URBAN FOREST ASSESSMENT RESULTS

Prepared for the City of Tumwater
January 2020

PENINSULA ENVIRONMENTAL GROUP, INC.
Community Specific — Resource Specific Planning

Urban Forest Assessment Results

January 2020

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1. INTRODUCTION

Trees measurably improve the livability of cities as they amplify human experience and wellbeing through environmental, economic and social benefits. Accessible, accurate and actionable urban forest and tree resource planning accelerates and strengthens the benefits received from urban and community forests. With this understanding, the City of Tumwater Tree Board commissioned a study on urban forest resources within the City. This report outlines the purpose, methods and results of multiple urban forest assessments and inventories undertaken by the City of Tumwater and Peninsula Environmental Group, Inc. in 2018 and 2019. Information presented in this report will guide leaders, planners and the community towards successful urban forest planning and resilient resource management.

Tumwater's historical and geographical context, as one of Washington's first settlements and the southernmost point of the Puget Sound and terminus of the Deschutes River, are important factors when understanding the emphasis, it's leaders place on natural resources, of which the urban forest is an important element. To reinforce this importance, City of Tumwater's leaders identified the desire to *Be a Leader in Environmental Sustainability* as a Strategic Priority and Goal for 2019-2024[1].

The City's Urban Forestry Consultants (UFC) conducted urban forest assessments and inventories including a significant street tree inventory, two geospatial urban tree canopy assessments, and a green spaces inventory. This report will be used in preparation of the 2020-2040 Tumwater Urban Forest Management Plan. Table 1 summarizes the different scales, geographic focuses, strategies and methods for each different assessment. Each section within this document describes the purpose, methods, brief data analysis and summary.

[1] City of Tumwater Council Resolution R2018-020

A STREET TREE INVENTORY was conducted on all trees growing within or near sidewalks in Tumwater. These include all residential trees installed in sidewalks and street trees on the sides of main roads. In total roughly 3,500 trees were identified and inventoried. Our inventory data aligned with the United States Forest Service's (USFS) i-Tree protocol for easy data migration into the software. In addition to the i-Tree data points, the urban forest team collected data on sidewalk displacement and planter types in order to study relations between tree species and hardscape damages.

GREEN SPACES owned by the City of Tumwater, including undeveloped natural areas, developed parks, and hybrid locations, were inventoried and assessed to prioritize their management. The urban forest team identified highly effective landscapes and those landscapes tolerance and associated threat in relation to forest pathogens and noxious weeds. In addition to rapid green space assessment and applied management perspectives, this inventory allows the City to understand green space equity and associated environmental justice. Understanding spatial proximity these healthy and unhealthy green spaces to schools, neighborhoods, and transit corridors allows for long-term planning of zoning and green space investment.

URBAN TREE CANOPY ASSESSMENTS were conducted using 2011 and 2017 datasets, with an auxiliary analysis on 2018 information. The goal of the Tumwater urban tree canopy (UTC) assessment is to aid in City-wide and long-term management decisions influencing the percentage of urban forest canopy across the city. This geospatial assessment works with image classification software utilizing recent aerial orthoimagery, near-infrared imagery, and LiDAR, to differentiate land cover types.

On additional inventory was conceptualized but not carried out: an i-Tree Eco plot-based ecosystem services inventory. This inventory is similar to the i-Tree Eco Street Tree inventory, but incorporates other components of the urban landscape, including hard surfaces and built infrastructure. The result is a more in-depth understanding of urban ecosystem services beyond the benefits of street trees.

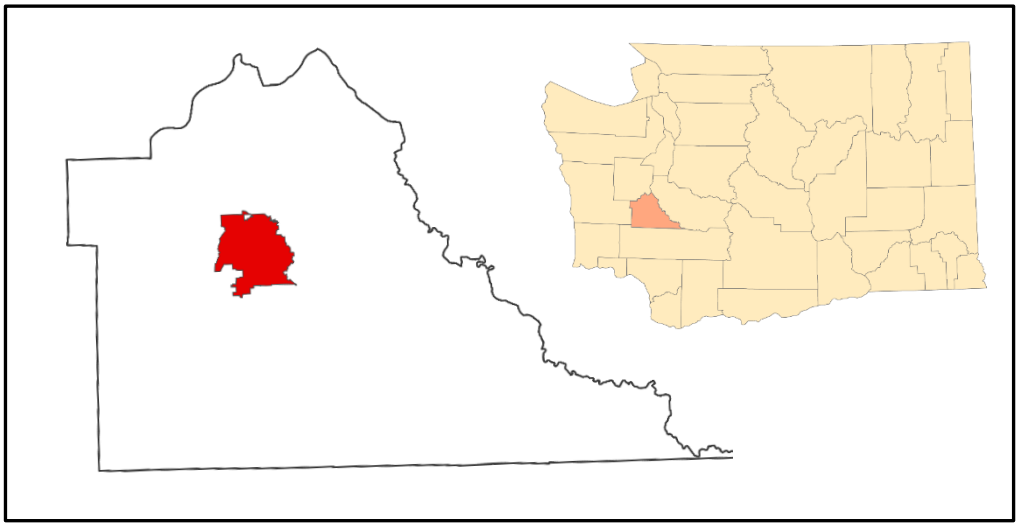


Figure 1: Tumwater is part of Thurston County in the South Sound of Washington.

Table 1: Summary Comparison of Methods Used and Proposed in Tumwater's Urban Forest Assessments.

ASSESSMENT	SCALE	INFORMS
 **STREET TREE INVENTORY**	Individual trees	• Provides location, condition, and maintenance objectives on street trees. • Identifies infrastructure conflicts with trees. • Can be used with asset management software for informing in real-time. • i-Tree analysis on individual trees.
 **GREEN SPACES INVENTORY**	Forested and natural management units	• Forest management prioritization framework. • Identified high and low priority management units.
 **URBAN TREE CANOPY ASSESSMENT**	Tumwater urban growth area and land use	• Informs tree canopy preservation and planting goals across multiple zoning and land use boundaries. • Used in City-wide Canopy Cover Goals.
 **ECOSYSTEM SERVICES INVENTORY**	Tumwater urban growth area and land use	• Model estimates ecosystem functions and economic values based on collected data. • i-Tree Eco plot driven ecosystem service tabulation, including urban forest values.


Certified Arborists

2. STREET TREE INVENTORY

2.1. PURPOSE & EXTENT

An extensive street tree inventory was conducted in 2018 to capture information on tree assets growing in or affecting the public right-of-way. All street trees and street tree stumps on city sidewalks in the City of Tumwater and Urban Growth Area (UGA) were inventoried. Criteria for street tree selection were trees growing between a street and a sidewalk, or within a sidewalk. This includes trees planted in cutouts, sidewalk strips, boulevards, or freeform planting areas. We did not inventory trees on the interior, or landowner side, of sidewalks but rather only those facing the street right-of-way. Large, landmark and historical trees throughout the City were inventoried where they were recognizable and accessible via the public right-of-way, or on city-owned property.

Data collected from trees followed the specifications of the United States Forest Service's (USFS) i-Tree Eco software. Beyond the USFS i-Tree Eco required data, additional information was collected planter type, the proximity of the tree to curbs, streets and sidewalks, and any damage to those hard surfaces.

Street trees often substantially affect human lives and wellbeing due to their accessibility. These factors make the sustainable management and proper care and maintenance of street trees important. Through this base-line inventory, Tumwater can begin managing street trees as assets similar to other essential city infrastructure.

2.2. METHODOLOGY

The City of Tumwater provided a GIS layer depicting locations of all public, city-owned sidewalks. Using this layer, and 2017 aerial imagery, sidewalks across the city were assessed remotely to determine presence of trees. These areas were divided into subsets for inventor crews. The City advertised and facilitated Urban Forestry volunteer groups between July 2018 and September 2018. These volunteer groups were led by UFC arborists or foresters, with data collected on tablets with survey software developed by UFC.

Volunteer events were carried out one weekend a month in June, July, August, and September of 2018. Volunteers were trained with a brief training and safety meeting held at Tumwater City Hall the

morning of the events. Trees in busy commercial and industrial areas were inventoried solely by the UFC to minimize exposure to volunteers. After the primary inventory phase, the UFC and City of Tumwater staff identified any areas which still required surveying, and they were assessed for matching criteria.

The volunteer field crew's tools included a tablet with connectivity, a Bluetooth GPS sensor, a Biltmore stick, yard sticks, compass and a rangefinder. A complete list of data points collected, their definitions, and their available attributes, are in the appendix.

2.3. RESULTS

In total around 3,500 trees were inventoried. The vast majority of street trees inventoried (roughly 97%) were deciduous broadleaf trees, and generally young to adolescent (53% identified as less than 6" diameter.). Acer (maple), Prunus (apples, cherries, plums) and Pyrus (pears) represent over 50% of the total species identified. Conditions of the street trees averaged 3.85 for the top 10 tree species, where Good is 4 and Fair is 3.

