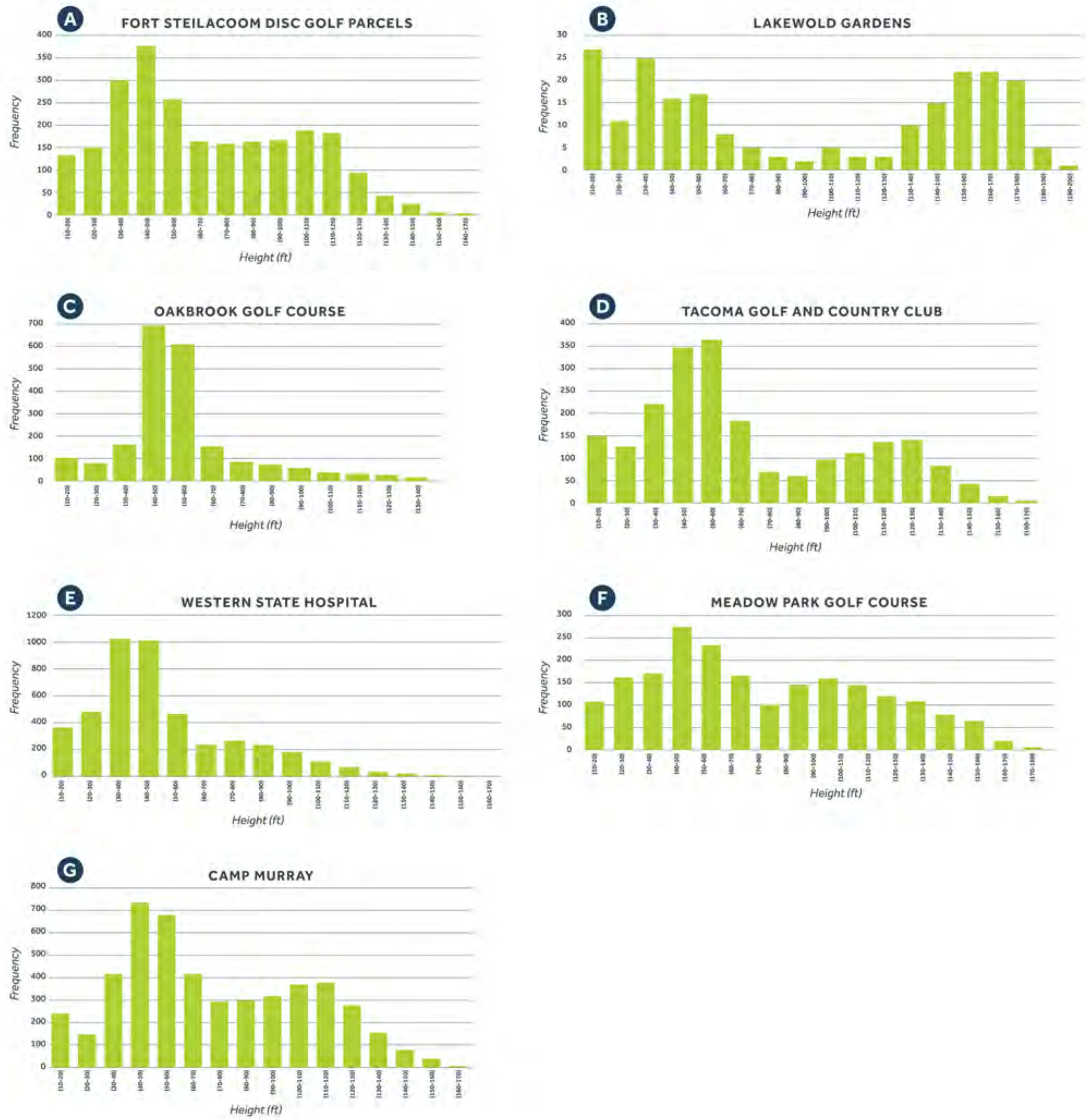

Figure 15. Tree height histogram at seven large acreage sites including (A) Fort Steilacoom Disc Golf Parcels, (B) Lakewold Gardens, (C) Oakbrook Gold Course, (D) Tacoma Golf and Country Club, (E) Western State Hospital, (F) Meadow Park Golf Course, and (G) Camp Murray.

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4. Tree Inventory Findings

The 2024 Lakewood tree inventory assessed 11,782 individual trees across public rights-of-way (ROWs), parks, and select public institutional grounds. ROWs included arterial and collector streets and all roads within public parks in the City. This section includes a summary of the findings of the tree inventory, with additional details provided in Appendix E. The number of trees inventoried at each site is shown in Table 10. See Appendix D for a map of tree inventory data collection locations.

Table 10. Number of trees inventoried at each site or type.

Site Name	Site Type	Count of Trees Inventoried
Public Rights-of-way	ROW	7,940
Active Park	Public Park	20
American Lake Park	Public Park	92
Edgewater Park	Public Park	21
Harry Todd Park	Public Park	463
Kiwanis Park	Public Park	42
Oakbrook Park	Public Park	31
Ponders Park	Public Park	32
Primley Park	Public Park	29
Springbrook Park	Public Park	132
Washington Park	Public Park	31
Utility Administration Office	Utility	1
JBLM North McChord Field	Public Institutional Grounds	3
Pierce College Campus	Public Institutional Grounds	609
Saint Clare Hospital	Public Institutional Grounds	367
Clover Park High School	Public Schools	180
Custer Elementary School	Public Schools	60
Dower Elementary School	Public Schools	147
Dr. Claudia Thomas Middle School	Public Schools	150
Early Learning Sites	Public Schools	60
Hudtloff Middle School	Public Schools	258
Idlewild Elementary school	Public Schools	160
Lake Louise Elementary School	Public Schools	208
Lakes High School	Public Schools	245
Lakeview Hope Elementary School	Public Schools	148
Lochburn Middle School	Public Schools	192
Oakbrook Elementary School	Public Schools	92
Tillicum Elementary School	Public Schools	45
Tyee Park Elementary School	Public Schools	24
Total		**11,782**

4.1 Species Diversity

Lakewood's inventoried tree population had a species richness of 161 species representing 69 genera. Species diversity in the urban tree population is vital to prevent significant losses due to an unexpected fatal pest or pathogen that moves into the region. The risk of ignoring species diversification can be costly for municipalities. Recommended diversity targets follow the 30-20-10 rule for species diversity (Plant & Kendal 2019). The rule specifies that any one species should be reflected in no more than 10% of the population, a single genus no more than 20%, and an individual tree family represents no more than 30% of the tree population.

The most abundant tree species in Lakewood were Douglas-fir (*Pseudotsuga menziesii*), Oregon white oak (*Quercus garryana*), Norway maple (*Acer platanoides*), cherry plum (*Prunus cerasifera*), and red maple (*Acer rubrum*), which together make up over half of all inventoried trees (54%). Douglas-fir and Oregon white oak, representing 30% and 11% respectively, are the only species that individually compose greater than 10% of the tree population (Figure 16).

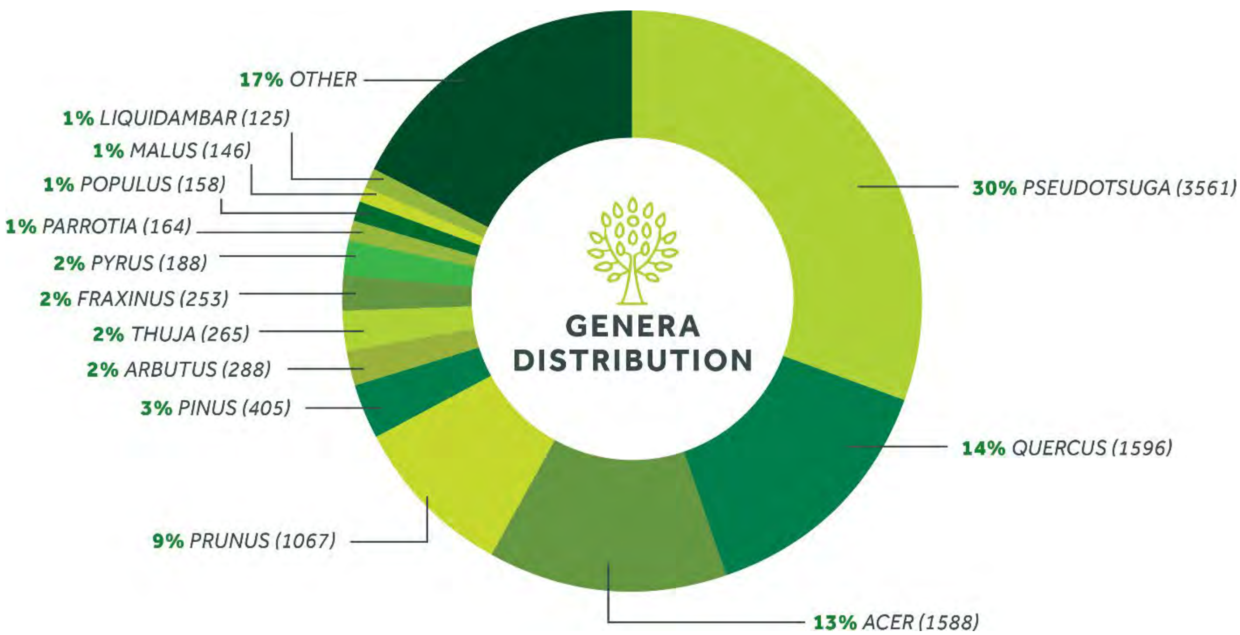

Figure 16. Genera distribution of inventoried trees, rounded to nearest percent.

Of the inventoried trees, 66% are represented by four genera, including *Pseudotsuga*, *Quercus*, *Acer*, and *Prunus* (Figure 16). With 30% of the tree population, *Pseudotsuga* is the only genus that exceeds the 20% species recommendation of the total tree population. Table 11 provides an overview of the top five genera documented during the inventory and the respective species.

In terms of species, Douglas-fir and Oregon white oak are the two species that exceed the 20% diversity recommendation. Although diversified tree populations are thought to be beneficial by increasing ecological resilience and spreading risk of environmental stresses across many different taxa, Douglas-fir and Oregon white oak are both native species and are highly valued for the ecological functions they provide.

Table 11. Five most abundant genera and respective species.

Genus	Species	Number	Percent of Total
Pseudotsuga (30%)	*Pseudotsuga menziesii*	3,561	30.2%
Quercus (14%)	*Quercus alba*	32	0.3%
	Quercus garryana	1,314	11.2%
	Quercus palustris	79	0.7%
	Quercus robur	37	0.3%
	Quercus rubra	134	1.1%
Acer (13%)	*Acer circinatum*	53	0.5%
	Acer fremanii	65	0.6%
	Acer ginnala	1	<0.1%
	Acer grandidentatum	9	0.1%
	Acer griseum	11	0.1%
	Acer macrophyllum	221	1.9%
	Acer palmatum	114	1.0%
	Acer palmatum 'Bloodgood'	2	<0.1%
	Acer platanoides	603	5.1%
	Acer platanoides 'Crimson King'	70	0.6%
	Acer rubrum	353	3.0%
	Acer saccharinum	51	0.4%
	Acer saccharum	30	0.3%
	Acer sp.	5	<0.1%
Prunus (9%)	*Prunus avium <cultivated>*	125	1.1%
	Prunus avium <wild>	78	0.7%
	Prunus cerasifera	35	0.3%
	Prunus cerasifera 'thundercloud'	496	4.2%
	Prunus domestica	1	0.0%
	Prunus emarginata	32	0.3%
	Prunus laurocerasus	47	0.4%
	Prunus lusitanica	5	<0.1%
	Prunus persica	3	<0.1%
	Prunus serrulata	183	1.6%
	Prunus sp.	49	0.4%
	Prunus sp.<flowering cherry>	10	0.1%
	Prunus sp.<fruiting cherry>	3	0.0%
Pinus (3%)	*Pinus contorta*	133	1.1%
	Pinus monticola	19	0.2%
	Pinus nigra	129	1.1%
	Pinus ponderosa	10	0.1%

Genus	Species	Number	Percent of Total
	Pinus sp.	44	0.4%
	Pinus strobus	4	<0.1%
	Pinus sylvestris	65	0.6%
	Pinus thunbergii	1	<0.1%

4.2 Tree Characteristics

4.2.1 Tree Diameter

The assessed trees had an average diameter of 14.8 inches with a maximum of 89 inches. The population was relatively evenly distributed among size classes (see Figure 17). Older and larger trees greater than 24 inches accounted for 18% of the tree population, most of which were Douglas-fir (11%) and Oregon white oak (4%). The distribution of large trees in the City is geographically variable, with substantial differences between zoning types and census tracts. The residential and open space and recreation land use zones typically had the greatest proportion of large trees, along with the Public Institutional, public ROW, and Neighborhood Commercial 1 (NC1) zones. Summary data for each of these segments is provided in Appendix E.

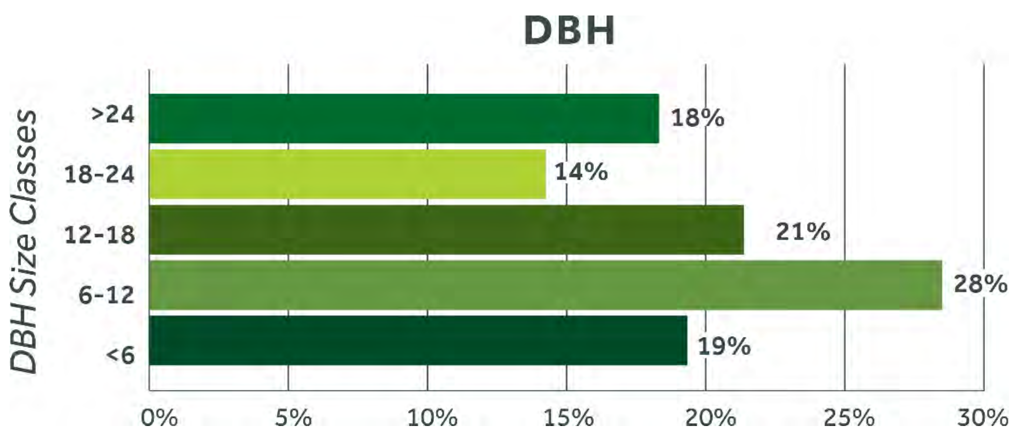

Figure 17. DBH size class distribution of inventoried trees.

4.2.2 Inventoried Tree Condition

Most trees surveyed in the inventory were in *good* condition (73%) (Figure 18). This represents a positive sign for the overall health and sustainability of the urban forest. Only 1% of trees were in *Excellent* condition. Trees assessed in *Fair* condition, with low vigor, minor dieback, or significant structural issues, accounted for 21% of the inventory. A *Fair* condition rating was given if reduced vigor and/or defoliation was due to pests or disease as well as those displaying symptoms of drought.

The remaining 4% of trees were categorized as being in a condition of *Poor*, *Very Poor*, or *Dead*, highlighting an important focal point for the City's urban forestry program. Although this represents a small portion of the overall tree population, addressing these trees is essential for maintaining the long-term health and resilience of the whole urban forest and the opportunity to further enhance the vitality of the urban canopy.

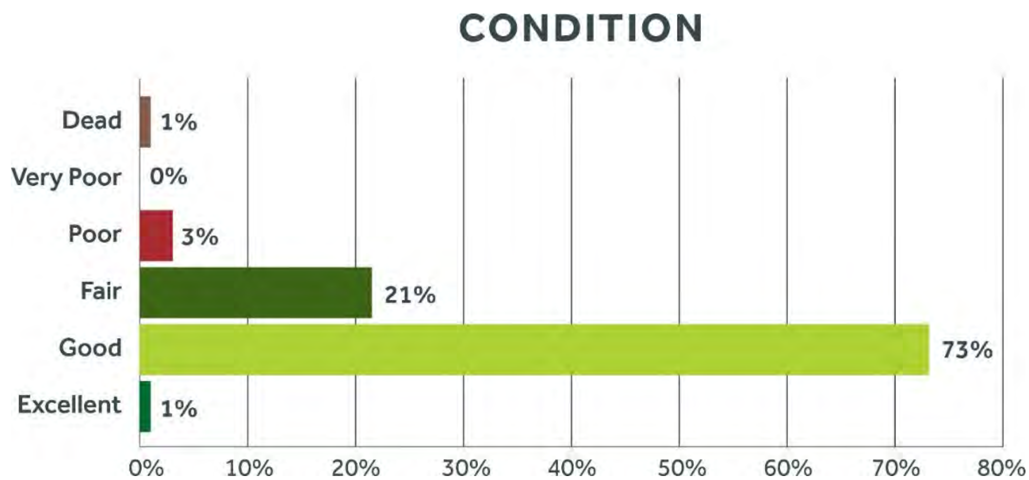

Figure 18. Condition of inventoried trees.

4.3 Tree Infrastructure Conflicts

Addressing infrastructure conflicts can lead to improved tree health, structure, and longevity. Most trees assessed during the inventory had been well maintained with few immediate pruning needs required to address canopy-related infrastructure conflicts. Most of the assessed trees are located in unrestricted landscaped areas (42%), unimproved rights-of-way (26%), or planter beds (29%). This distribution emphasizes the importance of these types of green infrastructure to support the urban forest canopy. The remaining 3% of trees were located in medians (1%) and tree wells (1%).

Facet arborists observed infrastructure conflicts in only 3% of Lakewood's trees. These include sidewalk uplift (0.8%), street uplift (0.3%), and root girdling (0.2%). The majority of tree conflicts are categorized as "other," which can include conflicts such as trees previously topped below power lines. While the proportion of infrastructure conflicts is relatively low, addressing these is essential to minimize long-term damage to infrastructure. One reason for the low infrastructure conflict result is that Lakewood is a young city; as it continues to perform needed and required work to construct public infrastructure appropriate for a city environment (i.e., sidewalks and other non-motorized transportation systems), the reality of removing trees in order to do so will affect the current tree canopy.

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5. Forest Landscape Assessment Tool (FLAT)

5.1 Tree-iage Categorization

The City of Lakewood's undeveloped natural areas range from pristine forests to prairies to areas dominated by invasive plant species. The distribution of these conditions is summarized in Figure 19, which provides the number of natural area acres within each Tree-iage category. Although each of the four sites assessed (Fort Steilacoom Park, Seeley Lake Park, Wards Lake Park, and the South Puget Sound Wildlife Area) are managed by a different landowner (e.g., city, county, and state agencies), the overall results are presented in the aggregate. Site-specific summaries are provided in Table 12 below and site-specific FLAT maps are found in Appendix G.

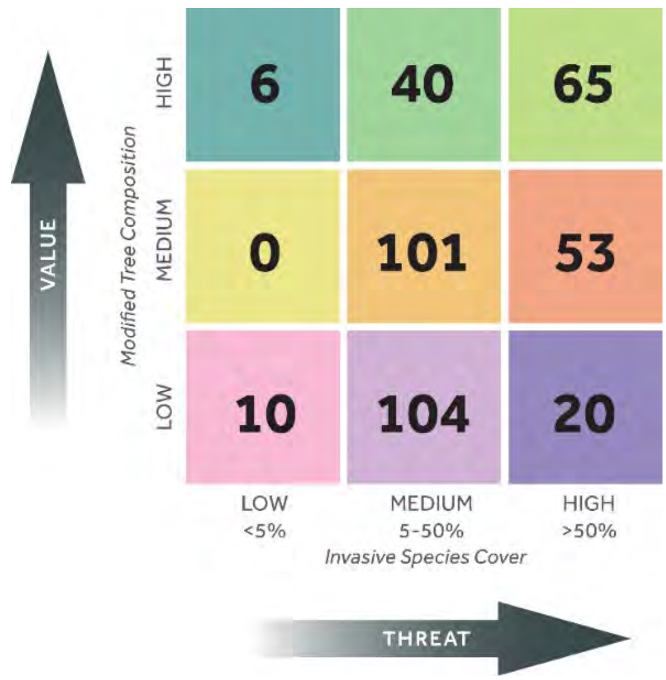

Figure 19. Total acreage for each Tree-iage category.

Of the inventoried natural areas, 28% were assessed to have an overstory composition well suited for the site and ecoregion, as represented by Categories 1-3 (See Chapter 2.4, Table 6 for a description of each tree-iage category). These include natural areas with an abundance of conifers, Pacific madrones, Oregon white oak, and wetlands that have water regimes that would not support a forested ecosystem. Only 1% of natural areas were in Category 1, which is characterized as having both the highest-ranking canopy composition and the lowest amount of invasive species coverage.

Medium-scoring habitat management units (HMUs) in Categories 5-6 represented 39% of the inventoried natural areas. These generally represented forested HMUs with a relatively high proportion of deciduous or non-native canopy species and moderate-to-high cover of invasive species. They also included areas of oak prairie ecosystems in which additional tree recovery is an objective of management plans. No HMUs were inventoried as Category 4.

Category 7-9 HMUs represent 34% of the natural area acreage had degraded or entirely deciduous forest canopies. These included areas of forest that had no conifers, madrones, native oaks, or non-forested natural areas capable of supporting forests. These HMU's also included open fields that could be restored to a forested condition. The majority of these HMUs had moderate levels of invasive species cover.

Table 12. Tree-iage acres per site

Site Name	Acres by Tree-iage Value									
	1	2	3	4	5	6	7	8	9	Total
Fort Steilacoom Park	0.0	0.0	54.1	0.0	33.8	20.8	10.2	104.2	20.1	243.3
Seely Lake Park	0.0	25.8	0.0	0.0	0.0	20.4	0.0	0.0	0.0	46.3
Wards Lake Park	0.0	11.2	10.5	0.0	0.0	12.3	0.0	0.0	0.0	34.0
South Puget Sound Wildlife Area	5.6	2.8	0.0	0.0	66.7	0.0	0.0	0.0	0.0	75.1

Invasive species were prevalent across the City, with 35% of natural areas having over 50% invasive species (see Figure 21). Additionally, 61% of open spaces had an invasive species cover between 5-50%. Only 4% of natural areas had less than 5% invasive species cover.

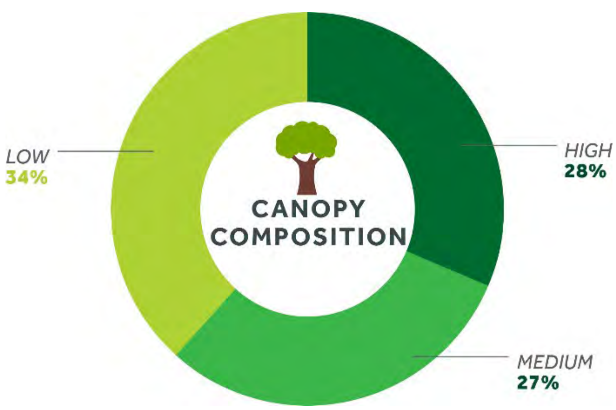

Figure 20. Canopy composition, area-weighted.

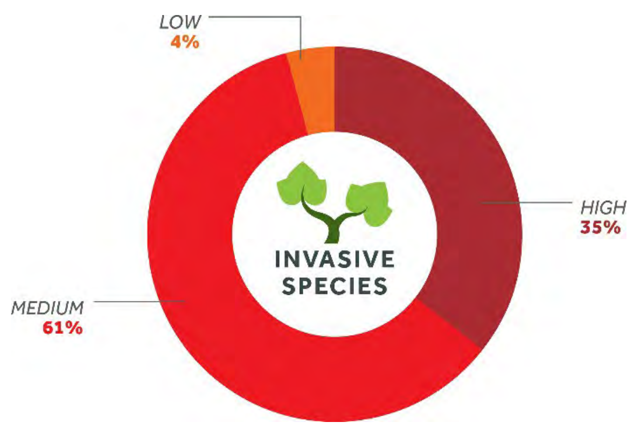

Figure 21. Invasive species cover, area-weighted.

5.2 Overstory Species Composition

Overstory species are categorized in each HMU by whether they are the most abundant, second most abundant, or third most abundant species. Douglas-fir is the most abundant species growing in Lakewood natural areas, followed by Oregon white oak and black cottonwood. Bigleaf maple, Oregon ash, black poplar, black locust, and Sitka willow are also listed as the most abundant trees in many HMUs, cumulatively 45% of all HMUs by area.

Since forests in this region were historically coniferous or oak woodlands, the assessment found a common but significant compositional shift toward early-seral deciduous and other introduced species. Such ecological shifts in urban forests underscore a need for restoration and management to improve degraded conditions where possible.

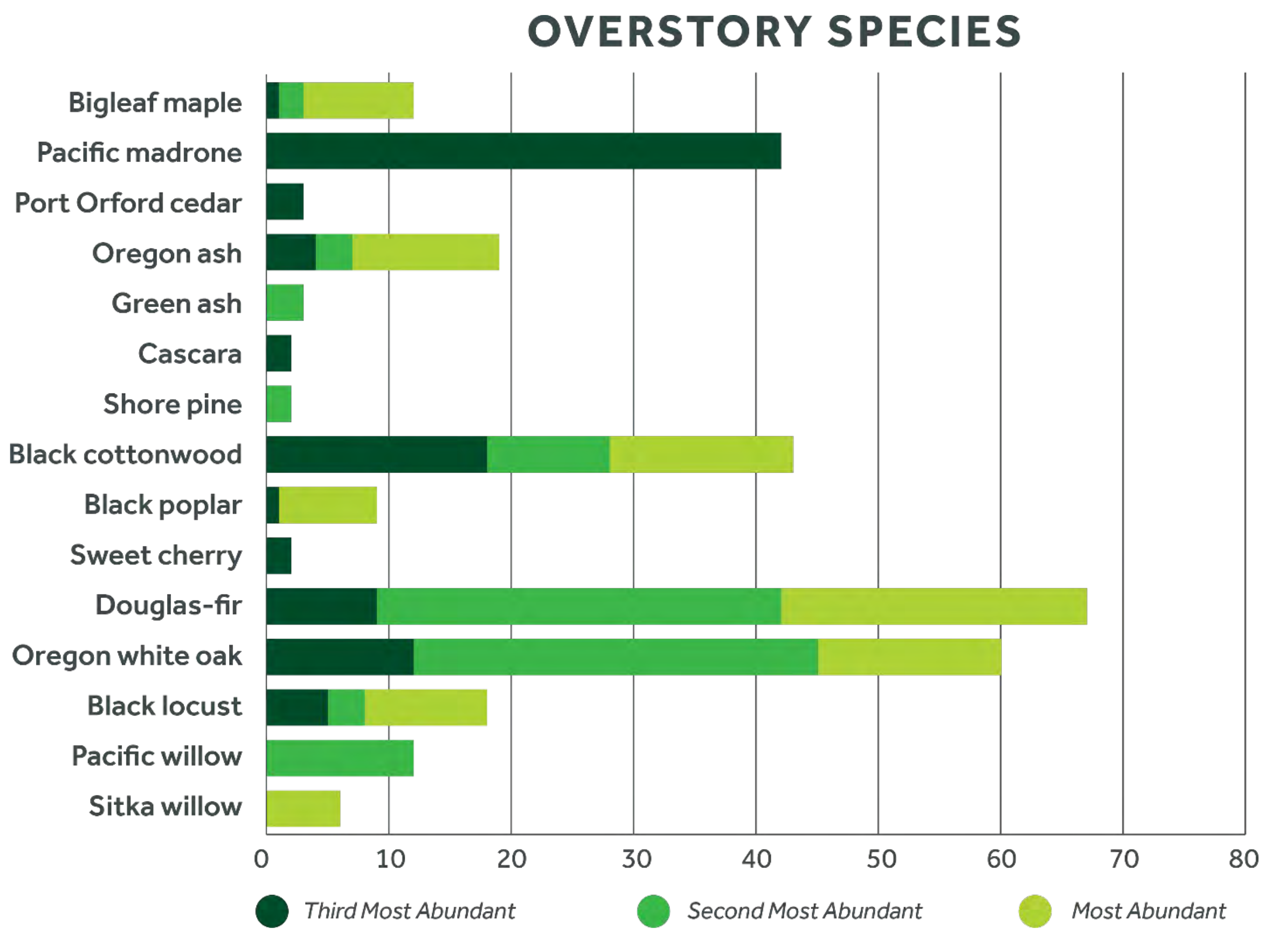

Figure 22. First, second, and third most abundant tree species per HMU-acre, area-weighted.

5.2.1 Regeneration Species

Tree regeneration was a concern for most HMUs, with 86% having a density of between 0-49 trees per acre (TPA), the lowest category. Of the 14% of sites with moderate regeneration (between 50-149 TPA) and abundant regeneration (>150 TPA), the sapling tree composition was primarily bigleaf maple and Oregon white oak. There were also significant amounts of Pacific madrone, Oregon ash, black cottonwood, Pacific willow, and western redcedar (Figure 23). Regeneration of introduced species was also observed and was not counted toward these metrics.

The relatively low levels of tree regeneration present in the assessed forests provided an indicator that management may be necessary to achieve the City's desired outcomes. Adding to the resilience of a forest, regeneration trees provide for a new generation of forest canopy trees following eventual disturbance events.

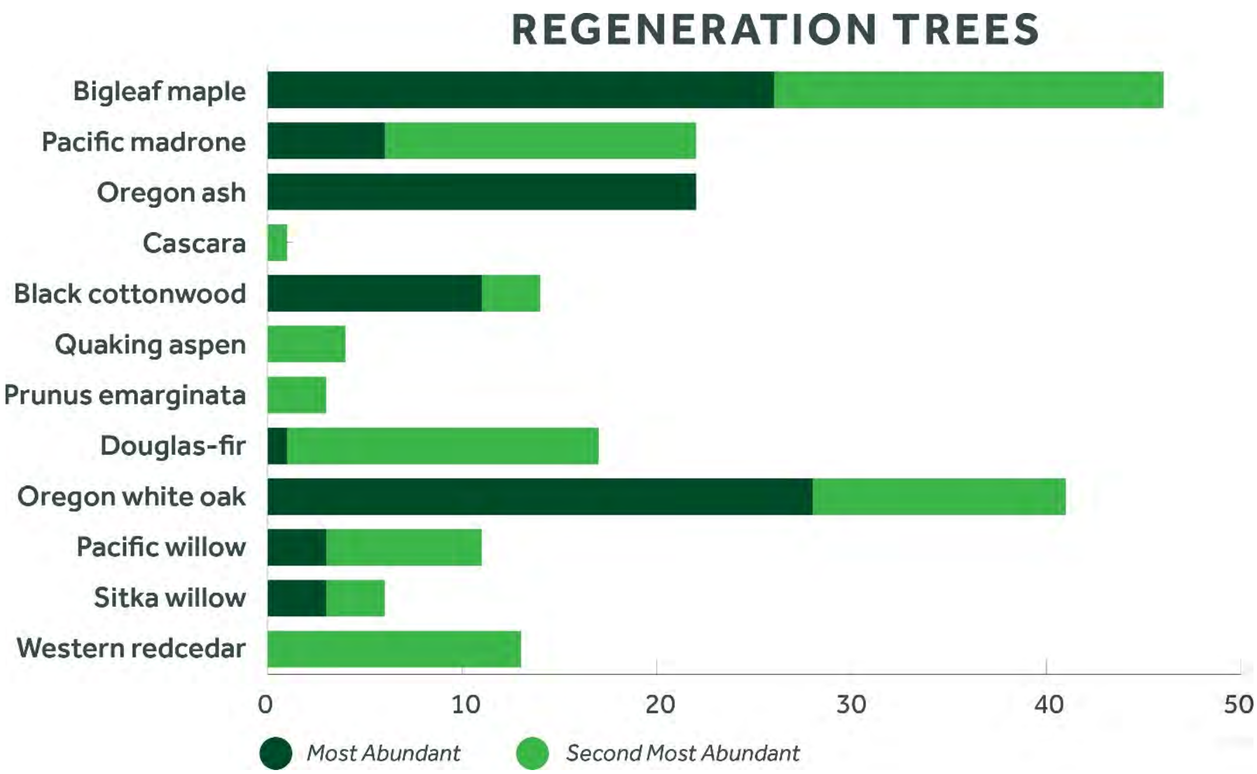

Figure 23. First and second most abundant regeneration tree species per HMU-acre, area-weighted.

5.2.2 Understory Species

The forest understory in the assessed HMUs was composed of a mix of native and invasive species. The most and second most abundant native plant species are shown in Figure 24. These are primarily common understory species that are well suited to the ecoregion, especially sword fern, osoberry, tall Oregon grape, and beaked hazelnut. Douglas spirea, cattail, red-osier dogwood, and swamp smartweed are particularly abundant in sites with large areas of wetlands.

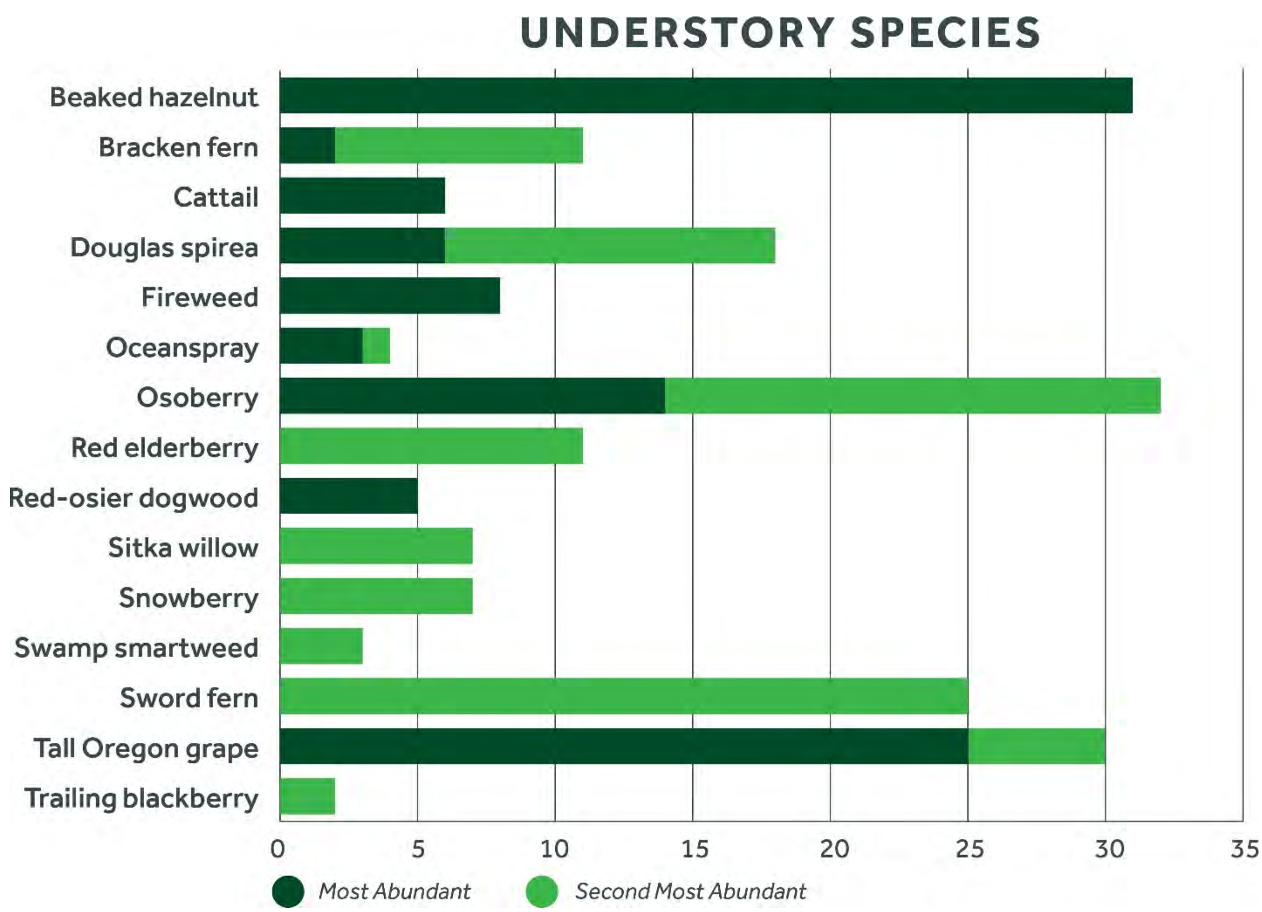

Figure 24. First and second most abundant understory species, area-weighted.

5.2.3 Invasive Species

Invasive plant species pose a significant and unique challenge in urban forest and natural area management and are labor-intensive and costly to control. Himalayan blackberry and English ivy are among the most abundant invasive plant species and pose significant threats to forests. Scotch broom, in addition to Himalayan blackberry, is particularly abundant in grasslands and shrublands. Lakewood's most, second most, and third most abundant invasive species presented in each HMU are shown in Figure 25.

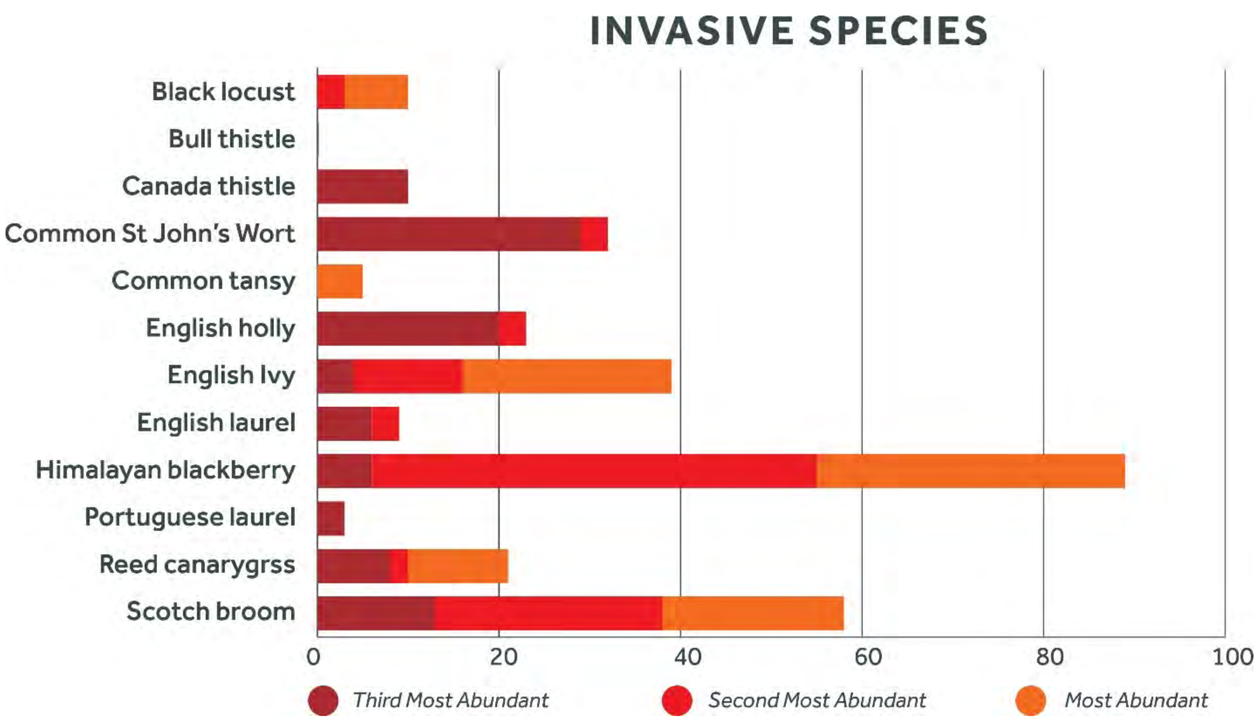

Figure 25. First, second, and third most abundant invasive species, area-weighted.

5.3 Stewardship Recommendations

The results of the FLAT inventory provide an overview of the ecological conditions of the four natural area parks based on canopy conditions and levels of invasive species cover. The stewardship strategies outlined in Table 13 are based on the FLAT data and Tree-iage categories, as well as industry best practices and on-the-ground experience of restoration professionals within the Puget Sound region. This UFAR is not intended to serve as a site-level stewardship plan, but rather a high-level summary of management approaches based on the tree-iage model.

The focus of these management approaches is the protection of existing desired overstory vegetation and the management of invasive species. Urban forests are particularly vulnerable to invasive species due to the amount of habitat fragmentation, edges, and open areas that are well suited to invasive plant introduction and colonization. Invasive plants disrupt native forests by outcompeting native understory vegetation and suppressing native tree seedlings' establishment. Without new trees to regenerate after forest disturbance, invasive trees and shrubs may eventually displace native forests.

Table 13. Management Approach per Tree-iage Category

Category	Management Approach
Category 1 Long-term Monitoring and Maintenance	Category 1 HMUs should be enrolled in a regular long-term maintenance and monitoring schedule to ensure invasive species do not re-establish significant populations on these sites or reach thresholds where invasive pressure causes loss of native understory or regenerating native canopy trees. Long-term monitoring should consist of "sweeps" through Category 1 HMUs at years 5, 10, and 20 post-enrollment of the site into active management.
Category 2 Invasive Plant Removal and Monitoring	Management is recommended to focus on more intensive invasive plant removal with additional years of follow-up removal. Initial clearing of invasive plants can be done through a combination of manual removal techniques and herbicide applications. In areas with medium invasive cover or species that are challenging to control, initial invasive removal may require more than one year of continued invasive removal maintenance.
Category 3 Intensive Invasive Plant Removal	With invasive plant cover greater than 50% and a high-value canopy, intensive invasive plant removal will be the priority for these HMUs. Due to the high level of invasive cover in the understory, invasive removal will result in significant bare ground and may require slope stabilization measures and/or mulch applications to protect exposed soils and suppress additional weed growth. Infill planting of native understory in addition to canopy tree seedlings will be needed.
Category 4 Planting, Maintenance, and Monitoring	Canopies with medium habitat composition scores that have at least 25% native canopy cover. Efforts will focus on controlling the low percentage of invasive species present. These HMUs can then be enrolled in long-term maintenance and monitoring to ensure invasive species do not re-establish on these sites or reach thresholds where they outcompete native understory plants.

Category	Management Approach
Category 5 Invasive Plant Removal and Planting	Category 5 HMUs will require intensive invasive plant removal similar to Category 2. Initial clearing of invasive plants can be done through a combination of manual removal techniques and herbicide applications. In areas with medium invasive cover or species that are challenging to control, initial invasive removal may require more than one year of initial removal. Native tree installation should be prioritized in these areas since these sites have less than 50% canopy cover.
Category 6 Intensive Invasive Plant Removal and Planting	With invasive plant cover greater than 50% and a medium-value canopy – intensive invasive plant removal will be the priority for these HMUs along with infill planting. Due to the high level of invasive cover in the understory, invasive removal will result in significant bare ground and may require slope stabilization measures and/or mulch applications to protect exposed soils and suppress additional weed growth. Infill planting of canopy species will be the priority coupled with native understory species.
Category 7 Site Assessment, Intensive Planting, and Long-term Monitoring	Given the low-quality canopy, yet low invasive threat on these sites, additional site assessment is recommended to determine the limiting factors to successful canopy establishment prior to any additional planting. It will be important to determine if issues such as historic site disturbance, soil conditions, or hydrology are impacting canopy establishment and retention.
Category 8 Invasive Plant Removal and Intensive Planting	Category 8 HMUs will require a large investment of time and resources and will be prioritized as funding becomes available. Since these acres are resource-heavy, land managers will focus efforts on managing Pierce County-regulated noxious weeds, addressing safety issues from hazardous trees, creating ivy rings as an emergency stop-gap measure to protect existing canopy, or supporting community-driven stewardship efforts. Category 8 sites will require invasive removal as well as robust planting to re-establish a sustainable assemblage of native plants and/or tree canopy.
Category 9 Intensive Invasive Plant Removal and Intensive Planting	Category 9 HMUs are the most heavily degraded and as such will require the greatest number of resources. These sites will be the lowest priority for forest or natural area management efforts but are unlikely to further degrade in the near term. Land managers should focus efforts on managing Pierce County-regulated noxious weeds, addressing safety issues from hazard trees, creating ivy rings as an emergency stop-gap measure to protect existing canopy, or supporting community-driven stewardship efforts.

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6. Public Tree Management

The practice of urban forest management is the implementation of policies, procedures, and protocols for tree planting, tree care and maintenance, and tree removal and replacement to support a healthy and sustained tree canopy. By using data about Lakewood's existing urban forest conditions to inform decisions regarding infrastructure development, land use management, and partnerships with utilities, agencies, and the public, the City ensures the work is done in support of the city's adopted urban forest and tree canopy goals.

This UFAR provides an assessment of the city's urban and community forest and is an important foundational component of the overall urban forestry management planning effort. However, it does not serve as a public tree management plan or program. The following section aims to provide information for the City's consideration regarding maintenance and management of public tree resources.

6.1 Tree Inventory Maintenance Recommendations

Below are recommendations about tree pruning needs and resolving conflicts between trees and infrastructure. The GIS data, which includes spatial information and arborist notes, provides detailed information on tree maintenance recommendations.

A proactive and structured municipal street tree maintenance program is essential to ensure the health, safety, and longevity of Lakewood's urban forest. Routine inspections should identify and address issues such as pests, diseases, and structural weaknesses early to minimize risks and costs. Regular maintenance should also be implemented to promote overall tree health and manage potential hazards. These may be prioritized in locations with high traffic, pedestrian use, or areas with potential conflicts with utilities and infrastructure.

Maintenance needs were identified for roughly 21% of the inventoried trees. Although this is a minority of the canopy, they represent a substantial workload considering the overall size of the City's urban forest canopy and will require the City to plan the use of its financial and human resources strategically. A list of tree maintenance recommendations is provided in Tables 14, 15, and 16. Lakewood's most abundant tree species were also the species identified as requiring the most maintenance.

Certain species have particularly high rates of maintenance needs; these include certain pines, magnolias, elms, English oak, European hornbeam, green ash, little leaf linden, white oak, Pacific yew, and Siberian elm. The inventory identified that 60-85% of the trees represented by these species are recommended for maintenance actions.

Although some species are known to require greater levels of care, the sample size was small for some individual species. Additionally, tree species may also be planted in groups within certain geographic locations in clusters of similar age and environmental conditions; such non-randomized sampling may not be representative of the entire population. This information should not be used to preclude the further planting of these species without evaluating their suitability for the Lakewood environment.

Table 14. Recommended tree maintenance for right-of-way trees.

Maintenance Type	Number of Trees	Notes
Raise canopy & clearance prune	483	Prune to clear ROW over sidewalks or roads.
Remove deadwood	258	Remove dead limbs.
Remove tree	154	Trees may be dead or in critical condition.
Training prune	56	Young trees need pruning to improve structure and future growth.
Side trim	25	Prune to clear ROW for sidewalks or roads.
Thin canopy	69	Prune to thin interior and competing limbs.
Grind stump	18	Grind stump of a previously removed tree.
Other	514	New trees needing stakes removed or other recommendations with details included in the notes.

Table 15. Recommended tree maintenance for city-managed parks.

Maintenance Type	Number of Trees	Notes
Raise canopy & clearance prune	14	Prune to clear ROW over sidewalks or roads.
Remove deadwood	109	Remove dead limbs.
Remove tree	34	Trees may be dead or in critical condition.
Training prune	0	Young trees need pruning to improve structure and future growth.
Side trim	0	Prune to clear ROW for sidewalks or roads.
Thin canopy	0	Prune to thin interior and competing limbs.
Grind stump	4	Grind stump of a previously removed tree.
Other	68	New trees needing stakes removed or other recommendations with details included in the notes.

Table 16. Recommended tree maintenance for public institutional grounds.*

Maintenance Type	Number of Trees	Notes
Raise canopy & clearance prune	30	Prune to clear ROW over sidewalks or roads.
Remove deadwood	235	Remove dead limbs.
Remove tree	51	Trees may be dead or in critical condition.
Training prune	0	Young trees need pruning to improve structure and future growth.
Side trim	2	Prune to clear ROW for sidewalks or roads.
Thin canopy	4	Prune to thin interior and competing limbs.
Grind stump	0	Grind stump of a previously removed tree.
Other	65	New trees needing stakes removed or other recommendations with details included in the notes.

**Sites represented in this table include Clover Lake School District and other public institutions not managed by Lakewood Public Works.*

6.2 Public Tree Asset Management

The following text is selectively excerpted and edited from a Technical Memorandum provided by Facet to the City of Lakewood on November 20, 2024. The memorandum summarized a work session held by the Facet and City project team that identified the City's data management objectives, assessed current staffing capacity, examined budget considerations, and identified available asset management tools. See Appendix H for the complete memorandum.

> *"Within the urban forest, public trees function as green infrastructure assets that provide a wide range of community benefits. Yet unlike most infrastructure assets, the value of trees appreciates over time. This is further justification to measure and proactively manage public trees for optimal condition and longevity, and to minimize risk to property and people.*
>
> *Many jurisdictions integrate their public individual tree data directly into a maintenance management system (MMS) such as Hansen, Cityworks, or PubWorks, developed to manage infrastructure assets such as light posts, fire hydrants, or sidewalks. However, unlike static assets, trees are dynamic biological organisms with attributes that change over time, such as health and condition, trunk diameter, and canopy spread. The maintenance status and needs of the tree are also tracked within the MMS and may include specific maintenance tasks such as clearance pruning, planting needed, stump removal, and removal of the tree. Some tree management software programs have been specifically designed to efficiently record and track these changes with other features, such as distributing workloads and strategically prioritizing tree pruning, removal, inspections, and other activities to meet certain management objectives. Many tree software systems interface with ESRI/GIS maps and can integrate with existing municipal maintenance management systems like Cityworks, customer service systems such as 311, and even social media platforms."*

The 2024 Lakewood urban forest assessment is a critical first phase in the development of the City's urban forestry program and the shift from a reactive to a more proactive form of tree management. In concert with the information gathered during the tree asset management consultation and work session, the results of this urban forest assessment can be used to inform the City's financial and other resource planning to implement its urban forestry and canopy cover goals in 2025 and beyond.

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APPENDIX A. Census Block Group Data

Census Tract and Block Group	Mean HH Income	Tree Equity	Land Area		Urban Tree Canopy			Plantable Area		
			Acres	*A%*	*Acres*	*A%*	*UTC%*	*Acres*	*A%*	*PA%*
071703 Block Group 1	54,828	65	6.9	0.1%	0.6	7.9%	0.0%	6.9	50.3%	0.1%
071704 Block Group 1	41,012	63	120.1	1.1%	7.6	6.3%	0.3%	120.1	17.2%	1.1%
071706 Block Group 1	50,403	71	157.9	1.4%	9.6	6.1%	0.4%	157.9	16.4%	1.4%
071803 Block Group 1	136,548	78	466.9	4.3%	94.9	20.3%	3.6%	466.9	47.2%	4.3%
071803 Block Group 2	59,539	76	334.0	3.1%	35.8	10.7%	1.3%	334.0	37.4%	3.1%
071803 Block Group 3	57,803	87	72.6	0.7%	21.3	29.4%	0.8%	72.6	29.2%	0.7%
071803 Block Group 4	95,625	91	71.8	0.7%	14.4	20.1%	0.5%	71.8	23.8%	0.7%
071805 Block Group 1	68,024	68	82.5	0.8%	6.6	8.1%	0.2%	82.5	22.5%	0.8%
071805 Block Group 2	72,078	68	103.6	0.9%	9.0	8.7%	0.3%	103.6	34.1%	0.9%
071805 Block Group 3	50,789	69	147.2	1.3%	15.6	10.6%	0.6%	147.2	20.0%	1.3%
071806 Block Group 1	51,429	67	214.8	2.0%	29.8	13.9%	1.1%	214.8	21.6%	2.0%
071806 Block Group 2	75,177	74	204.4	1.9%	41.8	20.4%	1.6%	204.4	40.1%	1.9%
071807 Block Group 1	62,586	100	617.8	5.7%	74.4	12.1%	2.8%	617.8	14.3%	5.7%
071807 Block Group 2	64,063	80	429.6	3.9%	50.9	11.8%	1.9%	429.6	22.1%	3.9%
071808 Block Group 1	63,998	80	116.5	1.1%	15.8	13.6%	0.6%	116.5	20.9%	1.1%
071808 Block Group 2	70,592	77	263.7	2.4%	62.4	23.7%	2.3%	263.7	25.7%	2.4%
071808 Block Group 3	38,551	77	92.2	0.8%	12.2	13.2%	0.5%	92.2	22.9%	0.8%
071901 Block Group 1	68,399	76	423.1	3.9%	58.9	13.9%	2.2%	423.1	18.9%	3.9%
071901 Block Group 2	48,719	80	126.4	1.2%	17.1	13.5%	0.6%	126.4	31.7%	1.2%
071901 Block Group 3	103,269	90	195.9	1.8%	30.7	15.7%	1.2%	195.9	41.8%	1.8%
071901 Block Group 4	n/a	n/a	280.5	2.6%	97.5	34.8%	3.7%	280.5	32.3%	2.6%
071902 Block Group 1	100,043	86	208.1	1.9%	59.4	28.5%	2.2%	208.1	30.5%	1.9%
071902 Block Group 2	86,458	91	144.7	1.3%	42.8	29.6%	1.6%	144.7	28.7%	1.3%
071902 Block Group 3	n/a	100	231.1	2.1%	90.2	39.0%	3.4%	231.1	25.2%	2.1%
071902 Block Group 4	250,000+	95	239.1	2.2%	113.0	47.3%	4.3%	239.1	28.8%	2.2%
071902 Block Group 5	n/a	n/a	691.1	6.3%	262.9	38.0%	9.9%	691.1	38.0%	6.3%
072000 Block Group 1	46,566	64	177.5	1.6%	24.8	14.0%	0.9%	177.5	25.7%	1.6%
072000 Block Group 2	42,277	76	168.1	1.5%	35.7	21.2%	1.3%	168.1	30.3%	1.5%
072000 Block Group 3	64,457	82	209.9	1.9%	53.1	25.3%	2.0%	209.9	24.8%	1.9%
072000 Block Group 4	n/a	n/a	106.1	1.0%	23.1	21.8%	0.9%	106.1	26.8%	1.0%
072105 Block Group 1	151,094	88	130.9	1.2%	25.8	19.7%	1.0%	130.9	29.0%	1.2%
072105 Block Group 2	118,289	90	378.7	3.5%	110.2	29.1%	4.1%	378.7	41.2%	3.5%
072105 Block Group 3	128,068	93	213.6	2.0%	55.0	25.7%	2.1%	213.6	41.3%	2.0%
072105 Block Group 4	69,776	96	337.5	3.1%	153.9	45.6%	5.8%	337.5	30.2%	3.1%
072106 Block Group 1	92,500	100	203.1	1.9%	83.5	41.1%	3.1%	203.1	22.9%	1.9%
072106 Block Group 2	84,667	86	349.6	3.2%	126.9	36.3%	4.8%	349.6	38.4%	3.2%
072106 Block Group 3	39,176	81	211.4	1.9%	38.3	18.1%	1.4%	211.4	28.2%	1.9%
072106 Block Group 4	56,964	87	75.4	0.7%	11.4	15.1%	0.4%	75.4	20.7%	0.7%
072107 Block Group 1	99,078	91	149.8	1.4%	31.0	20.7%	1.2%	149.8	34.7%	1.4%
072107 Block Group 2	124,219	95	282.2	2.6%	105.3	37.3%	4.0%	282.2	32.0%	2.6%
072107 Block Group 3	98,083	88	150.3	1.4%	53.1	35.3%	2.0%	150.3	30.7%	1.4%
072107 Block Group 4	n/a	n/a	593.7	5.4%	150.2	25.3%	5.7%	593.7	54.9%	5.4%
072108 Block Group 1	83,750	92	259.4	2.4%	95.7	36.9%	3.6%	259.4	32.0%	2.4%
072108 Block Group 2	97,232	81	133.1	1.2%	27.1	20.4%	1.0%	133.1	33.1%	1.2%
072108 Block Group 3	89,794	84	122.0	1.1%	36.6	30.0%	1.4%	122.0	31.6%	1.1%
072108 Block Group 4	85,540	86	148.1	1.4%	37.2	25.1%	1.4%	148.1	29.1%	1.4%

Census Tract and Block Group	Mean HH Income	Tree Equity	Land Area		Urban Tree Canopy			Plantable Area		
			Acres	*A%*	*Acres*	*A%*	*UTC%*	*Acres*	*A%*	*PA%*
072108 Block Group 5	n/a	n/a	132.2	1.2%	32.8	24.8%	1.2%	132.2	32.6%	1.2%
072109 Block Group 2	81,111	88	1.2	0.0%	0.1	7.7%	0.0%	1.2	21.0%	0.0%
072112 Block Group 1	94,875	86	159.8	1.5%	28.9	18.1%	1.1%	159.8	28.8%	1.5%
072112 Block Group 2	142,095	84	25.8	0.2%	4.0	15.5%	0.2%	25.8	43.2%	0.2%
072112 Block Group 3	75,735	85	140.2	1.3%	35.9	25.6%	1.4%	140.2	35.3%	1.3%
072308 Block Group 4	n/a	n/a	7.2	0.1%	3.3	46.2%	0.1%	7.2	27.3%	0.1%
072312 Block Group 1	105,273	92	0.7	0.0%	0.6	80.5%	0.0%	0.7	9.1%	0.0%
Totals			**10910.1**	**100%**	**2658.9**	**24.4%**	**100%**	**10910.1**	**31.4%**	**100%**

A%: Percent land, urban forest canopy area, or plantable area within each census block group.

UTC%: Percent urban forest canopy cover relative to the City total.

PA%: Percent plantable area relative to the City total.

Tree Equity: Scores provided by American Forests, obtained December 2024.

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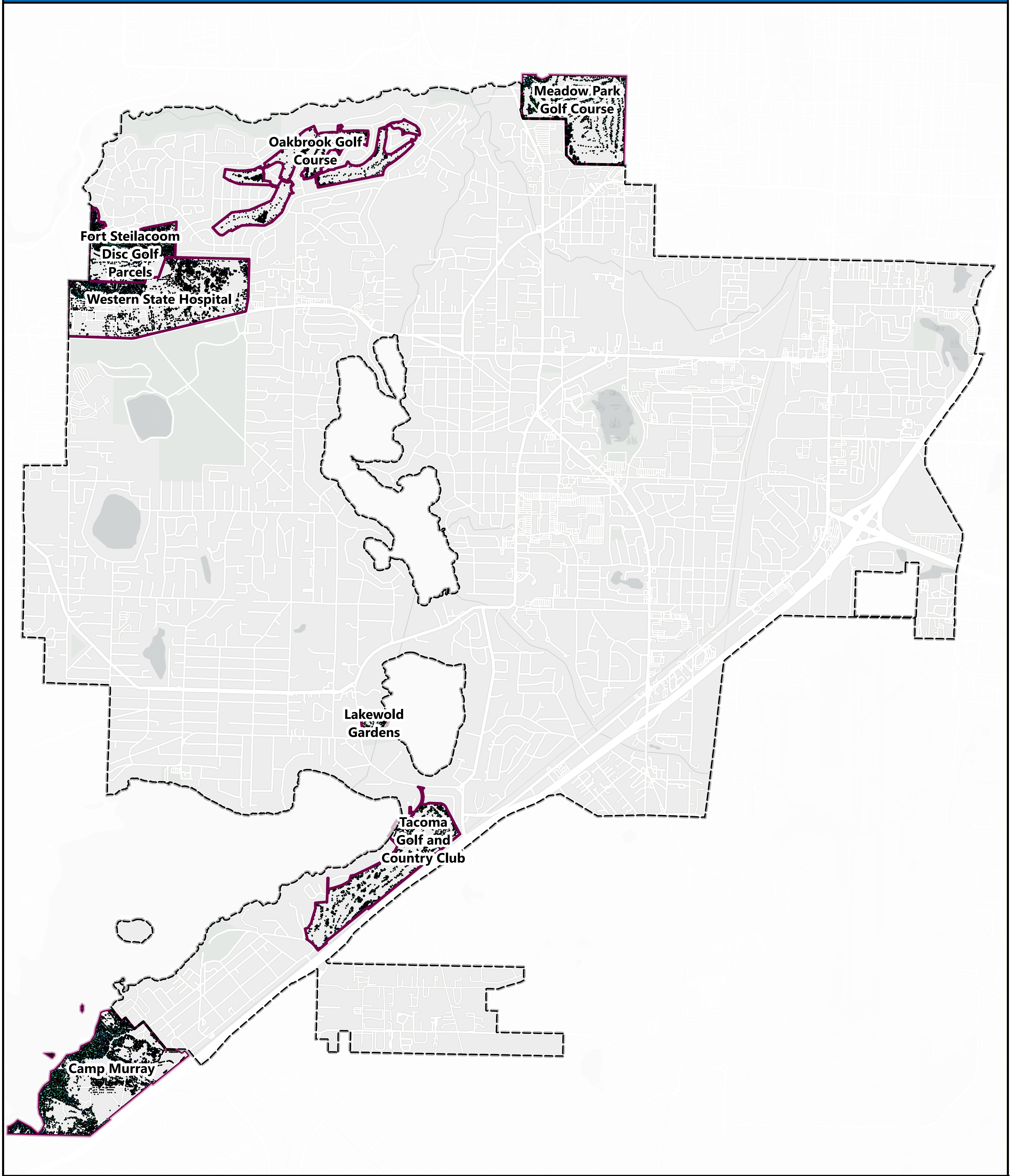
APPENDIX B. Canopy Height Model Results for Census Block Groups with <35% UTC

Census Block Group	GEOID	Area (ac)	Canopy Cover (%)	Tree Count
071703 Block Group 1	530530717031	6.9	7.90%	62
071704 Block Group 1	530530717041	120.1	6.30%	695
071706 Block Group 1	530530717061	157.9	6.10%	1,003
071803 Block Group 1	530530718031	466.9	20.30%	7,302
071803 Block Group 2	530530718032	334	10.70%	3,587
071803 Block Group 3	530530718033	72.6	29.40%	1,699
071803 Block Group 4	530530718034	71.8	20.10%	1,036
071805 Block Group 1	530530718051	82.5	8.10%	637
071805 Block Group 2	530530718052	103.6	8.70%	814
071805 Block Group 3	530530718053	147.2	10.60%	1,405
071806 Block Group 1	530530718061	214.8	13.90%	1,994
071806 Block Group 2	530530718062	204.4	20.40%	3,125
071807 Block Group 1	530530718071	617.8	12.10%	7,284
071807 Block Group 2	530530718072	429.6	11.80%	4,314
071808 Block Group 1	530530718081	116.5	13.60%	1,280
071808 Block Group 2	530530718082	263.7	23.70%	4,295
071808 Block Group 3	530530718083	92.2	13.20%	1,046
071901 Block Group 1	530530719011	423.1	13.90%	5,513
071901 Block Group 2	530530719012	126.4	13.50%	1,429
071901 Block Group 3	530530719013	195.9	15.70%	2,535
071901 Block Group 4	530530719014	280.5	34.80%	5,385
071902 Block Group 1	530530719021	208.1	28.50%	3,964
071902 Block Group 2	530530719022	144.7	29.60%	2,836
072000 Block Group 1	530530720001	177.5	14.00%	1,891
072000 Block Group 2	530530720002	168.1	21.20%	2,276
072000 Block Group 3	530530720003	209.9	25.30%	3,580
072000 Block Group 4	530530720004	106.1	21.80%	1,870
072105 Block Group 1	530530721051	130.9	19.70%	2,194
072105 Block Group 2	530530721052	378.7	29.10%	7,459
072105 Block Group 3	530530721053	213.6	25.70%	4,116
072106 Block Group 3	530530721063	211.4	18.10%	3,024
072106 Block Group 4	530530721064	75.4	15.10%	1,039
072107 Block Group 1	530530721071	149.8	20.70%	2,165
072107 Block Group 4	530530721074	593.7	25.30%	10,006
072108 Block Group 2	530530721082	133.1	20.40%	1,938
072108 Block Group 3	530530721083	122	30.00%	2,320
072108 Block Group 4	530530721084	148.1	25.10%	2,479
072108 Block Group 5	530530721085	132.2	24.80%	2,089
072109 Block Group 2	530530721092	1.2	7.70%	18
072112 Block Group 1	530530721121	159.8	18.10%	1,889
072112 Block Group 2	530530721122	25.8	15.50%	290
072112 Block Group 3	530530721123	140.2	25.60%	2,183
Total		**8158.9**	**19.2%**	**116,066**

APPENDIX C. Canopy Height Model Maps for Large Acreage Properties

LAKEWOOD CHM - OVERVIEW



LAKEWOOD APPENDIX MAPS

LAYERS

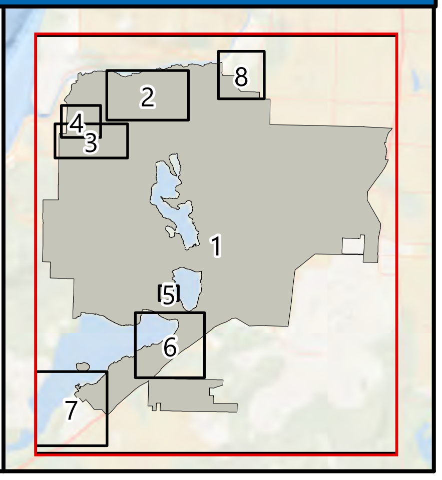
City Boundary
Site Boundary
Tree Canopy Tops

Canopy Height

200 ft

Surface

0 2,000 4,000 Feet



Print Date: 1/24/2025

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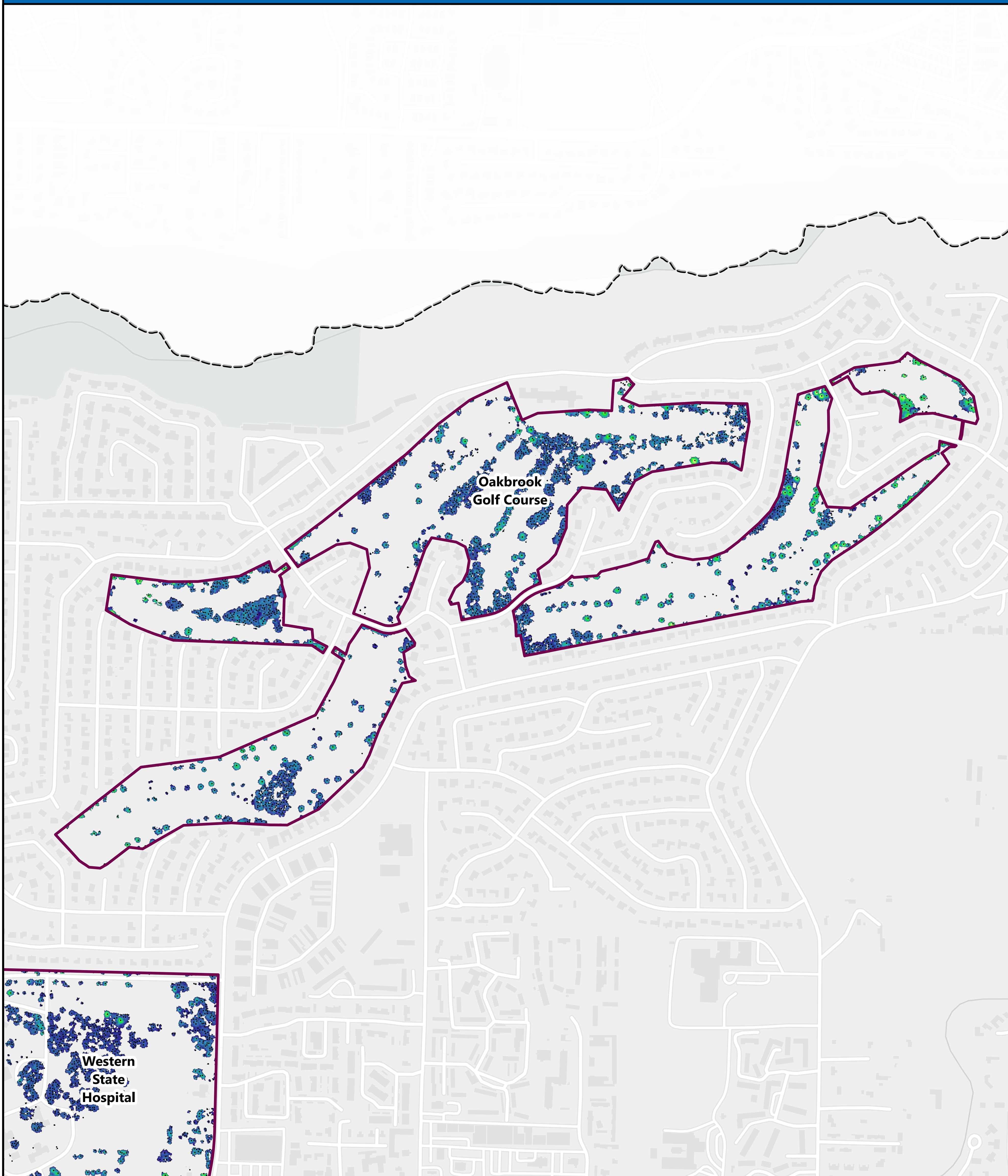
LAKEWOOD CHM - OAKBROOK GOLF COURSE



LAKEWOOD APPENDIX MAPS

LAYERS

City Boundary

Site Boundary

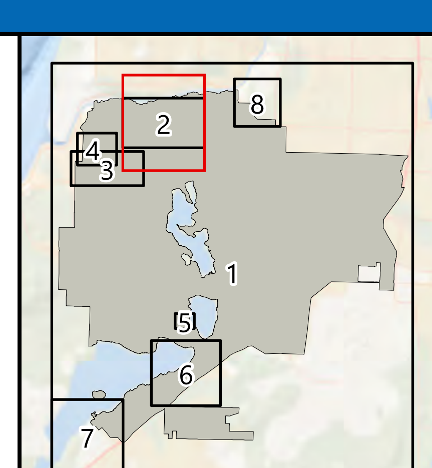
Tree Canopy Tops

Canopy Height

200 ft

Surface

0 540 1,080 Feet



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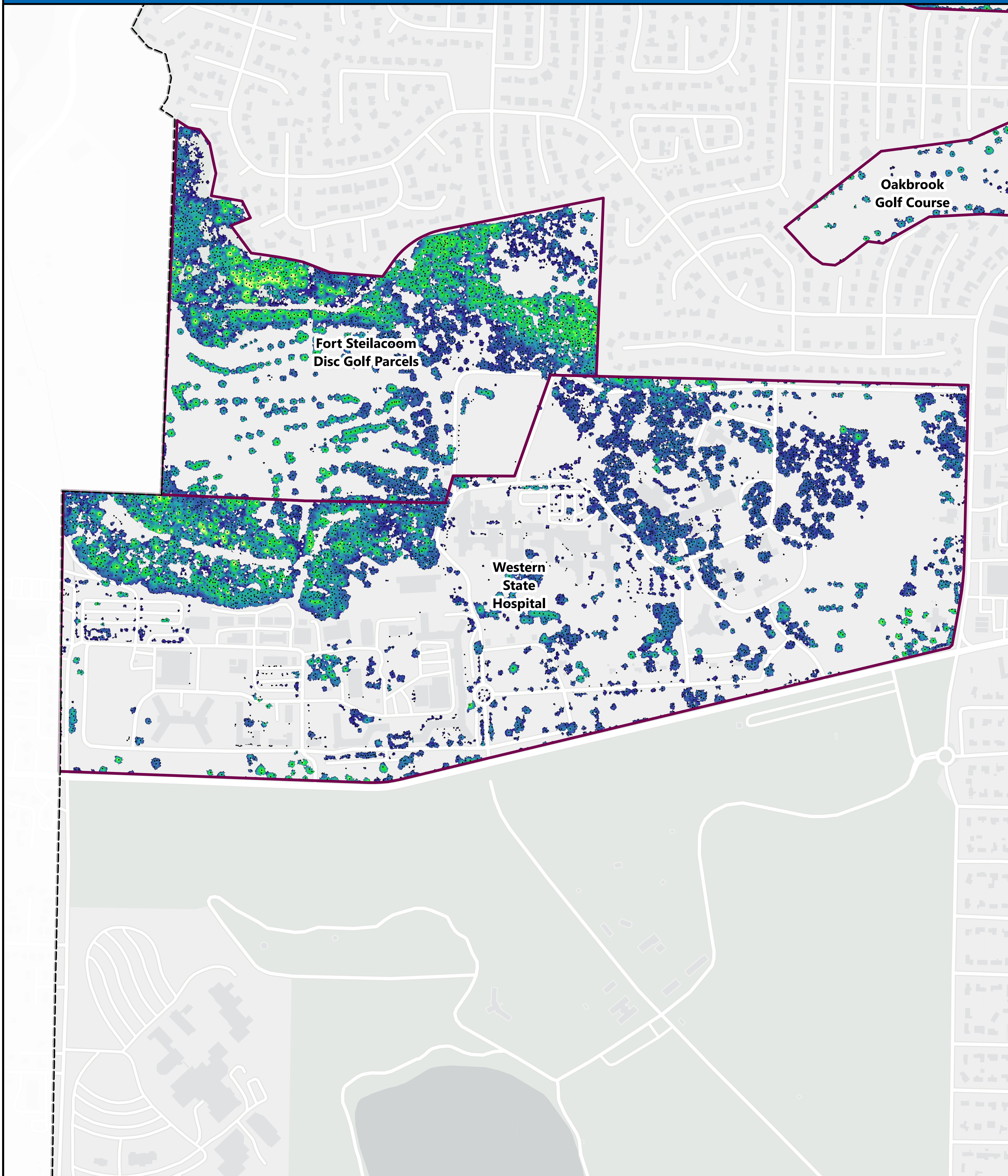
LAKEWOOD CHM - WESTERN STATE HOSPITAL



LAKEWOOD APPENDIX MAPS

LAYERS

City Boundary

Site Boundary

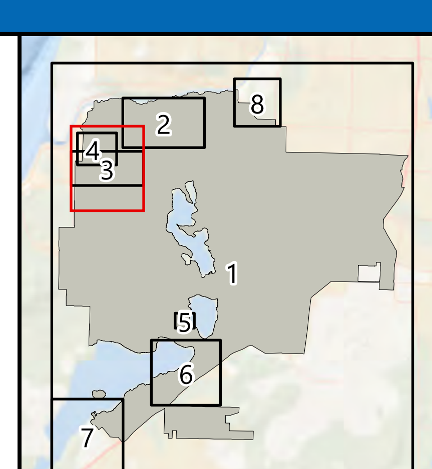
Tree Canopy Tops

Canopy Height

200 ft

Surface

0 480 960 Feet



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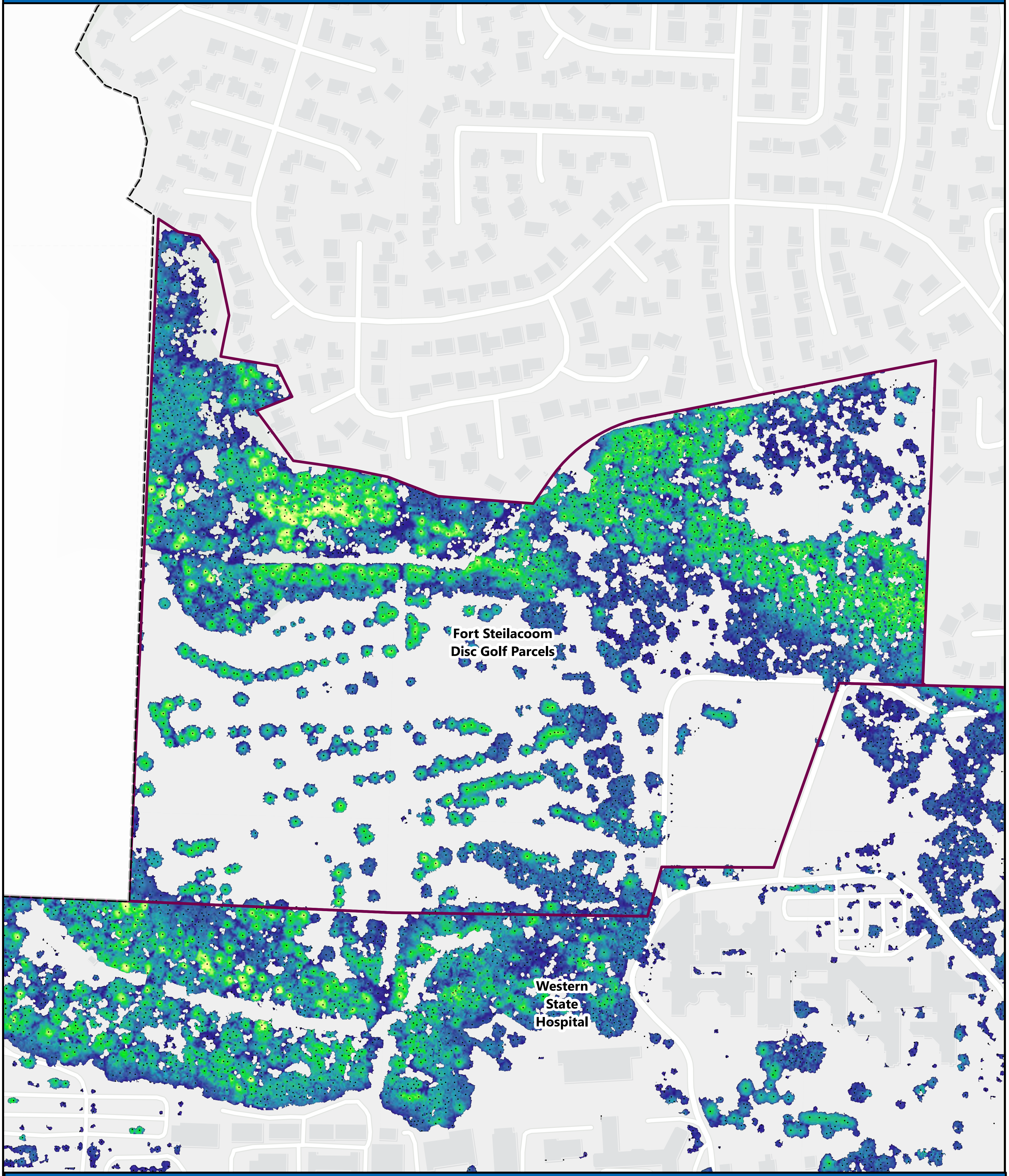
LAKEWOOD CHM - FORT STEILACOOM DISC GOLF



LAKEWOOD APPENDIX MAPS

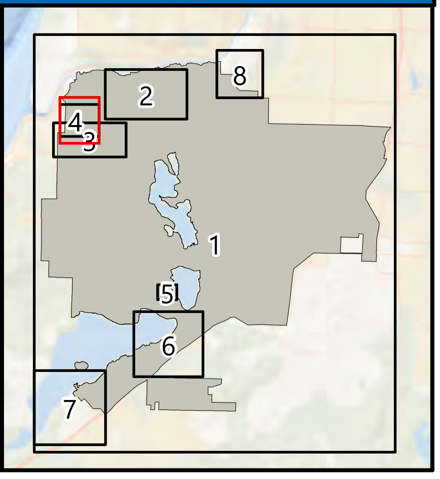
LAYERS

City Boundary
Site Boundary
Tree Canopy Tops

Canopy Height

200 ft
Surface

0 260 520 Feet



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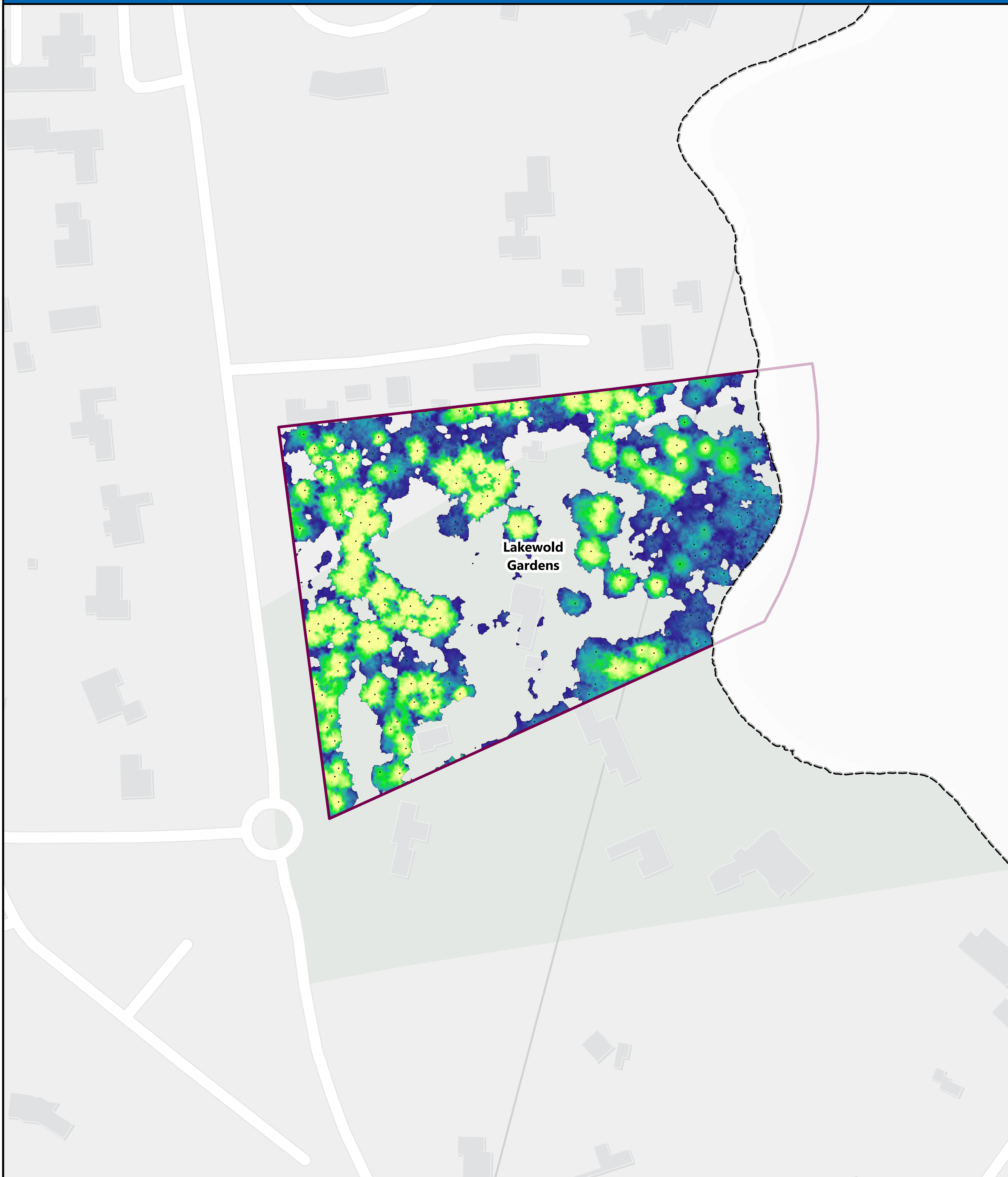
LAKEWOOD CHM - LAKEWOLD GARDENS



LAKEWOOD APPENDIX MAPS

LAYERS

City Boundary

Site Boundary

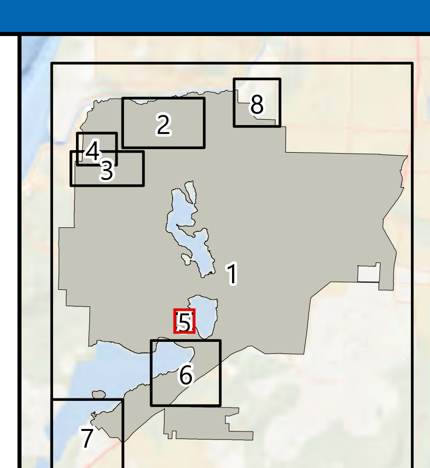
Tree Canopy Tops

Canopy Height

200 ft

Surface

0 125 250 Feet



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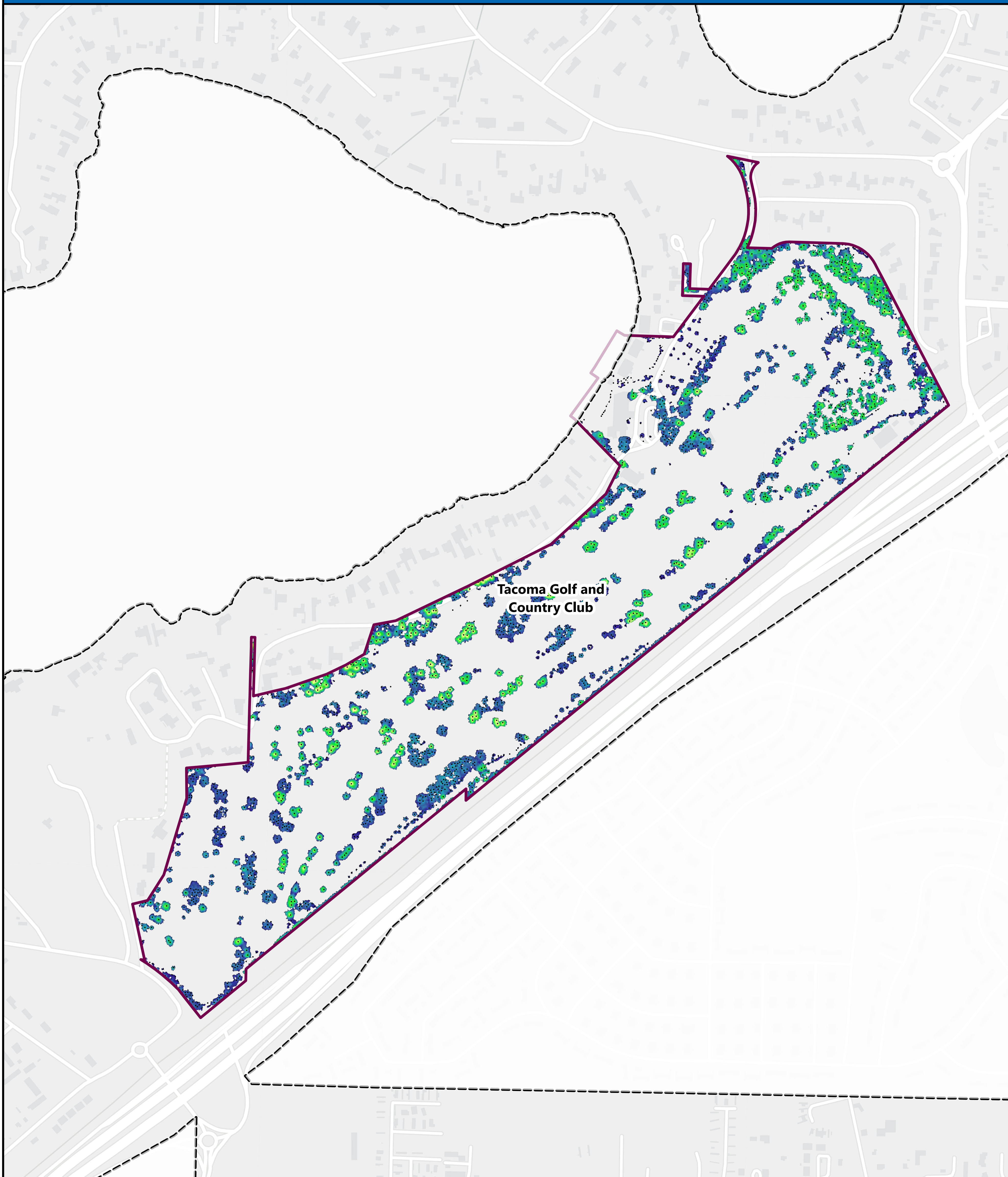
LAKEWOOD CHM - TACOMA GOLF & COUNTRY CLUB



LAKEWOOD APPENDIX MAPS

LAYERS

City Boundary

Site Boundary

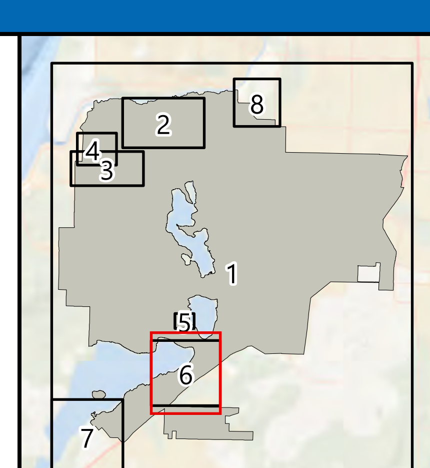
Tree Canopy Tops

Canopy Height

200 ft

Surface

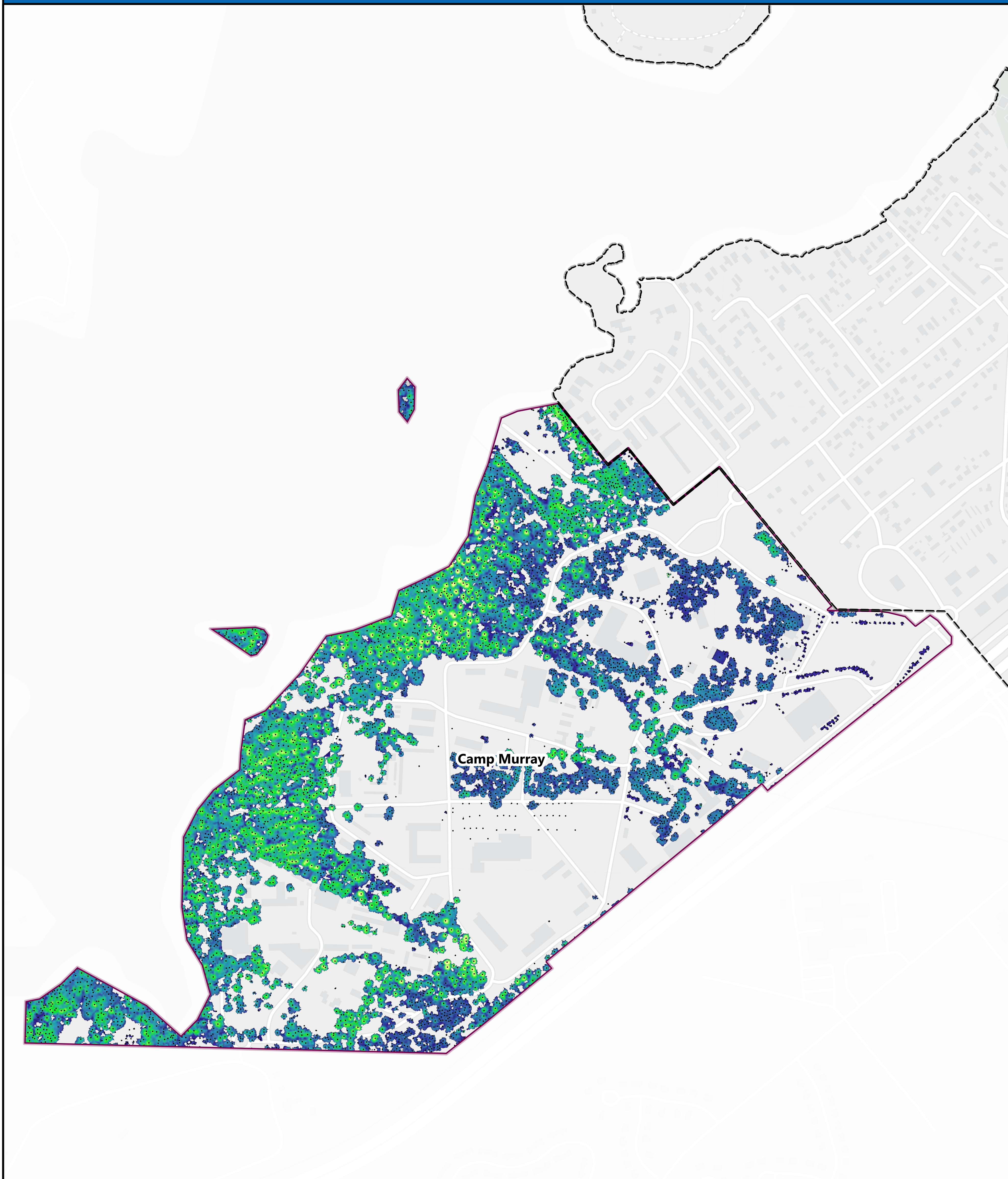
0 460 920 Feet



Print Date: 1/24/2025

FACET

LAKEWOOD CHM - CAMP MURRAY



LAKEWOOD APPENDIX MAPS

LAYERS

City Boundary

Site Boundary

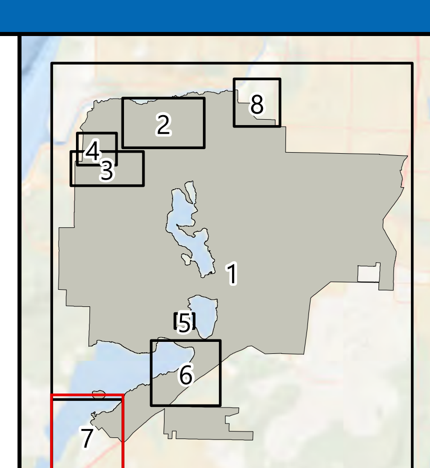
Tree Canopy Tops

Canopy Height

200 ft

Surface

0 470 940 Feet



Print Date: 1/24/2025

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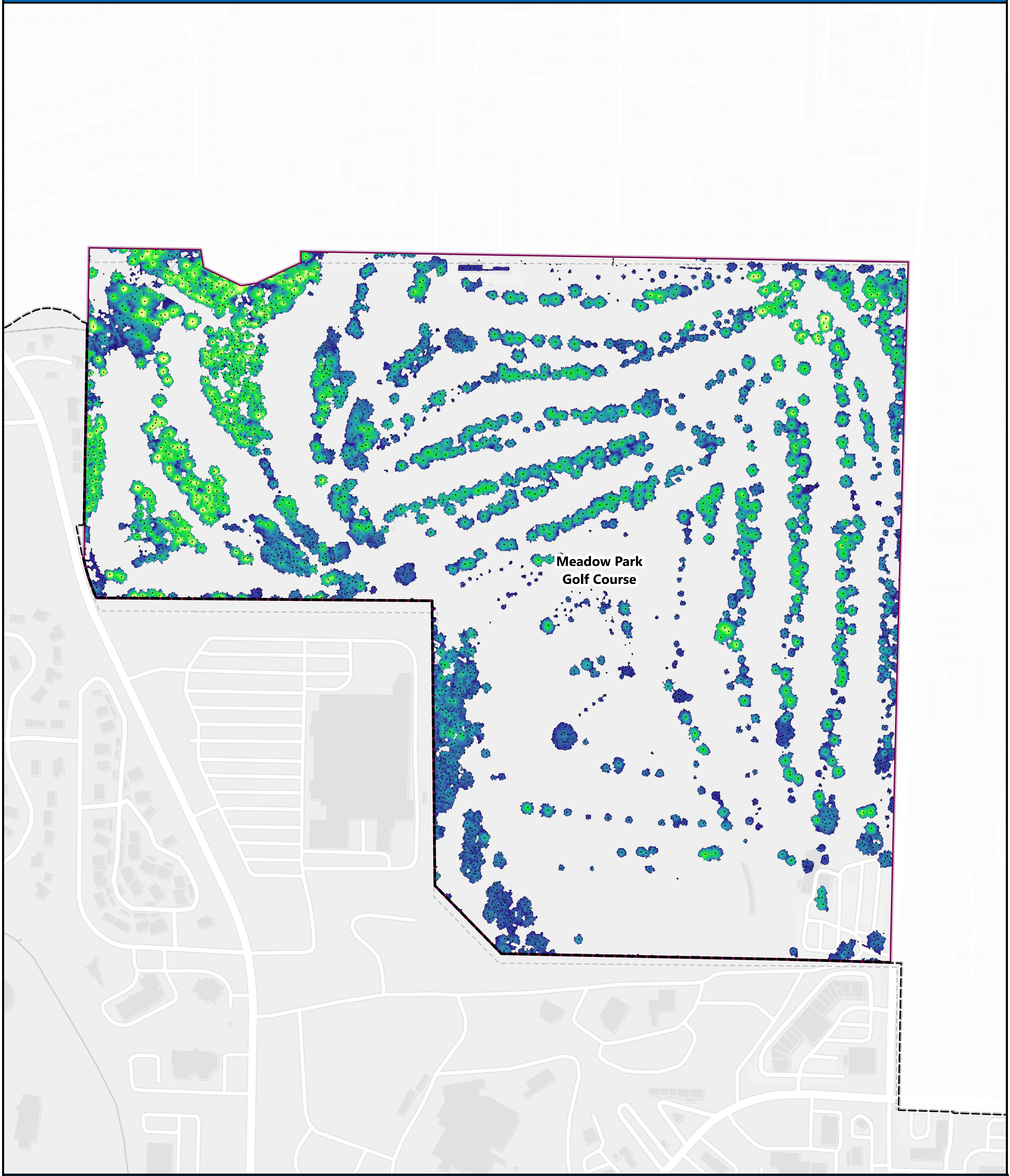
LAKEWOOD CHM - MEADOW PARK GOLF COURSE



LAKEWOOD APPENDIX MAPS

LAYERS

City Boundary

Site Boundary

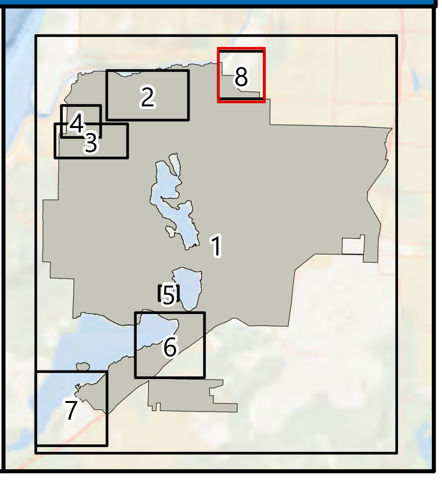
Tree Canopy Tops

Canopy Height

200 ft

Surface

0 300 600 Feet



Print Date: 1/24/2025

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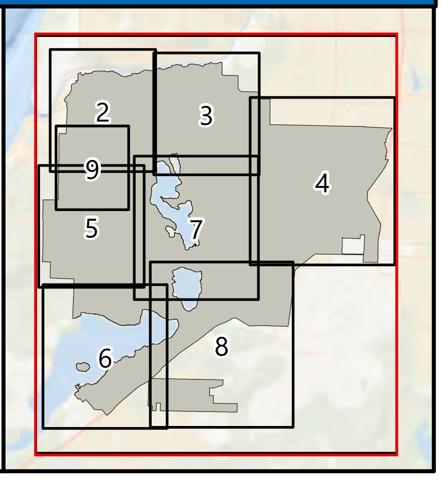
LAKEWOOD TREE INVENTORY

LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 2,000 4,000 Feet



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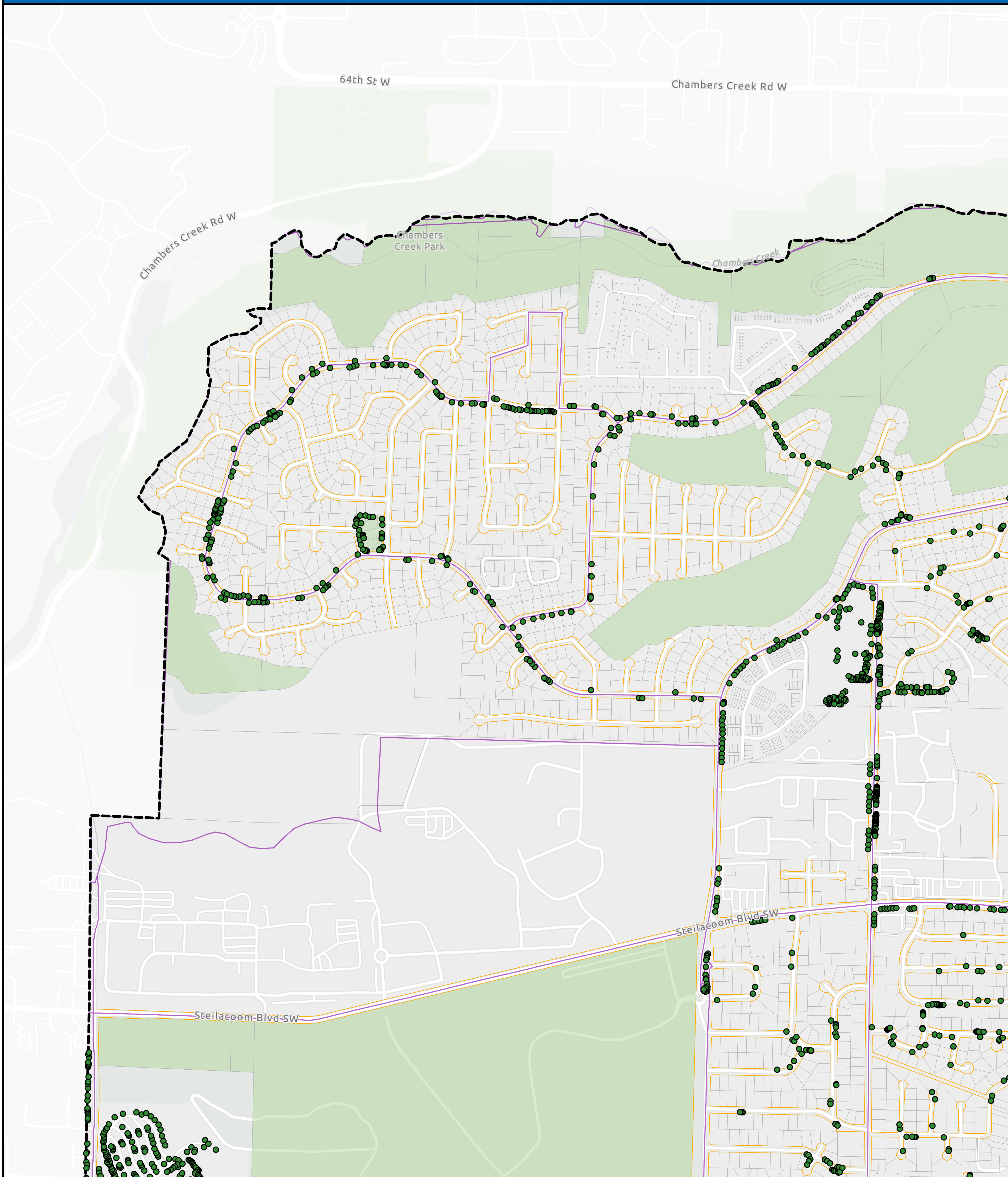
LAKEWOOD TREE INVENTORY

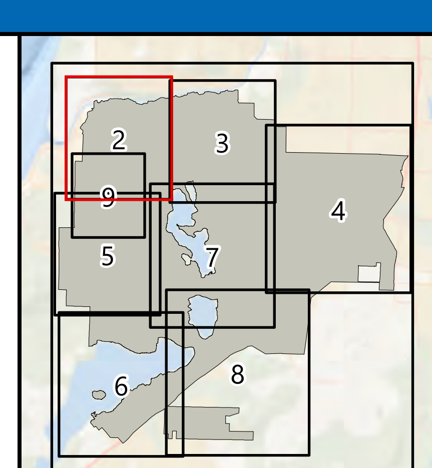


LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 700 1,400 Feet



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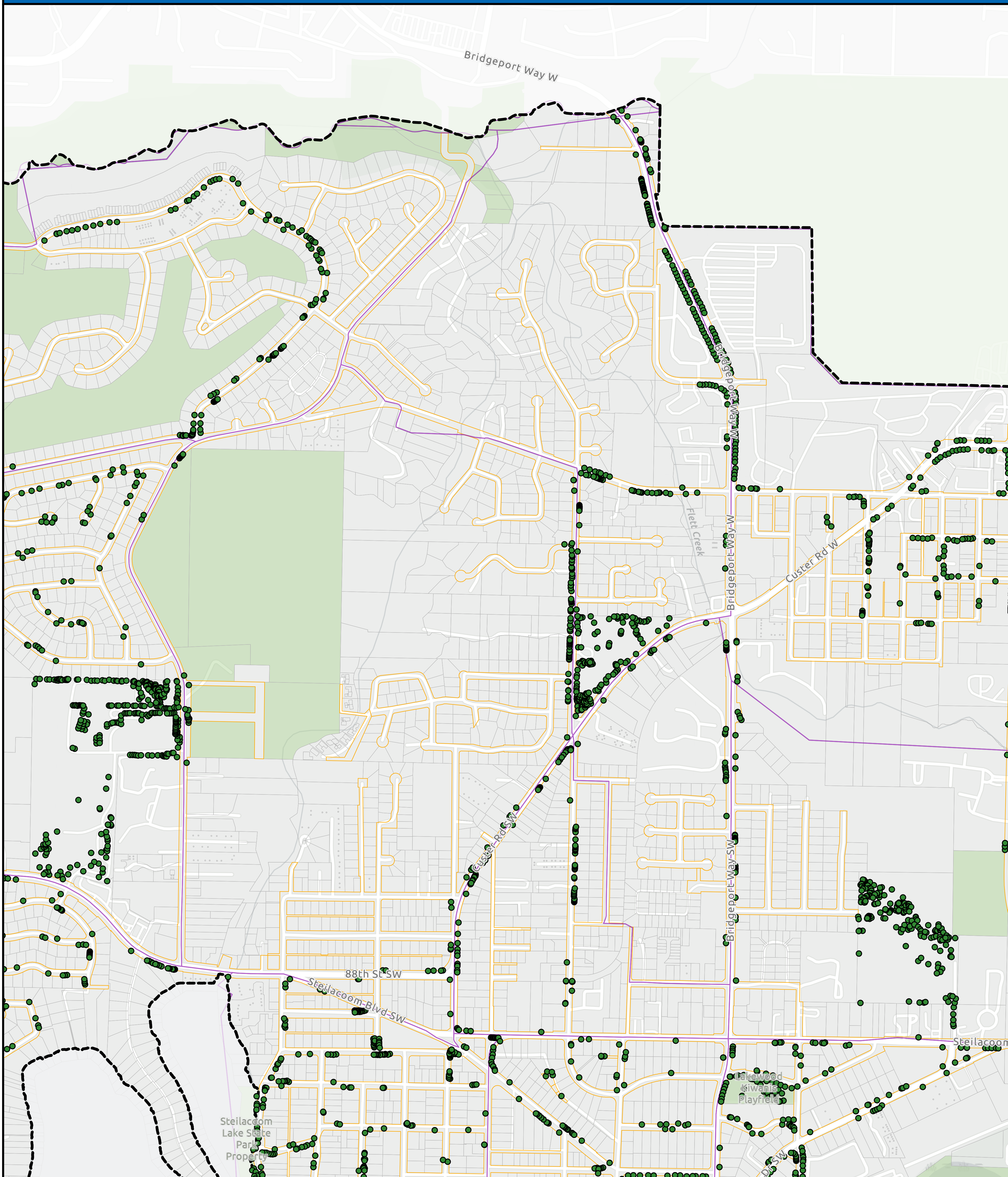
LAKEWOOD TREE INVENTORY

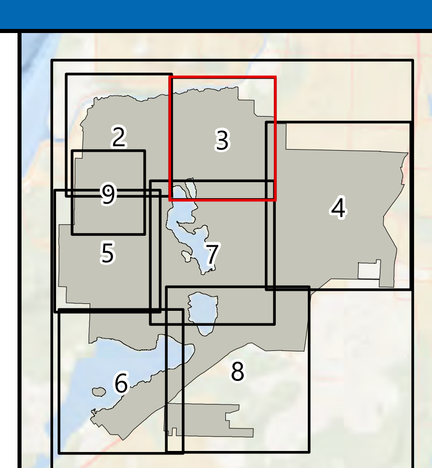


LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 700 1,400 Feet



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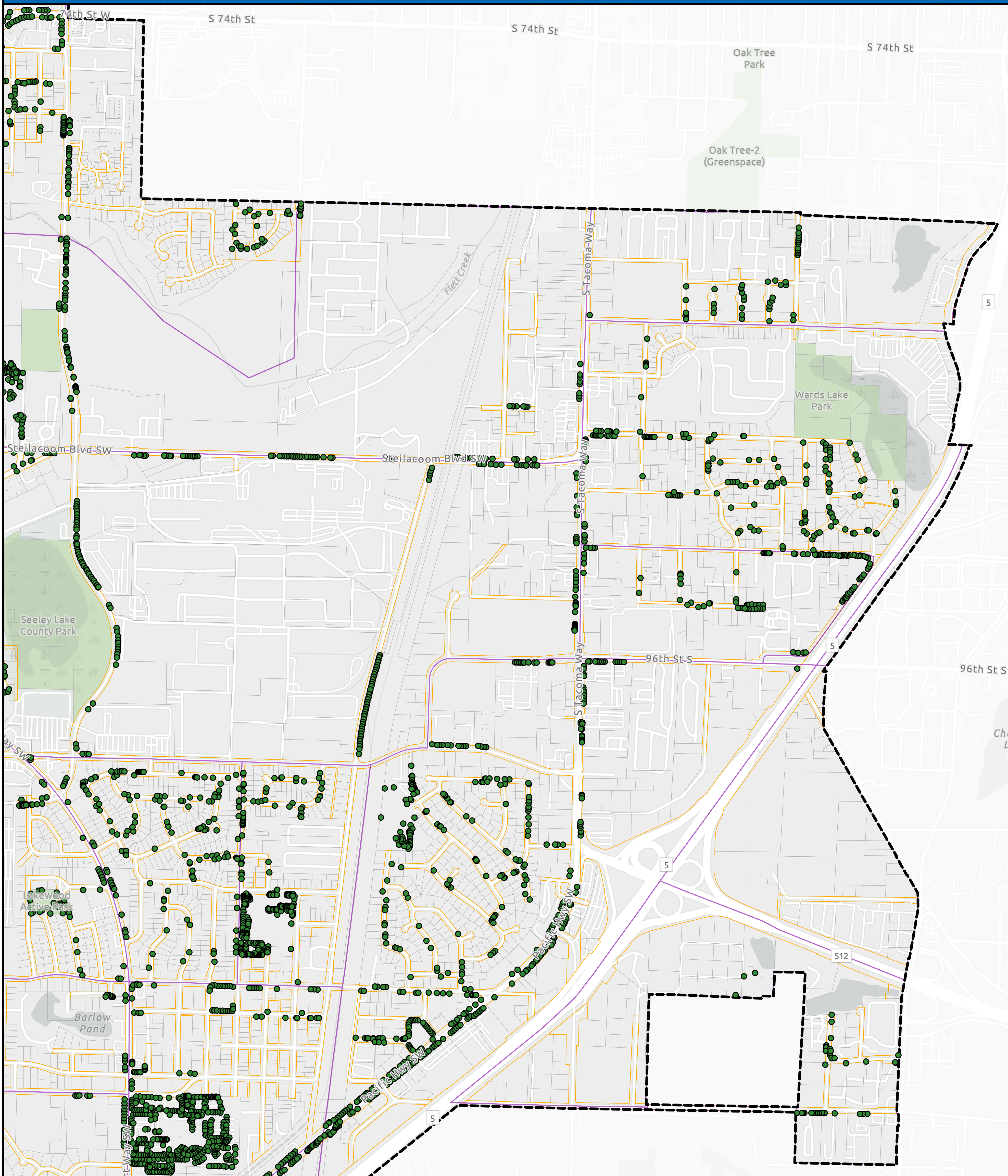
LAKEWOOD TREE INVENTORY

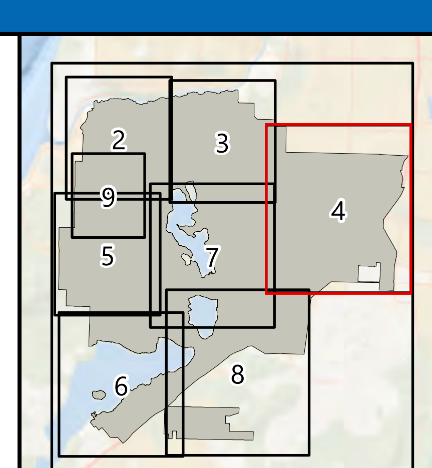


LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 960 1,920 Feet



Print Date: 12/18/2024

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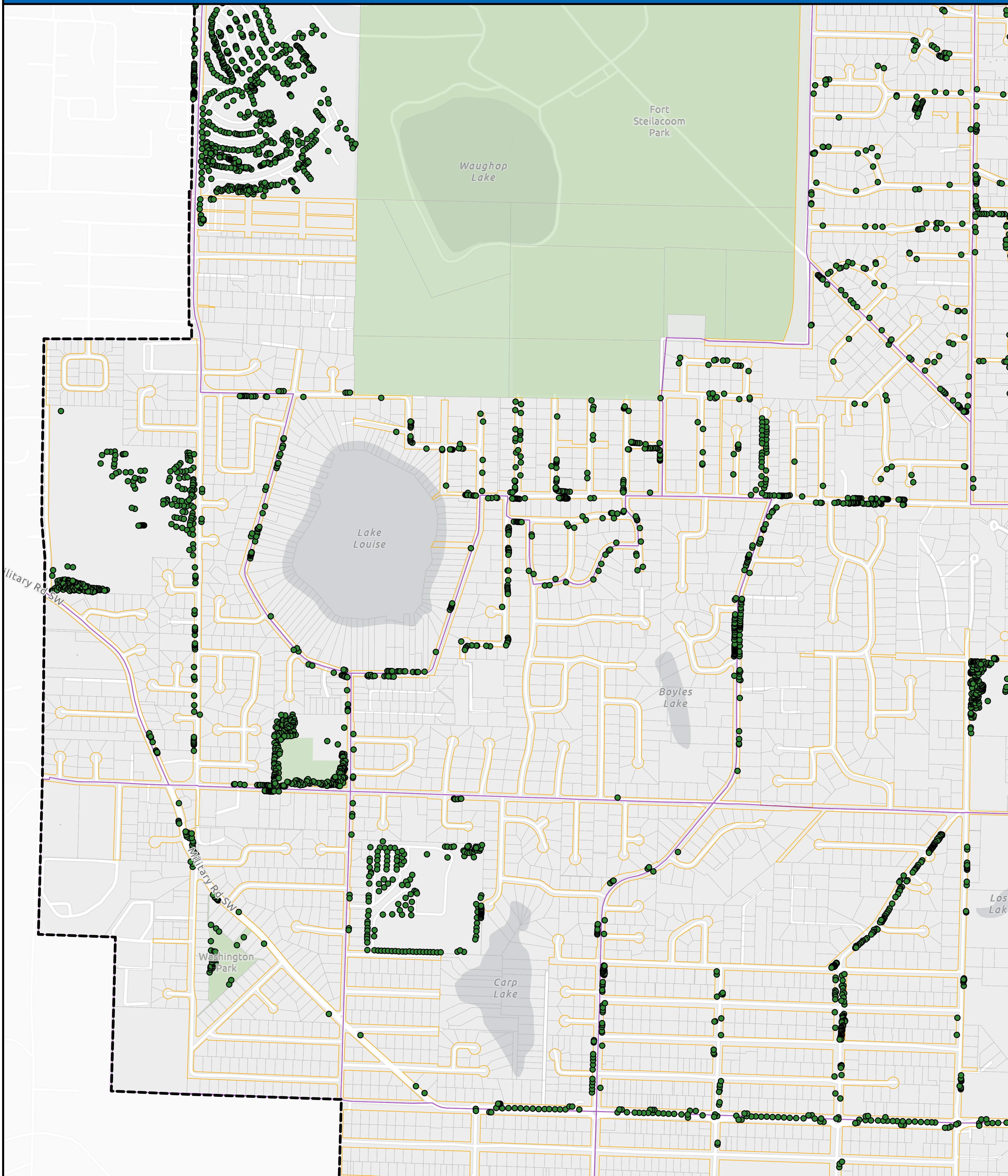
LAKEWOOD TREE INVENTORY

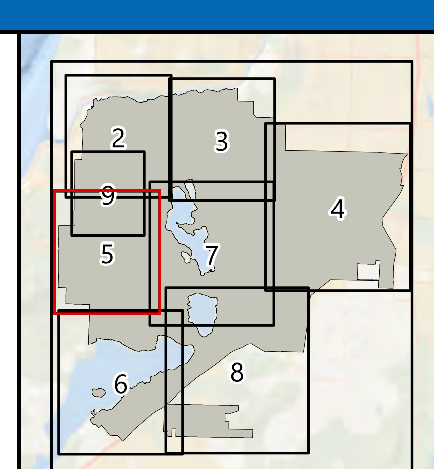


LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 700 1,400 Feet



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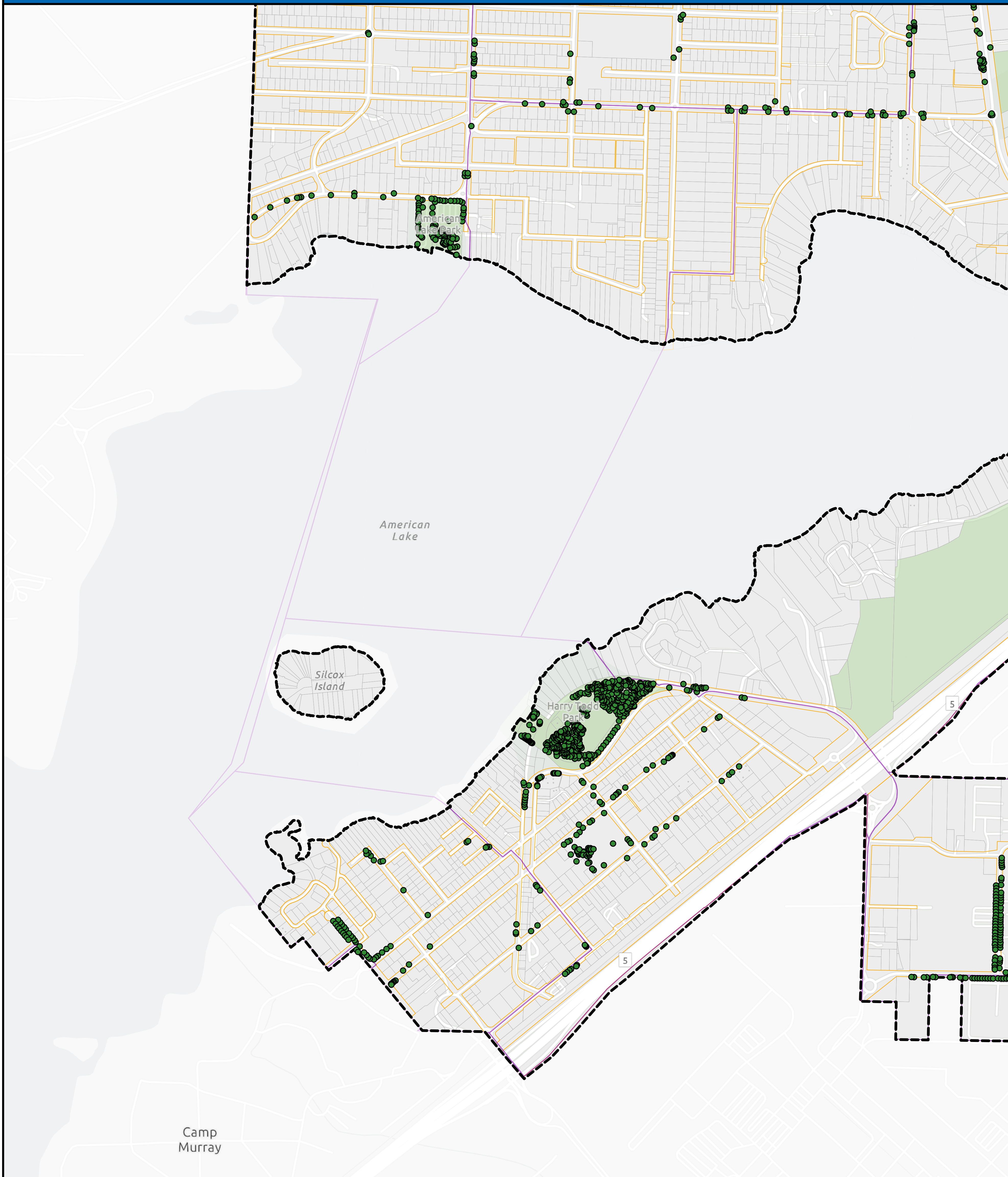
LAKEWOOD TREE INVENTORY

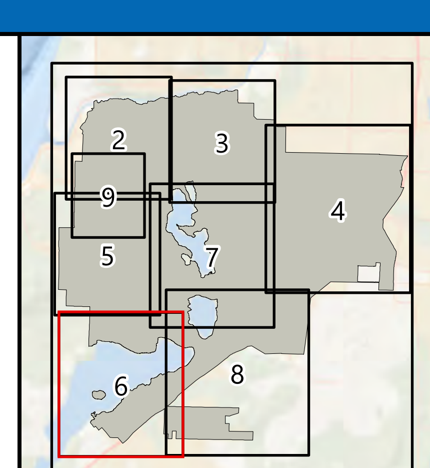


LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 820 1,640 Feet



Print Date: 12/18/2024

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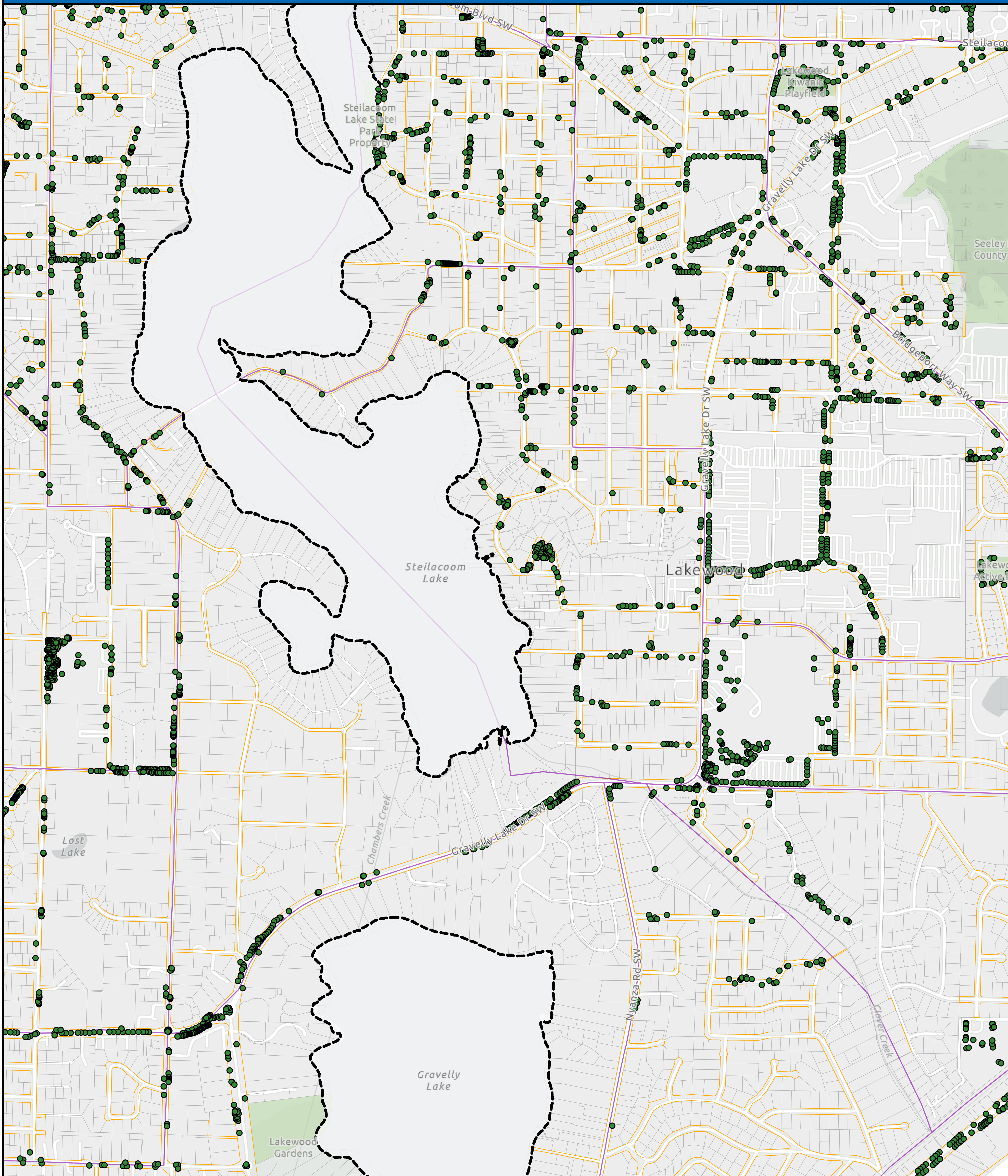
LAKEWOOD TREE INVENTORY

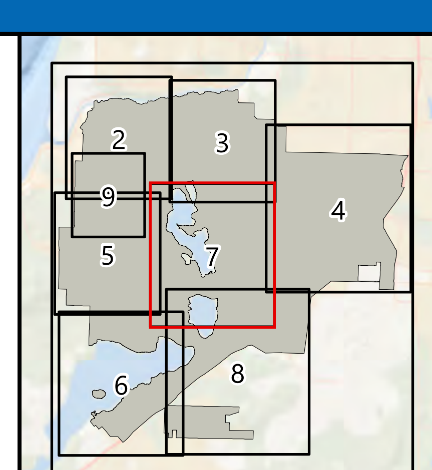


LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 820 1,640 Feet



Print Date: 12/18/2024

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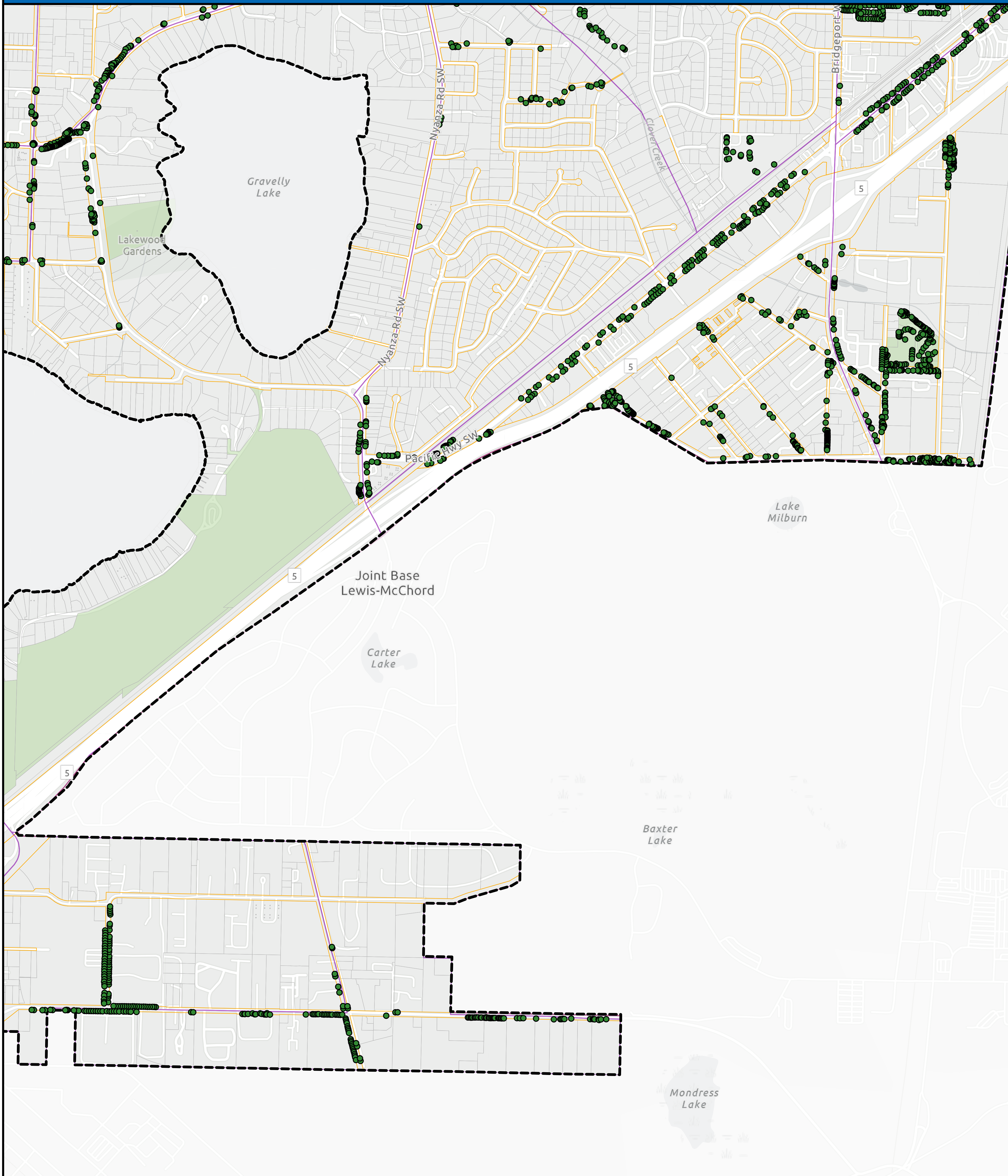
LAKEWOOD TREE INVENTORY

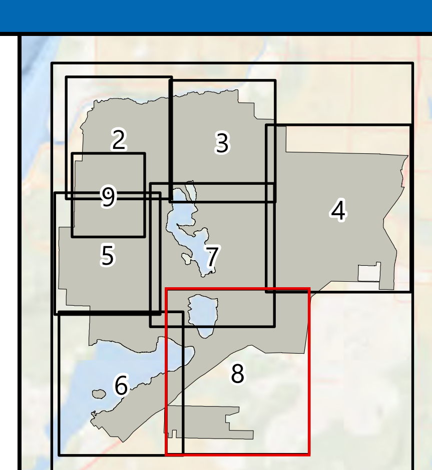


LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 950 1,900 Feet



Print Date: 12/18/2024

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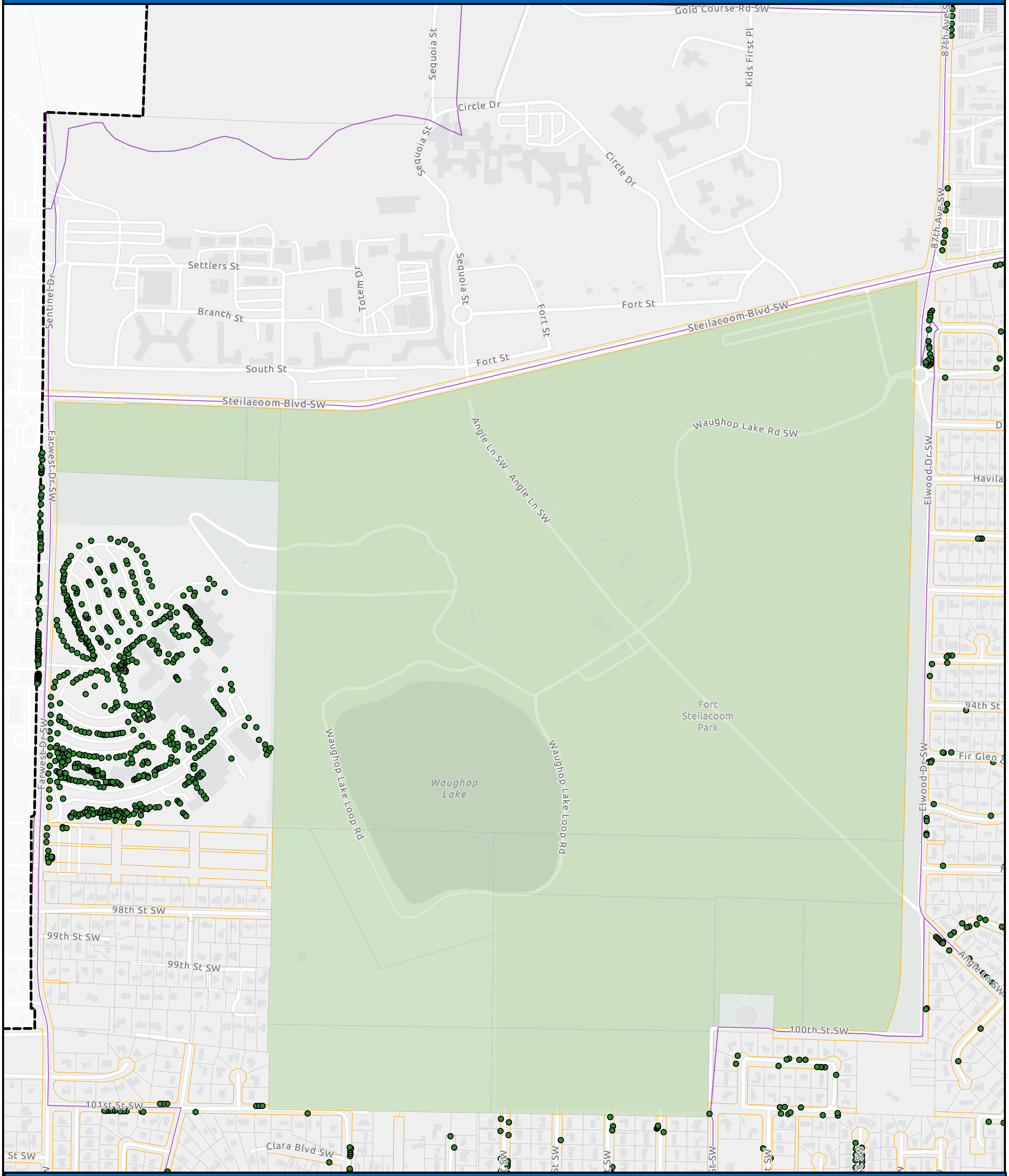
LAKEWOOD TREE INVENTORY

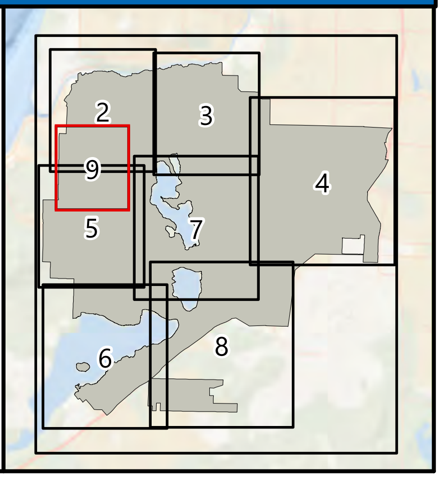


LAKEWOOD APPENDIX MAPS

LAYERS

- Tree Inventory Locations
- City Boundary
- Right of Way
- Parcels
- Parks
- Census Block Groups

0 480 960 Feet



Print Date: 12/18/2024

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APPENDIX E. Tree Inventory Data

Table B1. Inventoried tree species summary data by city zoning designation, rounded to nearest whole number.

Zoning	CC	#T	MDBH	D0	D25	D50	D75	D100	DC1	DC2	DC3	DC4	DC5	MR	C1	C2	C3	C4	C5	C6	SR	GR
Air Corridor 1	9.8%	96	16	5	8	12	18	46	2%	47%	24%	20%	7%	11	0%	65%	28%	4%	0%	3%	21	15
Air Corridor 2	21.3%	169	16	2	8	16	24	39	14%	21%	22%	16%	27%	12	1%	73%	24%	2%	0%	0%	39	25
Arterial Residential/Commercial	24.3%	40	17	2	9	15	25	35	5%	38%	13%	18%	28%	14	0%	53%	43%	3%	0%	3%	10	8
Central Business District	11.1%	605	12	0	7	11	16	57	17%	36%	29%	11%	7%	12	1%	63%	27%	4%	1%	3%	62	34
Clear Zone	2.9%	31	9	2	4	10	12	23	39%	32%	26%	3%	0%	7	0%	74%	23%	3%	0%	0%	13	10
Commercial 1	5.4%	152	9	2	7	8	10	35	12%	77%	7%	3%	2%	11	0%	63%	24%	10%	0%	4%	10	7
Commercial 2	5.6%	233	8	1	6	7	9	31	27%	58%	9%	3%	1%	8	0%	67%	24%	7%	0%	1%	19	11
Commercial 3	10.3%	28	7	2	3	7	10	12	32%	64%	4%	0%	0%	8	0%	93%	7%	0%	0%	0%	3	3
Industrial 1	6.3%	152	12	3	7	9	13	48	18%	55%	11%	9%	9%	10	0%	67%	30%	1%	0%	1%	10	9
Industrial 2	7.9%	1	20	20	20	20	20	20	0%	0%	0%	100%	0%	11	0%	100%	0%	0%	0%	0%	1	1
Industrial Business Park	11.0%	259	7	2	3	3	8	46	71%	11%	4%	5%	8%	8	0%	88%	11%	0%	0%	1%	20	15
Mixed Residential 1	11.0%	130	15	2	8	15	20	36	14%	22%	25%	22%	16%	12	0%	62%	32%	6%	0%	0%	37	23
Mixed Residential 2	23.3%	129	15	2	3	13	23	82	32%	15%	12%	16%	25%	13	7%	71%	20%	1%	0%	1%	27	21
Multifamily 1	23.4%	252	16	2	7	16	22	53	12%	27%	15%	23%	23%	13	0%	62%	20%	16%	1%	1%	39	24
Multifamily 2	25.2%	245	16	2	8	12	22	78	11%	37%	15%	17%	21%	13	0%	56%	38%	5%	0%	1%	37	24
Multifamily 3	15.7%	232	11	1	5	12	15	50	31%	22%	34%	11%	2%	10	0%	82%	14%	3%	0%	1%	26	21
Neighborhood Commercial 1	11.1%	11	13	2	2	13	16	34	36%	9%	36%	0%	18%	14	27%	36%	36%	0%	0%	0%	6	5
Neighborhood Commercial 2	11.3%	287	12	1	8	12	15	42	19%	33%	34%	10%	4%	10	0%	50%	40%	8%	1%	1%	37	24
Open Space & Recreation 1	34.5%	922	21	1	11	20	30	89	14%	14%	16%	17%	40%	15	1%	79%	17%	2%	0%	1%	43	29
Open Space & Recreation 2	25.1%	69	15	2	8	14	21	42	14%	29%	13%	25%	19%	11	0%	54%	29%	9%	4%	4%	12	10
Public Institutional	17.7%	3278	15	1	7	13	21	74	19%	26%	21%	16%	19%	13	0%	82%	15%	2%	0%	1%	92	50
Residential 1	48.1%	210	17	2	9	16	23	59	17%	15%	26%	21%	22%	9	0%	42%	49%	7%	1%	0%	20	16
Residential 2	44.9%	198	17	2	8	15	24	81	18%	18%	25%	13%	26%	12	1%	59%	36%	1%	0%	3%	21	18
Residential 3	30.2%	2578	15	2	8	13	21	66	16%	27%	22%	15%	20%	12	1%	72%	23%	2%	1%	1%	104	55
Residential 4	23.3%	1168	14	1	6	12	20	60	23%	25%	21%	12%	20%	12	4%	72%	19%	4%	0%	1%	92	50
Right Of Way	4.4%	53	15	3	6	16	21	34	28%	13%	19%	15%	25%	12	0%	85%	15%	0%	0%	0%	3	3
Transit Oriented Commercial	0.4%	254	9	2	7	9	12	38	16%	62%	20%	0%	2%	10	0%	69%	28%	2%	0%	2%	16	11
Lakewood Total	24.4%	11782	15	0	7	13	20	89	19%	28%	21%	14%	18%	12	1%	73%	21%	3%	0%	1%	161	69

CC: Canopy cover
#T: Number of trees
MDBH: Mean DBH
SR: Species richness
GR: Genus richness

MDBH: Mean DBH
D0: DBH minimum
D25: DBH 25th percentile
D50: DBH 50th percentile (median)
D75: DBH 75th percentile
D100: DBH maximum

DC1: DBH category 1, 0-6 inches
DC2: DBH category 2, 6-12 inches
DC3: DBH category 3, 12-18 inches
DC4: DBH category 4, 18-24 inches
DC5: DBH category 5, >24 inches

C1: Condition rating category 1, excellent
C2: Condition rating category 2, good
C3: Condition rating category 3, fair
C4: Condition rating category 4, poor
C5: Condition rating category 5, very poor
C6: Condition rating category 6, dead

Table B2. Inventoried tree species summary data by census block group, rounded to nearest whole number.

TCT	B	GID	CC	#T	MDBH	D0	D25	D50	D75	D100	DC1	DC2	DC3	DC4	DC5	MR	C1	C2	C3	C4	C5	C6	SR	GR
71706	1	530530717061	6.1%	40	10	2	5	11	13	23	0	33%	25%	10%	0%	8	0%	73%	20%	8%	0%	0%	14	11
71803	1	530530718031	20.3%	342	16	2	7	16	23	48	0	22%	16%	20%	23%	15	0%	85%	12%	1%	0%	2%	22	17
71803	2	530530718032	10.7%	292	12	1	6	9	16	55	0	41%	12%	10%	13%	10	0%	57%	32%	10%	0%	2%	31	20
71803	3	530530718033	29.4%	28	15	2	5	11	27	38	0	21%	11%	7%	32%	11	0%	82%	11%	7%	0%	0%	10	10
71803	4	530530718034	20.1%	119	8	1	3	5	10	35	1	13%	7%	7%	9%	5	0%	51%	36%	6%	0%	7%	17	13
71805	1	530530718051	8.1%	217	10	2	5	7	15	74	0	42%	15%	10%	5%	8	0%	79%	19%	1%	0%	0%	38	26
71805	2	530530718052	8.7%	160	14	3	9	15	20	32	0	24%	33%	23%	8%	12	0%	64%	29%	7%	0%	0%	40	27
71805	3	530530718053	10.6%	507	12	1	7	11	16	42	0	36%	32%	9%	4%	11	0%	76%	19%	4%	0%	1%	48	30
71806	1	530530718061	13.9%	407	13	2	7	10	18	44	0	48%	14%	14%	13%	12	0%	58%	28%	11%	0%	3%	25	19
71806	2	530530718062	20.4%	446	13	1	6	10	18	78	0	37%	12%	12%	14%	11	0%	70%	25%	3%	0%	2%	38	25
71807	1	530530718071	12.1%	444	14	2	7	10	17	66	0	44%	15%	8%	16%	13	0%	57%	36%	3%	0%	3%	43	27
71807	2	530530718072	11.8%	466	13	2	7	10	16	59	0	42%	20%	8%	14%	12	0%	73%	21%	5%	0%	0%	45	28
71808	1	530530718081	13.6%	44	19	2	8	21	27	39	0	18%	5%	20%	41%	14	0%	89%	11%	0%	0%	0%	17	12
71808	2	530530718082	23.7%	163	14	2	7	13	20	42	0	29%	23%	14%	18%	11	1%	67%	30%	2%	0%	0%	32	22
71808	3	530530718083	13.2%	107	13	5	8	10	17	46	0	54%	20%	16%	7%	10	0%	60%	34%	4%	0%	3%	20	13
71901	1	530530719011	13.9%	649	14	0	7	13	18	57	0	31%	28%	11%	15%	13	1%	67%	24%	6%	1%	2%	72	42
71901	2	530530719012	13.5%	201	21	3	14	20	27	82	0	18%	24%	21%	35%	17	0%	53%	44%	2%	0%	0%	28	18
71901	3	530530719013	15.7%	102	15	6	10	12	16	51	0	50%	28%	9%	13%	10	4%	54%	31%	11%	0%	0%	20	14
71901	4	530530719014	34.8%	80	18	3	12	18	22	60	0	19%	23%	31%	20%	12	6%	53%	28%	9%	5%	0%	16	13
71902	1	530530719021	28.5%	335	18	2	9	15	24	81	0	23%	26%	15%	25%	14	1%	80%	16%	1%	0%	2%	44	27
71902	2	530530719022	29.6%	293	18	1	10	15	26	89	0	29%	21%	12%	29%	14	3%	79%	17%	0%	0%	0%	33	24
71902	3	530530719023	39.0%	263	20	2	11	18	28	52	0	19%	21%	17%	35%	12	6%	61%	23%	3%	4%	2%	32	24
71902	4	530530719024	47.3%	150	15	3	8	13	20	47	0	27%	30%	17%	16%	9	0%	54%	43%	1%	1%	1%	13	12
71902	5	530530719025	38.0%	186	14	2	4	13	19	59	0	16%	27%	15%	13%	9	0%	42%	41%	16%	1%	1%	20	14
72000	1	530530720001	14.0%	92	5	2	3	3	3	42	1	0%	0%	0%	7%	6	0%	93%	7%	0%	0%	0%	7	6
72000	2	530530720002	21.2%	138	12	2	2	4	21	46	1	1%	11%	15%	20%	11	0%	64%	32%	0%	0%	4%	9	7
72000	3	530530720003	25.3%	580	23	1	15	23	31	55	0	13%	18%	20%	46%	16	0%	84%	14%	2%	0%	1%	26	18
72000	4	530530720004	21.8%	65	18	6	13	15	22	46	0	15%	52%	9%	20%	13	0%	91%	8%	0%	0%	2%	11	9
72105	1	530530721051	19.7%	152	16	4	11	14	20	53	0	32%	30%	19%	15%	11	0%	72%	16%	7%	1%	4%	26	18
72105	2	530530721052	29.1%	195	16	2	9	15	22	60	0	23%	22%	21%	22%	12	0%	57%	39%	2%	1%	1%	31	19
72105	4	530530721054	45.6%	127	16	3	9	16	22	33	0	24%	28%	20%	20%	12	0%	75%	19%	6%	0%	0%	32	22
72106	1	530530721061	41.1%	306	15	2	5	13	22	40	0	14%	22%	15%	20%	10	0%	80%	16%	3%	0%	2%	23	16
72106	2	530530721062	36.3%	117	16	2	7	16	22	66	0	25%	15%	23%	21%	10	0%	36%	58%	3%	3%	1%	18	13
72106	3	530530721063	18.1%	591	15	2	7	12	21	74	0	34%	18%	14%	18%	11	0%	83%	14%	2%	0%	0%	47	30
72106	4	530530721064	15.1%	156	19	4	14	18	24	53	0	14%	33%	24%	26%	15	0%	87%	11%	0%	0%	2%	11	8
72107	1	530530721071	20.7%	199	16	2	9	14	20	51	0	30%	29%	12%	20%	13	2%	81%	14%	2%	0%	1%	40	30
72107	2	530530721072	37.3%	493	16	2	9	14	20	60	0	24%	28%	18%	17%	13	0%	81%	17%	1%	0%	1%	41	25
72107	3	530530721073	35.3%	157	14	2	6	11	20	50	0	37%	18%	17%	14%	12	0%	71%	27%	1%	0%	1%	33	23
72107	4	530530721074	25.3%	864	13	1	6	12	19	52	0	25%	22%	16%	13%	12	0%	85%	13%	1%	0%	0%	63	39
72108	1	530530721081	36.9%	330	14	2	6	12	22	60	0	23%	19%	11%	23%	12	5%	79%	15%	1%	0%	0%	31	21
72108	2	530530721082	20.4%	100	7	2	2	2	9	52	1	6%	8%	3%	10%	6	9%	87%	4%	0%	0%	0%	13	10
72108	3	530530721083	30.0%	14	5	2	2	2	2	25	1	0%	0%	7%	7%	7	14%	43%	43%	0%	0%	0%	4	4
72108	4	530530721084	25.1%	115	14	1	2	5	25	49	1	6%	3%	11%	28%	10	10%	69%	14%	4%	1%	2%	9	8
72108	5	530530721085	24.8%	213	9	1	3	4	15	45	1	7%	13%	7%	11%	9	8%	62%	26%	0%	2%	2%	22	15
72112	1	530530721121	18.1%	631	15	2	6	13	22	50	0	27%	16%	17%	20%	12	0%	91%	8%	1%	0%	1%	34	24
72112	3	530530721123	25.6%	96	16	2	6	12	25	60	0	36%	11%	11%	27%	12	0%	58%	42%	0%	0%	0%	12	11
72308	4	530530723084	46.2%	1	12	12	12	12	12	12	0	100%	0%	0%	0%	12	0%	100%	0%	0%	0%	0%	1	1
72312	1	530530723121	80.5%	1	6	6	6	6	6	6	0	100%	0%	0%	0%	6	0%	100%	0%	0%	0%	0%	1	1
72903	1	530530729031	-	2	15	15	15	15	15	15	0	0%	100%	0%	0%	10	0%	100%	0%	0%	0%	0%	1	1
72907	3	530530729073	-	6	9	3	7	8	10	18	0	67%	0%	17%	0%	8	0%	83%	0%	0%	0%	17%	4	4

TCT: Census tract number
B: Census block number group
GID: Unique census block group unique GEOID identifier.
CC: Canopy cover
#T: Number of trees

MDBH: Mean DBH
D0: DBH minimum
D25: DBH 25th percentile
D50: DBH 50th percentile (median)
D75: DBH 75th percentile
D100: DBH maximum

DC1: DBH category 1, 0-6 inches
DC2: DBH category 2, 6-12 inches
DC3: DBH category 3, 12-18 inches
DC4: DBH category 4, 18-24 inches
DC5: DBH category 5, >24 inches

C1: Condition rating category 1, excellent
C2: Condition rating category 2, good
C3: Condition rating category 3, fair
C4: Condition rating category 4, poor
C5: Condition rating category 5, very poor
C6: Condition rating category 6, dead

SR: Species richness
GR: Genus richness

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Table B3. Inventoried tree species summary data.

Species	Common Name	#T	MDBH	DC1	DC2	DC3	DC4	DC5	C1	C2	C3	C4	C5	C6	NM	ADPT	VULN
Abies grandis	Grand fir	12	16	8%	25%	25%	25%	17%	0%	50%	8%	17%	8%	17%	8%	M	M-H
Abies procera	Noble fir	5	20	0%	0%	60%	20%	20%	0%	60%	40%	0%	0%	0%	20%	M	L-M
Abies sp.	Fir species	8	9	38%	25%	25%	0%	13%	13%	63%	25%	0%	0%	0%	13%	n/a	n/a
Acer circinatum	Vine maple	53	6	58%	34%	8%	0%	0%	0%	89%	9%	2%	0%	0%	2%	H	L-M
Acer fremanii	Freeman maple	65	10	9%	68%	20%	3%	0%	0%	75%	25%	0%	0%	0%	2%	n/a	n/a
Acer ginnala	Amur maple	1	4	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	n/a	n/a
Acer grandidentatum	Bigtooth maple	9	5	78%	22%	0%	0%	0%	0%	78%	22%	0%	0%	0%	11%	n/a	n/a
Acer griseum	Paperbark maple	11	5	91%	9%	0%	0%	0%	0%	100%	0%	0%	0%	0%	9%	L	H
Acer macrophyllum	Bigleaf maple	221	15	21%	29%	19%	10%	20%	0%	70%	23%	5%	0%	2%	0%	M	L-M
Acer palmatum	Japanese maple	114	9	29%	51%	16%	4%	1%	2%	87%	8%	4%	0%	0%	1%	M	L-M
Acer palmatum 'Bloodgood'	Japanese maple	2	6	50%	50%	0%	0%	0%	0%	100%	0%	0%	0%	0%	50%	M	L-M
Acer platanoides	Norway maple	603	13	9%	46%	25%	13%	7%	0%	72%	25%	1%	0%	1%	0%	H	M
Acer platanoides 'Crimson King'	Norway maple 'Crimson King'	70	13	21%	43%	20%	6%	10%	0%	67%	26%	7%	0%	0%	1%	H	M
Acer rubrum	Red maple	353	10	35%	33%	21%	10%	1%	0%	71%	18%	7%	1%	3%	0%	H	L
Acer saccharinum	Silver maple	51	13	25%	33%	16%	4%	22%	0%	69%	25%	6%	0%	0%	2%	M	L-M
Acer saccharum	Sugar maple	30	10	3%	80%	0%	17%	0%	0%	80%	17%	3%	0%	0%	3%	M	M-H
Acer sp. <tree>	Maple	5	16	20%	0%	40%	20%	20%	0%	60%	40%	0%	0%	0%	20%	n/a	n/a
Aesculus hippocastanum	Horsechestnut	16	13	25%	31%	13%	19%	13%	0%	94%	6%	0%	0%	0%	6%	M	M-H
Ailanthus altissima	Tree of Heaven	3	7	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	33%	H	M
Albizia julibrissin	Silktree	2	15	0%	0%	50%	50%	0%	0%	100%	0%	0%	0%	0%	50%	L	M
Alnus rubra	Red alder	22	6	77%	5%	14%	5%	0%	0%	91%	0%	5%	0%	5%	5%	L	H
Amelanchier alnifola	Western serviceberry	2	6	50%	50%	0%	0%	0%	0%	100%	0%	0%	0%	0%	50%	n/a	n/a
Amelanchier canadensis	Shadblow serviceberry	3	3	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	33%	n/a	n/a
Amelanchier sp.	Serviceberry species	13	4	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	8%	n/a	n/a
Araucaria araucana	Monkey puzzle tree	4	12	0%	25%	75%	0%	0%	0%	100%	0%	0%	0%	0%	25%	n/a	n/a
Arbutus menziesii	Pacific madrone	286	11	21%	38%	24%	10%	6%	1%	86%	8%	1%	1%	2%	0%	M	L-M
Arbutus unedo	Pacific madrone	2	2	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	50%	H	L
Betula nigra	River birch	1	15	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	100%	M	L-M
Betula papyrifera	Paperbark Birch	10	5	70%	30%	0%	0%	0%	0%	70%	20%	10%	0%	0%	10%	M	L-M
Betula pendula	European white birch	60	12	13%	38%	32%	15%	2%	2%	53%	20%	18%	2%	5%	2%	L	H
Betula sp.	Birch	1	7	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	n/a	n/a
Callitropsis nootkatensis 'pendula'	Alaska cedar, weeping	8	7	25%	63%	13%	0%	0%	0%	100%	0%	0%	0%	0%	13%	L	H
Callitropsis nootkatensis	Alaska cedar	26	8	15%	73%	8%	4%	0%	0%	92%	8%	0%	0%	0%	4%	L	H
Calocedrus decurrens	Incense cedar	55	13	22%	15%	51%	9%	4%	2%	82%	15%	2%	0%	0%	2%	n/a	n/a
Carpinus betulus	European hornbeam	73	3	92%	4%	4%	0%	0%	36%	60%	4%	0%	0%	0%	1%	M	L-M
Carpinus caroliniana	American hornbeam	11	9	9%	73%	9%	9%	0%	0%	100%	0%	0%	0%	0%	9%	H	L
Castanea dentata	American chestnut	7	21	0%	29%	14%	14%	43%	0%	57%	43%	0%	0%	0%	14%	n/a	n/a
Castanea sp.	Chestnut	1	4	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	n/a	n/a
Catalpa speciosa	Western catalpa	1	13	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	100%	M	M-H
Cedrus atlantica	Atlas cedar	6	25	0%	0%	17%	17%	67%	0%	100%	0%	0%	0%	0%	17%	n/a	n/a
Cedrus atlantica 'glauca'	Blue atlas cedar	11	15	0%	27%	45%	18%	9%	0%	100%	0%	0%	0%	0%	9%	n/a	n/a
Cedrus deodara	Deodar cedar	99	22	0%	8%	24%	28%	39%	0%	85%	12%	2%	1%	0%	1%	n/a	n/a
Cercidiphyllum japonicum	Katsuratree	35	8	23%	63%	11%	0%	3%	0%	69%	31%	0%	0%	0%	3%	L	H
Cercis canadensis	Eastern redbud	12	6	50%	33%	17%	0%	0%	0%	75%	25%	0%	0%	0%	8%	M	L-M
Chamaecyparis lawsoniana	Lawson falsecypress	65	17	3%	34%	18%	17%	28%	2%	57%	31%	3%	2%	6%	2%	M	M-H
Chamaecyparis obtusa	Hinoki falsecypress	22	7	27%	59%	14%	0%	0%	0%	91%	0%	5%	0%	5%	5%	L	H
Chamaecyparis pisifera	Sawara falsecypress	15	9	33%	40%	20%	7%	0%	0%	73%	27%	0%	0%	0%	7%	n/a	n/a
Cornus florida	Flowering dogwood	20	8	35%	45%	20%	0%	0%	0%	90%	10%	0%	0%	0%	5%	M	L-M
Cornus kousa	Kousa dogwood	66	6	61%	26%	14%	0%	0%	0%	92%	6%	0%	2%	0%	2%	H	M
Cornus nuttallii	Pacific dogwood	18	11	22%	33%	33%	6%	6%	0%	83%	6%	11%	0%	0%	6%	M	L-M
Cornus sp.	Ornamental dogwood	3	6	33%	67%	0%	0%	0%	0%	67%	33%	0%	0%	0%	33%	n/a	n/a
Cornus 'Eddie's White Wonder'	Eddie's white wonder dogwood	4	5	75%	25%	0%	0%	0%	0%	100%	0%	0%	0%	0%	25%	n/a	n/a
Corylus cornuta	Pacific dogwood	3	4	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	33%	n/a	n/a
Crataegus douglasii	Black hawthorn	12	5	92%	0%	0%	8%	0%	0%	100%	0%	0%	0%	0%	8%	n/a	n/a
Crataegus monogyna	Common hawthorn	49	8	37%	47%	6%	8%	2%	0%	71%	20%	4%	4%	0%	2%	M	M-H
Cryptomeria japonica	Japanese cedar	11	13	9%	27%	36%	18%	9%	0%	73%	18%	9%	0%	0%	9%	n/a	n/a

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Species	Common Name	#T	MDBH	DC1	DC2	DC3	DC4	DC5	C1	C2	C3	C4	C5	C6	NM	ADPT	VULN
Cupressus arizonica	Arizona cypress	2	17	0%	0%	100%	0%	0%	0%	50%	50%	0%	0%	0%	50%	n/a	n/a
Cupressus sp.	Cypress species	46	9	61%	11%	17%	9%	2%	0%	87%	9%	4%	0%	0%	2%	n/a	n/a
Fagus sylvatica	European beech	7	13	0%	57%	14%	14%	14%	0%	29%	71%	0%	0%	0%	14%	M	M-H
Fagus sylvatica 'purpurea'	European beech (purple)	2	22	0%	0%	50%	0%	50%	50%	50%	0%	0%	0%	0%	50%	M	M-H
Ficus carica	Common fig	1	6	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	L	M
Fraxinus americana	White ash	56	8	9%	86%	5%	0%	0%	0%	82%	11%	4%	0%	4%	2%	L	M
Fraxinus latifolia	Oregon ash	46	7	48%	35%	11%	7%	0%	0%	63%	30%	7%	0%	0%	2%	M	M-H
Fraxinus pennsylvanica	Green ash	106	8	22%	73%	6%	0%	0%	0%	70%	27%	2%	0%	1%	1%	M	L-M
Fraxinus sp.	Ash species	45	7	42%	47%	11%	0%	0%	0%	71%	11%	16%	2%	0%	2%	n/a	n/a
Ginkgo biloba	Ginkgo	33	4	76%	24%	0%	0%	0%	0%	61%	33%	0%	3%	3%	3%	H	M
Gleditsia triacanthos	Honeylocust	38	7	45%	32%	24%	0%	0%	0%	95%	3%	3%	0%	0%	3%	M	M-H
Hesperotropsis leylandii	Leyland cypress	79	11	27%	35%	24%	8%	6%	0%	97%	3%	0%	0%	0%	1%	n/a	n/a
Ilex aquifolium	English holly	89	8	24%	72%	4%	0%	0%	0%	93%	6%	1%	0%	0%	1%	M	L-M
Juglans regia	English walnut	4	21	25%	25%	0%	0%	50%	0%	75%	25%	0%	0%	0%	25%	M	M-H
Juglans sp.	Walnut species	1	4	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%	n/a	n/a
Juniperus chinensis 'Torulosa'	Hollywood juniper	1	4	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	H	L
Juniperus sp.	Juniper species	20	9	40%	35%	15%	10%	0%	0%	65%	35%	0%	0%	0%	5%	n/a	n/a
Laburnum anagyroides	Common goldenchain tree	11	7	73%	0%	18%	9%	0%	0%	73%	18%	9%	0%	0%	9%	L	H
Laburnum x watereri	Goldenchain tree	1	20	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	n/a	n/a
Lagerstroemia sp.	Crape myrtle	5	3	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	20%	H	L
Larix decidua	European larch	1	28	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	0%	100%	M	M-H
Liquidambar styraciflua	American sweetgum	125	14	6%	18%	59%	11%	6%	0%	82%	15%	2%	0%	1%	1%	L	M
Liriodendron tulipifera	Tuliptree	16	10	31%	44%	19%	0%	6%	0%	88%	6%	0%	6%	0%	6%	L	H
Magnolia grandiflora	Southern magnolia	3	9	67%	0%	0%	33%	0%	0%	100%	0%	0%	0%	0%	33%	M	L-M
Magnolia sp.	Magnolia species	6	6	50%	50%	0%	0%	0%	0%	33%	17%	50%	0%	0%	17%	n/a	n/a
Magnolia stellata	Star magnolia	30	6	60%	37%	3%	0%	0%	0%	97%	0%	3%	0%	0%	3%	n/a	n/a
Magnolia x soulangeana	Saucer magnolia	3	7	33%	67%	0%	0%	0%	0%	100%	0%	0%	0%	0%	33%	n/a	n/a
Malus domestica	Apple	9	10	22%	33%	33%	11%	0%	0%	44%	56%	0%	0%	0%	11%	M	M-H
Malus sp. <flowering>	Apple	111	6	65%	29%	6%	0%	0%	0%	79%	18%	2%	1%	0%	1%	M	M-H
Malus sp.<cultivated>	Apple	26	9	23%	58%	15%	4%	0%	0%	92%	8%	0%	0%	0%	4%	M	M-H
Nyssa sylvatica	Black tulepo	12	3	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	8%	H	L
Ostrya virginiana	Hop hornbeam	33	4	85%	15%	0%	0%	0%	0%	91%	9%	0%	0%	0%	3%	H	L
Parrotia persica	Persian ironwood	164	3	88%	12%	0%	0%	0%	16%	76%	7%	0%	1%	0%	1%	H	M
Picea abies	Norway spruce	10	13	10%	30%	40%	20%	0%	0%	50%	20%	30%	0%	0%	10%	M	M-H
Picea glauca 'Pendula'	Colorado blue spruce	3	16	0%	0%	100%	0%	0%	0%	0%	0%	33%	0%	67%	33%	M	M-H
Picea pungens	Colorado blue spruce	32	14	3%	38%	38%	13%	9%	0%	63%	28%	6%	3%	0%	3%	M	M-H
Picea pungens var. glauca	Colorado blue spruce	44	14	9%	16%	59%	16%	0%	0%	89%	5%	7%	0%	0%	2%	M	M-H
Picea sitchensis	Sitka spruce	14	19	0%	0%	36%	43%	21%	0%	71%	29%	0%	0%	0%	7%	n/a	n/a
Picea sp.	Spruce species	1	3	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	n/a	n/a
Pinus contorta	Shore pine	133	12	10%	42%	35%	11%	2%	2%	59%	29%	6%	0%	4%	1%	H	n/a
Pinus monticola	Western white pine	19	11	53%	5%	11%	21%	11%	0%	84%	11%	0%	0%	5%	5%	n/a	n/a
Pinus nigra	Austrian pine	129	15	2%	24%	50%	16%	9%	0%	81%	16%	2%	1%	0%	1%	M	M-H
Pinus ponderosa	Ponderosa pine	10	24	10%	0%	10%	40%	40%	10%	90%	0%	0%	0%	0%	10%	L	H
Pinus sp.	Unknown Pine	13	8	15%	77%	8%	0%	0%	0%	23%	69%	8%	0%	0%	8%	n/a	n/a
Pinus sp. <2 needle>	Unknown Pine	31	5	77%	23%	0%	0%	0%	0%	100%	0%	0%	0%	0%	3%	n/a	n/a
Pinus strobus	Eastern white pine	4	19	25%	0%	0%	50%	25%	0%	75%	0%	0%	25%	0%	25%	L	H
Pinus sylvestris	Scots pine	65	15	3%	34%	31%	20%	12%	0%	60%	35%	2%	0%	3%	2%	M	M-H
Pinus thunbergii	Japanese black pine	1	8	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	n/a	n/a
Platanus × acerifolia	London planetree	56	13	25%	38%	4%	18%	16%	0%	80%	18%	0%	0%	2%	2%	n/a	n/a
Platanus occidentalis	American sycamore	10	17	0%	0%	60%	30%	10%	0%	100%	0%	0%	0%	0%	10%	M	L-M
Populus alba	White poplar	8	11	50%	25%	0%	0%	25%	0%	63%	38%	0%	0%	0%	13%	M	L-M
Populus balsamifera	Black cottonwood	9	21	22%	22%	0%	0%	56%	0%	100%	0%	0%	0%	0%	11%	n/a	n/a
Populus nigra 'Italica'	Lombardy poplar	18	33	11%	6%	0%	17%	67%	11%	67%	11%	11%	0%	0%	6%	n/a	L-M
Populus tremuloides	Quaking aspen	52	11	19%	37%	27%	15%	2%	0%	94%	2%	4%	0%	0%	2%	M	L-M
Populus trichocarpa	Black cottonwood	71	15	18%	30%	11%	18%	23%	3%	82%	7%	3%	1%	4%	1%	n/a	n/a
Prunus avium <cultivated>	Sweet cherry	125	10	27%	46%	10%	10%	6%	0%	73%	26%	1%	0%	0%	1%	M	M-H
Prunus avium <wild>	Sweet cherry	78	7	54%	32%	10%	3%	1%	0%	76%	21%	4%	0%	0%	1%	M	M-H
Prunus cerasifera	Cherry plum	35	12	3%	51%	34%	9%	3%	0%	83%	17%	0%	0%	0%	3%	M	L-M

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Species	Common Name	#T	MDBH	DC1	DC2	DC3	DC4	DC5	C1	C2	C3	C4	C5	C6	NM	ADPT	VULN
Prunus cerasifera 'thundercloud'	Flowering plum	496	11	13%	47%	32%	7%	1%	1%	52%	41%	5%	0%	1%	0%	M	L-M
Prunus domestica	Sweet cherry	1	15	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	M	L-M
Prunus emarginata	Bitter cherry	32	7	50%	31%	9%	9%	0%	0%	78%	16%	0%	0%	6%	3%	n/a	n/a
Prunus laurocerasus	Cherry laurel	47	7	53%	36%	9%	2%	0%	0%	74%	26%	0%	0%	0%	2%	M	L-M
Prunus lusitanica	Portuguese laurel	5	6	60%	40%	0%	0%	0%	0%	20%	80%	0%	0%	0%	20%	n/a	n/a
Prunus persica	Peach	3	13	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	33%	M	L-M
Prunus serrulata	Japanese flowering cherry	183	14	7%	28%	40%	16%	9%	1%	49%	37%	13%	1%	0%	1%	M	M-H
Prunus sp.	Cherry species	49	9	33%	43%	14%	10%	0%	0%	82%	16%	2%	0%	0%	2%	n/a	n/a
Prunus sp.<flowering cherry>	Flowering plum	10	11	10%	50%	30%	10%	0%	0%	50%	30%	10%	10%	0%	10%	n/a	n/a
Prunus sp.<fruiting cherry>	Fruiting cherry	3	12	0%	33%	67%	0%	0%	0%	100%	0%	0%	0%	0%	33%	n/a	n/a
Pseudotsuga menziesii	Douglas-fir	3561	21	6%	15%	21%	21%	37%	1%	70%	25%	3%	0%	1%	0%	M	H
Pyrus calleryana	Callery pear	173	6	48%	49%	2%	2%	0%	0%	57%	42%	1%	0%	0%	1%	M	L-M
Pyrus communis	Common pear	8	7	13%	88%	0%	0%	0%	0%	100%	0%	0%	0%	0%	13%	M	L-M
Pyrus domestica	Pear tree	3	3	67%	33%	0%	0%	0%	0%	67%	33%	0%	0%	0%	33%	n/a	n/a
Pyrus sp.	Pear tree	4	9	0%	75%	25%	0%	0%	0%	100%	0%	0%	0%	0%	25%	n/a	n/a
Quercus alba	White oak	32	7	59%	25%	16%	0%	0%	0%	38%	63%	0%	0%	0%	3%	L	M
Quercus garryana	Oregon white oak	1314	20	6%	17%	22%	24%	32%	0%	85%	13%	0%	0%	0%	0%	M	L-M
Quercus palustris	Pin oak	79	11	27%	18%	47%	4%	5%	8%	71%	15%	6%	0%	0%	1%	M	M-H
Quercus robur	English oak	37	15	0%	49%	35%	3%	14%	0%	16%	22%	62%	0%	0%	3%	M	M-H
Quercus rubra	Red oak	134	19	4%	10%	31%	28%	26%	0%	89%	10%	1%	0%	0%	1%	M	M-H
Rhus glabra	Smooth sumac	1	4	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	n/a	n/a
Robinia pseudoacacia	Black locust	100	12	20%	42%	14%	7%	17%	0%	79%	16%	4%	0%	1%	1%	M	M-H
Salix babylonica	Weeping willow	1	10	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	n/a	n/a
Salix matsudana 'Tortuosa'	Corkscrew willow	3	18	0%	0%	67%	33%	0%	0%	0%	67%	33%	0%	0%	33%	n/a	n/a
Salix scouleriana	Scouler's willow	11	12	36%	18%	18%	27%	0%	0%	55%	45%	0%	0%	0%	9%	n/a	n/a
Salix sitchensis	Sitka willow	1	6	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	n/a	n/a
Salix sp.	Willow species	2	16	0%	50%	0%	50%	0%	0%	100%	0%	0%	0%	0%	50%	n/a	n/a
Sciadopitys verticillata	Umbrella pine	3	3	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	33%	n/a	n/a
Sequoia sempervirens	Coastel redwood	12	25	0%	17%	17%	25%	42%	0%	83%	17%	0%	0%	0%	8%	L	M
Sequoiadendron giganteum	Giant sequoia	3	23	33%	0%	0%	0%	67%	0%	67%	33%	0%	0%	0%	33%	M	M
Sequoiadendron giganteum 'Pendulum'	Giant sequoia	5	6	40%	60%	0%	0%	0%	0%	100%	0%	0%	0%	0%	20%	M	M
Sorbus aucuparia	European mountain ash	112	7	44%	43%	12%	2%	0%	1%	52%	38%	5%	1%	4%	1%	M	M-H
Styrax japonicus	Japanese snowbell	49	5	65%	35%	0%	0%	0%	0%	82%	12%	6%	0%	0%	2%	M	M-H
Syringa vulgaris	Common lilac	11	2	100%	0%	0%	0%	0%	0%	45%	55%	0%	0%	0%	9%	M	M-H
Taxus baccata	English yew	2	12	0%	50%	50%	0%	0%	0%	100%	0%	0%	0%	0%	50%	n/a	n/a
Taxus brevifolia	Pacific yew	29	14	0%	41%	41%	14%	3%	0%	17%	21%	17%	31%	14%	3%	n/a	n/a
Thuja occidentalis	Eastern arborvitae	137	5	80%	18%	1%	1%	0%	0%	66%	26%	0%	0%	8%	1%	H	M
Thuja plicata	Western red cedar	128	15	12%	37%	16%	10%	25%	2%	61%	24%	6%	2%	5%	1%	H	L
Tilia cordata	Littleleaf linden	56	10	7%	86%	2%	4%	2%	0%	91%	7%	0%	0%	2%	2%	H	M
Trachycarpus fortunei	Chinese windmill palm	7	6	43%	57%	0%	0%	0%	0%	43%	57%	0%	0%	0%	14%	n/a	n/a
Tsuga heterophylla	Western hemlock	25	20	0%	8%	36%	32%	24%	0%	32%	40%	0%	4%	24%	4%	L	M-H
Tsuga mertensiana	Douglas-fir	4	9	25%	50%	25%	0%	0%	0%	100%	0%	0%	0%	0%	25%	M	M-H
Ulmus americana	American elm	2	27	0%	0%	0%	50%	50%	0%	0%	50%	50%	0%	0%	50%	M	L-M
Ulmus pumila	Siberian elm	5	18	20%	20%	0%	20%	40%	0%	80%	20%	0%	0%	0%	20%	M	L-M
Ulmus sp.	Elm tree (species unknown)	53	4	81%	19%	0%	0%	0%	0%	94%	6%	0%	0%	0%	2%	n/a	n/a
Viburnum sp.	Viburnum	2	19	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	50%	n/a	n/a
Zelkova serrata	Japanese zelkova	69	6	52%	48%	0%	0%	0%	0%	62%	35%	0%	0%	3%	1%	H	M

Abbreviation Key

DC1: DBH category 1, 0-6 inches
DC2: DBH category 2, 6-12 inches
DC3: DBH category 3, 12-18 inches
DC4: DBH category 4, 18-24 inches
DC5: CBH category 5, >24 inches

C1: Condition rating category 1, excellent
C1: Condition rating category 2, good
C1: Condition rating category 3, fair
C1: Condition rating category 4, poor
C1: Condition rating category 5, very poor

#T: Number of trees
MDBH: Mean DBH

VULN: Tree species vulnerability ranking per Rutledge and Brandt (2022).
ADPT: Tree species adaptability ranking per Rutledge, A. and Brandt, L.A. (2022). Puget Sound Region: Tree Species Vulnerability Assessment. Summary Report from the Northern Institute of Applied Climate Science (NIACS). White Paper. Houghton, MI: U.S. Department of Agriculture, Northern Forests Climate Hub.

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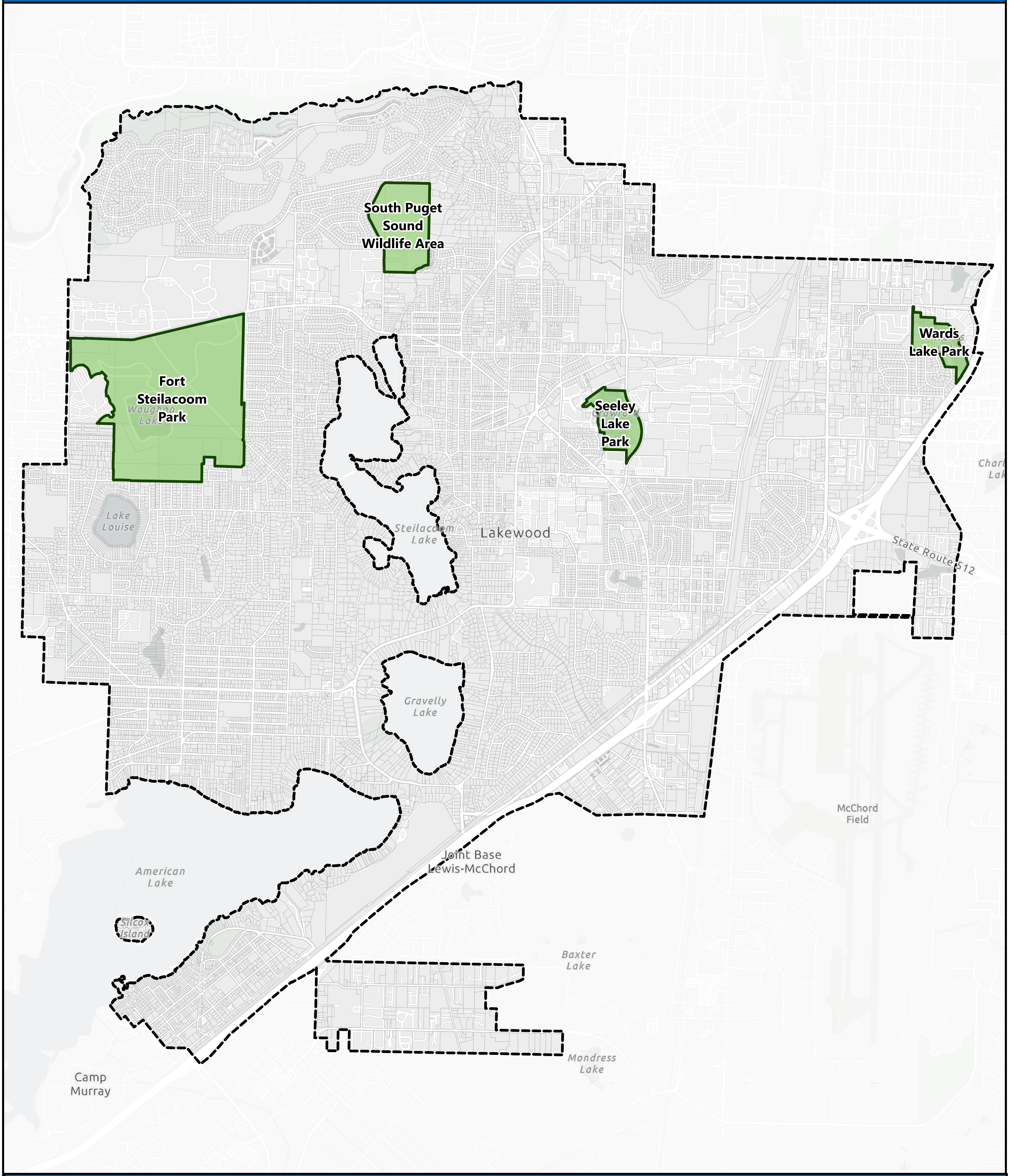
LAKEWOOD FLAT - OVERVIEW



LAKEWOOD APPENDIX MAPS

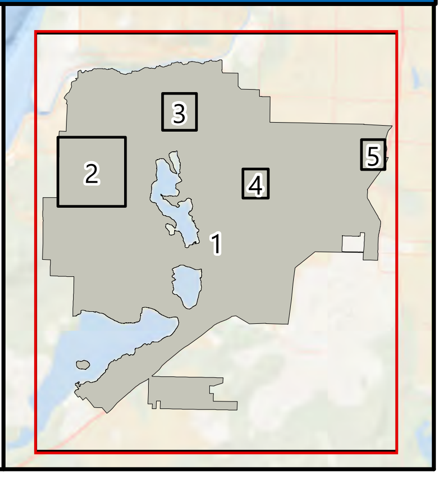
LAYERS

City Boundary

FLAT Sites

Parcels

0 2,000 4,000 Feet



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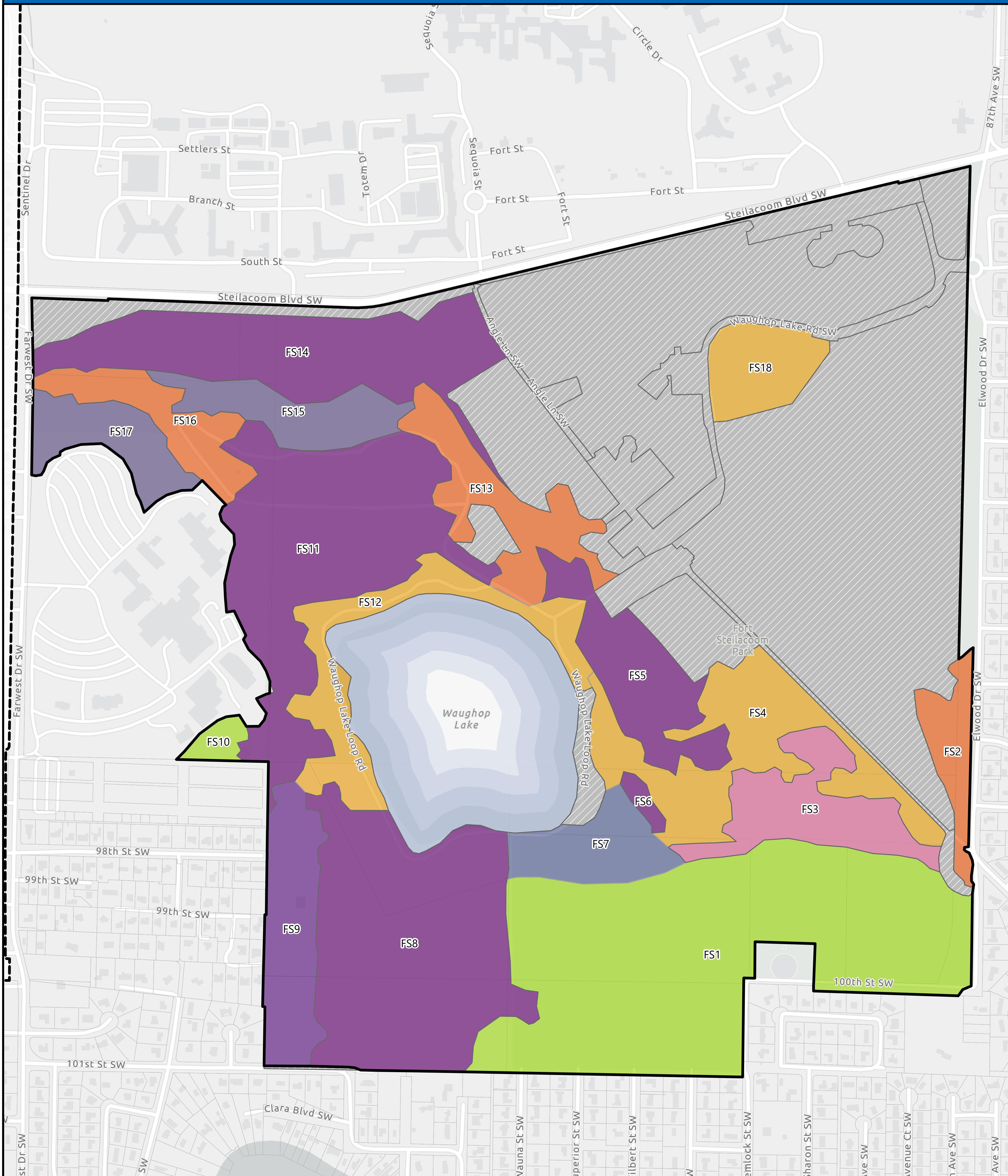
LAKEWOOD FLAT - FORT STEILACOOM PARK



LAKEWOOD APPENDIX MAPS

LAYERS

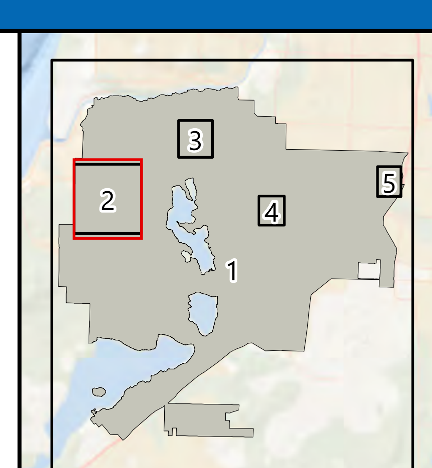
- City Boundary
- Hardscaped or Landscaped
- Natural Area, < 25% Forest Canopy
- Open Water
- Parcels

Tree Composition / Invasive Species Threat

Tree Composition	Low	Med	High
High	1	2	3
Med	4	5	6
Low	7	8	9

Invasive Species Threat

0 440 880 Feet



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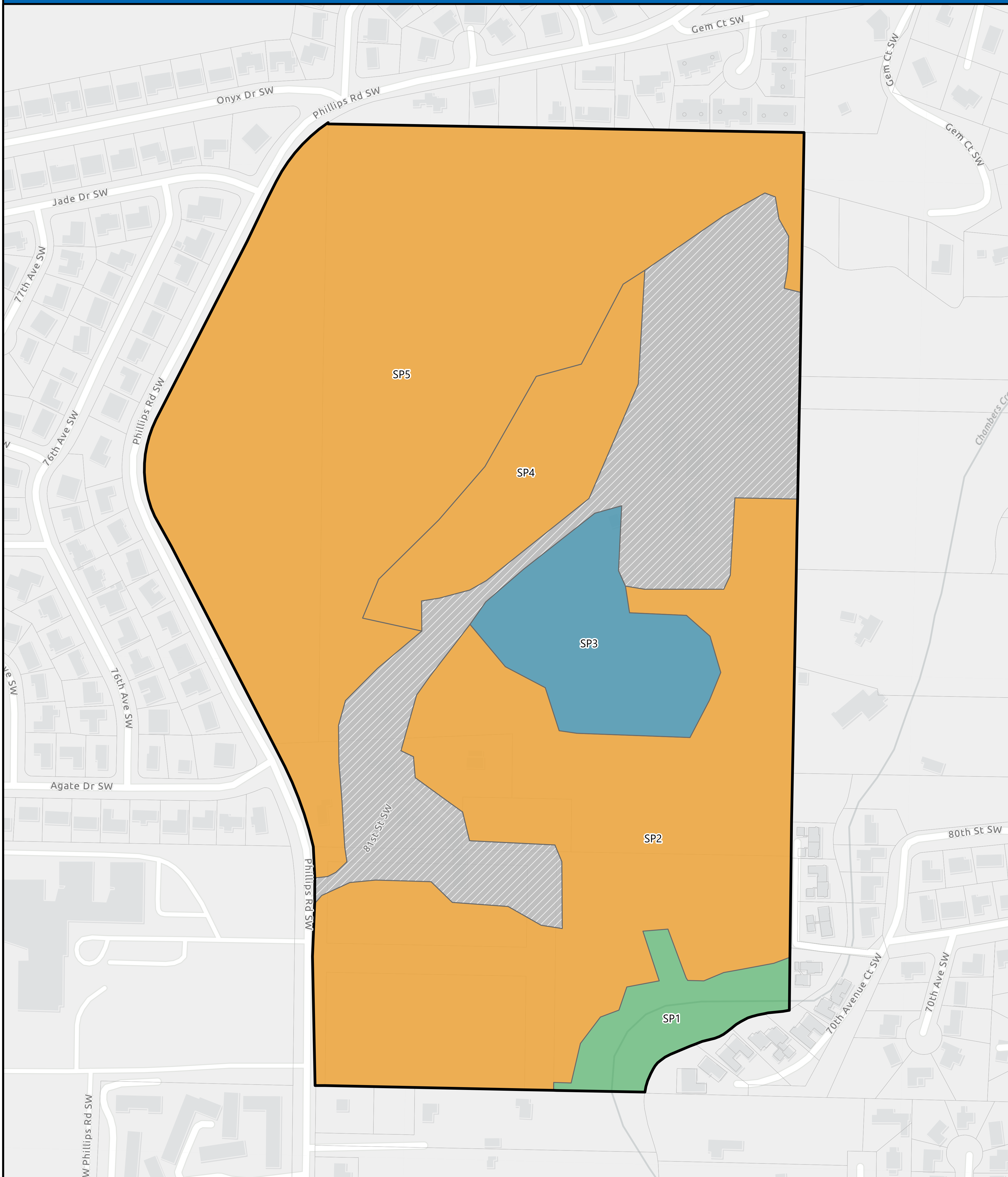
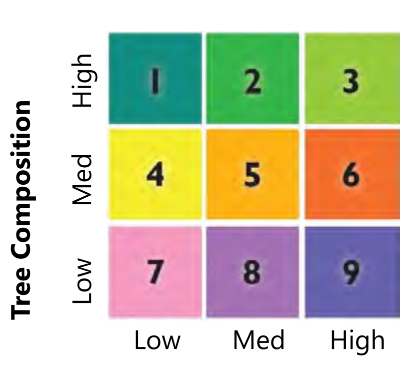
LAKEWOOD FLAT - SOUTH PUGET SOUND WILDLIFE AREA



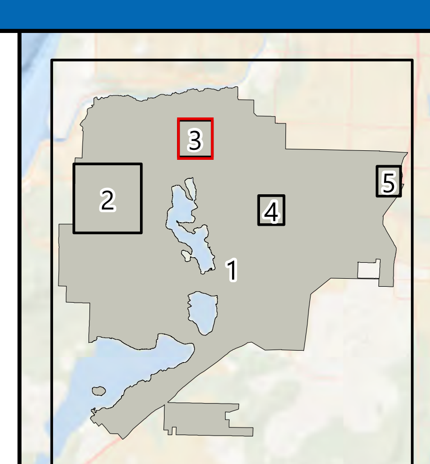
LAKEWOOD APPENDIX MAPS

LAYERS

- City Boundary
- Hardscaped or Landscaped
- Natural Area, < 25% Forest Canopy
- Open Water
- Parcels



0 225 450 Feet



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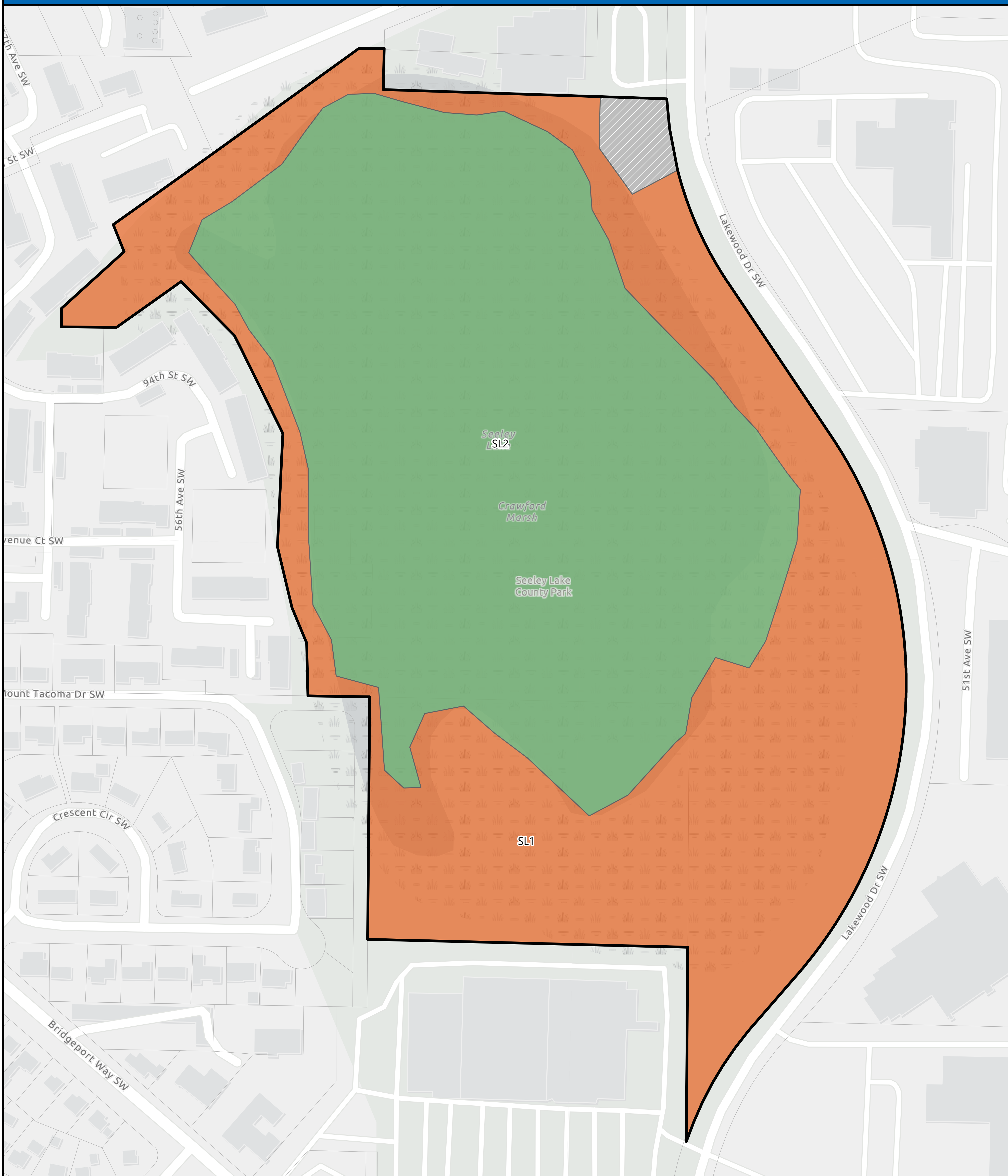
LAKEWOOD FLAT - SEELEY LAKE COUNTY PARK



LAKEWOOD APPENDIX MAPS

LAYERS

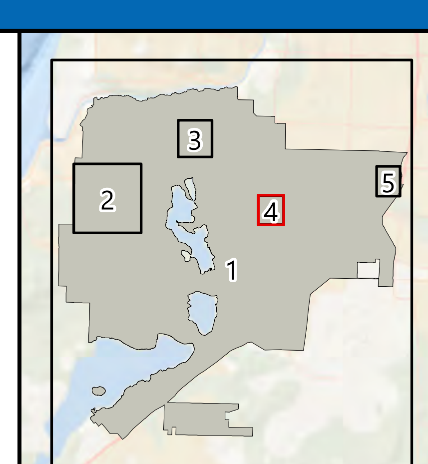
- City Boundary
- Hardscaped or Landscaped
- Natural Area, < 25% Forest Canopy
- Open Water
- Parcels

Tree Composition / Invasive Species Threat

Tree Composition	Low	Med	High
High	1	2	3
Med	4	5	6
Low	7	8	9

Invasive Species Threat

0 160 320 Feet



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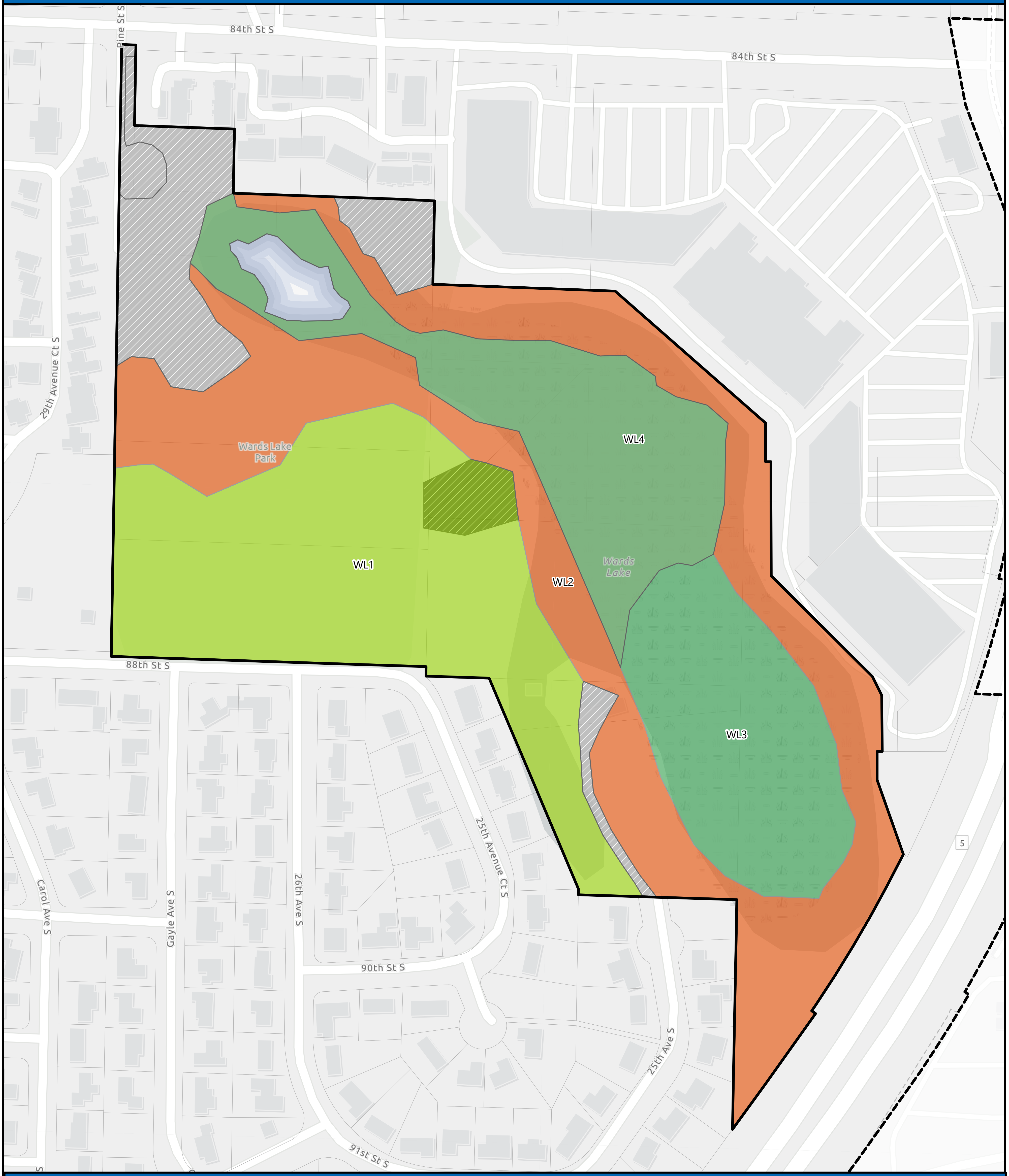
LAKEWOOD FLAT - WARDS LAKE PARK



LAKEWOOD APPENDIX MAPS

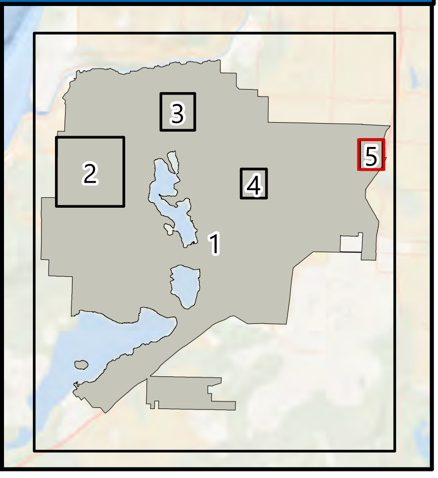
LAYERS

- City Boundary
- Hardscaped or Landscaped
- Natural Area, < 25% Forest Canopy
- Open Water
- Parcels

Tree Composition / Invasive Species Threat

	Low	Med	High
High	1	2	3
Med	4	5	6
Low	7	8	9

0 160 320 Feet



Print Date: 12/18/2024

FACET

APPENDIX G. Tree Inventory Asset Management Consultation Memorandum

TECHNICAL MEMORANDUM

Date:	November 20, 2024
To:	Tiffany Speir, Planning Manager
Cc:	Jeff Rimack, Planning & Public Works Director Mary Dodsworth, Parks, Recreation & Community Services Director
From:	Deb Powers, Senior Arborist Kim Frappier, Senior Urban Forester/Environmental Planner
Project Name:	City of Lakewood 2024 Tree Inventory
Facet Number:	2403.0418

Task 4: Asset Management Software Consultation

Within the urban forest, public trees function as green infrastructure assets that provide a wide range of community benefits. Yet unlike most infrastructure assets, the value of trees appreciates over time. This is further justification to measure and proactively manage public trees for optimal condition and longevity, and to minimize risk to property and people. Urban forests are measured in several ways by (1) assessing the entire population (e.g., the outline of tree canopy cover, as seen from above), (2) by forest stands, or (3) by conducting an individual tree inventory (e.g., trees within public rights-of-way or developed parks). These data can then be analyzed and tracked to inform long-term management decisions or support the day-to-day maintenance of public trees.