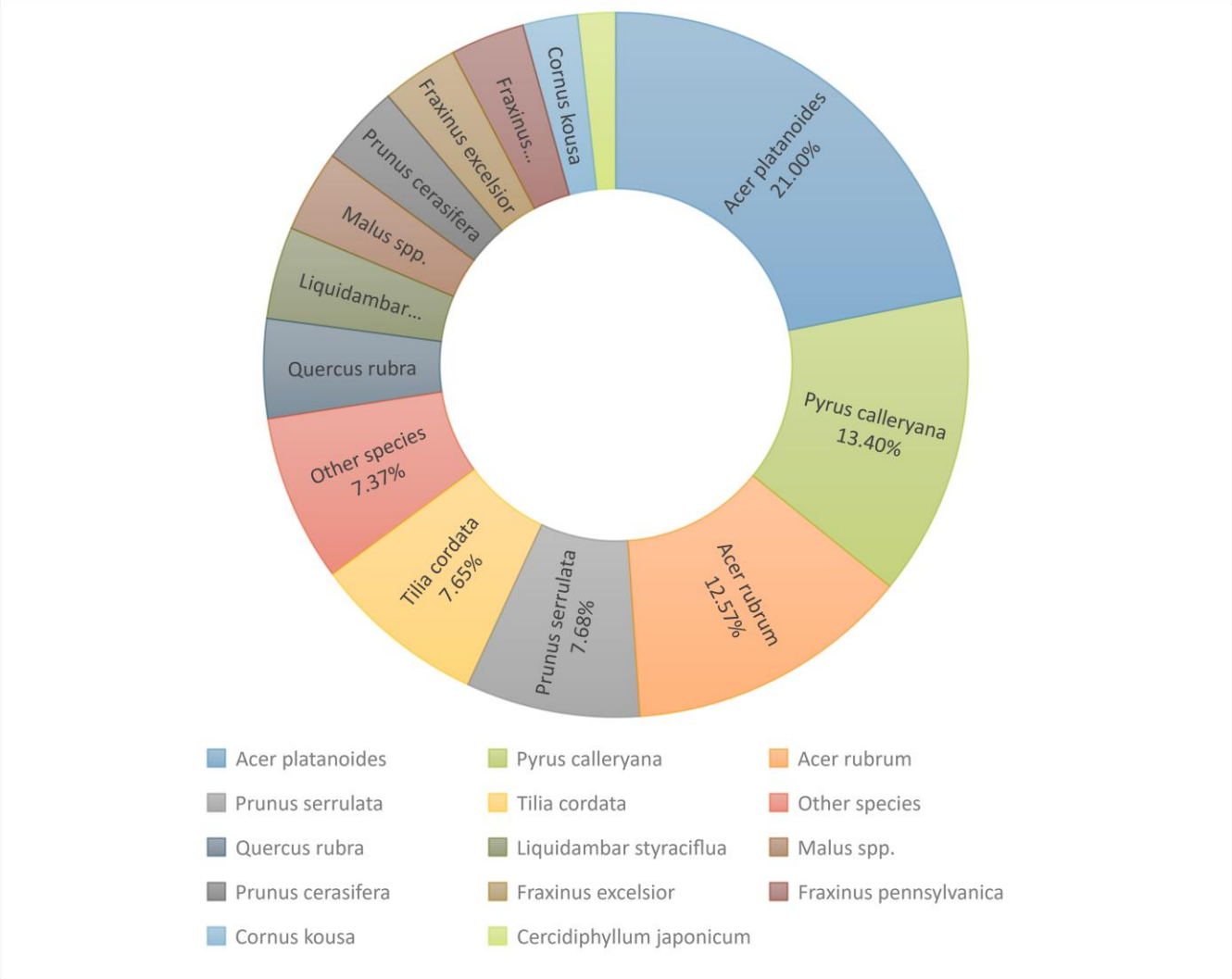
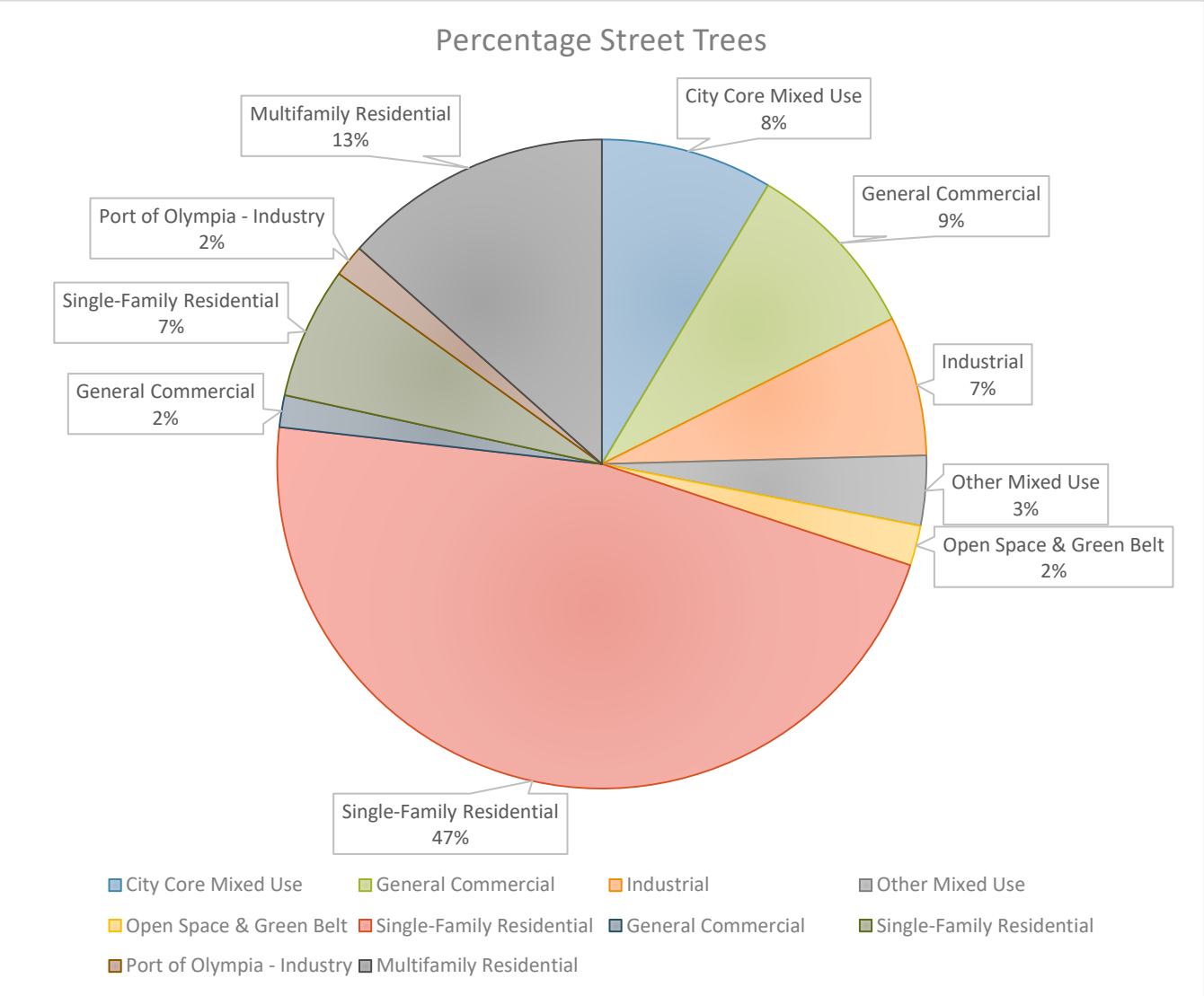


Figure 2: Top 15 street tree species

Figure 3: Street tree percentage by Tumwater Zone District.



Street trees inventoried across Tumwater primarily lay in the Singe-Family Residential areas, followed by Multifamily Residential areas. The comprehensive 2018 street tree inventory cataloged the composition and distribution of Tumwater's street trees. The 10 top tree species inventories include of maple, pear, cherry, linden among others. Their conditions generally ranged from poor to good out of seven total condition classes. These condition classes were taken directly from the i-Tree Eco Street Tree protocol and include excellent, good, fair, poor, critical, dying and dead.

Results from the i-Tree Eco analysis on tree benefits indicate 587.3 pounds of air pollution are intercepted by street trees annually. These same street trees sequester 10.44 tons of carbon annually while total sequestered carbon among street trees is 291 tons. Avoided stormwater runoff is primarily achieved through larger trees, including the Norway maple while consists 21% of Tumwater's street trees. These maples reduce surface water runoff by approximately 28,000 cubic feet per year.

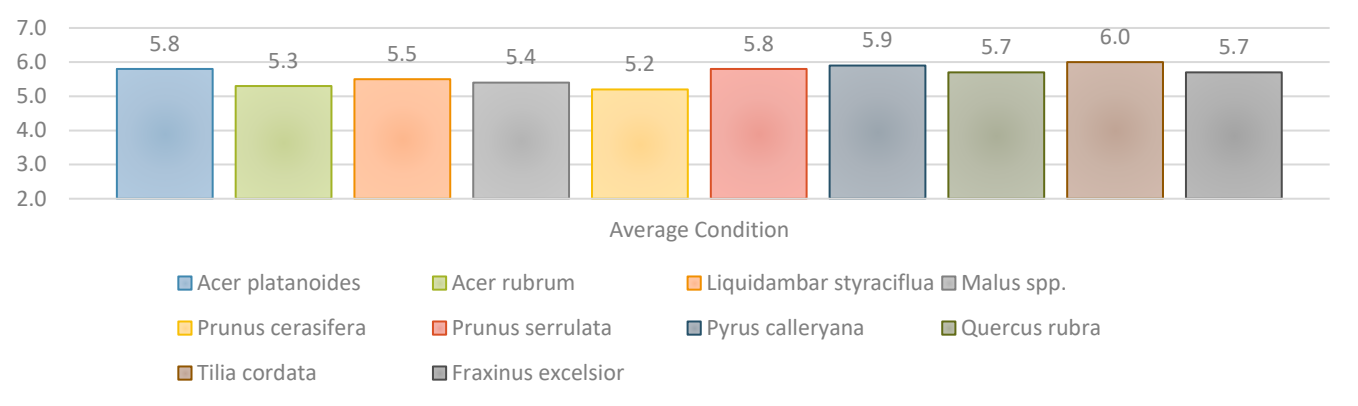
To determine an approximate tree age composition of the 3,500 inventoried trees, the measured diameters were analyzed using a tree age model (Łukaszkiewicz and Kosmala 2008[2]). The model estimated that 53% of the street inventoried trees were less than 10 years old and 82% were less than 25 years old. This means the majority of Tumwater's street trees are young and some have achieved only one-quarter of their life span.