This purpose of this technical memorandum is to:

- Document how the City is currently managing its public tree assets.
- Provide an overview of different asset management strategies including how software can be used, variables to consider, and the long-term benefits of tracking specific tree attributes.
- Introduce software options for the City's review prior to engaging with vendors.

What is Tree Asset Management?

Many jurisdictions integrate their public individual tree data directly into a maintenance management system (MMS) such as Hansen, CityWorks, or PubWorks, developed to manage infrastructure assets such as light posts, fire hydrants, or sidewalks. However, unlike static assets, trees are dynamic biological organisms with attributes that change over time, such as health and condition, trunk diameter, and canopy spread. The maintenance status and needs of the tree are also tracked within the MMS and may include specific maintenance tasks such as clearance pruning, planting needed, stump removal, and removal of the tree. Some tree management software programs have been specifically designed to efficiently record and track these changes with other features, such as distributing workloads and strategically prioritizing tree pruning, removal, inspections, and other activities to meet certain management objectives. Many tree software systems interface with ESRI/GIS maps and can integrate with existing municipal maintenance management systems like Cityworks, customer service systems such as 311, and even social media platforms.

Project Background

The City of Lakewood seeks to develop a municipal urban forestry program to ensure a sustainable and resilient urban forest canopy into the future. In June 2024, the City launched the first phase of this effort - a City-wide urban forestry study of both public and private trees, using three data collection methodologies:

1. Individual tree assessment. Specific attributes such as genus and species, DBH (trunk diameter measured at 54 inches above grade), condition, etc. were collected through a “boots-on-the-ground” inventory of individual trees in these locations:
    - City-owned and managed public rights-of-way (ROW)
    - City-owned and managed parks
    - Select public institutional grounds (hospital and campus properties)
    - The Lakewood Clear Zone for the JBLM North McChord Field
2. Forest stand assessment. Forest Landscape Assessment Tool (FLAT) methodology is a stand management approach utilized for large acreage wooded sites. FLAT is a rapid ecological assessment technique used to characterize forest canopy and understory conditions, looking at forest health indicators and levels of invasive species threats. Facet assessed forest stands in Ward Lake, Fort Steilacoom, and Seeley Lake Parks.
3. Tree canopy cover/LiDAR Assessment. Baseline information on private properties where landowner permissions could not be obtained and where individual tree assessment is not cost-effective was needed. Facet collected tree canopy cover data for specific large-acreage properties and census tracts identified in the 2022 tree canopy cover assessment, such as Lakewood Gardens and Tacoma Golf & Country Club. This assessment uses aerial imagery to assess tree canopy cover in given areas. When compared to other land cover areas (impervious surfaces, turf/meadow, water, etc.), this data provides a snapshot of the degree of tree canopy coverage as viewed from above.

This data will become a foundational component of the City’s Urban Forestry Management Plan scheduled for development in 2025. In addition to collecting and analyzing the above-referenced data, this tree inventory project seeks to understand how the City can utilize this data to improve the management and maintenance of publicly owned and managed trees. To that end, Facet is providing consultation services to assist the City in considering how tree data can be utilized City-wide and within each division or workgroup, facilitate awareness of tree data needs across divisions, and introduce tree inventory software system features that may enhance each division's tree management efforts.

Work Session

Facet facilitated a staff work session on October 23, 2024, to gain an understanding of Lakewood's current tree asset management approach, its current staff and program capacity, any data management and work order needs, and the desired public tree maintenance and programmatic goals. To solicit information on the current and anticipated tree management needs, Facet developed questions that would prompt participant discussion in four general categories:

- Public tree management
- Staffing
- Funding/budget
- Current asset management tools

The City of Lakewood 2024 Tree Inventory Project Manager reviewed and approved the specific questions prior to the work session (Attachment A).

Participants

Staff were selected to represent all divisions responsible for trees in some capacity and would reflect both management and maintenance perspectives. Departments that were represented include Planning and Public Works (recently combined in Lakewood) and Parks. Staff positions include directors, managers, and superintendent levels, with roles in capital improvement project management, long-range planning, permitting, development review, code administration, policy/code development, contractor oversight, operations, and maintenance. Facet's Kim Frappier and Deb Powers facilitated the work session. Participants included:

- Tiffany Speir, Planning Manager; 2024 Tree Inventory Project Manager
- Mary Dodsworth, Parks Director
- Jeff Rimack, Director of Planning & Public Works
- Troy Pokswinski, Planning & Public Works Capital Projects Manager
- Weston Ott, City Engineer
- Angie Silva, Assistant Director of Planning & Public Works
- David de la Cruz, Parks Development Project Manager
- Scott Williams, Parks and ROW Maintenance Superintendent

It was noted that field staff responsible for public tree care were not represented in the work session. The City Project Manager arranged for field staff to submit a completed questionnaire later, which has been included in the responses below.

Work Session Outcomes

At the onset of the work session, Facet asked participants to describe what role they have in urban forest management and what they hope to use the tree inventory data for, providing examples like "track ongoing tree health," "track planting activities," "prioritize maintenance needs," or "provide daily work orders." Although participants had specific focus areas in mind at the beginning of the work session, the group became engaged and interested in managing trees for a broad range of objectives through the 1.5-hour session. The following responses were derived from the questions but also resulted from the organic discussions related to the four categories below.

PUBLIC TREE MANAGEMENT: WHAT ARE YOUR OBJECTIVES?

Participants stated that their needs for tree data related to management or programmatic issues rather than day-to-day asset maintenance. Staff identified the need for both canopy cover data, as well as individual tree assessment data for various reasons:

- Canopy cover data is important to support/track progress towards a City-wide canopy cover goal to support climate change, housing policy, and private property regulatory issues. Canopy cover may help to manage "other" trees – presumedly on private property – that obstruct street trees. Park staff expressed the need to understand how park tree canopy cover can be described in the the Parks Legacy Plan.
- Individual tree assessment data is needed for general asset maintenance/management, to run data queries, to track planting/removal of ROW trees, to better manage ROW permits, and for any work, including construction in the ROW. Individual tree data is also needed to
    - Improve transfer of responsibilitites between Operations and Maintenance.
    - Better manage public trees for species diversity, age distributuion, condition and health of tree stands.
    - Shift from a mostly response-driven approach using the 311 customer service system to a more proactive, strategic management approach.

When asked which trees staff are currently managing, the responses reflect the departments represented in the work session: Planning and Public Works and Parks.

STAFF: WHAT IS CURRENT CAPACITY?

City staff were asked to describe their current operations (e.g., the process of how crews are assigned and accomplish tasks) and questions related to public tree maintenance and management of inventory data. Staff responsible for tree maintenance disclosed that there has been little proactive management since 2002, and that tree planting, minor operations, and high-priority tasks are done on a more response-driven model. That approach didn't allow for preventative maintenance, opportunistic improvements, and permit/plan review related to removal, pruning, and planting requests. Examples – provided included:

- Pruning is usually generated from the 311 system, an annual work plan for street trees, and a school-generated work plan for bus clearance. Pruning is proactive only on an as-needed, project-by-project basis. No proactive corridor pruning or regular monitoring takes place.
- Tree removals are usually related to an accident response, when trees are damaged and cut to a stump when scheduled. Stump removals occur twice per year when they have a plethora of stumps. The resulting available spaces are not on a replanting schedule.
- There is no active plan for tree replacements/replanting for park and street trees.
- Contractors or a third-party arborist are brought in for major operations as needed to offset the staff of four that are responsible for maintaining all ROW and park trees (in addition to other duties such as roadside mowing).
- There is an ISA-Certified Arborist on Parks staff, who is utilized for minor tree risk assessments and to perform park tree maintenance.

FUNDING/BUDGET CONSIDERATIONS

When asked if funding or other resources had been established for tree inventory software acquisition, participants responded that the urban forestry program has yet to launch and that funding decisions were deferred to a later date, after a baseline had been established for what their needs are and who will maintain the data.

CURRENT ASSET MANAGEMENT TOOLS

The City currently utilizes StreetSaver MMS combined with an ESRI-based GIS system and Excel spreadsheets to keep track of tree assets. Currently, Parks and Public Works field staff update existing tree data, but it hasn't been formally acknowledged who will maintain the new tree data collected as part of the 2024 tree study. A more focused, long-term discussion is needed about asset management tools. The City's current permit database system is the PALS system (Pierce County) but will be changed to Camino by July 2025.

The City is currently using the following tools to track on-the-ground maintenance needs:

- Field Maps Collector to update tree inventory data which can be accessed on mobile devices.
- An in-house ArcGIS module to track locations and other data. An IT program spearheads this.
- Spreadsheets with limited data fields, which are not used to assign work, establish priorities, analyze trends, etc.
- The 311 customer service platform, which is being used as a work order system and set time frames for completing work tasks.

Future Software Needs

City staff stated that the tree asset management software is needed to facilitate the shift from reactive to proactive management using priority levels and work schedules by area or ROW corridors. It was noted that software functionality should also inform contractors' work and help to establish levels of service for budgeting purposes. It was mentioned that a prior tree assessment provided a 5-year plan to spread out work based on priorities that distinguished immediate needs from the operations that could be distributed over near and longer-term periods, which would be automated by software.

Staff identified the following priority software features considered high priority to meet key maintenance and management objectives:

- Tree attributes that are easily accessible (in the field) and could be manipulated for queries and reporting purposes including tree species, DBH, health/condition, heritage tree status, and planting date.
- Capability of easily using the same data to manage assets for species diversity, age distribution, and other objectives.
- Daily work orders for ROW and formally landscaped park area trees (but not open space forested areas) that relate to a strategic planning approach, such as pruning cycle/corridor pruning, seasonal tree planting, ensuring equitable distribution of public tree care throughout the City, etc. versus a reactionary "putting out fires" approach.
- Scheduled, proactive monitoring to prevent tree failure due to pests/disease infestation, abundance of poor condition/senescent/hazard trees, accidental damage resulting from inadequate clearances, etc.
- Capability to easily provide the public and decision-makers a better understanding of the urban forest, specific trees (e.g. Heritage Trees), or service level/budget concerns.

Some additional features identified by staff that could be useful software functions include:

- Use of data to quantify ecosystem services or other benefits (iTree tools).
- Capability to reference files (or interface with a City database) to easily obtain information such as arborist reports related to individual inventoried public trees.
- Set up reminders triggered by date or certain actions, such as "monitor" or "require arborist report".
- Show potential conflicts or impacts to other infrastructure elements, such as local utilities (overhead or underground), pathways, etc.
- Integrate with customer service reporting platforms that generates work orders, such as the current Lakewood 311 in use, or other municipality's "See, Click, Fix" system so work requests overlay with tree data and mapping information.

Linking Tree Attributes to a Healthy Urban Forest

Often, the technology selected to streamline municipal processes may not deliver the same features or functions as expected. The resulting platform may be unsuitable for the primary users, or the features may not have been carefully considered for all users and audiences or to remain relevant in its future use. To guide decisions in selecting tree inventory software options, the following attributes are considered key performance indicators of a healthy, resilient urban forest (Clark et al 1997) that remain relevant today as criteria for managing public trees. Most of these have already been identified by staff as management objectives or desired software features. When weighing the different needs identified by staff herein with software costs, Facet recommends the City keep the following performance indicators at the forefront for decisions related to software acquisition.

- **Accessible canopy cover data**. Benefit: baseline canopy data can optimize the coordination of development services, improve internal efficiency, and serve as a tool for public outreach.
- **Current canopy cover data**. Benefit: tracked over time and compared to canopy cover policy goals, is an indicator of acceptable levels of environmental health and liveability balanced with growth and development.
- **Public tree inventory**. Benefit: proactively manage public trees and monitor service levels, develop work plans appropriately, and justify funding needs. Quantify assets, risks, and liabilities. Plan proactive tree management strategies and distribute workloads efficiently. Lower public tree maintenance costs.
- **Uneven tree age distribution** (a balance of large and small DBH trees). Benefit: facilitates long-term budget forecasting. Annual costs for the care of public trees can be more evenly distributed over many years. A varied age-class distribution is important for optimizing environmental benefits and results in a healthier, more resilient and sustainable urban forest.
- **Species suitability.** Benefit: informs tree planting and removal strategies that reduce tree maintenance and removal costs.
- **Species diversity.** Benefit: Healthier, resilient and sustainable urban forest. Informs tree planting and removal strategies that reduce substantial impacts or catastrophic loss from pests or disease. (e.g., Dutch elm disease, Emerald Ash borer), which is costly for municipalities.
- **Public tree condition.** Benefit: Successful budgeting. Increased public safety. Reduced risk.
- **Management of trees and vegetation in public natural areas.** Benefit: The value of the asset is known and preservation/maintenance is easier to track, resulting in healthier, more resilient natural areas.
- **Tree planting and establishment.** Benefit: Ensure an even urban forest succession, increase tree canopy cover and mitigate effects resulting from tree removal on public and private property. Control costs by proactively replacing tree assets on public property.
- **Native trees/vegetation.** Benefit: Resilient urban forest if climate-adaptable replacement species are considered. Often requires less maintenance, optimizes ecosystem health, and provides pollinator and wildlife habitat.

Based on the Clark model for sustainable urban forest programming, the ability to track and manage tree attributes associated with these criteria ensures efforts are aligned with best practices toward a healthy, resilient urban forest.

Next Steps

Collecting inventory data on public trees is a major step towards proactive management of an important infrastructure asset. So that public trees function well in their intended landscape, provide optimal benefits to the community, and remain reasonably safe for property and people, this technical memo was developed in anticipation of the City of Lakewood establishing an urban forestry program and acquiring its tree management software. Recognizing how the City is currently managing its public tree assets, combined with recent findings from updated tree inventory data enables the City to consider appropriate tree asset management software and management strategies, enabling a shift from a reactive to more proactive public tree management approach.

Ideally, the software system will support and not dictate a user's management objectives and activities. The work session outcomes herein help to understand what types of questions the inventory needs to answer. Yet, as development of the urban forest program progresses, additional information will be needed on:

- Who will be responsible for managing the system?
- Is the tree inventory software under consideration compatible with StreetSaver, Lakewood 311, or other existing platforms?
- How much training time is required by the software, compared to staffing capacity?
- What kind of upgrades and technical support does the software company offer?

Facet recommends that the City consider the features and costs of various municipal tree inventory software platforms (Attachment A) to answer these and additional questions and considerations that the software users may have. Facet can also facilitate the scheduling of software demonstrations to assist in the decision-making process.

If you have any questions, please contact us at your convenience.

References

Clark, J., Metheny, N., Cross, G., Wake, V. 1997. A Model of Urban Forest Sustainability. Journal of Arboriculture 23(1): January 1997.

Attachments:

ATTACHMENT A. Work Session Questions

FACET

Formerly DCG/Watershed

Tree Management Software Programs

The purpose of this list is to introduce software options for City review, prior to engaging with vendors. The list comprises software options for municipal tree management, with features that integrate into other municipal platforms. Because features and options vary widely across tree management software platforms and costs are regularly updated, only contact information and general notes are provided below.

Table 1. Tree Management Software.

Tree Inventory Software/App	Developed by	Notes
My City's Trees https://mct.tfs.tamu.edu/app	US Forest Service, Texas A&M Univ., and i-Tree	Open source. Launched in Chicago, available for 9+ cities in the US. Web-based
Tree Plotter https://planitgeo.com/treeplotter/	PlanIT Geo	Web/cloud-based GIS tree inventory platform optimized for live access using mobile devices.
OpenTreeMap https://opentreemap.github.io/	Azavea	Open source or subscription inventory-ecosystem services calculation tool. Used by cities such as Philadelphia, San Francisco, and Grand Rapids.
TreeKeeper https://www.davey.com/environmental-consulting-services/treekeeper-inventory-management-software/	Davey Resource Group	Web/cloud-based GIS tree inventory platform optimized for live access using mobile devices. Extensive features and ability for custom functions and strong customer support. Drawbacks include cost and may have a steep learning curve for new users.

Tree Inventory Software/App	Developed by	Notes
Tree Works https://www.kenersongroup.com/Home/TreeWorksOnline	Kenerson Group (Community Forests Consultants, Jim Flott) https://www.asca-consultants.org/members/?id=38116022	Online ESRI GIS-based platform. Collect data with traditional Windows-based devices with ArcPad or edit inventory with live access using mobile devices.
Arbor Pro https://arborprousa.com/arborpro-software/	ArborPro Management Software	Web/cloud-based GIS tree inventory platform optimized for live access using mobile devices.
Ecoteka https://www.natural-solutions.world/ecoteka	Natural Solutions, Inc.	Open-source platform (free to use and customize) with mobile device accessibility, easy to use. Tracks tree condition and maintenance activity. Drawbacks include limited advanced features and basic mapping capabilities.
Urban Forest Ecosystem Service Benefits Software		
iTree Streets https://www.itreetools.org/tools/i-tree-streets	Davey/USFS (previously Stratum)	Assess street tree benefits using existing inventory data. Can collect data on mobile device
iTree Eco https://www.itreetools.org/tools/i-tree-eco-mobile-data-collection-mdc	Davey/USFS (previously UFORE)	See above. Calculates ecosystem service benefits, can collect inventory data.
BenMAP https://www.epa.gov/benmap	EPA, integrated into iTree ECO	Uses GIS data to estimate economic and health implications of urban forests based on air quality.

ATTACHMENT A. Work Session Questions

City of Lakewood
Tree Management Software Consultation

Tree inventory asset management helps municipalities keep track of routine tree maintenance and can be used for both short- and long-term urban forest planning and management processes. There are several software programs specifically designed to manage tree inventory data, track ongoing tree health, planting activities, and maintenance needs, and provide day-to-day work orders (See Table 1 on page 4 for a list of tree management software programs). Some jurisdictions integrate their tree inventory data directly into their public works asset management software (e.g. CityWorks) where each tree is treated and tracked as an asset, much like a fire hydrant or street segment.

The following questions are intended to solicit information to better understand the City's current and anticipated tree management tracking needs, staffing, and existing asset management system. After the work session, Facet will draft a summary memo with additional information and recommendations based on city staff feedback.

Why and which tree assets are you managing?

1. How will you be using your tree data? Typically, inventories are used to
    a. Proactively manage assets, versus responding to the highest priorities ("putting out fires")
    b. Manage assets with specific objectives for species diversity, age distribution, etc.
    c. Ensure equitable distribution of tree care services
    d. Prevent catastrophic loss due to pests/disease infestation, abundance of poor condition/senescent/hazard trees, etc.
    e. Quantify ecosystem services or other benefits
    f. Give the public a better understanding of the urban forest, certain tree populations or specific trees (e.g. Heritage Trees)
    g. Identify new tree planting areas, etc.
2. Which trees are you looking to manage?
    a. ROW (arterials/collectors, side streets, unopened/unmaintained ROW)
    b. Parks (formal landscaped or managed areas)
    c. Green belt/open space/forested areas
    d. Individual trees that meet certain criteria ("notable")?
3. Which tree attributes (species, DBH, condition, etc.) need to be collected or updated regularly to achieve your primary objectives?
4. Does inventory software need to categorize:

a. Management actions

b. Priority levels, ie high, medium, and low for scheduling work by area or ROW corridors

c. Management cycles for different intensities or pruning objectives (e.g., establishment/young tree structural pruning years 1-4, sight-line and clearance pruning years 5-10+, mature tree pruning years 6-7+ on a rotational basis thereafter. As needed for emergencies, accidents, inclement weather, etc. tree removal, or urgent pruning needs.

5. Who is the audience for inventory data findings/results and mapping?

   a. Decision-makers for budgeting and policy purposes

   b. Public education/outreach

Staffing

6. Who is collecting and updating tree inventory data?

   a. City arborist/urban forester

   b. Public works staff

   c. Parks staff,

   d. Consultants

   e. Volunteers

7. After the data is collected, will manage the data? [Consider the steps/frequency of inventory updates for tree removals, plantings, inspections, or other actions that change DBH or condition attributes and if those inventory updates could occur in the field.]

   a. City arborist/urban forester

   b. Maintenance staff

   c. GIS staff

   d. Other

Funding/Budget Considerations

8. What is the City's budget and resources available for Tree Asset Management Software?

Current Asset Management Program

9. What MMS (maintenance management system) is your Public Works or Parks department using now for managing grey infrastructure assets such as sidewalks, sewer/stormwater? Examples: Hansen, etc.

10. Is the system a web-based, cloud-based app? Does it have the capability to adapt its attributes, run queries, or be compatible with other inventory software? Static vs. dynamic asset management.

11. What permit database software is your City using now? Energov, Advantage, TraKit/ComDev, etc.

12. Are your MMS assets mapped in GIS so data can be shared by other departments? Viewed online?

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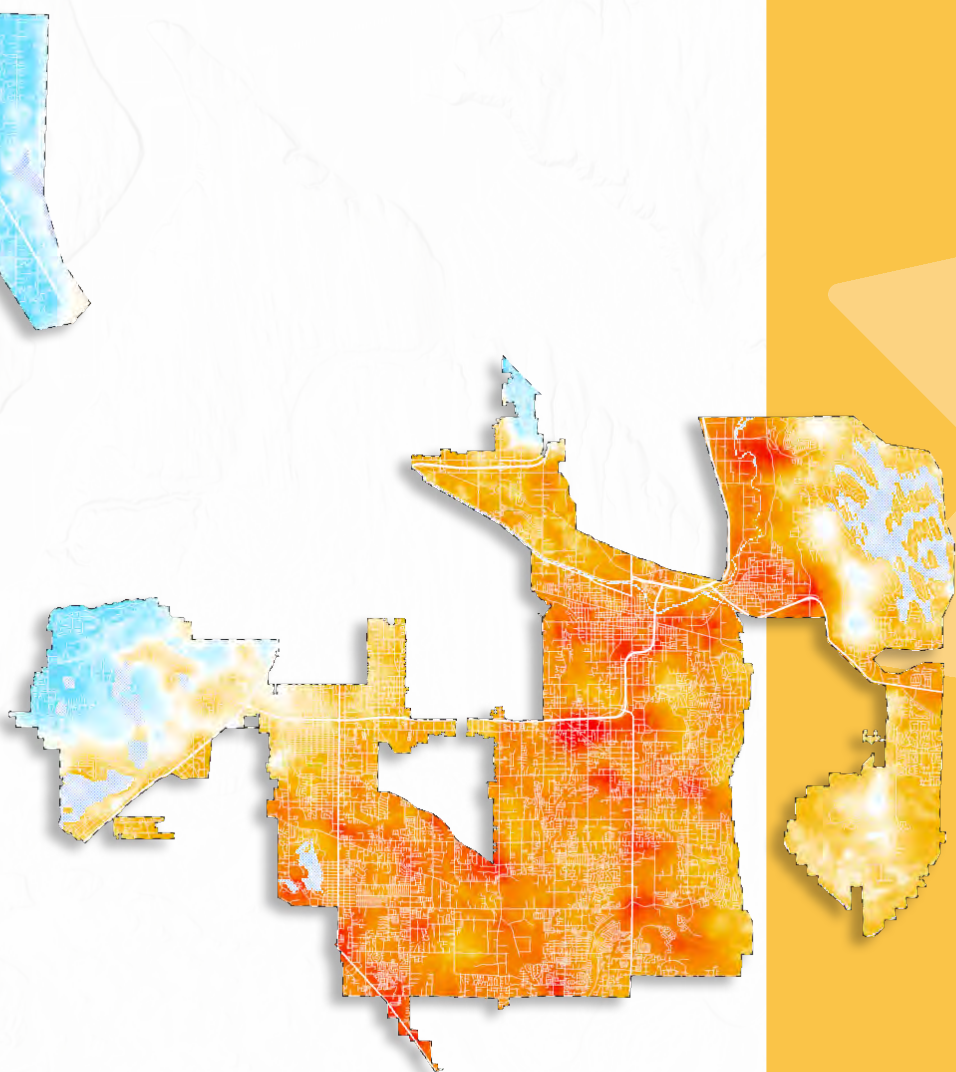
Pierce County
Washington



CAPA strategies

HEAT WATCH Report

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Acknowledgements

The CAPA Heat Watch program, equipment, and all related procedures referenced herein are developed through a decade of research and testing with support from national agencies and several universities. Most importantly, these include our partners at the National Integrated Heat Health Information System, the National Oceanic and Atmospheric Administration's (NOAA's) Climate Program Office, and National Weather Service, including local weather forecast offices at each of the campaign sites, The Science Museum of Virginia, and U.S. Forest Service (USDA). Past support has come from Portland State University, the Climate Resilience Fund, and the National Science Foundation. We are deeply grateful to these organizations for their continuing support.

Heat Watch Pierce County was conducted as part of the CAPA-NIHHIS 2024 Heat Mapping Campaign. Learn more about the campaign and this public-private partnership here.

This report was prepared by CAPA Strategies, LLC

September 2024

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Executive Summary

We know that extreme heat is the most deadly of all natural disasters and that its impacts are not evenly distributed across people and places. Location matters. Those who live in historically disinvested neighborhoods, with limited access to resources and greenspace, and those struggling with additional health concerns are all at greater risk when it comes to the impacts of extreme heat. Our infrastructure systems (e.g. energy, transportation) are also at risk, which can further compromise a region's capacity to provide essential cooling resources. Heat Watch provides a new level of detail about where heat is most concentrated across cities, improving on coarse satellite-derived descriptions and better describing the human experience of heat.

Accomplishing this high level of detail and spatial coverage is only made possible by the efforts of campaign organizers and local volunteer data collectors, who co-designed a mobile monitoring study with CAPA to measure heat across the diverse land uses and geographical features of your region. Heat-focused partnerships emerged between local stakeholders like residents, municipal staff, health officials, emergency responders, researchers, and non-profit organizations. Throughout the process, teams learned about the Urban Heat Island (UHI) effect in their area and raised awareness of the issue through training, discussions, and media coverage.

Volunteers at Tacoma Tree Foundation table.

Heat Watch is one step in the journey towards adaptation to extreme heat. By bridging innovations in community climate action, sensor technology, and spatial analytics, together we have achieved two main objectives:

1. Developed high resolution descriptions of the distribution of ambient (air) temperature and humidity (heat index) across your region; and

2. Engaged local communities to create partnerships to better understand and address the inequitable risks posed by extreme heat

The results provide a snapshot in time of how urban heat varies across neighborhoods and how local landscape features affect temperature and humidity. In this report we present the process, mapping outputs, media coverage and photographs from Heat Watch, as well as next steps for how to build on the results.

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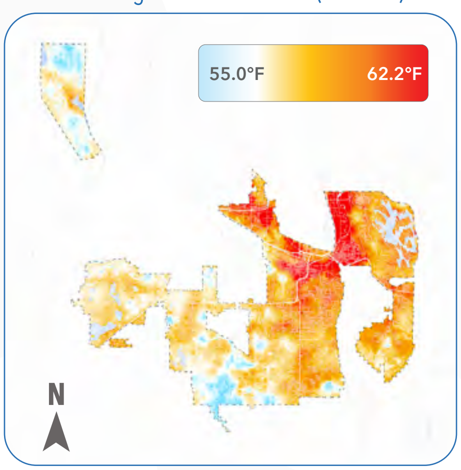
Executive Summary

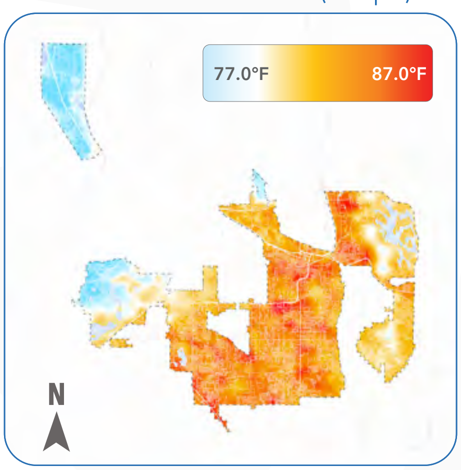
The results presented in this report are the traverse point data – the heat measurements collected by participants – and 'area-wide models' which are generated through analysis of the traverse points and their surrounding landscape features. We focus primarily here on temperature to establish a baseline of the results, while relative humidity and heat index results are available separately.

In reviewing the results, please note that while absolute temperatures (e.g. 94.1°F) are provided, we recommend focusing on the distribution of temperatures (e.g. top 20% hottest areas) within each time period. As temperatures rise, the hottest places are likely to remain the hottest. The report also includes a Frequently Asked Questions section with further detail on the data, models and visuals produced.

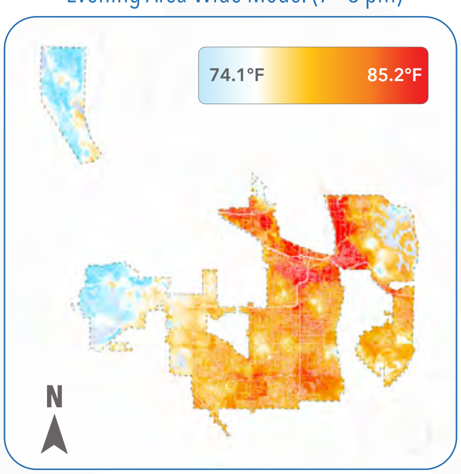
Morning Area-Wide Model (6 - 7 am)



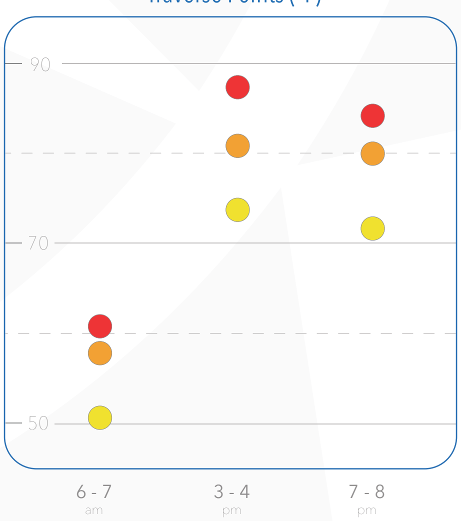
Afternoon Area-Wide Model (3 - 4 pm)



Evening Area-Wide Model (7 - 8 pm)



Traverse Points (°F)



Study Date

August 4th, 2024

157.0 mi²
Study Area

42
Volunteers

16
Routes

123,691
Measurements

88.8°F
Max Traverse Temperature

14.1°F
Max Temperature Differential

HEAT WATCH

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Welcome

Congratulations and thank you to all of the organizers and participants of Heat Watch Pierce County! After weeks of planning and coordination, local partners successfully completed their heat mapping campaign by collecting thousands of temperature and humidity data points in the morning, afternoon and evening of a long, hot day on August 4th, 2024. Using this information, CAPA analysts were able to generate highly detailed models of urban heat across the study region and throughout the day.

With this new information, local decision makers will be better equipped to safeguard human life against the growing impacts of extreme heat. Heat Watch serves as an essential part of a broader 'heat planning' framework that provides a comprehensive approach for adaptation to heat. When situated with local contextual information that describes social, physical and economic conditions, Heat Watch data can help to identify people and places at highest risk to extreme heat and drive appropriate intervention strategies and policies.

CAPA Strategies is a team of analysts, planners and social scientists who recognize the need for holistic, data-driven, and equity-focused approaches to climate action. Heat Watch is one tool in a systematic process for identifying risks and advancing actions for local adaptation to our warming planet. Through collaborative and community-based approaches such as this, we envision a more connected, informed and climate resilient region.

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CAPA HEAT WATCH

Process

CAPA Strategies has developed the Heat Watch campaign process over several iterations, with methods well established through peer-reviewed publications[1], testing, and refinement.

The current campaign model requires leadership by local organizers, who engage community groups, new and existing partner organizations, and the media in generating a dialog about effective solutions for understanding and addressing extreme heat.

CAPA provides training, equipment, and support to the recruited community groups as they endeavor to collect primary temperature and humidity data across a metropolitan region.

The seven main steps of the campaign process are summarized to the right. An overview of the analytical modeling methodology is presented later in this report and described at full length in peer-reviewed publications.

1. Goal Setting

Campaign organizers determine the extent of their mapping effort, prioritizing areas experiencing environmental and social justice inequities. CAPA then divides this study area into routes, each containing a diverse set of land uses and land covers.

2. Engagement

Organizers recruit volunteers, often via non-profits, universities, municipal staff, youth groups, friends, family, and peers. Meanwhile, CAPA designs the data collection routes by incorporating important points of interest such as schools, parks, and community centers.

3. Training

Volunteers attend a training session to learn the why and how of the project, their roles as data collectors, and to share their personal interest in the project. Participants sign a liability and safety waiver, and organizers assign teams to each polygon and route.

4. Activation

With the help of local forecasters, organizers identify a high-heat, clear day (or as near to one as possible) and coordinate with their volunteer teams. Once confirmed, CAPA ships the sensor equipment and bumper magnets to be distributed to campaign participants.

5. Execution

Volunteer teams conduct the heat campaign by driving sensor equipment along pre-planned traverse routes at coordinated hour intervals. Each second the sensors collect a measurement of ambient temperature, humidity, longitude, latitude, speed and course.

6. Analysis

Organizers collect and return the equipment, and CAPA analysts begin cleaning the data, as described in the Mapping Method section below, and utilize machine learning algorithms to create predictive area-wide models of temperature and heat index for each traverse.

7. Implementation

Campaign organizers and participants review the Heat Watch outputs (datasets, maps, and report), and campaign teams meet with CAPA to discuss the results and next steps for addressing the distribution of extreme heat in their community.

[1] The most relevant and recent publications to the Heat Watch campaign process include:

Shandas, V., Voelkel, J., Williams, J., & Hoffman, J., (2019). Integrating Satellite and Ground Measurements for Predicting Locations of Extreme Urban Heat. Climate, 7(1), 5. https://doi.org/10.3390/cli7010005

Voelkel, J., & Shandas, V. (2017). Towards Systematic Prediction of Urban Heat Islands: Grounding Measurements, Assessing Modeling Techniques. Climate, 5(2), 41. https://doi.org/10.3390/cli5020041

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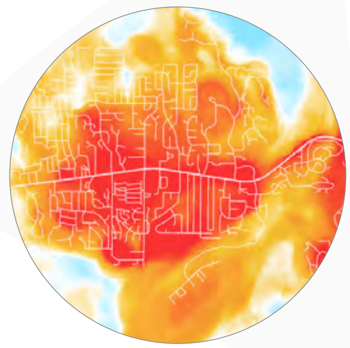
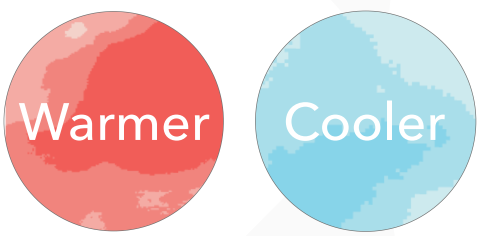
About The Maps

The following sections present results from the campaign: traverse point measurements and area-wide models at morning, afternoon and evening. Below are several key details to keep in mind as you view the results.

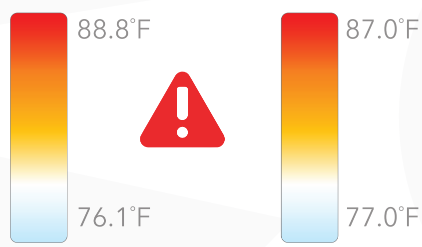
Traverse point maps present the near-surface air temperature measurements gathered during the campaign, filtered to usable data for modeling.



Area-wide maps present high resolution models of temperature across the study area based on the traverse points and Sentinel-2 spectral imagery.



The data are classified by natural breaks in order to clearly illustrate the variation between warmer (red) and cooler (blue) areas across the map.



Note that the scales are different between the traverse point and area-wide maps due to the predictive modeling process.

How does your own experience with heat in these areas align with the map?

Find your home, place of work, or favorite park on the maps and compare the heat throughout the day to your personal experience.

What about the landscape (trees, concrete buildings, riverside walkway) do you think might be influencing the heat in this area?

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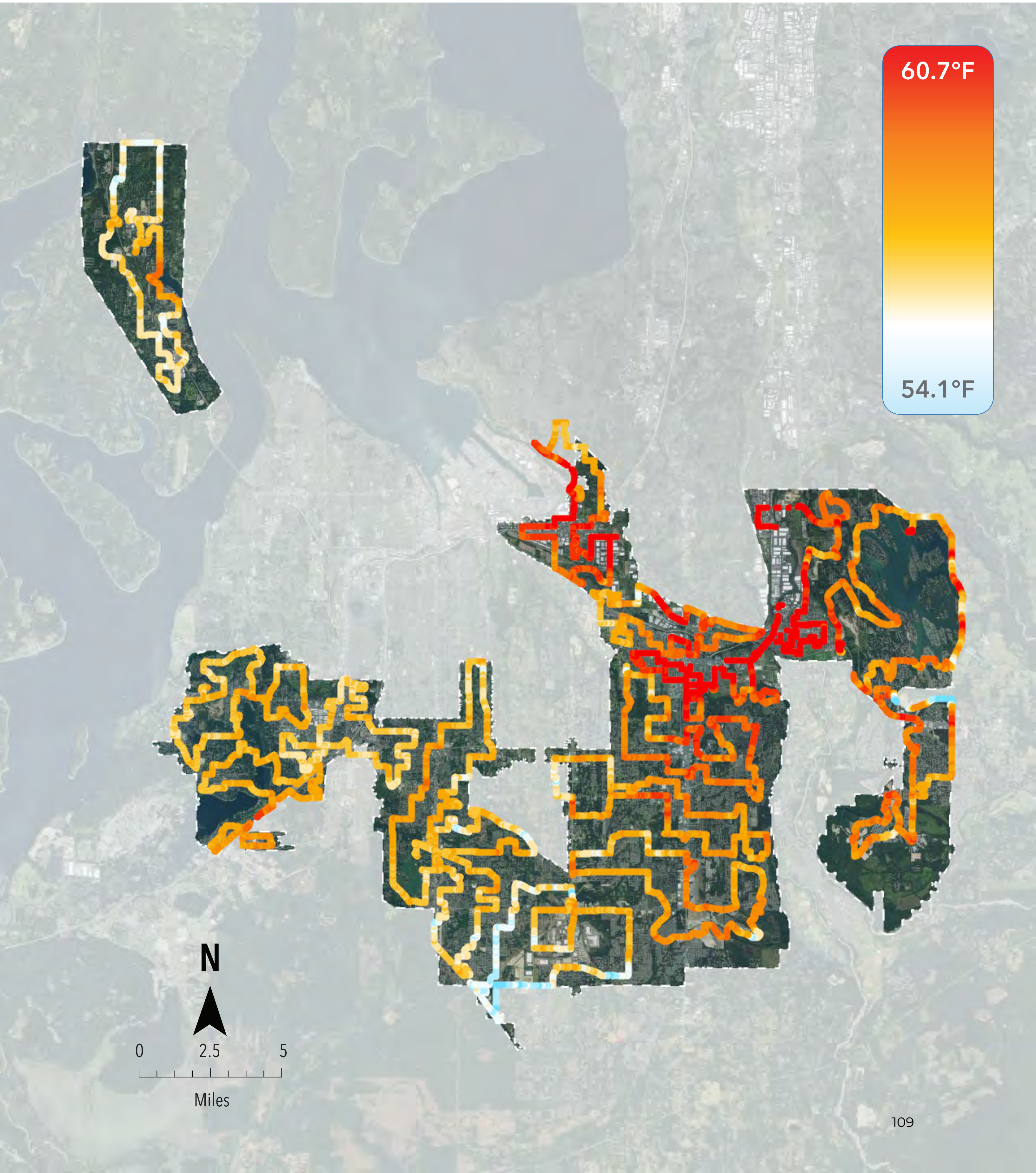
Morning Traverse Points

Temperature (6 - 7 am)



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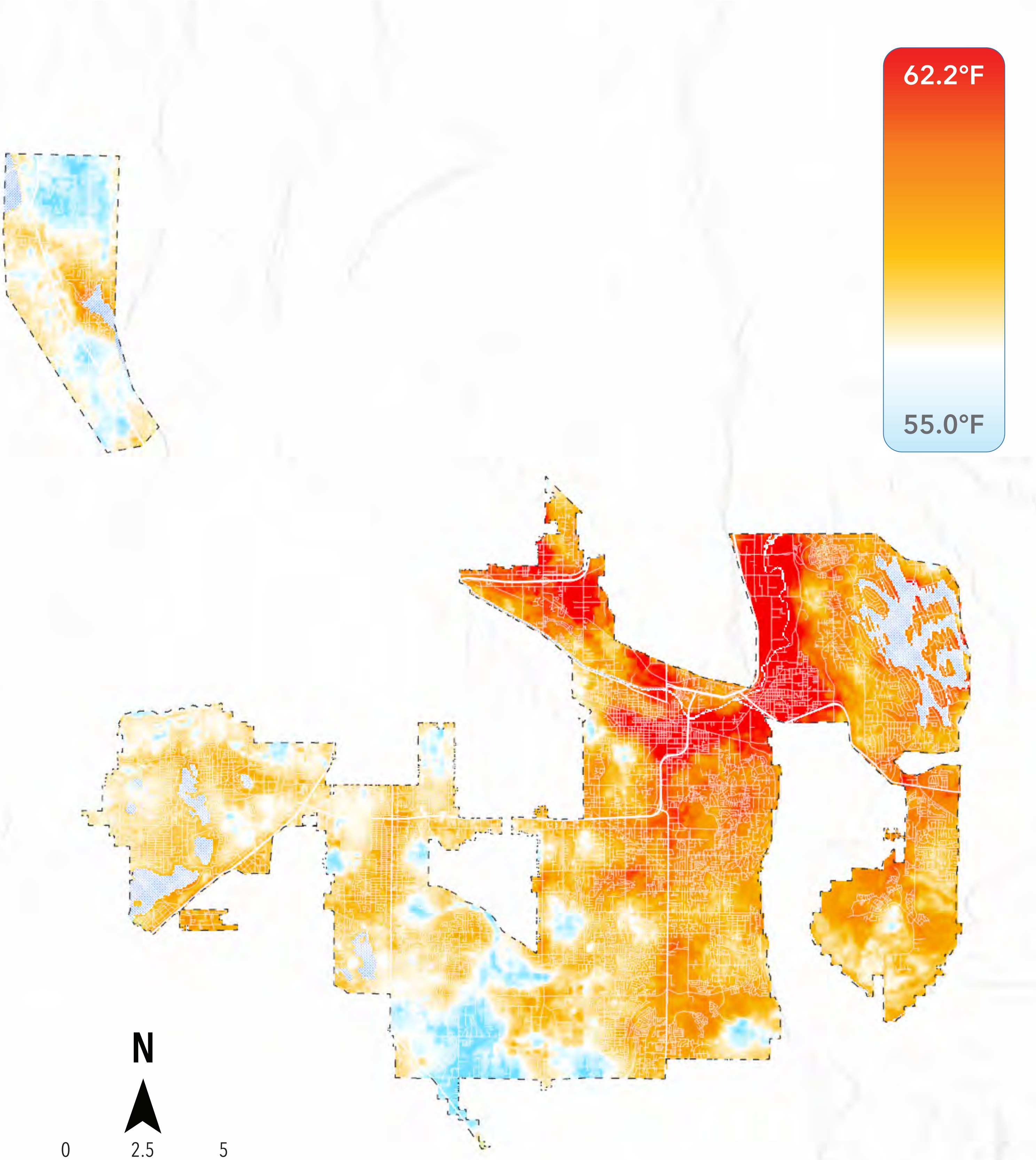
Morning Area-Wide Model

Temperature (6 - 7 am)



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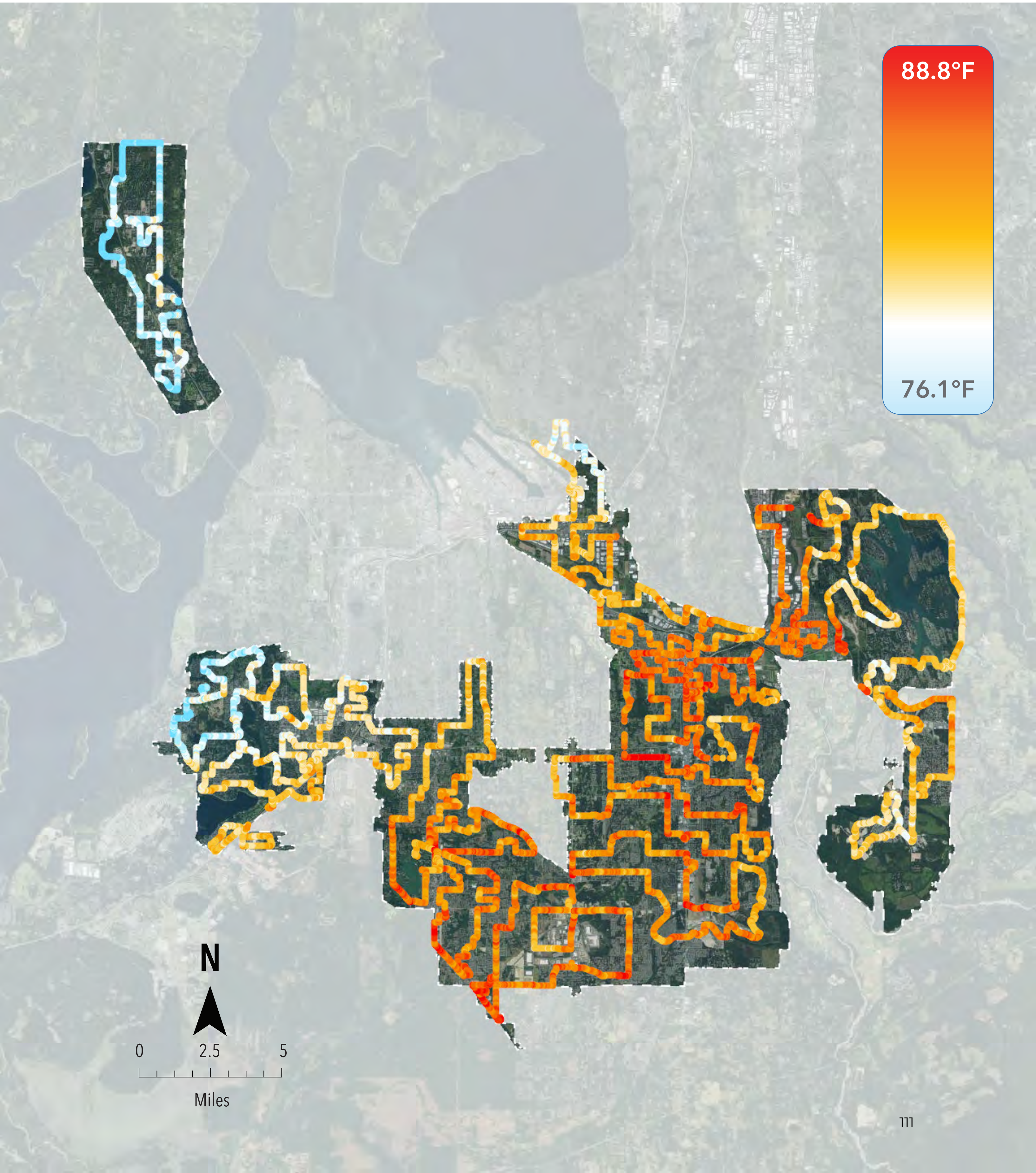
Afternoon Traverse Points

Temperature (3 - 4 pm)



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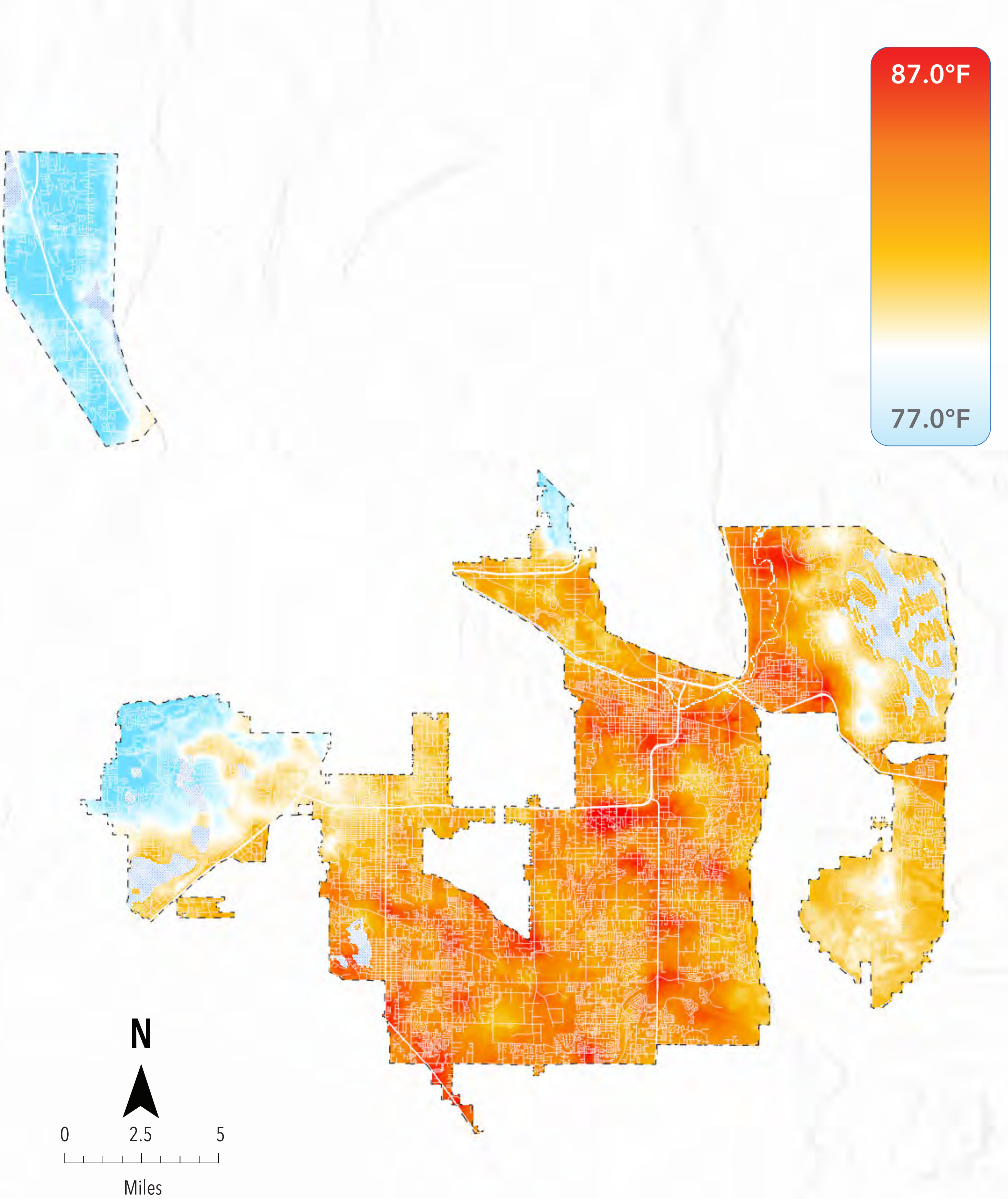
CAPA

Afternoon Area-Wide Model

Temperature (3 - 4 pm)

HEAT WATCH



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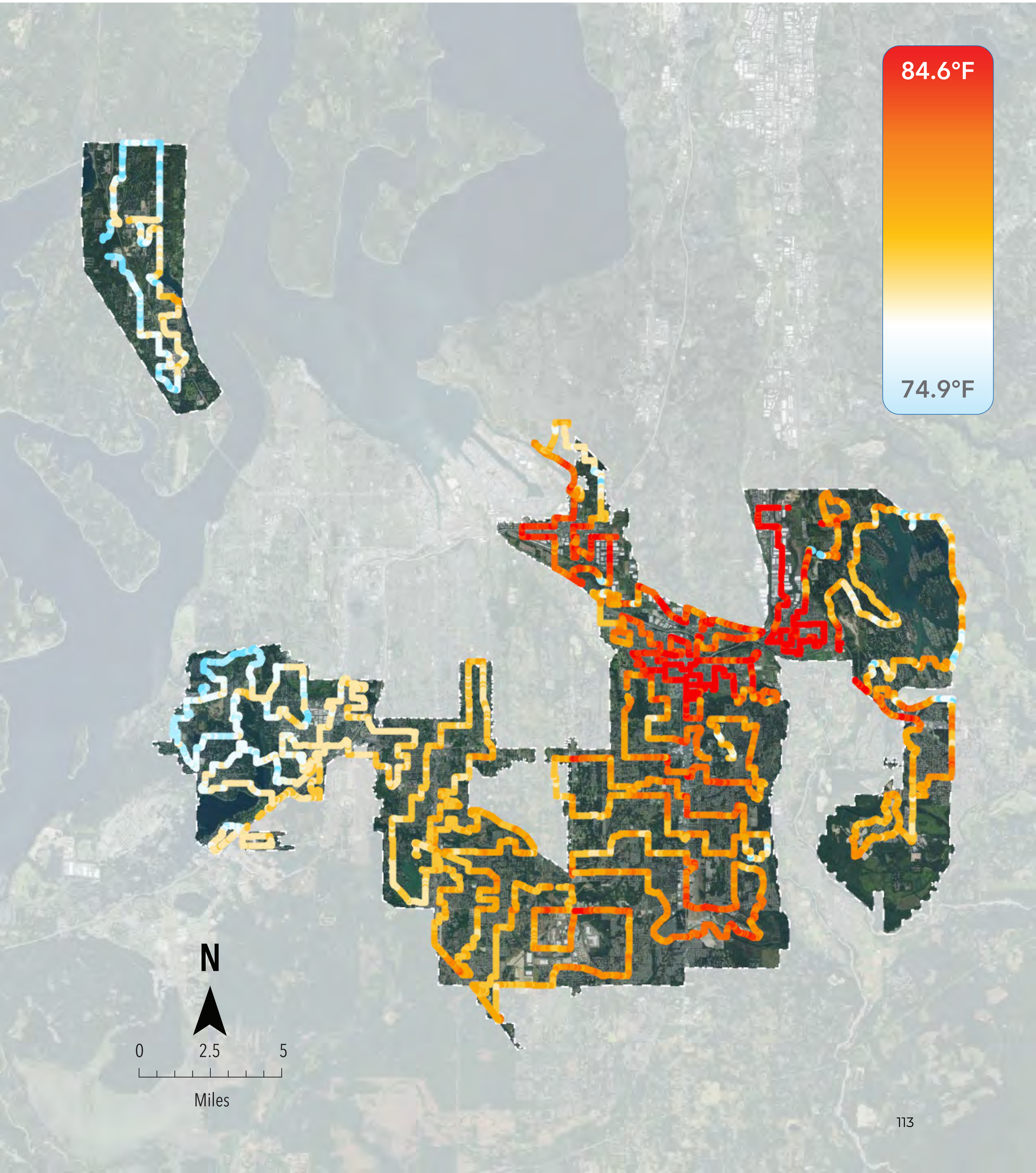
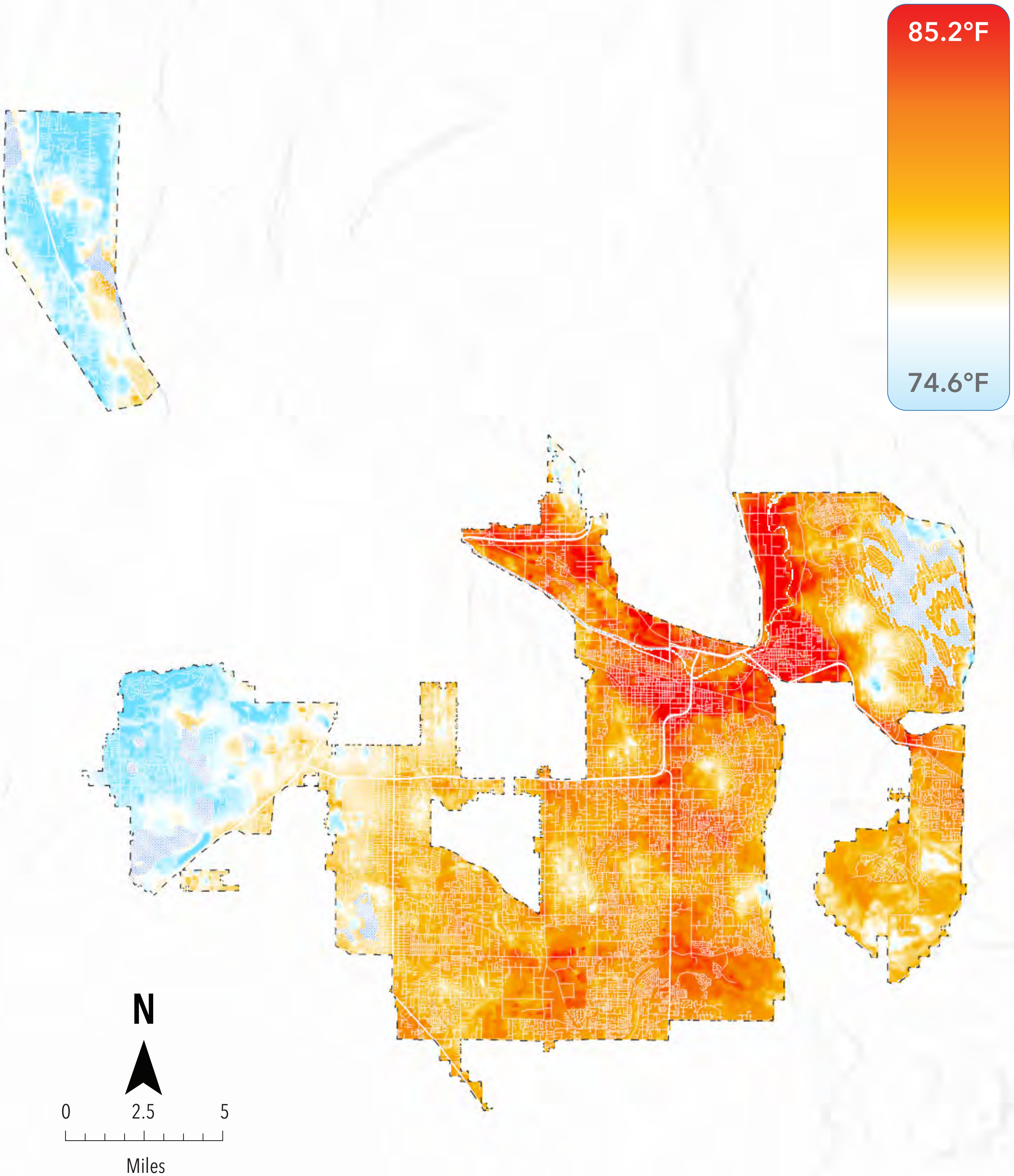
Evening Traverse Points

Temperature (7 - 8 pm)



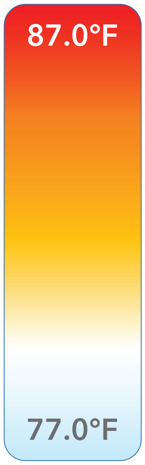
Evening Area-Wide Model

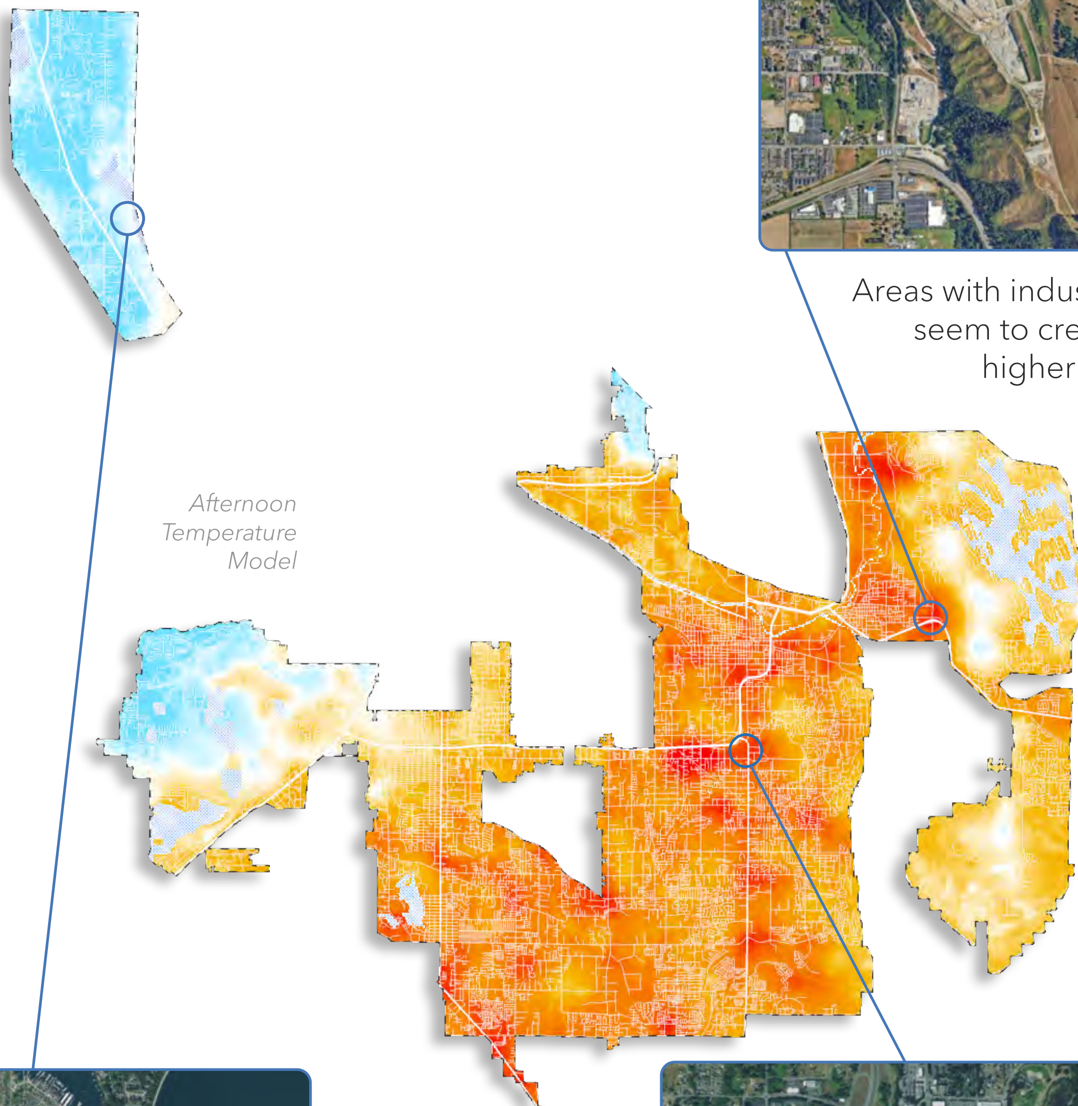
Temperature (7 - 8 pm)



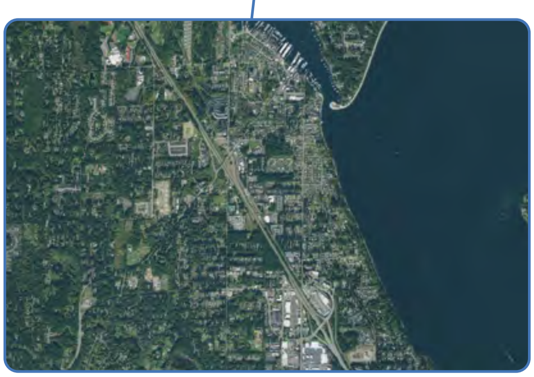
Initial Observations

The distribution of heat across a region often varies by qualities of the land and its use. Here are several observations of how this phenomenon may be occurring in your region.





Areas with industrial land uses seem to create pockets of higher temperatures.



The presence of street trees and proximity to water can serve to alleviate heat in dense urban areas.

Built-up urban areas appear to concentrate heat throughout the day and evening time.

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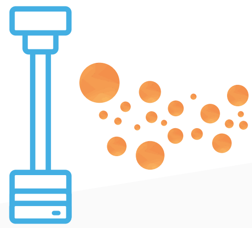
Modeling Method

The three key steps and geospatial processes that allow CAPA analysts to transform traverse point data into area-wide models of temperature.

1 Download & Filter

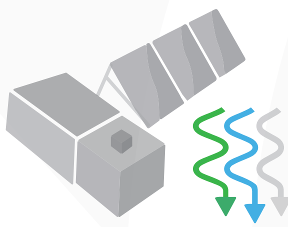


Download raw heat data from cloud storage

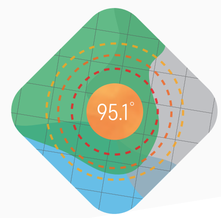
Compare data with field notes and debrief interview

Trim data to proper time window, speed, and study area

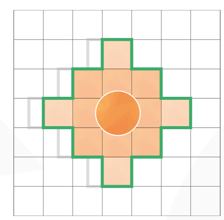
2 Integrate & Analyze



Download multi-band land cover rasters from Sentinel-2 satellite

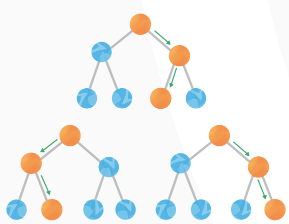


Calculate spectral indices reflecting land cover features

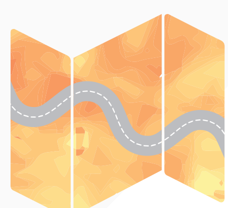


Transform land cover rasters using a moving window analysis

3 Predict & Validate



Combine heat and land cover data in geostatistical model



Create predictive raster surface models of each period

Perform cross validation using k-fold holdout method

The most relevant and recent publications include:

Shandas, V., Voelkel, J., Williams, J., & Hoffman, J., (2019). Integrating Satellite and Ground Measurements for Predicting Locations of Extreme Urban Heat. Climate, 7(1), 5. https://doi.org/10.3390/cli7010005

Voelkel, J., & Shandas, V. (2017). Towards Systematic Prediction of Urban Heat Islands: Grounding Measurements, Assessing Modeling Techniques. Climate, 5(2), 41. https://doi.org/10.3390/cli5020041

CAPA

Technical Notes

Comments on the process, outputs and evaluation of the modeling process

HEAT WATCH

Accuracy Assessment*	
Model Period	Adjusted R-Squared
6 - 7 am	0.95
3 - 4 pm	0.86
7 - 8 pm	0.94

Accuracy Assessment

To assess the strength of our predictive temperature models, we employ a 70:30 "holdout cross-validation method," which consists of predicting 30% of the data with the remaining 70%, selected randomly. An 'Adjusted R-Squared' value of 1.0 is perfect predictability, and 0 is total lack of prediction. Additional information on this technique can be found at the following reference: Voelkel, J., and V Shandas, 2017. Towards Systematic Prediction of Urban Heat Islands: Grounding measurements, assessing modeling techniques. Climate 5(2): 41.

Field Data

Like all field campaigns, the collection of temperature and humidity data requires adherence to a specific set of protocols and experimental controls. In the event that unreported or undetected error is introduced during the data collection process, the accuracy of the resulting datasets and models may be compromised in quality. While our team has a developed a multi-stage process for quality assurance and quality control (outlier removal), some errors can go unidentified and undetected, and thereby compromise the accuracy of the results. We suggest keeping this nature of field data collection in mind when reviewing the results.

Prediction Areas

The traverse points used to generate the areas wide models do not cover every square mile of the studied area -- rather, we take a sampling approach to gather representative measurements across the diversity of land-use, land-cover, and biophysical attributes of each study area. We suggest keeping this sampling and modeling approach in mind when reviewing the results.

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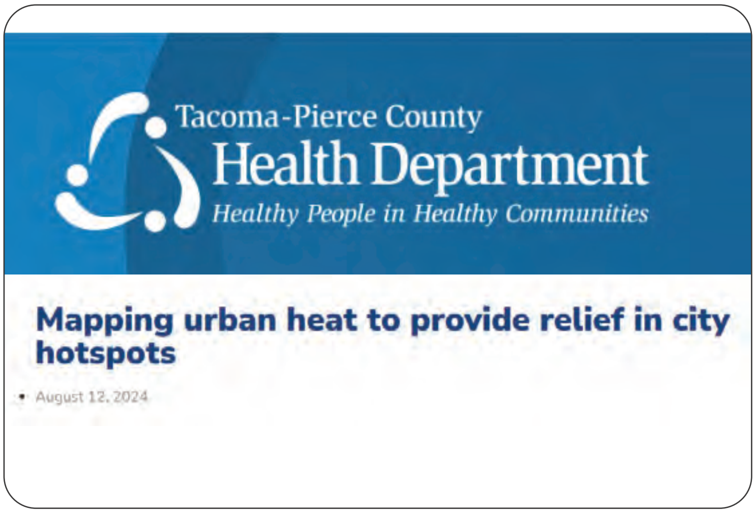
CAPA

Media

HEAT WATCH

Participant photos and news stories covering the campaign



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CAPA

Media

Participant photos and news stories covering the campaign

HEAT WATCH

Next Steps

Heat Watch data provides new and valuable descriptions of how heat is distributed across your city or region. With these new datasets in-hand, there are several short- and long-term next steps you can follow to build upon this work. We first suggest validating the information with local stakeholders, generating interpretations and meanings through further analysis, and/or employing the data across a myriad of applications for heat mitigation and heat preparedness. Consider how different communities and sectors are affected by these results. The collaboration between partners and volunteers who planned and conducted the campaign may also serve as a strong network for future efforts on heat.

Using GIS software you may investigate relationships between heat and the built environment using land use, canopy cover and impervious surface data; assess social vulnerability factors like age and income; and calculate impacts in specific sectors such as energy and public housing. The data may guide you in identifying priority areas for tree planting, planning resilience hubs in high-need areas, or understanding how much heat is present along transportation routes to schools. Such questions and many others can all be better addressed using the high resolution ambient descriptions provided by Heat Watch data.

These new datasets may also prompt and support further research needs into the intersection of heat with overlapping natural hazards like air quality as well as the indoor experience of residents during heat waves, and future projections of heat based on models of emissions levels and climate change. We know that increased temperatures will also lead to increased energy use and grid vulnerability. In fact, nearly all sectors of urban life are likely to be affected by rising temperatures and at inequitable rates of impact to our cities' populations.

Heat Action Plan

A significant longer-term application of Heat Watch results is building out a comprehensive and systematic approach to address the many physical, social and economic threats of extreme heat facing your communities. Developing a "Heat Action Plan" is essential for situating heat data within current conditions and stakeholder interests, defining local risk to extreme heat, and assembling actionable and place-based intervention strategies.

CAPA

HEAT WATCH

Next Steps

As plans can be complex documents requiring technical subject expertise, CAPA aims to support cities with an accessible Heat Action Plan product. This plan builds on Heat Watch data, synthesizes existing local plans, policies, and climate projections, collects social data from local communities, sets priorities, and offers recommendations for heat action at citywide and neighborhood levels. We capture baseline information about exposure, context, and potential risk, while revealing directions for deeper research, analysis, and strategy development. As a comprehensive document, CAPA's Heat Action Plan may serve as the central point of guidance and evaluation of progress towards local resilience to heat.


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We are thrilled to be a part of your path towards heat resilience and look forward to continuing to build a better prepared and more climate-responsive world together!

CAPA

HEAT WATCH

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Frequently Asked Questions (FAQ)

A. Data and Access

A1. How can I access the data from Heat Watch?

All Heat Watch data (traverses, models and metadata) are available on the Open Science Framework (OSF). When first delivered to campaign leaders, the OSF page is provided as a view-only link; once the results are approved by the local team, CAPA will update the OSF page to be publicly accessible. All Heat Watch data, this summary report, and metadata will then be available for download and use by the public.

A2. In what format are the data provided?

The traverse point data from each time period (morning, afternoon and evening) are provided as vector shapefiles.The models from each time period are provided as geo-tiff rasters at 10-meter resolution. In order to view and manipulate these data, GIS software is needed.

A3. What is the accuracy of the traverse point temperature measurements?

The Heat Watch sensor includes a temperature probe that is accurate to ±0.5°F. The response time (the amount of time it takes for the sensor to accurately measure a change in temperature) is 1 second.

B. Relative Humidity and Heat Index

B1. Where are the relative humidity and heat index results, and why are only the temperature results displayed in this report?

The relative humidity measurements and heat index calculations are provided in the traverse shapefiles for each time period; heat index models are provided with the rasters. We focus on temperature data in the report because it is the most plainly understood variable and based more on direct measurements of the environment. Temperature then provides the basis for incorporating relative humidity to calculate heat index.

B2. What is the accuracy of the relative humidity measurements?

The accuracy of the relative humidity sensor is ±3%.

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Frequently Asked Questions (FAQ)

B3. What is heat index and how is it calculated?

Heat index is an approximation of the heat felt when the presence of humidity is felt in combination with temperature. We calculate heat index by combining the measured traverse point temperature with its corresponding relative humidity measurement using the same equations as advised by the National Weather Service. Note that there are multiple ways of calculating heat index at various thresholds. To learn more, visit https://www.weather.gov/safety/heat-index.

B4. Where can the relative humidity and heat index data be accessed?

All results are available through OSF, and the relative humidity and heat index data can be viewed and manipulated using GIS software.

C. Maps and Visualization

C1. How can I visualize the data and make maps similar to the report?

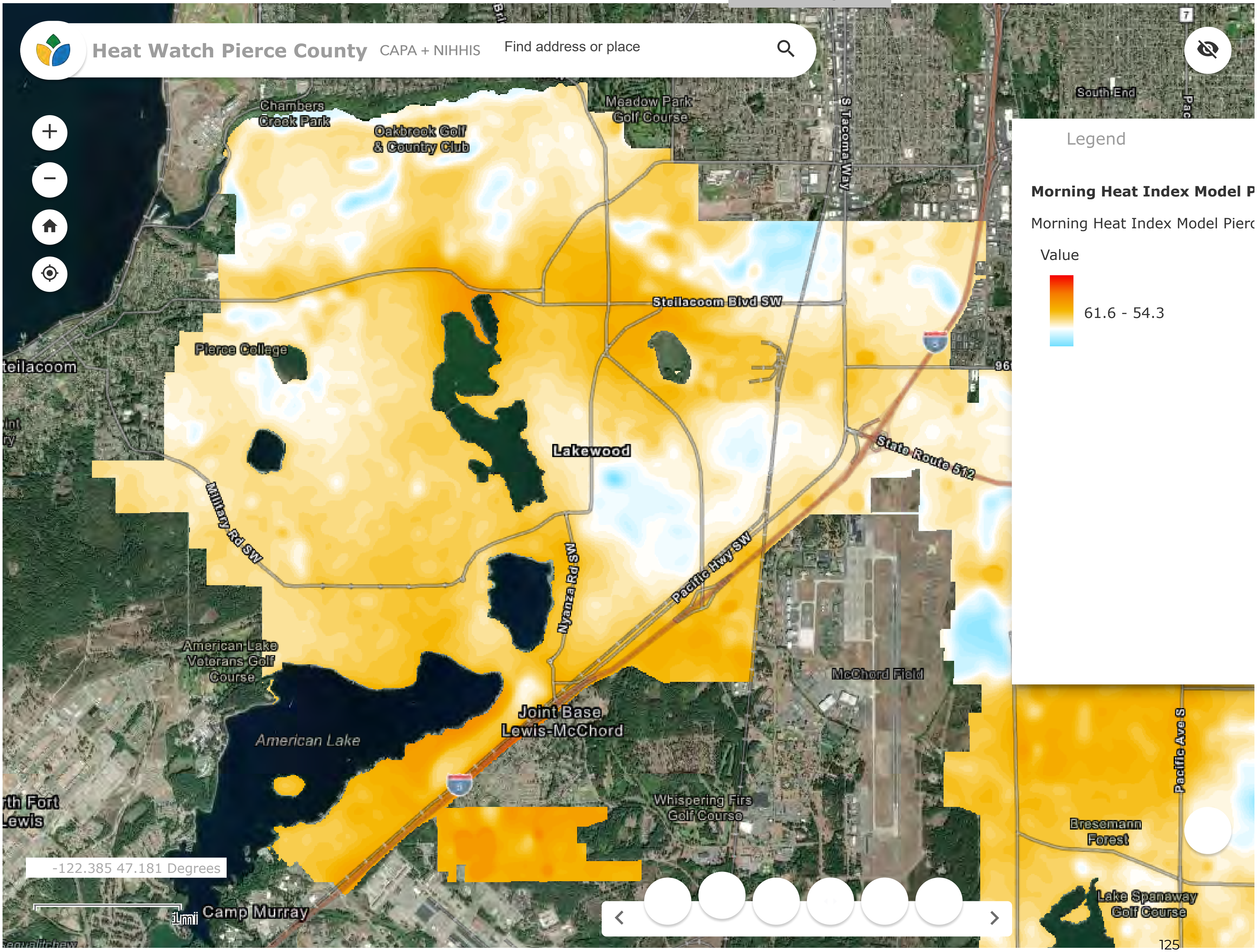
You can extract and print any map from this pdf report to use in media and other products. If you wish to visualize the data in similar style (colors, breaks, etc.) using a GIS tool, please see the CAPA Heat Watch Style Guide.

C2. Why do the maps show the temperature range of just that period (e.g. morning minimum temperature to morning maximum temperature), instead of the entire day (i.e. overall minimum to overall maximum)? Wouldn't this allow better visualization of how heat shifts throughout the day?

The temperature range of each time period is used in order to emphasize the distribution of heat within that specific time period. While the data can be visualized differently with the range from the entire day, the differences across the area then become much less apparent in the maps.

C3. Why are the ranges between traverses and models slightly different?

You may notice that for instance the maximum temperature in a traverse point dataset is 94.1°F, whereas the maximum temperature from its corresponding area-wide model is 94.5°F. The reason for this slight discrepancy is inherent to predictive modeling – all models introduce some degree of uncertainty and error. The best-fit model consists of many input variables that may produce a slightly higher or lower prediction of temperatures than measured by the traverses.


Heat Watch Pierce County
CAPA + NIHHIS
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Value
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Lakewood
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Pacific Hwy SW
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McChord Field
Joint Base Lewis-McChord
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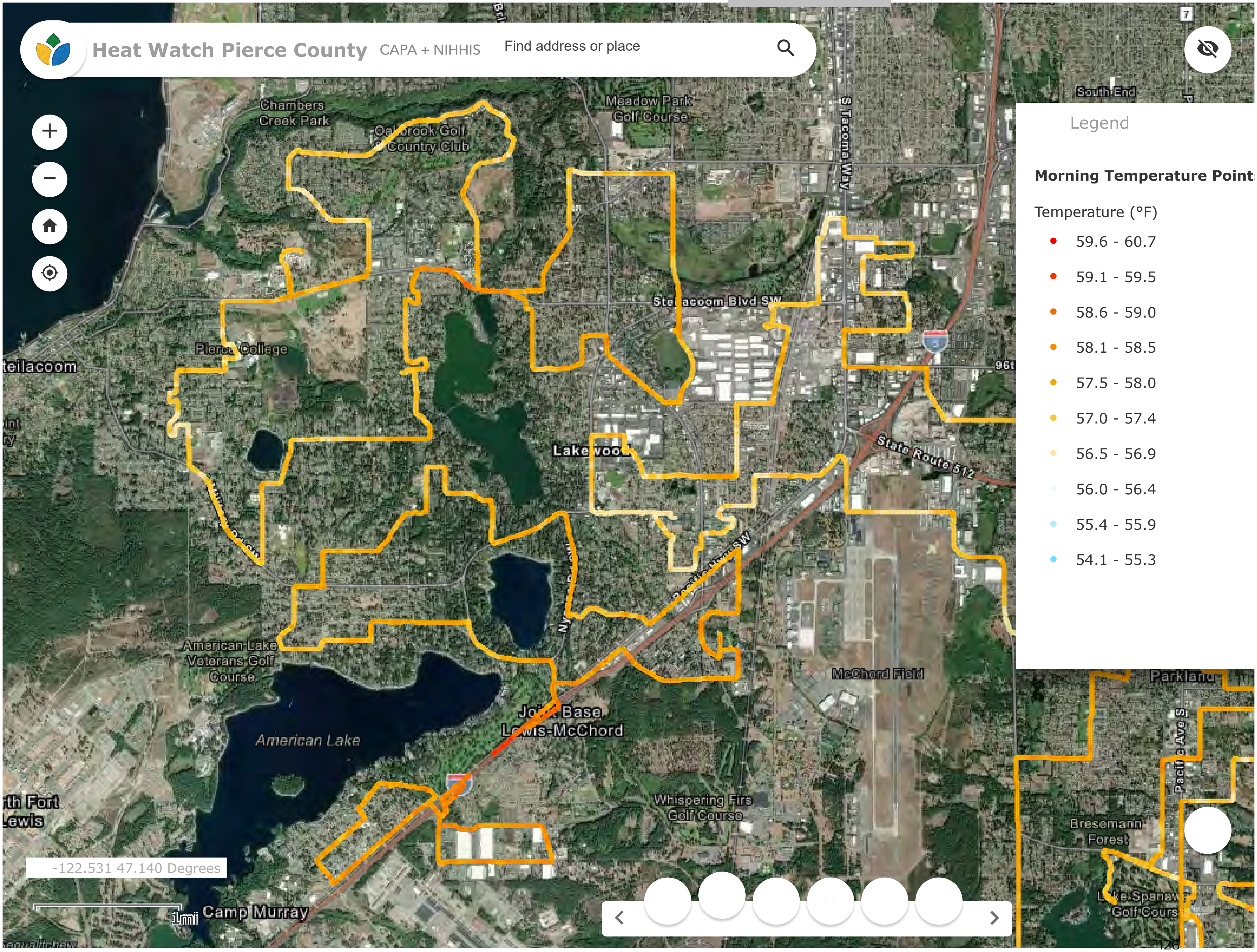
Heat Watch Pierce County
CAPA + NIHHIS
Find address or place
Legend
Morning Temperature Point
Temperature (°F)
59.6 - 60.7
59.1 - 59.5
58.6 - 59.0
58.1 - 58.5
57.5 - 58.0
57.0 - 57.4
56.5 - 56.9
56.0 - 56.4
55.4 - 55.9
54.1 - 55.3
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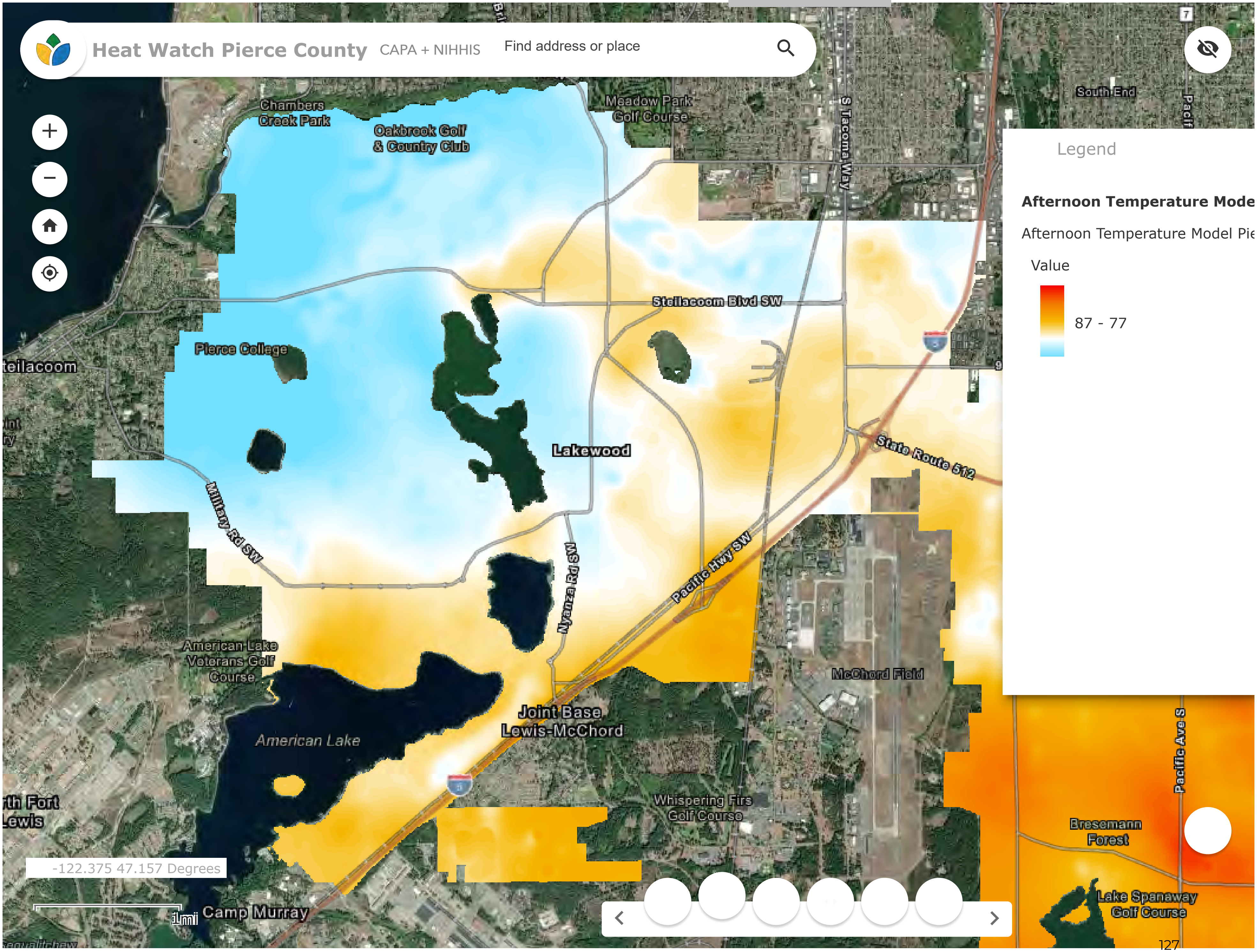
Heat Watch Pierce County
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Pierce College
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Military Rd SW
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Pacific Hwy SW
American Lake Veterans Golf Course
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Joint Base Lewis-McChord
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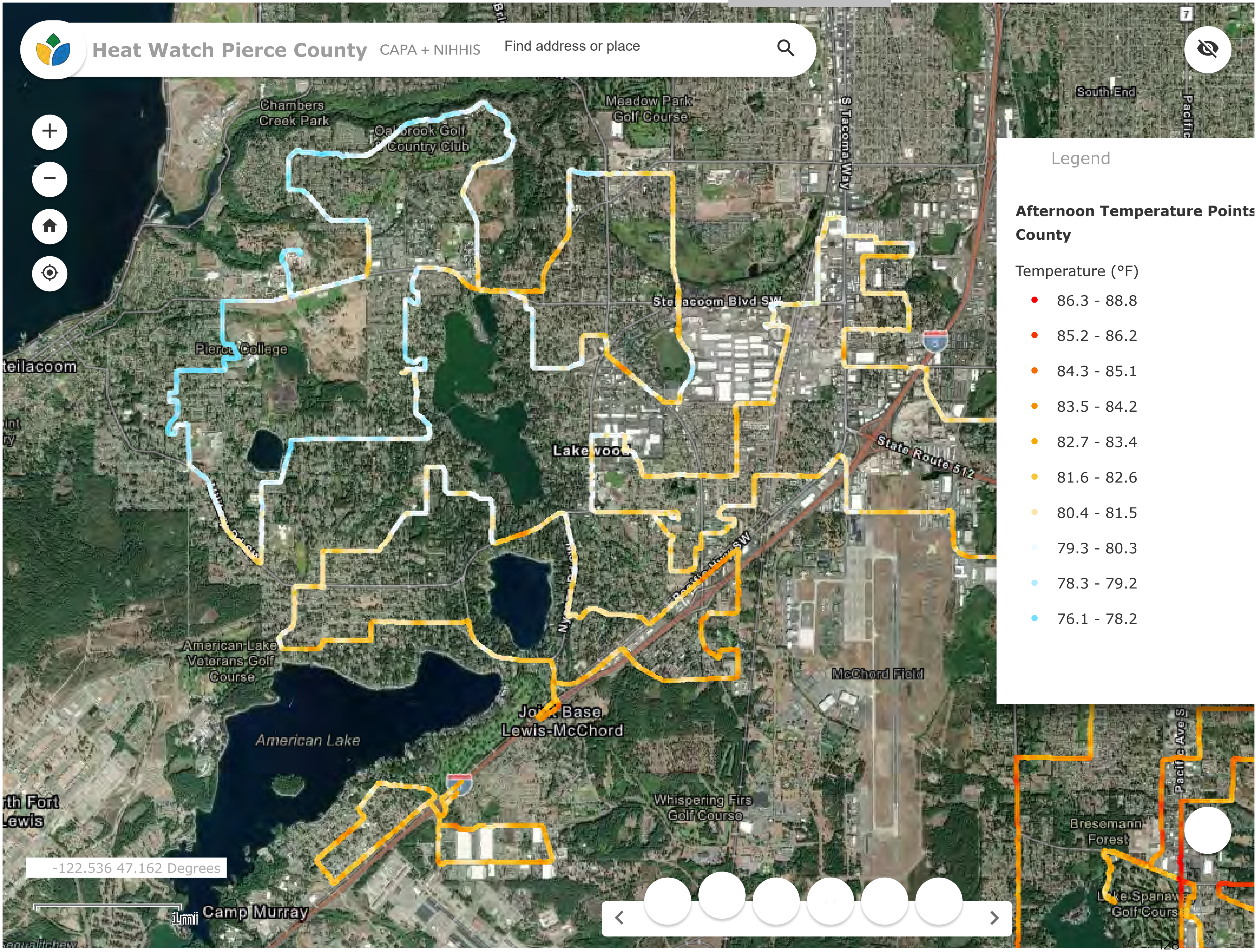
Heat Watch Pierce County
CAPA + NIHHIS
Find address or place
Legend
Afternoon Temperature Points
County
Temperature (°F)
86.3 - 88.8
85.2 - 86.2
84.3 - 85.1
83.5 - 84.2
82.7 - 83.4
81.6 - 82.6
80.4 - 81.5
79.3 - 80.3
78.3 - 79.2
76.1 - 78.2
Chambers Creek Park
Meadow Park Golf Course
S Tacoma Way
South End
Steilacoom Blvd SW
Pierce College
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American Lake Veterans Golf Course
American Lake
Joint Base Lewis-McChord
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Camp Murray
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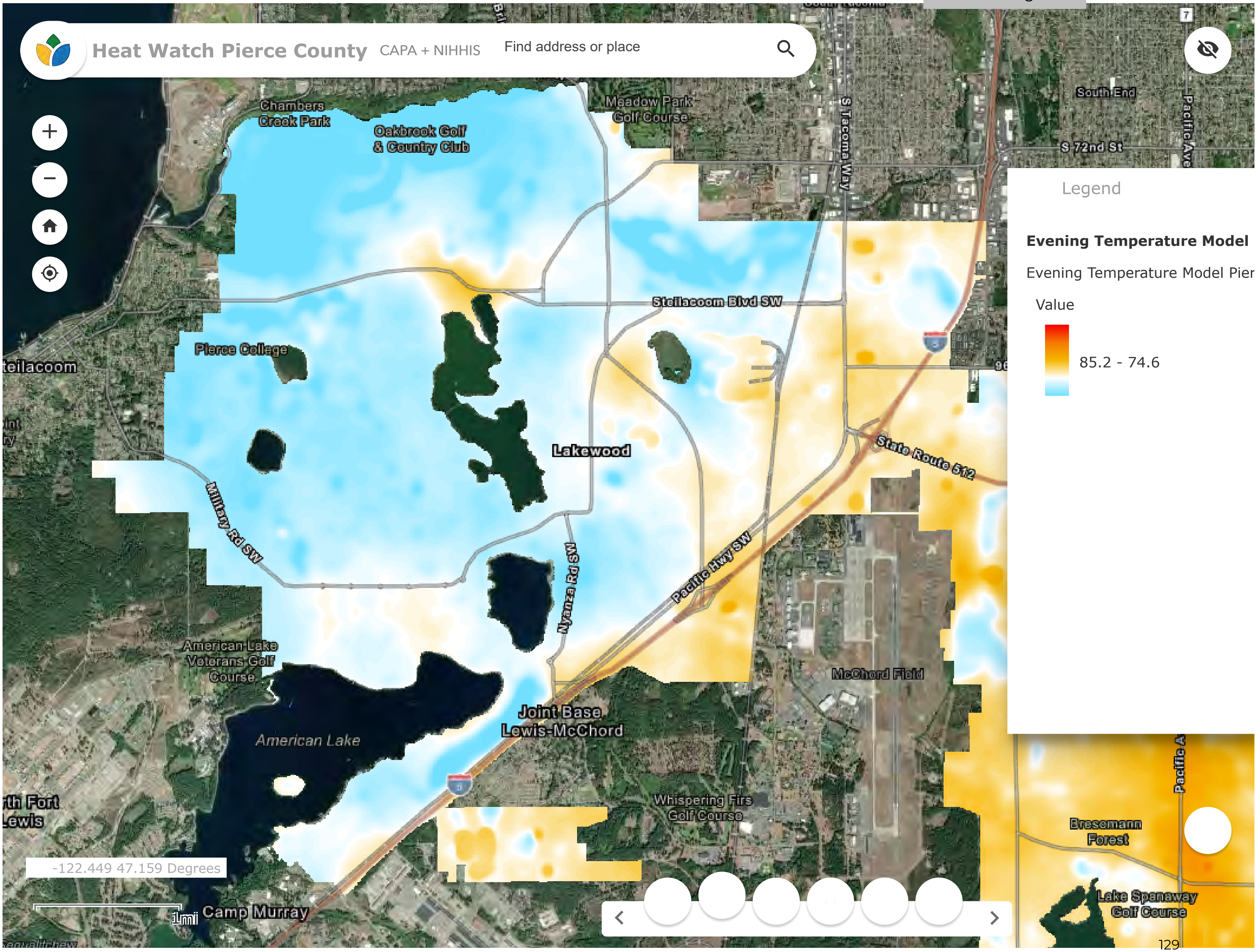

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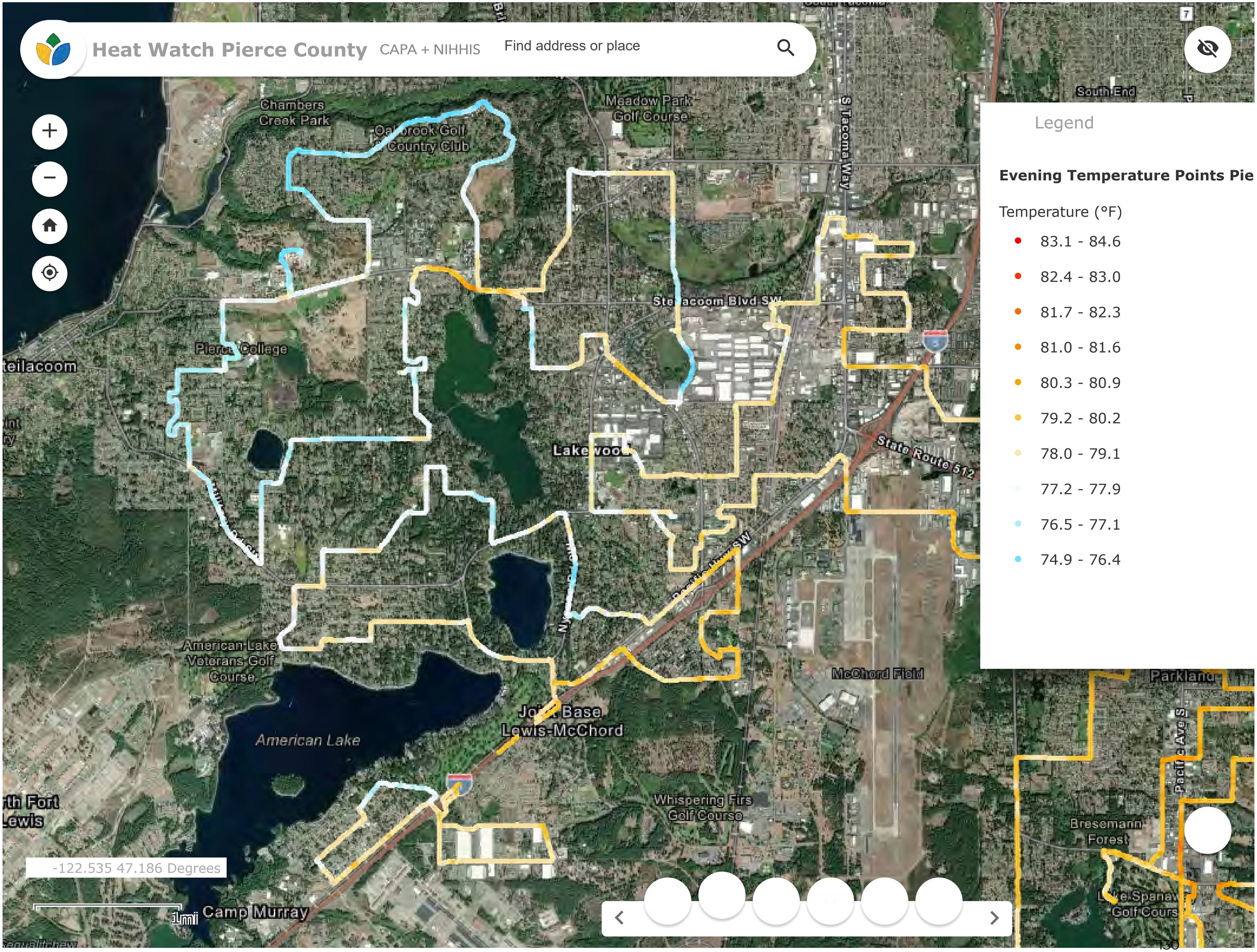

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Pierce County

Canopy Analysis

Summary Report

Pierce County

Canopy Analysis

Summary Report

by CAPA

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Introduction

Over the summer of 2024, Pierce County community members collected tens of thousands of heat measurements across select areas of the County with the mobile mapping program, CAPA Heat Watch. Results from this campaign provide new hazard descriptions of air temperature and heat index across the City at high resolution, improving on coarse descriptions of land surface temperature. In this analysis, we assess the relationships between these heat data and descriptions of key land cover characteristics, specifically canopy cover and impervious surfaces, to better understand which areas are more and less exposed to extreme heat and identify relevant solutions. We examine relationships using high resolution land cover data across two scales: the area-wide Pierce County study area, and eight sub-areas identified by the Puget Sound Regional Council's Urban Regional Geographies dataset. For each scale we provide a description of methods, data visualizations, and initial interpretations of results, as well as recommendations of how to leverage each data product towards targeted heat mitigation and adaptation actions.

Delivered alongside this report are several spatial data products, including the localized heat data as well as corresponding datasets for area-wide and sub-area results. These data products are available **here.**

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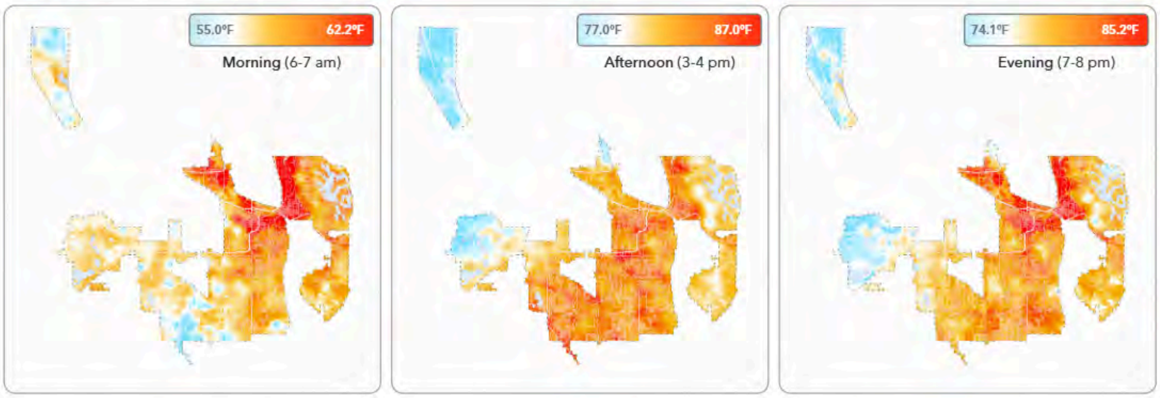
Localized Heat

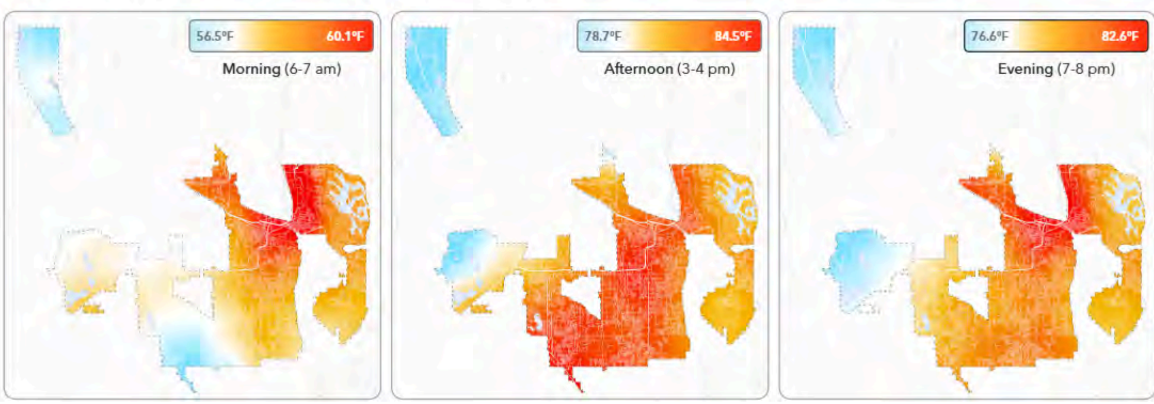
Heat Watch data describes the distribution of air temperatures at one to two meters above the ground across the Pierce County study area during typical urban heat island conditions. The data was collected by sensors mounted to passenger vehicles that traversed through a variety of land uses and land covers across the study area at simultaneous periods during the morning, afternoon and evening. Using the data, area-wide models of air temperature distribution were generated for the three time periods by integrating land cover imagery from the Sentinel-2 satellite in a machine learning process.

Figure 1. 2024 Heat Watch maps



As the Pierce County study area spans a wide region including the Puget Sound, the heat distribution patterns may be influenced by the regional geography of the area (for example, proximity to a large water body). To reduce this regional effect, a localized heat raster was developed. For each time period, a "temperature difference" raster was created by subtracting the temperature at each grid point from a coarse temperature raster (visualized below) produced by aggregating the Heat Watch data up to 25 kilometer resolution. The localized heat raster was then computed by averaging the temperature difference rasters from the three time periods. The localized heat data was used for area-wide and sub-area analyses.

Figure 2. 2024 Coarse (30-meter) Heat Watch maps



Area-Wide Results

Area-Wide Summary

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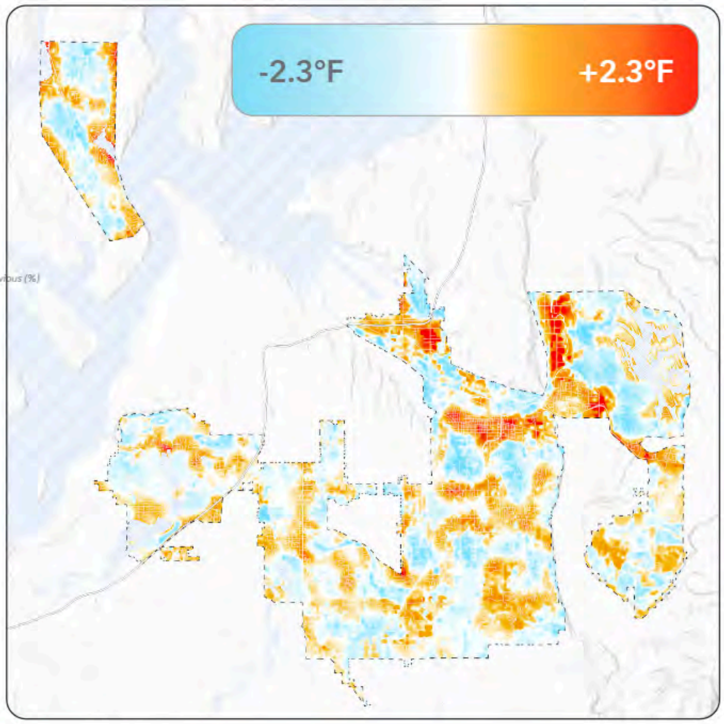
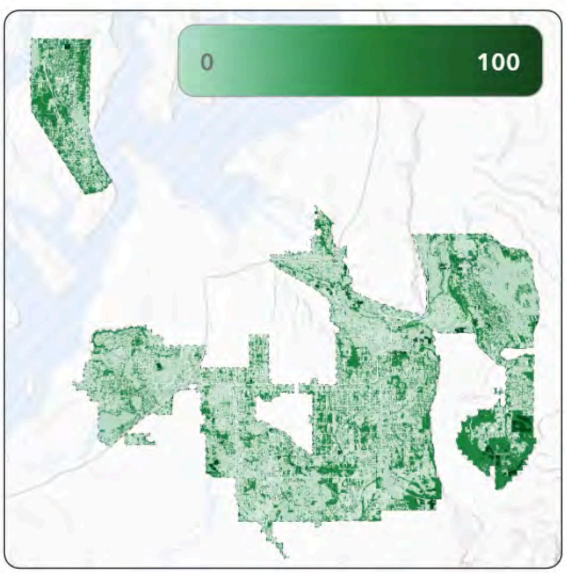
The localized heat raster displays heat distribution relative to the surrounding 25 km, reducing the regional effect due to differences in geography across the study area. Note that while the range of localized temperatures is roughly 5°F due to the processing steps (involving averaging of multiple time periods), temperature differences as wide as 14°F were measured during the Heat Watch campaign traverses.

The overall percentage of canopy across the area is 34% and impervious surfaces is 30%. Patterns between heat, canopy cover and impervious surfaces can be seen at the broad scale in the maps below. Cool areas with high canopy cover are seen in Clarks Creek Park and Wildwood Park near Puyallup, and surrounding Lake Tapps; warm areas with high impervious surface amounts can be seen in the industrial area around Sumner, Fife and Puyallup.

The following pages display the data summarized by 500-meter hexagon and present plots describing the overall pattern between canopy cover and impervious surfaces with localized heat across the study area.





Area-Wide Canopy Cover

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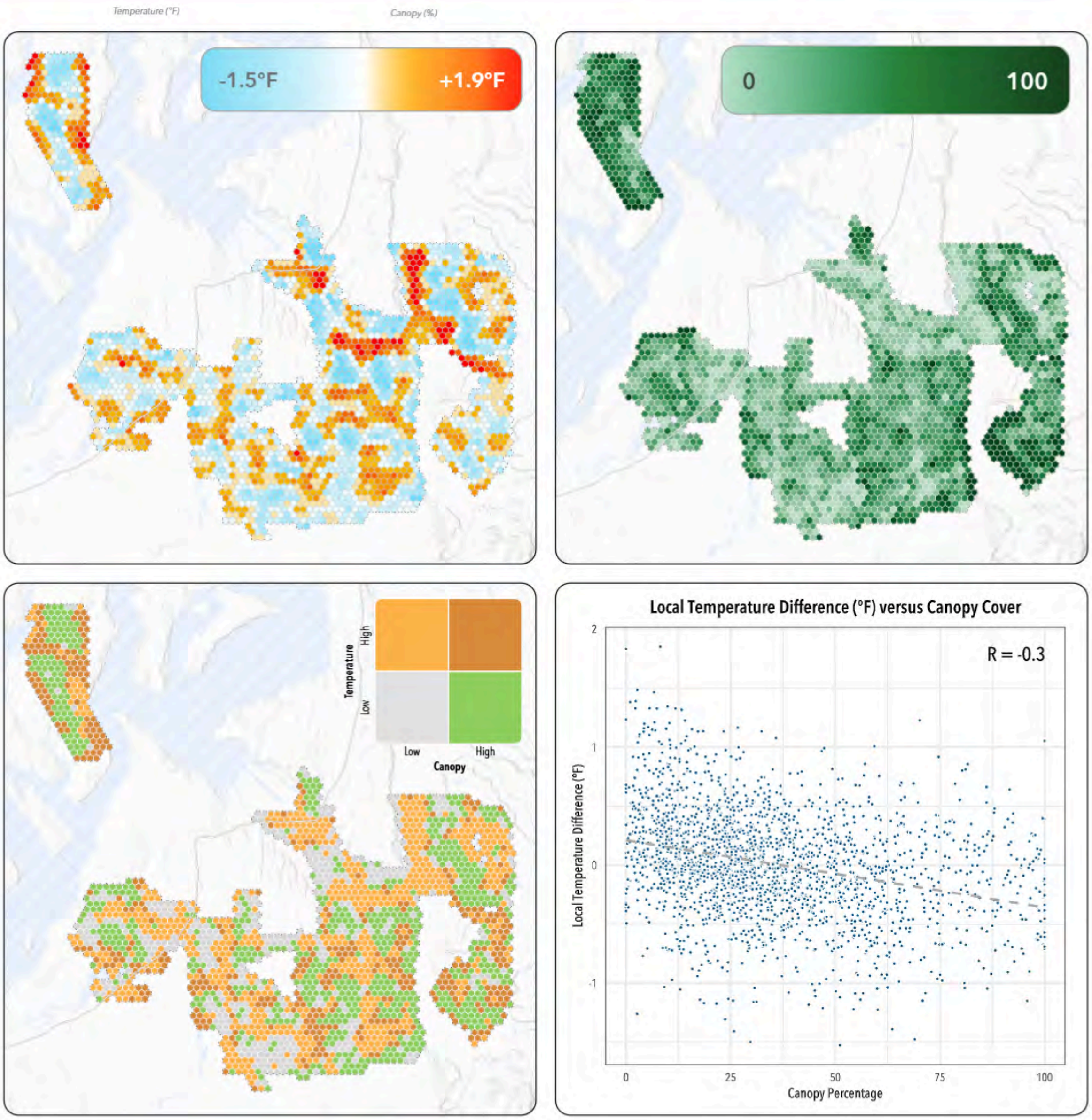

Area-Wide Impervious

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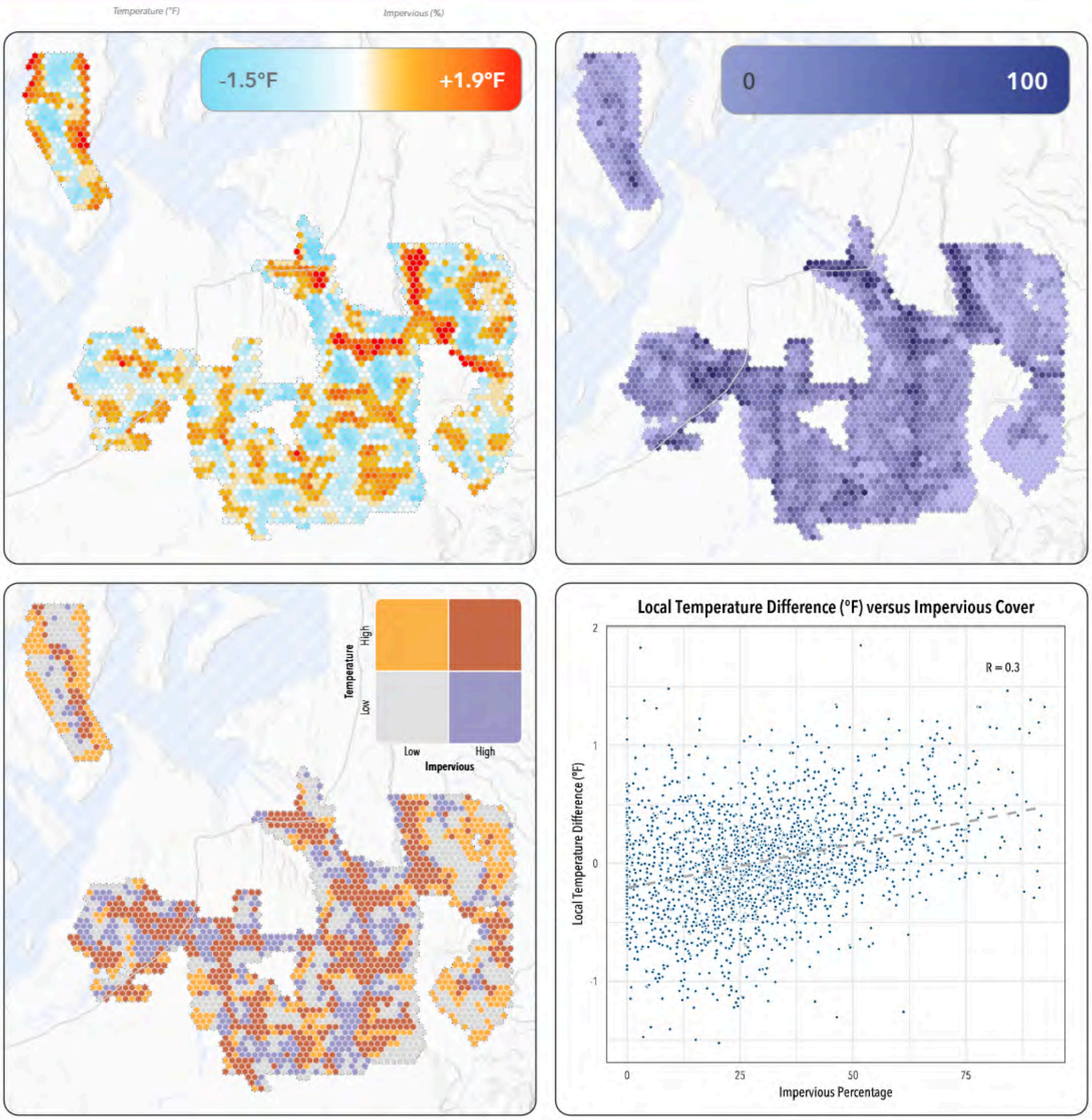

Sub-Area Results

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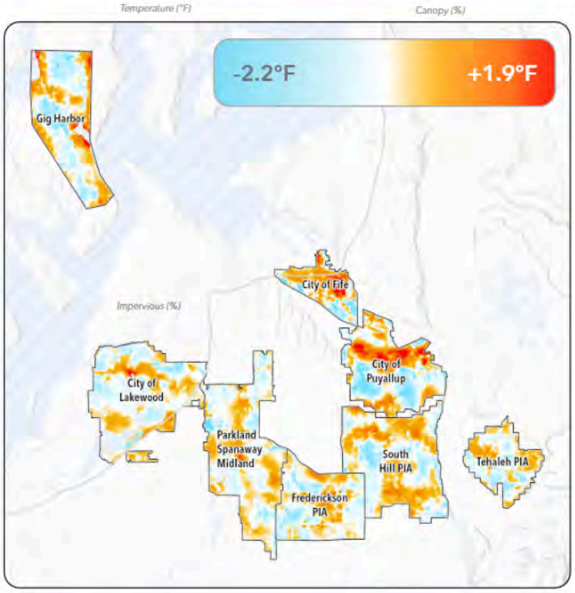

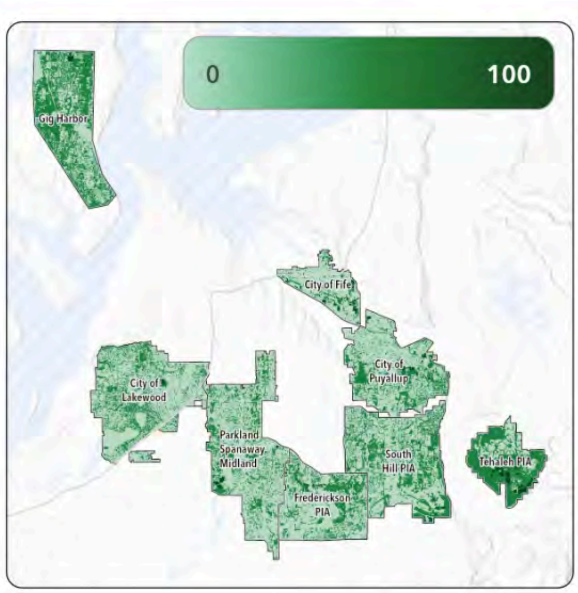

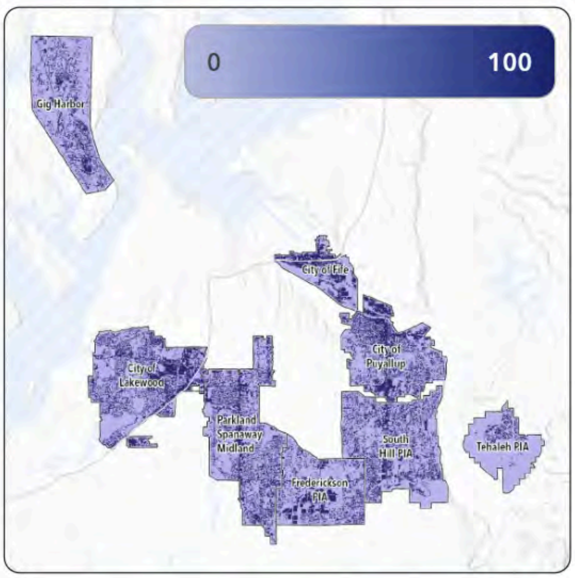

Summarized below, the percentage of canopy cover of sub-areas ranges from 16.8% in the City of Fife to 65.5% across Tehaleh PIA; conversely, the percentage of impervious surfaces coverage ranges from 9.3% in Tehaleh PIA to 44.4% in the City of Fife. Differences in sub-area average temperature from the global average range from -2.2°F in Gig Harbor to +1.3°F in Puyallup.

The following pages display the canopy and impervious surface raster data for each sub-area along with bivariate maps comparing the variables with localized heat using 500-meter hexagons as sampling units. Also presented are plots describing the relationship between localized heat, canopy cover and impervious surfaces within each sub-area.

Sub-Area	Canopy (%)	Impervious (%)	Avg Temp (°F)	Global Temp (°F)	Avg Temp Diff (°F)
Parkland Spanaway Midland	26.6	33.9	73.4	73.5	-0.1
Gig Harbor	53.9	22	71.3	73.5	-2.2
Frederickson PIA	29.7	30.3	73.9	73.5	0.4
Tehaleh PIA	65.5	9.3	73.2	73.5	-0.3
City of Fife	16.8	44.4	74.5	73.5	1.0
City of Puyallup	29.3	39.5	74.8	73.5	1.3
City of Lakewood	27.1	36.3	72	73.5	-1.5
South Hill PIA	36.4	30.1	74.2	73.5	0.7

Gig Harbor Canopy Cover

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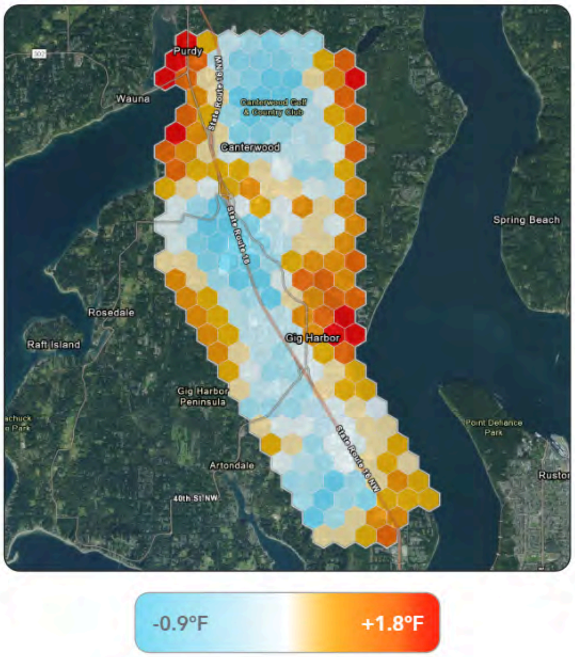

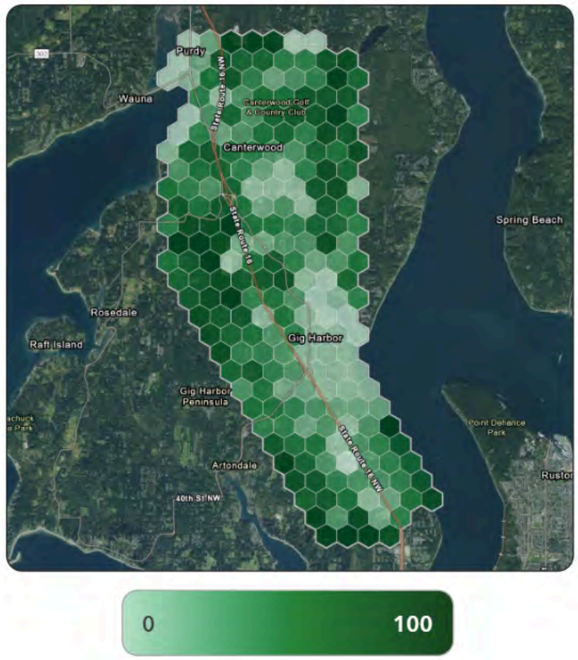

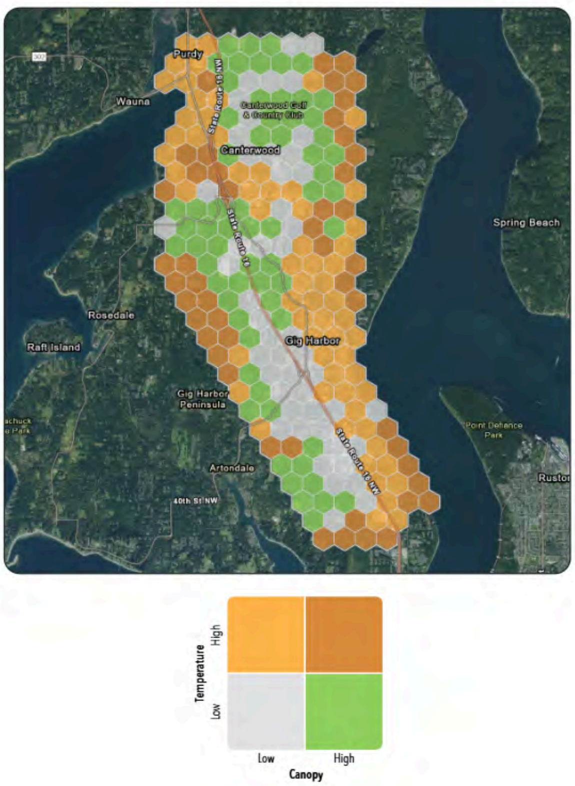

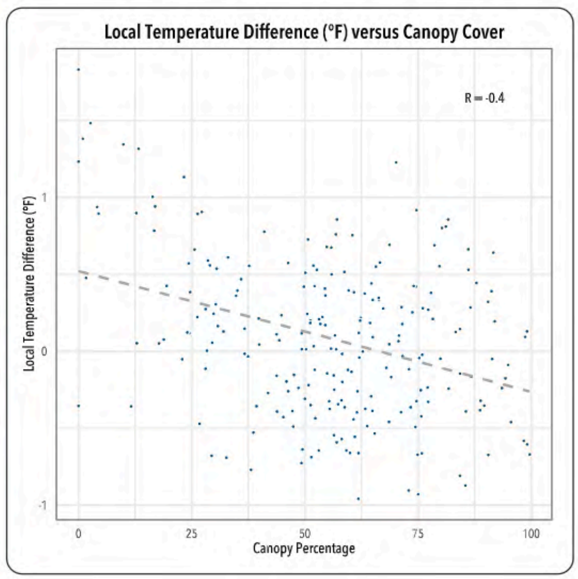

Gig Harbor Impervious Surfaces

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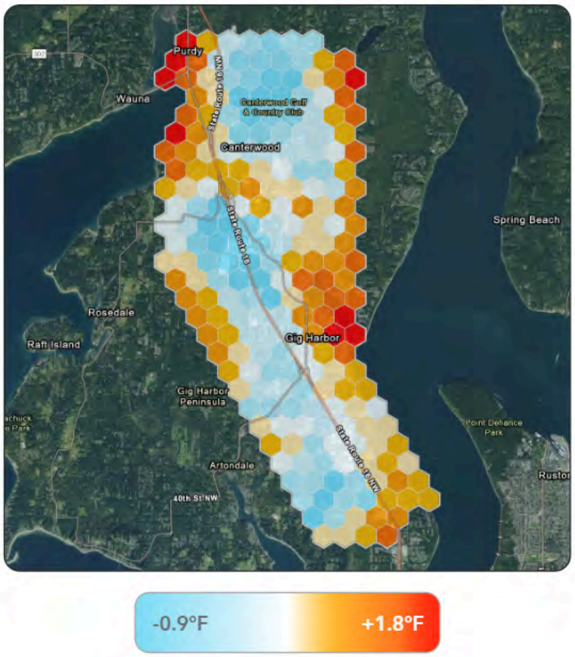

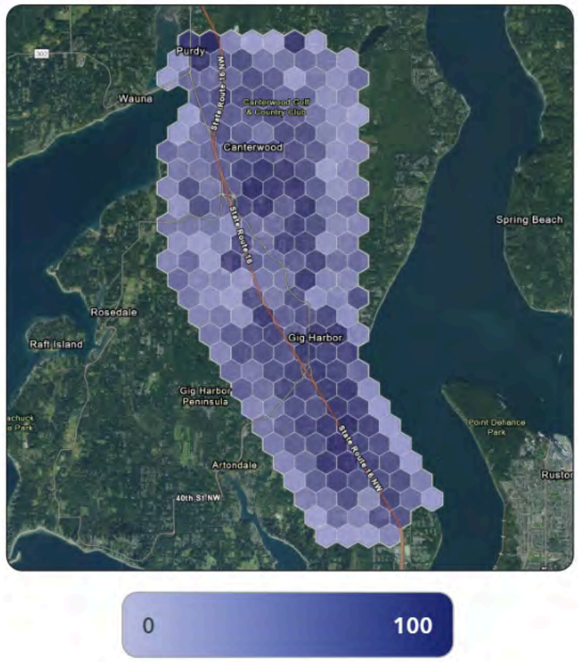

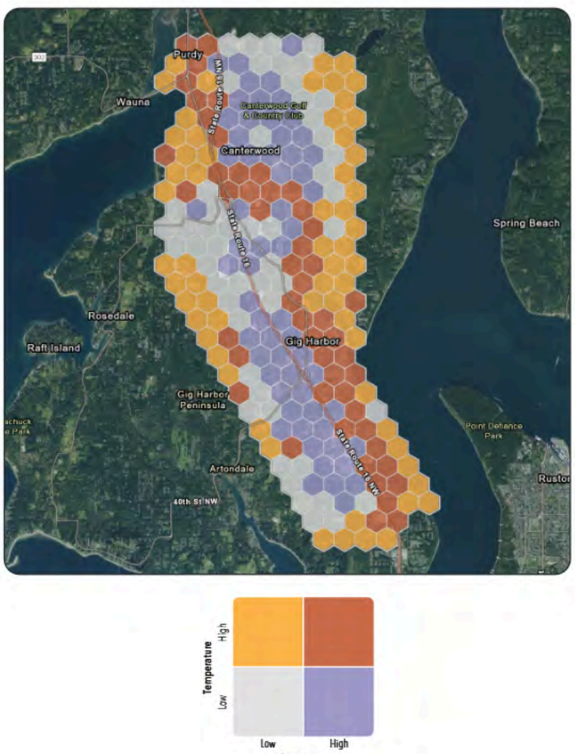

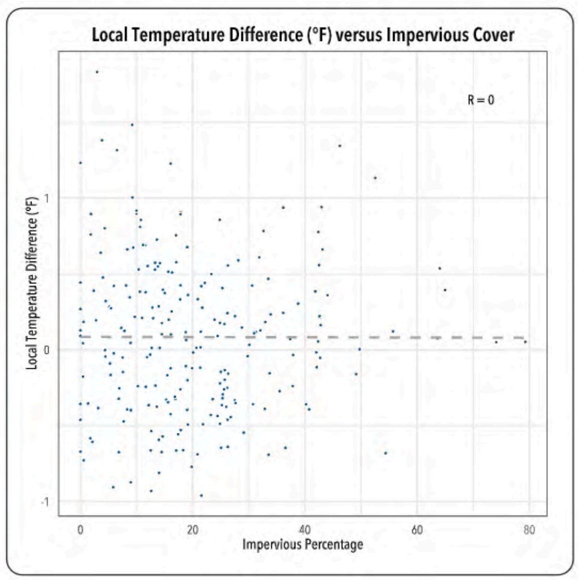

Tehaleh Canopy Cover

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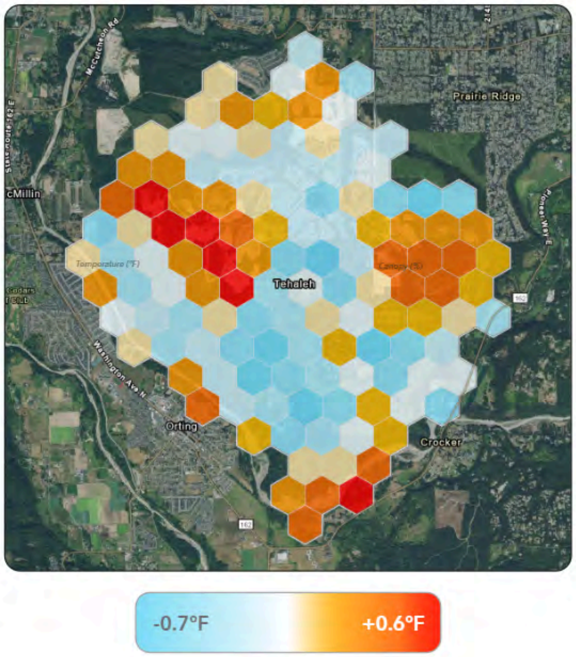

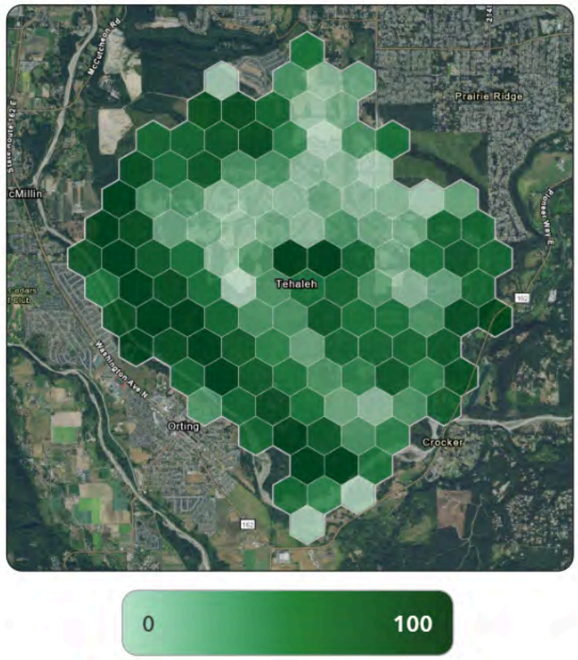

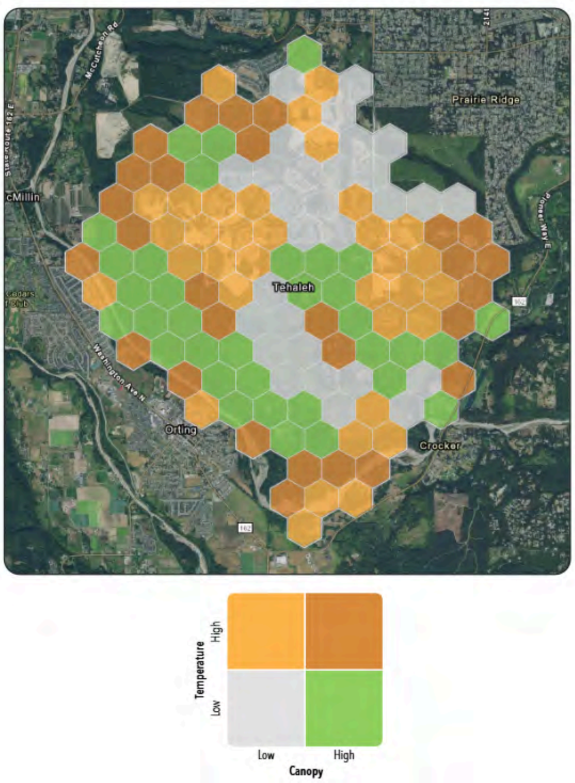

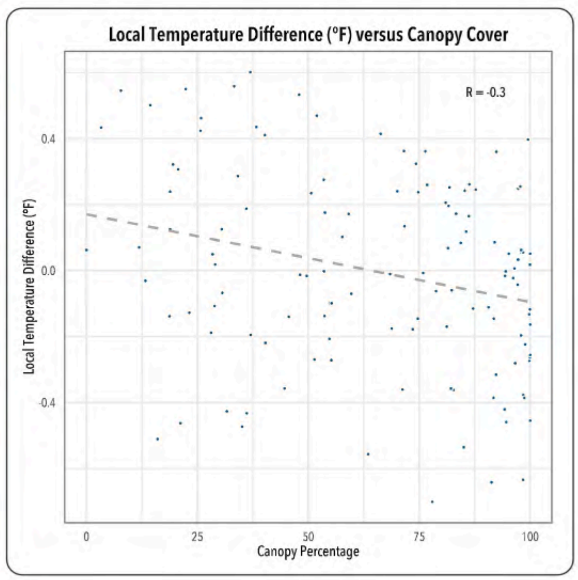

Tehaleh Impervious Surfaces

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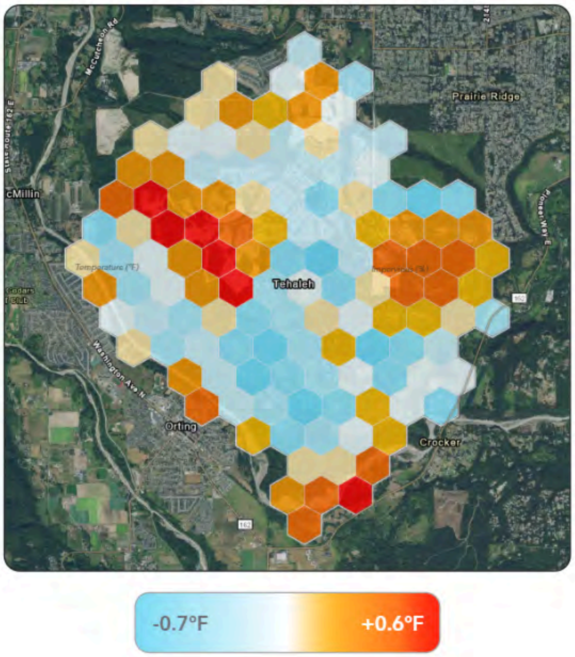

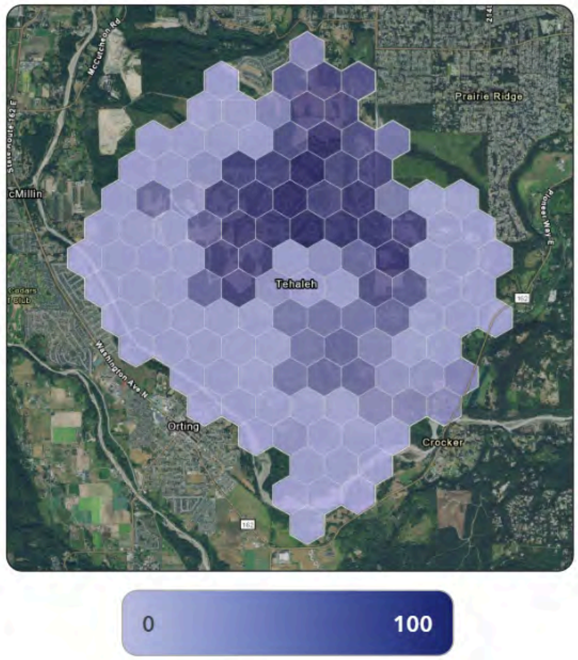

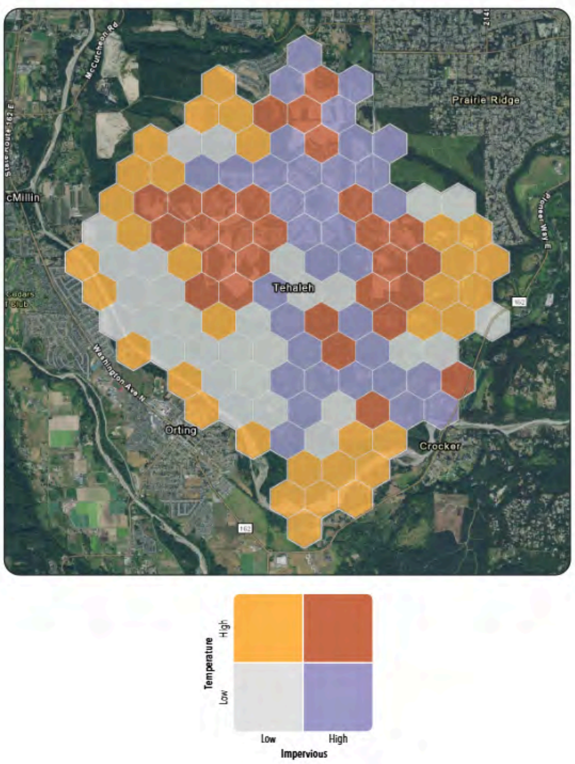

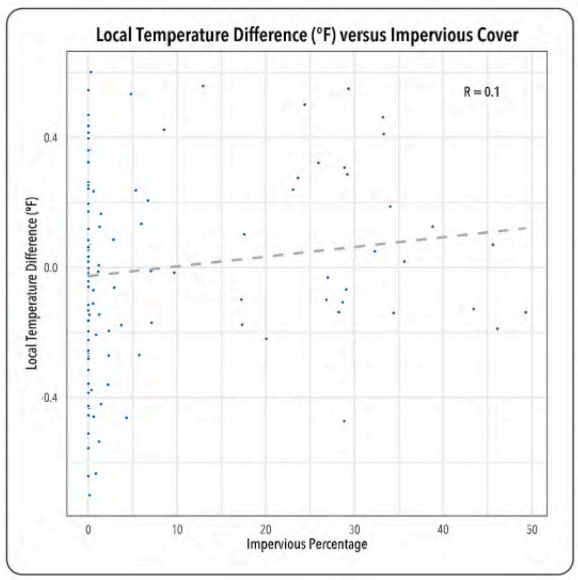

South Hill Canopy Cover

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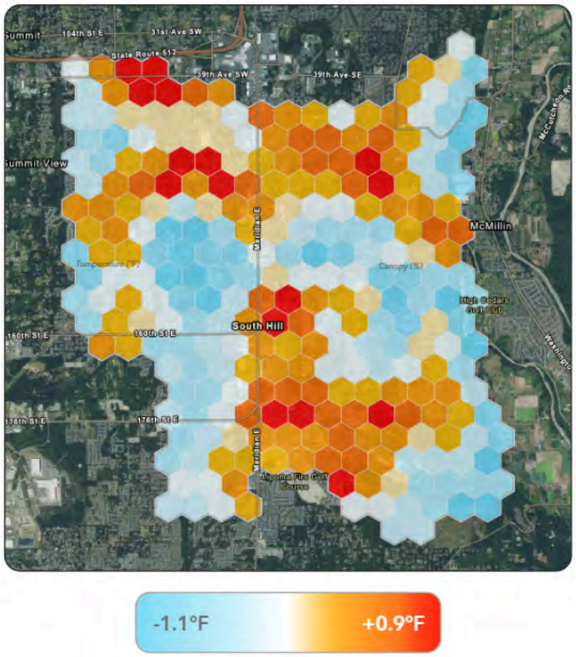

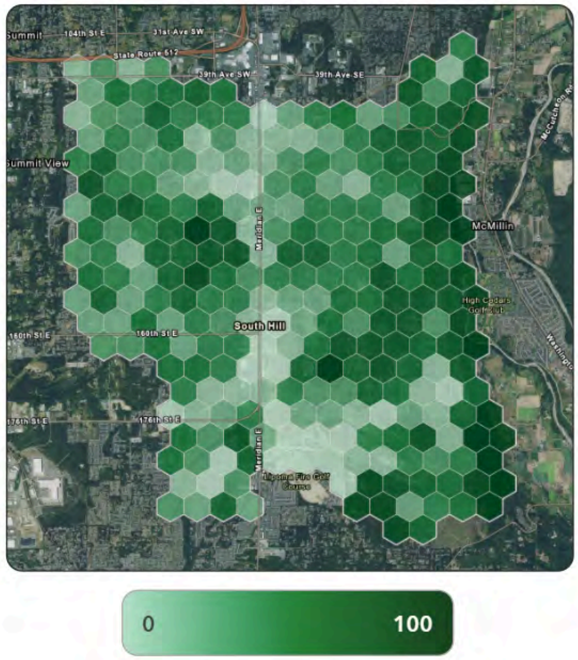

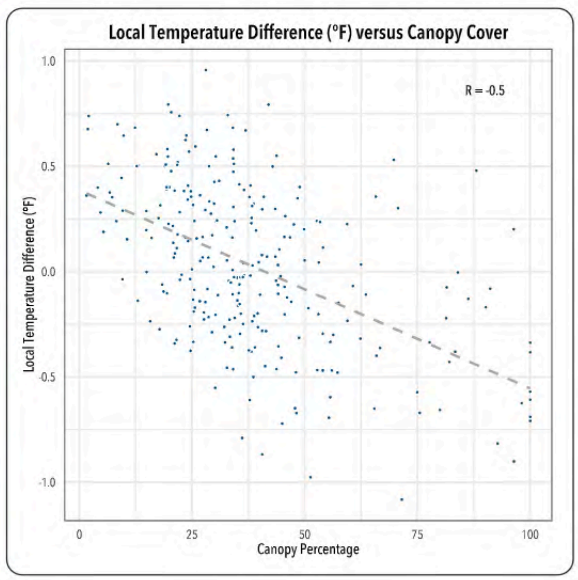

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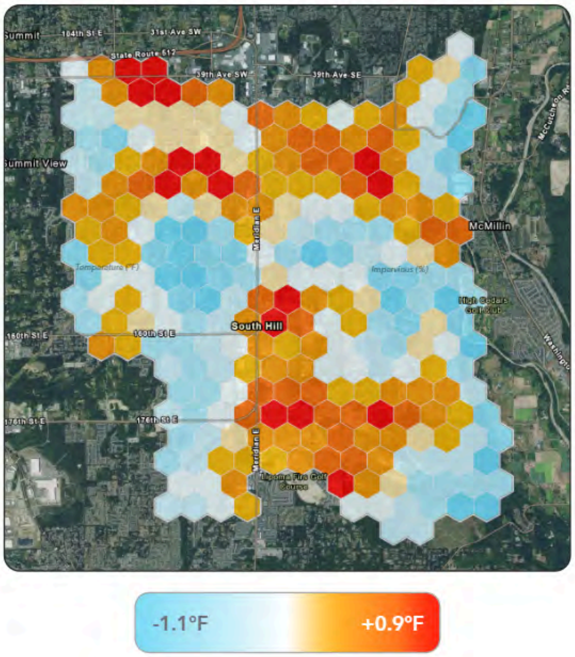

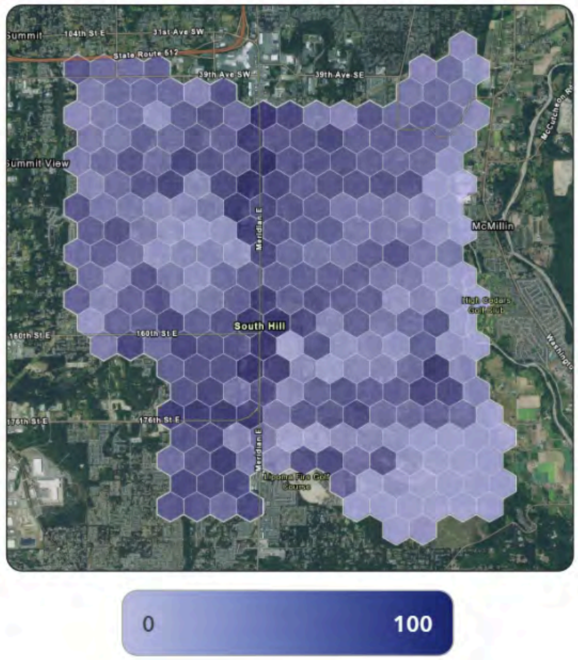

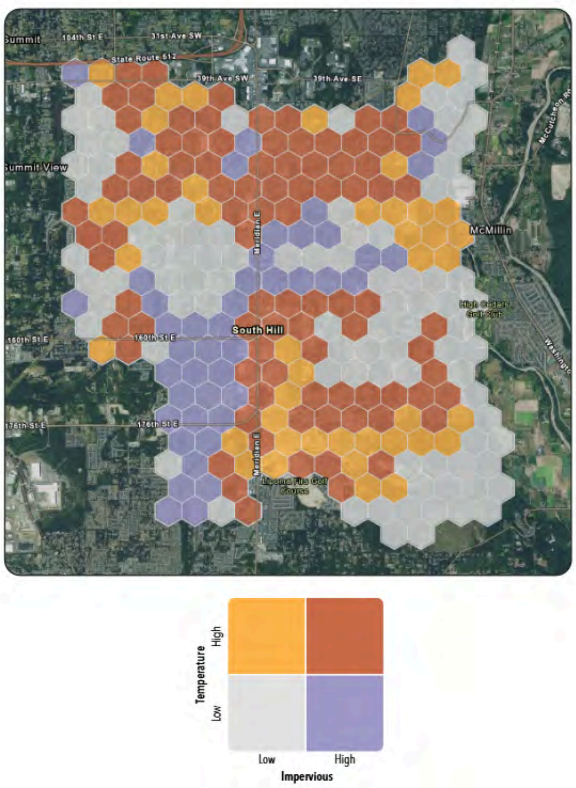

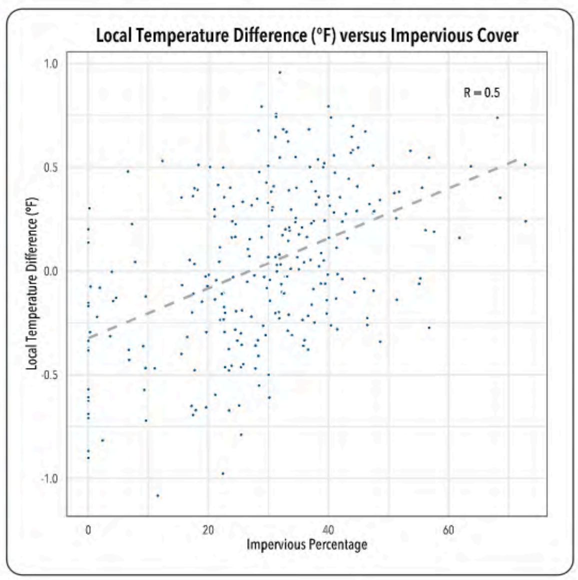

Parkland Canopy Cover

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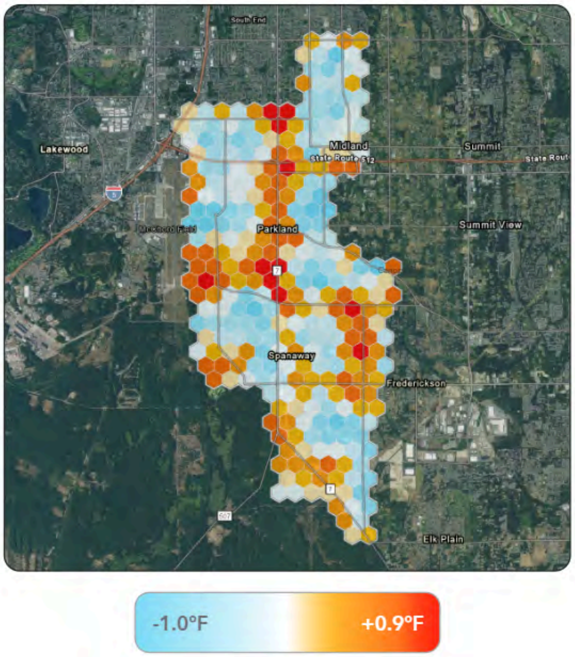
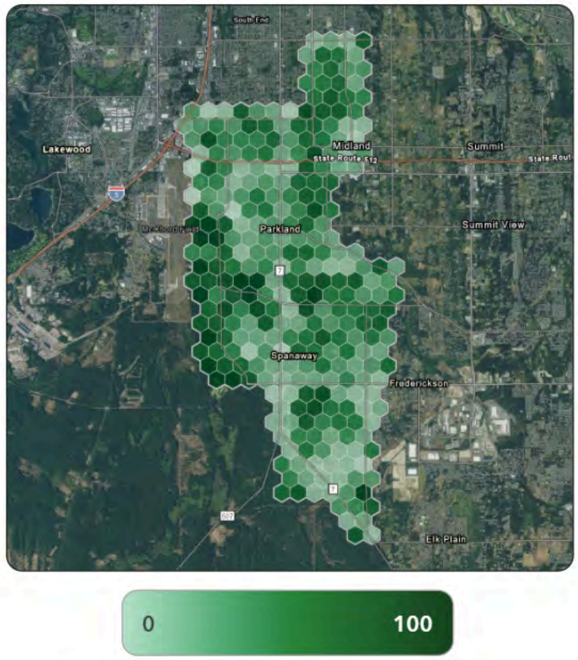
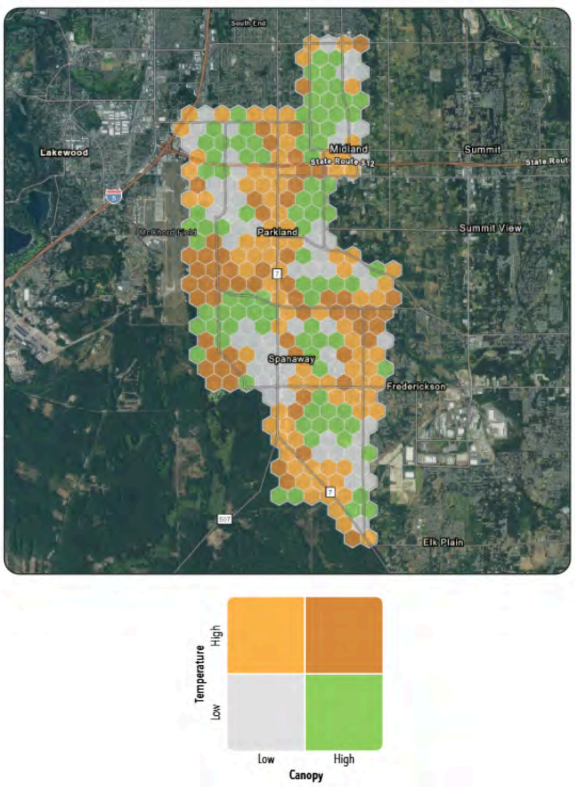
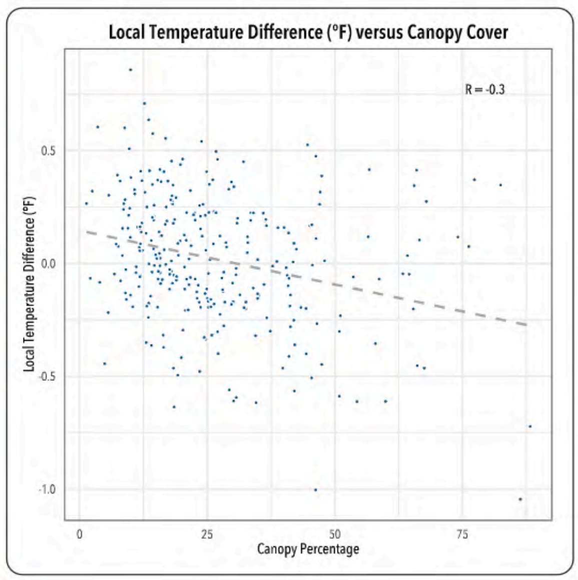
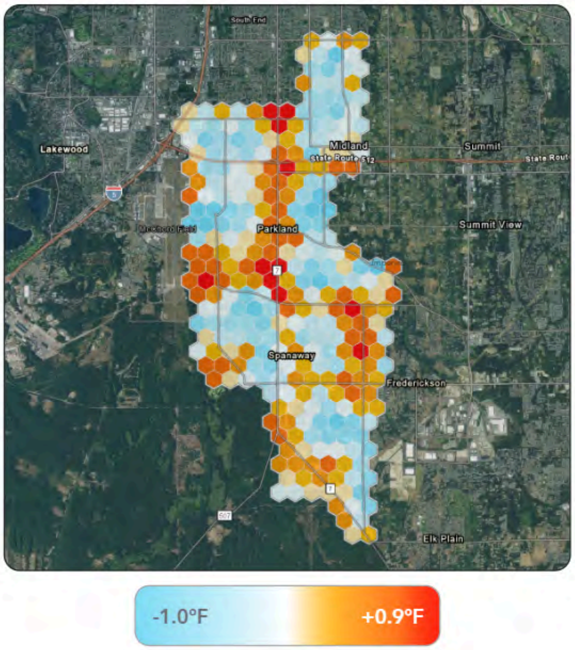


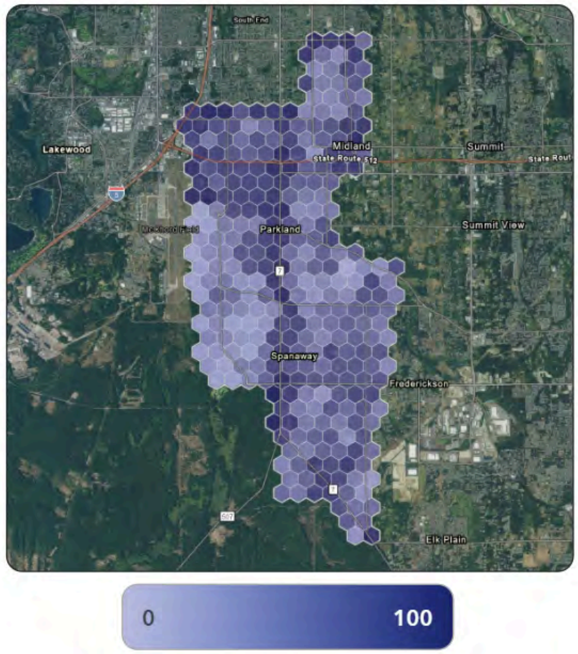






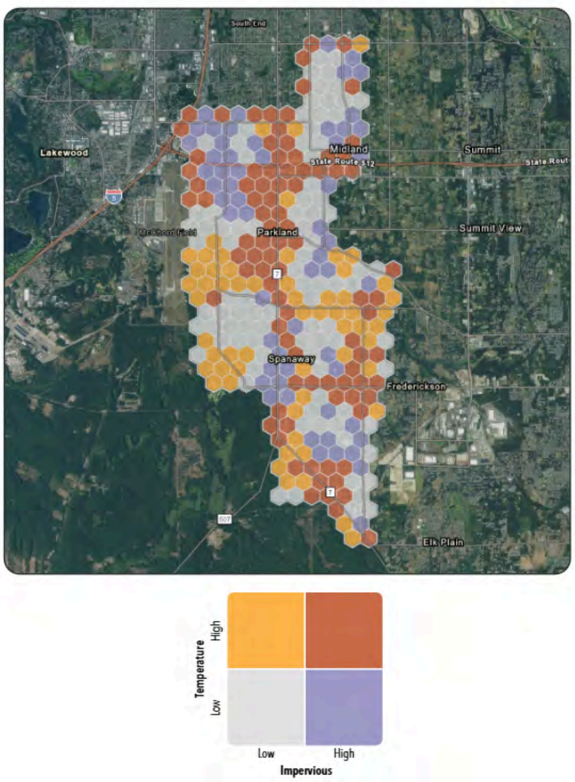


South End
Lakewood
Midland
State Route 512
Summit
Summit View
Parkland
Spanaway
Frederickson
Elk Plain
-1.0°F
+0.9°F

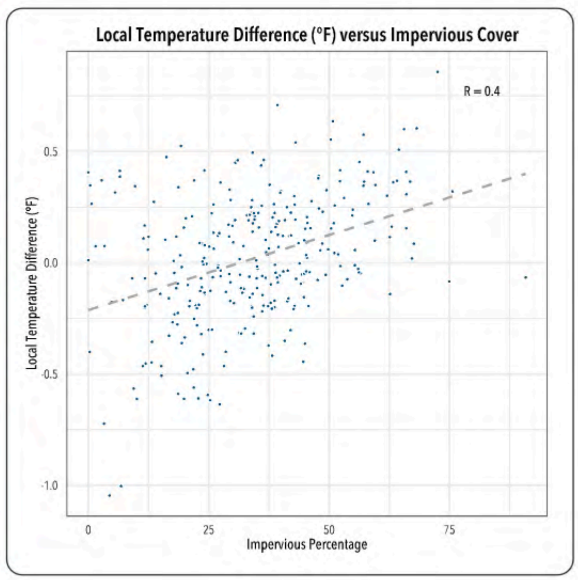


South End
Lakewood
Midland
State Route 512
Summit
Summit View
Parkland
Spanaway
Frederickson
Elk Plain
0
100

16

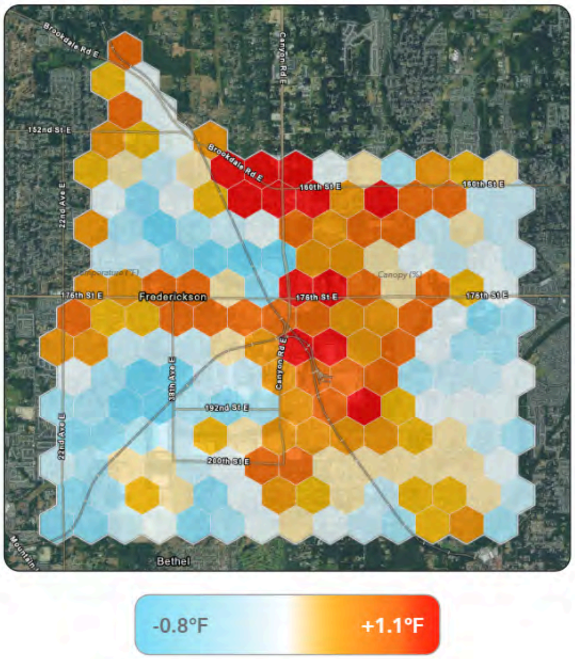


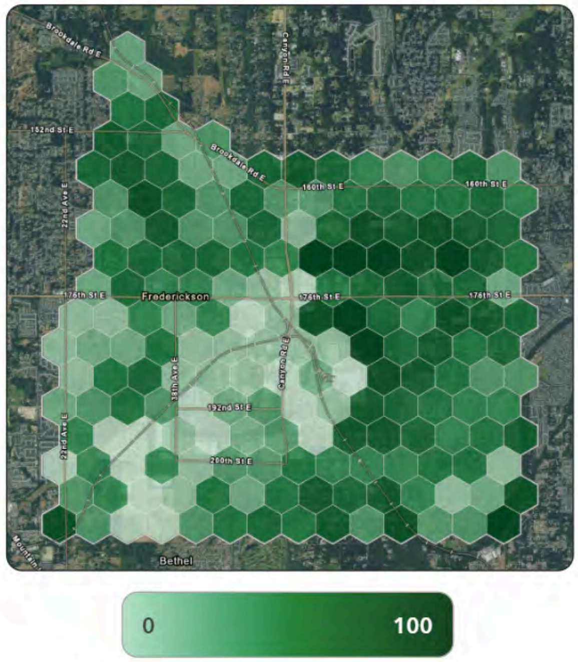
South End
Lakewood
Midland
State Route 512
Summit
Summit View
Parkland
Spanaway
Frederickson
Elk Plain
Temperature
High
Low
Impervious
Low
High



Local Temperature Difference (°F) versus Impervious Cover
R = 0.4
Local Temperature Difference (°F)
0.5
0.0
-0.5
-1.0
0
25
50
75
Impervious Percentage

Frederickson Canopy Cover





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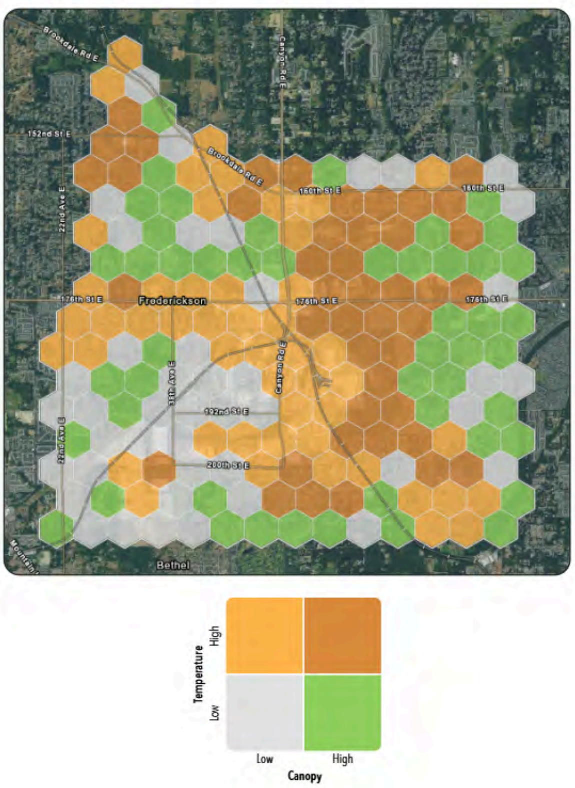

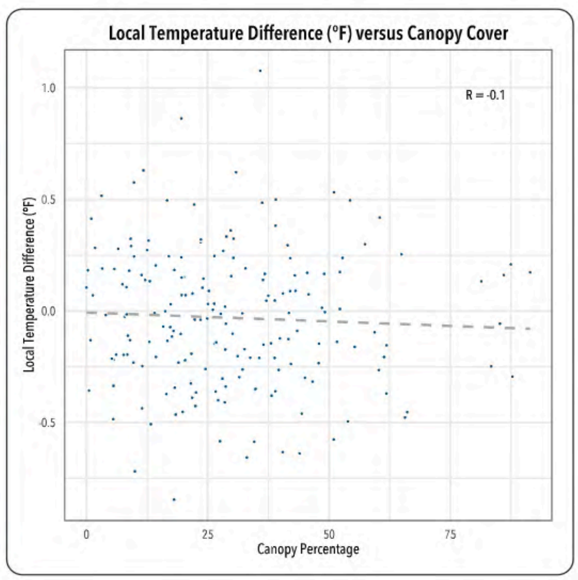

Frederickson Impervious Surfaces

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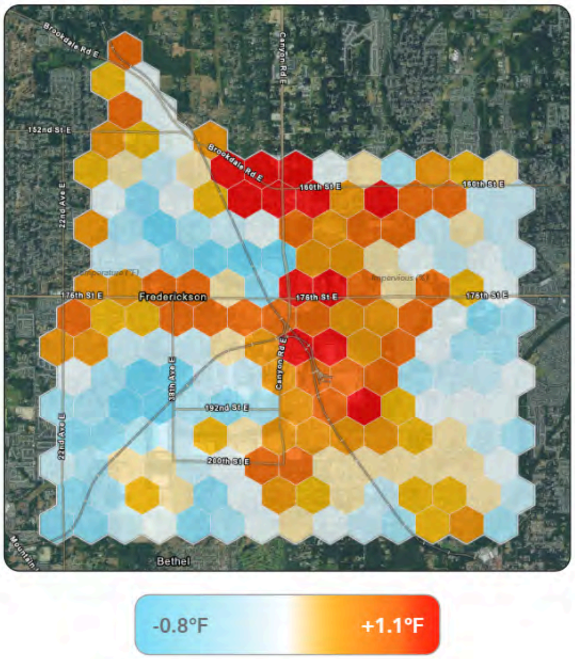

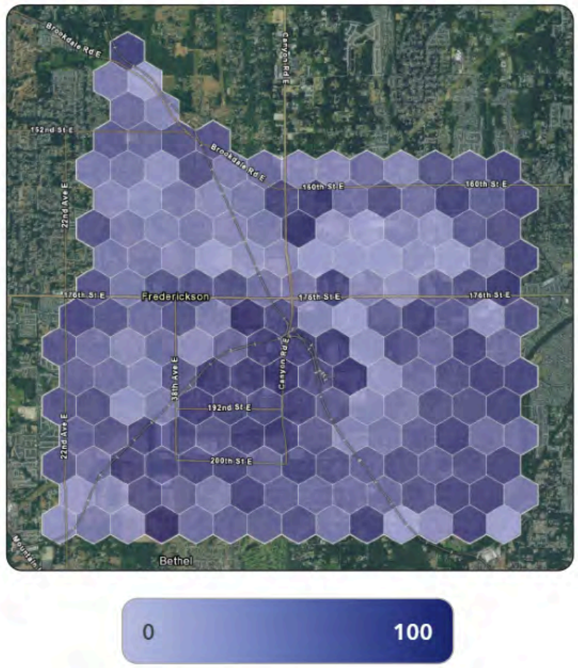

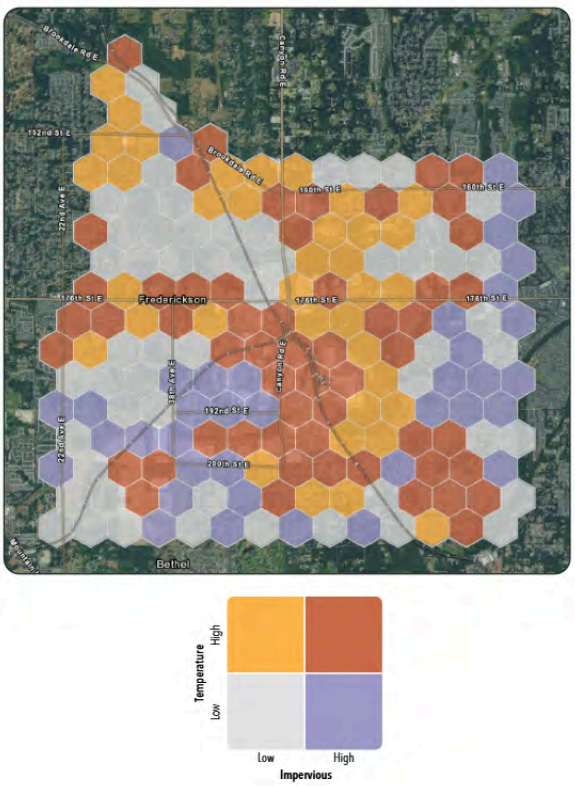

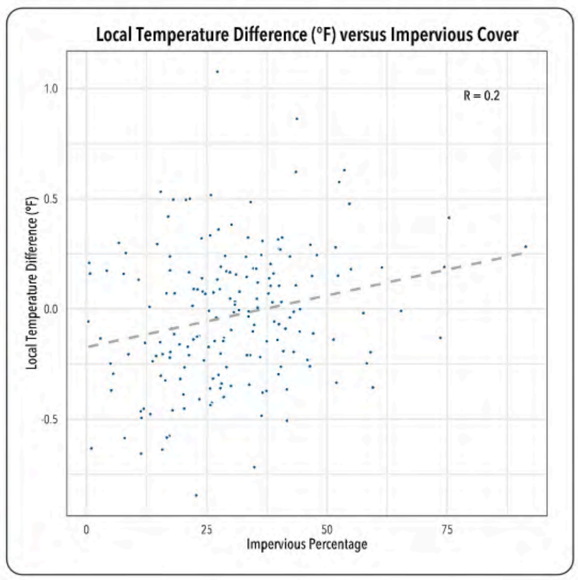

Puyallup Canopy Cover

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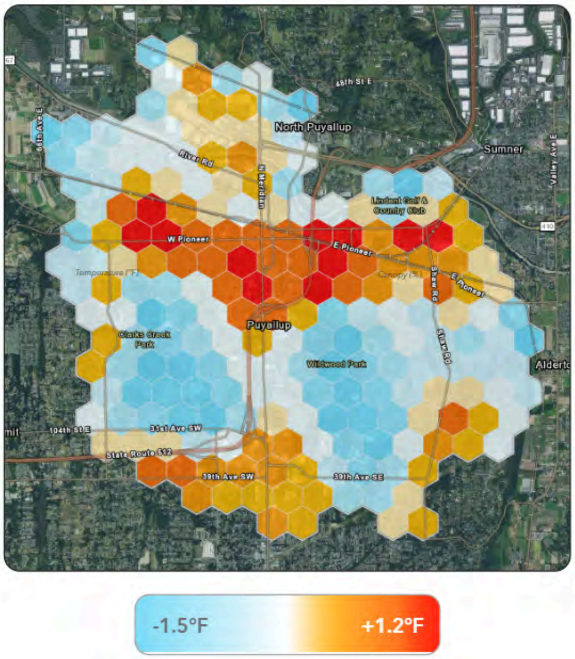

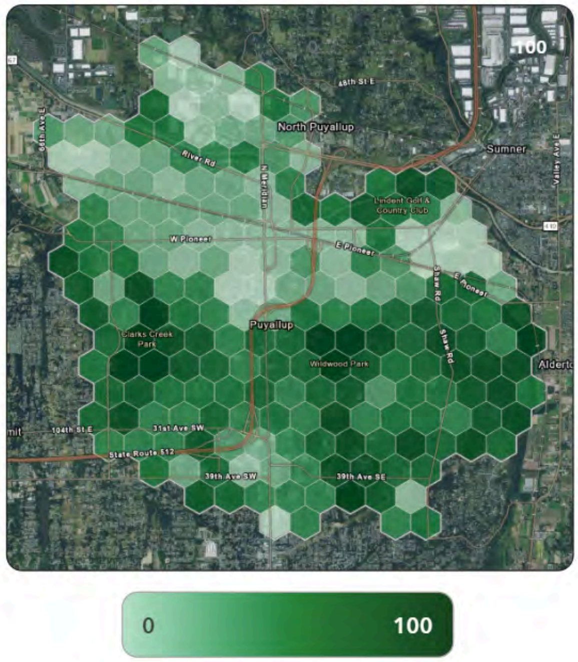

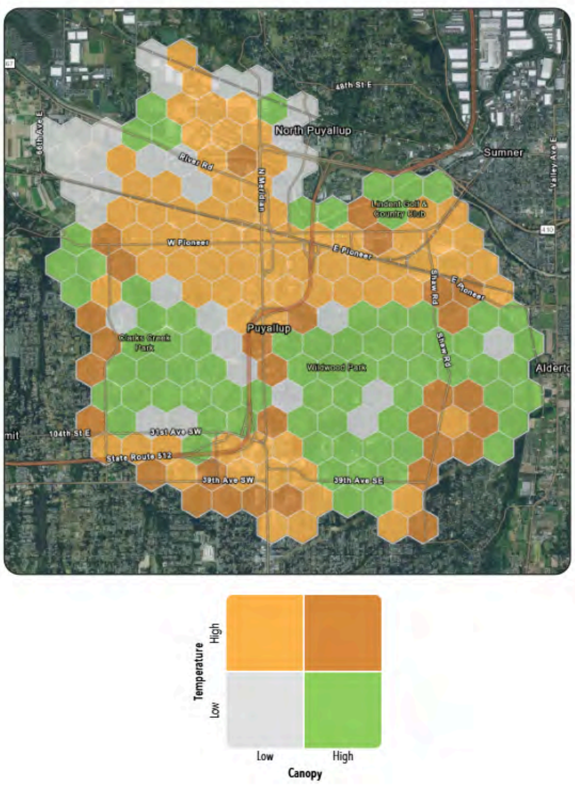

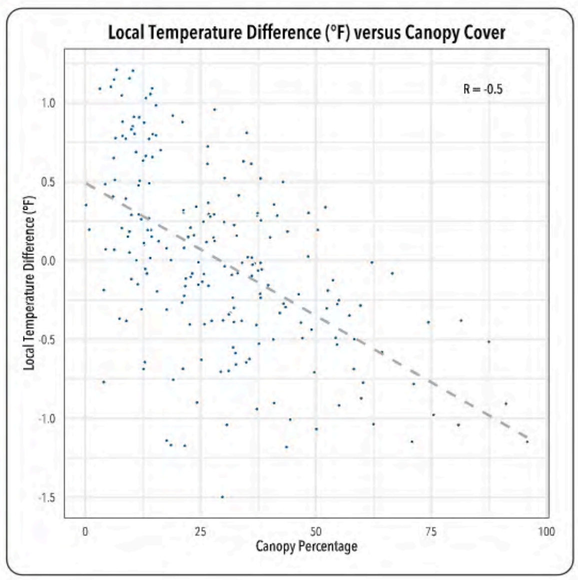

Puyallup Impervious Surfaces

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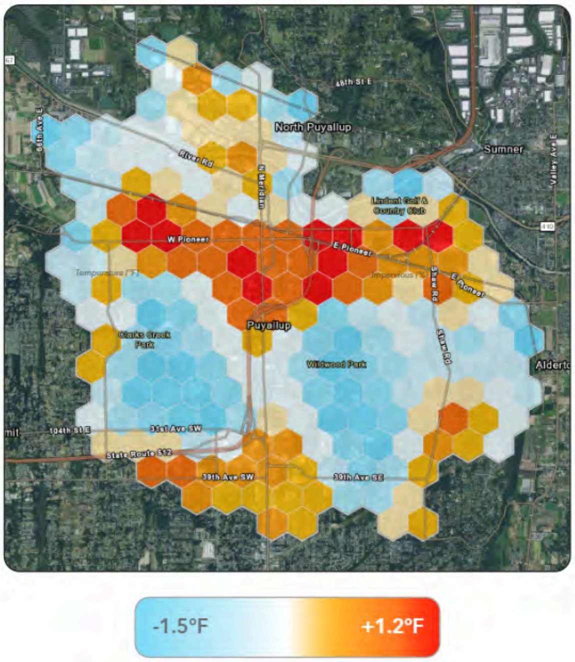

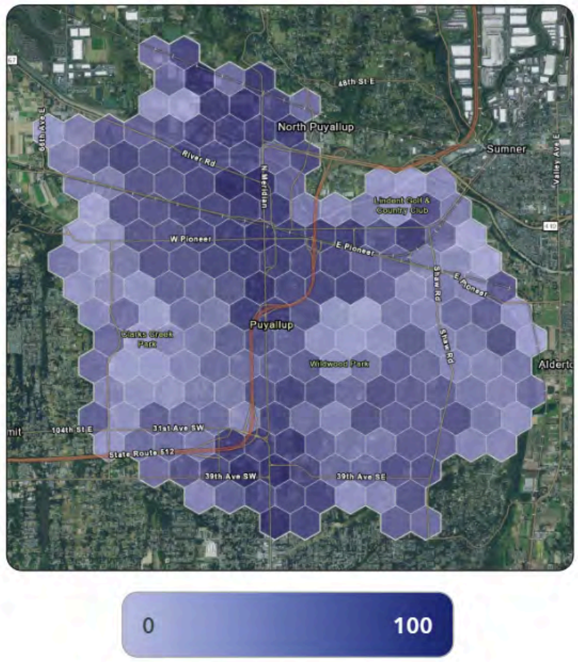

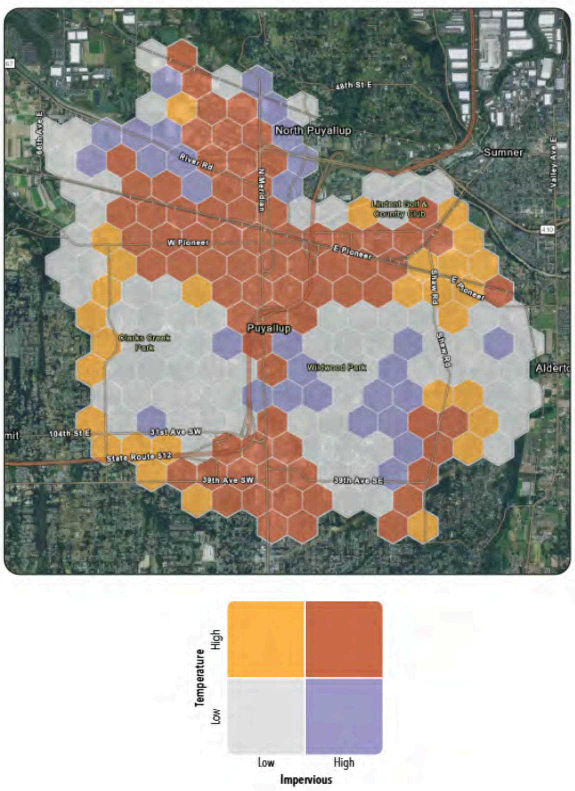

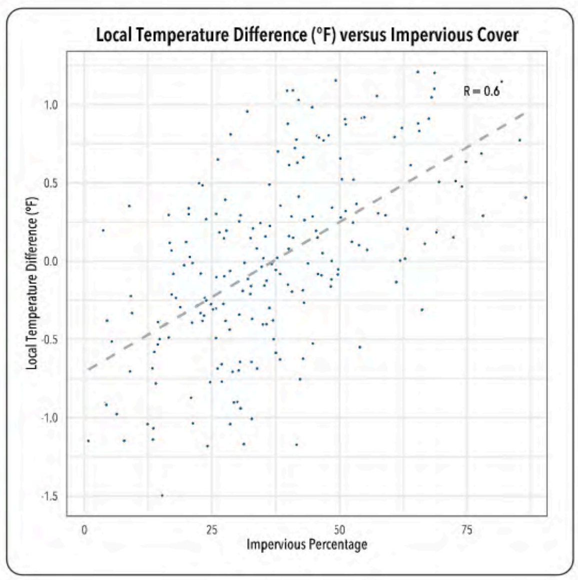

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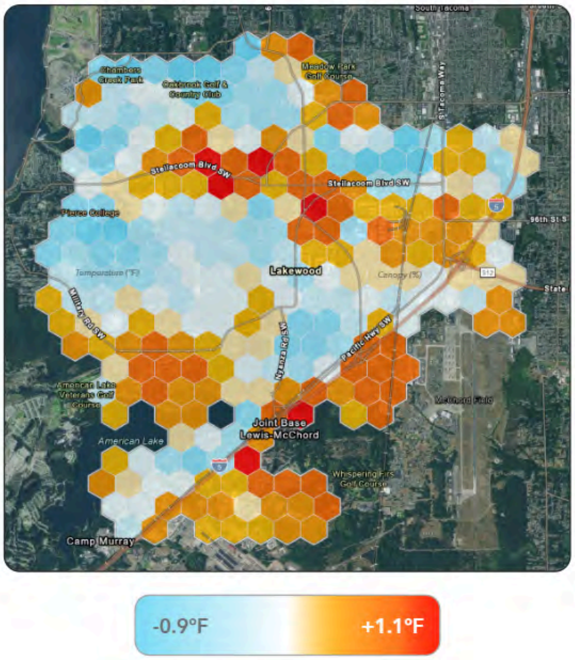