Proper care and maintenance of Tumwater's young and adolescent trees will support long-term urban forest health and green space access across the City.

RANKING	SPECIES	%
1	Norway maple	21%
2	Callery pear	13%
3	Acer rubrum	12%
4	Flowering cherry	8%
5	Littleleaf linden	8%
6	Northern red oak	4%
7	Sweetgum	4%
8	Flowering apple	4%
9	Cherry plum	4%
10	European ash	3%

Table 2: Above, top 10 Street Tree Species

Figure 4: Below, average conditions of top 10 species.



Diversity and abundance of street tree species are important in developing a resilient urban forest. A diverse ecological community is a strong one. Pests and diseases affect diverse plantings less than monocultures. In general, no single landscape (non-native) tree species should represent more than 8 to 15% of an urban forest. The City's updated approved street tree list provide lists of recommended tree species for different growing conditions in the City to support tree diversity within the urban ecosystem.

[2] Łukaszkiewicz, Jan & Kosmala, Marek. Determining the Age of Streetside Trees with Diameter at Breast Height-based Multifactorial Model. Arboriculture and Urban Forestry. May 2008. 137

Figure 5: Street tree diameter distribution.

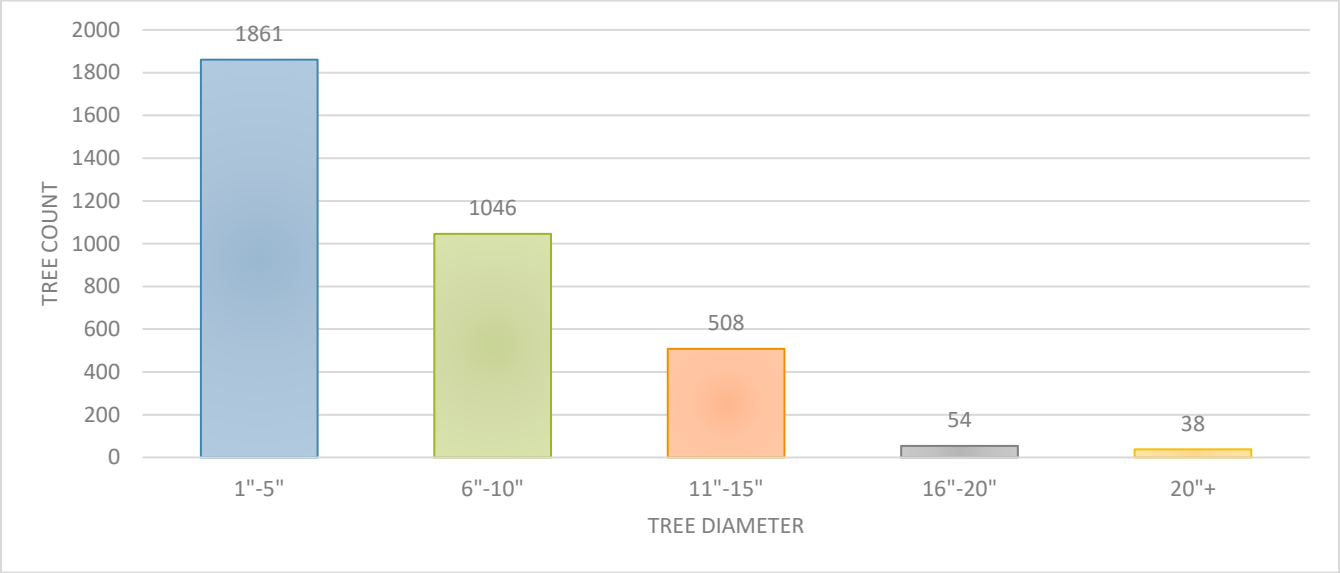
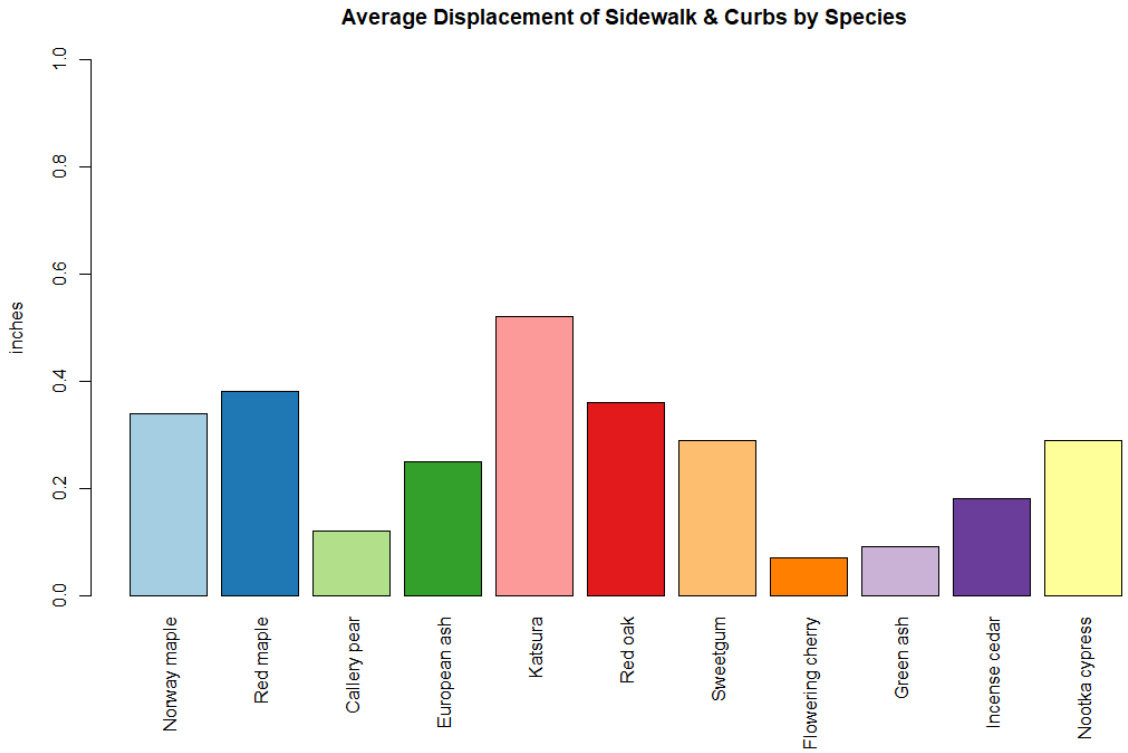
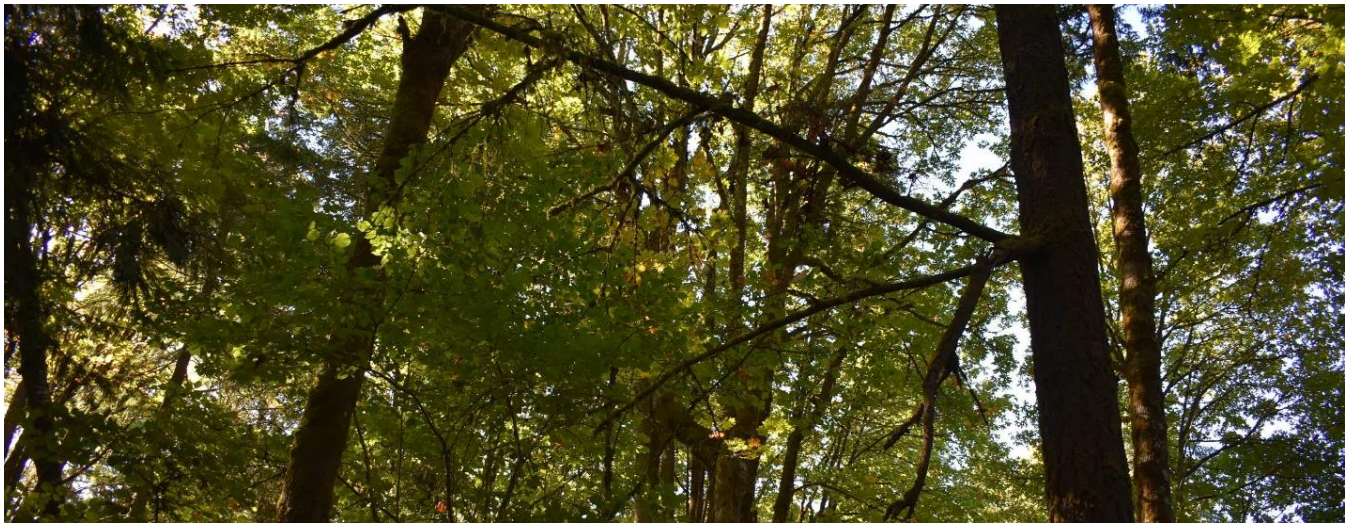


Figure 6: Average sidewalk displacement by street tree species.




STOP

3. GREEN SPACES INVENTORY



3.1. PURPOSE

The Urban Forestry Consultants applied the United States Forest Service's (USFS) Forest Landscape Assessment Tool (FLAT) to green spaces, open spaces, natural areas and parks in Tumwater. FLAT is a biological data collection protocol, used to rapidly characterize and prioritize management of natural areas. FLAT enables quick, qualitative comparisons of natural areas and forested landscapes which facilitates easy benchmarking and progress reports. The UFC captured canopy characteristics, primary and secondary understory species, invasive species presence, and several overstory forest health indicators. A rapid assessment is one where natural resource professionals collect landscape conditions while walking through an area rather than utilizing traditional forestry plots.

FLAT was selected based on its success in sampling Washington's Puget Sound region. The tool can be expanded and adapted for use in a wide variety of ecosystems and specific needs. Equally, given FLAT models are being applied throughout the Puget Sound ecoregion, it allows for long-range planning across city lines.

3.2. METHODS

Each green space is separated into one or more Management Units (MUs). These areas are assessed for their capacity to sustain certain types of canopy cover and their invasive plant species abundance and composition. Management Units are examined by a natural resource professional and estimates for forest stocking levels, canopy closure estimates, species regeneration and forest health indicators are tracked in a geodatabase. From these data, landscape functionality and thread are scored and ranked. Highly effective landscapes are identified in relation to their threat of noxious weed and restoration needs.

The value provided at the intersection of these highly functional landscapes and their threat levels provide us a Tree-iage number, one through nine. Figure 8 below shows Tree-iage totals and provides sample management recommendations for those areas. Tree-iage numbers provide an indicator of how well a specific management unit is achieving its potential function.

Tumwater can use this priority matrix to assign broad management goals to individual management units within each green space. The results are a visualization of landscape conditions in a clear, color

coded and standardized map. The priority matrix results can be used to inform city-wide green space management decisions to achieve improved ecological function, enhanced ecosystem services, and prioritize funding of restoration activities. Green space goals can range from monitoring and stewardship, long-term evaluation and planting, major invasive plant reduction, to a variety of other broad management goals. This allows cities to make informed management decisions that consider a green space priorities for management, and how they fit on the landscape as a whole.

Our adaption of the FLAT assessment was divided into three phases:

PHASE 1: LANDSCAPE TYPE MAPPING. Aerial imagery and parcel information are used from a desktop to geographically identify large scale forest and land types within each parcel of land. These largescale landscape features are divided into one or more Management Units (MUs), which are spatially referenced, numbered and broadly categorized into Forested, Vegetated/Natural, Open Water, Hardscape or Modified Landscape/Recreation.

PHASE 2: FIELD ASSESSMENT. Our trained foresters and natural resource professionals evaluate and interpret the parcel landscape to collect attribute information for each of the MU's previously typed and mapped. This is where we collect biological data necessary to identify landscape priorities. Lastly, our team ground truths MU boundaries and revisions are made as necessary.

PHASE 3: MANAGEMENT STRATEGIES AND PRIORITIZATION PHASE. Our last phase integrates the data collected in the field. This classifies the ecological conditions and landscape functionality of the parcel. Some landscapes are classified as highly functional and some function at reduced levels. Equally, some landscapes are minimally threatened by noxious weeds and invasive plants, while some are highly threatened. Within Phase 3, our classifications can be ranked for each MU and can be observed spatially.

FLAT uses a ranking scale of 1 to 9 (Tree-iage number) to indicate a balance of species composition value, which favors larger, long lived native trees, and the degree of health threat. For Tumwater, the main threat identified was invasive plant species cover, so that is used in the Tree-iage matrix for forest health threat. The Tree-iage matrix is how the data from the FLAT analysis can be displayed in a priory matrix, using forest composition level (high, medium, low), and invasive plant species cover (high, medium, low).

3.3. PROPERTIES ASSESSED

Green spaces for this project were defined as properties owned by the City of Tumwater and include:

- Unimproved/undeveloped natural areas and forests
- Improved/developed natural areas and forests, to include public and accessible stormwater infrastructure, and other green space assets.
- Developed City parks.
- Hybrid parks which contain both developed areas and natural areas.
- City owned buildings which rest on 5+ acres of natural area, which could be accessed by the public.

3.4. INTERPRETING TUMWATER GREEN SPACES MAP

Each green space assessed in Tumwater has an associated map that displays the management units within that green space, land classifications within the MU's, and what the Tree-iage priority matrix rating is, if applicable. The title on the top left of the map sheet is the name of the park shown on the map. Table 3 below shows the definitions of the classification types, Forested, Vegetated/Natural, Open Water, Hardscape, and Modified Landscape/Recreation. The priority matrix shown on the top middle of the map sheet provides a color legend for ranking.

A matching color for a management unit indicates that it is a natural area (either Forested or Natural) that has the priority ranking (1-9) of the associated color. All other classifications types do not have a priority ranking. The simple light green map at the top right of the green spaces map sheet shows the extent of Tumwater's Urban Growth Area, and where the subject green space is located within the City's UGA. The table at the bottom of the map sheet corresponds to the management units on the map, with the MU column matching the labels on the map. The table provides the classification type, which matches the legends, the priority matrix value, if applicable, and the acreage of each individual management unit.

Figure 7: Native garry oak in Tumwater facilities.

Table 3: Natural Area Data Attributes and Definitions.

Data attribute	Explanation
FORESTED	Landcover with canopy cover greater than or equal to 25 percent
VEGETATED/NATURAL	Landcover with area less than 25 percent forest canopy cover
OPEN WATER	Water, no woody vegetation
HARDSCAPE	Buildings, parking, impervious surfaces
MODIFIED LANDSCAPE & RECREATION	Landscaped or mechanically maintained landcover, including those areas maintained for recreation (ex: ball fields)
INVASIVE SPECIES	Designated nonnative plant species of importance
INVASIVE SPECIES COVER	Land coverage of invasive plant species
HIGH INVASIVE COVER	Invasive plant covers greater than 50 percent
MEDIUM INVASIVE COVER	5 to 50 percent invasive plant cover
LOW INVASIVE COVER	Less than 5 percent invasive plant cover
FOREST COMPOSITION	Forest composition refers to all plant species found in an area, focusing on trees in this case.
HIGH COMPOSITION	Greater than 50 percent conifer/madrone; or less than or equal to 50 percent conifer madrone with no capacity for restoration (includes wetlands)
MEDIUM COMPOSITION	1-50 percent conifer/madrone with capacity to support restoration; or less than 25 percent native cover with capacity to restore up to 50 percent conifer
LOW COMPOSITION	Less than 25 percent native cover with capacity for full restoration planting; or no conifer/madrone with capacity for full restoration

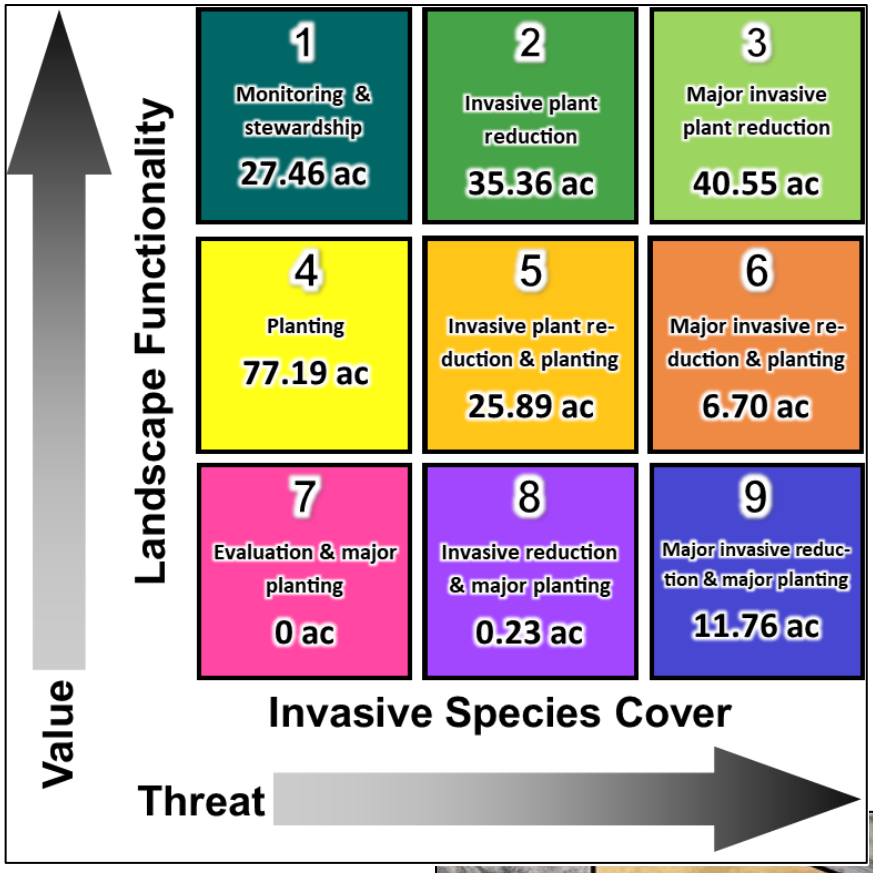


Figure 9: Green Space Tree-iage priority matrix showing total area in acres and potential management recommendations for those areas.