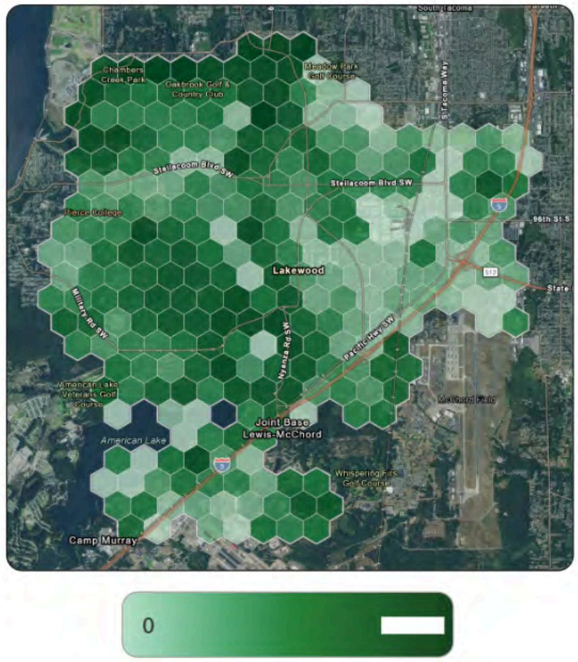

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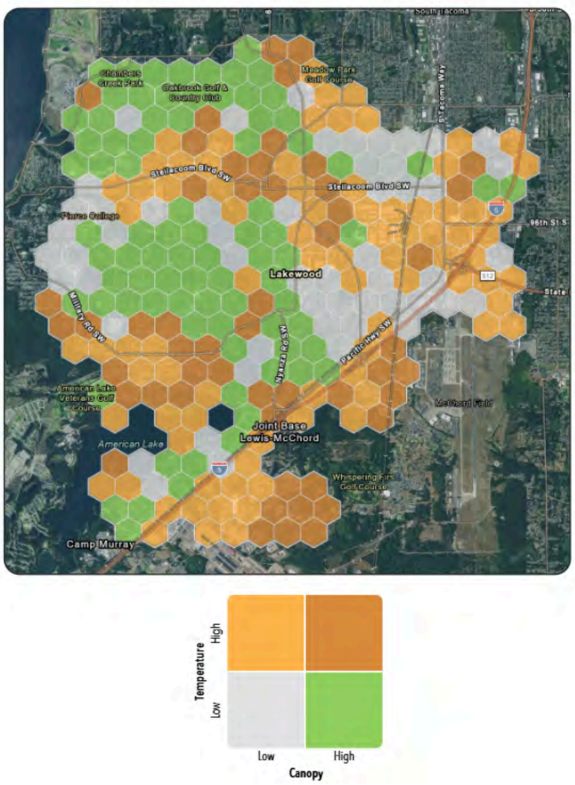
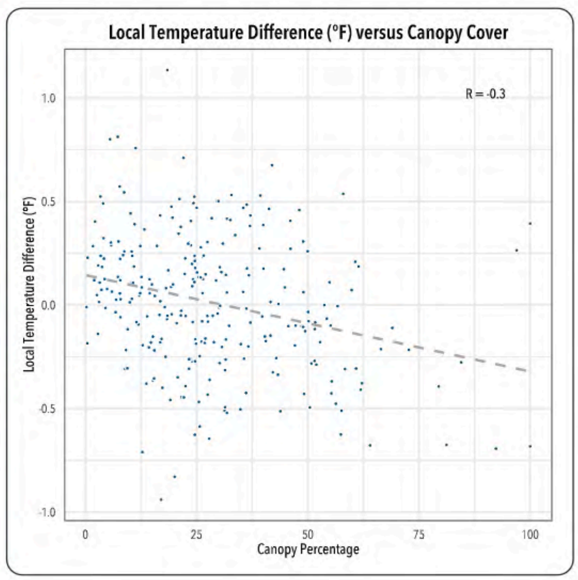
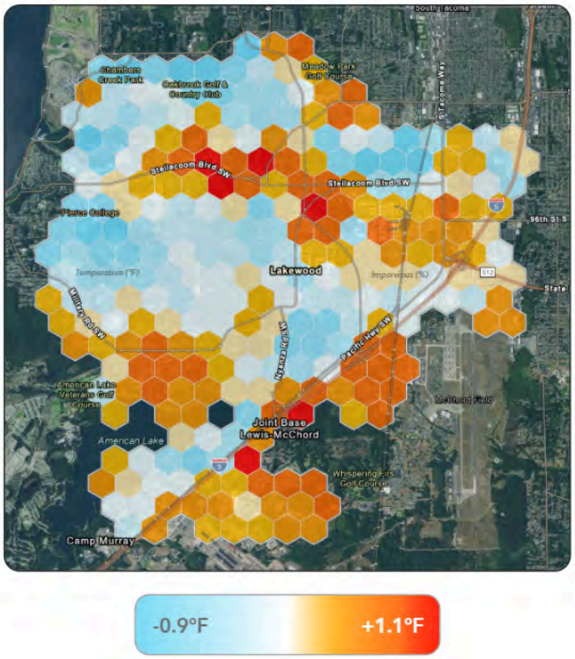
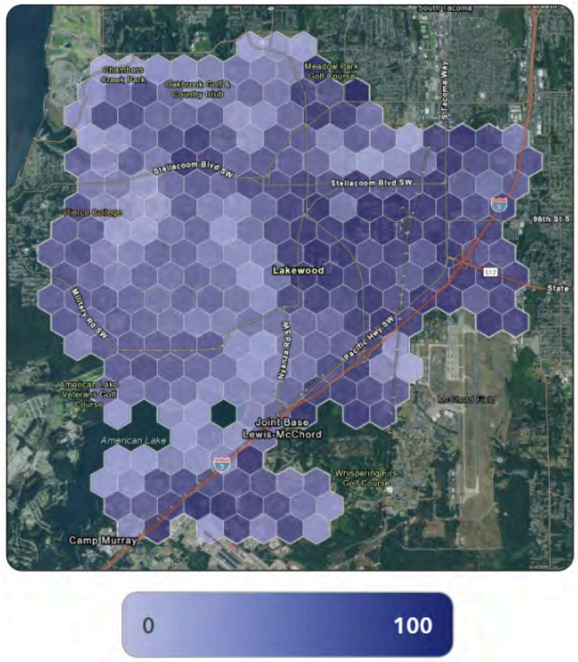
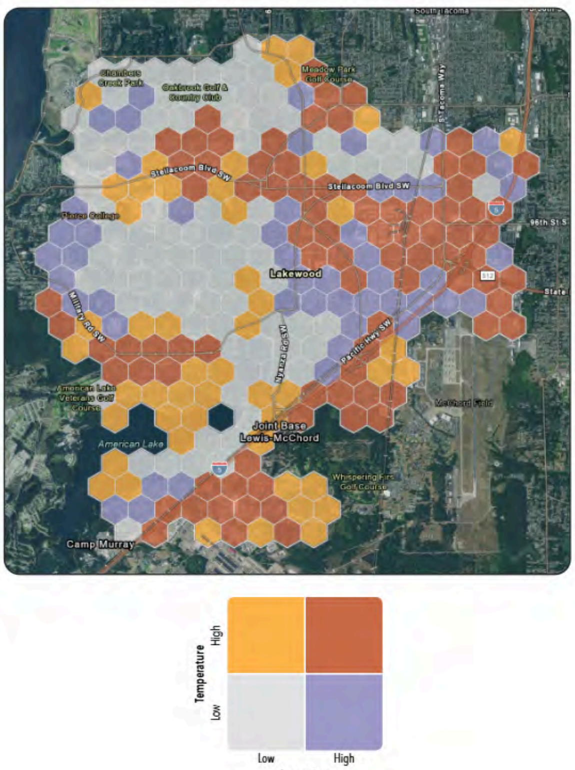
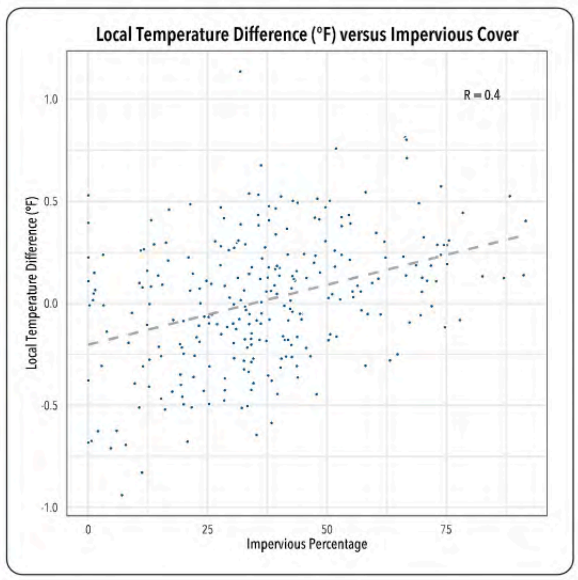


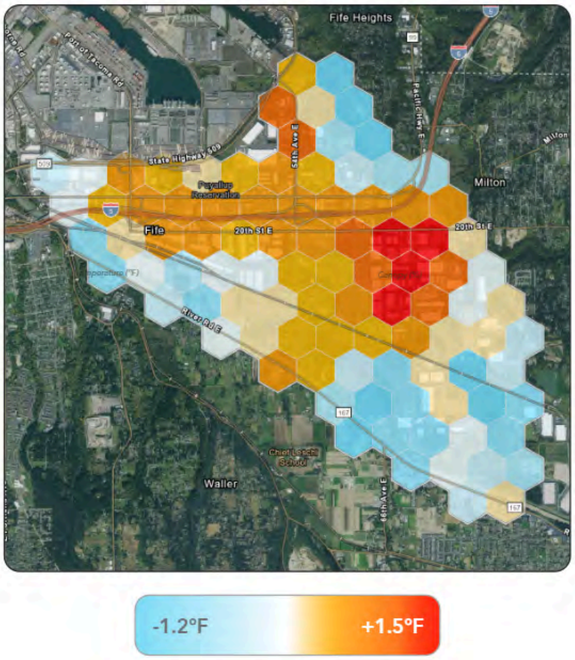



Stellacoom Blvd SW
Lakewood
Joint Base
Lewis-McChord
American Lake
Camp Murray
-0.9°F
+1.1°F

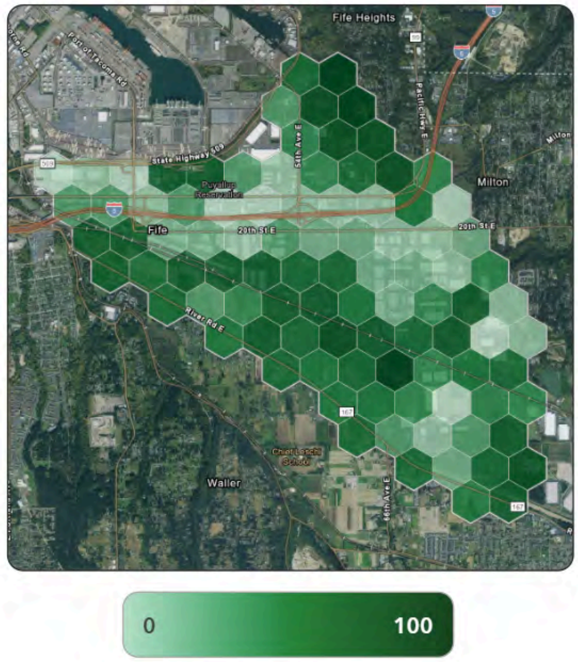

Stellacoom Blvd SW
Lakewood
Joint Base
Lewis-McChord
American Lake
Camp Murray
0
100


Stellacoom Blvd SW
Lakewood
Joint Base
Lewis-McChord
American Lake
Camp Murray
Temperature
High
Low
Low
High
Impervious


Local Temperature Difference (°F) versus Impervious Cover
R = 0.4
Local Temperature Difference (°F)
1.0
0.5
0.0
-0.5
-1.0
0
25
50
75
Impervious Percentage

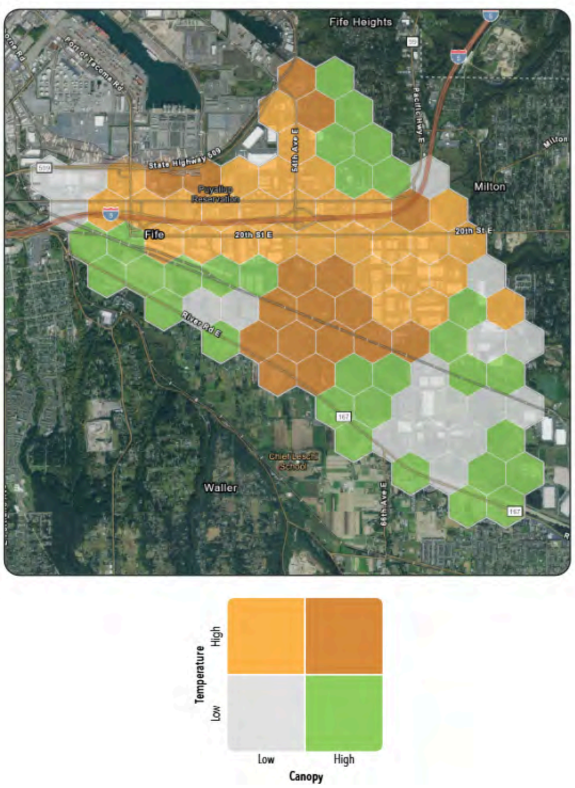


Fife Heights
Milton
Fife
20th St E
Waller
-1.2°F
+1.5°F

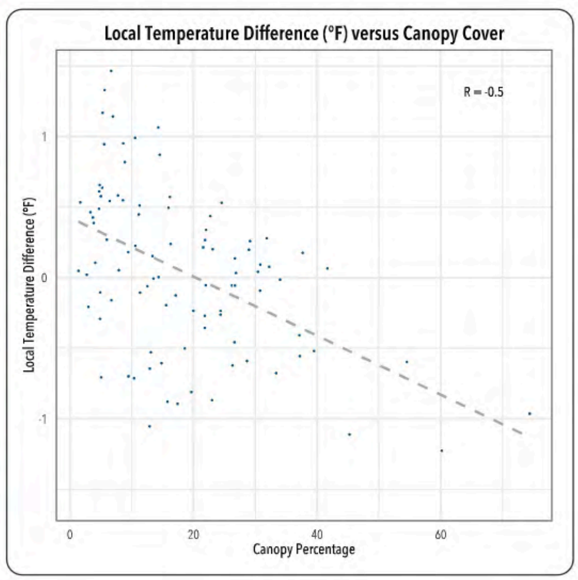


Fife Heights
Milton
Fife
20th St E
Waller
0
100

23



Fife Heights
Milton
Fife
20th St E
Waller
Temperature
High
Low
Low
High
Canopy



Local Temperature Difference (°F) versus Canopy Cover
R = -0.5
Local Temperature Difference (°F)
1
0
-1
0
20
40
60
Canopy Percentage

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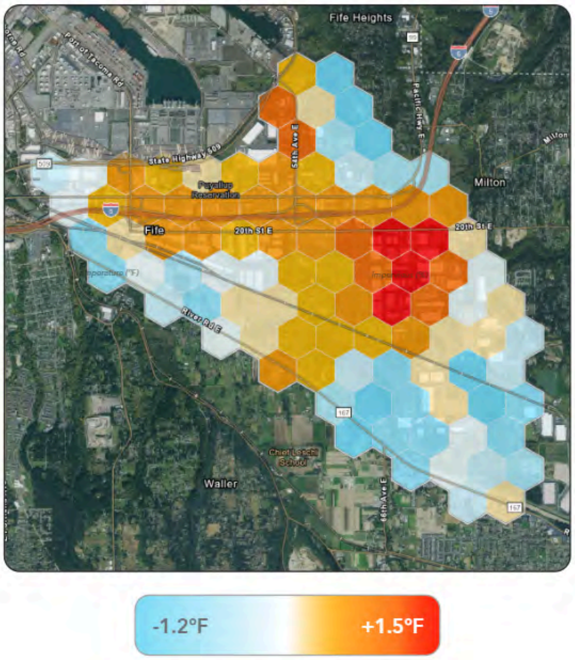

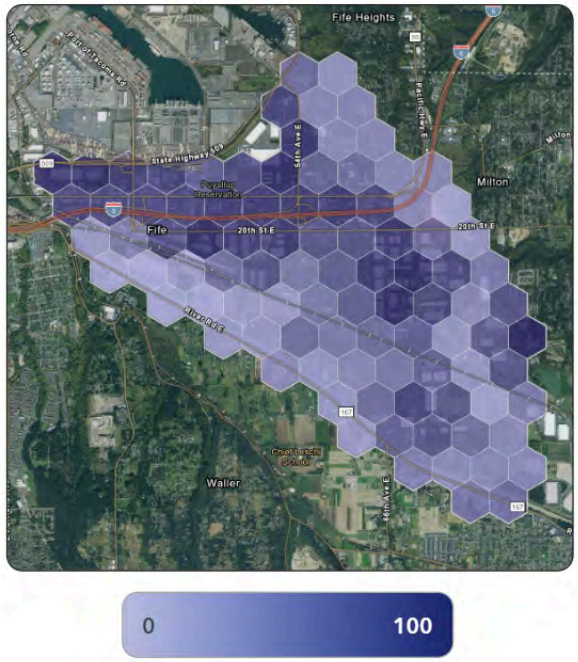

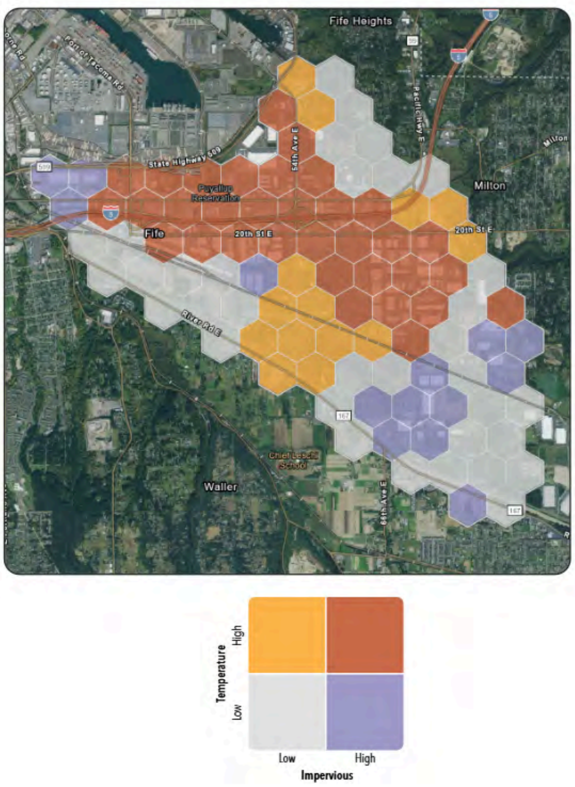

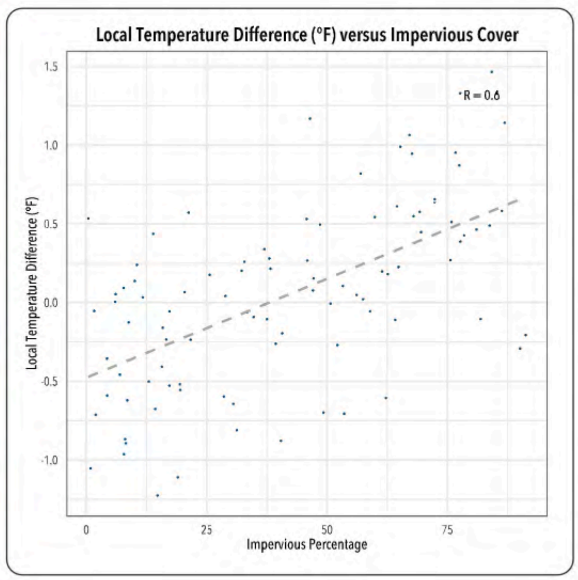

Recommendations

The data products and visualizations presented in this report provide new sets of information that can be leveraged for directing mitigation and adaptation strategies to reduce heat risk in areas of Pierce County facing high exposure and vulnerability to extreme heat. In this section we identify direct ways in which each of these products can be applied with relevant intervention strategies.

Canopy Cover

- Apply the canopy cover and heat assessment to target the expansion of canopy cover at both area-wide and sub-area scales.
    - Set targets and prioritize areas that are especially hot with low existing canopy cover. Studies have shown that the cooling benefits of trees level off when coverage reaches approximately 20-30%, while prior guidance has indicated ideal targets as high as 40%.
    - Plan for robust community engagement and localized data gathering when setting neighborhood targets to ensure that interventions will be welcomed by local residents and that interventions do not inadvertently create harm to vulnerable populations (e.g., exacerbating issues with tree debris and maintenance); use these maps and data as visual aids and communication tools when engaging with community members.
    - Prioritize native tree species when possible. Non-invasive, non-native species are also suitable for the future as native species may be unable to adapt to a warmer climate. A list of native and non-native "climate adapted species" which can survive in projected conditions should guide future planting selections.
    - Consider different planting configurations for different interests. A cluster of trees in one location (e.g., a forest) offers greater benefits in terms of air purification, stormwater control, and localized heat mitigation. The same number of trees spread equally over a large area (e.g. an entire city) will have less pronounced ecological effects, but will impact a greater number of urban residents. Placing trees within green space or near water features will maximize their cooling potential.
- Preserve existing mature tree canopy using this analysis as evidence for the cooling effect of trees. Full grown trees are up to 70 times more effective than saplings at capturing carbon, mitigating heat, and controlling stormwater.
- Target green job development in areas with lacking tree cover and high heat; youth conservation corps are especially valuable in helping to increase and maintain canopy cover.

Impervious Surfaces

- Apply the impervious cover and heat assessment to target the reduction of impervious surfaces in high heat areas identified at both the area-wide and sub-area level.
    - Utilize permeable and/or light pavements along pedestrian and bike paths to cool the path surface for people and pets.
- In areas with high impervious cover and heat, introduce non-vegetative shading solutions where feasible.
    - Locate shade structures in areas where people typically congregate or recreate for an extended period of time, such as picnic areas, playgrounds, or athletic courts.

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- Shade areas where individuals will be resting or waiting, such as benches and bus stops. Pergolas and shade canopies are popular options for this purpose.
- Aim for at least 30% shade coverage along transit paths and consider how shade structures will behave at different times of day and with different sun angles.
- Note that paths or sites with east-west exposure will require more shading than those with north-south exposure.
- Incorporate public art into shade structure to improve the aesthetic. Art may include messaging related to heat safety or other heat-related topics.

Data

The corresponding datasets for this report are available here.

CAPA

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ATTACHMENT C

Pierce County

Canopy Analysis

Summary Report

Pierce County

Canopy Analysis

Summary Report

by CAPA

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Table of Contents

Introduction

Over the summer of 2024, Pierce County community members collected tens of thousands of heat measurements across select areas of the County with the mobile mapping program, CAPA Heat Watch. Results from this campaign provide new hazard descriptions of air temperature and heat index across the City at high resolution, improving on coarse descriptions of land surface temperature. In this analysis, we assess the relationships between these heat data and descriptions of key land cover characteristics, specifically canopy cover and impervious surfaces, to better understand which areas are more and less exposed to extreme heat and identify relevant solutions. We examine relationships using high resolution land cover data across two scales: the area-wide Pierce County study area, and eight sub-areas identified by the Puget Sound Regional Council's Urban Regional Geographies dataset. For each scale we provide a description of methods, data visualizations, and initial interpretations of results, as well as recommendations of how to leverage each data product towards targeted heat mitigation and adaptation actions.

Delivered alongside this report are several spatial data products, including the localized heat data as well as corresponding datasets for area-wide and sub-area results. These data products are available **here.**

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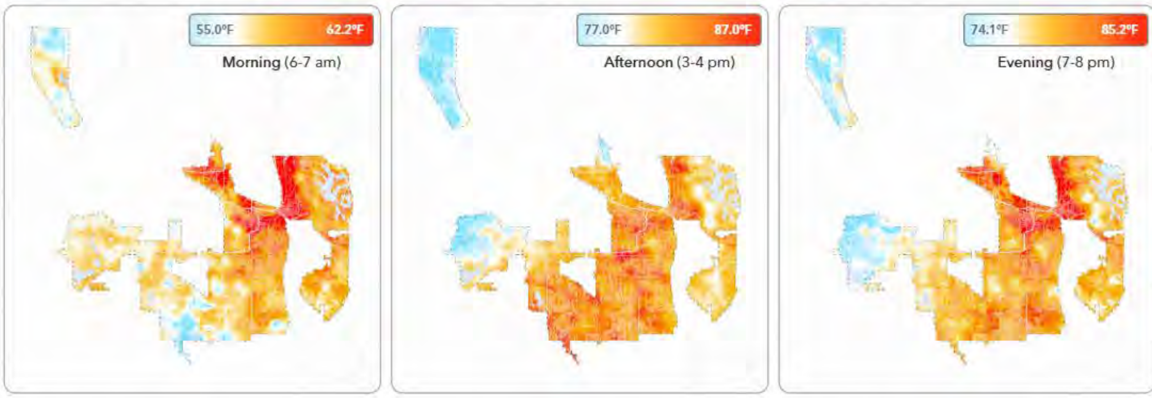
Localized Heat

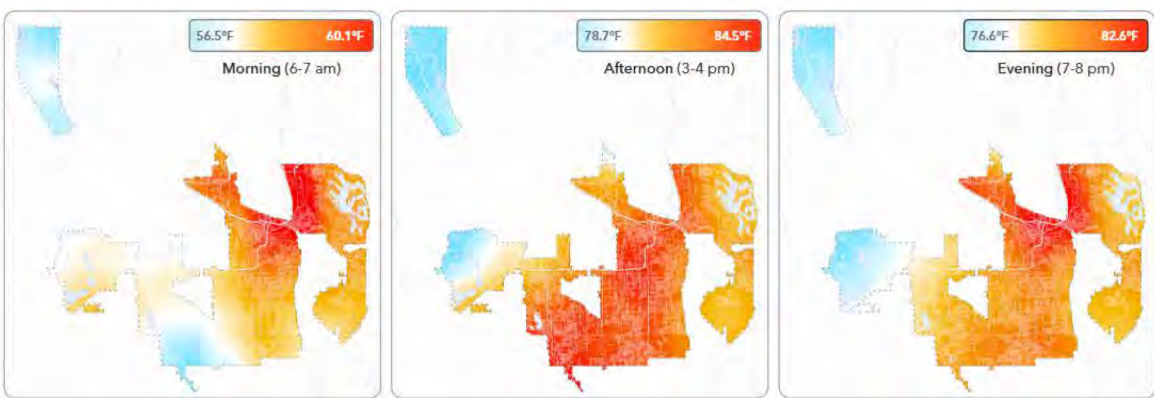
Heat Watch data describes the distribution of air temperatures at one to two meters above the ground across the Pierce County study area during typical urban heat island conditions. The data was collected by sensors mounted to passenger vehicles that traversed through a variety of land uses and land covers across the study area at simultaneous periods during the morning, afternoon and evening. Using the data, area-wide models of air temperature distribution were generated for the three time periods by integrating land cover imagery from the Sentinel-2 satellite in a machine learning process.

Figure 1. 2024 Heat Watch maps



As the Pierce County study area spans a wide region including the Puget Sound, the heat distribution patterns may be influenced by the regional geography of the area (for example, proximity to a large water body). To reduce this regional effect, a localized heat raster was developed. For each time period, a "temperature difference" raster was created by subtracting the temperature at each grid point from a coarse temperature raster (visualized below) produced by aggregating the Heat Watch data up to 25 kilometer resolution. The localized heat raster was then computed by averaging the temperature difference rasters from the three time periods. The localized heat data was used for area-wide and sub-area analyses.

Figure 2. 2024 Coarse (30-meter) Heat Watch maps



Area-Wide Results

Area-Wide Summary

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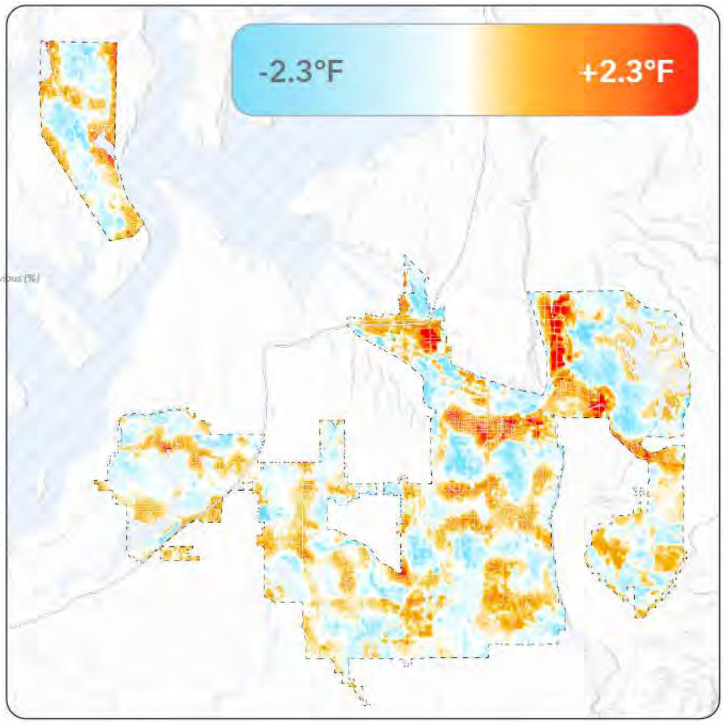
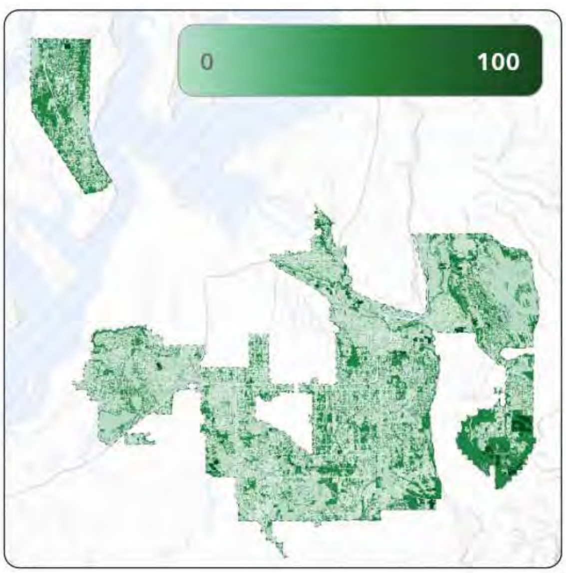
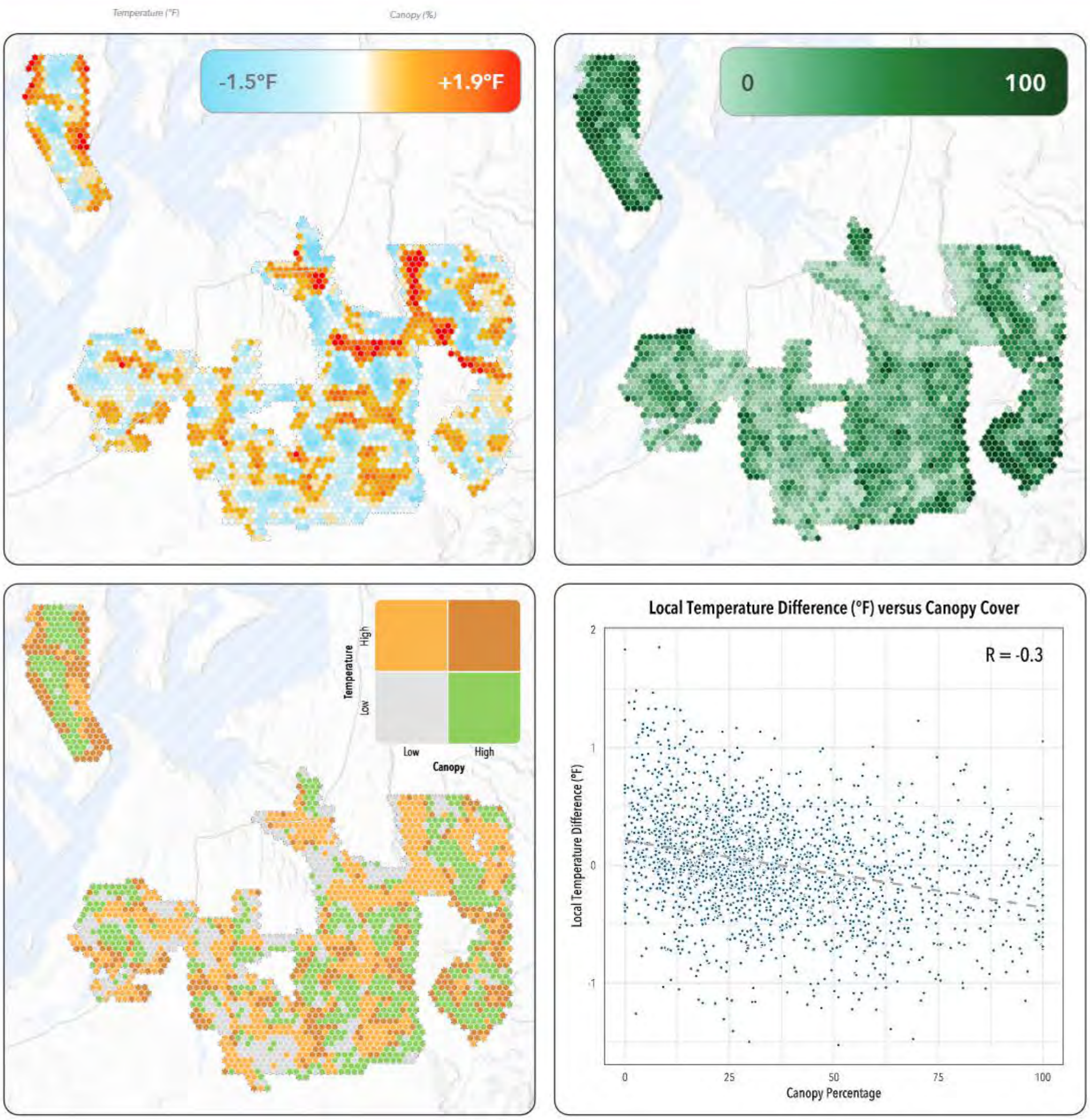
The localized heat raster displays heat distribution relative to the surrounding 25 km, reducing the regional effect due to differences in geography across the study area. Note that while the range of localized temperatures is roughly 5°F due to the processing steps (involving averaging of multiple time periods), temperature differences as wide as 14°F were measured during the Heat Watch campaign traverses.

The overall percentage of canopy across the area is 34% and impervious surfaces is 30%. Patterns between heat, canopy cover and impervious surfaces can be seen at the broad scale in the maps below. Cool areas with high canopy cover are seen in Clarks Creek Park and Wildwood Park near Puyallup, and surrounding Lake Tapps; warm areas with high impervious surface amounts can be seen in the industrial area around Sumner, Fife and Puyallup.

The following pages display the data summarized by 500-meter hexagon and present plots describing the overall pattern between canopy cover and impervious surfaces with localized heat across the study area.

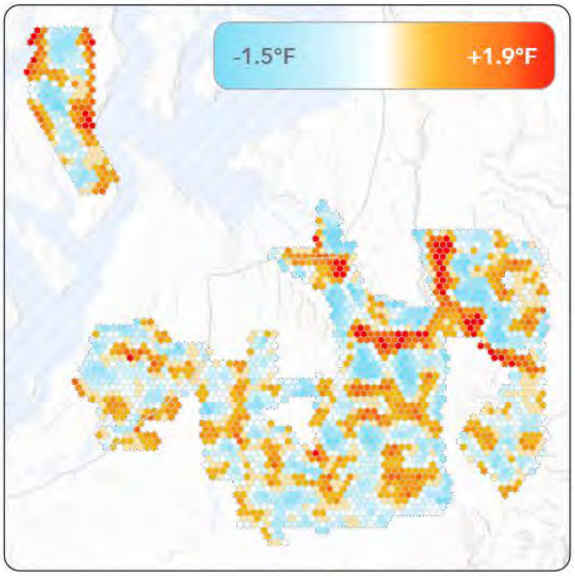


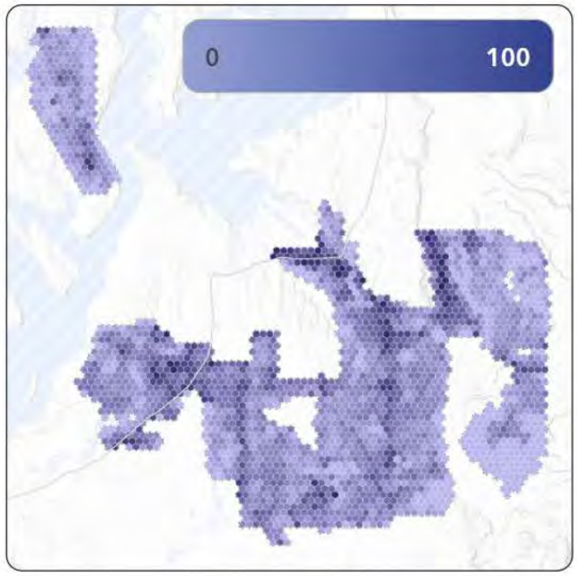


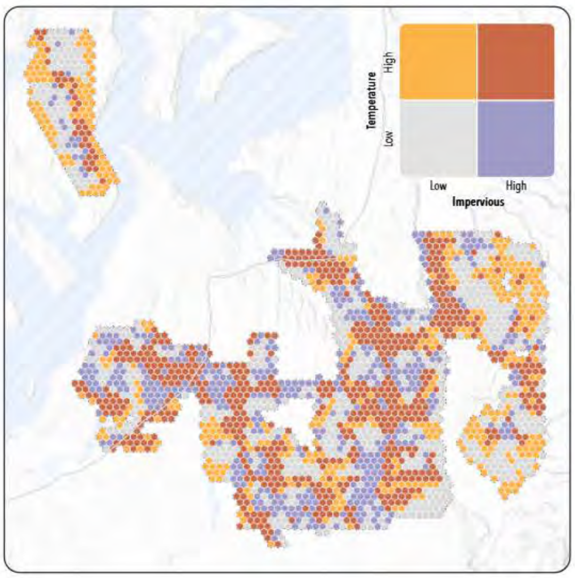

Temperature (°F)
Canopy (%)
-1.5°F
+1.9°F
0
100
Temperature
High
Low
Low
High
Canopy
Local Temperature Difference (°F) versus Canopy Cover
R = -0.3
Local Temperature Difference (°F)
2
1
0
-1
0
25
50
75
100
Canopy Percentage

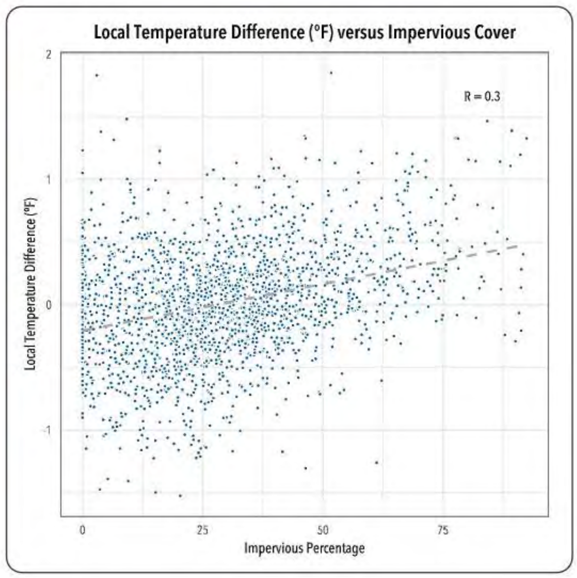
Temperature (°F)

Impervious (%)









Sub-Area Results

Sub-Area Summary

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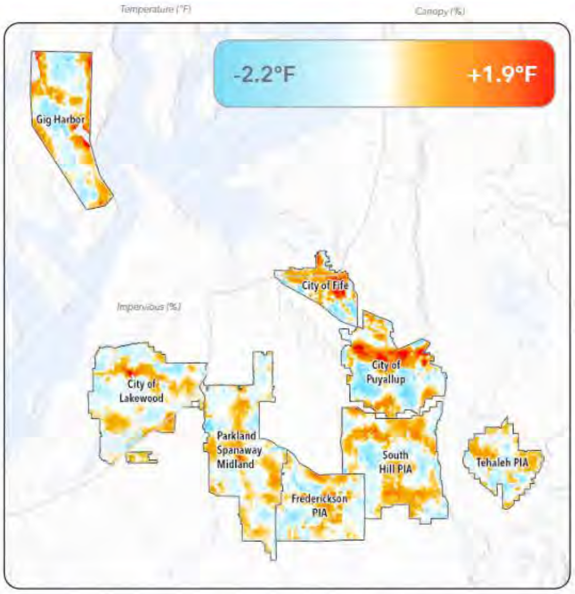
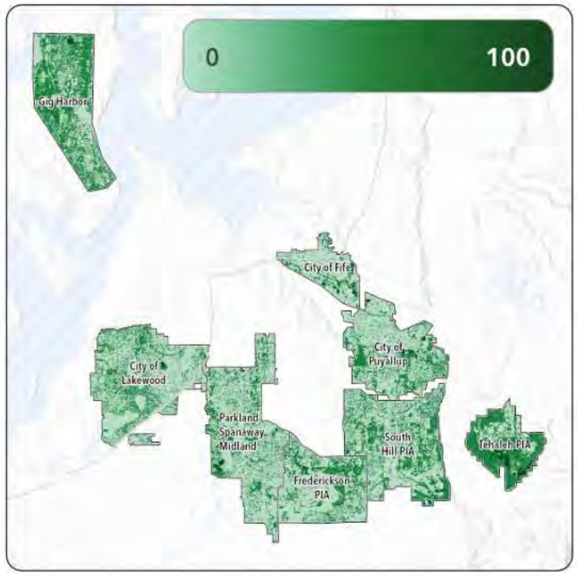
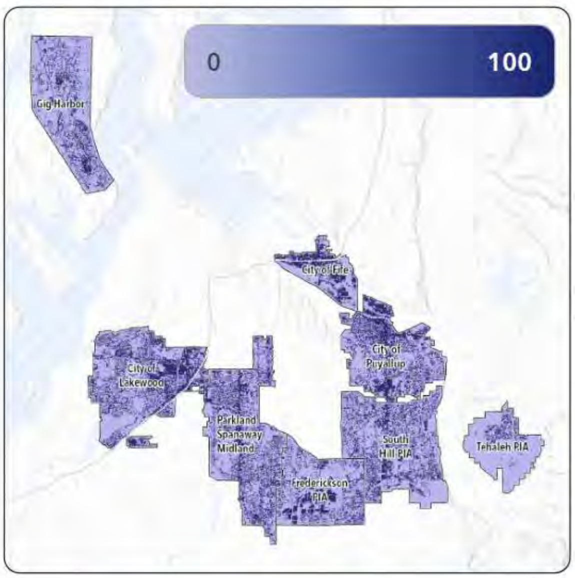






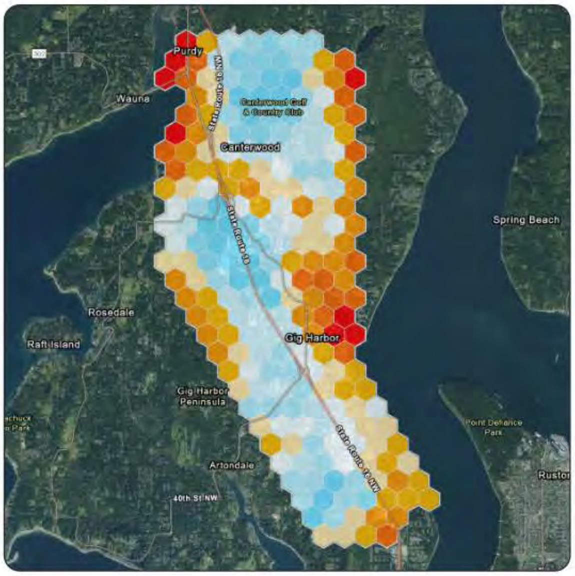
Summarized below, the percentage of canopy cover of sub-areas ranges from 16.8% in the City of Fife to 65.5% across Tehaleh PIA; conversely, the percentage of impervious surfaces coverage ranges from 9.3% in Tehaleh PIA to 44.4% in the City of Fife. Differences in sub-area average temperature from the global average range from -2.2°F in Gig Harbor to +1.3°F in Puyallup.

The following pages display the canopy and impervious surface raster data for each sub-area along with bivariate maps comparing the variables with localized heat using 500-meter hexagons as sampling units. Also presented are plots describing the relationship between localized heat, canopy cover and impervious surfaces within each sub-area.

Sub-Area	Canopy (%)	Impervious (%)	Avg Temp (°F)	Global Temp (°F)	Avg Temp Diff (°F)
Parkland Spanaway Midland	26.6	33.9	73.4	73.5	-0.1
Gig Harbor	53.9	22	71.3	73.5	-2.2
Frederickson PIA	29.7	30.3	73.9	73.5	0.4
Tehaleh PIA	65.5	9.3	73.2	73.5	-0.3
City of Fife	16.8	44.4	74.5	73.5	1.0
City of Puyallup	29.3	39.5	74.8	73.5	1.3
City of Lakewood	27.1	36.3	72	73.5	-1.5
South Hill PIA	36.4	30.1	74.2	73.5	0.7

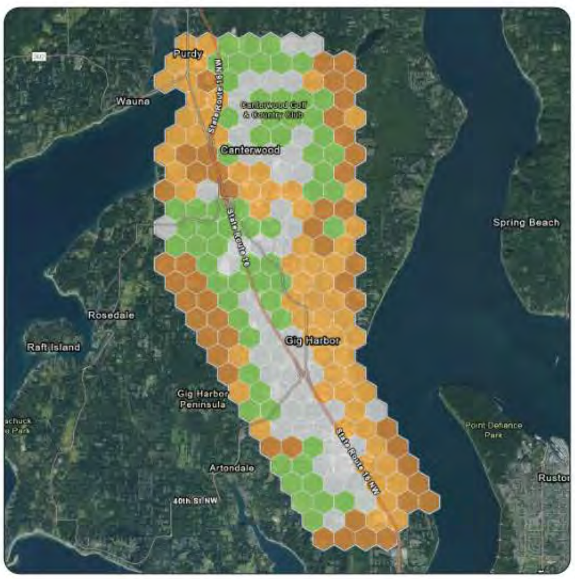
Gig Harbor Canopy Cover

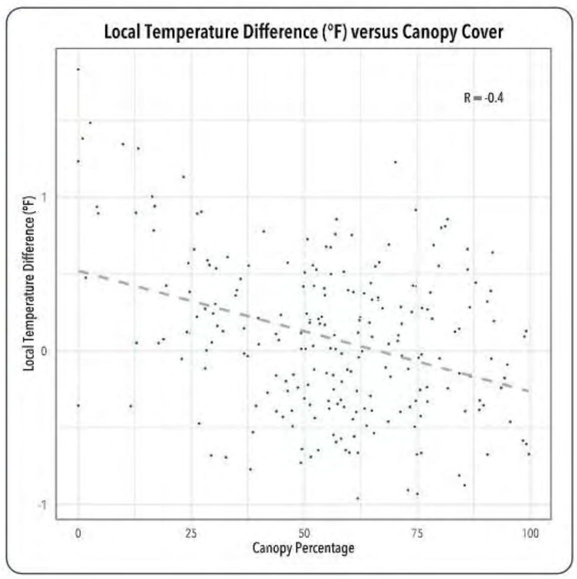
Return to Agenda

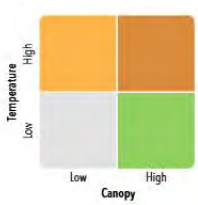


-0.9°F +1.8°F

0 100

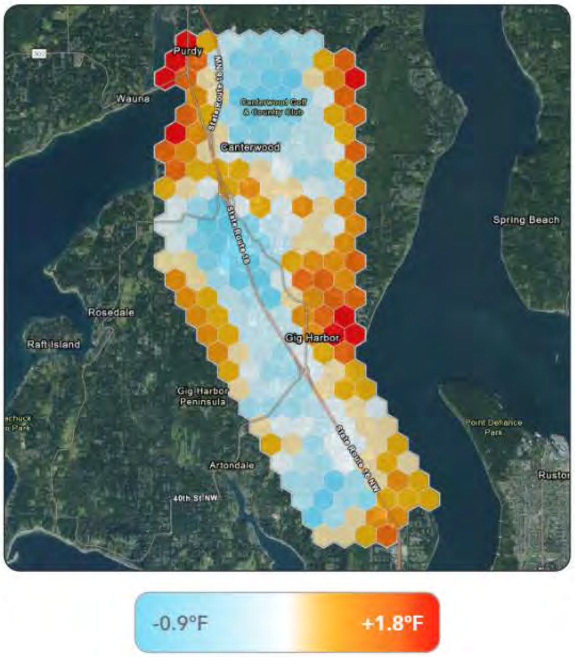


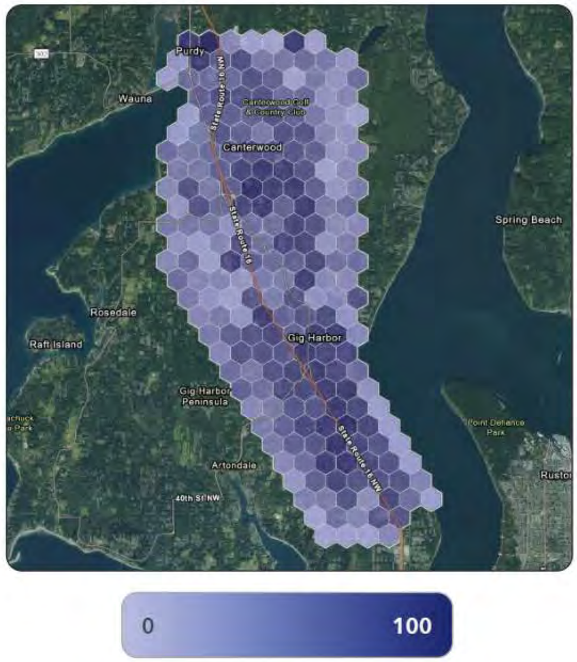


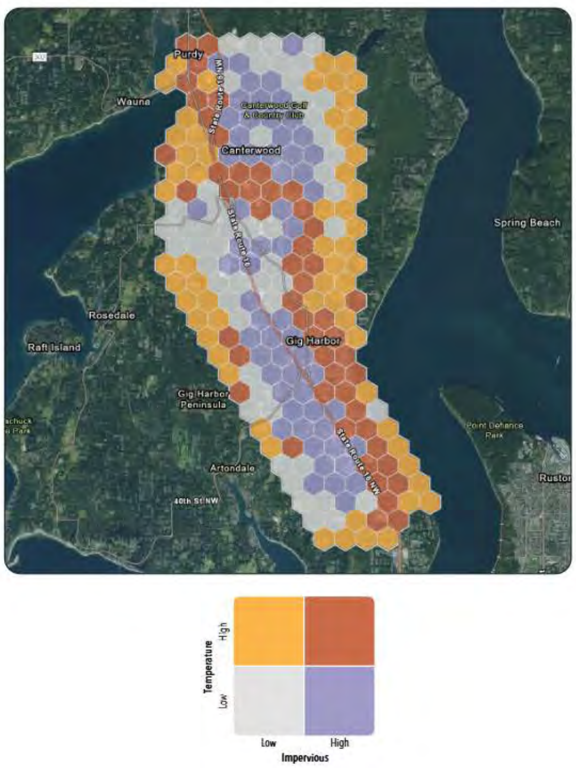


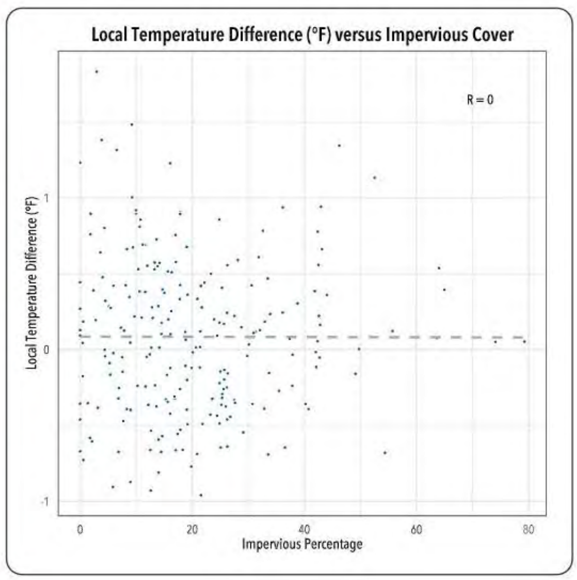
Gig Harbor Impervious Surfaces

Return to Agenda



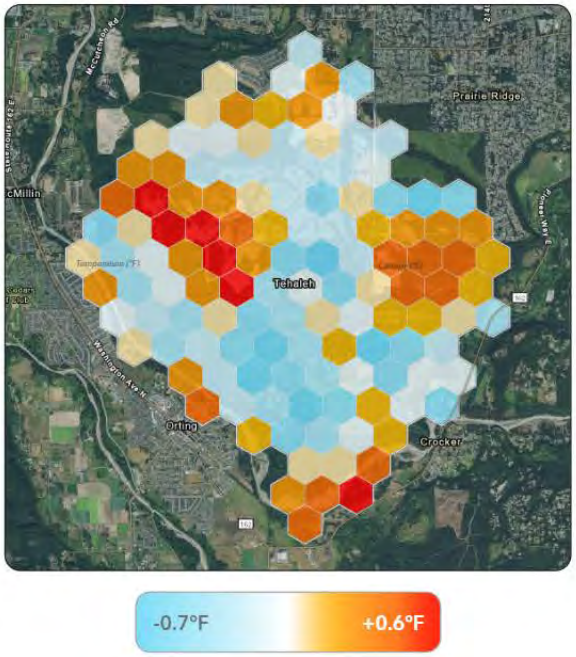


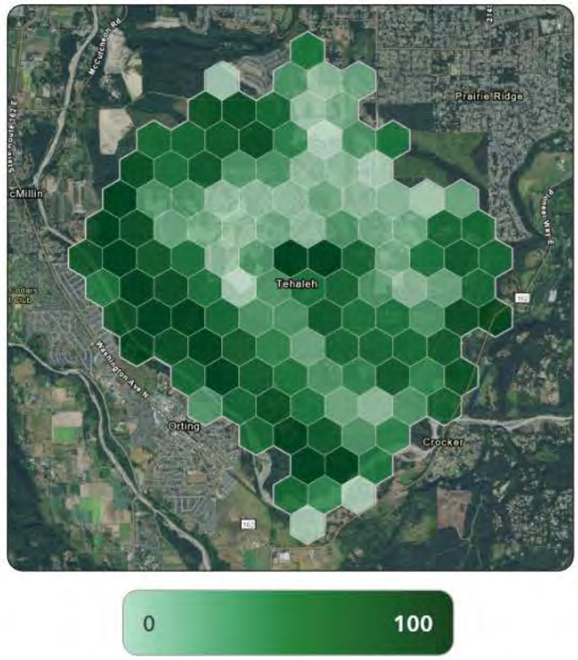


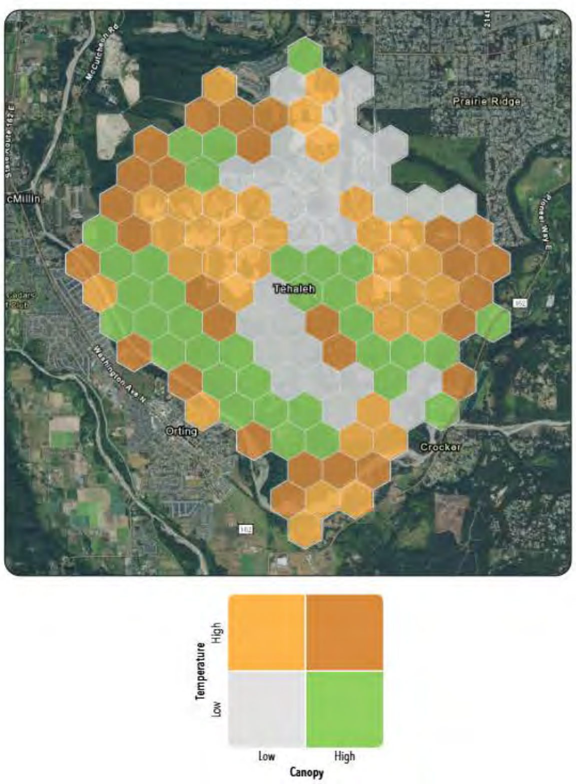


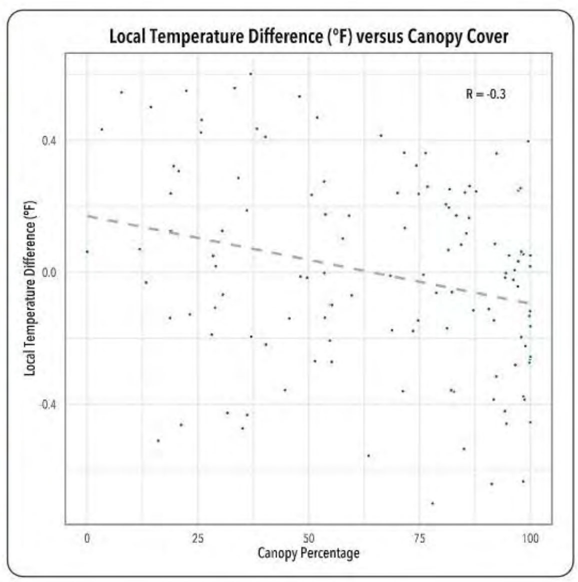
Tehaleh Canopy Cover

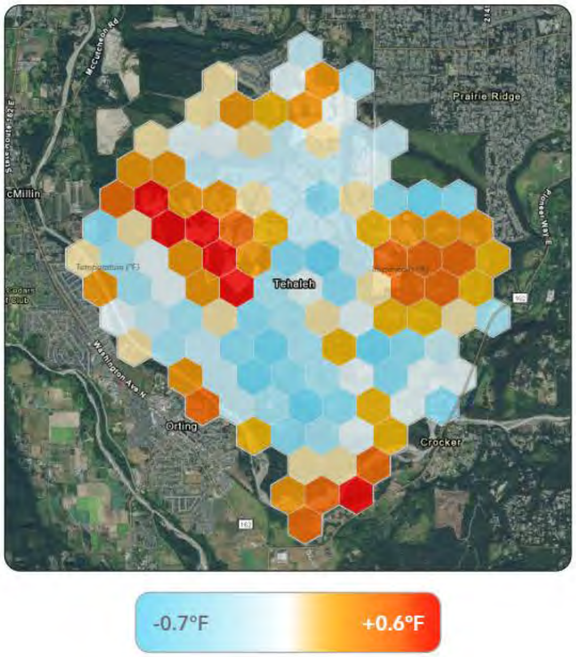
Return to Agenda



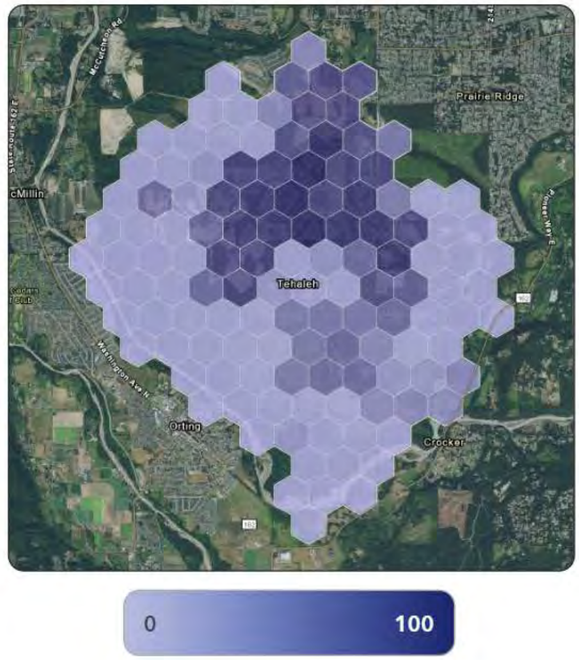






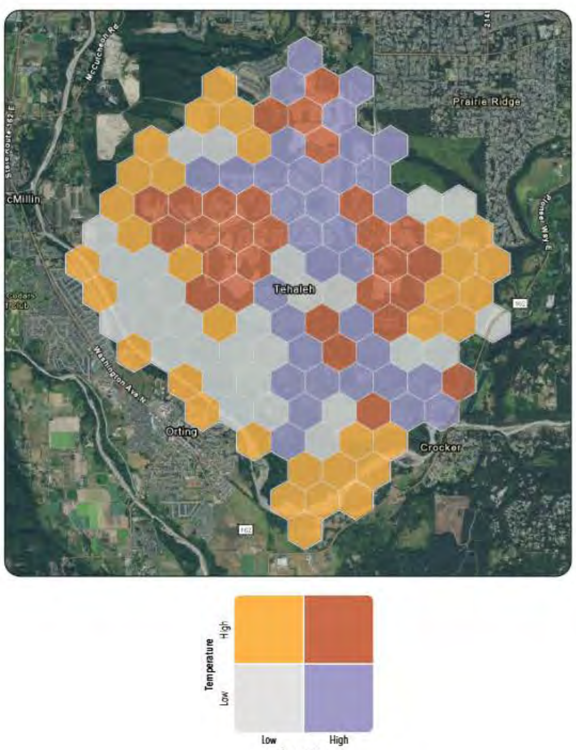


Prairie Ridge
cMillin
Tehaleh
Orting
Crocker
-0.7°F
+0.6°F

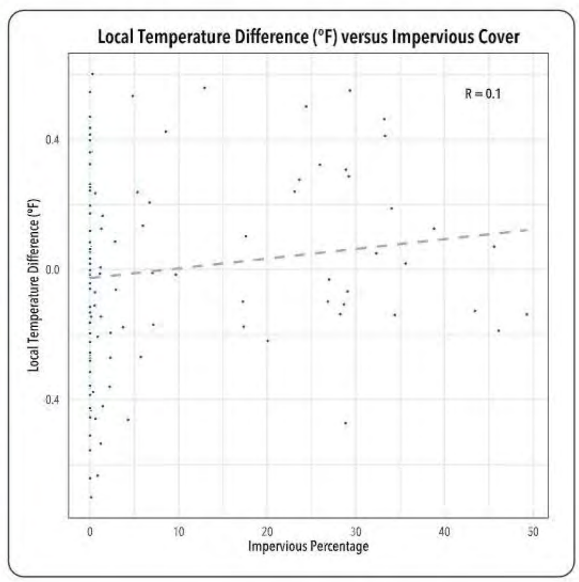


Prairie Ridge
cMillin
Tehaleh
Orting
Crocker
0
100

12



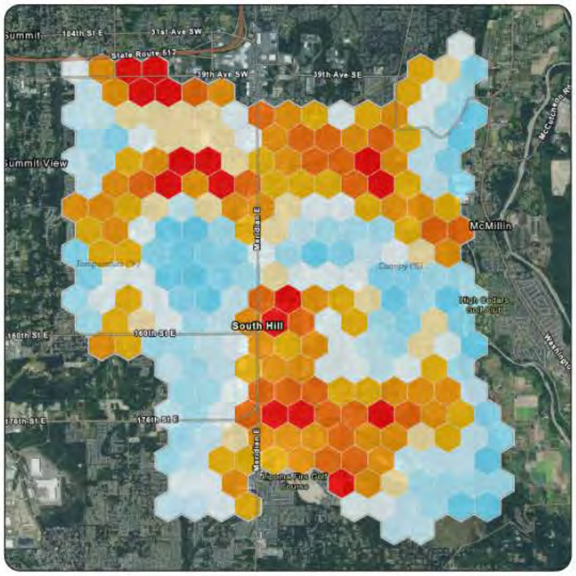
Prairie Ridge
cMillin
Tehaleh
Orting
Crocker
Temperature
High
Low
Low
High
Impervious



Local Temperature Difference (°F) versus Impervious Cover
R = 0.1
Local Temperature Difference (°F)
0.4
0.0
0.4
0
10
20
30
40
50
Impervious Percentage

South Hill Canopy Cover

Return to Agenda



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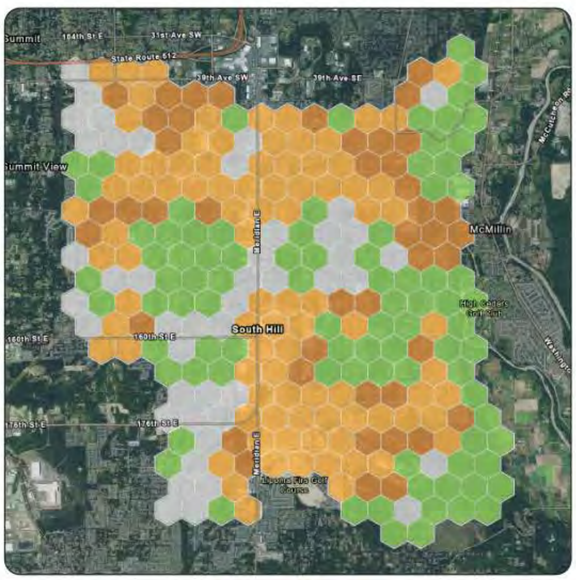
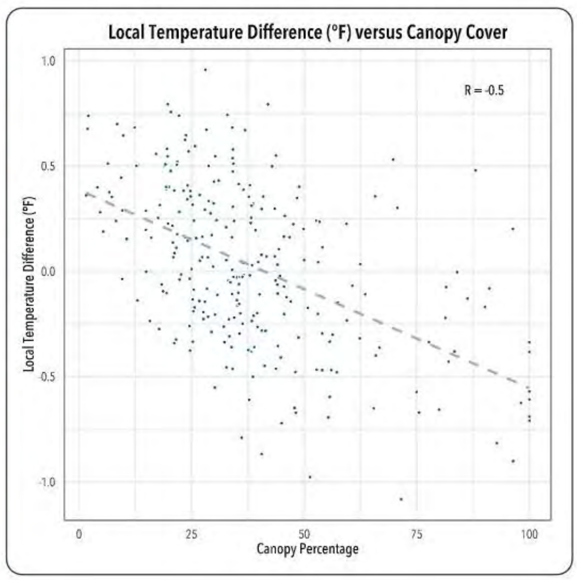
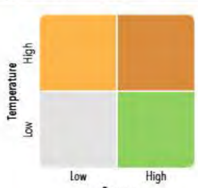
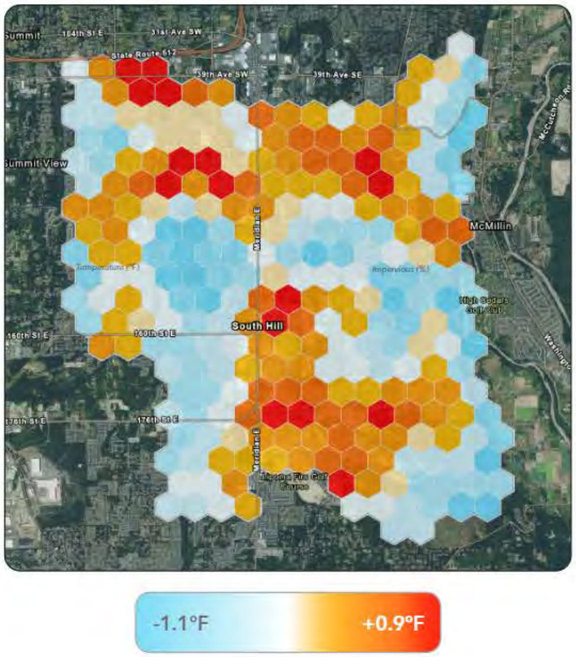


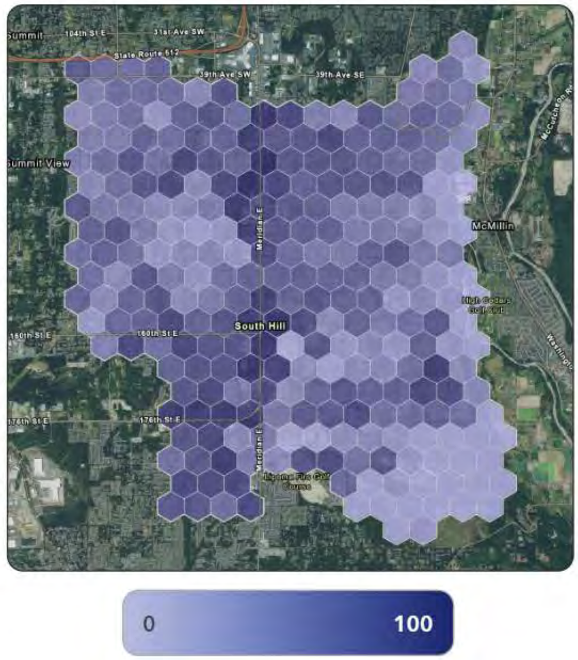


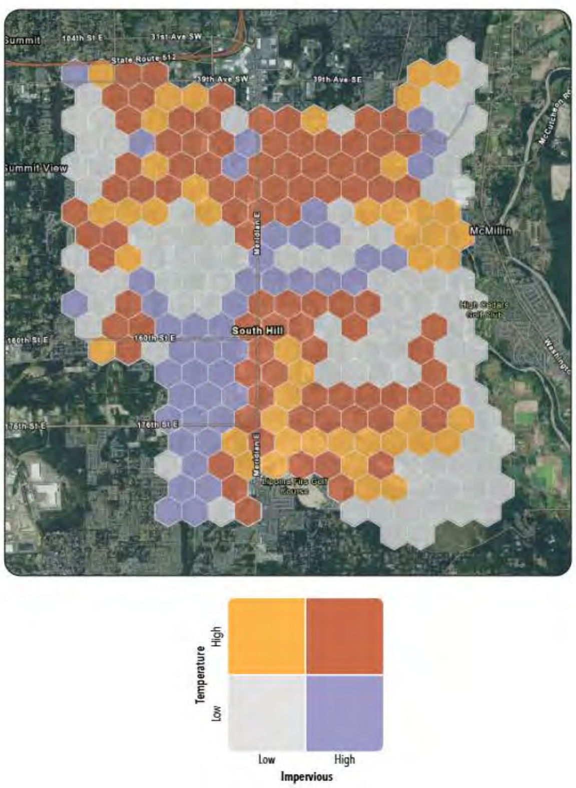


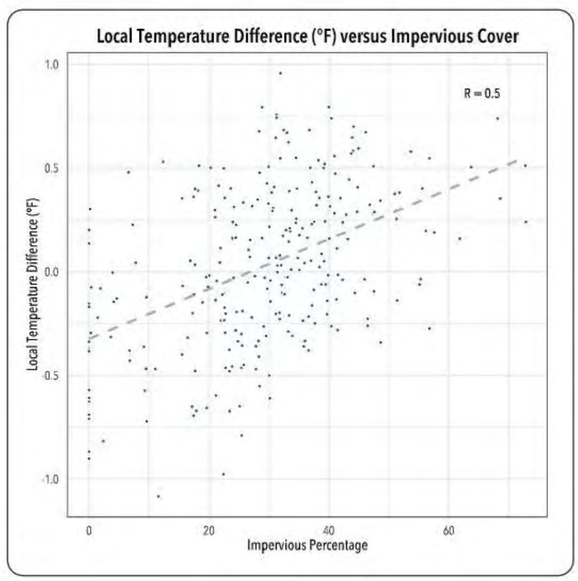
South Hill Impervious Surfaces

Return to Agenda









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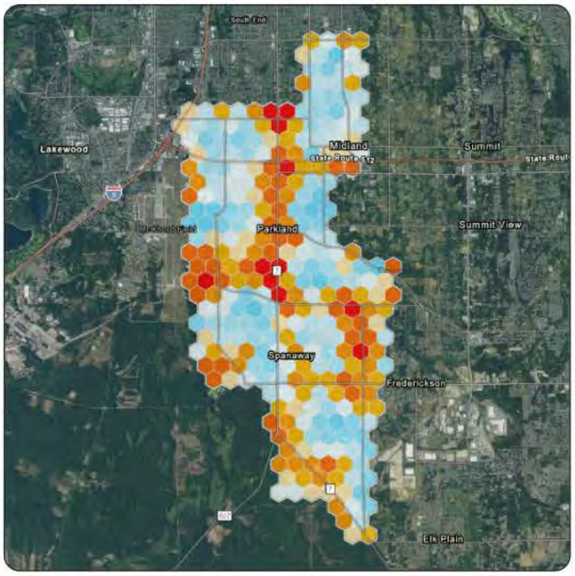
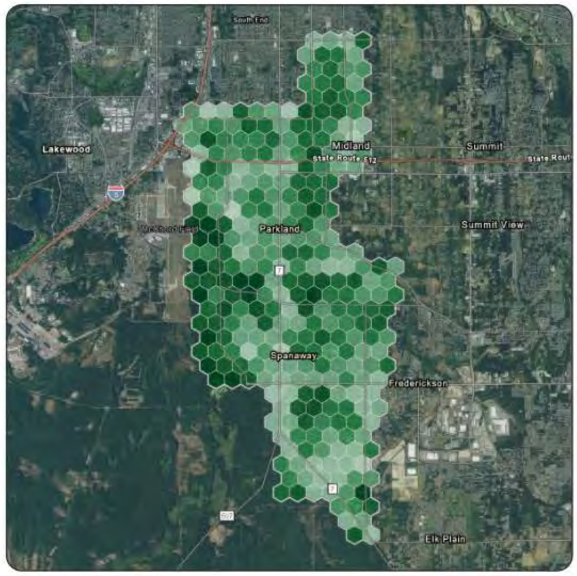
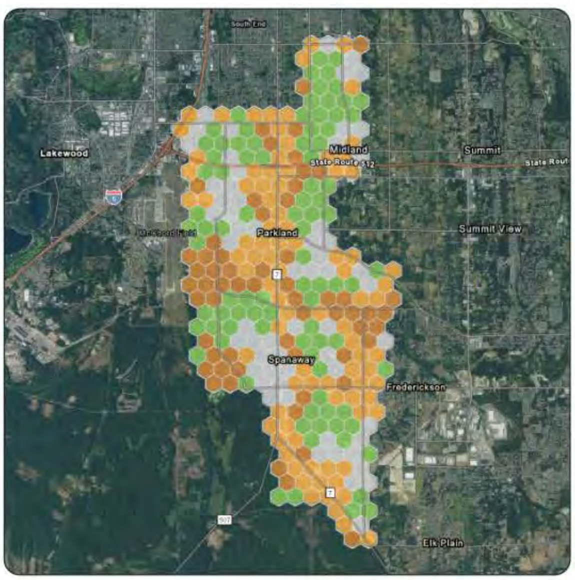
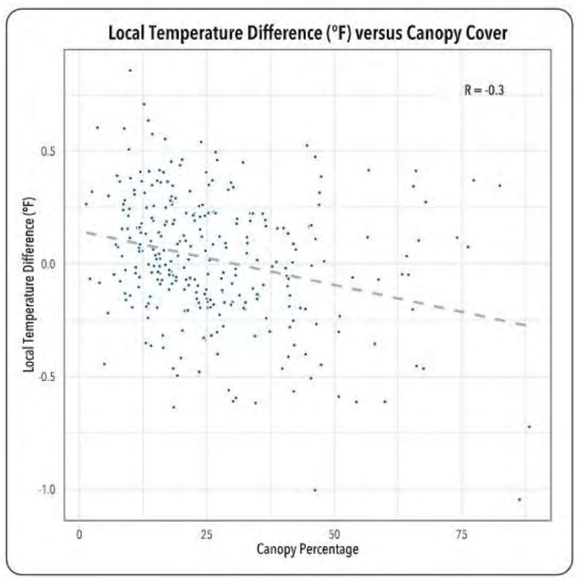
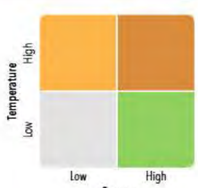




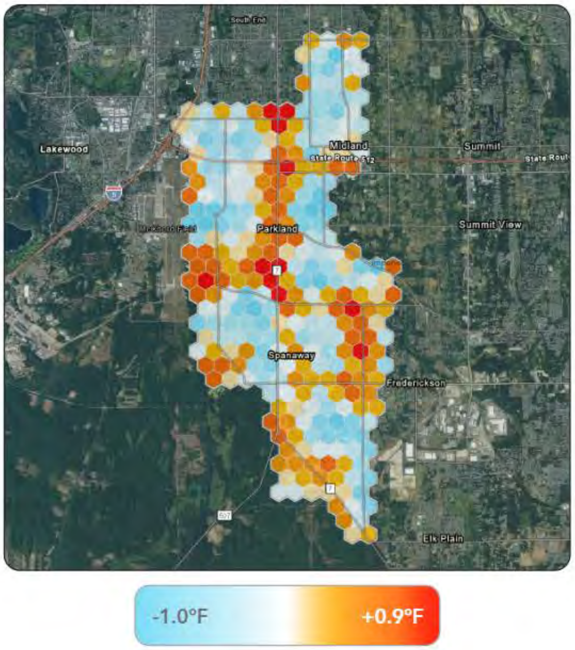


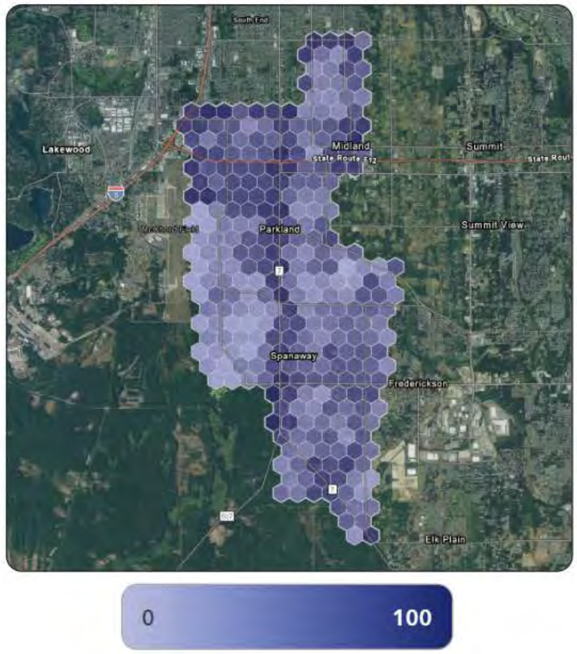




Parkland Impervious Surfaces

Return to Agenda





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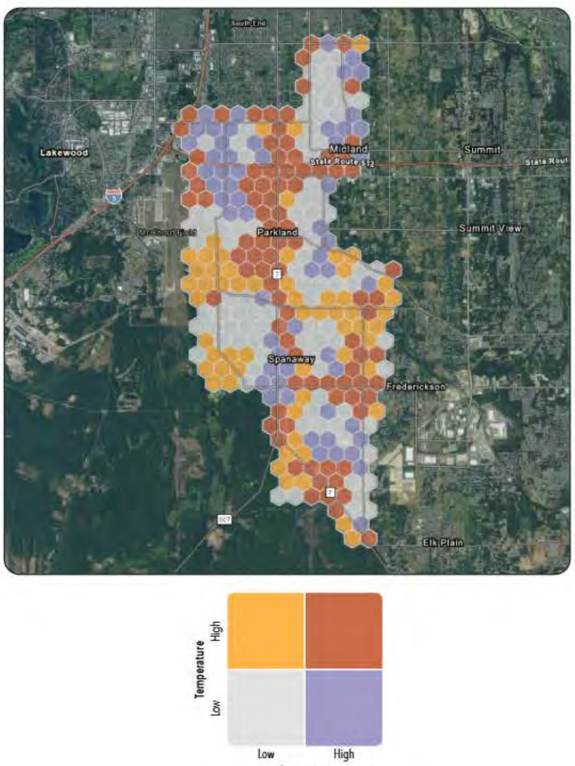
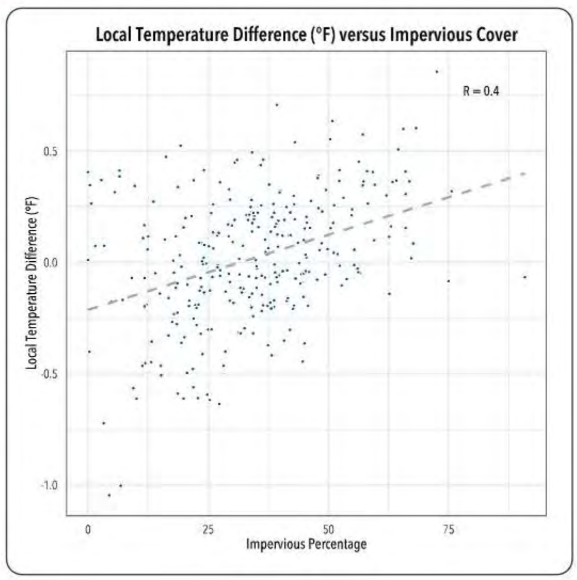
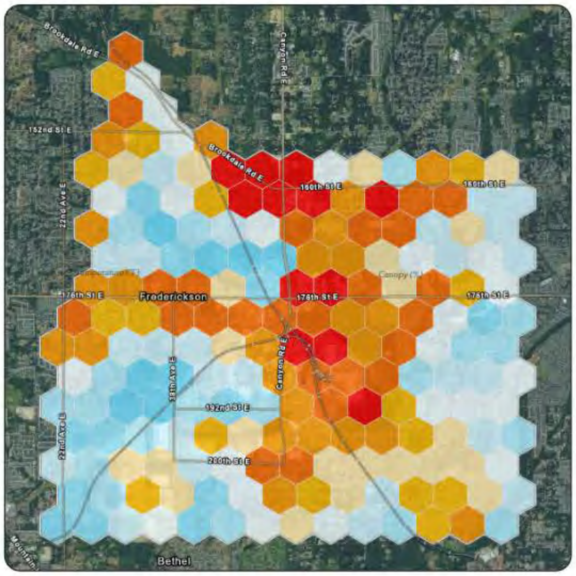
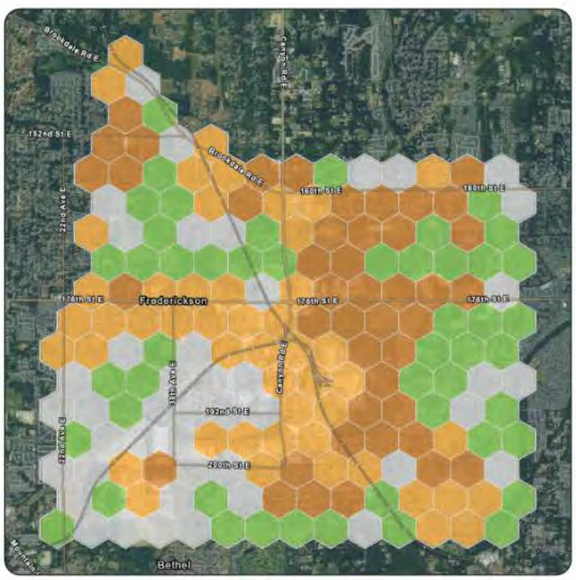


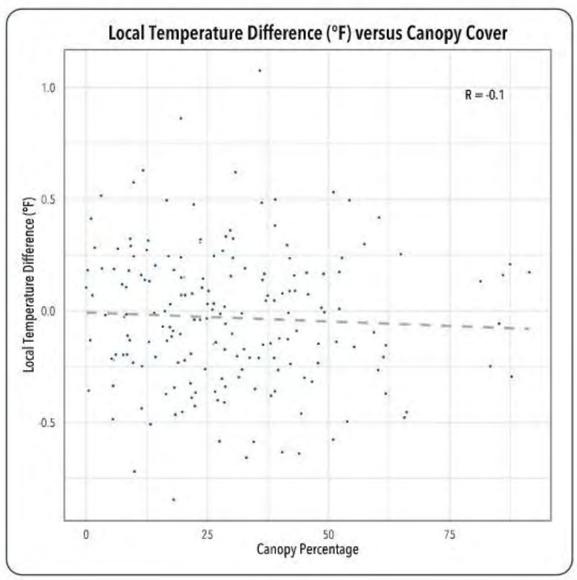


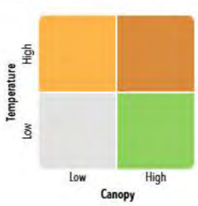
Fredrickson Canopy Cover

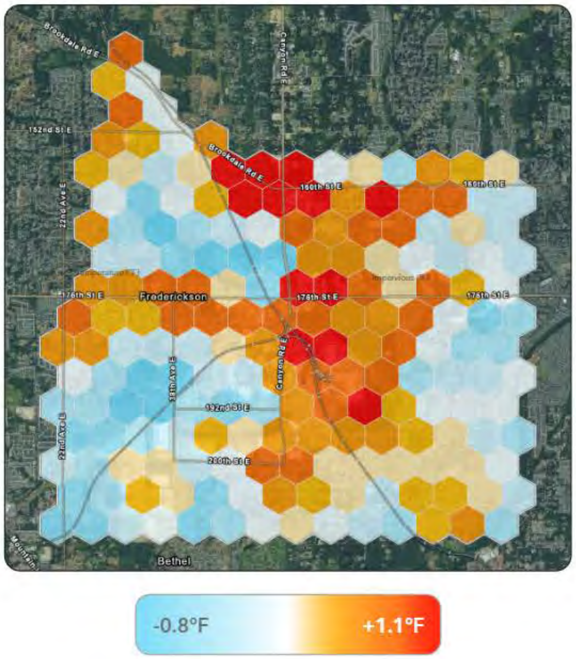
Return to Agenda

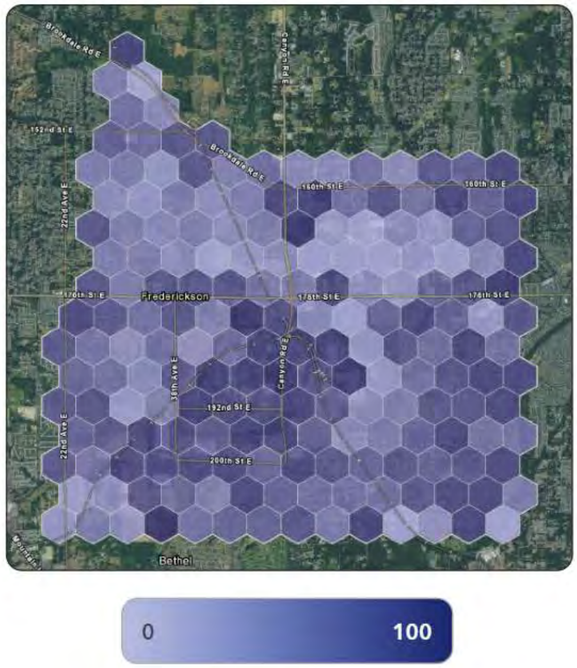


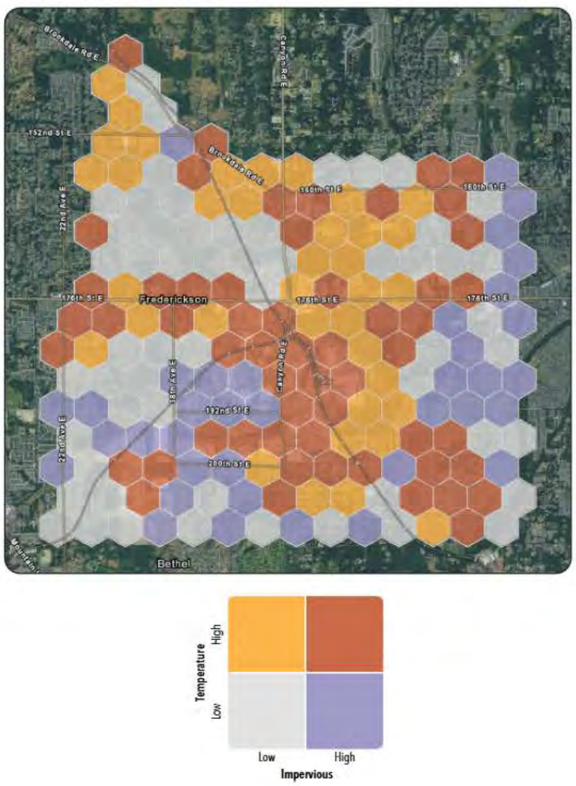


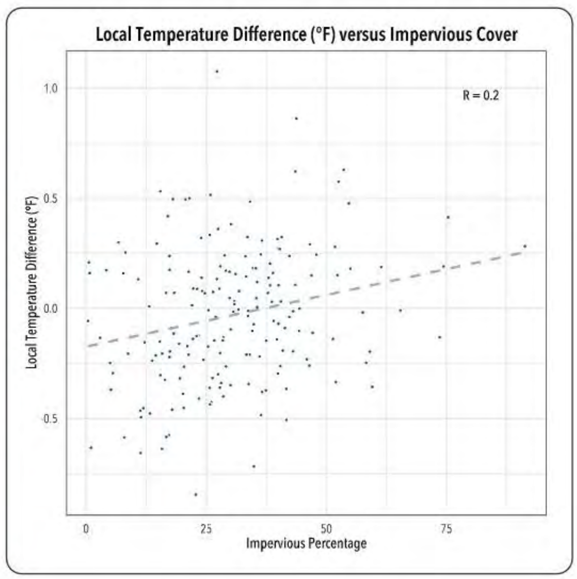





Brookdale Rd E
152nd St E
160th St E
176th St E
Frederickson
Canyon Rd E
22nd Ave E
192nd St E
200th St E
Bethel
-0.8°F
+1.1°F

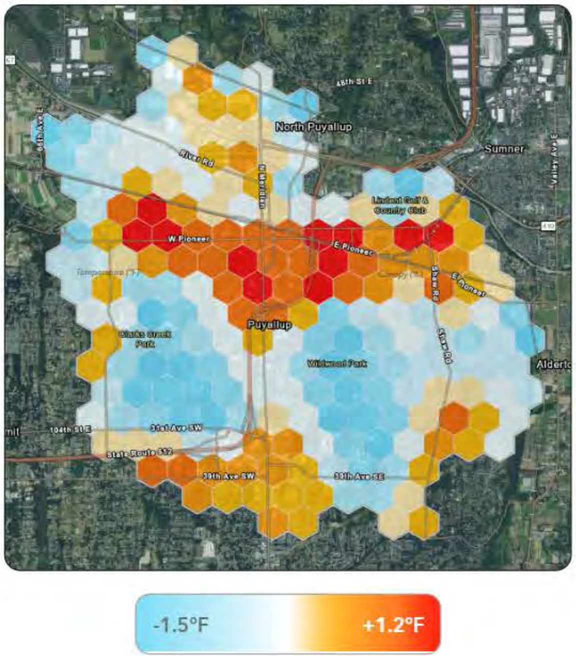

Brookdale Rd E
152nd St E
160th St E
176th St E
Frederickson
Canyon Rd E
22nd Ave E
192nd St E
200th St E
Bethel
0
100

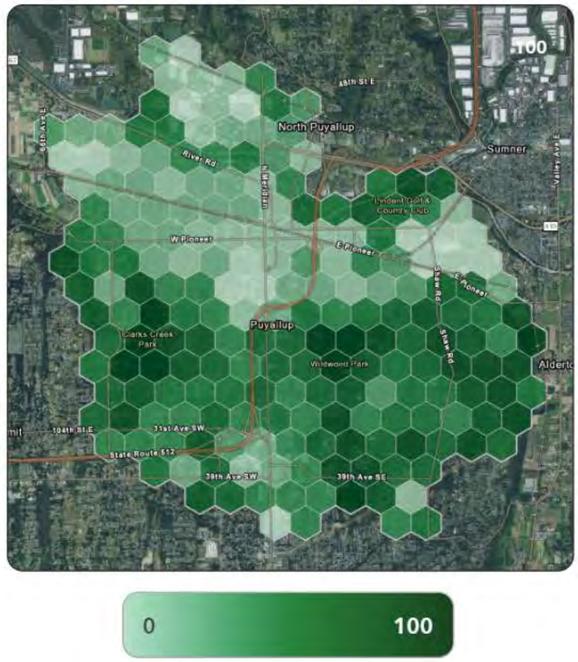

Brookdale Rd E
152nd St E
160th St E
176th St E
Frederickson
Canyon Rd E
22nd Ave E
192nd St E
200th St E
Bethel
Temperature
High
Low
Low
High
Impervious

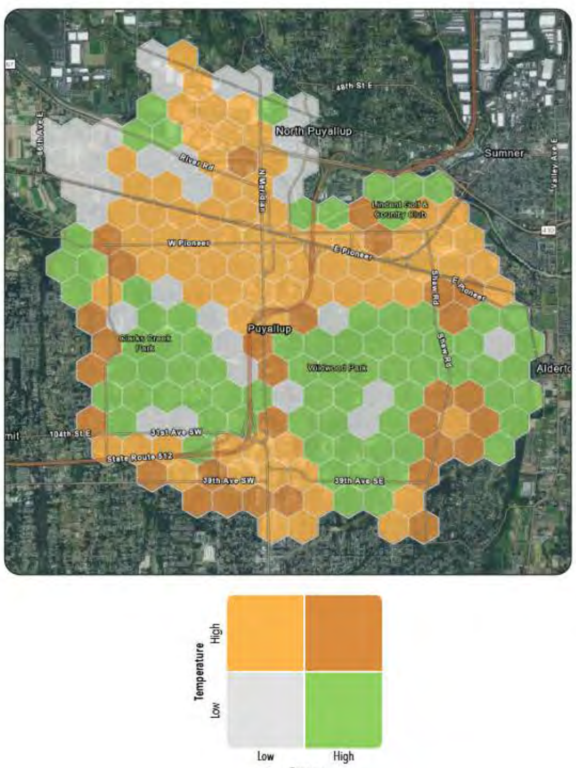

Local Temperature Difference (°F) versus Impervious Cover
R = 0.2
Local Temperature Difference (°F)
1.0
0.5
0.0
-0.5
0
25
50
75
Impervious Percentage