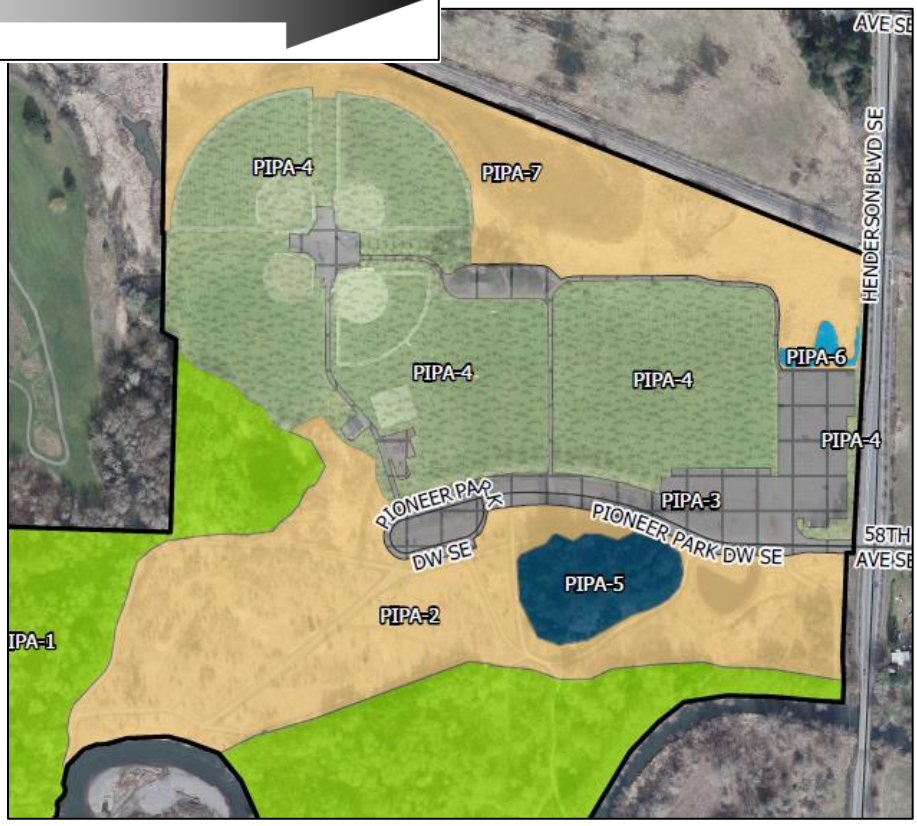


Figure 8: Example of Green Space map identifying land use types.

Table 4: Priority Matrix Value by Classification, with Sum and Average of Acreage.

Tree-iage Number	Number of Units	Total Acres
FORESTED	**25**	**148.47**
1 – Low Priority	8	10.26
2	5	13.79
3	3	34.86
4	3	76.64
5	4	9.1
6	2	3.82
7	0	0
8	0	0
9 – High Priority		
NATURAL AREA	**20**	**76.63**
1 – Low Priority	3	17.2
2	4	21.57
3	2	5.69
4	2	0.55
5	4	16.79
6	2	2.84
7	0	0
8	1	0.23
9 – High Priority	2	11.76

Table 5: Number of Management Units (MU) by Land Classification.

Land Classification	Total Acres	Number of Units
FORESTED	148.47	25
NATURAL AREA	76.63	20
HARDSCAPE	28.38	22
LANDSCAPE/RECREATION	227.58	21
OPEN WATER	9.88	7

4. URBAN TREE CANOPY ASSESSMENT

4.1. PURPOSE

The goal of the Tumwater urban tree canopy (UTC) assessment is to aid in citywide, regional and long-term management of urban forest canopy. Decisions influencing the percentage of urban tree canopy across the city play into tree preservation goals and tree planting goals. Applying urban tree canopy covers to zoning and census data informs decision makers and stakeholders of urban tree canopy cover distribution according to social demographics like income and people of color, affirming the City's commitment to environmental justice.

Urban tree canopy give insight to large-scale ecosystem services within the City. UTC's are benchmarkable and can generally be used over-time to inform long-term swings in urban tree canopy. Interpretation of UTC percentages and goals are normally on large scales – across land use designations and entire cities. By spatially identifying the distribution of canopy across different neighborhoods or zones we enable more informed decision making related to the urban forest.

This geospatial assessment works with object-based image analysis software utilizing high-resolution multispectral imagery and LiDAR to differentiate land cover classes and object heights. After land cover classes are stratified LiDAR is used to identify object heights.

4.2. BOUNDARIES

Three distinct geographical and geophysical boundaries were used in this UTC to provide actionable information at multiple scales and for a diverse range of audiences. Analysis was performed at the following boundaries:

1. Tumwater Urban Growth Area
2. Sub-watersheds (HUC)
3. Tumwater Land Uses images

4.3. SUMMARY OF DATA

	URBAN TREE CANOPY	40% 36%	2017 2011
	IMPERVIOUS SURFACES	22% 19%	2017 2011
	TARGET CANOPY	45%	2040

4.4. METHODOLOGY

DATA SOURCES

Multiple datasets were used in the assessment process. The main component of the 2011 and 2017 assessments were high-resolution (1-meter) multispectral imagery from the U.S. Department of Agriculture's National Agriculture Imagery Program (NAIP). Additional LiDAR data from GeoTerra, Inc form 2018 and LiDAR data from the Washington State Department of Natural Resources derived height data. In 2018, Tumwater commissioned a high-resolution fixed-wing survey, which included multispectral imagery and LiDAR.

The 2017 NAIP imagery was obtained in the summer during leaf-on conditions and approximates the canopy cover of both deciduous and evergreen trees. The 2018 imagery was obtained from aerial imagery in March, during leaf-off, and approximates only evergreen canopy. This 2018 flight was performed in early spring, prior to leaf emergence, resulting in an examination of only evergreen plants. GIS layers for further analysis were provided by both the City of Tumwater and Thurston County.

Aerial Photography

- National Agriculture Imagery Program (NAIP), USDA. 4-band RGBir, 1meter pixel resolution, acquired July-2017 Project Name: 201707_WASHINGTON_NAIP_1X0000M_UTM_CNIR.
- GeoTerra, Inc. 0.25in pixel resolution, 4-band RGBir, 8-bit orthophotography, acquired March-12-2018. Metadata can be found on the accompanying document, GeoTerra Metadata Job #180008.

LiDAR

- Fugro EarthData, Inc. for 2011 Thurston County LiDAR acquisition project. Acquired June 2011 to July 2011. DSM and DTM sourced from WDNR LiDAR Portal.
- GeoTerra, Inc., same 2018 project as above aerial data. LAS Dataset.

LAND COVER MAPPING

Two land cover datasets, or the NAIP datasets described above, were used to classify land cover. Analyses were performed using an object-based image analysis software – ArcGIS Pro with Spatial Analyst extension. This process aligns objects spectral signatures across four spectral bands (blue, green, red, and near-infrared). Additionally, the process identifies and algins object pattern relationships, textures and object height. This remote sensing process analyzed NAIP land cover data and LiDAR height data, results in six land cover classifications, described below in Figure 10. The output of this classification process is then further refined by retraining the classification algorithm based on human experience and known limitations.

After processing land cover classes, the resulting data is assessed for accuracy. At ~90% accuracy the assessment is considered complete. This data is then combined with zoning, and neighborhood data to get more specific information about how canopy cover is distributed within Tumwater.

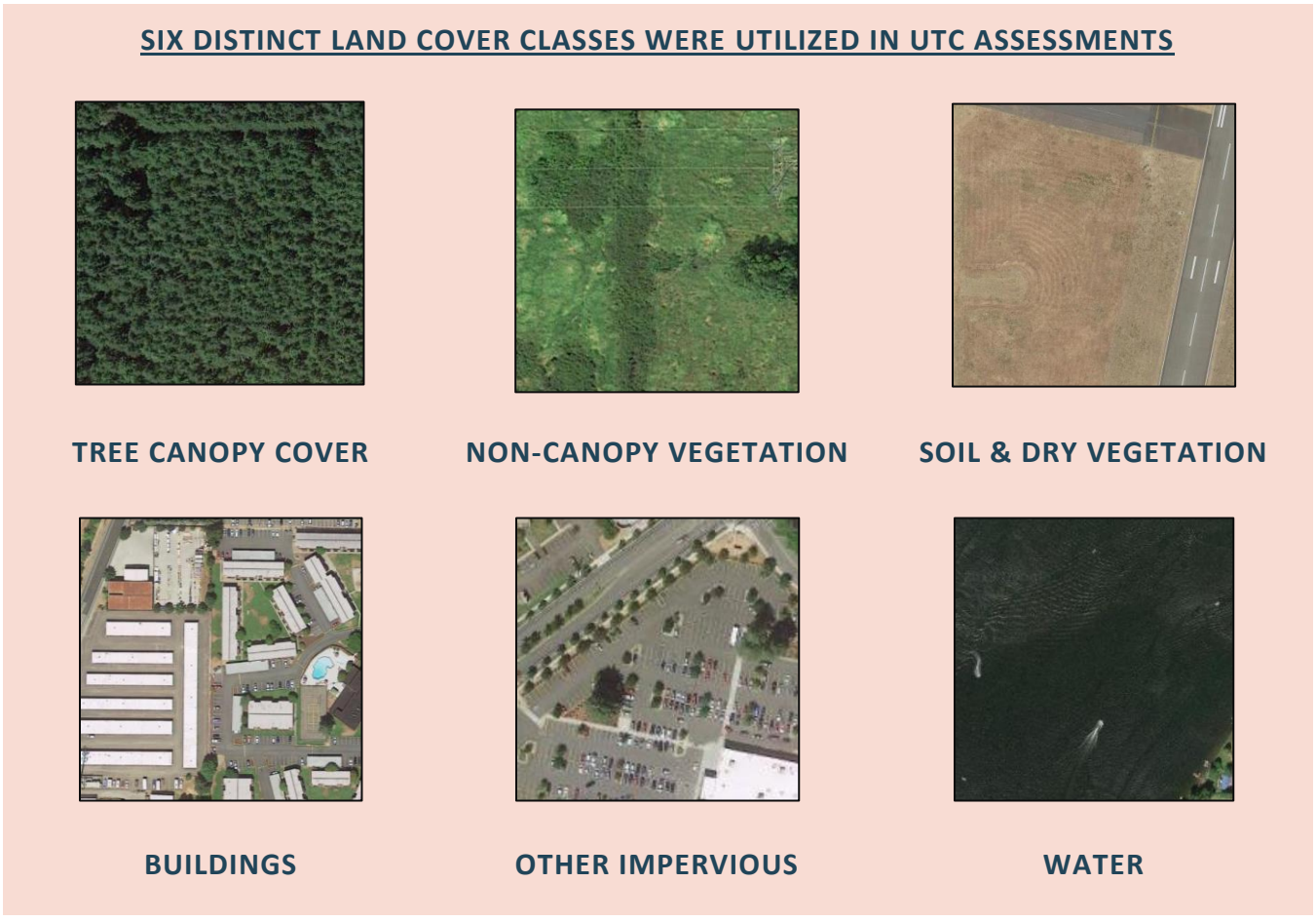


Figure 10: Land use cover classifications.