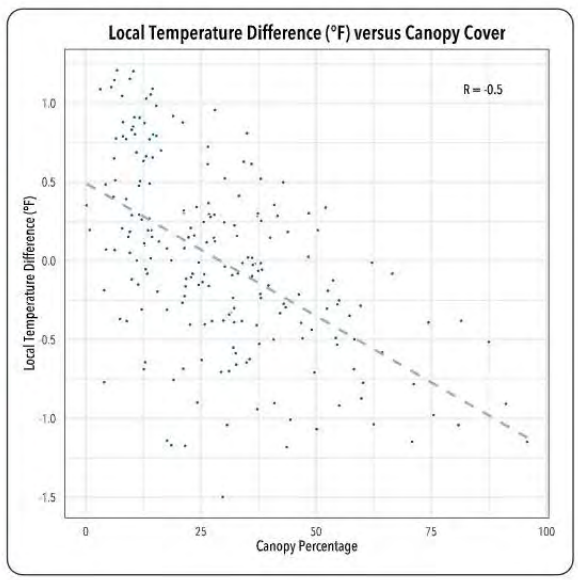
Puyallup Canopy Cover

Return to Agenda



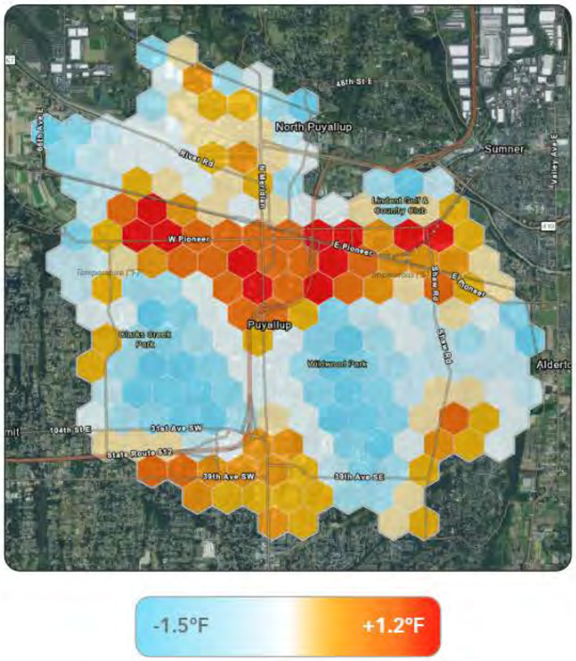


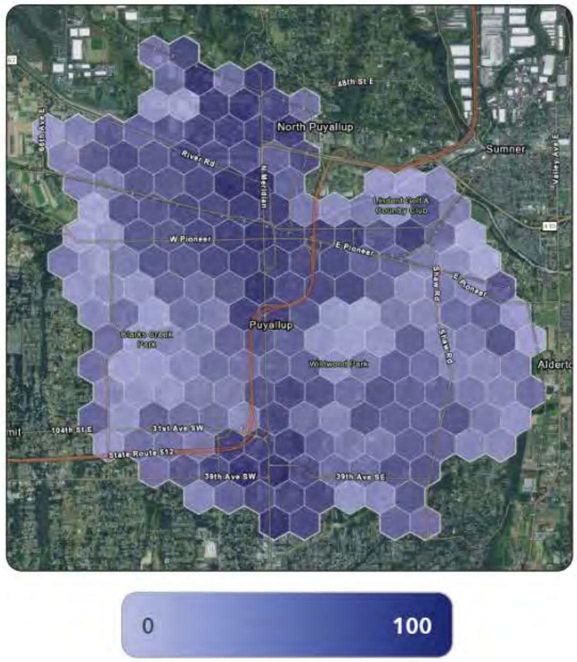


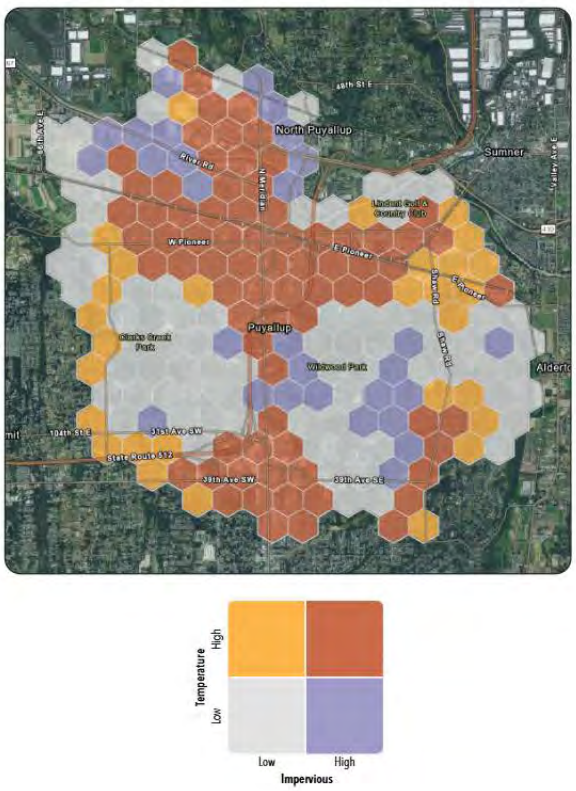


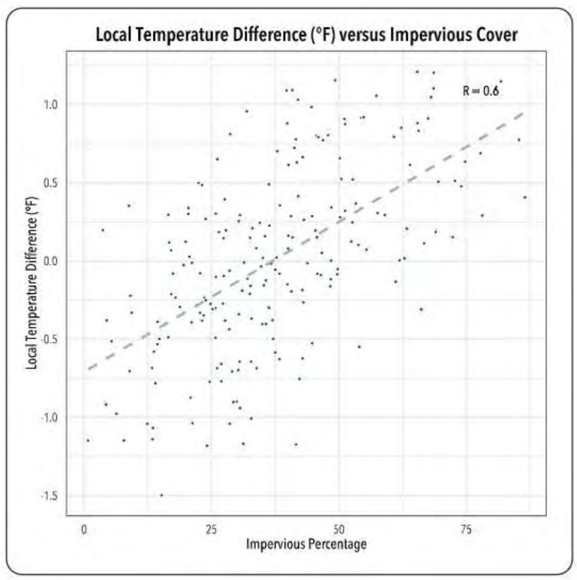
Puyallup Impervious Surfaces

Return to Agenda

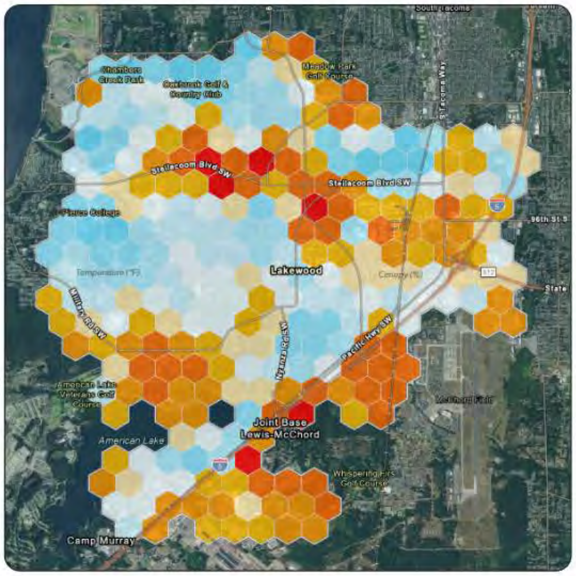


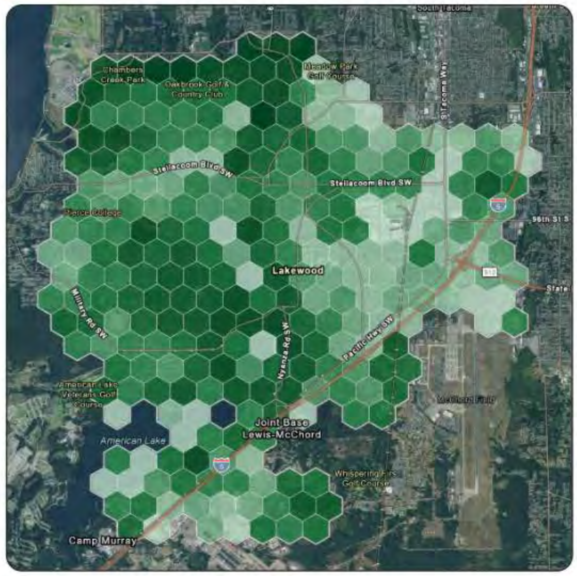


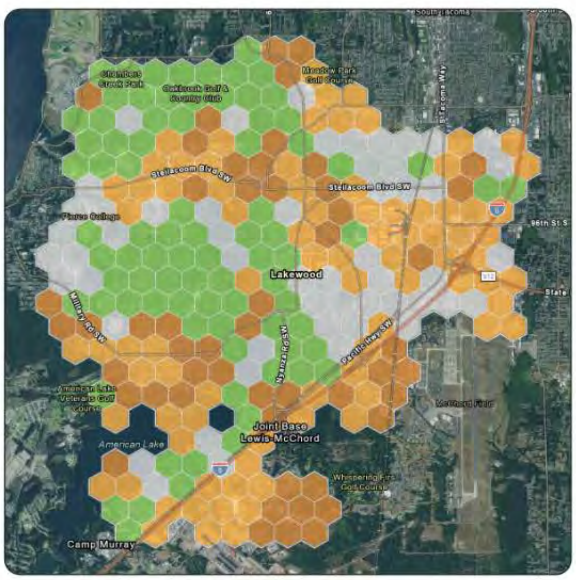


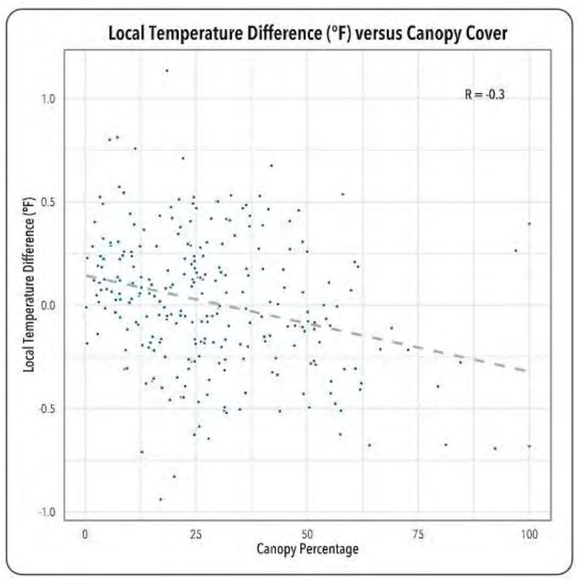


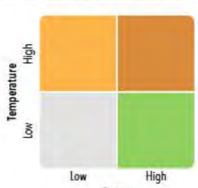
Return to Agenda





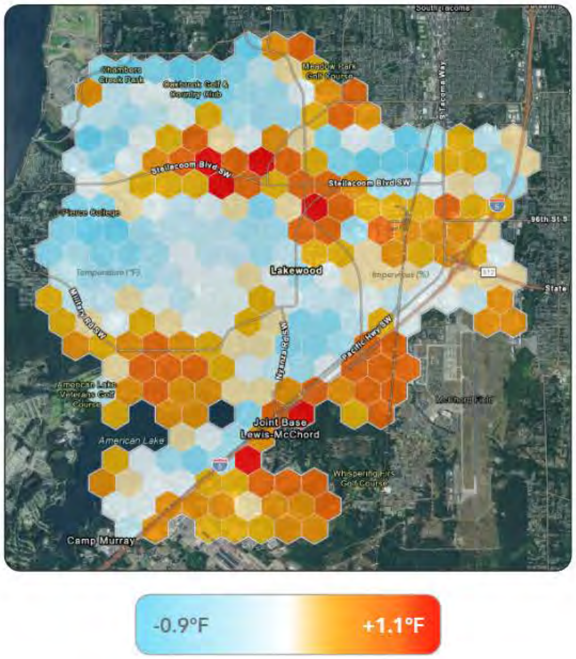


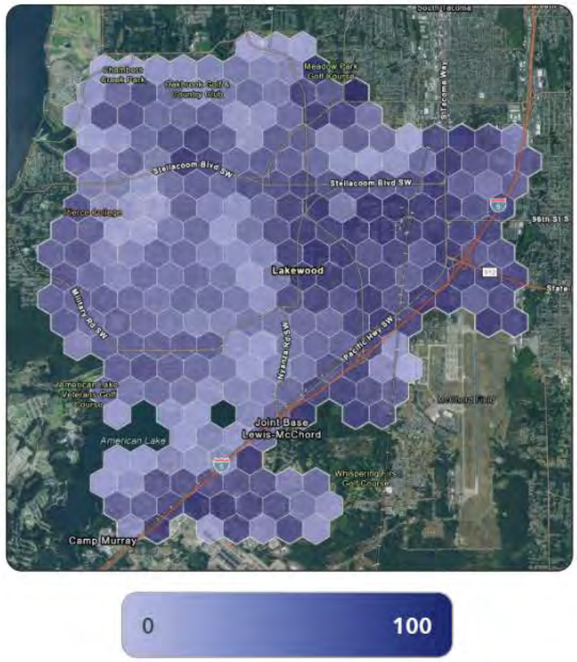


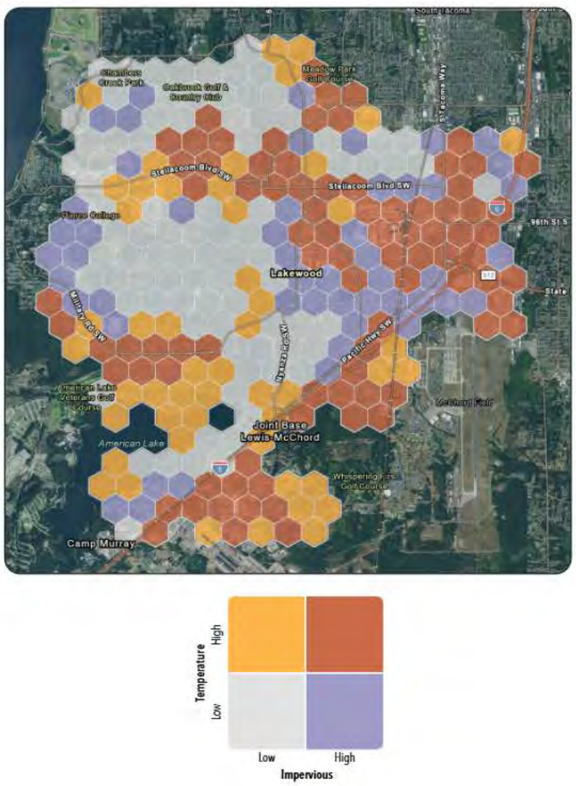


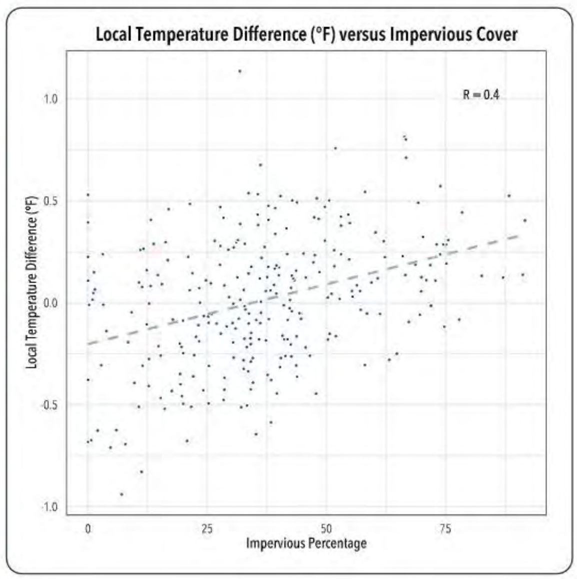
Lakewood Impervious Surfaces

Return to Agenda



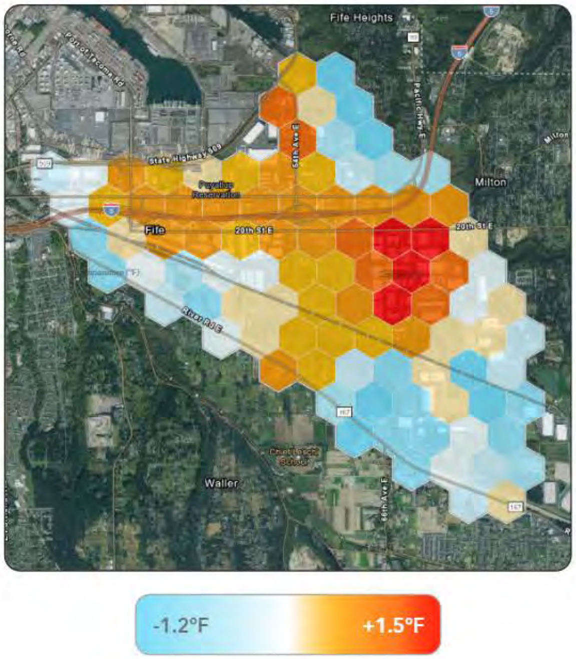


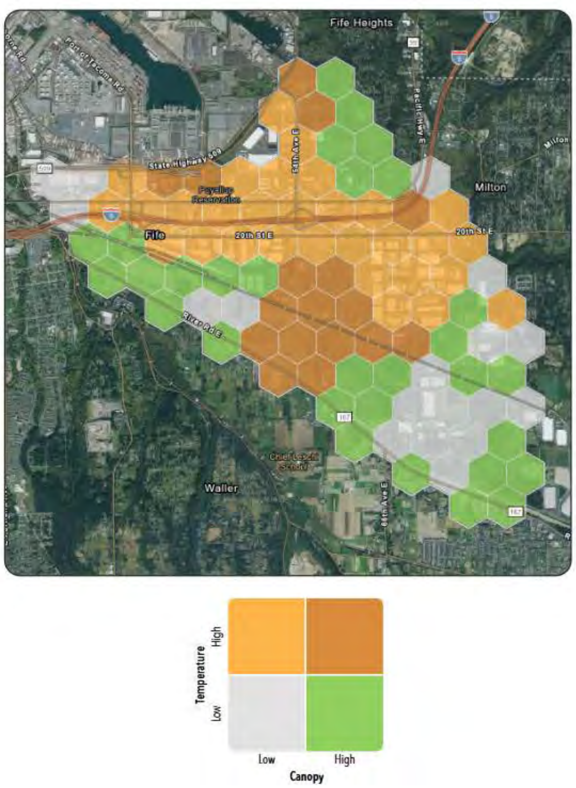


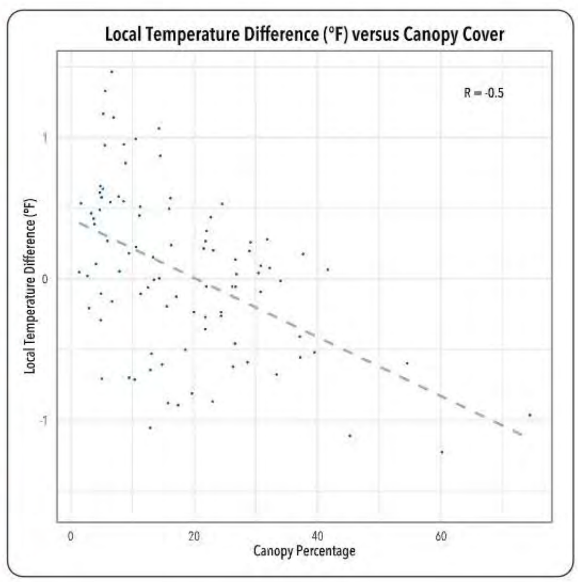


Fife Canopy Cover

Return to Agenda

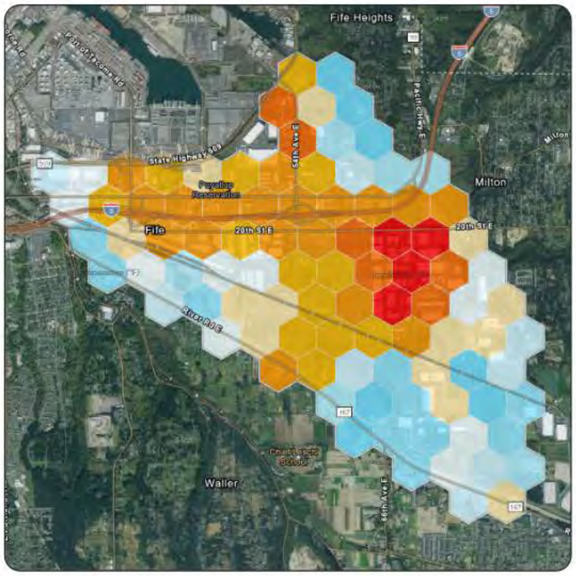




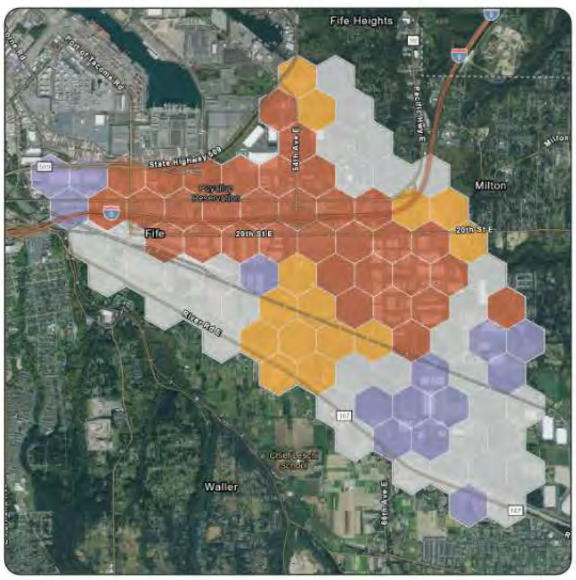


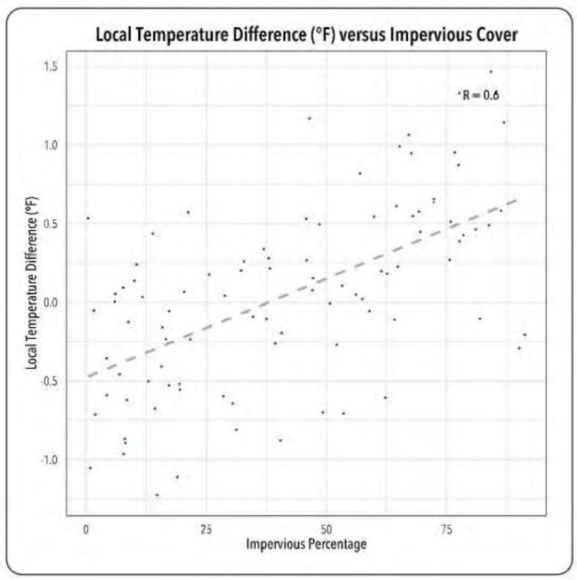
Fife Impervious Surfaces

Return to Agenda



24





Recommendations

The data products and visualizations presented in this report provide new sets of information that can be leveraged for directing mitigation and adaptation strategies to reduce heat risk in areas of Pierce County facing high exposure and vulnerability to extreme heat. In this section we identify direct ways in which each of these products can be applied with relevant intervention strategies.

Canopy Cover

- Apply the canopy cover and heat assessment to target the expansion of canopy cover at both area-wide and sub-area scales.
  - Set targets and prioritize areas that are especially hot with low existing canopy cover. Studies have shown that the cooling benefits of trees level off when coverage reaches approximately 20-30%, while prior guidance has indicated ideal targets as high as 40%.
  - Plan for robust community engagement and localized data gathering when setting neighborhood targets to ensure that interventions will be welcomed by local residents and that interventions do not inadvertently create harm to vulnerable populations (e.g., exacerbating issues with tree debris and maintenance); use these maps and data as visual aids and communication tools when engaging with community members.
  - Prioritize native tree species when possible. Non-invasive, non-native species are also suitable for the future as native species may be unable to adapt to a warmer climate. A list of native and non-native "climate adapted species" which can survive in projected conditions should guide future planting selections.
  - Consider different planting configurations for different interests. A cluster of trees in one location (e.g., a forest) offers greater benefits in terms of air purification, stormwater control, and localized heat mitigation. The same number of trees spread equally over a large area (e.g. an entire city) will have less pronounced ecological effects, but will impact a greater number of urban residents. Placing trees within green space or near water features will maximize their cooling potential.
- Preserve existing mature tree canopy using this analysis as evidence for the cooling effect of trees. Full grown trees are up to 70 times more effective than saplings at capturing carbon, mitigating heat, and controlling stormwater.
- Target green job development in areas with lacking tree cover and high heat; youth conservation corps are especially valuable in helping to increase and maintain canopy cover.

Impervious Surfaces

- Apply the impervious cover and heat assessment to target the reduction of impervious surfaces in high heat areas identified at both the area-wide and sub-area level.
  - Utilize permeable and/or light pavements along pedestrian and bike paths to cool the path surface for people and pets.
- In areas with high impervious cover and heat, introduce non-vegetative shading solutions where feasible.
  - Locate shade structures in areas where people typically congregate or recreate for an extended period of time, such as picnic areas, playgrounds, or athletic courts.

- Shade areas where individuals will be resting or waiting, such as benches and bus stops. Pergolas and shade canopies are popular options for this purpose.
- Aim for at least 30% shade coverage along transit paths and consider how shade structures will behave at different times of day and with different sun angles.
- Note that paths or sites with east-west exposure will require more shading than those with north-south exposure.
- Incorporate public art into shade structure to improve the aesthetic. Art may include messaging related to heat safety or other heat-related topics.

Data

The corresponding datasets for this report are available here.

CAPA

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Establishing the Roots of Urban Forestry in Lakewood, WA:

An Implementation Guide

By: Jamie Ziah, Zihao Xu,
Marlyn Sanchez, and Alla Smilnak Cross

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UNIVERSITY of WASHINGTON

Acknowledgments

We would like to express our deepest gratitude to the following people who provided invaluable support and guidance over the last five months, without whom this report would not have been possible.

First and foremost, we would like to express our deepest gratitude to our main contacts at the City of Lakewood, namely **Dave Bugher**, **Tiffany Spier**, and **Michael Vargas**. Their unwavering dedication, invaluable insights, continuous feedback, and collaborative partnership throughout the last five months have been instrumental in shaping and creating this report.

We would also like to extend our heartfelt appreciation to our Capstone Advisor, **Dr. Ann Bostrom**, for her guidance throughout this project. Dr. Bostrom's contributions greatly enhanced the quality and depth of our research and analysis, and we are truly grateful for her support and commitment.

Thank you to staff members of the **Washington Department of Natural Resources**, the **City of Issaquah**, the **City of Vancouver**, and **Forterra** for their generous contributions of time and expertise. Their dedication to the promotion and conservation of urban forests in Washington has been a true inspiration to us. The valuable insights they shared greatly enriched our understanding of urban forestry and were instrumental in shaping the content of this report.

To our **capstone seminar colleagues** we are grateful for your peer feedback and support throughout this entire process. Your constructive input and encouragement kept us motivated over the past five months. We are truly grateful for the collaborative and safe environment that you have fostered, and we extend our deepest thanks to each and every one of you.

Last, but certainly not least, thank you to our respective **families**, **friends**, and **partners** for your enduring love and support. We could not have completed this project without it.

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Positionality Statement

Our team would like to acknowledge the inherit privilege and biases that we hold as graduate students at the University of Washington Evans School of Public Policy and Governance. We are each from areas outside of Washington State, with two authors from the United States, specifically Illinois and Georgia, and two authors from the Dominican Republic and China. These identities and experiences have shaped how we approach this project, and we acknowledge that our assumptions and inherent biases influence the outcomes of any work we produce. We are committed to questioning these assumptions and combating our biases through intentional conversations about race, gender, and equity, as well as through the careful development of research questions and methodologies.

We recognize that our team's identities do not represent the entirety of the City of Lakewood's community. We attempted to center Lakewood’s goals and did our best to incorporate a diversity, equity, and inclusion lens throughout our report. We understand that as graduate students living and studying in Seattle, we are outsiders to the community of Lakewood, and we did our best to respect this community.

Lastly, we approached this project as consultants who are not employed by the City of Lakewood. We present this report and our recommendations with the hope that equity will be centered in the use of any of our materials.

Land and Labor Acknowledgements

We would like to acknowledge that the University of Washington is on the traditional land of the first people of Seattle, the Duwamish People past and present. We honor with gratitude the land itself and the Duwamish Tribe. We strive for public service in community and recognition of their ancient heritage with deep gratitude to the original caretakers of this land, many who are still here.

We recognize that this land, which was taken from native peoples, was used to exploit and indenture people of color. We acknowledge that enslaved and indentured peoples were forced into unpaid and underpaid labor in the construction of this country, state, and city. To the people who contributed this immeasurable work and their descendants, we acknowledge their indelible mark on this city.

City of Lakewood’s Indigenous People and Lands Acknowledgement

Every community owes its existence and vitality to generations from around the world who contributed their hopes, dreams, and energy to making the history which led to this moment. The City would like to recognize that we are on the lands of the Nisqually People and acknowledge the history of dispossession that allowed for the growth of our community. We offer respect to the Nisqually People and their Elders, past, present, and emerging. We recognize our responsibility to value all people and are committed to equitably serving all people in our diverse community.

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Meet the Team

Jamie Ziah

Jamie is a second-year masters candidate at the Evans School of Public Policy and Governance where she is studying Environmental Policy. She is the GreenEvans Communications Director, which is the environmental policy student group. Jamie received her Bachelor of Natural Resources and Environmental Science from the University of Illinois at Urbana-Champaign. Her professional experience includes ecological restoration, environmental advocacy, and data analysis. Most recently she interned at the Environmental Protection Agency working on climate change data integration.

Zihao Xu

Zihao is a second-year international student earning his Master of Public Administration at the Evans School of Public Policy and Governance. Zihao completed his undergraduate education in Beijing, China where he obtained a bachelor's degree in Finance along with a dual degree in English. His expertise spans across international and cross-cultural communications, consultancy in environmental policy and financial evaluation, as well as investment advisory. As part of his academic journey at the Evans School, he interned as a policy analyst at an education policy-focused consulting firm.

Marlyn Sanchez

Marlyn is a second-year masters candidate in Public Administration, and she is the Vice Chair of the Evans School Student Organization. Marlyn is a Fulbright Scholar from the Dominican Republic. She is also a Chevening alumni and holds a Master of Science in International Development from the University of Edinburgh. Marlyn's professional experience and interests involve policy analysis, project management, and evaluation work in the public and nonprofit sectors, especially around development, gender, youth, and education.

Alla Smilnak Cross

Alla is a second-year masters candidate at the Evans School of Public Policy and Governance. She is the Co-Chair of the Evans Student Budget Council and the Vice Chair of the UW Chapter of the International City/County Management Association. Alla served as the UW ICMA Local Government Finance Fellow in the City of Burien. Originally from Southeast Georgia, Alla lived in Nashville, TN for ten years before moving to Seattle. Her professional and policy interests include public financial management, performance management, policy analysis, and anti-violence and gender equity policy.

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Abbreviations and Glossary

Throughout this guide, there are several concepts that share similarities but have distinct differences that are crucial to differentiate and understand:

What is an Urban Forest?

An Urban Forest includes the forest resources available in urban areas, offering various benefits that contribute to the overall quality of life in cities. Urban forests include public and private properties, public community spaces, street trees, and yards (Dwyer et al., 2003; City of Issaquah & Forterra, 2020; City of Seattle, 2020).

And how is that different from Urban Forestry (UF)?

Urban Forestry refers to the planning and management of trees and forest resources in and around urban community ecosystems, including street trees and urban woodlands. Urban Forestry also recognizes the physiological, sociological, economic, and aesthetic benefits associated with trees (Konijnendijk et al., 2006; Konijnendijk et al., 2005).

Local governments can implement Urban Forestry Programs **(UFP)** and Urban Forest Management Plans **(UFMP)** to manage forest resources in cities. UFPs and UFMPs can establish clear goals, activities, financial resources, and outcomes to start, grow, and maintain a sustainable urban forest.

Other key concepts and abbreviations included in this report:

- **BIPOC:** Black, indigenous, and people of color
- **CBO:** Community-based organizations
- **ECCC:** Energy and Climate Change Chapter of the City of Lakewood's Comprehensive Plan
- **GIS:** Geographic Information System
- **M&E:** Monitoring and Evaluation
- **ROW:** Right-of-Way
- **UF:** Urban Forestry
- **UFMP:** Urban Forest Management Plan
- **UFP:** Urban Forestry Program
- **UTC:** Urban Tree Canopy or canopy cover refers to the percentage of the city that's covered by trees from an aerial view.

Executive Summary

Introduction

The City of Lakewood updated the Energy and Climate Change Chapter (ECCC) of its Comprehensive Plan in 2021. The ECCC outlines specific goals and tasks to address climate change impacts, energy use, and greenhouse gas emissions. The city's ECCC update includes two main urban forestry goals: (1) increasing Lakewood's urban tree canopy cover from 26% to 40% by 2050 and (2) developing and promoting an urban forest management plan in the near-term (i.e., beginning between 2021 and 2025). This report provides an urban forestry program (UFP) implementation guide for the City of Lakewood.

Research Question and Methods

To best develop an implementation guide for the City of Lakewood, we aimed to answer the following question:

> How should the City of Lakewood structure a UFP to meet its environmental goals, considering existing city frameworks, climate change implications, and financial constraints?

We used a mixed methods approach for our research, using qualitative and quantitative data from sources in private, public, and nonprofit sectors, as well as academic papers. We primarily used benchmarking case studies conducted on three cities in western Washington state that have established UFPs. In addition to the case studies, we analyzed secondary data on the city's tree canopy and relevant urban forestry expenditures. We also conducted semi-structured interviews with key actors to understand how other cities implemented UFPs in Washington.

Literature Review and Case Studies

Our literature review explores the importance of urban forestry and its impacts on climate, environment, and public health. The benefits of urban forests include heat mitigation, reduction in air pollution, energy savings, carbon sequestration and storage, biodiversity, stormwater management, and public and social support spaces. The literature review also provides an overview of best practices for tree selection, planting, maintenance, and community engagement approaches for the sustainable and equitable development of urban forests.

Roots of Effective Urban Forestry Programs

Through our research, we identified three foundations of sustainable UFPs: comprehensive resource assessments, community engagement, and administrative capacity. We used these foundations as our case study objectives and further delineated them into seven criteria that we used to analyze the existing UFPs and provide recommendations for Lakewood. Table 1 summarizes our key findings across the three objectives and seven criteria.

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Table 1: Summary of Roots of Urban Forestry Program Analysis

Objectives	Criteria
Resource Assessment: UFPs typically begin by conducting a comprehensive resource assessment that includes gathering data on the urban forest's general and specific conditions.	**Tree Population Assessment:** Lakewood contracted a high-level analysis of the current tree canopy in 2022. However, many UFPs begin by conducting an additional on-the-ground assessment of current tree health before restoration, maintenance, or planting.
Community Engagement: Community participation is essential to the sustainability of UFPs as they rely on ongoing community support and involvement to thrive.	**Strategies:** The city can utilize many community engagement strategies to implement and manage a UFP, including hosting community meetings and conducting public surveys to gather feedback. Many cities construct volunteer systems, including a Forest Stewardship Program, to train community members to lead volunteer activities.
	Equity Considerations: All three of our case study cities emphasized equity considerations as a critical focus for their UFPs, with a commitment to finding ways to engage diverse populations and address environmental justice. Our report offers various ways the city can implement an equitable UFP.
Administrative Capacity: Creating capacity within the current city organizational structure through advisory boards, staffing, and financial resources is common among UFPs.	**Plan Updates:** Most urban forest management plans are updated every three to five years.
	City Departments: Each of the case study cities houses its urban forestry program within a different department or departments, reflecting variations in organizational structure and priorities. All cities have either an advisory board or a commission, which can be essential to prioritizing UFP activities.
	Staff: Lakewood could consider hiring a full-time administrator, utilizing existing employees, or contracting with AmeriCorps to support the program.
	Budget: UFP expenditures vary depending on the size and scope of the program. Potential funding sources for UFP activities include: • Reallocated revenue from storm and surface water utility fees • City Tree Fund • General fund revenue • Government and nonprofit partnerships

Recommendations

Based on our analysis, we developed four recommended actions for implementing a UFP in the City of Lakewood.

Recommendation 1:

Develop a mission, vision, and goals for urban forestry in the City of Lakewood.

We recommend the city develop mission and vision statements for urban forestry work. We have provided draft statements in Chapter 6 of this report. The city should also prioritize specific program goals and outcomes. We suggest the goals of forest health, tree population expansion, community engagement, equitable access to urban forest benefits, and sustainability.

Recommendation 2:

Complete a comprehensive resource assessment and begin restoration practices in the city.

The city should complete a comprehensive resource assessment before beginning urban forestry fieldwork. A thorough, on-the-ground evaluation will provide the city with essential data on the health of the city's urban tree canopy. An ISA Certified Arborist should complete the assessment. We detail additional fieldwork steps in Chapter 6 of this report.

Recommendation 3:

Develop a comprehensive community engagement strategy.

The city should develop a UFP that aligns with the interests and needs of Lakewood's community, as a successful UFP depends heavily on robust support and active participation from the people of Lakewood. We recommend two main strategies to involve the Lakewood community in developing and implementing an urban forestry program: community outreach and constructing a robust volunteer system.

Recommendation 4:

Create administrative capacity within the existing city organizational structure.

Based on the three case studies, Lakewood's current structure, and our research, we developed three alternative organizational structures the city can consider for carrying out UFP activities:

- Option 1: Develop a standalone Urban Forestry Advisory Board (UFAB) to oversee urban forestry activities in the city.
- Option 2: Lakewood's Parks and Recreation Advisory Board (PRAB) expands its responsibilities to include urban forestry priorities.
- Option 3: Hire a full-time program administrator instead of a standalone board or PRAB expansion.

Based on these organizational structures and the plan outcomes defined in Recommendation 1, we developed priorities and preliminary budgets for years one through five of the UFP.

This executive summary serves as a concise overview of our research, analysis, and recommendations. For a more comprehensive understanding and additional context, we encourage readers to refer to the full report. The full report provides an in-depth exploration of the findings and insights gathered throughout our research process.

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Chapter 1: Introduction

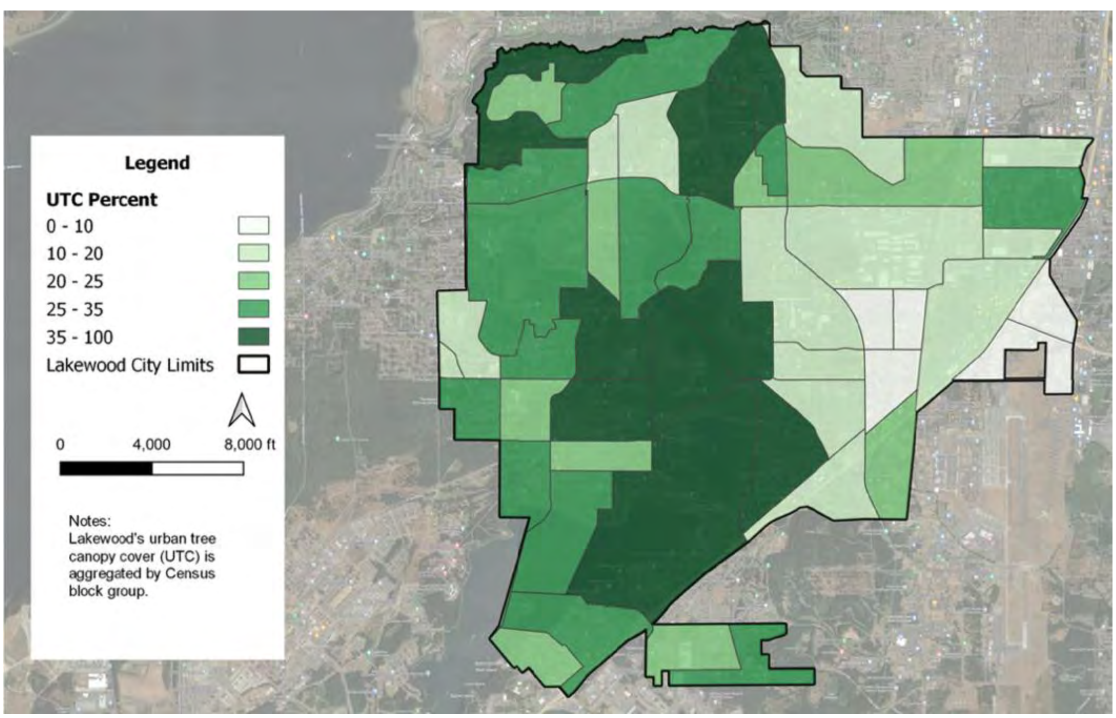
The City of Lakewood updated the Energy and Climate Change Chapter (ECCC) of its Comprehensive Plan in 2021. The ECCC outlines the city's specific goals and tasks to address climate change impacts, energy use, and greenhouse gas emissions. The city's ECCC update includes two main urban forestry goals: (1) increasing Lakewood's urban tree canopy cover from 26% to 40% by 2050 and (2) developing and promoting an urban forest management plan in the near-term (i.e., beginning between 2021 and 2025). In support of these goals, the city contracted the University of Washington Evans School Student Consulting Lab to develop this report, including an urban forestry program (UFP) implementation guide and preliminary budget for the first five years of official urban forestry activities. The following chapters include details on our research methods, findings, and recommendations for implementing a UFP in the City of Lakewood.

1.1 Background

Over the past several years, the City of Lakewood has actively worked towards achieving the goals outlined in its ECCC. In 2021, the city commissioned the Evans School Student Consulting Lab project titled *A Study on Climate Change Perceptions in Lakewood, WA.* The project focused on understanding climate change perceptions in the city and making recommendations for engaging citizens in climate change efforts (Thompson et al., 2022).

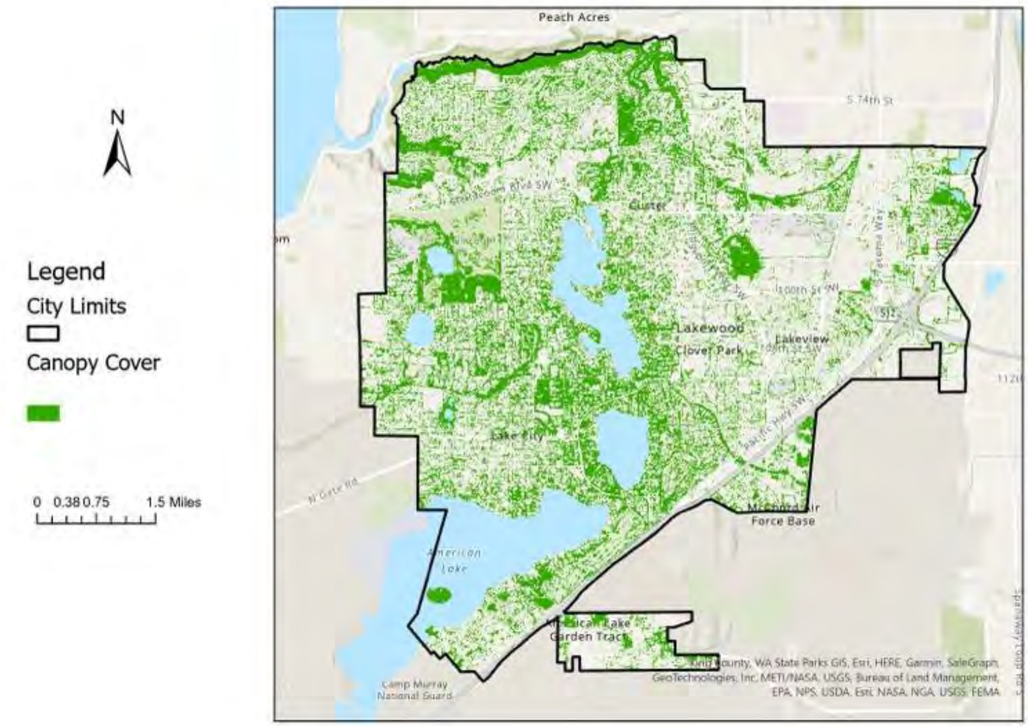
The city recently updated its municipal code related to preserving the city's urban tree canopy (UTC) and protecting significant trees. The Lakewood City Council adopted Ordinance 775 on November 7, 2022, and it went into effect on March 1, 2023. As part of this update, the city contracted PlanIT Geo to analyze the city's current UTC, which was estimated to be at 26.3%. Of the total UTC, 72% is on private land, and 28% is on public land (Peiffer et al., 2022). See Figure 1 for the distribution of UTC in Lakewood grouped by census blocks.

Figure 1: City of Lakewood – Current Tree Canopy Distribution (PlanIT Geo, 2022)



PlanIT Geo's analysis provides an aggregated view of the tree canopy data, using census blocks to simplify the data visualization and analysis (Peiffer et al., 2022). Figure 2 presents Lakewood's UTC using Google (n.d.) Insights Explorer data. Google's data offers a more detailed and granular depiction of the city's tree canopy compared to Figure 1. It provides precise information on the location of individual trees, allowing for a more comprehensive understanding of the distribution and extent of UTC in Lakewood.

Figure 2: City of Lakewood – Google (n.d.) Insights Tree Canopy Data



The city set an ambitious goal to increase UTC from 26% to 40% by 2050, resulting in a 14-percentage point increase and 1,500 acres of new canopy. PlanIT Geo estimates $1.2 million in additional benefits over the next 25 years, including lower energy costs due to lower surface temperatures and decreased stormwater maintenance resulting from trees intercepting and storing runoff, thus reducing the burden on stormwater systems (Peiffer et al., 2022).

The updated tree ordinance includes new regulations on removing and maintaining significant trees throughout Lakewood, particularly the Oregon White Oak (Ordinance No. 775, 2022). The Oregon White Oak is the only oak native to the state of Washington and is considered a priority species for conservation and management by the Washington Department of Fish and Wildlife (WDWF, 1998). The new regulations are crucial for the city to maintain and increase its tree canopy due to the Oregon White Oak's high population in the area. As outlined in the ordinance, other allowable activities include removing diseased trees and trees that present an imminent threat to properties with an approved tree removal permit, trimming guidelines and uses for commercial, industrial, multifamily, institutional, or other developments (Ordinance No. 775, 2022).

The city established a tree fund to collect donations and penalty fees related to regulations outlined in the ordinance. Funds can be used for purchasing, planting, and maintaining trees, as well as other urban forestry-related activities such as education programs and tree canopy monitoring. The city sought community feedback through a public comment process during the ordinance development. The public comment process and the city's dedication to maintaining and preserving trees throughout the city renewed community interest in a UFP in the city.

The City of Lakewood's initiatives, such as establishing a long-term UTC goal and implementing preservation guidelines, provide valuable insight and inform our urban forestry implementation guide. Through the efforts of elected officials, city staff, and the larger Lakewood community, the city is part of an active and ongoing effort to become a climate-resilient community.

1.2 Research Question

The City of Lakewood aims to establish a sustainable approach to preserve existing trees, increase the current tree canopy, and implement best practices in urban forest management. The city requested an initial five-year implementation guide and budget to achieve this goal. This report examines the city's organizational structure, including its capacity to undertake new initiatives and collaborate across departments, as well as relevant regulations, codes, and ordinances to inform the design of the implementation guide. Based on the City of Lakewood's goals, we developed the following research question to guide our work:

> How should the City of Lakewood structure an urban forestry program to meet its environmental goals, considering existing city frameworks, climate change implications, and financial constraints?

To help answer this research question, we identified the following sub-questions to guide our research and recommendations:

- What is the current status of the City of Lakewood's tree canopy? What are the current challenges and opportunities for improving the city's tree canopy?
- What are the best practices and necessary components for a UFP in the City of Lakewood?
- What are the costs associated with developing and implementing a UFP?

1.3 Client Objectives and Deliverables

The city seeks an in-depth report outlining the necessary components for implementing a UFP in the city. This report aims to provide actionable steps for the City of Lakewood to implement the program and a detailed understanding of the financial commitment required for the UFP's first five years. Based on the city's objectives and our research questions, this report provides the following deliverables:

- analysis of current tree canopy status in the City of Lakewood, produced in collaboration with the City of Lakewood
- recommendations on management, evaluation, equity, and community engagement to develop and maintain a UFP; and
- recommendations for UFP structure in the first five years of implementation, including staffing, function, budget, and revenue recommendations.

1.4 Report Structure

We divided the remainder of this report into five chapters:

Chapter 2: Research Methods provides a detailed explanation of our research approach and the various tools we used to address our research question.

Chapter 3: Literature Review provides an overview of the literature that informed our research and analysis, including the benefits of urban forestry and management best practices.

Chapter 4: Case Studies provides an overview of the case studies we conducted to examine existing UFPs and assess best practices.

Chapter 5: Analyzing the Roots of Effective Urban Forestry Programs and Opportunities for Lakewood provides an analysis of the city's current tree canopy, fieldwork, community engagement, monitoring, and budgetary considerations.

Chapter 6: Urban Forestry Implementation Guide details the proposed implementation details for the UFP, including recommended resource assessment, community engagement strategies, city structures, and financial estimates.

Chapter 2: Research Methods

This chapter provides a detailed description of our research approach and the specific tools we used to answer our research question. We identified and analyzed qualitative and quantitative data from private, public, nonprofit, and academic sources through a mixed methods approach. The results from our research methods inform the analysis of the City of Lakewood's current canopy and context and the UFP implementation guide.

We applied diverse research methods to achieve our specific objectives. Our primary method was a benchmarking case study of Washington UFPs, specifically those in Seattle, Issaquah, and Vancouver. These case studies informed our analysis and recommendations for developing a UFP and estimating expenditures for the City of Lakewood. We also conducted a secondary analysis of tree canopy data and budget estimates produced by the City of Lakewood, nonprofits working in the environmental field, and the private sector. Finally, we conducted semi-structured interviews with key actors to understand other cities' processes for establishing their UFPs in the State of Washington.

2.1 Case Studies Approach

Several cities in Washington have implemented UFPs that are now at different stages of development. While some programs are still in their initial phases, others have progressed to more advanced stages of maturity. To design appropriate recommendations for Lakewood, we learned about how other cities are implementing their UFPs, how they got to where they are today, and the resources cities are investing in to take care of their public open spaces and tree populations. The case study cities were selected in consultation with our client.

We limited our case studies to western Washington State because of the shared environmental characteristics of the region and the framework provided by the Evergreen Communities Act and House Bill 1216. Therefore, all three cities are in the Pacific Northwest Region and share similar habitats and environmental characteristics. Each city is either in or near temperate rainforest ecosystems with common tree species like Douglas fir, Western Red Cedar, and Western Hemlock (Washington Forest Protection Association, n.d.).

We also based our selection on each city's performance in renowned indexes such as the American Forests' Tree Equity Score and the Arbor Day Foundation's Tree City recognition. The Tree Equity Score is a tool that measures "whether there are enough trees in a neighborhood for everyone to experience the health, economic and climate benefits that trees provide. Scores are based on tree canopy, surface temperature, income, employment, race, age, and health factors" (American Forests, 2021a, What do the Scores Mean section). Arbor Day's Tree City recognizes cities based on four core standards: 1) form a tree board or department; 2) establish a tree care ordinance; 3) maintain a community forestry program with an annual budget of at least $2 per capita; and 4) proclaim and observe Arbor Day. All four standards require a strong commitment to tree preservation (Arbor Day Foundation, n.d.-a).

Our three case study cities, Issaquah, Vancouver, and Seattle, have Tree Equity Scores of 88, 78, and 91, respectively (American Forests, 2021b). Additionally, these cities have been recognized as Tree Cities for 29, 33, and 37 years, respectively (Arbor Day Foundation, 2021). Vancouver and Seattle have received Arbor Day's Growth Awards for 22 years. The Arbor Day Growth Award recognizes cities for high levels of work in annual activities in five categories that support sustainable programs and community engagement: building the team, measuring trees, planning, performing the work, and having a community framework (Arbor Day Foundation, n.d.-b). In addition to the cities' performance on the Tree Equity Score and their recognition as a Tree City, we looked at each city's budget and environmental context to ensure each offered appropriate comparisons or context to the City of Lakewood.

Evaluating other UFPs was essential to answering our research question and fulfilling our objectives, especially in developing the program structure and determining recommendations regarding staff, budget, and revenue. The case studies were particularly informative about plan structure, community engagement, budgetary considerations, maintenance guidelines, and evaluation approaches.

The case studies analysis was guided by three overarching objectives: resource assessment, community engagement, and administrative capacity. We defined these three objectives through our interview with the Washington Department of Natural Resources (DNR). DNR expressed that these three objectives were essential to effective and sustainable UFPs. Using Lakewood's priorities, we further delineated these objectives into seven criteria, as seen in Table 2. The following definitions of objectives and criteria are the frame for the case study analysis in Chapter 4.

Table 2: Case Studies Objectives and Criteria

Objectives	Criteria
Resource Assessment	Tree Population Assessment
Community Engagement	Strategies
	Equity Considerations
Administrative Capacity	Plan Updates
	City Departments
	Staff
	Budget

Resource Assessment

This objective refers to identifying the existing tree canopy within city limits and assessing the health conditions of the tree population. The criterion under this objective is *Tree Population Assessment*, which refers to the process of a specialist assessing the conditions of the existing tree population. A comprehensive tree assessment is a foundation for designing management steps for a UFP. The assessment is foundational because it is the tool that allows the city to know where to prioritize restoration and maintenance to keep trees healthy and ensure suitable planting conditions for new trees.

Community Engagement

This objective refers to the public's role in developing and managing a UFP. The first criterion is *Strategies,* which refers to participation methods and spaces cities use to integrate the community into urban forestry efforts. The second criterion is *Equity Considerations*. We decided to include equity as a criterion because one challenge of urban forests is that tree population tends to be more prominent in affluent areas and smaller in low-income and vulnerable neighborhoods (American Forests, 2021b). Therefore, we consider equity an essential piece of community engagement, especially considering our use of the Tree Equity Score to this report.

Administrative Capacity

This objective refers to the indicators, organizational structure, budgets, and human resources that are necessary to implement and sustain a UFP. The first criterion, *Plan Updates*, focuses on the frequency and process of revising urban forest management plans in cities, including the involvement of stakeholders. The second criterion is *City Departments,* which refers to the position of the UFP within the city's organizational chart, including the department responsible for managing and overseeing the program. It also considers the presence of accountability mechanisms like volunteer advisory boards or city commissions. The third criterion is *Staff*, which refers to the number of Full-Time Employees (FTE) working on the UFPs and their specific responsibilities. The aim of the Staff criterion is to understand the amount of staff work required to implement a UFP and how cities navigate staffing as the program grows. The final criterion is *Budget*, which refers to the program's allocated resources and the distribution of those resources to program activities. This criterion also outlines funding sources cities use to fund their UFPs, including fees, grants, and taxes.

Chapter 4 analyzes each case study through the lens of the objectives and criteria defined in this section and summarizes the results for each case.

2.2 Secondary Analysis of Data

We used data produced by leading organizations working in urban forestry and technological tools to understand Lakewood's current canopy coverage, including where the city needs to prioritize increasing the canopy in the future. The analysis included:

- an assessment of the canopy analysis completed by PlanIT Geo for the City of Lakewood's tree ordinance update, which includes city demographics, current canopy coverage, and recommended planting locations;
- a comparison of Google Insight Explorer canopy data and PlanIT Geo's to ensure the highest accuracy for the canopy analysis;
- a review of American Forests' data, including the Tree Equity Score, to understand Lakewood's challenges in terms of equitable distribution of the benefits of their urban forest; and
- a review of budgetary information from Lakewood's 2023-2024 Biennial Budget to estimate maintenance costs, supplies, and personnel requirements for the UFP.

Chapter 5 in this report focuses on analyzing the outlined quantitative and qualitative data, which informed our recommendations for the city.

2.3 Semi-structured Interviews

We conducted four semi-structured interviews with experienced professionals who work with and in cities to design and implement UFPs. The interviewees were two Washington Department of Natural Resources (DNR) staff members, the City of Vancouver's Urban Forester, the City of Issaquah's Parks and Community Services Director, and Forterra's Managing Director for Restoration and Stewardship. These interviews informed our recommendations for managing and restoring land and existing trees in urban settings. We also identified priorities and important considerations for the early stages of a UFP, such as community engagement approaches and determining where to house the program within the city. These interviews gave us insight into budgeting considerations and cost estimates for UFP activities.

We contacted UFP professionals in Issaquah and Vancouver, as listed on their websites and online program materials. In consultation with our client, we prioritized those two cities based on their potential to inform the program's initial stages and budgeting. Specific questions around program expenditures were central to our decision to conduct the interviews and to prioritize Issaquah and Vancouver. The City of Seattle's budget is significantly larger than what Lakewood might consider at this stage. Given time limitations, the scope of this report, and client preferences, this project does not include any outreach to Lakewood's community. However, community outreach and spaces for public participation are central to our recommendations, as discussed in Chapters 5 and 6.

2.4 Limitations

Given the fixed timeline of five months for this project, certain methods that could have been beneficial in the development of Lakewood's UFP, like semi-structured interviews with community members, were not included. Getting input from the community is a critical element for developing, implementing, and sustaining a UFP. In lieu of including this method in our research design, we supported our analysis with relevant survey data obtained from Lakewood's community on climate change perceptions (Thompson et al., 2022). Additionally, we recommend in Chapter 6 that the City of Lakewood collect additional input from the community.

Another significant limitation was the lack of a comprehensive tree assessment containing specific information on the condition of the existing tree population, including invasive species presence and forest health. Conducting a tree assessment is a crucial first step in implementing an effective UFP. Therefore, our recommendations in this report will be subject to the findings of a future tree assessment that can provide accurate information on maintenance needs in Lakewood. Without the assessment, we estimated budgetary expenses and developed maintenance goals and indicators based on the case studies, Lakewood's context, and resources available to Lakewood. Finally, we relied on data produced by PlanIT Geo, American Forests, and Google's Environmental Insights Explorer to estimate management units and tree conditions.

Chapter 3: Literature Review

We began our research by conducting an in-depth literature review to provide a comprehensive understanding of urban forestry in the context of sustainable urban development. This chapter is comprised of three main parts:

1. a broad introduction to urban forestry, including its definition and fundamental concepts;
2. an exploration of the benefits of urban forestry from three critical perspectives: climate impacts, environmental impacts, and public health impacts, as well as how equity should be considered through all these lenses; and
3. a synopsis of best practices in urban forestry, including:
    - basic principles
    - a comparison between adaptive management and traditional ecosystem management
    - effective community engagement strategies

This literature review aims to provide a comprehensive understanding of these interrelated themes to establish a solid foundation for implementing a successful and sustainable UFP for the City of Lakewood.

We used keywords like “urban forestry,” “urban forestry management,” and “ecosystem management” to find scholarly articles in the University of Washington online library holdings and Google Scholar to inform our research, as well as consulted references from other cities’ UFPs. In Chapter 4, we outline further analysis of UFP best practices by reviewing the three case studies in detail.

3.1 What is an Urban Forest?

There are various definitions for the concepts of Urban Forests and Urban Forestry. The Green Issaquah Partnership indicates: “An urban forest encompasses all the trees in a defined urban area, such as a city” (City of Issaquah & Forterra, 2020, p. 6). We can broadly define urban forests as encompassing a wide range of tree populations, including those situated within municipal parks, along metropolitan roadways, and in residential zones, both in private yards and communal living spaces. Urban forests also extend to trees present in public community areas, such as libraries and public gardens, as well as in greenways, wetlands, river corridors, nature preserves, and natural areas. Tree shelter belts and working trees at industrial brownfield sites also contribute to the overall concept of urban forests (City of Issaquah & Forterra, 2020). Seattle’s Urban Forest Management Plan states that Seattle’s urban forest consists of the trees and associated understory plants in the city, as well as the ecosystem services that they provide. The urban forest extends across public and private properties and rights-of-way, including trees in yards, parks, natural areas, and along streets (City of Seattle, 2020). In general, we define a “Urban Forest” as the collection of trees, vegetation, and green spaces within a city or urban environment that contribute to the development of the overall ecosystem, providing critical environmental, social, and economic benefits to communities.

3.2 The Importance of Urban Forestry

Urban Forestry is the planning, managing, and maintaining of urban forests to optimize their benefits for the community and the environment. The City of Vancouver (2007) has defined urban forestry in its Urban Forestry Management Plan as the study and management of the city’s urban forest, which is comprised of the trees, shrubs, and other vegetation in parks, along streets, in yards, on unbuilt properties, and in urban natural areas. The presence of an urban forest provides significant benefits to every city inhabitant. Incorporating trees into a city substantially enhances communities’ overall quality of life and vitality. Urban trees can also provide various environmental benefits, such as mitigating air pollution, reducing greenhouse gas emissions, and mitigating stormwater runoff (City of Vancouver, 2007).

Nitoslawski et al. (2019) state that the benefits of urban forests include, but are not limited to, heat mitigation, reduction in air pollution, energy savings, carbon sequestration and storage, biodiversity, stormwater management, and public and social support spaces. Urban forests also offer a sense of place and belonging, which is vital for the general well-being of people living in cities (Nitoslawski et al., 2019). Urban forestry aims to promote the health and resilience of urban ecosystems while enhancing the quality of life for residents and addressing issues related to climate change, air and water quality, and public health. The following sections analyze the impacts of urban forestry, specifically through the lenses of climate, environment, and public health.

Climate Impacts

Climate change is already affecting the Pacific Northwest and, as a result, the City of Lakewood. Climate change has significant implications for UFP implementation in Lakewood, particularly considering the increased intensity and frequency of heat waves and other extreme weather events, such as flooding (Snover, 2013). Scientists expect the average temperature in the Puget Sound Region to increase by 5.0°F to 8.6°F by the end of the 21st century, resulting in an estimated average between 57.4°F and 61.0°F. The increase is in relation to the historic average temperature of 52.4°F from 1971 to 2000 (Rutledge & Brandt, 2022). Littell et al. (2009) report that Washington State will have increasingly hot summers with decreased rainfall, potentially leading to a significant increase in the area burned in forest fires, from 425,000 acres annually on average from 1916 to 2006 to an increase of an average of 1.1 million by 2040. The increase in temperature will result in more air pollution from fires, along with other heat-caused air pollution. Increased air pollution and extreme heat are predicted to cause over 100 deaths per year in Seattle alone in 2025 (Littell et al., 2009). Air pollution unfairly impacts the most disadvantaged communities; if left unchecked, these climate impacts will threaten Lakewood's poorest and most vulnerable population (WA DOH, n.d.).

Urban forests play a critical role in adapting to and mitigating the impacts of climate change for future generations. As humans continue to emit more greenhouse gases (GHGs), GHG concentrations in the atmosphere are rising, and the atmosphere is trapping more heat. Urban forests sequester carbon dioxide, removing it from the atmosphere, which is essential to fighting climate change. Trees act as natural carbon sinks by absorbing carbon dioxide from the atmosphere and storing it in their biomass (USDA, 2018). Nowak & Crane (2002) argue that increasing the number of trees could lead to a slower accumulation of atmospheric carbon, which would lessen the warming effect of climate change. Urban forests have an average carbon storage density of 25.1 tC/Hr (a ton of carbon per hectare) throughout the United States. UFPs in the Pacific Northwest are known to sequester even more carbon than the national average, making the area uniquely equipped to combat climate change (Nowak & Crane, 2002).

One of the most essential benefits of urban forests is their climate change adaptation capabilities. As previously mentioned, two of the leading climate change threats facing the Pacific Northwest are increased temperatures and an increased number of severe weather events. Increased temperatures leave urban communities especially vulnerable to the heat island effect, where impervious, dark surfaces (i.e., streets and buildings) trap heat, creating higher temperatures in the surrounding area. Trees provide shade over urban areas and create a natural cooling effect through evapotranspiration that can reduce temperatures by 1°C (Kurn et al., 1994). This drop in temperature can decrease energy usage, reduce strain on the power grid during heat waves, and extend the life of street pavement (Safford et al., 2013). Lower-income neighborhoods often have less tree coverage and are more susceptible to heat islands and their adverse effects (Subramanian, 2016). Utilizing urban forestry to alleviate heat stress can particularly benefit marginalized communities that bear the disproportionate impact of urban heat islands.

Adverse weather effects from climate change will increase flooding in the Puget Sound area (Littell et al., 2009). Lakewood is currently engaged in evaluating strategies the city could use in the event of a 100-year flood in the area. Urban forests can reduce the intensity of these floods in multiple ways. Tree canopies create a barrier that rain must pass through before hitting the pavement of a road and going into the city's drainage system (Kurn et al., 1994). This delay helps relieve the sewers and the soil from having to absorb more water quickly. The same effect happens with fallen branches and leaves that trees leave behind: rain is further delayed from running into the soil, which reduces flooding. Trees also reduce storm runoff by absorbing water into their leaves, bark, and roots (Fazio, 2010). An urban forest can even reduce the erosion and effects of high winds during storms (Safford et al., 2013). These benefits will reduce the costs associated with more frequent severe weather events due to property damage, which poorer communities would struggle to pay.

Environmental Impacts

Not only do urban forests provide communities with climate change protection, but they also create habitat for local wildlife and promote biodiversity. Habitat degradation is a significant cause of biodiversity loss across the globe (Roeland et al., 2019). St. Clair & Howe (2009) argue that urban forests are an opportunity to connect the old-growth forests of the Pacific Northwest with different, more urban regions. Creating habitat through an UFP provides space for biodiversity to thrive. Biodiversity is nature's primary tool against disasters and other environmental shocks. Maintaining high biodiversity leads to a more resilient ecosystem, thus leading to a healthier environment overall (St. Clair & Howe, 2009). As climate change continues to stress local environments at higher rates, preserving the Pacific Northwest's biodiversity is more important than ever.

Fragmentation is one of the main challenges that wildlife and plant life face when creating a healthy ecosystem. Fragmentation occurs when the habitat is segmented into small plots of land that can be very far away from each other. The smaller the land fragment or the farther away from another habitat fragment, the more likely it is that biodiversity loss will occur in that land fragment (Fahrig, 2003). When land is fragmented, species often struggle to find mates or suitable lands for their offspring to survive. Most species thrive if they can travel over land; this includes plants spreading seeds and animals finding food and partners. Therefore, an urban forest can decrease the spaces between habitat fragments and increase the habitat size (Dwyer et al., 1992).

Implementing a UFP allows the City of Lakewood to adopt an adaptive management strategy for improving the local ecosystem's health. Ecosystems in urban areas typically require more resources to carry out their natural processes. For instance, very few trees grow naturally in urban areas without first being planted. Therefore, old-growth forests will require adaptive (or active) management techniques to be replenished, enabling those forests to continue to provide ecosystem services to the urban areas and the wildlife in the greater Pacific Northwest. Urban areas are subject to invasive species choking out native plants and preventing them from growing new natives. Adaptive management techniques involve removing harmful invasives as well as planting and maintaining native trees like Douglas-firs and Gary Oaks.

Public Health Impacts

Urban forests have many public health benefits including mental health benefits, air pollution filtration, and even increased public safety. Trees can naturally filter the air around them by absorbing multiple hazardous air pollutants. Such hazardous air pollutants include ground-level ozone, nitrogen oxides, sulfur dioxide, and particulate matter (Zupancic et al., 2015). These pollutants are classified as criteria air pollutants under the Clean Air Act, which the Environmental Protection Agency regulates. These pollutants can cause many adverse health effects, such as respiratory illness, asthma, heart disease, and even death (Axelrad et al., 2013). Urban areas are exposed to a higher concentration of these air pollutants than other more rural areas (Zupancic et al., 2015). Lower-income neighborhoods in the City of Lakewood face a higher risk of exposure to air pollutants. The Washington Department of Health's Health Disparities Map categorizes most of Lakewood under the highest risk category for health disparities, including air pollution (WA DOH, 2023). Urban forests create a natural filtration system that helps reduce the risk of exposure. One tree in an urban area can filtrate out 50 pounds of air particulates in a single year (Dwyer et al., 1992).

There is overwhelming evidence that green spaces and urban forests positively affect mental health (USDA, 2018). Exposure to nature has been shown to leave people feeling less stressed and less depressed overall. Living near natural areas also encourages more outside physical activity, leading to a healthier life and improving mental health. Natural spaces have also been shown to help prevent children from developing learning disorders, such as attention deficit hyperactivity disorder. Exposure to nature helps reduce stress, leading to higher memory retention and an increased attention span. Urban forests can help people manage stress, anxiety, and mood disorders while providing a recreation space for increased physical fitness (USDA, 2018). It is important to recognize that due to the unequal distribution of current green spaces, lower-income communities reap fewer benefits than high-income areas (Subramanian, 2016).

Urban forestry can also increase public safety by increasing an area's sense of community. Natural spaces tend to increase property values and the desirability of living in specific neighborhoods. This allows for more resources for the community and for the green space to be well maintained. As mentioned before, urban forests also provide recreational areas for people to experience nature. All this feeds into a sense of community which leads to more public safety (Brunson, 1999).

3.3 Best Practices

This section expands on best practices for urban forestry management from the perspective of academic literature, highlighting general strategies and approaches that ensure sustainable and equitable development of urban forests. We have organized the discussion into four main parts. We begin by providing an overview of basic best practices that encompass tree selection, planting, and maintenance. The second section presents a comparison between adaptive management and traditional ecosystem management, detailing their respective advantages and limitations in the context of urban forestry. We then outline a summary of community engagement best practices, emphasizing the importance of inclusive and participatory approaches to urban forest management. Finally, we provide an overview of Lakewood's existing research regarding community engagement. This section aims to provide a general yet comprehensive understanding of some of the most effective methods for managing urban forests and fostering their long-term health and resilience by examining these key elements.

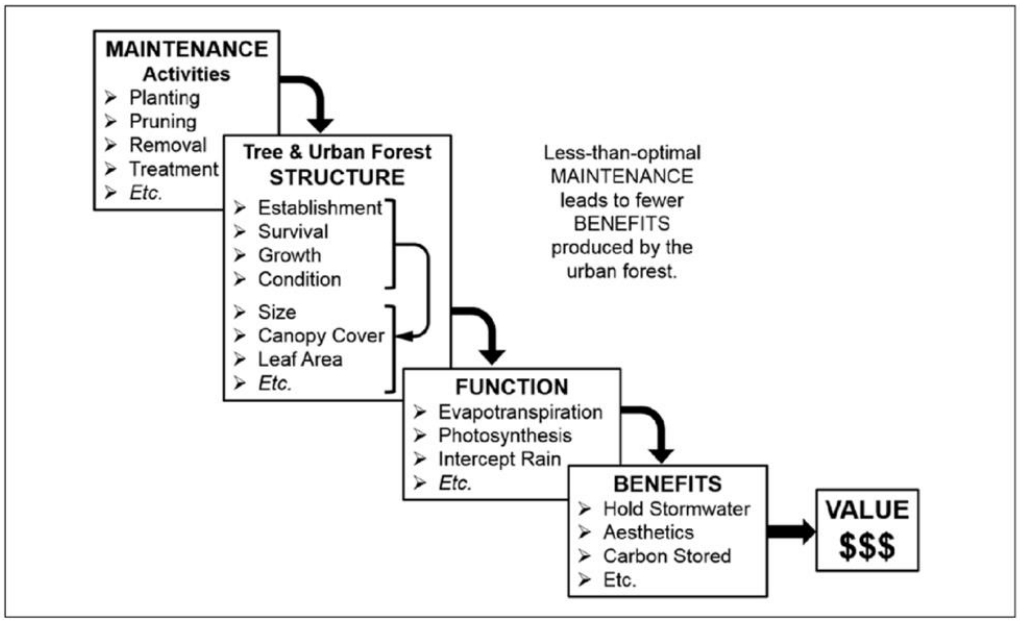
The specifics of urban forestry management or how to implement a UFP are addressed in our case study analysis in Chapter 4 instead of this section.

General Best Practices

Tree selection is a fundamental component of urban forestry management. The effectiveness of urban forestry hinges on the trees' ability to perform as designed, even in stressful environments (Sæbø et al., 2003). Consequently, the selection and utilization of appropriate tree species is an essential element in an approach focused on enhancing the quality of and reducing expenses associated with establishing and managing urban green spaces. Sæbø et al. (2003) identified several criteria for the selection of trees for urban forestry. Among those, the basic properties of the trees are (1) climate adaptation; (2) resistance to diseases; and (3) large phenotypic plasticity in the plant materials. Specific properties related to trees in urban settings are (1) aesthetic characteristics; (2) social factors; (3) root quality; (4) growth potential and form; (5) wind resistance; (6) drought resistance; (7) resistance to breakage of limbs and (8) tolerance of air pollution (Sæbø et al., 2003). Equally crucial in urban forestry management is the implementation of proper tree-planting techniques.

Finally, having solid tree maintenance strategies directly impacts the tree structure, which in turn impacts the functions and benefits provided by the urban forest. Implementing a regular maintenance program that includes watering, pruning, mulching, and monitoring for pests and invasive species can prolong the life of trees and maximize their benefits to the urban environment. Vogt et al. (2015) produced Figure 3 to demonstrate how maintenance is linked to the benefits and costs of trees, which concludes that less-than-optimal maintenance may lead to decreased benefits produced by the urban forest.

Figure 3: The Logic of Tree Maintenance (Vogt et al., 2015, p. 295)



Vogt et al. (2015) also concluded that in the initial stages of a tree's existence, specifically during the establishment and immature phases, it is crucial to provide sufficient maintenance to ensure its early survival and integration within the urban environment. As the tree matures, the focus of maintenance shifts towards prolonging its life span and averting potential collapse, which can effectively postpone the costs associated with tree removal (Vogt et al., 2015).

Adaptive Management vs. Traditional Ecosystem Management

When discussing best practices in urban forestry, an important distinction is the difference between adaptive and traditional ecosystem management. Historically, formal management approaches to valuing the natural world were based solely on commodities like timber and fish until the late 1800s. At that time, analysts began to include the intrinsic value of nature as a consideration (Robbins et al., 2014). To correct the depletion of natural resources, the United States government adopted what is now called a "traditional" approach to protect the natural world. This traditional approach led to preservation efforts, such as establishing the first national parks. The new management practice was focused on the preservation of the natural world and conserving resources for future generations. Conservation marked the beginning of government consideration regarding sustainability. Historical conservationist Gifford Pinchot described conservation as "the greatest good for the greatest number" (Robbins et al., 2014, p. 70).

A significant aspect of conservation and preservation involves leaving nature in its untouched state, free from human intervention. The issue is that humans, as a highly impactful species, have already made substantial impacts on most of the land, altering it from its natural state (Robbins et al. 2014). The concept of adaptive management stems from the idea that effective ecosystem management involves more than just extracting necessary resources or simply leaving land unaltered. It emphasizes the importance of monitoring, planning, and implementing measures to restore and maintain the health of the land even after humans have altered it (Haney & Power, 1996).

In urban areas, the need to actively maintain the land becomes even more crucial due to the extensive alterations that occur to the natural environment. Native ecosystems in urban settings often face challenges that they may not be able to overcome without intervention and assistance. Therefore, it is essential to implement measures to support and enhance urban ecosystems, ensuring their sustainability and resilience in the face of urbanization and human activities. Adaptive management is described as "learning by doing". It is the process of learning from the ecological, socioeconomic, institutional, and cultural issues of an area and developing a plan to address those issues (Haney & Power, 1996). The plan to address these issues is put in place, evaluated, changed, and re-implemented. Evaluation and adaptation are at the heart of this process and are directly related to successful practices in urban forestry. Adaptive management provides cities with a framework to evaluate the existing health of their ecosystems and tree canopy, enabling them to develop strategies for maintaining and enhancing a healthy urban environment.

Community Engagement Best Practices

Community engagement is essential in developing and implementing a UFP. The City of Issaquah and Forterra (2020) state in the Green Issaquah Partnership that the program's success greatly depends on the engagement and endorsement of the public. They argue that creating a program that resonates with and caters to the needs and interests of the community it serves is essential. They also estimate that if every Issaquah resident contributed just 2.5 hours over the course of the 20-year program, the city would achieve its community engagement and restoration goals, illustrating the importance of community engagement. The City of Vancouver (2007) also mentions in its UFMP that the successful implementation of their plan requires broad support and participation from diverse segments of the community. Vancouver specifically states that property owners, business owners, and neighborhoods can all contribute to the realization of the goals of the plan. Property owners can strategically plant new trees and properly maintain trees to maximize benefits. Business owners can sponsor local tree-planting projects and encourage their employees to participate in volunteer activities. Neighborhoods can help educate people about the benefits of trees and proper maintenance practices while coordinating neighborhood tree-planting projects. Throughout the various stages of development, the input and feedback from residents, forestry experts, and business stakeholders played a significant role in shaping the goals and strategies for Vancouver's UFP (Vancouver, 2007).

Scholars agree with the importance of community engagement in UFPs. Campbell-Arvai and Lindquist (2021) support the significance of community engagement in the development and long-term support of urban green spaces and green stormwater infrastructure. Similarly, Morgan and Ries (2022) highlight the role of community involvement in promoting tree survival and sustained stewardship, ultimately leading to the long-term benefits of increased canopy coverage. Furthermore, Nitoslawski et al. (2019) emphasize the importance of smart city trends and technologies in enhancing urban forest management and involving various stakeholders, including governmental authorities, non-governmental organizations, businesses, citizens, and local associations.

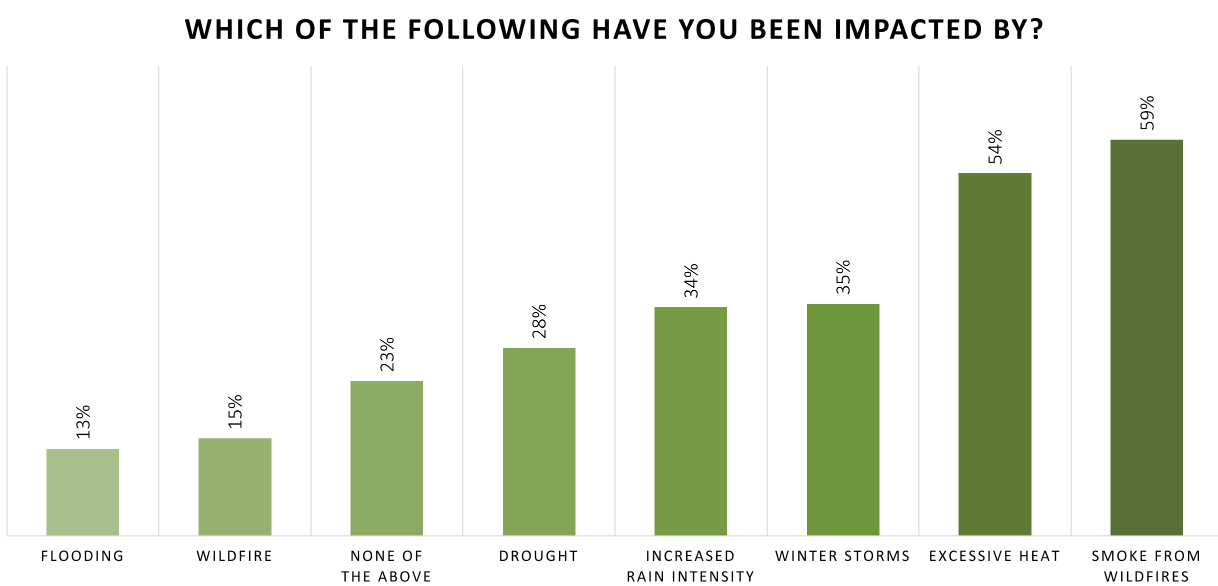
Cities must find proper motivating factors to encourage UFP involvement from community members. Morgan & Ries (2022) found that people love trees for various reasons, including the aesthetic appeal, environmental contributions, and health benefits of trees. Therefore, emphasizing these motivating factors in marketing and outreach efforts is crucial to engage community members in tree-related initiatives.

Lakewood's Community Engagement Research

In 2022, the Evans School Student Consulting Lab produced a report titled *A Study on Climate Change Perceptions in Lakewood, WA*. This report aimed to help the city improve its communication and outreach efforts regarding climate change by exploring how the community members engage the issue and understanding their primary concerns and expectations regarding the city's actions. We reviewed this report to gain insight into the recommendations for improving communication with Lakewood's residents regarding climate change. We aim to incorporate these suggestions into our community engagement recommendations for implementing a UFP.

The report indicates that among the weather events that may have the most impact on the lives of residents, "smoke from wildfires" (59%) and "excessive heat" (54%) are two extreme weather events that residents in Lakewood are concerned about the most, as shown in Figure 4 (Thompson et al., 2022). These results suggest that explaining the benefits of urban forestry to reduce those weather events may help attract the community's support.

Figure 4: Lakewood Climate Survey Response (Thompson et al., 2022).



The report also provided several recommendations for governmental communication and outreach. Firstly, governmental discourse on climate change should emphasize the benefits of potential climate initiatives and educate the public about feasible lifestyle changes, giving special attention to the simplest and most accessible ones for everyday citizens. Secondly, the government should establish communication strategies that recognize people's concerns and associate them with specific actions at the local level. Thirdly, employing clear language that firmly anchors the city's climate-related communications in scientific resources may enhance residents' faith in the city's reliance on credible sources for climate-related decision-making. Lastly, future climate change public perception studies should not only inquire about respondents' sources of climate information but also seek to identify their most trusted sources (Thompson et al., 2022).

For outreach and equity consideration, the report highlighted several recommendations for the city to consider during community engagement, including but not limited to the following:

1. Use a more personal approach (such as canvassing) and offer incentives for engagement (such as gift cards);
2. Continue to provide the primary non-English languages spoken in Lakewood with translations in addition to Spanish and Korean;
3. Consider capitalizing on all existing relationships the city maintains with individuals or organizations representing or serving these populations;
4. Have one-on-one conversations with community members;
5. In the engagement process, the City of Lakewood should acknowledge the historical relationship between the government and these communities;
6. Provide compensation to community members who give their time, effort, and knowledge in the City's outreach process; and
7. Contract community-based organizations (CBOs) that 1) are in neighborhoods of interest, 2) serve Lakewood's low-income and BIPOC residents, or 3) represent the needs of residents with marginalized identities. (Thompson et al., 2022, p. 59).

3.4 Literature Review Summary

This chapter presents an in-depth literature review using the University of Washington online library and various cities' UFPs. Our goal was to establish a general understanding of urban forests, emphasize the significance of urban forestry, and outline best practices for urban forestry management.

First, based on the definition provided by other cities' UFPs, we defined "urban forest" as the collection of trees, vegetation, and green spaces that exist within a city or urban environment that contribute to the development of the overall ecosystem, providing critical environmental, social, and economic benefits to local communities.

We also utilized scholarly articles from the University of Washington online library and Google Scholar to carry out an in-depth exploration of the benefits provided by Urban Forestry. Specifically, we discovered that urban forests play an important part in climate change adaptation capabilities and create habitat for local wildlife, thereby fostering biodiversity. Urban forests also absorb multiple hazardous air pollutants to generate positive effects on people's both physiological and psychological health, while also nurturing a strengthened sense of community cohesion.

Finally, we summarized several overarching practices that could improve urban forestry management. These include the selection and deployment of appropriate tree species, the implementation of effective tree maintenance strategies, the benefits of employing adaptive management in an urban forestry context compared with traditional ecosystem management, the importance of community engagement, and some general practices. We also summarized previous studies on the design of Lakewood's community engagement strategies.

The next chapter presents a detailed analysis of existing UFPs in Issaquah, Vancouver, and Seattle.

Chapter 4: Case Studies

We reviewed best practices and strategies in urban forestry from three other Washington cities to develop a UFP implementation guide for the City of Lakewood that maximizes benefits for its citizens and creates the healthiest urban forest possible. In this chapter, we summarize UFP practices in each city to determine the most essential implementation considerations for Lakewood.

The three cities we selected for our research were Issaquah, Vancouver, and Seattle, Washington. Each city's UFP is at a different stage, meaning each is more or less advanced in reaching its ultimate objectives. The differences in size and scope, as well as the variation in local government organizational characteristics and budget size, were instrumental in understanding the possibilities, costs, and benefits of implementing a UFP, as well as the main priorities during implementation.

We analyzed each city against three objectives and seven criteria as explained in Chapter 2:

- Resource Assessment: Tree Population Assessments
- Community Engagement: Strategies and Equity Considerations
- Administrative Capacity: Plan Updates, City Departments Involved, Staffing, and Budget

This chapter, along with the benefits of UFPs outlined in the literature review, is central to the recommendations provided in Chapter 6.

Forterra

The Green Cities Partnership is a key factor in understanding the organization and implementation of the UFPs in Issaquah and Seattle. Forterra (n.d.-b) established the "Green City Partnerships" program in 2004 to address the need for more proactive efforts to maintain urban parks and natural areas. During our interview with Forterra's Interim Managing Director, we learned that the connection between the Green Cities Partnerships and Forterra's mission is that "Forterra was thinking about broader sustainability issues – how people were living in cities and towns […] Forterra realized cities didn't have resources to do broad assessments of city tree canopy (inside and outside of parks)". This program created a network of cities dedicated to protecting forested parks, natural areas, and communities in Washington State. Today, the network contains a total of 14 Green Cities, logging over 115,000 volunteer hours at more than 1000 events each year. The goal of this network is to improve quality of life and enhance forest benefits in cities by restoring forested parks and natural areas, galvanizing an informed and active community, and ensuring long-term sustainable funding and community support. Forterra currently works closely with the 14 Green City municipalities to develop achievable goals, shared visions, long-term plans, and community-based stewardship programs to care for the valuable forests and natural areas in urban environments. Forterra also supports this network by hosting annual summits and quarterly meetings to exchange ideas and offer solutions.

Forterra's Green Cities Department has historically supported all Green City Partnerships and worked to keep all partnerships connected through the Green Cities Network (Forterra, n.d.-b). However, within the last few years, Forterra has started to shift its organizational priorities. During our interview with Forterra, we learned that the organization is currently assessing whether to pursue expansion of the Green Cities initiative or to prioritize existing Green Cities and ensuring the long-term effectiveness of their urban forestry efforts. We discuss the implications of this development in our Partnership Guide in Appendix A.

4.1 City of Issaquah, WA

Introduction

The City of Issaquah, through a collaboration with Forterra, began an evaluation of the general condition of Issaquah's forested parks and natural areas in 2019. At that time, they established the Green Issaquah Partnership: a program to protect, enhance, and sustain Issaquah's forested parks, natural areas, and scenic resources (City of Issaquah & Forterra, 2020). The intent of the Green Issaquah Partnership 20-Year Implementation Guide is to describe the challenges facing urban forests today, as well as the benefits of restoring and enhancing those forests. This guide also shares important results of the health assessment of Issaquah's forested parks and natural areas, sets goals to restore Issaquah's forested parks and natural areas, and recommends actions and benchmarks to reach those goals to benefit Issaquah's people and ecosystem (City of Issaquah & Forterra, 2020).

Issaquah and Forterra

Issaquah joined the Green City Partnerships network in 2019. Since then, Forterra has worked collaboratively with the city on urban forestry activities, including conducting outreach activities to solicit input specifically for the Green Issaquah Partnership, providing training guides applicable to both city staff and Forest Stewards in forest restoration projects, assisting Issaquah in estimating program costs, and coordinating initial volunteering programs using the networks' existing model (City of Issaquah & Forterra, 2020). As of 2023, Forterra is no longer working directly with Issaquah on Green Issaquah Partnership activities. This change is due to Forterra's recent organizational shifts.

In an interview with Issaquah's Parks and Recreation Director we learned that the city is now partnering more closely with city communities to recruit, train and support volunteer stewards to lead forest restoration projects in priority parks.

Resource Assessment

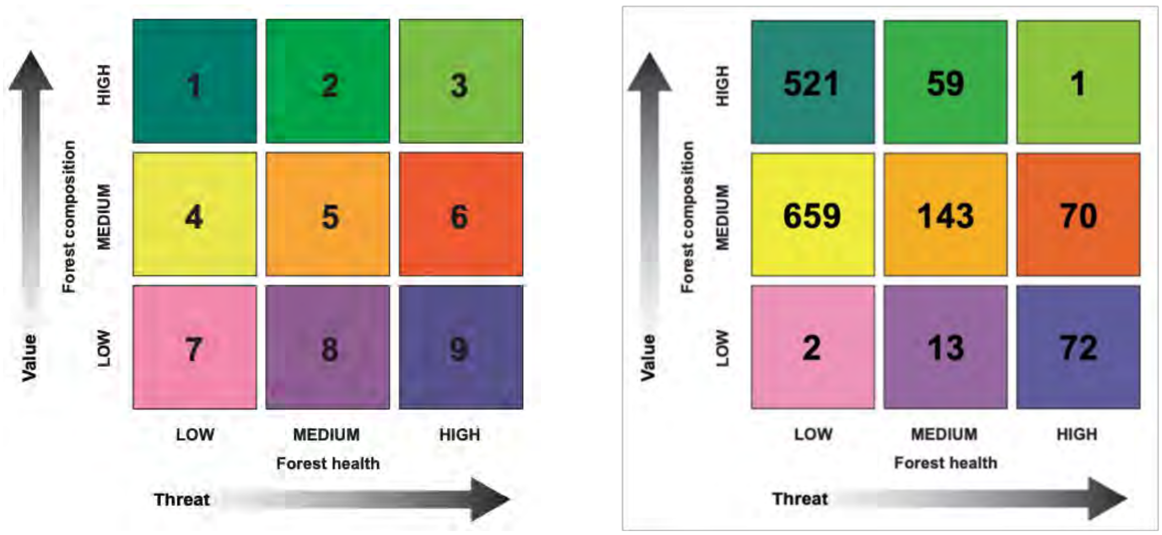
The City of Issaquah used the Forest Landscape Assessment Tool (FLAT) to conduct its resource assessment. There are three main steps Issaquah took to utilize FLAT: forest-type mapping, on-the-ground forest assessment, and management strategies prioritization (City of Issaquah & Forterra, 2020).

First, using GIS analysis, the city classified natural areas within the partnership project area through digital orthophoto interpretation and divided each stand into one of five categories: forested, natural, open water, hardscaped, or landscaped (City of Issaquah & Forterra, 2020). The final delineated stands are called Management Units (MU), and all MUs were assigned to unique letter combinations for future restoration planning and data tracking.

Next, the Green Issaquah Partnership used FLAT, a prioritization tool that uses habitat composition and invasive plant cover as the two parameters, to prioritize restoration to conduct a forest health assessment (Ciecko et al. 2016). This assessment includes characterizing conditions across Issaquah's forested parks and natural areas, documenting the presence of regenerating trees (i.e., canopy species less than 5 inches in diameter at breast height) and stocking class (i.e., estimated number of trees per acre and spacing between trees). Using this assessment, the city was able to produce a general picture of the overall condition at any given site and on a landscape or city scale, which serves as a high-level baseline from which finer-scale, site-specific restoration planning can be conducted (City of Issaquah & Forterra, 2020). In the field, the city surveyed each MU to identify its specific habitat type (e.g., conifer forest, deciduous forest, riparian, shrubland) and to capture information on the dominant overstory species and tree canopy cover (City of Issaquah & Forterra, 2020). The city then assigned a value (i.e., high, medium, or low) to each MU based on habitat composition. Details on how values are assigned can be found in Chapter 6 of this report.

After assigning values to all MUs, the city hired a professional urban forester who used the tree-iage matrix system to assign a tree-iage category or priority rating to the MUs. Categories range from 1 to 9, with 1 representing high-quality habitat and low invasive species threat, and 9 representing low-quality habitat and high invasive species threat (City of Issaquah & Forterra, 2020). By summing the acres in each row and column, the city was able to have a clear understanding of the total distribution of the project acres, as shown in Figure 5. The tree-iage matrix was then used to develop future management strategies and prioritize MUs.

Figure 5: FLAT assessment Tree-iage Matrix (left) and Distribution of Issaquah Project Acres by Tree-iage Category (right) (Ciecko et. al., 2016; City of Issaquah & Forterra, 2020)



Community Engagement

The main community engagement strategies that the City of Issaquah used were conducting community surveys to gather information on residents' priorities and outreach to gain support from its existing partners for its UFP. The city then incorporated the needs of partners, residents, and volunteers into several goals and objectives for the partnership. For instance, one of the most common themes that emerged from surveying Issaquah residents was the hope that the city would work with the school district to engage students in restoration projects, both as in-school outdoor-classroom activities and for service hours outside of school hours (City of Issaquah & Forterra, 2020). As a response to this theme, the seventh community objective for the partnership is to seek opportunities to engage youth and provide education. Specifically, the Green Issaquah Partnership will work with Issaquah Public Schools to engage youth in outdoor experiences and environmental stewardship. The city hopes that opportunities like this will serve as pilot projects and guides for other potential collaborations with schools.

The Green Issaquah Partnership also includes the structure for a centralized volunteer system, making it easier for the community to get involved (City of Issaquah & Forterra, 2020). Additionally, individuals can become a Forest Steward for any city park. As Forest Stewards, volunteers will receive training, tools, and resources supported by the Green Issaquah Partnership to operate their restoration project and lead other volunteers at events. We discuss the Forest Steward Program in-depth in Chapter 5. The Green Issaquah Partnership also provides educational resources and training to private property owners and residents to encourage them to be good stewards of the forest and their property. The accomplishment of Issaquah's UFP activities will tracked, reported, and celebrated by the city each year.

Equity Considerations

One of the community objectives of the Green Issaquah Partnership is to "develop and implement community outreach and engagement strategies to equitably serve Issaquah's residential population" (City of Issaquah & Forterra, 2020). The partnership hopes to provide various ways to equitably engage every resident by building relationships with community groups and local organizations. Community members are encouraged to participate in caring for the shared public urban forests and natural areas regardless of age, income, ethnicity, or language spoken at home. The partnership also highlights that volunteer restoration projects are opportunities for neighbors, families, friends, and newcomers to unite in revitalizing their parks, fostering community bonds through shared experiences, and deepening ties to the natural world and each other (City of Issaquah & Forterra, 2020). In addition to seeking opportunities to work with existing successful community organizations and programs, the Green Issaquah Partnership emphasizes employing new and creative strategies over the life of the program as one of the goals to equitably engage the city's diverse population.

Implementation Logistics

Plan Updates

The first five years of the Green Issaquah Partnership focus on building and supporting a volunteer base, spreading program awareness, and demonstrating restoration and planting results on the ground. After those five years have passed, staff time will be reallocated to fieldwork like volunteer management and coordination of field crews. The Partnership also requested that the city establish a Community Advisory Committee to help involve community members in the partnership (City of Issaquah & Forterra, 2020).

The Green Issaquah Partnership relies on both hired staff and volunteer partners that include public, nonprofit, and public organizations. Issaquah uses a four-phase approach to restoration fieldwork that was developed in the Green Seattle Partnership (City of Issaquah & Forterra, 2020). The four phases are:

- Restoration Phase 1: Invasive plant removal
- Restoration Phase 2: Secondary invasive removal and planting
- Restoration Phase 3: Plant establishment and follow-up maintenance
- Restoration Phase 4: Long-term stewardship and monitoring

Each phase is planned to take several years and is tracked through work logs to track the progress of the plan and the canopy. More details about the four-phase restoration approach can be found in Chapter 6.

Staffing

The Issaquah program places significant reliance on volunteers to support various aspects of their urban forestry activities, including on-the-ground fieldwork and coordination of other volunteers. The Issaquah program aims to recruit approximately 100,000 volunteer hours throughout the 20-year program duration (City of Issaquah & Forterra, 2020). The original staffing recommendations outlined in the guide suggest Forterra could provide volunteer hours instead of hiring paid staff.

The Green Issaquah Partnership outlines the need for a dedicated city staff member that can allocate at least half of their time to managing and coordinating volunteer efforts. This staff member would spend a portion of their time coordinating the Forest Steward Program, which involves training stewards, working with them to develop site plans, providing support and encouragement, and coordinating their efforts with other staff members. The staff member would also dedicate time to education and outreach, with the possibility of receiving support from Forterra or the city's Communications Department.

Their program requires at least a part-time position in the first few years to coordinate field restoration, which will need to be a full-time position by 2025. There could be a need for a part-time or full-time staff member dedicated to fund development and management whose main job is finding and applying for grants and funding opportunities. The high-end estimate of staffing suggestions for the Issaquah plan for the first 5 years is 4-5 paid full-time staff members within the Parks and Community Services Department (PCSD) whose main responsibilities are the Green Issaquah Partnership.

Per the City of Issaquah's 2023-2024 Proposed Biennial budget, the city is planning to hire one FTE Urban Forest Supervisor and one FTE 0.5 Volunteer Coordinator to manage the Forest Steward Program starting in 2023(City of Issaquah, 2022).

City Departments

Issaquah's PCSD has housed the UFP since its implementation. However, the program consists of coordinated efforts amongst multiple city departments, including Community Planning & Development and Public Works. In 2023, the city will establish a Natural Resource Team within PCSD. The Natural Resource Team will work to coordinate efforts across departments. The Urban Forest Supervisor and Volunteer Coordinated will be held in the Natural Resource Team.

The City of Issaquah does not currently have an advisory board or commission.

Budget

The city's urban forestry expenditures are relatively low compared to the other two case study cities due to the relative age and size of the program. According to our interview with a city staff member, the city initially invested approximately $100,000 into a comprehensive resource assessment in 2018 that was used to inform the Green Issaquah Partnership Implementation Guide. In the city's 2023 proposed budget, the city budgeted approximately $360,000 for urban forestry activities, which includes hiring a full-time Urban Forest Supervisor, a part-time Volunteer Coordinator, and development of an Urban Forestry Management Plan.

In 2019 and 2020, the city received funding from Forterra to be used for implementing the UFP. The city received $100,000 in 2019 and $50,000 in 2020 (City of Issaquah, 2019). Based on our interview, we know the remaining expenditures were funded through city resources. Urban forestry activities primarily take place within PCSD so we can assume that most of the funding came from the city's General Fund as PCSD is 86% funded with General Fund revenue (City of Issaquah, 2022). The new Urban Forest Supervisor position will be fully funded through the city's Stormwater Fund (City of Issaquah, 2022). We discuss the use of Storm and Surface Water Utility Fees as a revenue source more in-depth in Chapter 5.

The exact breakdown of the city's UFP expenditures can be seen in Table 3. Please note that these expenditures do not include regular, ongoing tree maintenance and planting in the city (e.g., tree pruning related to repaving streets). The expenditures outlined are specifically defined within the city's budget as relating to urban forestry.

Table 3: City of Issaquah, WA - 2023 Urban Forestry Expenditures

Department	**Expenditure Detail**	**2023 Adopted**
Parks and Community Services	New Position - Full-Time Urban Forest Supervisor	185,686
Parks and Community Services	New Position - Part-Time Volunteer Coordinator	77,547
Parks and Community Services	Development of Urban Forestry Management Plan	100,000
	Total	**363,233**

4.2 City of Vancouver, WA

Introduction

The City of Vancouver's UFP is part of the city's Department of Public Works and works closely across all departments. The city first developed its Urban Forestry Management Plan in 2007, which provided a foundation and guideline for its future program and activities. In 2021, the city produced an annual report, a tree canopy assessment, as well as its Urban Forestry Work Plan. As stated by the City of Vancouver (2022a), the current UFP "seeks to improve the quality of life in the city by enhancing tree canopy to provide clean air and water for current residents, visitors, and future generations" (p. 4). The City of Vancouver is currently engaged in initiatives to expand tree canopy throughout the city. However, at the program's inception in 2007, the city was primarily focused on the restoration and maintenance of the existing tree canopy and green spaces. Over the past 15 years, since the program's inception, the city has continued its restoration practices while gradually expanding its public and private UTC expansion efforts.

The program is supported by the Urban Forestry Commission, a seven-member volunteer commission appointed by the Vancouver City Council. The Commission helps the city to develop management methods to preserve the trees and forests, educate residents on the importance of urban trees, and organize tree plantings (City of Vancouver, 2022a).

Resource Assessment

There are three parts to the tree canopy assessment for Vancouver. The first is to quantify the city's existing tree canopy cover. Using high-resolution multispectral imagery from the U.S. Department of Agriculture's National Agriculture Imagery Program (NAIP) collected in 2019 and 2020, the city was able to derive the land cover dataset and classify all types of land cover (City of Vancouver & PlanIT Geo, 2021). The city also used tree canopy and land cover data from the EarthDefine US Tree Map to classify a five-class land cover, including urban tree canopy, soil and dry vegetation, other vegetation, impenetrable surfaces, and surface water. These data were then used to extract generalized tree species composition using a Normalized Difference Vegetation Index (NDVI), supervised training, and an iterative machine learning approach (City of Vancouver & PlanIT Geo, 2021). Google StreetView also provided street-level images for the city to obtain training and verification samples of deciduous and evergreen trees.

The second is to identify areas where the tree canopy could be expanded. All land areas in Vancouver that did not have existing tree canopy coverage were classified as either possible planting area (PPA) or unsuitable for planting (City of Vancouver & PlanIT Geo, 2021). PPAs were estimated from the non-canopy vegetation layer. Unsuitable areas and areas that are not viable to plant trees due to biophysical or land use restraints were manually delineated and overlaid with the existing land cover data set. The City of Vancouver and PlanIT Geo (2021) reported the results as "PPA Vegetation, Unsuitable Vegetation, Unsuitable Impervious, Unsuitable Soil, and Total Unsuitable" (p. 4). This process is conducted on both private land and public land. Some of the results show that 66% of all UTC in Vancouver is found on private land, with public land and rights-of-way (ROW) occupying the remaining 34% evenly. Similarly, private land contains 74% of all PPA, while 14% is found in the ROW and just 12% on public lands. (City of Vancouver & PlanIT Geo, 2021).

Finally, tree canopy change between 2011 and 2019/2020 was analyzed across the same geographic assessment. Both tree canopy data sets were created from the EarthDefine US Tree Map. Using machine learning techniques to produce highly comparable datasets, the city was able to find the canopy changes in percentages during the period. And in 2021, Vancouver hired PlanIT Geo to perform a full tree canopy assessment and a partial park tree inventory.

Community Engagement

The first step in community engagement has been outlined in the 2007 Urban Forestry Management Plan, which delineated four primary outreach methods:

1. review of two citizen-based planning efforts conducted between 2004 and 2006
2. public opinion survey completed in November 2006
3. stakeholder interviews
4. community meetings were conducted during October 2006 and February 2007 (City of Vancouver, 2007)

An electronic version of the draft plan was posted on the city's website requesting residents' comments via email.

In the latest 2021 report, the city marked promoting an urban forest stewardship ethic in the community as one of the four goals in its urban forestry work plan. Apart from the existing partnerships with neighborhood associations, faith-based organizations, nonprofit organizations, public agencies, and private businesses, the city planned to strengthen and expand community partnerships with underserved organizations and communities, local businesses, regional partners, etc. For instance, the city decided to foster civic involvement through the Neighborhood Tree Stewards program, a comprehensive training and education program that empowers neighborhood volunteers to become leaders in urban forest management. Also, by offering Tree Talk workshops on various tree-related topics monthly throughout the year, the city planned to expose participants to knowledge on a variety of trees to plant in landscapes that offer a myriad of benefits (City of Vancouver, 2021).

Equity Considerations

In the first draft of its 2023 Urban Forestry Management Plan, Vancouver highlights the importance of fostering equity and environmental justice by addressing the uneven distribution of canopy resources and benefits. The plan acknowledges that existing tree canopy coverage tends to be larger and more established in wealthier neighborhoods since canopy expansion and maintenance largely depend on tax dollars. The plan points out that communications that build trust with disadvantaged communities should begin months before tree planting starts. The plan argues that by engaging with respected community leaders to introduce the concept of tree canopy expansion, organizing community outreach events at an earlier stage, and soliciting local input on tree species selection, a strong partnership with the community's residents can be established. The plan asserts that identifying areas in most need of tree canopy covers, tree plantings, and urban forestry services (e.g., a program assisting low-income property owners with the management of hazardous or invasive trees) will address community equity and environmental justice (City of Vancouver & PlanIT Geo, 2023).

Implementation Logistics

Plan Specifics

The City of Vancouver's UFP has been actively working in the city since 2007. As of its 2021 plan update, the Urban Forestry Division's main goals are categorized into three overarching responsibilities: planning, education, and management (City of Vancouver, 2007). Planning refers to reviewing site development applications, partnering with agencies and professionals to grow the tree canopy, and assessing and monitoring the health of the forest resources. Community outreach and education are outlined more above but entail the promotion of learning about trees, coordinating their NeighborWoods Program, and hosting community events and training. The management responsibility involves coordinating with city departments, enforcing policies, identifying funding, and customer service.

In order to understand current and future opportunities and challenges, the City of Vancouver implemented a Strengths, Weaknesses, Opportunities, and Threats (S.W.O.T.) assessment in 2007 (City of Vancouver, 2007). This assessment was a way to organize and synthesize comments from the public, agency and local organization staff, and the Urban Forestry Commission. Based on this feedback and the needs of the community the Urban Forestry Division established four main goals to guide the direction of the program:

- Preserve existing trees and institutionalize planning, maintenance, and operating principles that improve canopy health.
- Restore canopy-deficient areas through tree planting to provide equitable distribution of urban forest benefits to all Vancouver residents.
- Promote an urban forest stewardship ethic within the community.
- Adhere to City of Vancouver's Operating Principles and establish Vancouver Urban Forestry as a leader in Pacific Northwest municipal forest management.

The city developed a priority-level system to gauge the timeline of specific action steps under each of its four main goals (City of Vancouver, 2007). They developed a matrix of all the planned steps they determined would let them achieve their goals. The priority levels correspond to an approximate timeline as follows:

Priority	**Timeline (approx.)**
High	immediately to 3 years
Medium	within next 3 to 10 years
Low	as budget, staffing and other resources allow

Staffing

The City of Vancouver's Urban Forestry Program currently consists of four full-time staff members, including one Urban Forester, two Urban Forest Specialists, and one Urban Forest Outreach Coordinator. This staffing equates to about one full-time employee per 46,548 residents. The city also contracts with AmeriCorps and currently has two AmeriCorps members supporting UFP activities.

City Departments

The Vancouver City Council has appointed a seven-member volunteer commission called the Urban Forestry Commission to advise their City Council on urban forestry efforts. The commission helps the city to develop good management practices to preserve community trees, educate citizens, and organize tree plantings. Commission members are appointed for four-year terms.

In Vancouver, the commission was created as a result of community interest in an urban forestry program but limitations regarding organizational capacity. In an interview with the program's Urban Forester, we learned that at the time the city's parks department did not consider urban areas outside of parks as integral to their mission Therefore, urban forestry activities were not prioritized within the parks budget, and instead the department allocated more resources to their core activities. As a result, the community pushed for a voluntary board that could prioritize the UFP and advocate for appropriate budgetary allocation while supporting program implementation.

Similar to the Green Issaquah Partnership, the Vancouver Urban Forestry Program has relied on multiple partnerships with nonprofits, public agencies, and neighborhood associations to help implement coordination of planting efforts and develop the plan itself. UFP activities are centrally managed by the Urban Forestry Division, which is housed in the city's Public Works department. The division works closely with the Vancouver-Clark Parks & Recreation, Transportation, and Development Review departments.

Budget

Vancouver is the only city of our three case studies that had a standalone urban forestry department at the time of this report. As a result, we were able to easily identify 2023 expenditures related to urban forestry activities within the city's 2023-24 Biennium Budget. Total projected expenditures for UFP activities were estimated at approximately $1.9 million (City of Vancouver, 2022b). This was a 97% increase from previous years' total expenditures of approximately $900,000. This increase was due, at least in part, to a comprehensive update to the city's Urban Forestry Management Plan for the first time since 2007, which required significant investment in contract labor and plan development (City of Vancouver, 2022b; Ellenbecker, 2023).

According to the city's budget, an estimated 95% of program expenditures in 2023 will be funded through the city's Surface Water Management Fund (City of Vancouver, 2022b). The primary revenue source for this fund is city storm and surface water utility fees. UFP expenditures account for approximately 7.5% of the total estimated fund revenue in 2023 (budget p. 99). The remaining 5% of UFP expenditures will be funded through the City Tree Reserve Fund. The fund is primarily funded through penalties and fees related to the city's tree ordinance and donations (municipal code 20.770.040 City Tree Account).

The city's 2023 UFP expenditures are outlined by revenue source in Table 4. Since all UFP activities are held in a single department within the city, expenditures are instead delineated based on revenue source. Please note that these expenditures do not include regular, ongoing tree maintenance and planting in the city (e.g., tree pruning related to repaving streets). The expenditures outlined are specifically defined within the city's budget as relating to urban forestry.

Table 4: City of Vancouver, WA - 2023 Urban Forestry Expenditures by Revenue Source

Revenue Source	Expenditure Detail	2023 Adopted
SWM Fund	Salaries and Benefits	693,250
SWM Fund	Supplies and Services	770,620
SWM Fund	Interfund	353,052
	Total	**1,816,922**

Revenue Source	Expenditure Detail	2023 Adopted
City Tree Reserve Fund	Supplies and Services	80,155
City Tree Reserve Fund	Other Intergovernmental	3,000
City Tree Reserve Fund	Interfund	3,264
	Total	**86,419**

4.3 City of Seattle, WA

Introduction

The City of Seattle originally developed its UFMP in 2007 and more recently produced an update in 2020. The update provided a framework for policies and actions that guide the city's decision-making to help preserve, maintain, restore, and enhance its urban forest. The core of the plan is a set of outcomes, strategies, actions, and indicators that support a healthy and sustainable urban forest across Seattle's publicly and privately owned land. The UFMP was produced by the joint effort of the City of Seattle Urban Forestry Core Team, which is a group representing city departments with tree management and regulatory responsibilities, and the Urban Forestry Commission (City of Seattle, 2020).

Resource Assessment

The city undertook a comprehensive canopy cover assessment in 2016 using light detection and ranging (LiDAR) data, which is a surveying method that uses lasers to create a 3D model (City of Seattle, 2020).

The plan first defined nine management units that cover all the land in the city, which allowed for easy coordination of GIS mapping layers and related planning initiatives. The units include eight distinct areas selected based on physical characteristics:

1. Single-Family Residential
2. Multi-Family Residential
3. Commercial/Mixed-Use
4. Industrial
5. Institutional
6. Downtown
7. Developed Parks
8. Parks' Natural Areas

A ninth unit, the Right-of-Way, goes through each of the other eight units. With the criteria of these management units, the city was able to construct an overview of canopy cover, as shown in Table 5.

Table 5: Seattle Canopy Coverage by Management Unit in 2016 (Seattle UFMP, p.13)

Management Unit	Land area (acres)	% of city land area	2037 UFMP Goal (set in 200)	2016 Canopy Cover
Single-Family Residential	29,918	56%	33%	32%
Multi-Family Residential	5,646	11%	20%	23%
Commercial / Mixed Use	4,522	8%	15%	14%
Downtown	815	1%	12%	10%
Industrial	6,191	11%	10%	6%
Institutional	1,101	2%	20%	25%
Developed Parks	2,578	4%	25%	37%
Parks' Natural Areas	2,356	7%	80%	89%
Citywide	54,379	100%	30%	28%
Right-of-Way	14,682	27%	24%	23%

In addition to measuring citywide canopy cover, the city initiated an ongoing process of developing inventories of certain public and street trees. The Seattle Department of Transportation (SDOT) aims to complete a 100 percent inventory of all street trees in Seattle by the end of 2024, which will enable SDOT and other departments that manage urban forestry activities to better prepare for street tree-related emergencies and enhance the future of street trees across Seattle communities.

In a parallel effort, the Green Cities Research Alliance assessed Seattle's urban forest to quantify the regional impact of trees on pollution reduction, carbon storage, and energy conservation. Researchers randomly selected a total of 223 plots of trees throughout Seattle on both private and public land to assess. Researchers were able to capture the size and condition of Seattle's urban forest, which they used to quantify the public benefits and economic value of the ecosystem. This comprehensive assessment was vital for understanding the current and future management needs of the city's urban forest to infer the development of solid management policies (City of Seattle, 2020; Ciecko et al., 2012).

Community Engagement

Public engagement around the city's UFMP was shaped by the Equity and Environment Initiative and the city's Race and Social Justice Initiative (City of Seattle, 2020). Several key commitments were identified, including intentional engagement with historically underrepresented communities before plan update drafting, reviewing, and valuing all feedback from historically underrepresented communities, transparency, and engaging the public in developing the plan.

According to the City of Seattle (2020), before the UFMP was developed, the city worked with various governmental agencies to "engage native peoples, as well as the African American, East African, Chinese, and Latinx communities living in and around the Greater Seattle region" (p. 6). Throughout the drafting process, the city kept close contact with members of nine environmental-justice priority communities (African American, Chinese, disabled, East-African, Latino, Native American, seniors, Southeast Asian Cham refugees, and unhoused populations), presenting ideas and collecting feedback so that the goals and strategies could reflect on racial and social equity.

Equity Considerations

During the plan update process, the city's Equity and Environment Initiative recognized the disproportionate impact of past policies and practices on communities of color, which were referred to as "environmental justice priority communities" in their UFMP. Therefore, the city stated the determination to provide clean, healthy, resilient, and safe environments for communities of color, native peoples, immigrants, refugees, people with low incomes, youth, and individuals with limited English proficiency.

The Race and Social Justice Initiative (RSJI) is the city's current initiative that ensures the Seattle government realizes its vision of racial equity. According to the City of Seattle (2020), RSJI is "a citywide effort to end institutional racism in city government, and to achieve racial equity across the community" (p. 22).

The city also launched the Equity and Environment Initiative and produced the Equity and Environment Agenda, which is a blueprint to progress racial equity in Seattle's environmental work. The agenda lays out four key goals and recommended strategies in areas like healthy environments for all, jobs, local economies, youth pathways, equity in city environmental programs, and environmental narrative and community leadership (City of Seattle, 2020).

Implementation Logistics

Plan Specifics

Seattle's Urban Forest Management Plan is a 30-year plan that is divided by Management Units that are based on different types of land (i.e., residential, downtown, mixed-use, etc.). Their plan started off by utilizing the

Model of Urban Forest Sustainability to guide the design of their management plan (City of Seattle Urban Forestry Coalition, 2007). This model outlined four principles that Seattle followed for their management plan:

- Sustainability is a broad, general goal that results in the maintenance of environmental, economic, and social functions and benefits over time;
- Urban forests primarily provide services rather than goods;
- Sustainable urban forests require human intervention; and
- Trees growing on private lands compose the biggest part of urban forests.

Using the sustainability model, the City of Seattle also incorporated three main management elements for their plan. The plan began by assessing these three elements:

1. **Tree Resource**: the trees themselves, as individuals or in forest stands
2. **Management Framework**: the policy, planning and resources— including staff, funding, and tools — brought to bear on the tree resource; and
3. **Community Framework**: the way residents are engaged in planning and caring for trees. Because most trees in the urban forest are on private property, a successful program requires that the community plant and maintain trees on their property.

Seattle's plan then goes through the different conditions, issues/opportunities, and goals/actions for each of the nine "Management Units" that they identified. This way they could have different strategic approaches for the different types of land use in the city.

Staffing

The city established the Urban Forest Coalition in 1994, which was a cooperative effort of nine city departments that shared different tree management responsibilities before the UFMP was ultimately developed. The coalition was responsible for implementing other tree-related policies, programs, and budget initiatives. In 2007, the coalition was tasked with the implementation of the UFMP. Today, this coalition has been replaced by the city's Urban Forestry Core Team which manages the bulk of cross-departmental coordination on UFP activities (City of Seattle Urban Forestry Core Team, 2020). It is unclear how many staff members are fully dedicated to implementing Seattle's UFMP. According to the City of Seattle (2022), the city will establish a City Urban Forester position in 2023. This new position will be housed in the Office of Sustainability and Environment, and they will work with staff across city departments to coordinate urban forestry efforts throughout the city.

City Departments

The city also has an urban forestry commission. The Seattle Urban Forestry Commission (UFC) is a voluntary space with 13 members appointed by a majority vote of the City Council (6), the mayor (5), by a majority vote by the UFC members (1) or by a special process (1). Members serve three-years terms and positions are a mixture of specialists such as Wildlife Biologist, Urban Ecologist, Natural Resource Agency or University Representative or community representatives.

Due to the size and resources available to Seattle, there are many departments that are responsible for implementing different aspects of the UFMP, and representatives from each department make up the Core Team. The departments involved in Seattle's UFMP are as follows: Finance and Administrative Services, Office of Planning and Community Development, Office of Sustainability and Environment, Seattle Center, Seattle City Light, Seattle Department of Construction and Inspections, Seattle Department of Transportation, Seattle Parks and Recreation, Seattle Public Utilities, and Trees for Seattle (City of Seattle Urban Forestry Coalition, 2007).

Budget

The City of Seattle's decentralized approach to urban forestry is also reflected in its budgeting practices. Each individual department manages a separate budget that includes that department's urban forestry expenditures. This budget structure does not allow us to provide a single urban forestry budget for a given year as many expenditures may be recorded under broad, high-level activities that are not explicitly labeled as urban forestry. However, the City of Seattle's 2023-2024 Adopted Budget did provide insight into the city's current spending for activities that are explicitly earmarked for urban forestry.

As outlined in the city's 2023-2024 Adopted Budget Summary, Mayor Bruce Harrell is launching a One Seattle Tree Strategy that "will provide a framework needed to maintain the city's commitment to a 30% tree canopy cover goal" (City of Seattle, 2022). This strategy includes close to $800,000 over the next two years for improving the city's tree canopy. The first and second components of this strategy are under the jurisdiction of the Seattle Department of Sustainability and Environment. The first initiative supports greening and tree planting on private properties for industrial and industrial-adjacent areas of the city. This initiative has a proposed budget of $300,000 in 2023 and an additional $300,000 in 2024 (City of Seattle, 2022). The One Seattle Tree Strategy also includes $150,000 for the development of a Tree Canopy Equity and Resilience Plan. This plan will identify locations for increasing tree canopy on private and public land, with a specific focus on low-canopy neighborhoods in environmental justice priority areas (p. 41). The third component of the program provides $320,000 to Seattle Parks and Recreation to increase capacity for tree planting, specifically in Seattle Parks.

Most expenditures outlined above, including all activities in the One Seattle Tree Program, will be funded through the JumpStart Payroll Expense Tax, which is a funding Green New Deal programs throughout the city (City of Seattle, 2022). Other urban forestry activities are funded through the city's general fund or through revenues specific to each department.

The city's 2023 UFP expenditures are outlined in Table 6. Please note that these expenditures do not include regular, ongoing tree maintenance and planting in the city (e.g., tree pruning related to repaving streets). The expenditures outlined are specifically defined within the city's budget as relating to urban forestry.

Table 6: City of Seattle, WA - 2023 Urban Forestry Expenditures

Department	Expenditure Detail	2023 Adopted
Office of Sustainability and Environment	New Position - Full-Time City Urban Forester	147,000
Office of Sustainability and Environment	Development of Tree Canopy Equity and Resilience Plan	150,000
Department of Transportation	Tree Planting in Right-of-Way Initiative	250,000
Department of Construction and Inspections	Additional Capacity for Tree Protection	54,961
Office of Sustainability and Environment	Greening of Industrial Properties in Equity Focus Areas	300,000
Parks and Recreation	Increased Tree Planting and Maintenance in Parks	637,000
	Total	**1,538,961**

4.5 Case Studies Summary

We analyzed each city according to our seven criteria (Table 1): tree population assessments, strategies, equity considerations, plan updates, commission, city departments involved, staffing, budget, and funding sources. At the end of this section, Table 7 synthesizes the content of each case study and summarizes key information for each city based on our criteria.

Resource Assessment

All three cities conducted a tree assessment early in the design process of their forestry program. In Issaquah's case, the approach was a FLAT assessment that focused on identifying trees' conditions to create management units. Meanwhile, Vancouver did an assessment that focused on creating additional imagery data of the canopy and land covers, and a tree inventory which is more detailed than a flat assessment. Finally, Seattle completed a canopy assessment and is in the process of doing a tree inventory of street trees. In each case, the resource assessment looks different, and each approach carries specific benefits and costs. Issaquah's case centers more on the management units throughout the city; thus, the assessment supports the management efforts for the plan. However, for Vancouver and Seattle, the assessment goes further as it also includes a tree inventory which adds additional information on the types of trees in the city. Tree inventory is costly, as it requires more work on the ground to identify trees.

Community Engagement

Strategies and Equity Considerations

All three cases implement steward programs to integrate volunteers, which are integral to successful implementation and long-term program sustainability. Aside from steward programs, cities also carry out periodic surveys, meetings, or other spaces to gather feedback from the public to inform the plan. In Issaquah and Vancouver, volunteers have been central to gathering community insight and integrating community perspectives throughout the program, allowing volunteers to develop ownership of the urban forest and ensure the program's sustainability. All three cities emphasize the significance of considering feedback from minority communities and plan to integrate this into their community outreach efforts.

Administrative Capacity

Plan Updates

Cities release updates to their programs every three to five years to integrate resident feedback, make budgetary adjustments, as well as any other technical adjustments related to tree maintenance or public versus private land. There is no clear rationale for why they update the plans at three or five-year increments, but there is an implicit agreement that frequent revision is important to stay on track with the cities' long-term plans for their urban forest.

City Departments

The City of Issaquah manages its UFP within its Parks, Recreation and Community Services Department. The City of Vancouver houses its program within Public Works. However, both cities work closely across city departments to prioritize urban forestry activities and coordinate city efforts. The benefit of this approach is that program goals and activities are prioritized because it has staff and funding dedicated solely to the program.

It is worth mentioning that Vancouver is able to maintain a department with four full-time employees and considerable annual expenditures because of the stable stormwater fee revenue stream Vancouver uses to fund its program. However, Vancouver's approach involves coordination among multiple departments, recognizing the need to work collaboratively with different teams that may have varying priorities and perspectives, particularly when addressing challenges related to street trees. Finally, Seattle's program is managed through a collaborative approach involving staff from various city agencies. These staff members come together to collectively determine the program's initiatives.

As we mentioned in the case of Vancouver, there can be challenges in aligning interests among city departments. However, one significant advantage of involving multiple departments is that the program becomes a citywide effort that benefits from diverse perspectives and has the potential for a greater impact when all participating departments contribute their resources to the plan.

Vancouver and Seattle have volunteer advisory boards or commissions that oversee the implementation and management of their UFPs. As explained in each section, the establishment of boards or committees dedicated to the UFP ensures that it remains a priority in the city, particularly for departments that have specific responsibilities within the program. These boards help maintain focus, coordination, and accountability for the successful implementation of the UFP, even when different departments are responsible for specific tasks. Seattle's approach to the UFP differs from that of Vancouver and Issaquah, where the program responsibility is centralized within a single department. This centralized approach allows for focused management and coordination within a single department, ensuring that the UFP receives dedicated attention and resources.

Staffing

The cases studied show variations in staff size, ranging from 1 full-time employee in Issaquah to 9 employees in Seattle. The size of the staff is closely linked to the financial resources allocated to the program. The program strategy plays a crucial role in determining the necessary number of employees to initiate and sustain the program over time. The specific needs, goals, and scale of the program will influence the staffing requirements, whether it's centralized or distributed across the city.

Budget

The budgets of the three case study cities differ significantly. Issaquah, being the newest UFP, has the lowest budget with approximately $360,000 in total expenditures for 2023. Vancouver, with its four dedicated staff members, has the highest total annual expenditure, amounting to nearly $2 million in 2023. For a detailed comparison of the budgets of the three case study cities, please refer to Appendix B.

The City of Issaquah's similar governmental structure and size to Lakewood made it a valuable case study in developing the UFP for Lakewood. Vancouver's Urban Forestry Management Plan, established in 2007, provided insights into the early stages of UFMP development and showcased a comprehensive forestry plan. Seattle, with its ample financial resources, highest tree equity score, and larger governmental structure, served as an example of a more ambitious forestry plan. The combination of these case studies contributed to a well-rounded understanding of UFP implementation in different contexts.

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Table 7: Case Study Criteria and Summary Findings

Objectives	Criteria	Issaquah	Vancouver	Seattle
Resource Assessment	Tree Population Assessment	Use the Forest Landscape Assessment Tool (FLAT) to produce baseline plans; Utilize GIS and the Tree-iage Matrix to classify acres as Management Units (MU).	Use high-resolution multispectral imagery from NAIP and data from the EarthDefine US Tree Map to classify all types of land covers and acquire canopy changes; identify areas where the tree canopy can be expanded; hire PlanIT Geo to perform a full tree canopy assessment and a partial park tree inventory.	Comprehensive canopy cover assessment in 2016 using light detection and ranging (LiDAR) data; defined 9 management units covering entire city for easy coordination of GIS mapping layers and related planning initiatives; SDOT will complete a 100% inventory of street trees by EOY 2023.
Community Engagement	Strategies	Use community surveys to gather the public's priorities; Construct a centralized volunteer system with Forest Stewards as leaders.	Use existing citizen-based planning efforts, stakeholder interviews, public opinion surveys, and two community meetings to engage with the public; promote urban forest stewardship by working with nonprofits to foster civic involvement; Offer monthly Tree Talk workshops on various tree-related topics.	RSJI outlined key commitments, including intentional engagement with historically underrepresented communities before plan update drafting, reviewing, and valuing all feedback from those communities, transparency, and engaging the public in developing the plan.
	Equity Considerations	List developing new and creative strategies to equitably engage the city's diverse population as one of the Guide's goals.	Plan to incorporate demographics on race, language, and income from the 2020 Census and American Community Survey in future canopy mapping projects to analyze and address tree canopy distribution and environmental justice.	RSJI aims to end institutional racism in city government and achieves racial equity across the community; With the help of RSJI and the Equity and Environment Initiative, the city stated the determination to provide clean, healthy, resilient, and safe environments for all communities.
Administrative Capacity	Plan Updates	Every 3 years.	Every 5 years.	Every 5 years.
	City Departments	Parks and Recreation.	Public Works.	Numerous.
	Staff	1 FTE and 1.5 FTE.	5 FTE and AmeriCorps members.	Core Team composed of 9 FTE across departments.
	Budget	2023 Adopted: $363,000	2023 Adopted: $1,900,000	2023 Adopted: $1,500,000

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Chapter 5: Analyzing the Roots of Effective Urban Forestry Programs and Opportunities for Lakewood

The three main objectives that emerged in our case studies comprise the pillars or "roots" of effective urban forestry programs (UFP). This chapter analyzes how these roots apply to the City of Lakewood and provides implementation considerations based on the results from our literature review and case studies.

The discussion in this chapter informs our recommendations and the proposed implementation guide in Chapter 6, in the following structure:

1. We analyze Lakewood's currently available resources to start the program and the additional needs to fulfill the city's urban forestry objectives.
2. We discuss community engagement strategies from other cases and how they relate to Lakewood's context.
3. We evaluate implementation logistics for the program, especially around partnership opportunities and staffing, analyzing them with Lakewood's aspirations and available financial resources.

5.1 Resource Assessment

Throughout our case studies, interviews, and research we observed an important constant throughout all urban forestry examples and resources, which is that the first step for a successful UFP should always be a resource assessment of current tree canopy coverage and forest health. Issaquah, Vancouver, and Seattle all started their plans with a virtual Geographic Information System (GIS) canopy assessment that classified the land coverage types (i.e., grassland, forest, open water, etc.) and identified different management units of land. Each city used a different visualization data set, but every case utilized similar methods of identification and classification of land-use types (City of Issaquah & Forterra, 2020; City of Vancouver, 2007). As mentioned in Chapter 1 of this report, the City of Lakewood conducted a similar canopy analysis to update its Tree Code. This section summarizes the findings of this canopy analysis along with our own GIS analysis to inform our recommendations.

Our research also provided a clear next step after a GIS tree canopy analysis is performed, which is implementing an on-the-ground assessment of the land management units identified in the previous step. Due to the different city sizes in our case study, the ground assessments of each urban forestry plan were quite different. In this chapter, we analyzed these options to decide which path would be most beneficial for the City of Lakewood's program and examined different urban forestry tools to help with the assessment.

Assessment of Lakewood's Current Tree Canopy

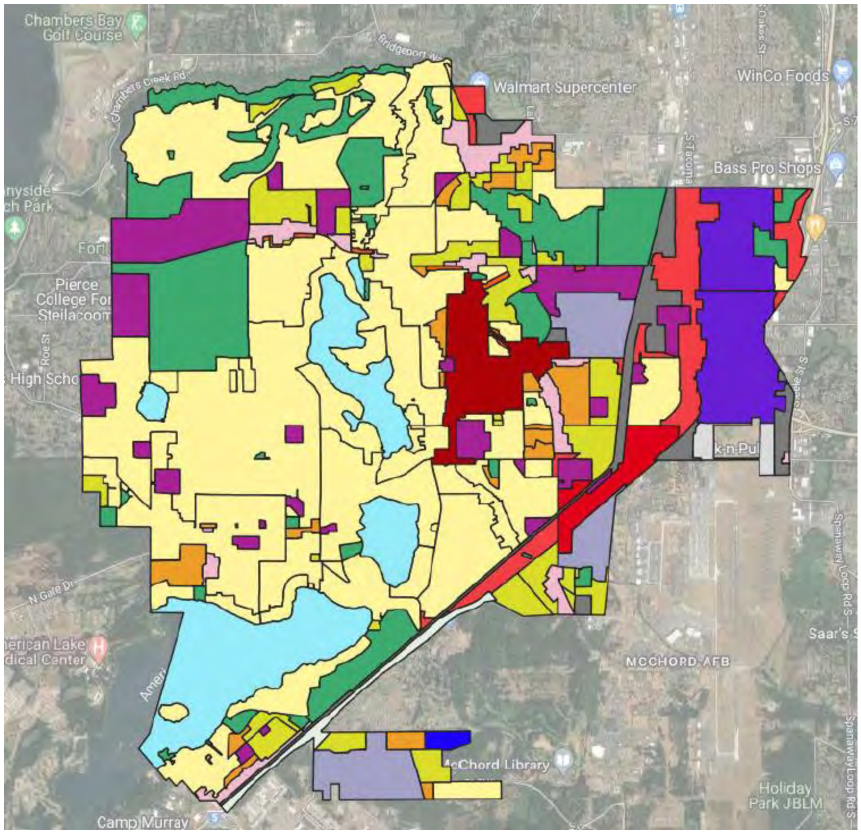
For the City of Lakewood to develop a UFP that fulfills its goals, any plan needs to be grounded in the most effective scientific management tools. Below we will outline the current assessment of Lakewood's tree canopy, which is the basis of our recommended actions outlined in Chapter 6.

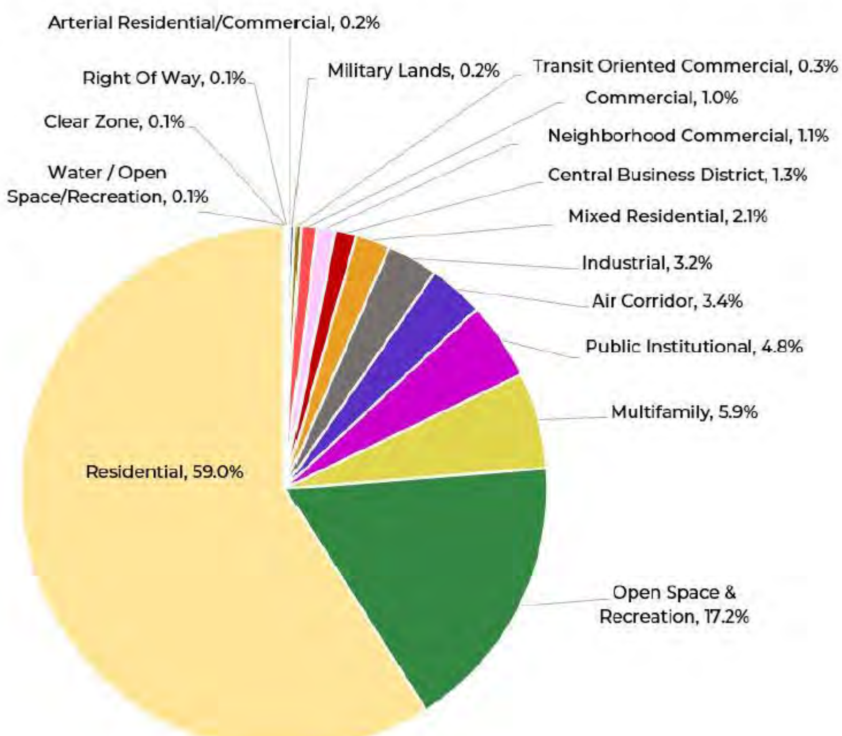
Canopy Assessment

Lakewood contracted PlanIT Geo to assess the city's current tree canopy during the city's tree code update in 2022. The assessment utilized GIS to review Lakewood's land and determined potential planting sites where the city could prioritize planting trees. The assessment involved analyzing the current urban tree canopy (UTC), types of land cover, zoning categories, equity considerations, and local plant species. Tree Equity Score, unemployment, demographic, zoning, and surface temperature data was used to help inform the equity considerations of each census block (PlanIT Geo, 2022). We contacted the foresters that performed the canopy analysis for Lakewood for more details about their analysis. They said they used Earth Define AI-driven data to perform the analysis which has a 60cm resolution. The data classifies the land into seven classes: tree canopy over impervious, shrub, other vegetation, impervious, bare soil, and water. No one variable was weighted more than the others during the assessment to determine which areas to prioritize planting. To see the details of each variable PlanIT Geo considered, the maps of this data are shown in Appendix C.

PlanIT Geo determined that the City of Lakewood's current citywide UTC is 26.3%. Of this total, 72% is on private land, and 28% is on public land. Approximately 28% of all private land has UTC cover, and approximately 22% of all public land has UTC cover. Figure 6 shows the specific breakdown of UTC by Zoning Category. PlanIT Geo's analysis outlines that there is a lot of work to be done on both public and private lands to develop a larger and healthier urban forest. This data serves as the foundation for conducting land health assessments, identifying areas in need of improvement or restoration, and developing cost-effective strategies. By understanding the existing canopy distribution, the UFP can prioritize resources and interventions to maximize the impact on the community's overall tree cover and associated benefits.

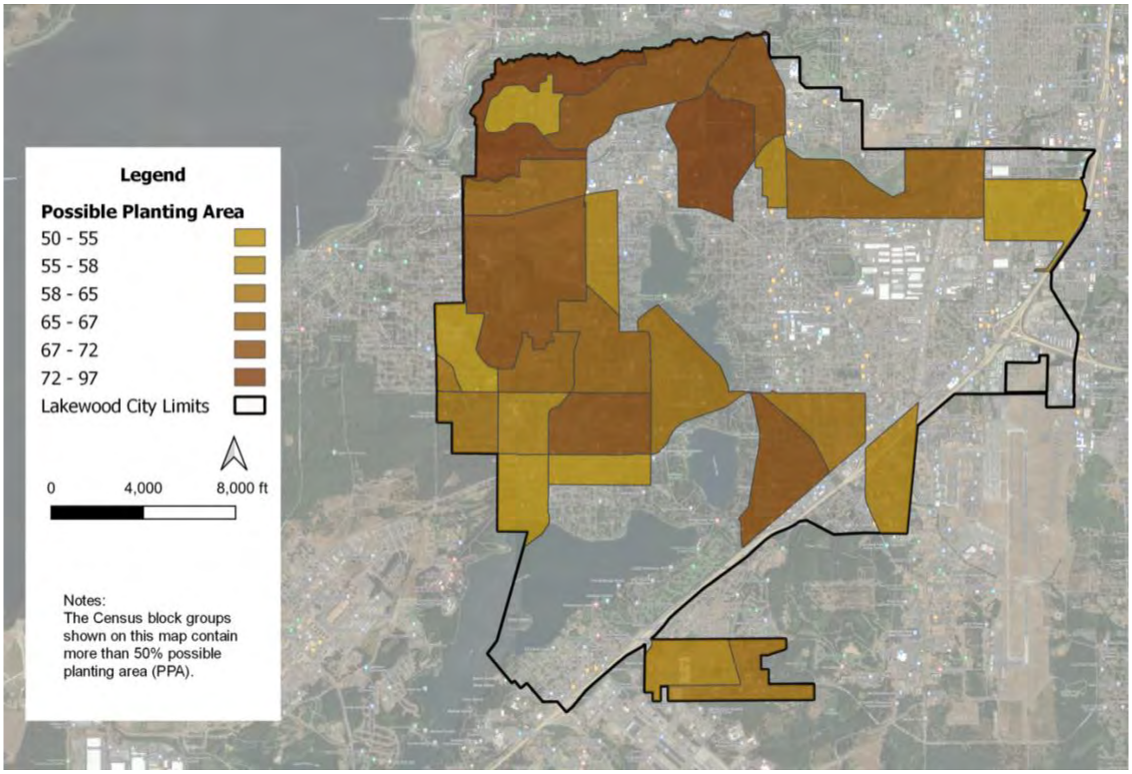
Figure 6: Visual Breakdown of Lakewood Urban Tree Canopy by Zoning Category (Peiffer et al., 2022)





PlanIT Geo also produced the map shown in Figure 7 which highlights census block groups with more than 50% possible planting area. This map identifies areas where trees can be feasibly planted, taking into consideration factors such as available space, location in parks, and other feasibility considerations. The darker shaded census blocks indicate areas with higher potential for increasing the tree canopy.

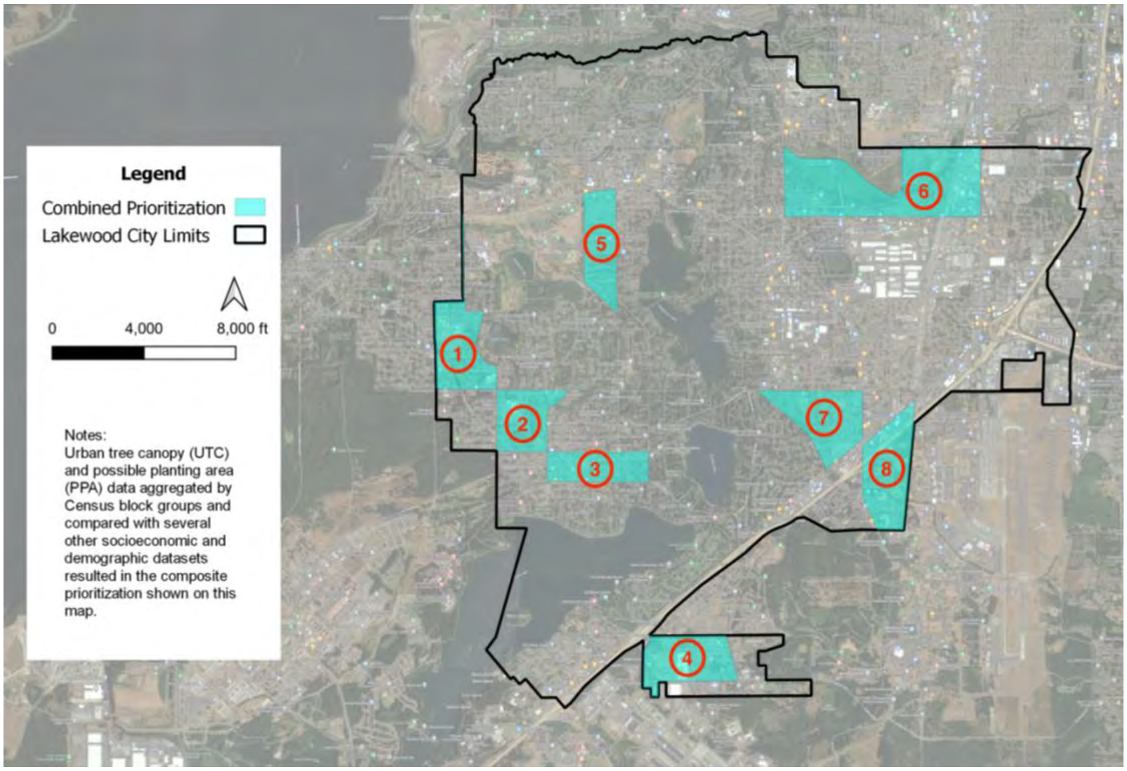
Figure 7: Possible Planting Areas of Census Block Groups (PlanIT Geo, 2022)



Using the available information on possible planting locations and the equity variables, PlanIT Geo created a map that identifies and prioritizes census block groups that would derive the most benefit from tree planting initiatives. Figure 8 presents the identified priority areas for tree planting and management in Lakewood. These areas, referred to as Management Units (MUs), are categorized into eight distinct zones for ease of identification and implementation.

To provide the City of Lakewood with a more specific recommendation on where to start a forest health assessment and thus urban forestry activities, we analyzed the eight MUs displayed in Figure 8 more closely. We wanted to consider the zoning of each MU to understand what areas were publicly owned land that the city would be able to manage directly. The zoning of each MU is shown in the maps in Appendix C. The MUs have various land uses, and most are mainly residential areas. We wanted to identify the MU that has the most open space, publicly owned land, and had the lowest Tree Equity Score according to National Explorer. Identifying where there is a lot of open space and publicly owned land will allow the city to start planting more quickly. While the city has a lot of potential areas to expand its tree canopy, we wanted to provide guidance on where the easiest, most cost-effective, and most equitable place might be to start the field assessment.

Figure 8: Planting Prioritization of Census Block Groups (PlanIT Geo, 2022)



Tools and Strategies

The Green Issaquah Partnership guide benefited from utilizing the forestry management procedures outlined in the Forest Landscape Assessment Tool (FLAT). Not only is this tool publicly available, but it is also relatively simple to implement with easy-to-understand results. The guide was developed by the City of Seattle and is implemented by all "Green Cities" in Forterra's Green City program. Seattle and Vancouver, on the other hand, are both doing more expensive assessments on top of or in place of FLAT. These assessments are conducted either by professionals like PlanIT Geo or by each city's hired staff. Because of FLAT's low cost and ease of use, Lakewood would easily be able to use this assessment tool without the added expenses associated with performing a full tree audit like the larger cities of our case studies. However, full tree audits could provide Lakewood with the most data on forest health, the number of trees, and possible planting areas. A thorough tree audit is also very time-consuming which goes against the city's goal of increasing the canopy quickly.

Table 8 shows the three phases of utilizing FLAT to obtain data on the city's forested land. Obtaining this data informs future management strategies (i.e., invasive species control, planting, and maintenance) by assessing the health of the forest and other ecological conditions (Ciecko et. al., 2016). Following the FLAT phases will allow for more informed ecological management decisions and lead to a stronger and longer-lasting UFP overall. Planting trees before assessing the health of an area could lead to trees not surviving due to invasive species overcrowding, poor soil health, or any number of other ecological issues. The FLAT tool guide provides simple yet thorough guidelines to follow when assessing the health of an urban forest that will be imperative to Lakewood's UFMP.

Table 8: Description of FLAT Phases (Ciecko et al., 2016)

FLAT Phase 1: Forest Cover Type Mapping	FLAT Phase 2: Field Assessment	FLAT Phase 3: Management Prioritization
Aerial imagery and boundary data are used in a lab or office to divide a project area into management units (MUs), the unit of observation and measurement for the assessment. Data attributes are also developed during Phase 1 based on local conditions and assessment purposes (e.g., species composition, size and age classes, invasive species, tree-canopy vigor, etc.).	A trained field team visits the project area to collect estimates of each attribute for each MU. Such teams may include professionals, technicians, and volunteers.	The data, which provide a snapshot of ecological conditions in the project area (within and across all MUs), can be used to classify or rank each MU. The assigned values can be viewed spatially to provide a mapped, visual representation of landscape conditions. These results can then be used to prioritize where on-the-ground management actions would most improve ecological function and health, contributing to long-term sustainability of a forest area.

5.2 Community Engagement

The following section presents a comprehensive analysis of the community engagement strategies from the case studies in Chapter 4. Aiming to provide Lakewood with a community engagement framework tailored to its unique context, the proposed strategies encompass a diverse array of approaches and activities, including hosting community meetings, launching public surveys, constructing a volunteer system, building a forest stewardship program, hosting workshops for private property owners, and collaborating with other organizations. Detailed implementation strategies are elaborated in Chapter 6.

Community Meetings

From the case studies we learned that hosting community meetings is one of the most common ways for cities to conduct outreach and engage with the community during the initial phases of their UFPs. The suggestions gathered during these meetings help cities adjust their UFP to better serve constituents. Issaquah, Vancouver, and Seattle all used similar strategies to raise awareness, gather public opinions, and garner political support when formulating their UFPs. The City of Vancouver used community meetings during the initial phases of developing its UFP in 2006 and 2007, while Issaquah marked the meetings as the main strategy to acquire goals and objectives for its Green Issaquah Partnership. Seattle, with its larger capacity, hosted community meetings in collaboration with the Department of Neighborhoods through the Community Liaisons program to engage with diverse communities. Therefore, it could be beneficial for the City of Lakewood to host community meetings as one of the first steps toward building a UFP that aims for achievable goals and public support.

Launch Public Surveys

Public surveys are another activity that cities commonly use to acquire comments and suggestions from the public for their UFPs, as cities sometimes are constrained by budgets to host in-person community meetings regularly. Public surveys are commonly conducted in the form of online surveys, which offer several advantages in terms of cost-effectiveness and convenience. By using online surveys, the city can provide an accessible platform for the public to submit their comments and feedback conveniently from their own devices. This eliminates the need for physical paper surveys and allows for a larger reach and participation from a wider range of individuals. Additionally, online surveys streamline the data collection process, making it easier for the city to compile and analyze the public's comments efficiently. However, online surveys do have the disadvantage of potentially reaching a limited audience. Typically, online surveys attract individuals who are already interested or engaged in the related topics or issues. This self-selection bias may result in a sample that is not fully representative of the entire population or community. Therefore, public surveys have the potential to exclude the viewpoints of individuals who are not actively engaged or interested in UFPs, despite their potential to provide valuable insights and contributions. For the City of Lakewood, public surveys can serve as valuable complementary tools to community meetings, allowing for a broader reach and gathering input from a diverse range of community members. Since the City Council has already recognized regular community-wide surveys as one of the 2021-2024 goals during its July 2022 study session, the city has the potential to incorporate questions regarding the UFP activities and priorities into existing regular surveys to save resources (City of Lakewood City Council, 2022). By combining these two strategies, the city can enhance the outreach process and gather more detailed and useful responses from a wider range of stakeholders.

Construct a Volunteer System

Experiences from other cities show that volunteers are essential for successful UFPs, as they provide an additional workforce apart from government staff, and can help plant trees, remove invasive species, and perform other activities to help meet UFP goals. In interviews with representatives from Issaquah, Vancouver, and Forterra, we learned that each city has devoted resources to constructing a central system to manage the volunteers. The implemented system enables the city to effectively track past volunteer efforts and strategically plan future work, providing a comprehensive overview of progress for each MU. This streamlined approach facilitates efficient UFP operation, allowing for improved coordination and monitoring of volunteer activities. Implementing a volunteer tracking system that captures individual volunteer contributions enables the city to recognize and reward exceptional volunteers. By acknowledging their efforts, providing rewards, and expressing appreciation, the program can inspire and motivate volunteers, fostering a culture of value and appreciation for their voluntary work. This approach encourages continued engagement and dedication among volunteers, contributing to the long-term success of the program. Given the benefits and advantages mentioned, it would be valuable for the City of Lakewood to allocate resources towards the development and implementation of a volunteering system that effectively manages and tracks the progress of volunteers' work

Build a Forest Stewardship Program

Issaquah established its Forest Stewardship Programs with the purpose of engaging individuals who are passionate about urban forests and interested in expanding their knowledge. These programs aim to identify and empower individuals who are willing to take on leadership roles, guiding and inspiring other volunteers to make positive changes and enhance the environment within their community. In addition to recruiting volunteers, Issaquah's Forest Stewardship Program also aimed to engage individuals who wanted to expand their knowledge of urban forests and develop their leadership abilities. Through a structured training process, these individuals became "Forest Stewards" who worked either independently or in small teams to organize and implement restoration projects in specific parks. They played a crucial role in leading volunteer events and closely collaborated with city staff (City of Issaquah & Forterra, 2020). Implementing a similar stewardship system in the City of Lakewood could be highly beneficial. It would not only provide more opportunities for community members to actively participate in tree planting and care initiatives but also allow the city to achieve the goals of its UFP in a cost-effective manner. By having Forest Stewards capable of leading volunteers and organizing events aligned with the UFP's objectives, the volunteer efforts would become valuable contributions to the city's UFP.

Host Workshops for Private Owners

Both Issaquah and Vancouver host activities like Tree Talk Workshops as one of their private landowner engagement strategies. These talks serve to involve private owners and educate them on how to better maintain private trees. The City of Lakewood could consider hosting similar activities, if feasible, to enhance its engagement with private landowners. Since the government does not have direct control over privately-owned trees, educating tree owners about the importance of specific tree species that contribute to the overall environmental well-being is key. By promoting the maintenance of trees that align with the city's goals outlined in the UFP, private landowners can play an integral role in supporting the city's broader goals and objectives.

Collaborate with Other Organizations

All of our case study cities have established partnerships with various organizations to help fulfill their UFP goals. Issaquah and Seattle partnered closely with Forterra, a nonprofit organization that works with cities to help evaluate the health and condition of their forests and develop a program to protect, enhance, and sustain those resources. Vancouver also partnered with various neighborhood organizations, both private and nonprofit, to help achieve its UFP goals. Partnerships with relevant organizations offer funding opportunities and access to field experts, which can enhance the implementation of Lakewood's UFP. Partnerships with potential organizations are a valuable option for the City of Lakewood to consider as a way of increasing its capacity to implement its UFP, especially since the initial resources for developing and implementing its UFP are limited. Appendix A presents a partnership guide that could support the exploration of potential partnerships to support the City of Lakewood’s urban forest.

Equity Considerations

The cities highlighted in Chapter 4 emphasized that equity considerations are key focal points for developing their future UFP goals. Specifically, all three cities committed to finding creative ways to incorporate demographics on race, language, and other neighborhood characteristics in order to equitably engage the city’s diverse populations and address environmental justice issues. The City of Seattle introduced the Race and Social Justice Initiative (RSJI) and the Equity and Environment Initiative to address and rectify environmental disparities and promote social justice within the city. All three cities also highlighted the importance of considering minorities during planning phases and community meetings to make sure low-income earners, people of color, immigrant communities, and senior citizens all have fair treatment and meaningful involvement in the development, implementation, and enforcement of environmental laws, regulations, and policies (City of Issaquah & Forterra, 2020; City of Seattle, 2020; City of Vancouver, 2021).

The City of Lakewood (2022) has already demonstrated a strong commitment to equity and inclusion by recently hiring a professional Diversity, Equity, and Inclusion (DEI) manager. This consultant will launch a training initiative for city personnel, aiming to enhance the related values across the departments. This training initiative will be a multi-year process that includes examining city processes and implementing DEI lenses consistently throughout projects, which provides opportunities to incorporate important values into the new UFP in a meaningful and impactful manner and result in a more harmonious and socially responsible urban forestry program that benefits the entire Lakewood community.

5.3 Administrative Capacity

City Departments

As outlined in Chapter 4, there are various organizational and administrative structures supporting each city's UFP, including differences in the city departments that are involved in administering the UFP. Vancouver and Seattle have advisory boards with members from the community to ensure oversight and prioritization of the city's urban forestry goals. Seattle's Urban Forestry Commission supports the city departments that carry out specific forest management tasks. The City of Seattle does not have a single agency identified as the sole authority for urban forestry throughout the city. Instead, there is an Urban Forestry Core Team, which is composed of City of Seattle employees across multiple departments. Establishing a commission or advisory board provides accountability and assists city departments with multiple responsibilities to allocate sufficient time for UFP implementation.

The Vancouver houses their urban forestry management within a single department, which is located within Public Works. Even so, the City of Vancouver prioritizes cross-department collaboration on the health and maintenance of trees throughout the city. Vancouver also has an Urban Forestry Commission that supports coordination in the city and ensures UFP prioritization. The city manages collaboration through frequent communication among departments, along with well-documented guidelines and requirements for tree maintenance. The Urban Forester is an ISA Certified Arborist and is able to provide guidance on trees throughout the city to all departments. In addition to the voluntary commission, Vancouver has a small team dedicated to the UFP that coordinates with city departments continuously, supporting logistics and holding volunteering events.

Finally, the City of Issaquah, whose UFP is a relatively new initiative, has a more insular management structure, with the majority of the UFP work taking place within its Parks Community Services Department.

During our interviews, many experts suggested that a single department should house the UFP, in contrast to the City of Seattle's cross-departmental Core Team. Housing the program under a single agency with a dedicated staff member, either a current city employee or a new hire, can ensure that the initiative takes priority in the city. Based on the current organizational structure of Lakewood, the city could consider housing a UFP under Parks, Recreation, and Community Services (PRCS) or Public Works Engineering because of the maintenance work that will be central to the UFP. The advantages of this approach are that those departments already do similar work to the one the UFP will require, so they will have the expertise and knowledgeable staff to implement the program at a lesser cost. The downside of this first option is that the PRCS and PWE departments have many other responsibilities within the city and have limited capacity to manage the UFP. The city could also consider a Core Team comprised of representatives from Community and Economic Development, PRCS, and Public Works. The advantage of that approach is that having more stakeholders within the city facilitates work distribution, ensuring neither department is overburdened by the program and the UFP is more sustainable. The downside of the approach is that with very diffuse responsibilities, the program would not be a priority for the departments that already have many priorities. This downside could be addressed by having a standalone advisory board and/or creating a position whose sole responsibility would be to coordinate program activities throughout the city and whose main priority will be ensuring each party is meeting its goals, as approved in the program plan. That position must be given authority to follow up with other departments to ensure the work is sustainable and no department is burdened with the coordination and logistics between departments. In light of the above, creating a new urban forestry advisory board to oversee the program at the city level, following Vancouver's and Seattle's examples, might be the best option for Lakewood, considering the city structure and capacity to take on a new UFP.

Staffing

Each of the three case study cities has a different staffing structure. The City of Seattle, which has the oldest and most established program, does not have UFP-specific staff. Instead, representatives from related departments comprise a Core Team that leads urban forestry initiatives in the city. In an interview with Vancouver's Urban Forester, we learned that the city has four full-time urban forestry staff members, including the urban forester. Vancouver also hosts AmeriCorps members who provide additional assistance on UFP activities. Issaquah's Parks and Community Services Director informed in an interview that over the last four years, an existing Parks and Community Services employee has coordinated UFP activities in Issaquah. Additionally, Issaquah will hire two dedicated staff members in 2023 – a full-time Urban Forest Supervisor and a part-time Volunteer Coordinator.

Lakewood could also consider hiring a full-time administrator in the first year who manages UFP activities and volunteer efforts, particularly if there is no capacity for a current staff member to take on this responsibility. Alternatively, Lakewood could consider a similar model to Issaquah's where existing employees, within the relevant city departments, administer the urban forestry program in the initial implementation period. The city could apply to become a host for AmeriCorps members, which could also support the program at a lower cost to the city. However, there is a rigorous application process, and this strategy would require a dedicated supervisor for any AmeriCorps members.

Budget

The projected 2023 expenditures for UFP activities in each city vary greatly across each city. In the initial years of a UFP, the largest expenditures to consider are staffing, resource assessments, and volunteer supplies. There are many funding sources that the case study cities used to fund UFP activities. We have outlined the four main sources below:

Reallocate Storm and Surface Water Utility Fee Revenue

Through our interviews, we learned that cities could allocate a portion of storm and surface water fees to urban forestry activities. There are equity implications associated with using city fees, which are regressive in nature, to fund urban forestry. Allocating a portion of fee revenue to urban forestry activities also means that the revenue will not be available for other stormwater management purposes. Nonetheless, it is crucial to recognize the long-term benefits that trees provide by reducing stormwater and surface water management costs. According to the U.S. Department of Agriculture Forest Service (2020), trees benefit city stormwater systems through rainfall "intensity reduction, stormwater infiltration and uptake, and nutrient load reduction" (p. 1). Therefore, urban forest activities can be a useful tool for managing storm and surface water systems and reducing management costs in the long term. Lakewood's updated tree ordinance currently references the benefits urban trees provide to storm and surface water management systems.

The City of Vancouver utilizes this fee to fund urban forestry staffing and activities. In 2023, 95% of the departmental budget, including four staff members, is estimated to be funded through this fee (City of Vancouver, 2022b). The City of Issaquah is using a portion of this fee to fund a full-time Urban Forest Supervisor starting in 2023 (City of Issaquah, 2022).

Surface and stormwater utility fees can be a consistent and stable revenue source for UFPs. The city would need to document how revenues were used and how those activities promote better storm and surface water systems.

City Tree Fund

Many cities, including Lakewood, have established Tree Funds that are funded through penalties and fees related to tree maintenance throughout the city. These funds can also be funded through donations. The City of Lakewood's tree ordinance outlines that the Tree Fund can be used for the following activities:

- acquiring, maintaining, and preserving wooded areas
- planting and maintaining trees
- establishment of a public nursery
- urban forestry education
- implementation of tree canopy monitoring program

Each of the activities outlined below are within the scope of a UFP and can be used to fund the implementation of a UFP.

General Fund Revenue

All three of our case study cities utilize a portion of General Fund Revenue for UFP activities. Lakewood could consider allocating a percentage of General Fund revenues to UFP activities, similar to the 1% that the city currently allocates to Human Services.

Government and Nonprofit Partnerships

There are many government and nonprofit grants and partnerships available to financially support urban forestry work within the City of Lakewood. We have provided a full list of public and nonprofit agencies for potential partnerships the city can consider in Appendix A.

The analysis discussed in this chapter is the foundation for the Urban Forestry Implementation Guide prepared for Lakewood. Chapter 6 is comprised of recommendations for the first five years of plan development and implementation.

Chapter 6: Urban Forestry Implementation Guide

Lakewood established a goal to increase its urban tree canopy from 26% in 2022 to 40% in 2050, which is an increase of 14 percentage points. This goal is driven by the city's conviction that trees offer numerous benefits to the community, including air pollution filtration, stormwater management, wildlife habitat, carbon sequestration, and overall improvement in community members' quality of life. This chapter provides a detailed Urban Forestry Implementation Guide to support the city's efforts to increase its canopy coverage and maintain its existing urban trees. The following pages cover vision, mission, goals, equity commitments, an analysis of the City of Lakewood's current canopy coverage, fieldwork steps, best practices, community engagement, monitoring and evaluation, and as well as available resources for initiating and sustaining the program.

The guide provides strategic recommendations and priorities for the first five years of the urban forestry program (UFP), utilizing the analysis of existing information on Lakewood's urban trees and public spaces. The four main recommendations are as follows:

- Recommendation 1: Develop a mission, vision, and goals for urban forestry in the City of Lakewood.
- Recommendation 2: Complete a comprehensive resource assessment and begin restoration practices in the city.
- Recommendation 3: Develop a comprehensive community engagement strategy.
- Recommendation 4: Create administrative capacity within the existing city organizational structure.

To ensure the successful implementation of these recommendations, it is essential to engage in detailed discussions with the Lakewood community. Additionally, it is advisable to involve an ISA Certified Arborist who can provide expert technical assistance and evaluate canopy recommendations.

RECOMMENDATION 1:
Develop a mission, vision, and goals for urban forestry in the City of Lakewood.

Mission and Vision Statements

Mission and vision statements guide program action and are important tools for an effective management strategy. We drafted mission and vision statements to support the City Council and all relevant departments in establishing the program. However, we recommend that these draft statements be revised and agreed on by the parties that will implement the program after consultation with the community.

Mission Statement:

> The City of Lakewood Urban Forestry Program is a multi-agency effort in which volunteers, residents, businesses, local organizations, and the City of Lakewood design and work together to transform, protect, and grow natural resources in the city.

Vision Statement:

> City of Lakewood creates a sustainable and healthy urban forest with adequate tree species for its local ecosystem that is protected by the city and its community enjoys the benefits of urban trees and recognizes their environmental and economic value.

Plan Goals and Outcomes

In addition to establishing mission and vision statements, setting specific goals and outcomes is crucial to guide the implementation of this guide effectively, particularly in the initial stages. The following goals are derived from the analysis of Lakewood's unique context, available resources, and best practices observed in other cities across Washington state. We have identified associated outcomes for each goal. To ensure the plan's success, Recommendation 4 provides detailed monitoring and evaluation actions aligned with these goals and outcomes. Furthermore, specific indicators have been developed to measure progress under each goal.

- **Forest health:** Improved urban forest health, appropriate tree planting, and invasive species control throughout the City of Lakewood's parks and urban areas:
  - Implement restoration practices in the prioritized Management Units (MU) in Lakewood through the end of year 5.
  - Identify and remove invasive plants from Lakewood's parks and forested urban areas.
  - Establish clear responsibilities in tree maintenance within the city structure and standardize maintenance practices, to ensure regular maintenance operations and canopy health.
- **Tree population expansion:** Increased canopy coverage within the city limits, including the City of Lakewood's parks and forested urban areas:
  - Grow the urban tree canopy (UTC) in the City of Lakewood by 40% by 2050.
  - Plant native trees and plants that are appropriate for the City of Lakewood's ecosystem.
  - Define priority management areas based on land, environmental, and equity considerations including, but not limited to land cover, zoning categories, local plant species, the Tree Equity Score, unemployment, demographics, and surface temperature data.
- **Community engagement:** Lakewood residents are regularly consulted to design and update the plan, and the community is actively engaged in the management and restoration of the city's urban forested areas:
  - Create a voluntary Urban Forestry Advisory Board as a space for community stewardship of the program. This outcome only applies if the city follows Options A or B in Recommendation 4.
  - Strengthen relationships with businesses, nonprofit organizations, schools, and other local allies to collaborate in efforts related to the urban forest.
  - Recruit volunteers and build community capacity for long-term engagement.
  - Survey the community regularly to maintain an updated understanding of their interests and needs, as well as the community's understanding of the city's plan and how to support it.
  - Engage community members in restoration and monitoring projects; and
  - Create comprehensive guidelines and communications to engage the community in the protection, restoration, and maintenance of trees on the right-of-way and private property.
- **Equitable access to urban forest benefits:** Community members across the city enjoy the benefits of a healthy and growing urban forest, independently of their area of residence, race, or socioeconomic conditions:
  - Prioritize tree planting in canopy-deficient areas to ensure equitable distribution of benefits to all residents.
  - Allocate financial and human resources recognizing economic and social equity.
  - Communicate and promote the benefits associated with urban forests on quality of life, including psychological, social, and economic benefits.
  - Develop communication strategies and tools to ensure accessibility for all, such as including subtitles for recorded meetings and translating relevant documents to languages other than English.

- **Sustainability:** Sustainable financial resources and operational capacity support the evolution of urban forestry in the City of Lakewood; tree canopy growth; forest health and an engaged community that enjoys the benefits of forested urban areas:
    - Dedicate financial resources to support the mission of urban forestry in the city.
    - Strengthen partnerships with nonprofits and business leaders in urban forestry development to collaborate in further developing this Urban Forestry Program and support plan revisions in the future.
    - Position the City of Lakewood as a model for urban forestry programs in Washington State.

RECOMMENDATION 2:

Complete a comprehensive resource assessment and begin restoration practices in the city.

This section outlines seven steps for how the city can begin implementing and prioritizing urban forestry activities throughout the city. The city should begin by conducting a tree assessment, using the results to control for invasive species and to establish maintenance priorities. It is important the city take steps to ensure the health of the current tree population prior to planting new trees, especially in the first five years of the program.

Field Step 1: Select Management Units and data attributes for a comprehensive Tree Assessment.

Before the city can begin planting trees and controlling invasives, it needs to complete FLAT Phase 1 of the FLAT assessment outlined in Chapter 5. While the UFP should ultimately conduct on-the-ground field assessments of the entirety of its urban forest, we recommend the city begin with assessments of the eight MUs identified in Chapter 5 (Figure 8).

Of the eight MUs identified, we conducted further analysis to determine which MU the city could begin assessing. The goal of our analysis was to identify which MU had substantial amounts of open space and publicly owned land, which also having a relatively low Tree Equity Score according to National Explorer. Prioritizing an MU with more publicly owned land will help the city focus efforts to public tree canopy and to reduce costs low by utilizing resources that are already available, such as parks maintenance staff. An MU with large amounts of open space will also reduce the costs associated with invasive species control due to the prior and ongoing maintenance on that land. We chose to include the Tree Equity Score in our analysis due to our recommended plan outcome of equitable access to urban forest benefits.

We identified MU 6 as having the most public land and MU 4 as the area with the lowest Tree Equity Score (American Forests, 2023). MU 4 has a Tree Equity Score of 45 out of 100, while MU 6 has a score of 78 (American Forests, 2021b). While MU 6 has a much higher Tree Equity Score than MU four, the census block just south of it has the same score as MU 6 at 45 (American Forests, 2023). Due to its proximity to a low equity score census block and its abundance of public land, MU 6 would give the city the most opportunity of canopy growth while also addressing equity issues. MU 6 is also the largest census block, which provides Lakewood with options on where to start the tree health assessment.

The city should select relevant data attributes before beginning the assessment. These data attributes are the different ecological and local assessment qualities that the city can prioritize. The attributes can be species composition, size and age of species, invasive species, etc. Table 9 shows examples of data attributes that are relevant to the city’s goals and that are commonly used in assessments of this nature. We recommend that the city work in tandem with a professional urban forester to develop a comprehensive list of data attributes. The city should develop a site identification system that the city can easily track and can be understood by city staff and volunteers. For a full list of potential data attributes, please see the FLAT guide (Ciecko et. al., 2016).

Table 9: Examples of Data Attributes for FLAT Assessment

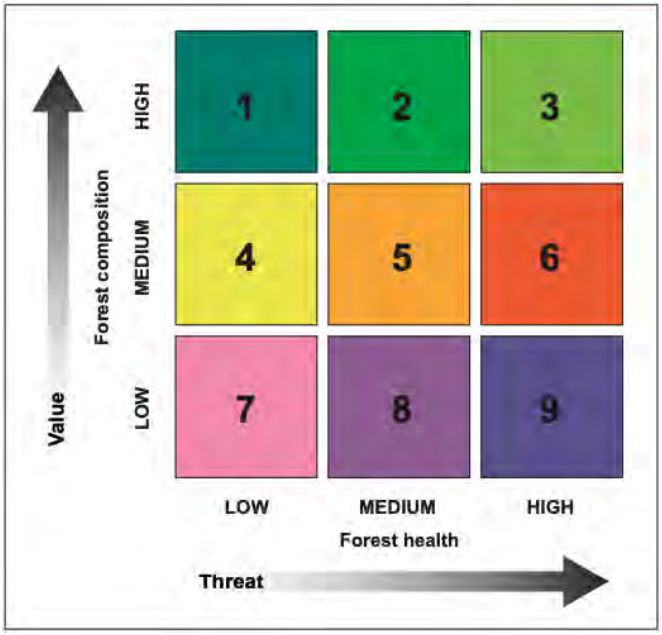
Data Attribute	Detail
Site Identification	Name or management number, some way to identify the site and its data
Date	When progress assessments are made it will be important to have a baseline
Land Cover Type	Identification based on the classifications determined from the tree code review: Grass/Open Space, Bare Soil, Impervious, Tree Canopy, Shrubs
Tree Species Composition	Document what trees are where to know what natives are common and how to promote biodiversity
Age Class	Lakewood is having issues with Gary Oaks aging so documenting the relative age of trees would be relevant for each MU's assessment
Stocking	Crown closure estimate as viewed directly above
Shrub Species Composition	Grassland and shrubland are a large percentage of Lakewood's open spaces
Invasive Density/Composition	Understanding the breadth and depth of invasive invasion of MUs will be very relevant for management strategies
Soil Health	This could include root rot, bare soil, dryness, or other relevant details

Field Step 2: Tree-iage Assessment.

Both Seattle and Issaquah used the Tree-age Assessment model in developing their implementation plans. While Seattle is currently conducting a full tree audit, the FLAT assessment was originally developed in partnership with the City of Seattle. Since the tool was designed in the Pacific Northwest, it provides relevant resources for communities with similar ecosystems, which makes it a good tool for the City of Lakewood. After the relevant data attributes are selected in Field Step 1, the next step for the city is to continue the tree assessment by implementing FLAT Phase 2. This involves a field assessment of MUs by trained staff or volunteers to get an overview of the ecological health of the MU. The field assessment will involve assessing each MU based on each data attribute.

The ecological health rating will then be assessed on the Tree-iage Matrix and each MU will be assigned a tree-iage category or a priority rating from the matrix. The Tree-iage Matrix can be seen in Figure 9.

Figure 9: Tree-iage Matrix (Ciecko et. al., 2016)



As shown in Figure 9, tree-iage categories range from 1 to 9. The Green Issaquah Partnership implementation guide describes the rating system as follows,

> A rating of 1 represents high-quality habitat and low invasive-species threat, and 9 represents low-quality habitat and high invasive-species threat. An MU that appears in tree-iage category 3 scored high for habitat value and high for invasive cover threat. MUs scoring low for habitat value and medium for invasive cover threat were assigned to category 8 based on the tree-iage model. (City of Issaquah and Forterra, 2020, p. 32).

Since there are limited values to represent forest health and composition, the ratings can be subjective based on who is performing the assessment. Because of this subjectivity and because of how vital forest health is to this program, we recommend the City of Lakewood hire a professional urban forester to perform this audit. This will ensure consistency and accuracy throughout the assessment.

After this broad overview assessment of each MU is recorded, then the city, in consultation with an urban forester, will determine what maintenance and restoration each MU requires. Some areas will have higher invasive threats that will require more work initial. However, some MUs will likely have lower invasive threats and can instead be early planting areas. To easily understand where Lakewood's MUs fall within each health category, the assessment should be organized by individual acre. The city can also use this organization to estimate total maintenance needed across all UTC acres.

We recommend that the City of Lakewood begin with MU 6 from Figure 8 in Chapter 5. Since this management unit is primarily publicly owned land, there will be less of a barrier for the city to start its assessment and implement FLAT. This MU is also near a census block with a low Tree Equity score, so starting the assessment there will help reduce the negative effects of a small tree canopy. MU six is also the largest MU at about 465 acres, which we recommend be broken up into smaller sub-management units.

The tree-iage method is explained in greater detail in the FLAT guide (Ciecko et. al., 2016).

Field Step 3: Identify and prioritize work in MUs.

Once the city has completed the field assessment of the MUs, the next step is FLAT Phase 3, which is management prioritization. The city should identify areas of priority based on the tree-iage method outlined in Field Step 2. Based on the identified MUs, the city should design annual and multi-year restoration plans for the high priority MUs. Comprehensive restoration and maintenance schedules ensure that sites do not revert to pre-work condition, which can cost additional resources and cause the public to lose faith in the project.

As new sites are identified for restoration, the tree-iage model can help establish the level of priority and work necessary. For example, MUs falling into tree-iage category 1, which signifies a "high-quality" habitat with little to no invasive plants, will immediately be eligible for restoration and routine monitoring and maintenance. Other high-value habitats, falling into tree-iage categories 2 and 3, will be considered high-priorities for protection and restoration. As the city prioritizes work, it should consider additional factors (i.e., public access and safety or proximity to wetlands, streams, and shorelines). If there are existing agreements with other entities to manage specific areas, such as utility corridors, the entities will still maintain responsibility for providing maintenance as previously agreed upon.

Field Step 4: Continue maintenance in parks and natural areas.

The City of Lakewood currently invests significant time and resources in the maintenance of local parks and natural areas. This ongoing maintenance should continue as the city determines other areas of prioritization. The city should prioritize specific areas within parks and natural areas to focus additional maintenance based on the comprehensive assessment recommended in Field Step 2, areas of importance as defined by the Lakewood community members, and available resources.

Field Step 5: Identify areas appropriate for professional crew intervention.

In this guide, we emphasize the need for volunteers for UFP maintenance and planting. However, not all projects are suitable for volunteers. The city should determine which sites are not suitable for volunteers and should utilize city staff and contract services to carry out maintenance and restoration in those sites.

Field Step 6: Implement restoration best practices on all project sites.

The *Four-Phase Approach* to restoration field work is an important best management practice (BMP) that was developed by Seattle Parks and first outlined in the Green Seattle Partnership (City of Seattle, 2007). As outlined in our literature review and Chapter 5, restoration and adaptive management are essential to the long-term health of existing and newly planted trees. Figure 10 illustrates the potential progression of forested parklands and urban forests over 100 years with and without regular restoration and maintenance.

Restoration activities fall into four main phases:

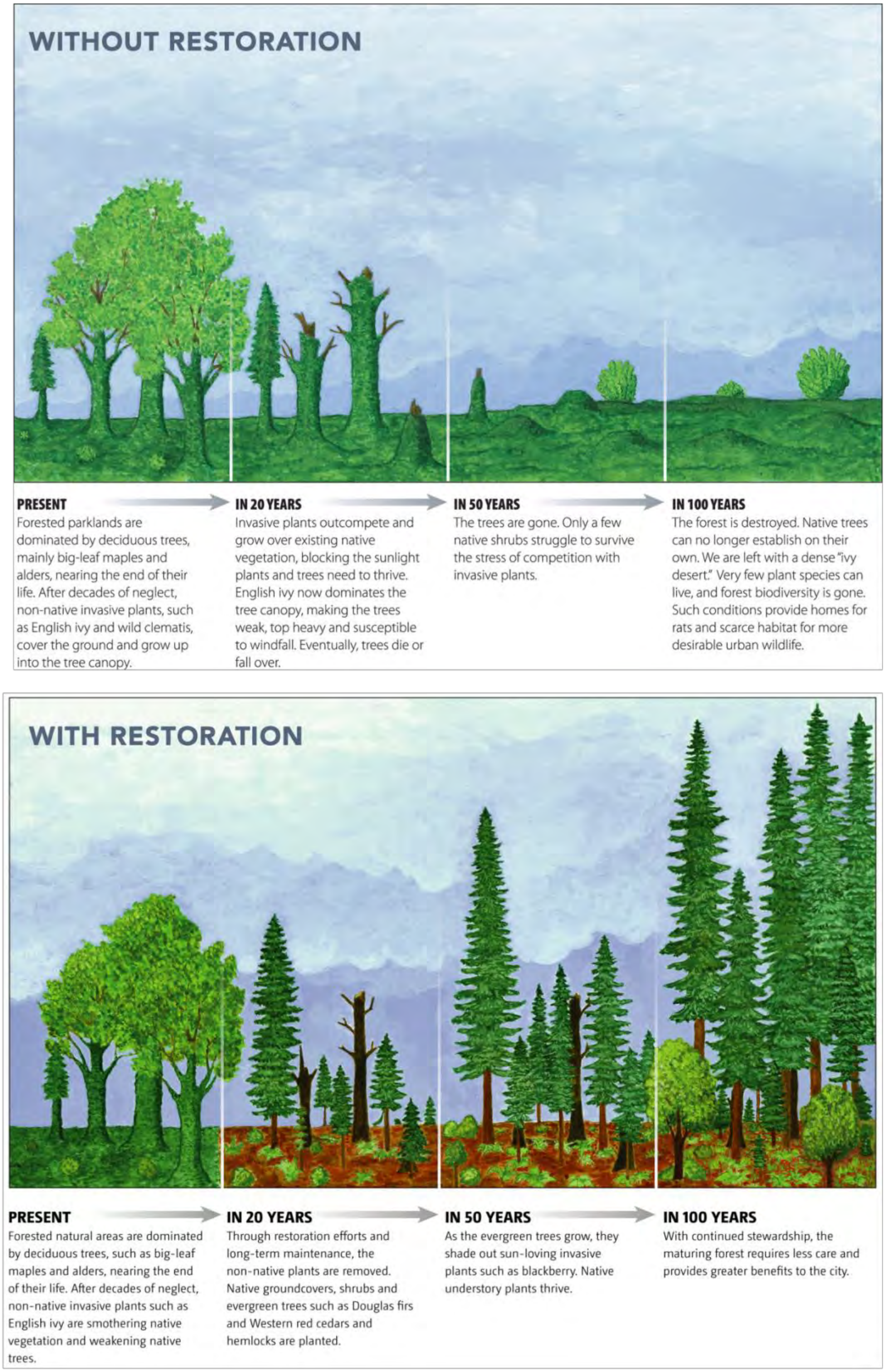
Restoration Phase 1: Invasive Plant Removal

Restoration Phase 2: Secondary Invasive Removal and Planting

Restoration Phase 3: Plant Establishment and Follow-Up Maintenance

Restoration Phase 4: Long-Term Stewardship and Monitoring

Figure 10: Illustration of Urban Forest Progression with and without Restoration Practices (Provided by Green City Partnerships, Forterra (2023))



The Four-Phase Approach to fieldwork has been adapted from the Green Seattle Partnership and the Green Issaquah Partnership for the City of Lakewood. Moving through each of these phases may take several years. These restoration phases should be used on MUs that have been identified through a comprehensive resource assessment. All work should be thoroughly documented to track, measure, and report progress.

MUs that have been determined to fall under tree-iage category 9, which indicates high invasive cover and low-value canopy, may spend long periods in the first three phases outlined below before moving into Restoration Phase 4. Comparatively, MUs that fall into tree-iage category 1, indicating high-value canopy and low invasive cover, may require very little time in the first three phases and may move rapidly into Restoration Phase 4. The city should complete an assessment of each site before work begins in the appropriate phase.

Restoration Phase 1: Invasive Plant Removal

The goal of the first aim is to clear the site of invasive plants. According to the Pacific Northwest Invasive Plant Council (n.d.), invasive plants negatively impact native plants, wildlife, and entire ecosystems. The impacts of invasive plants are widespread and far-reaching. When invasive plants are present, they degrade soil, which can lead to erosion and can ultimately negatively impact water quality. Invasive plants can also put endangered plant species at further risk, which leads to lower biodiversity (Pacific Northwest Invasive Plant Council, n.d.).

The city should focus on specific tree-iage areas within each MU. This helps ensure that invasive plants are thoroughly cleared, which can minimize potential regrowth. Removal techniques vary based on habitat and species. Please see Appendix E for a list of invasives common in the areas, including removal techniques, and see Appendix G for a list of native plants as a reference when identifying native vs. invasive. Initial removal may take more than one year to complete.

MUs with 50% or greater invasive cover are classified as “high threat from invasive species” and fall into tree-iage categories 3, 6, and 9. These sites will require major invasive-plant reduction, which will likely require skilled crews and special equipment. They may also require a significant investment of both funding and volunteers. Due to the high investment necessary to clear sites of invasive plants, the city should prioritize ongoing monitoring and maintenance to ensure significant removal is not necessary again in the future.

MUs with invasive cover between 5% and 50% are classified as “medium threat from invasive species” and fall into tree-iage categories 2, 5, and 8. These sites will also require invasive removal. However, growth in these areas is likely to be sporadic and less severe, which makes it more appropriate for volunteers.

MUs with 5% invasive cover or less are classified as “low threat from invasive species” and fall into tree-iage categories 1, 4, and 7. These sites need little to no invasive plant removal. Restoration Phase 1 work in these sites could involve walking around the site to visually check that invasives are caught before the problem can escalate.

Restoration Phase 2: Secondary Invasive Removal and Planting

After Restoration Phase 1 is complete and a planting site is identified, an additional round of invasive plant removal should take place. This additional round of removal targets any potential invasive plant regrowth, and it prepares the site for young native plants.

Planting should primarily take place in the fall, although certain planting could continue through March (Llewellyn, 2022). The city should work with a certified arborist to develop appropriate plant palettes and work plans for each planting site. Please see Appendix F for a list of trees that can be used as a guide in work plan development, including ideal habitat, soil, and shade conditions. The city can also refer to a recent publication on climate resilience in the area, which provides information on selecting trees specifically based on current and future climate impacts (Raymond et al., 2022).

Restoration Phase 3: Plant Establishment and Follow-Up Maintenance

This phase repeats invasive plant removal and requires continued maintenance and care for newly established plants. While native plants have adapted to the Puget Sound's drier summer climate, newly installed plants may experience transplant shock. This can impact root and shoot health. As a result, many plants require up to five years of care centered around establishment to ensure survival. Depending on site conditions, MUs may stay in Restoration Phase 3 for many years.

Restoration Phase 4: Long-Term Stewardship and Monitoring

The final phase in this approach is long-term site stewardship, which includes monitoring sites to provide information for ongoing maintenance. Many monitoring activities, such as walking parks trails and other MUs to find invasive species, can be completed by volunteers. Properly trained volunteers may also complete regular documentation of sites by measuring growth and noting site characteristics and plant survival rates.

Maintenance activities will vary based on site location and habitat. However, it will typically involve spot removal of invasive plant regrowth and periodic planting where needed. Many maintenance activities can be completed by individual volunteers or volunteer groups. It is essential that maintenance is properly planned and executed to ensure that any problems do not escalate, which could cause the site to return to Restoration Phase 1, costing significant financial and time investments.

The goal of this four-phased approach is that, in time, all MUs will be enrolled in the restoration process and graduate to Restoration Phase 4. To support the whole health of the city's urban forest, it is important that a comprehensive assessment and thorough preliminary field work take place before extensive planting begins.

Field Step 7: Develop a private land strategy to increase community involvement and support.

As previously mentioned, 72% of Lakewood's UTC is on privately held land, meaning that the majority of the city's tree canopy is outside the jurisdiction of the city. As such, large portions of the priority MUs outlined in Chapter 5 are privately held. Based on this, the city should develop a private land strategy to increase and restore UTC on private land. The community engagement process outlined later in this chapter will provide a foundation for engaging the community. However, the city can implement the following initiatives to actively engage the public in restoration and planting efforts on their own land.

Yard Tree Giveaways

Many surrounding cities, including the City of Tacoma and the City of Seattle, hold tree giveaways one or two times each year. Some cities also provide a bag of mulch and comprehensive care instructions for each tree. Lakewood community organizations, such as the Lakewood Chamber of Commerce, hosted tree giveaways in the past. Lakewood should hold regular tree giveaways for residents. The city should either hold a separate giveaway or partner with the Chamber of Commerce to increase participation and impact. This initiative removes the barrier of choosing and purchasing a tree for residents, which can be particularly important for low-income residents. Lakewood should consider providing transport and planting trees for residents with limited mobility. The City of Lakewood Tree Fund, which is funded through tree preservation efforts, could be a revenue source for this service.

Create Mechanisms to Reduce Tree Purchasing Costs

Similar to tree giveaways, offering a tree rebate to community who purchase trees for private property encourages tree planting in the city. The City of Vancouver, WA offers residents a 50% rebate, up to $50, for up to five trees through their "Treefund" program. Offering reimbursements of this nature can significantly decrease the cost of planting a tree for residents, encouraging residents to plant more trees.

Provide Tree Maintenance for New Private Trees

The city should focus on private land in low-income neighborhoods, which are often disproportionately impacted by high surface temperatures. One way to increase privately planted trees in these communities is for the city to offer to plant trees in these neighborhoods and to provide ongoing maintenance every five years. This initiative would be a considerable undertaking for the city and should only be implemented once a UFP is established and public trees are being regularly maintained.

Develop and Communicate Comprehensive Right-of-Way or "Street Tree" Guidelines

Currently, communication to the Lakewood public surrounding Right-of Way (ROW) planting, maintenance, and removal is imprecise and difficult for the public to find. The city provides guidelines around protected trees, but there is no clear general guidance on street trees. This lack of communication around street trees poses many issues for the city and its residents. For example, if a street tree is planted too close to a street or a stop sign, it may ultimately need to be removed due to visibility issues. If a tree that is too tall at maturity is planted in the ROW, it may impact electricity lines or their maintenance, which could ultimately lead to the tree's removal. To mitigate these issues, the city should develop a webpage that includes comprehensive education and guidance on street trees. This webpage should include recommendations on the types and sizes of trees that can be planted, tree care, planting and spacing, and maintenance. The city should also provide visual guides to residents on ROW planting. An example guide, created and used by the City of Tacoma, can be found in Appendix D.

As part of developing and communicating these guidelines, the city should consider implementing a permit system for the planting of ROW trees to ensure that all requirements are met. Many cities in the surrounding area, including the City of Tacoma, require permits for planting ROW trees to help mitigate issues related to improper planting.

To see examples of comprehensive ROW and Street Tree webpages, including permitting information, Lakewood can refer to the City of Tacoma, WA urban forestry and planting in the ROW websites (City of Tacoma, n.d.). The City of Vancouver, WA also provides comprehensive resources on its tree permitting website that Lakewood should consider providing to its residents (City of Vancouver, n.d.).

Community Education

The city should provide or source educational opportunities where residents can learn about the benefits of increasing city tree canopy on private land. While the city may not have the capacity to house these sessions in the initial phases of this program, there are many government and nonprofit resources available. For a list of potential partnerships, please see Appendix A.

RECOMMENDATION 3:

Develop a comprehensive community engagement strategy.

It is essential to develop a UFP that aligns with the interests and needs of the Lakewood community, as a successful UFP depends heavily on robust support and active participation from community members. It is also necessary to consider accessibility and representation for the diverse community in the City of Lakewood when designing and implementing a UFP to ensure equity and inclusivity. Therefore, in this section, we outline two main community engagement strategies, including several activities for effectively gathering and applying community perspectives in UFP implementation. The two main strategies we outline are conducting community outreach and constructing a volunteer system.

We used previous studies on Lakewood's community engagement, as mentioned in Chapter 3, as well as existing engagement and outreach strategies mentioned in Chapter 4 to inform our recommendations.

The community engagement strategies included in this recommendation are independent of the city's administrative approach to managing the UFP. Having a standalone advisory board, as discussed in Recommendation 4, does not take away the need or relevance of the community engagement strategies included in this section.

Community Outreach

We outlined the importance of community outreach in UFP development and implementation in Chapter 5. The activities we recommend the city consider include hosting community outreach meetings, launching public surveys, hosting workshops for property owners, and reaching out to existing and prospective organizations.

Host Community Outreach Meetings

First, we recommend that the City of Lakewood hold community meetings. These meetings serve as a direct line of communication where the city can both communicate the purpose and benefits of the UFP while also receiving community feedback on necessary changes and considerations for the UFP (City of Issaquah & Forterra, 2020; City of Vancouver, 2007). Based on the approach that Issaquah and Vancouver used, we recommend a specific sequence for the city to conduct its outreach meetings to make these meetings effective.

The city should first identify and meet with community leaders, including those who represent minority and historically underrepresented groups, such as Black, Indigenous, and People of Color (BIPOC) communities that are often disproportionately affected by environmental and urban planning decisions. Communicating with these community leaders early in the process can help to ensure that BIPOC voices are represented and heard in the formulation of the UFP. The outline of the meeting should include the following topics:

- the danger of climate change and how it might affect residents in Lakewood individually
- the importance of urban forestry
- plans to incorporate residents in the urban forestry program
- strategies to communicate UFP information to the public

We recommend the city conduct this meeting as soon as possible to prepare for the subsequent community outreach steps. The city's Diversity, Equity, and Inclusion (DEI) manager mentioned in Chapter 5 can host this meeting to publicly acknowledge the importance of considering minority communities in the UFP development and maintaining communication with leaders of these communities.

Next, we recommend that the city host several town hall community meetings, conveying the importance of urban forests, sharing the goals and progress of the UFP, as well as announcing volunteer opportunities. The City of Vancouver conducted two similar community meetings to gather suggestions in October 2006 and February 2007, prior to the release of its 2007 UFP. Through these meetings, the City of Vancouver was able to explain the program and answer any questions from the public.

In addition to in-person town hall meetings, we recommend that the city also offer a virtual attendance option, allowing individuals with limited mobility or those who face transportation challenges to actively participate in the decision-making process and contribute to a more equitable UFP. The city currently offers virtual attendance for other public meetings, such as City Council and Commissions and Advisory Board meetings. Offering an online option can also allow the city to record these meetings, making them available for later viewing to guarantee that the information is accessible to those who are unable to attend in real time. Furthermore, we recommend the city equip the recording with subtitles to address the needs of English as a Second Language (ESL) speakers, eliminate language barriers, promote an inclusive environment, and foster a sense of belonging among diverse community members.

To ensure that ESL and BIPOC communities have adequate opportunities to provide suggestions on the UFP, the city should host some of its outreach meetings in relevant city districts (e.g., the International District, Springbrook, etc.), as well as in community centers for BIPOC populations. The city could also explore collaboration opportunities with local cultural community-based organizations (CBOs) and faith-based organizations, further demonstrating the city's commitment to creating an equitable UFP and that incorporates community voices.

The city can also increase diverse participation from the community by utilizing local media and official urban forestry websites to promote community meetings. The City of Vancouver has utilized its website and local news media to spread the word about its UFP and to encourage community participation (City of Vancouver & PlanIT Geo, 2023).

The city should hold community meetings biannually. Spacing meetings out in this way will allow the city to parse through and incorporate relevant community feedback between meetings while also keeping the city informed periodically. The City of Vancouver hosted two public meetings with an interval of approximately 6 months during its UFP's initial development phase (City of Vancouver, 2007). We expect the first meeting to be more time-consuming, as it will likely take considerable time to communicate the initial information for the UFP. As the public's familiarity with the topic increases, future meetings will only include briefing UFP progress for the past six months, goals for the next six months, and answering any questions. The time the city chooses for these meetings should be widely accessible, such as evenings or weekends. This will allow individuals who work during the day or those with other daytime commitments to still engage in the meetings.

Community meetings will not only support transparency but also ensure that no interested parties are excluded from the conversation, maximizing the possibility of acquiring constructive feedback.

Launch Public Surveys

Coinciding with community meetings, we recommend the city launch public surveys to gather community feedback on UFP priorities and activities. This activity is implemented by the case study cities and is outlined in Chapter 4. The city should also use surveys to gather community insight on ROW trees. Currently, many ROW trees are unclaimed and therefore not receiving ongoing maintenance. Through surveys, the city can learn about property owners' opinions on the ROW trees and develop relevant policy and communication.

Host Workshops to Educate Property Owners on Tree-Related Topics

We recommend the city host workshops for property owners on maintaining and preserving private trees. This activity should be implemented once the city has established a UFP and has capacity to perform additional community outreach activities. Since private land UTC goals can only be satisfied by private property owners, it is essential to educate community members on tree preservation and maintenance. These workshops also offer opportunities to update and remind community members on the regulations outlined in the city's tree ordinance, including permit requirements and relevant fines. The frequency of these activities depends on the city's capacity and private landowner availability, which can be determined using previous community meetings or online surveys.