ZONING AND LAND USE

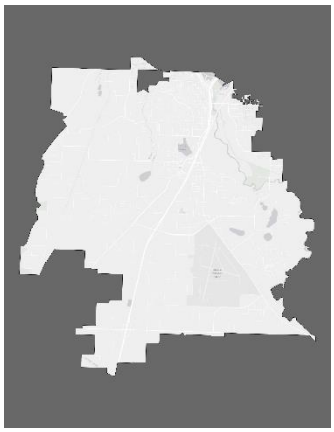
Zoning within the City of Tumwater helped inform similar land use policies for the UTC analysis. There are 23 different zoning designations which we consolidated to 11. Our consolidation was advised by the Tree Board and Department of Community Development to ensure accurate translation from zones to land use. This effort to reduce zoning designation into concentrated land use elements aligns with citywide policies, land use development types and planting availability. A map of the land use types is in the appendix.

Tumwater Expanded Zoning		Acres	Zoning by Land Use		Acres of Canopy in 2017
1	Port of Olympia - Olympia Regional Airport	806	**Port of Olympia - Olympia Regional Airport**	**1**	**24**
2	Port of Olympia - Industry	690	**Port of Olympia - Industry**	**2**	**290**
3	Light Industrial	2,335	**Industrial**	**3**	**822**
4	Heavy Industrial	107			
5	Brewery District	180	**City Core Mixed Use**	**4**	**141**
6	Capitol Boulevard Community	141			
7	Town Center	205			
8	Mixed Use	100	**Other Mixed Use**	**5**	**38**
9	Neighborhood Commercial	39			
10	Community Services	41	**General Commercial**	**6**	**317**
11	Business Park (UGA Only)	76			
12	General Commercial	499			
13	Historic Commercial	85			
14	Commercial Development (UGA Only)	22			
15	Residential/Sensitive Resource	774	**Single-Family Residential**	**7**	**3,011**
16	Single-Family Low Density	3,677			
17	Single-Family Medium Density	1,738			
18	Manufactured Home Park	123			
19	Multifamily High Density	117	**Multifamily Residential**	**8**	**322**
20	Multifamily Medium Density	696			
21	Open Space	1,083	**Open Space & Green Belt**	**9**	**710**
22	Green Belt	367			
	Total	**13,900**	**–**		**5,675**

Table 6: Consolidation of Tumwater Zoning into Land Use

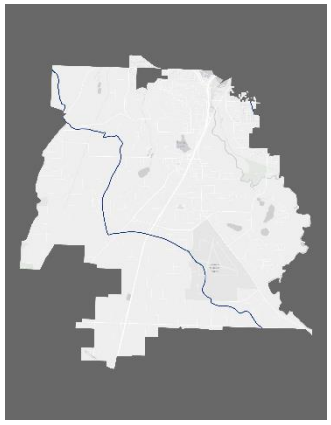
ASSESSMENT BOUNDARIES

Urban tree canopy and associated metrics were analyzed across a variety of geographical and geophysical boundaries. This diversity of scales and boundaries will assist the City, county and stakeholders in decision making locally and regionally. The following scales were used for this assessment:



Tumwater's Urban Growth area was the primary geographical boundary to which all the data was summarized.

TUMWATER URBAN GROWTH AREA



Three HUC-12 watersheds have ranges within the City of Tumwater. Ellis Creek watershed is limited to a few square meters, while Deschutes River and Upper Black Lake Comprise nearly 50% of the City.

171100190503 - ELLIS CREEK-FRONTAL BUDD INLET

171100160202 - DESCHUTES RIVER-CAPITOL LAKE

171001030501 - UPPER BLACK RIVER

Zoning designations across Tumwater were consolidated into specific land use types as noted in Table below.

TUMWATER LAND USES

4.5. DETAILED FINDINGS

LAND COVER TYPE		2011 UTC	2017 UTC	DIFFERENCE	2040 GOAL
	Tree Canopy Cover	36%	40%	+4%	45%
	Non-Canopy Vegetation	25%	16%	-9%	
	Soil & Dry Vegetation	18%	21%	+3%	
	Buildings	5%	6%	+1%	
	Other Impervious	14%	16%	+2%	
	Water	1%	1%	0%	

Table 7: Urban tree canopy in both 2011 and 2017 per land cover type.

Land Use Type	 Tree Canopy Cover			
	2011 Tree Canopy	2017 Tree Canopy	Difference	Recommended 2040 Goal
PORT OF OLYMPIA - OLYMPIA REGIONAL AIRPORT	3%	3%	0%	3%
PORT OF OLYMPIA - INDUSTRY	35%	42%	+7%	35%
INDUSTRIAL	30%	34%	+4%	35%
CITY CORE MIXED USE	22%	27%	+5%	28%
OTHER MIXED USE	23%	27%	+4%	30%
GENERAL COMMERCIAL	35%	44%	+9%	35%
SINGLE-FAMILY RESIDENTIAL	43%	48%	+5%	55%
MULTIFAMILY RESIDENTIAL	35%	40%	+5%	40%
OPEN SPACE & GREEN BELT	47%	49%	+2%	65%
TUMWATER + URBAN GROWTH AREA	**36%**	**40%**	**+4%**	**43%**

Table 8: Urban tree canopy per land use in 2011, 2017, and recommended goals for 2040.

The former two tables highlight specific information related to the urban tree canopy analysis from 2011 and 2017. First the information is presented by land cover class, or physical characteristics of objects. Secondly, information is stratified per land use type, or political and zoning classifications to areas. It's important to note, Table 8, specifically corresponds to tree canopy cover and not the other land covers classes. Other dynamic land cover class changes, such as water, buildings and other impervious are not represented in this report, but data is provided to Tumwater for further land use planning and analysis. See the appendix for a full table of 2011 and 2017 tabulations.

Table 9: Land use type per tree height percentage in 2011.

RANGE	PERCENT OF TOTAL	
0-25 FEET	31%	
26-50 FEET	24%	
51-100 FEET	38%	
100+ FEET	7%	

Large stature trees, those capable of growing above 50 feet in height, are important elements of the urban forest. Compared to a small-stature tree, a strategically located large stature tree has a bigger impact on conserving energy, mitigating an urban heat island, and cooling a parking lot. They do more to reduce stormwater runoff; extend the life of streets; improve local air, soil and water quality; reduce atmospheric carbon dioxide; provide wildlife habitat; increase property values; enhance the attractiveness of a community; and promote human health and well-being.

Accommodating larger trees is an ongoing challenge that is complicated by the competing needs for utility lines and impervious surfaces. Some ways to incorporate large-stature trees into planting plans include transportation corridors mitigation and enhancement and incentivizing developers with a less of large-stature trees instead high quantities of small-stature trees.

Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service, Davis, California and the Southern Center for Urban Forestry Research & Information, Southern Research Station, USDA Forest Service, Athens, Georgia. 2004

Table 10: Watershed level urban tree canopy distribution, including evergeen and deciduous composition.

HUC Watershed	171001030501 - UPPER BLACK RIVER	171100160202 - DESCHUTES RIVER-CAPITOL LAKE	171100190503 - ELLIS CREEK-FRONTAL BUDD INLET
LAND AREA	1,039 acres	1,796 acres	3 acres
2011 TREE CANOPY	**39%**	**34%**	**29%**
Total Acres of Canopy	405 acres	611 acres	<1 acre
Distribution of Canopy	40%	60%	<1%
2017/18 TREE CANOPY	**45%**	**38%**	**30%**
Total Acres of Canopy	468 acres	682 acres	<1 acre
Distribution of Canopy	46%	67%	<1%
Evergreen Acres	332 acres	467 acres	
Evergreen Percent	32%	26%	
Deciduous Acres	135 acres	215 acres	
Deciduous Percent	13%	12%	

Table 11: Total evergreen and deciduous tree canopy composition within Tumwater + UGA based on 2017/18 UTC Assessment.

	TOTAL EVERGREEN TREE CANOPY	**28% out of 40%**
	TOTAL DECIDUOUS TREE CANOPY	**12% out of 40%**

4.6. ACCURACY

Due to the season which GeoTerrra, Inc. captured imagery and LiDAR over Tumwater, the information does not contain a substantial portion of deciduous trees. The leaf-less condition of deciduous trees during the LiDAR data acquisition created imprecise segments of information in the dataset.

While the 2011 UTC may be older, it likely has higher precision due to the inclusion of LiDAR information, allowing us to capture heights of vegetative elements throughout Tumwater.

Insofar as land cover classifications, excluding the stratification of tree canopy from its underling group of vegetation, both UTC's are at or above 90% accurate. The 2011 UTC has an accuracy rating of 93% while the 2017 UTC's accuracy is approximately 90%.