Conduct Outreach to Potential Community Partners

Building and maintaining community partnerships can support the implementation and success of the UFP (City of Vancouver, 2007). Therefore, we recommend the City of Lakewood prioritize outreach to organizations that can help promote or execute UFP activities. The city can begin outreach by determining opportunities to support UFP activities within existing city partnerships with area nonprofits, private businesses, and schools. The city can then use a snowball method to expand its connections to other organizations. Ideally, a good partnership base represents a collaborative effort across all three sectors: public, nonprofit, and private. The public sector includes the city's administrative staff, volunteers, and schools, while the private sector can include contractors, consultants, local business partners, and property owners.

Construct a Volunteer System

As mentioned in Chapter 5, volunteers are crucial in helping Lakewood accomplish its goals in UFP. Volunteers also need to be carefully guided to conduct UFP activities. Therefore, we recommend the City of Lakewood establish a volunteering system to effectively recruit and manage volunteers. This system includes a stewardship system, volunteers, and a volunteer coordinator.

Build a Forest Stewardship Program

As mentioned in Chapter 5, we recommend that the City of Lakewood construct a Forest Stewardship Program, similar to that of the City of Issaquah, to guide volunteer activities.

The city should begin by recruiting Forest Stewards as part of the town hall meetings described in the previous section. The city should call for community members who are interested in learning more about tree protection, tree health, invasive species, etc., and who want to become leaders in this field. The city should then interview interested community members to determine if they would be a good fit for the program and as leaders of other volunteers. Selected community members will become Forest Stewards once they have completed training from city staff. The training should cover tree maintenance, invasive removal, and planting guidelines.

Similar to the City of Issaquah, we recommend Lakewood begin by recruiting 10 Forest Stewards to determine if this system is appropriate for the community. Once Forest Stewards demonstrate proficiency in restoration practices and volunteer management, the city should allocate one to two acres of MUs for each steward to manage. Initial allocation for each steward should not exceed three acres total to ensure stewards are able to manage their allocation. The city should begin recruiting 5 additional stewards annually starting in Year 3 to expand program acre coverage.

Recruit Passionate Volunteers

It is essential for the city to develop a volunteer base that is passionate about preserving the city's environment and who believe in the numerous benefits of urban forests. We recommend the city recruit 10 volunteers per Forest Steward starting in Year 2. However, this criterion can be modified depending on Forest Steward capacity and the total number of volunteers available. These volunteer teams, led by Forest Stewards, can restore and enhance the city's urban forest. This system also allows the city to leverage the program's financial resources and allows more areas in Lakewood to be actively maintained and restored (City of Issaquah & Forterra, 2020).

Volunteer recruitment should be included as part of the city's UFP community outreach meetings. The city could also use an urban forestry webpage and the city's social media to promote volunteer opportunities.

The city can also collaborate with local organizations to maximize volunteer recruitment efforts. The City of Lakewood has many respected community organizations, such as the Rotary Club and the Kiwanis Club, that are already actively engaged in facilitating community events and activities, such as hosting community gardens. We recommend the city research potential collaborations with these organizations to identify and recruit prospective volunteers. Community members that participate in community events or leadership are already demonstrating a commitment to improve and support the City of Lakewood. Therefore, the city has an opportunity to engage these dedicated community members in UFP activities.

Volunteers will be assigned to work under Forest Stewards, based on the Forest Steward acre allocation and the volunteers' work location preferences. Forest Stewards and their volunteer teams will begin with invasive controls in their designated areas. This maintenance work will keep the existing tree canopy healthy and ensure Lakewood's canopy coverage does not decline. To motivate Forest Stewards and volunteers, city staff should hold regular meetings, praising volunteer work, progress, and contributions to a healthier environment for the people of Lakewood.

Appoint a Volunteer Coordinator

We recommend the city appoint a volunteer coordinator to manage the communication between city staff and volunteers. The duties of this volunteer coordinator include ongoing volunteer recruitment, organizing and tracking volunteer progress, recognizing volunteer efforts through awards, and making necessary changes to the Forest Steward goals as they relate to the UFP. The coordinator should also be responsible for implementing a volunteer management software to track volunteer events and activities. The position of volunteer coordinator can be filled by the existing Neighborhood Coordinator position, which is outlined in Budget 1, or by the Full-Time Program Administrator, which is outlined in Budget 2.

RECOMMENDATION 4:
Create administrative capacity within the existing city organizational structure.

Organizational Structure

As has been discussed in Chapters 4 and 5, creating a sustainable administrative structure for the UFP is essential to its success. We identified three organizational structures Lakewood could implement to manage the UFP.

Option A: Establish a standalone advisory board to oversee the UFP

The city should create a new Urban Forestry Advisory Board (UFAB) that will follow the city's current bylaws regarding volunteer boards. For this option, we recommend that UFP activities are distributed among the city's the Parks, Recreation and Community Services Department (PRCS), the Community and Economic Development Department (CED), and the Public Works Engineering Department (PWE). Existing staff within those departments will dedicate time to carrying out UFP activities. Urban forestry priorities and activities would be supported by the advisory board. To see cost estimates for this structure, please see Budget 1 details in the following section.

Option B: Expand the responsibilities of the Parks and Recreation Advisory Board

For this option, Lakewood should update the mandate for the existing Parks and Recreation Advisory Board (PRAB) to include UFP goals and support coordination with city departments responsible for implementation.

Lakewood should hire a position to coordinate UFP implementation across city departments. With many departments sharing responsibility, accountability and administrative support are key to ensuring program efficiency and progress, as existing departments already have many priorities. If the city decides to update PRAB's mandate, a program coordinator will still be necessary to support the UFP as PRAB already has several priorities. To see cost estimates for this structure, please see Budget 2 details in the following section.

Option C: Hire a full-time program coordinator

The third approach is having a full-time program coordinator manage the program without the support of an advisory board. PRCS, CED, and PWE will share responsibilities to implement the UFP, per the departments' agreement during the design process for this implementation guide. Additionally, a full-time coordinator will coordinate UFP tasks with those departments. The program coordinator could be located within the City Manager's office.

Collaboration between different departments is essential to UFP success, regardless of the organizational structure the city chooses. The city should manage this program with an integrated approach to trees considering activities that concern more than one agency, such as:

- storm and surface water management
- transportation
- electric utility

To see cost estimates for this structure, please see Budget 2 details in the following section.

Budget

Based on our prior recommendations and the three organizational structure options above, we have developed priorities for years one through five. Table 10 shows program priorities for the first five years. Each priority is designated to specific city departments based on the activity. These priorities and designations were developed in partnership with our client.

Table 10: Urban Forestry Priorities Years 1 through 5

Ownership	Priorities	Y1	Y2	Y3	Y4	Y5
CED and Parks	Standardize Citywide Tree Maintenance Practices	🍃				
PWE	Evaluate and Update Surface Water Fee Usage	🍃	🍃			
CED	Coordinate Contract Arborist Work	🍃	🍃	🍃	🍃	🍃
CED and Parks	Community Outreach and Engagement	🍃	🍃	🍃	🍃	🍃
CED and Parks	Volunteer Recruitment and Appreciation	🍃	🍃	🍃	🍃	🍃
CED and Parks	Explore External Partnerships and Funding	🍃	🍃	🍃	🍃	🍃
CED, Parks, and PWE	Coordinate UFP priorities planting and maintenance	🍃	🍃	🍃	🍃	🍃

Based on these priorities, we developed two preliminary budgets for the five-year implementation period. The priorities remain the same across organizational structures and budgets.

Budget 1

This budget provides cost estimates assuming the city chooses organizational structure Option A and develops a standalone advisory board. This budget utilizes city staff to carry out day-to-day UFP activities and does not include cost estimates for a new hire. Based on conversation with our client, this budget does not show the costs associated with developing an advisory board. The expenditure costs are relatively low but require additional staff time and city resources to develop the board.

Budget 2

This Budget provides cost estimates assuming the city chooses either organizational structure Option B or C. This budget provides estimates for a new hire to oversee day-to-day UFP activities and to coordinate cross-departmental coordination throughout the city.

Table 11 shows budget highlights for the first two years of implementation. Staffing expenditures, including salaries and benefits, are the only expenditures that vary across budgets. Budget 1 includes cost estimates with four current city staff spending a small percentage of their time on UFP activities. Combined, their UFP work is equivalent to one FTE. Budget 2 staffing costs include one new hire that would potentially be in the City Manager's office.

Professional services and supplies expenditures remain the same for the two budget options. These estimates are based on current city estimates as outlined in the city's 2023-2024 Biennial Budget, estimates provided during our interviews, and industry norms.

Table 11: Year 1 Budget Highlights

Expenditure Category	**Budget 1**: Standalone Board	**Budget 2:** No Standalone Board
Salaries and Benefits	$ 112,108	$ 122,162
Professional Services	135,000	135,000
Supplies and Indirect Costs	1,035	1,035
Total	**$ 248,143**	**$ 258,197**
Annual Increase	*10% decrease from Y1 to Y2* *23% average increase Y2-Y5*	*9% decrease from Y1 to Y2* *22% average increase Y2-Y5*

To see the full implementation budgets for years one through five, please see Appendix H. For more detail on the underlying budget assumptions, please see Appendix I.

Funding Sources

In Chapter 5, we outline funding sources utilized by the case study cities. We recommend the City of Lakewood consider the following funding sources:

- establish a connection between urban forestry activities and stormwater management and utilize a portion of the city's current Storm and Surface Water Utility Fee to fund activities;
- utilize current funds available through the City of Lakewood's Tree Fund;

- consider reallocating or increasing the percentage of General Fund Revenue that is dedicated to urban forestry activities;
- pursue federal, state, and local government grants, along with nonprofit partnerships, as outlined in Appendix A; and
- public, market-based funding sources, such as carbon credits, as outlined in Appendix A.

Estimating Future Program Costs

This section outlines financial, staff, volunteer, and external resources the city should consider as it moves past the initial 5-year period and into a long-term UFP.

Once the city has completed a FLAT assessment and identified priority MUs, the determined tree-iage categories can provide insight on restoration costs across all MUs. The City of Issaquah and Forterra, estimated a cost estimate per acre per tree-iage category. This estimate is shown in Figure 11. The City of Lakewood should consider a similar model to estimate restoration costs once an assessment is complete.

Figure 11: City of Issaquah - 20-Year Cost Estimate Per Acre by Tree-iage Category

Tree-iage Category	Acreage	Average Restoration Cost/Acre	Total Cost per Tree-iage Category
1	521	$5,000	$2,605,000
2	59	$13,900	$820,100
3	1	$20,600	$20,600
4	659	$10,800	$7,117,200
5	143	$16,100	$2,302,300
6	70	$26,900	$1,883,000
7	2	$14,500	$29,000
8	13	$24,200	$314,600
9	72	$35,400	$2,548,800
TOTAL	**1,540**		**$17,640,600**

Budget Categories

Once the city has developed and implemented a UFP, the expenses below are the areas of the budget that should be prioritized:

- **Field Expenses:** this includes materials and crew hours necessary to complete restoration projects, including the removal of invasive species, regular planting, and ongoing maintenance;
- **Staff Time:** this includes city staff, UFP partners, and contracted workers that are necessary for program coordination, planning, monitoring, as well as volunteer outreach, marketing, and management;
- **Supplies and Materials:** this includes any items needed for volunteer recruiting, training, and regular appreciation; and
- **Overhead:** this includes any overhead costs for field and office work.

Monitoring and Evaluation

This section describes how the city can monitor progress, develop program updates, and report on program milestones. Monitoring and evaluation (M&E) can also inform the program's systematic evolution and improvement and can identify needs to redefine goals.

The conclusions from M&E efforts should clearly state how well the plan is achieving its outcomes and inform any necessary adaptations. Adaptations and updates are often important and critical to continue moving in the right direction and getting closer to the vision that guides the plan, which ultimately is the overall goal. Table 12, shown on the following page, outlines the key actions for the first five years which are associated with the five goals described under Recommendation 1 earlier in this chapter.

Program Evaluation

Every two years, the UFAB or the program coordinator should present a report including a summary of actions undertaken, as well as clear connections between those actions and their impact on outcomes. The biannual evaluation report should be a tool to understand how the program is doing and how close the city is getting to each outcome. The report should also include recommendations on required updates and highlight any urgent matters that require attention from the city departments involved. The Board should present this report to Lakewood's City Council, as well as to all city departments sharing operational, managerial, or financial responsibilities within the plan. As the City of Lakewood and the Advisory Board establish new partnerships, those partners should also receive the evaluation reports.

The advisory board or the program coordinator should consider a deeper evaluation that culminates in a program update every five years, from the start of the program.

Table 12: Key Actions

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Forest Health				
- Complete FLAT Phases 2 and 3, which includes comprehensive tree assessment - Standardize tree maintenance practices	- Begin four-phase restoration on priority MUs.	- Continue four-phase restoration on priority MUs, incorporating new MUs as possible.	- Begin four-phase restoration on remaining MUs. - Hire an urban forester to lead restoration and maintenance efforts.	- Continue four-phase restoration on all MUs, including monitoring and ongoing invasives control.
Tree Population Expansion				
- Maintain 28% public UTC.	- Maintain 28% public UTC. - Begin planting new trees on publicly owned land guided by four-phase restoration.	- Maintain 28% public UTC. - Continue planting trees on publicly owned land guided by four-phase restoration.	- Maintain 28% public UTC. - Continue planting trees on publicly owned land guided by four-phase restoration.	- Maintain 28% public UTC. - Continue planting trees on publicly owned land guided by four-phase restoration. - Begin outreach to increase trees planted on privately owned land.

Community Engagement				
- Open nomination process for UFAB (only applies to Options A and B in Rec. 4). - Survey community to gather input on urban forestry in city. - Communicate city's efforts on UFP openly and on various platforms. - Recruit and train 10 Forest Stewards (FS).	- UFAB is a working body with authority given by the City Council (only applies to Options A and B in Rec. 4). - Recruit 10 volunteers per FS. - Establish relationships with local nonprofits and businesses.	- Recruit and train 5 additional FS. - Recruit 10 volunteers per FS.	- Recruit and train 5 additional FS. - Recruit 10 volunteers per Forest Steward.	- Recruit and train 5 additional FS. - Recruit 10 volunteers per FS. - Survey community to gather input on urban forestry in city. - Communicate the results of the five-year program evaluation.
Equitable Access				
- Implement community engagement strategies to ensure participation from all population groups within Lakewood in volunteer and information activities. - Include specific questions in community surveys to identify opinions and challenges per racial group, associated with the UFP. - Translate public-facing UFP documents to languages other than English, as relevant for Lakewood's community to ensure access for ESL speakers.	- Implement community engagement strategies to ensure participation from all population groups within Lakewood in volunteer and information activities. - Include specific questions in community surveys to identify opinions and challenges per racial group, associated with the UFP. - Translate public-facing UFP documents to languages other than English, as relevant for Lakewood's community to ensure access for ESL speakers. - Monitor progress on Tree Equity Score.	- Implement community engagement strategies to ensure participation from all population groups within Lakewood in volunteer and information activities. - Translate public-facing UFP documents to languages other than English, as relevant for Lakewood's community to ensure access for ESL speakers. - Monitor progress on Tree Equity Score.	- Implement community engagement strategies to ensure participation from all population groups within Lakewood in volunteer and information activities. - Translate public-facing UFP documents to languages other than English, as relevant for Lakewood's community to ensure access for ESL speakers. - Include specific questions in community surveys to identify opinions and challenges per racial group, associated with the UFP. - Monitor progress on Tree Equity Score.	- Implement community engagement strategies to ensure participation from all population groups within Lakewood in volunteer and information activities. - Translate public-facing UFP documents to languages other than English, as relevant for Lakewood's community to ensure access for ESL speakers. - Monitor progress on Tree Equity Score.
Sustainability				
- Approve funding to formally start the UFP Explore external partnerships and funding sources	- Explore external partnerships and funding sources.	- Expand capacity for increased community events.	- Expand capacity for increased community events.	- Expand capacity to provide more financial resources for private trees.

Conclusion

Urban forests offer a range of benefits to cities and their community members, including addressing climate change, improving the environment, and enhancing public health. The City of Lakewood is committed to taking proactive measures to maximize these benefits and ensure they are accessible to all community members. By implementing an urban forestry program (UFP), Lakewood can systematically plan and execute initiatives to achieve its goal of reaching 40% urban tree canopy cover by 2050. This report outlines the initial steps that Lakewood should undertake in establishing a UFP, considering existing city frameworks, the implications of climate change, and financial constraints.

This report provides a practical implementation guide based on four recommendations focusing on strategic planning, resource assessment and management, community engagement, and organizational capacity. These recommendations aim to support Lakewood in making informed decisions related to program administration, implementation costs, potential partnerships, and management of trees, among other critical components. The Lakewood City Council should, in collaboration with city departments and the community, carefully evaluate the alternatives presented in this guide and determine the most suitable course of action for Lakewood before proceeding with implementation.

It is important to acknowledge that each city is unique, and this report is limited by the information from our case studies, interviews, and research. The research and interviews were conducted within time constraints, resulting in limited input from professionals in the field. The City of Lakewood should continue to foster partnerships with individuals contacted during the research phase and other urban forestry organizations and experts.

There are also limitations in our recommendations regarding in which MUs the city should begin the forest health assessment. Our analysis was dependent on data and analysis completed by PlanIT Geo. The suggested planting areas primarily focused on privately owned land, and due to limited capacity, we could not extensively identify publicly owned land, such as rights-of-way or other street tree areas, for potential plantings. Furthermore, the proposed budgets outlined in this report are subject to change based on external factors, such as economic fluctuations or unforeseen environmental events that may necessitate increased funding for urban forest maintenance.

We recommend the City of Lakewood integrate this guide into its decision-making process as it examines existing city structures and determines efforts to enhance the environmental well-being of the community through urban forestry. By incorporating the recommendations outlined in this implementation guide, Lakewood can develop a UFP that is environmentally sustainable, socially equitable, and economically viable. Urban forestry in the City of Lakewood will contribute to a greener, healthier, and more vibrant community.

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Appendices Guide

- **Appendix A: Partnership Guide**
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Appendix A: Partnership Guide

Partnerships are categorized by the types of assistance or partnership offered by each organization.

Partnership and Assistance Key

Community engagement or volunteer resources

Educational resources for city employees or volunteer training

Financial assistance or grant funding

Technical assistance for program development or urban forest management

Government Partnerships

Organization	Assistance	Details
Washington Department of Natural Resources (WA DNR)		WA DNR offers Community Forestry Assistance Grants ranging from $5,000 to $40,000. Grants require a 100% match. WA DNR also offers extensive education and technical assistance for urban forestry programs.
Washington State Recreation and Conservation District (WA RCD)		WA RCD offers various grants for conservation and restoration of urban forests. Two potential grants the city could consider: - Community Forests Program – Award limit is $3 million and requires a 15% match - Habitat Conservation Projects – Award varies from $25,000 with no upward limit. Requires a 50% match.
Pierce Conservation District (PCD)		A few partnership opportunities with PCD: - PCD has historically offered a Green Partnership Grant to support projects in the PCD project area. Grants were suspended for 2023 but could be awarded in future years. - PCD also sponsors a native plant sale that Lakewood can promote to residents. - PCD is extremely knowledgeable about the area's unique environmental settings and can utilized for both technical and educational assistance.
South Sound Military and Communities Partnership (SSMCP)		Lakewood should consider partnering with SSMCP be as the city begins community engagement efforts related to UFP activities.
Nisqually Indian Tribe		Lakewood should consider partnering with the Nisqually Indian Tribe as the city begins community engagement efforts related to UFP activities.

Washington State Department of Commerce (WA DOC)		WA DOC has a Defense Community Compatibility Account to support infrastructure projects related to land use and infrastructure near military installations. Lakewood's unique position near Joint Base Lewis-McChord makes them eligible for these grants, as evidenced by its winning this award in recent years. The city could consider pursing this grant again, specifically for UFP purposes.
Washington Department of Fish and Wildlife (WDFW)		WDFW offers technical and educational assistance, as well as opportunities to increase community engagement in UFP activities. WDFW also offers a Watchable Wildlife Grant Program that the city could apply for. The purpose of grant awards is to support wildlife viewing and to foster appreciation of wildlife.

Nonprofit Partnerships

Organization	Assistance	Details
Forterra		While Forterra is currently restructuring their Green City Partnership program, the organization is still a valuable potential partnership for the city. Forterra could be a source of educational and technical assistance, as well as future financial assistance. Forterra also created the Forest Steward program and offers a comprehensive Field Guide for volunteers.
Lakewood Multicultural Coalition		Lakewood should consider partnering with the Lakewood Multicultural Coalition as the city begins community engagement efforts related to UFP activities.
The Garry Oak Coalition (GOC)		The Garry Oak Coalition is a nonprofit located in Lakewood and dedicated to the preservation of area Garry Oaks. Lakewood should consider partnering with the GOC as the city begins community engagement efforts related to UFP activities.
Tacoma Tree Foundation		The Tacoma Tree Foundation is a community-based nonprofit that is committed to growing the urban forest in Tacoma. Due to the close proximity, the city should consider partnering with the foundation for community engagement and educational opportunities.
Washington State University Extension Forestry		The Puget Sound Region Extension Forestry offers online courses and public resources for people who own wooded property. The available resources could be extremely useful as Lakewood develops its volunteer based. This includes a course on Forest Stewardship that is intended for private landowners but is also applicable to public land.
City Forest Credits		City Forest Credits is a nonprofit carbon registry that partners with private organizations, allowing them to purchase carbon credits for urban forest projects. Those carbon credits can be used for urban forestry planting activities. The city can apply to partner with this organization to fund tree planting and restoration activities.
American Forests		American Forests is a national organization that is dedicated to forest conservation in the United States. American Forests has completed comprehensive resource assessments, including FLAT assessments, for other cities in the area.

Appendix B: Comparison of Case Study UFP Expenditures

City of Issaquah, WA – Implementation began in 2019

Department	Expenditure Detail	2023 Adopted
Parks and Community Services	New Position - Full-Time Urban Forest Supervisor	185,686
Parks and Community Services	New Position - Part-Time Volunteer Coordinator	77,547
Parks and Community Services	Development of Urban Forestry Management Plan	100,000
	Total	**363,233**

City of Vancouver, WA – Implementation began in 2007

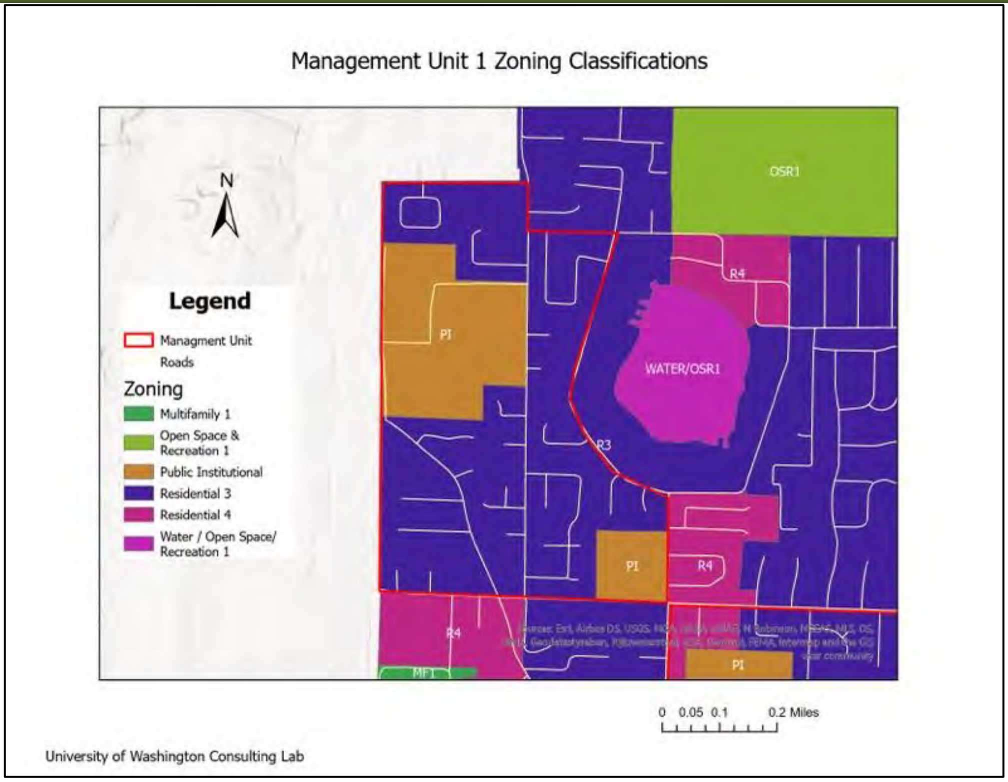
Revenue Source	Expenditure Detail	2023 Adopted
SWM Fund	Salaries and Benefits	693,250
SWM Fund	Supplies and Services	770,620
SWM Fund	Interfund	353,052
	Total	**1,816,922**

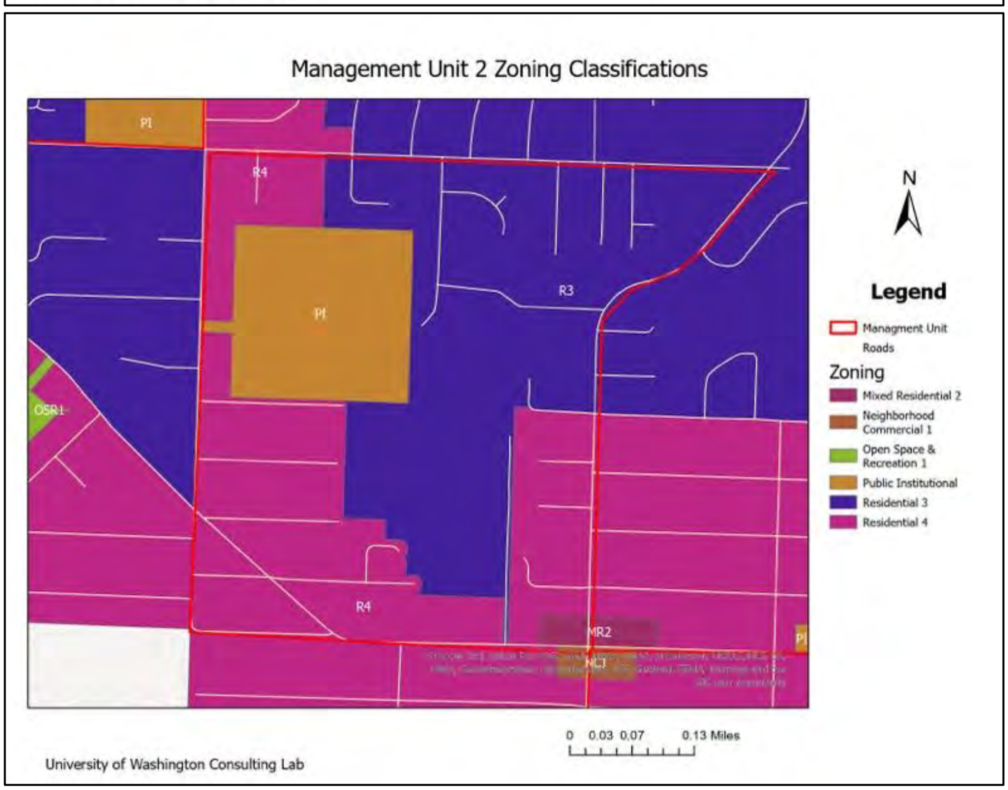
Revenue Source	Expenditure Detail	2023 Adopted
City Tree Reserve Fund	Supplies and Services	80,155
City Tree Reserve Fund	Other Intergovernmental	3,000
City Tree Reserve Fund	Interfund	3,264
	Total	**86,419**

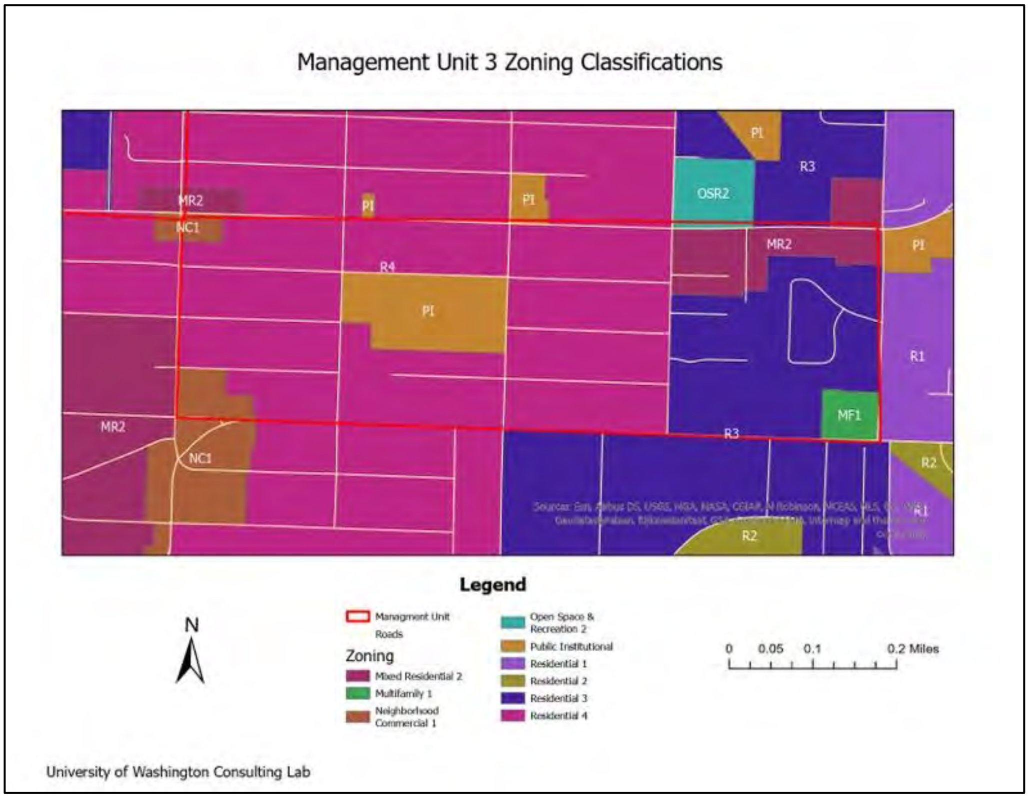
City of Seattle, WA – Implementation began in 2007

Department	Expenditure Detail	2023 Adopted
Office of Sustainability and Environment	New Position - Full-Time City Urban Forester	147,000
Office of Sustainability and Environment	Development of Tree Canopy Equity and Resilience Plan	150,000
Department of Transportation	Tree Planting in Right-of-Way Initiative	250,000
Department of Construction and Inspections	Additional Capacity for Tree Protection	54,961
Office of Sustainability and Environment	Greening of Industrial Properties in Equity Focus Areas	300,000
Parks and Recreation	Increased Tree Planting and Maintenance in Parks	637,000
	Total	**1,538,961**

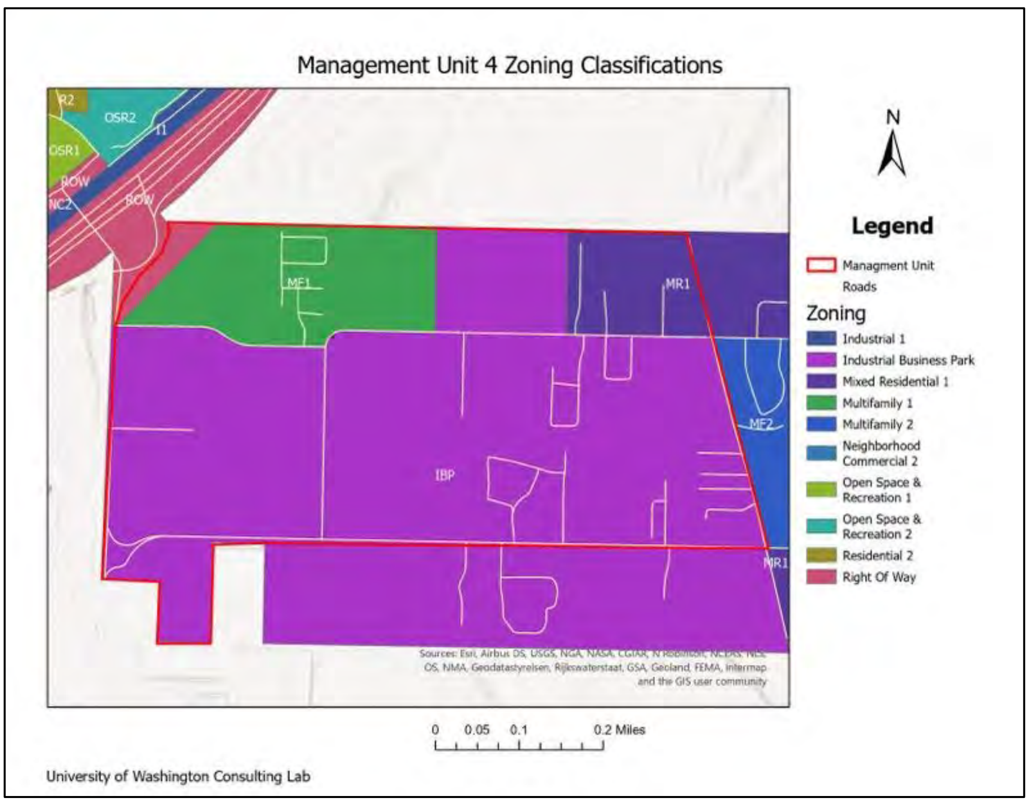
Appendix C: Management Units with Zoning Classifications





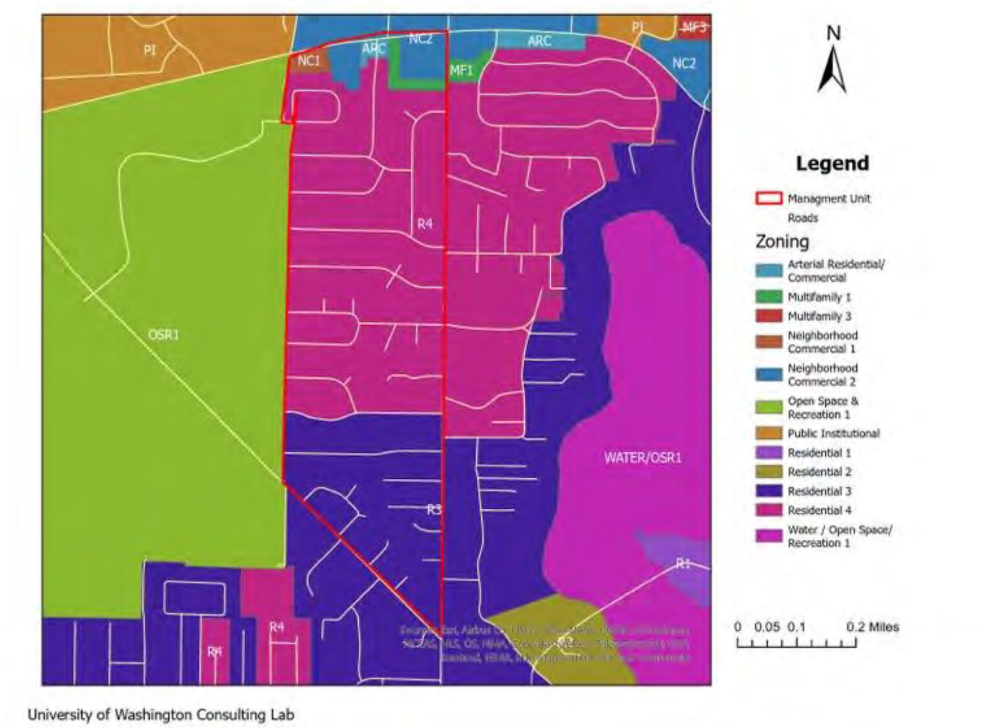


Management Unit 3 Zoning Classifications
MR2
NC1
PI
R4
OSR2
R3
MR2
R1
MF1
R2
Legend
Managment Unit
Roads
Zoning
Mixed Residential 2
Multifamily 1
Neighborhood Commercial 1
Open Space & Recreation 2
Public Institutional
Residential 1
Residential 2
Residential 3
Residential 4
N
0 0.05 0.1 0.2 Miles
University of Washington Consulting Lab

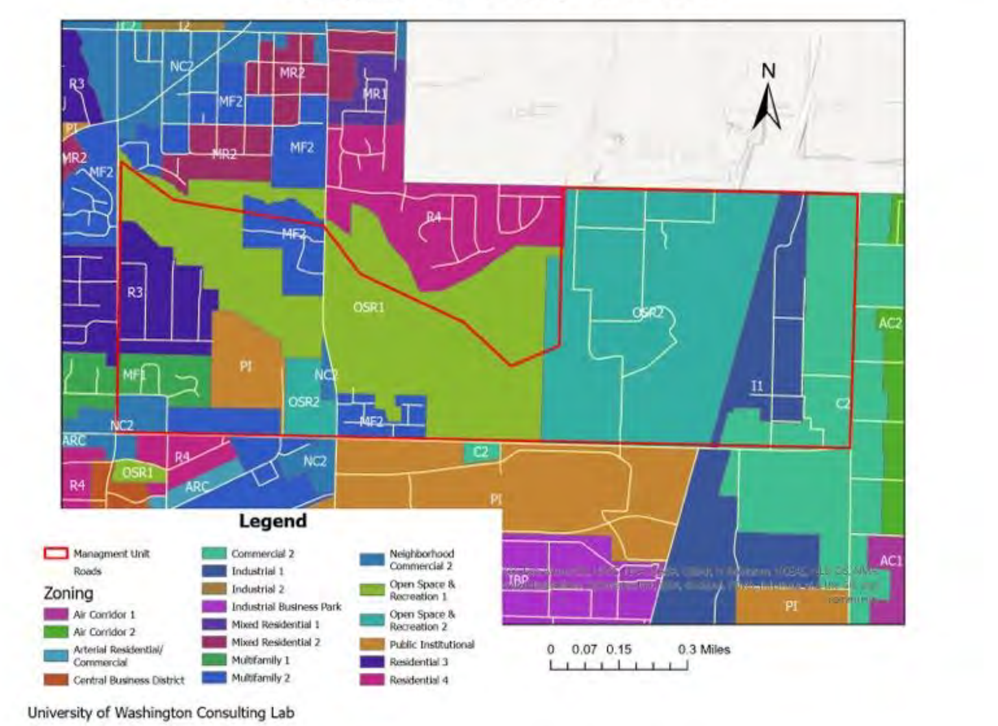


Management Unit 4 Zoning Classifications
R2
OSR2
OSR1
I1
ROW
NC2
MF1
MR1
MF2
IBP
Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community
N
Legend
Managment Unit
Roads
Zoning
Industrial 1
Industrial Business Park
Mixed Residential 1
Multifamily 1
Multifamily 2
Neighborhood Commercial 2
Open Space & Recreation 1
Open Space & Recreation 2
Residential 2
Right Of Way
0 0.05 0.1 0.2 Miles
University of Washington Consulting Lab

Management Unit 5 Zoning Classifications



Management Unit 6 Zoning Classifications



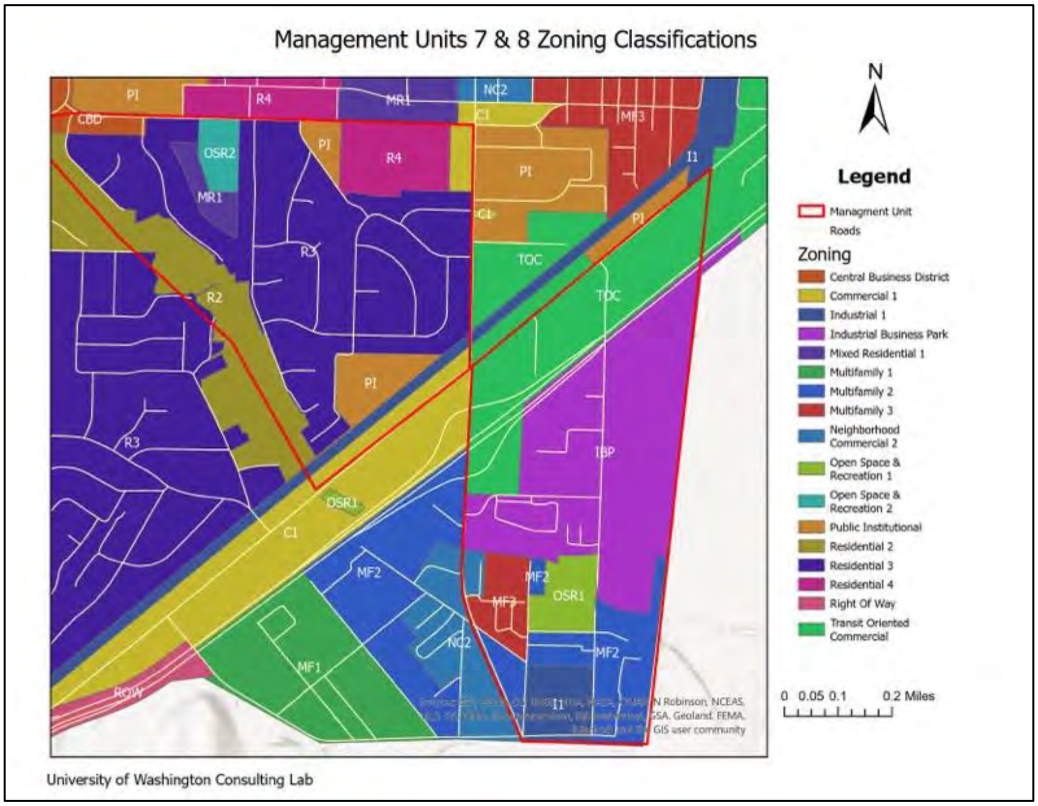
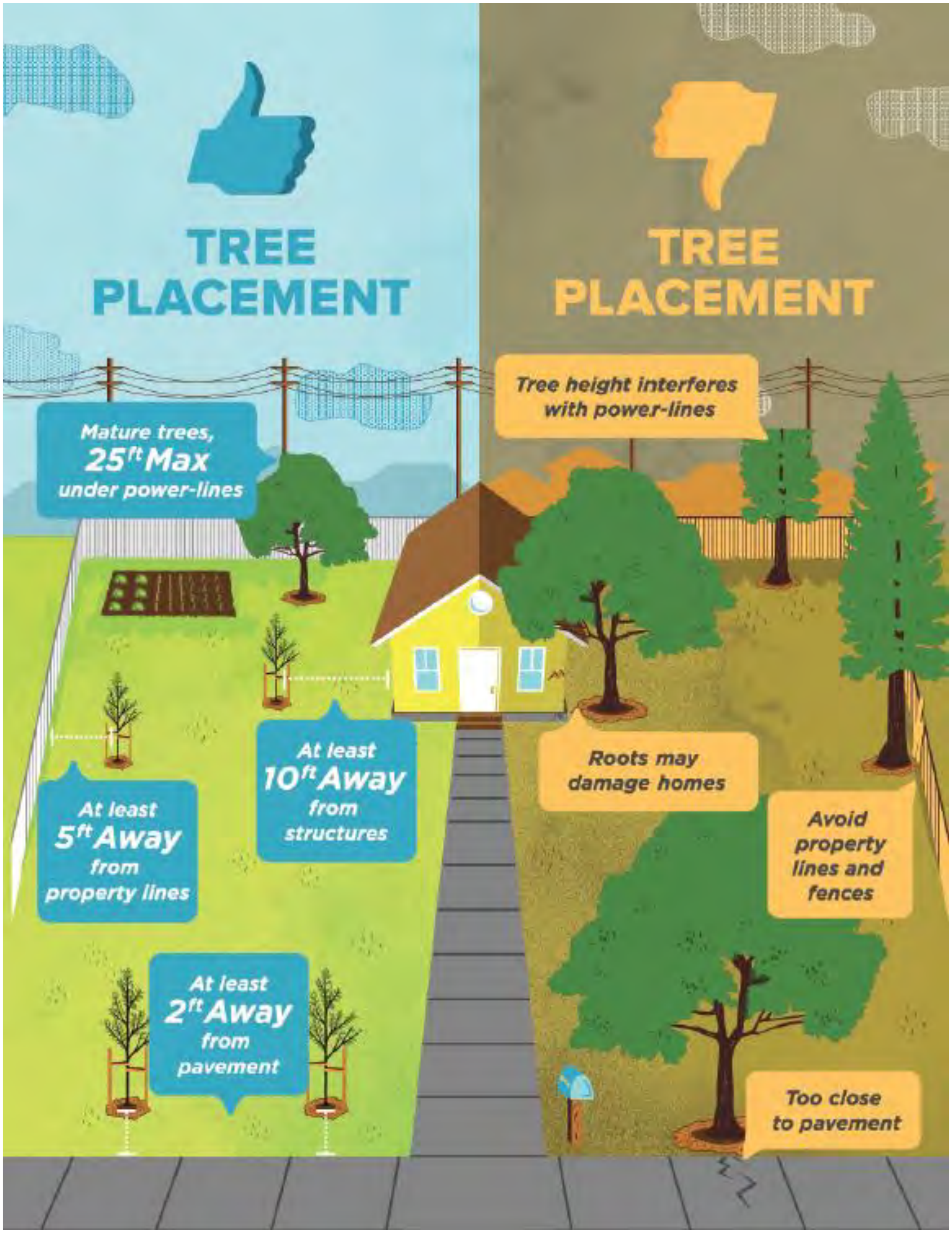


Table 13: Area of Management Units in Acres

Management Unit Identification Number	Total Acreage
1	181.22
2	143.82
3	132.25
4	181.98
5	149.16
6	465.99
7	210.76
8	206.09

Appendix D: City of Tacoma Tree Planting Guide



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Appendix E: Invasive Species

Tree / Plant	Name	Plant Type	Size at maturity	Habitat	Flower Description	Leaf Description	Stem Description	Fruit Seed Description
Clematis vitalba	Clematis	vine	up to 65.6 feet	forest lands, forest edges and openings, riparian areas, waste areas, roadsides and coastal and lowland areas.	Flower clusters grow from leaf axils (area where leaf connects to stem) and also at stem tips. 3 to 22 flowers per cluster. Flowers do not have petals. Sepals, petal-like, white to cream, 4 to 6, about 2 times as long as wide with hairs on both sides.	Leaves are arranged opposite each other on the stems and are pinnately compound, divided into 5 leaflets. Leaflet margins are smooth to somewhat toothed. Leaflets have some small hairs on the leaf veins below and no hairs above.	Stems are climbing, become woody and may have curling to winding leaf stems (petioles).	Seeds with feathery hairs, each having a stem-like projection, 1.4 inches (3.5 cm) long. Clusters of seeds can be seen on plants all winter.
Convolvulus arvensis	Field bindweed	vine		ravines, greenbelts, forested parks and farmlands as well as residential settings such as driveways, flower gardens and ornamental borders.	Flowers are bell or funnel-shaped, white to pinkish and approximately 1 inch in diameter. They have 2 small bracts located 1 inch below the flower.	Leaves are alternate, more or less arrowhead-shaped and have pointed or blunt lobes at the base.	Stems are perennial and deciduous, growing along the ground and twining around and through other plants, to around 6.5 feet in length.	Seed in a small capsule, about 0.25 inch in size.
Cytisus scoparius	Scotch broom	evergreen shrub	3 to 10 feet	roadsides, pastures, grasslands, open areas and areas of recent soil disturbance.	Flowers are typical of those in the pea family. They are bright yellow, about 3/4 inches long and have 5 petals.	There are few leaves. The upper are simple and the lower are 3 parted. They are deciduous and pointed at both ends. Leaves may fall early in the year, leaving bare green stems.	Stems are woody and dark green. Young branches have 5 green ridges with hairs. When mature, stems become glabrous and ridges disappear. Young stems remain green throughout the year.	Seed pods are brown-black, legume-like, flattened and have hairy margins with several seeds per pod.

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Tree / Plant	Name	Plant Type	Size at maturity	Habitat	Flower Description	Leaf Description	Stem Description	Fruit Seed Description
Hedera helix	English ivy	evergreen vine	up to 99 feet	woodlands, forest edges, riparian areas, fields, hedgerows, coastal areas, and disturbed habitats.	English ivy matures to produce adult stems and flowers when it begins to grow vertically. The small (0.2 to 0.3 inch), bisexual, greenish-white flowers occur in umbrella-like clusters in the fall. The juvenile stage, time before it flowers, may be for 10 years or longer.	Leaves are alternate each other on the stems and leathery, with long petioles and have two forms: adult and juvenile leaves. Juvenile leaves are deeply 3 to 5 lobed and 1.6 to 4 inches long and wide. Adult leaves occur on flowering stems and are primarily un-lobed leaves and egg-shaped to diamond shaped. Only young leaves are hairy.	Stems are climbing vines, shrub-like or groundcovers. Young stems have hairs while older stems are hairless. Stems growing along the ground can develop (adventitious) roots and climbing stems produce root-like structures that can secure it to buildings, trees or anything it is climbing up.	The dark colored fruits (dark blue to black, berry-like drupes) mature in the spring. Each fruit is around 0.16 to 0.31 inch (4 to 8 mm) wide and contains 4 to 5 seeds.
Heracleum mantegazzianum	Giant hogweed	Class A noxious weed	15 to 20 feet	roadsides, other rights-of-way, vacant lots, streams and rivers.	Giant hogweed has broad, flat-topped flower clusters (umbels) of many small white flowers. Each flower cluster may grow to a diameter of 2.5 feet.	The compound leaves of giant hogweed may grow as large as five feet wide. Each leaflet is deeply cut/lobed with leaf edges being sharply toothed (incised).	The stem and stalks are hollow and vary 2 to 4 inches in diameter. Stems have distinctive purplish-red, bumpy blotches with stiff hairs.	The flowers produce large elliptic dry seeds marked with brown swollen resin canals.

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Tree / Plant	Name	Plant Type	Size at maturity	Habitat	Flower Description	Leaf Description	Stem Description	Fruit Seed Description
Ilex aquifolium	English holly	evergreen shrub	as tall as 30 feet	anywhere that is shady, in a variety of soil types.	Female plants have small, white to light green flowers that have 4 round petals. Male plants non-descript light green to white round shapes with 4 anthers coming from the center. All the flowers grow individually and directly from the branches, on very short stems.	Holly's leaves are lobed, ending in sharp points. They are deep green and covered in a waxy coating.	Thick, woody stems that start off olive green and can age to brown green.	Bright, red berries, which are popular with birds.
Polygnoum cispidatum	Japanese knotweed	perennial invasive plant	4 to 8 feet	waste places, gardens, roadsides and stream and riverbanks.	The whitish to whitish-green flowers are in drooping panicles (clusters) from leaf axils. Male and female flowers are on separate plants.	Alternately arranged with petioles (stalks) and are 4 to 6 inches long, ovate and have a truncated base and an abrupt tip.	Stems are upright, branching and deciduous.	The fruits are approximately 1/8 inch long, shiny brown and triangular.
Prunus laurocerasus	English laurel	evergreen plant	2 to 5 inches	landscape plantings	Flowers in upright racemes, 2-5 inches long. Flowers white, with 5 petals and about 0.4 inches (1 cm) wide.	Alternately arranged, leathery with serrated to almost smooth margins and two glands at the base of the blade near point of attachment with petiole. Blades ~2-8 inches long, oval to elliptic-oblong in shape, and dark to medium green above, paler green below.	Stems have smooth reddish brown to dark brown bark. New stems are green.	Fruit is a black to purple-black drupe, 0.5" long.

Tree / Plant	Name	Plant Type	Size at maturity	Habitat	Flower Description	Leaf Description	Stem Description	Fruit Seed Description
Rubus armeniacus	Himalayan blackberry	non-native plant	up to 13.1 feet	mixed and deciduous forests and a variety of disturbed sites such as roadsides, railroad tracks, logged lands, field margins and riparian areas.	Flower clusters (panicles) are flat-topped and have 5 to 20 flowers. Each flower has 5 petals that are white to rose colored and about 1 inch in diameter.	Leaves are alternately arranged on stems. Each leaf is palmately compound and made up of 3 to 5 (typically 5) leaflets with toothed margins.	Stems can reach up to 20 to 40 feet and can root at their tips when they touch the ground. Canes have hooked, sharp prickles, also called thorns, with thick bases. Stems green to reddish to purplish-red, strongly angled, and woody. They made dense thickets that are impassable and sprawl over the surrounding vegetation.	Flowers form blackberries—a grouping of small, shiny, black druplets that each contain one seed. Blackberries are about 1/2 inch to 7/8 inch in size.
Senecio jacobaea	Tansy ragwort	perennial herbaceous plant		roadsides, in pastures, fields and cleared forested areas. It is not particular to soil type.	Flowerheads are in somewhat flat-topped clusters. Flowerheads yellow with many disk flowers and 13 ray flowers (which look like petals), overall having a daisy-like appearance. Flowerheads have around 13 bracts at their base with dark tips.	Leaves are twice divided, with petioles (leaf stems) on leaves near the base and without petioles toward stem tips. First year leaves in a basal clump (rosette). Second year leaves are alternate along the stem, 1.6 to 7.9 inches long by 0.8 to 2.4 inches wide.	Stems reach up to 4 feet tall, numbering one to many from roots. They branch near their tips.	Seeds are sparsely hairy to glabrous (hairless and smooth).

Appendix F: Tree Guide

Tree	Name	Plant type	Size at maturity	Width	Land/ Restoration Use	Habitat	Sun/Shade tolerance	Soil Preferences	Cultivation Preferences
Abies grandis	grand fir	Evergreen perennial	50 ft	30-40 ft	erosion control screen windbreak	Riparian, Rocky/Gravelly, Forest	Sun, part shade, shade	Well drained soils	Well-drained
Acer macrophyllum	bigleaf maple, oregon maple	Deciduous perennial	49-50 ft	45-80 ft	erosion control windbreak	Forest	sun, part shade, shade	Gravelly soils, Deep soils	tolerates wet season well-drained
Alnus rubra	red alder	Deciduous perennial	39-50 ft	30-50 ft	Fire resistant erosion control hedgerow windbreak	Wetland, Riparian, Rocky/Gravelly, Forest, Meadows/Fields, Disturbed	Sun, part shade, shade	clay soils, nutrient poor soils	tolerates constant flooding
Arbutus menziesii	arbutus, madrone, madrona	Evergreen perennial	19-50 ft	20-40 ft	erosion control hedgerow windbreak	Rocky/Gravelly, Forest, Disturbed	sun, part shade	Gravelly soils, Shallow soils	tolerates seasonal wet well-drained
Cornus nuttallii	Pacific dogwood	Deciduous perennial	29-50 ft	20-25 ft	erosion control hedgerow windbreak	riparian, forest	part shade, shade	well drained soils	Well-drained
Crataegus douglasii	Black Hawthorn, Douglas's Hawthorn	Deciduous perennial	13-27 ft	12-20 ft	erosion control hedgerow thicket-forming windbreak	Wetland, Riparian, Saline/Estuarine, Rocky/Gravelly, Forest, Meadows/Fields, Steppe, Disturbed	Sun, part shade, shade	Well drained soils	Well-drained
Fraxinus latifolia	Oregon ash	Deciduous perennial	32-50 ft	15-40 ft	erosion control hedgerow windbreak	riparian	Sun, part shade, shade	organic soils	tolerates wet season

Tree	Name	Plant type	Size at maturity	Width	Land/ Restoration Use	Habitat	Sun/Shade tolerance	Soil Preferences	Cultivation Preferences
Malus fusca	Pacific crabapple	Deciduous perennial	13-40 ft	15-25 ft	erosion control hedgerow windbreak	Wetland, Riparian	Sun, part shade, shade	Well drained soils	tolerates seasonal wet
Picea sitchensis	Sitka spruce	Evergreen perennial	39-50 ft	20-40 ft	erosion windbreak	riparian, saline/estuarine, rocky/gravelly, forest	sun, part shade	well drained soils	Well-drained
Pinus contorta	shore pine, lodgepole pine	Evergreen perennial	9-50 ft high	20-45 ft	erosion control hedgerow screen windbreak	Wetland, Riparian, Saline/Estuarine, Forest, Disturbed	sun	gravelly soils, peaty soils, nutrient poor soils	tolerates wet season
Populus Trichocarpa	Black Cottonwood	Deciduous perennial	50 ft	20-30 ft	erosion control windbreak	Wetland, Riparian, Forest, Disturbed	sun	Well drained soils	tolerates wet season
Pseudotsuga menziesii ssp. menziesii	Douglas fir	Evergreen perennial	50 ft	20-30 ft	Fire resistant erosion control windbreak	rocky/gravelly, forest, disturbed	sun, part shade	Gravelly soils, well drained soils	well-drained
Quercus garryana	Garry oak, Oregon white oak	Deciduous perennial	40-90 ft	30-70 ft	Erosion control hedgerow windbreak	rocky/gravelly, forest, meadows/fields	sun	Sandy soils, Gravelly soils, Well drained soils, Deep soils	well-drained
Rhamnus purshiana	cascara	Deciduous perennial	14-40 ft	15-20 ft	erosion control hedgerow windbreak	Wetland, Riparian, Forest, Disturbed	Sun, part shade, shade	muddy soils, well drained soils	drought tolerant well-drained
Salix hookeriana	Hooker’s willow	Deciduous perennial	6-27 ft	15-20 ft	erosion control hedgerow thicket-forming	Wetland, Riparian, Saline/Estuarine, Rocky/Gravelly	sun, part shade	Sandy soils	tolerates constant flooding

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Tree	Name	Plant type	Size at maturity	Width	Land/ Restoration Use	Habitat	Sun/Shade tolerance	Soil Preferences	Cultivation Preferences
Salix scouleriana	Scouler's willow	Deciduous perennial	3-50 ft	30-40 ft	erosion control hedgerow	Riparian	Sun, part shade, shade	Gravelly soils, well drained soils	drought tolerant tolerates constant flooding
Taxus brevifolia	Western yew, pacific yew	Evergreen perennial	39-50 ft	10-30 ft	erosion control hedgerow windbreak	forest	sun, part shade, shade	Gravelly soils, Deep soils	Well-drained
Thuja plicata	Western redcedar	Evergreen perennial	49-50 ft	25-50 ft	erosion control hedgerow screen windbreak	aquatic, wetland, riparian, forest	part shade, shade	clay soils, muddy soils, nutrient rich soils	tolerates wet season
Tsuga heterophylla	Western Hemlock	Evergreen perennial	50 ft	25-40 ft	erosion control hedgerow screen	forest	part shade, shade	Well drained soils, mineral soils	well-drained

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Appendix G: Native Plant Guide

Species Code	Botanic Name	Common Name	Growth Form	Life History	Flowering Period	Average Soil Moisture Regime	Shade Tolerance
ACCI	Acer circinatum	vine maple	shrub	perennial	Mar–Jun	dry–moist	part shade-shade
ACMI	Achillea millefolium var. occidentalis	yarrow	forb	perennial	July–Sep	dry–moist	sun–part shade
ACTI	Achlys triphylla	vanillaleaf	forb	perennial	Apr–July	dry–moist	part shade–shade
ADAL	Adiantum aleuticum	Western maidenhair fern	fern	perennial	moist–wet	part shade–shade	
ADBI	Adenocaulon bicolor	pathfinder	forb	perennial	Jun–Oct	moist	moist shaded
ALCE	Allium cernuum var. obtusum	nodding onion	forb	perennial	July–Aug	dry–moist	sun
AMAL	Amelanchier alnifolia	serviceberry, saskatoon	shrub	perennial	Apr–Jun	dry–moist	shade-tolerant/intolerant
ARDI	Aruncus dioicus var. acuminatus	goatsbeard	forb	perennial	May–July	moist	sun–part shade
ASCA	Asarum caudatum	wild ginger	forb	perennial	Apr-July	moist	part shade–shade
ASSU	Aster subspicatus	Douglas aster	forb	perennial	July-Oct	dry	Wet-moist
ATFI	Athyrium filix-femina	lady-fern	fern	perennial	moist–wet	sun–shade	
BEAQ	Berberis aquifolium	tall Oregongrape	shrub	perennial	Mar–Jun	dry–moist	shade-tolerant/intolerant
BENE	Berberis nervosa	dull/Cascade Oregon-grape	shrub	perennial	Apr–Jun	dry–moist	shade-tolerant/intolerant
BLSP	Blechnum spicant	deerfern	fern	perennial	dry–wet	part shade–shade	
CADE	Carex densa	dense sedge	grass	perennial	moist–wet		
CADE	Carex deweyana var. deweyana	Dewey's sedge	grass	perennial	dry–wet	sun–shade	
CAME	Carex mertensii	Merten's sedge	grass	perennial	moist–wet		
CAOB	Carex obnupta	slough sedge	grass	perennial	moist–wet	sun–part shade	
CAPA	Carex pachystachys	thick-headed sedge	grass	perennial	moist–wet		
CAQU	Camassia quamash	common camas	forb	perennial	Apr–Jun	dry–moist	shade-intolerant
CASC	Campanula scouleri	Scouler's bellflower	forb	perennial	dry–moist	sun–part shade	
CIAL	Circaea alpina ssp pacifica	enchanter's nightshade	forb	perennial	May–Jun	dry–moist	sun–part shade
COCO	Corylus cornuta var. californica	beaked hazelnut	shrub	perennial	Feb–Mar	dry–moist	sun–shade
COSE	Cornus sericea	Red-osier dogwood	shrub	perennial	Jun–Aug	moist–wet	sun–shade
COUN	Cornus unalaschkensis	western bunchberry	forb	perennial	May–Jun	moist–wet	part shade–shade
DECE	Deschampsia cespitosa	tufted hairgrass	grass	perennial	Jun	dry–wet	sun–part shade
DIFO	Dicentra formosa ssp. formosa	Pacific bleedingheart	forb	perennial	Apr–May	dry–moist	part shade–shade

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Species Code	Botanic Name	Common Name	Growth Form	Life History	Flowering Period	Average Soil Moisture Regime	Shade Tolerance
DREX	Dryopteris expansa	spreading woodfern	fern	perennial	NA	moist	sun–shade
EROR	Erythronium oreganum var. oreganum	Oregon fawnlily	forb	perennial	Apr–May	dry	shade–part shade
ERSP	Erigeron speciosus	showy fleabane	forb	perennial	dry–moist	sun–part shade	
FEOC	Festuca occidentalis	western fescue	grass	perennial	Jun	dry–moist	part shade
FERO	Festuca roemeri	Roemer's fescue	grass	perennial	May–July	dry–moist	shade-tolerant/intolerant
FRVE	Fragaria vesca spp. bracteata	wood's strawberry	forb	perennial	Apr–Jun	dry–moist	shade-tolerant/intolerant
GASH	Gaultheria shallon	salal	shrub	perennial	Apr–May	dry–moist	part shade–shade
GEMA	Geum macrophyllum	large-leaved avens	forb	perennial	May–Jun	moist–wet	sun–part shade
GLEL	Glyeria elata	tall managrass	grass	perennial	May–July	moist–wet	sun–full sun
GRIN	Grindelia integrifolia	entire-leaved gumweed	forb	perennial	Jun	moist	sun–full sun
HODI	Holodiscus discolor	oceanspray	shrub	perennial	May–Jun	dry–moist	sun–shade
HYTE	Hydrophyllum tenuipes	slender-stem waterleaf	forb	perennial	Apr-May	moist–wet	part shade–shade
IRTE	Iris tenax	Oregon iris	forb	perennial	May–Jun	moist–wet	sun–part shade
LOCI	Lonicera ciliosa	orange honeysuckle	vine	perennial	May–Jun	moist	part shade–shade
LOHI	Lonicera hispidula	hairy honeysuckle	vine	perennial	May–July	dry–moist	sun–part shade
LOIN	Lonicera involucrata var. involucrata	black twinberry	shrub	perennial	Apr–July	moist–wet	sun–shade
LYAM	Lysichiton americanus	skunkcabbage	forb	perennial	Mar–May	wet	part shade–shade
MADI	Maianthemum dilatatum	false lily-of-the-valley	forb	perennial	Apr–Jun	moist	sun–shade
MARA	Maianthemum racemosum ssp. amplexicaule	large false Solomon's seal	forb	perennial	May-Jun	moist	Part sun–Shade
MYCA	Myrica californica	Pacific wax myrtle	shrub	perennial	May–Jun	dry–moist	sun–part shade
MYGA	Myrica gale	Sweet gale	shrub	perennial	NA	moist–wet	sun–part shade
OECE	Oemleria cerasiformis	Indian plum	shrub	perennial	Feb–Apr	dry–moist	part shade–shade
OXOR	Oxalis oregona	redwood sorrel	forb	perennial	Apr–Sep	dry–moist	part shade–shade
PEFR	Petasites frigdus	coltsfoot	Forb	perennial	Feb–Mar	moist–wet	sun–shade
PEOV	Penstemon ovatus	broad-leaved penstemon	forb	perennial	Jun–Aug	dry–moist	sun–part shade
PHCA	Physocarpus capitatus	Pacific ninebark	shrub	perennial	May–Jun	moist–wet	sun–shade
PHLE	Philadelphus lewisii	mockorange	shrub	perennial	May–July	dry–moist	sun–part shade
POGL	Polypodium glycyrrhiza	licorice fern	fern	perennial	moist–wet		

Species Code	Botanic Name	Common Name	Growth Form	Life History	Flowering Period	Average Soil Moisture Regime	Shade Tolerance
POMU	Polystichum munitum	western sword fern	fern	perennial	NA	dry–moist	part shade–shade
PTAQ	Pteridium aquilinum var pubescens	bracken fern	fern	perennial	dry–moist		
RHMA	Rhododendron macrophyllum	Pacific rhododendron	shrub	perennial	May–July	dry–moist	part shade–shade
RILA	Ribes lacustre	swamp currant	shrub	perennial	Apr–May	moist–wet	sun–shade
RISA	Ribes sanguineum var. sanguineum	red-flowering currant	shrub	perennial	Feb–Apr	dry–moist	sun–part shade
ROGY	Rosa gymnocarpa	baldhip rose	shrub	perennial	May–Jun	dry–wet	sun–shade
RONU	Rosa nutkana	nootka rose	shrub	perennial	May–Jun	moist–wet	sun–part shade
ROPI	Rosa pisocarpa	clustered wild rose	shrub	perennial	May–July	moist–wet	sun–shade
RUPA	Rubus parviflorus	thimbleberry	shrub	perennial	May–July	dry–moist	sun–shade
RUSP	Rubus spectabilis	salmonberry	shrub	perennial	Mar–Jun	moist–wet	sun–shade
RUUR	Rubus ursinus	trailing blackberry	shrub	perennial	Apr–Aug	dry–moist	sun–shade
SALU	Salix lucida	Pacific willow	shrub	perennial	Apr–May	moist–wet	sun–part shade
SARA	Sambucus racemosa var racemosa	red elderberry	shrub	perennial	May–July	dry–moist	sun–shade
SCAC	Scripus acutus	hardstem bulrush	grass	perennial	Apr–May	wet	sun
SCMI	Scripus microcarpus	panicled bulrush	grass	perennial	May–Jun	wet	sun–part shade
SIKE	Sidalcea kendrsonii	checker mallow	forb	perennial	Jun–Aug	moist–wet	sun
SOCA	Solidago canadensis	Canada goldenrod	forb	perennial	Jun–Sep	dry–moist	sun–part shade
SPDO	Spirea douglasii	hardhack	shrub	perennial	May–July	moist–wet	sun–part shade
SYAL	Symphoricarpos albus var. laevigatus	common snowberry	shrub	perennial	May–Aug	dry–moist	sun–shade
TEGR	Tellima grandiflora	fringecup	forb	perennial	Apr–July	moist	part shade–shade
TITR	Tiarella trifoliata var trifoliata	threeleaf foamflower	forb	perennial	May–Aug	moist	part shade–shade
TOME	Tolmiea menziesii	youth-on-age	forb	perennial	May–Aug	dry–moist	part shade–shade
TROV	Trillium ovatum ssp. ovatum	western trillium	forb	perennial	Mar–May	dry–moist	part shade–shade
VAOV	Vaccinium ovatum	evergreen huckleberry	shrub	perennial	Apr–July	dry–moist	part shade–shade
VAPA	Vaccinium parvifolium	red huckleberry	shrub	perennial	Mar–May	dry–moist	part shade–shade

Source: Own creation with information from Forterra (n.d.-d); Forterra (n.d.-a); King County (n.d.); Washington Native Plant Society (n.d.).

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Appendix H: Budget Options

Budget 1: The city establishes a standalone urban forestry advisory board.

Department	Expenditures	Year 1	Year 2	Year 3	Year 4	Year 5
CED	0.50 FTE - Associate Planner	57,500	59,442	61,450	63,526	65,672
CED	0.15 FTE - Neighborhood Coordinator	16,800	17,367	17,954	18,561	19,188
Parks	0.25 FTE - Recreation Coordinator	26,014	26,892	27,801	28,740	29,711
PWE	0.10 FTE - Administrative Assistant	11,794	12,192	12,604	13,030	13,470
	Subtotal Salaries and Benefits	**112,108**	**115,894**	**119,809**	**123,856**	**128,040**
CED	Comprehensive Tree Assessment	100,000	0	0	0	0
CED	Contract Arborist	35,000	35,000	40,000	50,000	50,000
Parks and PWE	Contract Tree Maintenance and Planting	0	40,000	80,000	120,000	160,000
	Subtotal Professional Services	**135,000**	**75,000**	**120,000**	**170,000**	**210,000**
Parks and PWE	Purchase Trees	0	25,000	50,000	75,000	100,000
All	Volunteer Maintenance and Planting Supplies	0	5,258	5,258	2,629	876
All	General Office and Operating Supplies	1,035	1,035	1,035	1,035	1,035
	Subtotal Supplies and Indirect Costs	**1,035**	**31,293**	**56,293**	**78,664**	**101,911**
	Total Expenditures	**248,143**	**222,187**	**296,102**	**372,520**	**439,951**
	Difference from Budget B	*(10,055)*	*(12,290)*	*(10,746)*	*(11,109)*	*(11,484)*

Ownership	Priorities	Year 1	Year 2	Year 3	Year 4	Year 5
CED and Parks	Standardize Citywide Tree Maintenance Practices	x				
PWE	Evaluate and Update Surface Water Fee Usage	x	x			
CED	Coordinate Contract Arborist Work	x	x	x	x	x
CED and Parks	Community Outreach and Engagement	x	x	x	x	x
CED and Parks	Volunteer Recruitment and Appreciation	x	x	x	x	x
CED and Parks	Explore External Partnerships and Funding	x	x	x	x	x
CED, Parks, and PWE	Coordinate UFP priorities	x	x	x	x	x
CED, Parks, and PWE	Trees planted @ $250 per tree	0	100	200	300	400
	Change in trees planted annually	*0%*	*100%*	*100%*	*50%*	*33%*
	Percentage volunteer-led tree planting	*0%*	*50%*	*50%*	*50%*	*50%*

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Budget 2: The city does not establish a standalone urban forestry advisory board. This includes the Parks and Recreation Advisory Board establishing urban forestry as one of their priorities.

Department	Expenditures	Year 1	Year 2	Year 3	Year 4	Year 5
CM Office	Full-Time Program Administrator	122,162	128,185	130,555	134,965	139,524
	Subtotal Salaries and Benefits	**122,162**	**128,185**	**130,555**	**134,965**	**139,524**
CM - Program Admin	Comprehensive Tree Assessment	100,000	0	0	0	0
CM - Program Admin	Contract Arborist	35,000	35,000	40,000	50,000	50,000
CM - Program Admin	Contract Tree Maintenance and Planting	0	40,000	80,000	120,000	160,000
	Subtotal Professional Services	**135,000**	**75,000**	**120,000**	**170,000**	**210,000**
CM - Program Admin	Purchase Trees	0	25,000	50,000	75,000	100,000
CM - Program Admin	Volunteer Maintenance and Planting Supplies	0	5,258	5,258	2,629	876
CM - Program Admin	General Office and Operating Supplies	1,035	1,035	1,035	1,035	1,035
	Subtotal Supplies and Indirect Costs	**1,035**	**31,293**	**56,293**	**78,664**	**101,911**
	Total Expenditures	**258,197**	**234,478**	**306,848**	**383,629**	**451,435**
	Difference from Budget A	*10,055*	*12,290*	*10,746*	*11,109*	*11,484*

Coordinated with	Priorities	Year 1	Year 2	Year 3	Year 4	Year 5
CED and Parks	Standardize Citywide Tree Maintenance Practices	x				
PWE	Evaluate and Update Surface Water Fee Usage	x	x			
CED	Coordinate Contract Arborist Work	x	x	x	x	x
CED and Parks	Community Outreach and Engagement	x	x	x	x	x
CED and Parks	Volunteer Recruitment and Appreciation	x	x	x	x	x
CED and Parks	Explore External Partnerships and Funding	x	x	x	x	x
CED, Parks, and PWE	Coordinate UFP priorities	x	x	x	x	x
CED, Parks, and PWE	Trees planted @ $250 per tree	0	100	200	300	400
	Change in trees planted annually	*0%*	*100%*	*100%*	*50%*	*33%*
	Percentage volunteer-led tree planting	*0%*	*50%*	*50%*	*50%*	*50%*

Appendix I: Budget Assumptions

The underlying assumptions for each budget are detailed below. The assumptions are delineated based on budget:

- Budget A: Expenditures that only apply to Budget A
- Budget B: Expenditures that only apply to Budget B
- Budgets A & B: Expenditures that apply to both Budget A and Budget B

BUDGET A: Standalone Urban Forestry Advisory Board

Staffing

Program Administrator – 1 FTE – City Manager's Office

This position is equivalent to the current Assistant to the City Manager / Policy Analyst position. This equivalent is based on conversations with our client indicating that the City Manager's office could be suitable for this position for the initial years of the UFP and that this position equivalent would be appropriate.

To account for potential differences in qualifications and benefit selections, we used three different sources of reported salary and benefits for this position. We began by pulling the city's budgeted salary and benefits for this position in 2023. The second source we used is the salary range listed on the original job posting, which ranges from $81,096 to $102,876.

The projected benefit costs in 2023 and 2024 are 38.97% and 38.89% of salaries for the respective year. To calculate unknown benefit costs for the low and high salary ranges, we used an average percentage of 38.93%.

To calculate annual compensation increases over the five-year period, we examined the average increase from 2023 to 2024 for all departments relevant to UFP activities, specifically the City Manager's Office, Community and Economic Development (CED), Parks, Recreation, and Community Services (PCSD), and Public Works Engineering (PWE). To provide the most conservative estimate, we used the CED average increase of 3.38% annually, as it is the highest across departments. Table 14 below shows the five-year compensation projections.

Table 14: Program Coordinator - Compensation Estimates

Source	Year 1	Year 2	Year 3	Year 4	Year 5
2023-2024 Proposed Budget	110,898	114,644	118,517	122,520	126,659
Online Job Description - Low Range	112,665	116,471	120,405	124,473	128,677
Online Job Description - High Range	142,924	147,752	152,743	157,902	163,236
Average Salary and Benefits	**122,162**	**128,185**	**130,555**	**134,965**	**139,524**

Budget B: No Standalone Urban Forestry Board

Staffing

Associate Planner – 0.5 FTE – Community Economic Development

This estimate is based on guidance provided by the city using expenditures that were approved in the 2023-2024 Biennial Budget. The city has approved funding for one limited-term Associate Planner in CED for 2023 and 2024. We project the expenditure to be extended for an additional three years. We estimate that this position would spend 50% of their time on urban forestry activities. We used the 2023 to 2024 compensation increase for CED of 3.38% to estimate salary and benefits over five years. This expenditure is intended to be offset by Tree Preservation Revenue.

Neighborhood Coordinator – .15 FTE – Community Economic Development

This estimate is based on guidance provided by the city using expenditures that were approved in the 2023-2024 Biennial Budget. The city has approved funding for one limited-term Neighborhood Coordinator in CED for 2023 and 2024. We projected the expenditure to be extended for an additional three years. We estimate this position will spend 15% of the time on urban forestry activities. We used the 2023 to 2024 compensation increase for CED of 3.38% to estimate salary and benefits over five years.

Recreation Coordinator – 0.25 FTE – Parks, Recreation, and Community Services

This estimate is based on the 2023 salary and benefits for a Recreation Coordinator in PRCS. We choose a coordinator-level position to align with the Neighborhood Coordinator in CED. We estimate that this position will spend 25% of the time on urban forestry activities. We used the 2023 to 2024 compensation increase for CED of 3.38% to estimate salary and benefits over five years.

Administrative Assistant – 0.1 FTE – Public Works Engineering

This estimate is based on the 2023 salary and benefits for the PWE Administrative Assistant (City of Lakewood Career Pages, n.d.). This position currently splits time across three PWE divisions, so this position would not ultimately carry out urban forestry activities. Therefore, this position is used solely for compensation estimation purposes. We estimate that this position will spend 10% of the time on urban forestry activities. We used the 2023 to 2024 compensation increase for CED of 3.38% to estimate salary and benefits over five years.

Table 15 summarizes the annual compensation estimates for each position.

Table 15: Existing FTE Compensation Estimates

FTE % and Position	Year 1	Year 2	Year 3	Year 4	Year 5
1 FTE - Associate Planner	115,000	118,885	122,900	127,052	131,344
0.5 FTE - Associate Planner	**57,500**	**59,442**	**61,450**	**63,526**	**65,672**
1 FTE - Neighborhood Coordinator	112,000	115,783	119,694	123,738	127,917
0.15 FTE - Neighborhood Coordinator	**16,800**	**17,367**	**17,954**	**18,561**	**19,188**
1 FTE - Recreation Coordinator	104,054	107,569	111,202	114,959	118,842
0.25 FTE - Recreation Coordinator	**26,014**	**26,892**	**27,801**	**28,740**	**29,711**
1 FTE - Neighborhood Coordinator	112,000	115,783	119,694	123,738	127,917
0.1 FTE - Neighborhood Coordinator	**11,200**	**11,578**	**11,969**	**12,374**	**12,792**

Budgets A and B: Applicable to both budgets

Professional Services

Comprehensive Tree Assessment

This estimate is based on our interview with Issaquah's and Vancouver's UFP program directors. The final expenditure would change depending on the total size of the land assessed and other conditions such as the timeline and extent or details of the assessment.

Contract Arborist

This estimate is based on guidance provided by the city using expenditures that were approved in the 2023-2024 Biennial Budget. The contract arborist labor is estimated at $35,000 in 2023 and 2024 and coordinated by CED. Tree Preservation Revenue is expected to offset this expenditure for 2023 and 2024.

We have projected the expenditure to be extended for an additional three years and to increase in Years 4 and 5 to align with the city's increased urban forestry activities.

Contract Operations and Maintenance

We used existing city contract tree labor estimates in this assumption. On page 258 of the city's 2023-2024 biennial budget, the city approved $32,000 in contract tree planting and maintenance for 40 trees. We used a simple calculation to estimate the cost of contract labor at $800 per tree planted.

The total expenditure each year is based on the projected number of trees planted and the amount of volunteer engagement each year. The assumption for the number of trees planted each year is outlined under "Purchase Trees" below. We estimate that volunteers will plant 50% of all trees planted each year for the first five years. As the program grows and as volunteer-led planting increases, the percentage of trees planted by contract labor will decrease.

Supplies and Indirect Costs

Purchase Trees

This estimate is based on current inventory and prices provided by Puget Sound Plants. Based on interviews with case study UFPs, the city should consider planting more mature trees to promote successful planting. Based on current availability at their Olympia nursery, the average price for a larger tree (i.e., trees sold in at least a #7 container) is $244. Based on this average, we used a cost of $250 per tree in our estimate. However, this cost could vary greatly depending on the sizes of trees purchased and the vendor.

The number of trees planted each year is based on the city beginning with a low number of plantings in Year 2 and increasing the number of trees planted by 100 each year as program capacity and volunteer efforts grow.

Volunteer Maintenance and Planting Supplies

This estimate is based on maintenance costs and small tools and minor equipment costs in other city departments. We used departments with activities and supply costs comparable to volunteer planting and maintenance activities, such as gloves, parks maintenance, herbicides, and others. The estimate included in both budgets is the average for the comparable costs in Lakewood's biennial budget.

General Office and Operating Supplies

This estimate is also based on comparable approved costs for other departments in Lakewood's biennial budget. Some examples include City Manager/Communications, Administrative Services, CED, PRCS, and Legal departments. The number included in the budget options is the average of all comparable identified costs in the approved biennial budget.

Indirect Costs

If the city uses user-charges, such as stormwater fees, to fund the UFP, it should include indirect costs in the program's budget to account for overhead costs. The U.S. Government has different best practices to estimate indirect costs, which are usually expressed as a percentage of total direct costs (TDC) or the modified total direct costs (MTDC) and can go from 10% to 40% depending on the project (University of Idaho, n.d.; USAID, 2017). If user-charges are used in the future, Lakewood can add the base 10% for indirect costs, given that the new program will not represent significant overhead costs of no more than 3 FTE in the first five years. Ten percent of total direct costs represent at least $25,000 in both budget options presented in this report, the minimum monetary value recommended (University of Idaho, n.d.; USAID, 2017).

Proposed Natural Environment & Climate Change (NECC) Program

February 10, 2025
City Council

Tiffany Speir, Planning Division Manager

Background

In recent years, Lakewood has taken a number of policy and regulatory steps to address various environmental concerns, including tree preservation, tree canopy increase, urban forestry, energy efficiency, and climate change preparation and resiliency (including hazard management planning.) State law was also recently updated to require local governments to make more specific climate change-related changes to their policies and regulations by 2029.

Recommendation

In order to best integrate these efforts into an organized, resource-efficient, and cost-efficient body of work, the **City is recommending replacing the 2022 Three Year Energy & Climate Change Work Plan with a "Natural Environment and Climate Change" ("NECC") Program, which would include:**

- **compiled policy direction from existing City initiatives and priorities;**
- **a 10+ year Implementation Plan; and**
- **a 3-5 year Work Plan.**

Status of Implementing the 2022 Three Year Energy & Climate Change Work Plan

The 2022 Three Year Energy & Climate Change Work Plan included 15 items.

As of February 2025:
- 9 items are complete,
- 4 are ongoing, and
- 2 are not started.

1	Establish (and regularly update) a new climate change chapter to the City's Comprehensive Plan.	Complete.
2	Develop a five-year plan for reducing greenhouse gas emissions.	Not started
3	Update the City's Non-motorized Transportation Plan (also referred to as Active Transportation Plan.)	Complete
4	Clover Creek Floodplain Engineering Alternatives Analysis.	Complete
5	Review, and as appropriate, update Lakewood Municipal Code (LMC) Title 14, Environmental Protections.	Complete.
6	Work with Pierce County and Pierce County municipalities to develop a regional approach and best practices to address climate change. One strategy: adopt revised climate change Pierce Countywide Planning Policies (CPPs.)	Ongoing
7	Develop a public engagement plan for climate change (and Comprehensive Plan periodic update.)	Complete
8	Incorporate an environmental justice assessment into the Energy & Climate Change Chapter work plan.	Complete
9	Lakewood, as a member of the South Sound Military Communities Partnership (SSMCP), advocate for improvements to the I-5 corridor the Nisqually Delta at both the state and federal levels.	Ongoing
10	Revise the Lakewood's tree preservation code.	Complete
11	Explore the feasibility of reducing the City hall footprint from three floors to two floors. (Potentially reducing energy consumption.)	Complete
12	Every two years, or as otherwise dictated by WA State, update LMC Title 15, Buildings and Construction Codes to address hazards resulting from climate change.	Ongoing
13	Support the implementation of the Tacoma-Pierce County Solid Waste Management Plan.	Complete
14	Coordinate a regional electric vehicle (EV) infrastructure strategy with neighboring cities, Pierce County and the State.	Not started
15	Develop/promote an urban forest management/ master reforestation plan.	Ongoing

Why a Natural Environment and Climate Change (NECC) Program?

The NECC program is intended coordinate and consolidate existing required and voluntary actions that the City will conduct over the next 10+ years. Priorities, policies, data and action items from existing sources are the basis of the NECC program and are listed here in chronological order:

- 2022 Lakewood Tree Canopy Cover Analysis;
- 2022 Three Year Energy & Climate Work Plan;
- 2023 E2SHB 1181 ("Improving the state's response to climate change by updating the state's planning framework");
- 2023 *Establishing the Roots of Urban Forestry in Lakewood, WA: An Implementation Guide*;
- 2024 Comprehensive Natural Environment (NE) and Energy & Climate Change (ECC) Elements;
- 2024 Energy Efficiency Community Block Grant (EECBG) Program;
- 2024 Lakewood Urban Forest Assessment Report;
- 2024 Pierce County Heat Watch Report; and
- 2024 Pierce County Canopy Analysis Report.

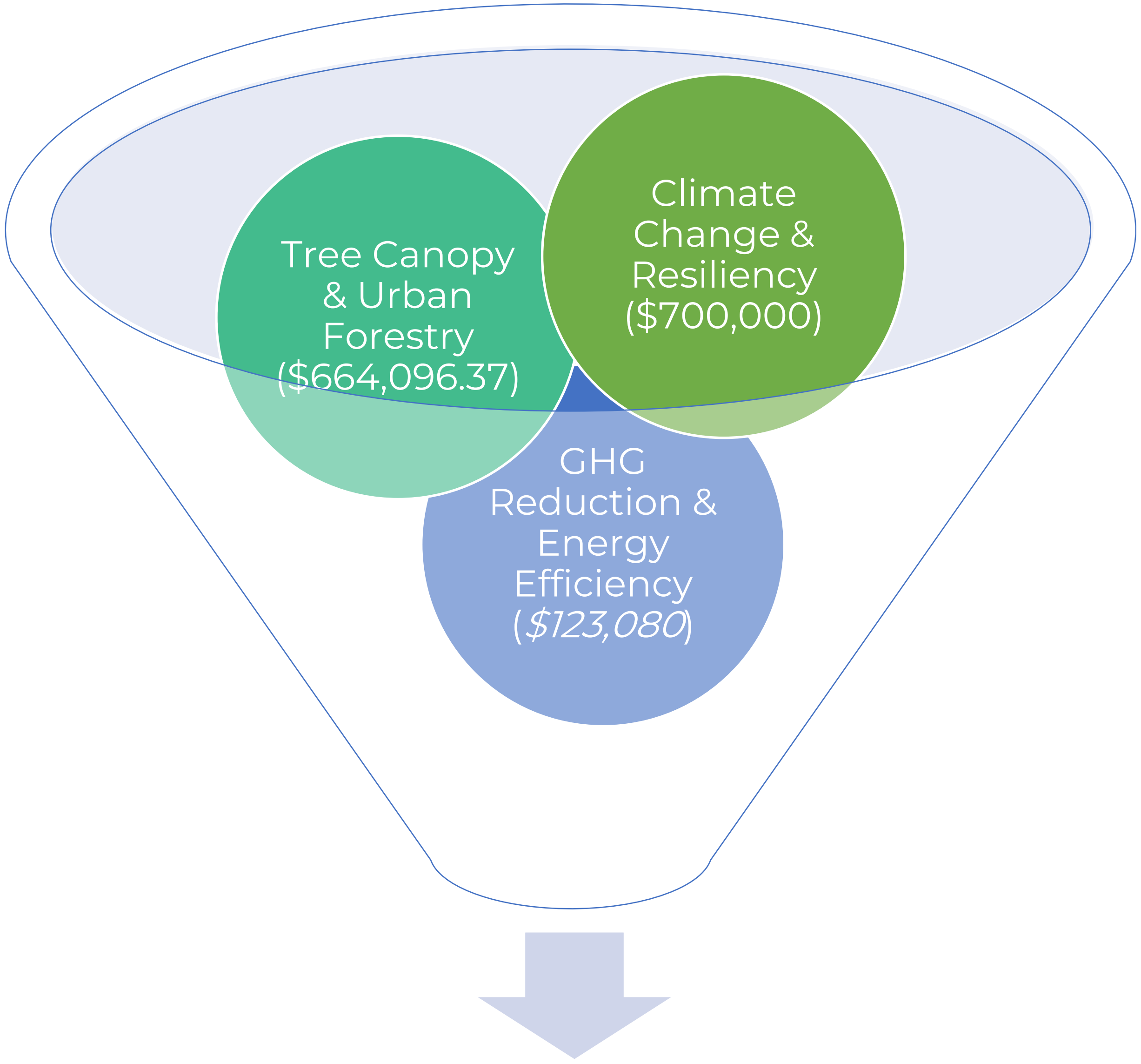
Currently Identified Funding for Individual Items proposed for NECC Program

- City ARPA Funds: $190,000 (must be spent by 12/31/26)
- City Tree Fund: $474,096.37
- WA Commerce: $700,000* (to be spent by 6/30/29)
- Federal Energy Efficiency Community Block Grant: $123,080**

TOTAL: *$1,487.176.37*

**awarded by State each biennium 2023-2029*

***pending approval*



Natural Environment & Climate Change Program (NECC) (*$1,487.176.37*)

Note: The recommended NECC program **would not propose new policies, strategies, or actions**. Rather, it would incorporate items from existing initiatives and priorities previously approved by the City Council and/or required by state law.

Note: The recommended NECC program **would be cross-departmental**, meaning not only PPW, but also PRCS, Communications, Legal, and even LPD would be involved in implementing different parts of it over time.

Note: There are other ongoing efforts related in some way to what the NECC program would encompass, such as the 2026 update to the Parks Legacy Plan and the development of the 2025-2029 Pierce County Hazard Mitigation Plan. **Internal coordination will occur across departments to ensure consistency.**

NATURAL ENVIRONMENT AND CLIMATE CHANGE PROGRAM (NECC)

The purpose of the Lakewood NECC Program is to address City priorities and goals related to urban forestry management, tree canopy improvement and maintenance, climate change and resiliency, energy efficiency, and greenhouse gas emission reduction.

<u>Goals</u>

I. Tree Canopy Increase and Maintenance

- Achieve 40% citywide tree canopy cover by 2050
- Partner with agencies/organizations to promote voluntary tree planting on private property

II. Urban Forestry Program Launch and Maintenance

- Create administrative capacity within the exiting City organizational structure to handle program budget, implementation and monitoring.

III. Climate Change & Resiliency Goals and Regulations

- Comply with E2SHB 1181 by 12/31/2029

IV. Greenhouse Gas Emissions Reduction

- Meet PSRC 4-part GHG emissions goals
- Meet State of WA GHG emissions goals

V. Energy Efficiency Improvements in City Operations and Community

- Increase energy efficiency in City buildings and operations
- Educate, encourage, and incentivize/require residential and commercial/industrial energy efficiency improvements

Strategies for 10+ Year Implementation Plan and 3-5 Year Work Plan

From 2022 Three-Year Energy and Climate Work Plan

- Develop a five-year plan for reducing greenhouse gas emissions.
- Work with Pierce County and Pierce County municipalities to develop a regional approach and best practices to address climate change. One strategy: adopt revised climate change Pierce Countywide Planning Policies.
- Lakewood, as a member of the South Sound Military Communities Partnership (SSMCP), advocate for improvements to the I-5 corridor the Nisqually Delta at the state and federal levels.
- Every two years, or as otherwise dictated by Washington State, update LMC Title 15, Buildings and Construction Codes to address hazards resulting from climate change.
- Coordinate a regional electric vehicle (EV) infrastructure strategy with neighboring cities, Pierce County and the State*
- Develop/promote an urban forest management/master reforestation plan.

Strategies for 10+ Year Implementation Plan and 3-5 Year Work Plan

From EECBG Award (if awarded)

2025-2027

- Energy data collection to assist in reducing fossil fuel emissions, reducing total energy use, or improving energy efficiency;
- Developing an energy vision, goals, and strategies;
- Conducting stakeholder outreach, engagement, and education; and
- Writing, adopting, and publicizing updated Comprehensive Plan element(s) and ECC Work Plan to reflect results.

Strategies for 10+ Year Implementation Plan and 3-5 Year Work Plan

From E2SHB 1181 Requirements

2025-2027 (*Pending state funding approval*)

- Establish a Climate Policy Advisory Team (CPAT) to help guide the NECC implementation process by providing perspectives and recommendations relating to community development, the environment, transit, education, business, and more. CPAT members will be engaged periodically to review and comment on work products and guide public engagement.

- Update the Lakewood Comprehensive Plan Climate Change and Resiliency Element to include a Greenhouse Gas (GHG) sub-element and climate resiliency sub-element consistent with E2SHB 1181:
  - develop a local emission inventory, conduct a Vehicle Miles Traveled Per Capita (VMT) study, and project emission reductions to inform the adopted Comprehensive Plan goals and policies; and
  - explore expected local climate impacts; audit existing plans and policies for climate resilience opportunities, gaps, and barriers; assess local assets' climate vulnerability and risk; and develop and prioritize science-based climate resilience goals and policies for Comprehensive Plans.

Strategies for 10+ Year Implementation Plan and 3-5 Year Work Plan

From E2SHB 1181 Requirements

2025-2027 (*Pending state funding approval*)

- Update the Land Use Element to:
    - include green spaces, urban and community forests. Give special consideration to achieving environmental justice in the element's goals and policies; and
    - reduce and mitigate the risk to lives and property posed by wildfires by using land use planning tools.

Strategies for 10+ Year Implementation Plan and 3-5 Year Work Plan

From E2SHB 1181 Requirements

2027-2029 (*Pending state funding approval*)

- Update the Transportation Element Traffic Demand Forecast to:
  - address multimodal transportation demand forecasts and needs; and
  - address forecasts of traffic demands and needs outside of the City to inform an element that balances transportation system safety and convenience to accommodate all users of the transportation system to safely, reliably, and efficiently provide access and mobility to people and goods.
- Update the Transportation Element to:
  - include estimated multimodal level of service impacts, giving priority to inclusion of transportation facilities and services providing the greatest multimodal safety benefit to each category of roadway users for the context and speed of the facility;
  - include an inventory of active transportation facilities and multimodal level of service standards for all locally owned arterials, locally and regionally operated transit routes that serve urban growth areas, state-owned or operated transit routes that serve urban areas, and active transportation facilities; and
  - include an Americans with Disabilities Act (ADA) Transition Plan.
- Develop an Urban Heat Resilience Strategy.
- Develop Native & Climate-Resilient Planting Plans for Municipal Projects.
- Update the City's Urban Forest Management/Master Reforestation Plan.

Discussion

Is the City Council supportive of adopting a NECC Program?

Thank you!

City of
Lakewood