4.7. RECOMMENDED FUTURE DATASETS

Additional datasets will increase precision and accuracy of future UTC analyses in Tumwater. These additional datasets are tied to the following objectives and requirements:

Objective:	Required Information:
Informed decisions on environmental justice, canopy equity, social inequalities related to the urban forest.	**CENSUS DATA** Census data will allow City leaders, stakeholder and the community at large information on how urban tree canopy cover is distributed according to social demographics like income and people of color.
Identify square feet of canopy over impervious surfaces throughout the City. This data is used to inform data such as for use in stormwater buffer modeling and urban heat island mitigation.	**UPDATED BUILDINGS/FOOTPRINTS GIS LAYER** Accurate footprint data on buildings allows a variance measurement of visual canopy over footprint. The current building layer is from 2000 and a substantial portion of the footprint polygons are indicator marks, rather than footprint outlines.
	ROAD & SIDEWALK GIS LAYER Current street layer is made of GIS lines and street types, etc. With standard road with data for standard roads, i.e. collector, arterial, neighborhood, the street lines could be widened to reflect their precise scale. This could be accomplished for sidewalk data as well. Geospatial identification roads and sidewalks will further identify canopy cover over impervious data.
Quantify Possible Planting Areas (PPA). Consultants were unable to quantity with reasonable confidence PPA in the 2011 or 2017 UTC analyses. PPA is generally measured as impervious area and unplantable	**CITY OWNED/MAINTAINED PARCEL DATA** Current Thurston County Parcel GIS layer indicates property ownership for each parcel. We encountered a wide range of possible "ownership" entries when parcel was owned or maintained by the City of Tumwater. A solution would be a list of property owner entries that cumulative include all of Tumwater's parcels. Further information could be

areas subtracted from total UTC percentage. *PPA = UTC – Imperious – Unplantable* *This will require identifying biophysically inappropriate landscapes and locations, and appropriateness of specific land uses for increased canopy cover.* *Identify parcels the City can proactively maintain, in comparison to private parcels where City's influence is limited to through policy, education, etc.*	identified through City of Tumwater owned parks, facilities, water resources, open spaces, etc. Currently these ownerships have a variety of ownership entries in the Thurston County Parcel Layer.
	IDENTIFY DEVELOPMENT THREAT OF TREE STANDS Identifying development threat of tree stands allows the City to prioritize planting and policy. This information helps to understand what tree stands benefit the community, and how those may be altered or protected in the future.
	IDENTIFY BIOPHYSICALLY INAPPROPRIATE SITES Biophysically inappropriate planting sites in Tumwater include wetlands, estuaries, grassland prairies, municipal golf course and local farms.
	IDENTIFY URBAN CANOPY APPROPRIATENESS OF LAND USE DESIGNATIONS Land uses like the Tumwater airport and the municipal golf course may be considered inappropriate for sustaining canopy cover. Areas like improved rights-of-way, open spaces, city parks and city facilities may be considered appropriate and offer improved equity in sustaining tree canopy.
Future City acquired high-resolution datasets	**INCLUDE LIDAR IN FUTURE HIGH-RESOLUTION PHOTOGRAMMETRY** The 2018 fixed-wing aircraft high-resolution orthomosaic retained by the City of Tumwater included 4-bands (natural color and near-infrared) but did not include a LiDAR dataset. LiDAR datasets are normally available through a variety of other sources, including the Puget Sound LiDAR Consortium, Washington Department of Natural Resources, and the National Agriculture Imagery Program (NAIP).
	TIMING The 2018 Tumwater high-resolution imagery did not include deciduous tree cover. At the time of flying, deciduous trees were still bare of leaves. Flying during the summer will allow the City to accurately measure urban tree canopy of all city trees.

5. ECOSYSTEM SERVICES INVENTORY

5.1. PURPOSE

The purpose for plot-based sampling is to collect data for a large area in a reasonable time frame and with a reasonable assurance that plot data accurately depicts the conditions across the area. For a city, the best method is often to have stratified random samples, which are plots randomly generated within predefined stratifications, such as zones, neighborhoods, or land uses. This can ensure that all different areas of a city are accounted for and makes it easier to implement area-specific strategic management goals. Generally, 200 1/10th acre plots randomly distributed across a city will yield a standard error of about 10% for an estimate of the entire city.

5.2. DATA COLLECTED

As with all sampling, the amount of data collected at each plot will determine what level of analysis can be performed. For i-Tree Eco, the base required data for each tree is species and diameter at breast height (DBH), and for each plot it is the percent of the plot that was assessed, and the percent tree canopy cover in that plot. From that base level, there is a vast amount of data that can be collected for both the plots and the trees in the plots that opens up the option for additional analyses on such categories as Energy, Wildlife, Forecast, Shrubs, Plantable space, Pests, and Cover under canopy. These analyses can yield information on:

- Number of trees
- Species composition
- Leaf area and biomass
- Pollution removal and value
- Carbon storage, sequestration, and value
- Hydrology effects and value
- Volatile organic compound emissions
- Oxygen production

A specific description of what variables are required by i-Tree Eco for each analysis can be found in Table 12, sourced from the i-Tree Eco v6.0 Manual.

Table 12. Plot Information (plot-based sample project).
Use this table to help guide your field data collection decisions:
The Description column provides more information about each data variable. The extra model components shown in the right-hand columns require certain optional data to be collected. The optional data that must be collected for each extra model component are designated by an "x"

Data Variables		Description	Shrubs	Plantable space	Wildlife	Grass/Herbaceous pollution
Minimum required fields						
Percent measured		The amount of plot than can be accessed, measured, and/or included in this study	REQUIRED			
Percent tree cover		The amount of the plot covered by tree canopy (in percent).	REQUIRED			
General fields						
Land use	Actual land use	Land use type(s) that are seen in the field				
	Percent of plot	The amount of the plot area covered by each land use				
Percent shrub cover		The amount of the plot covered by shrub canopy (in percent)	x		x	
Percent plantable space		The amount of the plot area that is plantable for trees (i.e., plantable soil that is not under tree canopy or other overhead restrictions and where tree planting/establishment would not be prohibited due to land use, such as a baseball field)		x		
Plot address		Street address of plot or notes for locating plots in areas without street addresses				
GPS coordinates		Longitude and latitude of plot center				
Reference objects	Object type	Visible landmark(s), such as a stop sign or permanent structure, that are seen when standing at plot center				
	Direction	The direction from the plot center to the reference object				
	Distance	The distance from the plot center to the reference object				
	DBH	Stem diameter measured at breast height (DBH) if the reference object is a tree				
Ground cover	Ground cover	Ground cover type(s) that are seen in the field			x	x
	Percent of plot	The amount of the plot area covered by each ground cover			x	x
Shrub details	Species	Name of shrub species	x			
	Height	Average height of shrub group (i.e., mass of shrubs of the same species)	x			
	Percent of area	The amount of the shrub area in the plot covered by each shrub group	x			
	Percent missing	The percent of the shrub group volume that is missing (i.e., not occupied by leaves)	x			

Table 8 (continued): Tree Information (plot-based sample project).
Use this table to help guide your field data collection decisions:
The Description column provides more information about each data variable. The extra model components shown in the right-hand columns require certain optional data to be collected.

Data Variables		Description	Energy	Pests (IPED)	Hydro		
Minimum required fields							
Species		Identify and record the species and genus names of each tree	REQUIRED				
DBH		Measure the tree stem diameter at breast height and record the measurement for each tree	REQUIRED				
General site fields							
Land use		Land use type in which tree is located					
Status		Status of tree as planted or self-seeded					
Distance to plot center		The distance from the tree to plot center					
Direction to plot center		The direction from the tree to plot center					
Street tree/non-street tree		Identify if tree is a street tree or not (Y/N)					
Public/private		The classification of each tree as city managed (public) or not (private)					
Cover under canopy	Percent impervious	The percent of the area beneath the drip line of the tree that is impervious			x		
	Percent shrub	The percent of the area beneath the drip line of the tree that is shrub			x		
Tree detail fields							
Total tree height		Height from the ground to the top (alive or dead) of the tree					
Crown size	Height to live top	Height from the ground to the live top of the tree					
	Height to crown base	Height from the ground to the base of the live crown					
	Crown width	The width of the crown in two directions: north-south and east-west					
	Percent crown missing	Percent of the crown volume that is not occupied by branches and leaves					
Crown health	Dieback	Estimate of the percent of the crown that is composed of dead branches					
	Condition	Estimate of the condition of the crown recorded as 100 minus the percent of the crown composed of dieback (i.e., dead branches)					
Crown light exposure		Number of sides of the tree receiving sunlight from above (maximum of 5)					
Energy	Direction	Direction from tree to the closest part of the building			x		
	Distance	Shortest distance from tree to the closest part of the building			x		
Management fields							
Maintenance recommended		User defined general maintenance recommendations (e.g. routine prune) for the tree					
Maintenance task		User defined priority maintenance tasks (e.g., pest treatment) for the tree					
Sidewalk conflict		Extent of damage to sidewalks from nearby trees defined by user					
Utility conflict		User defined potential or existing conflicts between tree branches and overhead utility lines					
User ID		Unique tree ID					

Table 8 (continued): Tree Information (plot-based sample project).
Use this table to help guide your field data collection decisions:
The Description column provides more information about each data variable. The extra model components shown in the right-hand columns require certain optional data to be collected. The optional data that must be collected for each extra model component are designated by an "x"

Data Variables		Description	Energy	Pests (IPED)	Hydro	
Management fields (continued)						
Pests (IPED)	Signs and symptoms of tree stress	Absence or presence of signs and symptoms of dieback, epicormic sprouts, wilted foliaged, environmental stress, or human stress		x		
	Signs and symptoms of foliage/twigs	Absence or presence of signs and symptoms of defoliation, discolored foliage, abnormal foliage, or insect signs and extent of foliage affected		x		
	Signs and symptoms of branches/bole	Absence or presence of signs and symptoms of insects or diseases on the branches/bole and location of signs or symptoms		x		

The level of data collected is dependent on time frame, budget, and desired level of post-sampling analysis. Some of the information will overlap with information gathered during the Street Tree Inventory, but overall the stratified random plot-based sampling can gather a much wider range of information. By not being restricted to common street tree areas such as sidewalks, plot-based sampling can assess areas that would not otherwise be captured. By gathering plot data in addition to tree data a more robust analysis can be performed for overall city ecosystem services being provided by trees and shrubs.

APPENDICES

6. STREET TREE DATA POINTS

Table 13: Data gathered during the street tree inventory, and descriptions of each data field.

GlobalID	**Unique ID for each tree**
Tree Location	GPS point at the location of the tree
Survey Date	Date tree was surveyed
Surveyor	Individual(s) who assessed the tree
Street Name	Street name of the adjacent street
Street Type	Street type based on following list: • Residential • Collector • Alley • Private Street/ Roadway • Unimproved R/W • Freeway • Principal Arterial • Commercial-Industrial Collector • Urban Collector • Minor Arterial • Arterial • "0" – currently on River Road. (Sourced from Tumwater Geospatial Layers.)
Cross Street	Closest nearby cross street.
Zoning	Zoning based on following list: • Airport Related Industrial • Brewery District • Business Park • Capitol Boulevard Community • Commercial Development • Community Services • General Commercial • Green Belt • Heavy Industrial • Historic Commercial • Light Industrial • Manufactured Home Park • Mixed Use • Multi-Family High Density • Multi-Family Medium Density • Neighborhood Commercial • Open Space

	• Residential/Sensitive Resource • Single Family Low Density • Single Family Medium Density • Town Center (Sourced from Tumwater Geospatial Layers.)
Asset Type	Asset type assessed, from the following list: • Available Planting Space • Landmark Tree • Street Tree • Stump
Remnant Tree	Whether the tree was planted or is part of a pre-development forest
Common Name	Tree common name (e.g. bigleaf maple)
Scientific Name	Tree scientific name (e.g. *Acer macrophyllum*)
Tree Type	Tree type, from the following list: • Evergreen broadleaf • Evergreen conifer • Deciduous broadleaf • Deciduous conifer
Tree Form	Tree form, from the following list: • Columnar • Conical • Irregular • Open • Oval • Pyramidal • Round • Spreading • Vase • Weeping
Tree Height (ft.)	Total tree height in feet
Tree DSH (in.)	Stem diameter in inches at standard height (4.5ft), measured for all stems at standard height
Crown Height (ft):	Height of the top of the live crown of the tree, in feet
Crown Base Height (ft):	Height of the bottom of the live crown of the tree, in feet
Crown Width N - S (ft.)	Width of the crown measured on a north to south axis, in feet
Crown Width E - W (ft.)	Width of the crown measured on an east to west axis, in feet
Crown Missing (%)	Percent of crown missing from the overall canopy
Crown Dieback (%)	Percent of crown dieback from the overall canopy
Tree Condition	Tree condition, from the following list: • Dead

	• Dying • Critical • Poor • Fair • Good • Excellent
Fungi Type	Any indicators of fungal infection (e.g. fruiting bodies, hyphae in wood decay)
Insects Indicators	Any indicators of detrimental insect presence (e.g. infestations, tent caterpillar webs, aphid honeydew)
Previous Failures	Any indicators of previous failures (e.g. broken tops or large branches, root plate lifting)
Adaptive Growth	Any indicators of adaptive growth (e.g. reiterations, epicormic sprouting)
Chlorosis	Any indicators of chlorosis (e.g. yellowing outside of expected senescence)
Sidewalk Damage (in.)	Any sidewalk lifting due to roots, with displacement measured in 0.25 inch increments
Curb Damage (in.)	Any curb lifting due to roots, with displacement measured in 0.25 inch increments
Planter Type	Planter type asset was in, from the following list: • Cutout • Free form • Median • Planting area • Strip
Planter Length (ft.)	Length of the planter type, measured parallel to road, in feet
Planter Width (ft.)	Width of the planter type, measured perpendicular to road, in feet
Tree Grate Present	Presence of tree grate
Tree Distance to Sidewalk (ft.)	Distance of tree's main stem to the nearest sidewalk or curb edge, in feet
Utility Line Height (ft.)	Height of utility line in feet, from following list • None • <20ft • 20ft – 35ft • >35ft
Risk Evaluation	Rapid assessment to determine if a risk evaluation is required for the tree, yes or no
Vehicle Clearance	If pruning is required for vehicle clearance, yes or no
Pedestrian Clearance	If pruning is required for pedestrian clearance, yes or no
Sign Clearance	If pruning is required for sign visibility, from the following list: • Casual – street signs, auxiliary signs, etc. • Critical – stop signs, yield signs, do-not-enter signs, etc.
Previously Topped	If the tree was previously topped, yes or no

Recommend Removal	If the tree is recommended for removal, yes or no
Improper Mulching	If improper mulching was observed at the tree (e.g. excessive mulch touching stem of tree, "volcanoing", etc.), yes or no
Remove Tree Supports	If the tree requires tree supports to be removed, before they cause long term damage or alterations to growth, yes or no
Tree Grate Maintenance	If the tree grate requires maintenance, yes or no

7. STREET TREE DATA ANALYSIS

This is not an exhaustive list of pivot tables but provides a starting point and overview for the interpretation of the street tree inventory data.

Table 14: Tree Count by Zoning District.

Zoning District	Tree Count
Single Family Low Density	923
Single Family Medium Density	723
Multi-Family Medium Density	477
General Commercial	316
Light Industrial	248
Residential/Sensitive Resource	226
Town Center	128
Mixed Use	123
Brewery District	96
Open Space	70
Capitol Boulevard Community	69
Airport Related Industrial	58
Community Services	56
Historic Commercial	2
Business Park	0
Commercial Development	0
Green Belt	0
Heavy Industrial	0
Manufactured Home Park	0
Multi-Family High Density	0
Neighborhood Commercial	0
Grand Total	**3539**

Table 15: Tree Count by Street Type.

Street Type	Tree Count	Percent
Residential	1781	50.67%
Arterial	954	27.14%
Collector	633	18.01%
0* (River Dr SE is unclassified in GIS layer.)	74	2.11%
PRIVATE STREET/ROADWAY	46	1.31%
UNIMPROVED R/W	14	0.40%
COMMERCL-INDUST COLLECTOR	13	0.37%
Grand Total	**3539**	100.00%

Table 16: Tree Count per Tree Species.

Species Richness = 58	(Species abundance)	
Tree Species	**Tree Count**	**Percent**
Abies nordmanniana	1	0.03%
Acer campestre	21	0.60%
Acer circinatum	1	0.03%
Acer ginnala	5	0.14%
Acer grandidentatum	9	0.26%
Acer grandidentatum 'Schmidt'	16	0.46%
Acer negundo	6	0.17%
Acer negundo 'Variegatum'	1	0.03%
Acer palmatum	1	0.03%
Acer platanoides	720	20.48%
Acer platanoides 'Crimson Sentry'	18	0.51%
Acer rubrum	243	6.91%
Acer rubrum 'Armstrong'	173	4.92%
Acer rubrum 'Bowhall'	4	0.11%
Acer rubrum 'Red Sunset'	22	0.63%
Acer truncatum x A. platanoides 'Warrenred'	11	0.31%
Amelanchier canadensis	9	0.26%
Betula papyrifera	4	0.11%
Betula utilis var. jacquemontii	30	0.85%
Calocedrus decurrens	44	1.25%
Carpinus betulus	9	0.26%
Carpinus betulus 'Fastigiata'	18	0.51%
Castanea dentata	1	0.03%
Cercidiphyllum japonicum	59	1.68%
Chamaecypairs nootkatensis 'Pendula'	2	0.06%
Chamaecyparis lawsoniana	2	0.06%
Chamaecyparis nootkatensis	17	0.48%
Cornus florida	57	1.62%
Cornus kousa	85	2.42%
Cupressus sempervirens	5	0.14%
Eriobotrya japonica	7	0.20%
Fraxinus angustifolia	21	0.60%
Fraxinus excelsior	119	3.39%
Fraxinus pennsylvanica	108	3.07%
Fraxinus pennsylvanica 'Summit'	7	0.20%
Liquidambar styraciflua	143	4.07%

Liriodendron tulipifera	1	0.03%
Malus spp.	127	3.61%
N/A*	5	0.14%
Nyssa sylvatica	38	1.08%
Pinus contorta	6	0.17%
Platanus occidentalis	8	0.23%
Platanus x acerifolia	4	0.11%
Populus deltoides 'Pendula'	1	0.03%
Prunus cerasifera	125	3.56%
Prunus serrulata	270	7.68%
Pseudotsuga menziesii	10	0.28%
Pyrus calleryana	470	13.37%
Pyrus calleryana 'Chanticleer'	1	0.03%
Quercus coccinea	2	0.06%
Quercus garryana	7	0.20%
Quercus macrocarpa	5	0.14%
Quercus palustris	2	0.06%
Quercus rubra	154	4.38%
Salix babylonica 'contorta'	1	0.03%
Sorbus aucuparia	2	0.06%
Styrax japonicus	5	0.14%
Thuja plicata	3	0.09%
Tilia cordata	269	7.65%
Grand Total	**3515**	**100.00%**

Table 17: Tree Count by Tree Type.

Tree Type	Tree Count	Percent
N/A*	5	0.14%
Deciduous Broadleaf	3417	97.21%
Evergreen Conifer	90	2.56%
Evergreen Broadleaf	3	0.09%
Grand Total	**3515**	**100.00%**

Table 18: Tree Count by Tree Form.

Tree Form	Tree Count	Percent
Columnar	555	15.79%
Conical	19	0.54%
Irregular	166	4.72%
Open	2	0.06%
Oval	231	6.57%
Pyramidal	102	2.90%
Round	1613	45.89%
round	68	1.93%
Spreading	77	2.19%
Vase	651	18.52%
Weeping	18	0.51%
N/A	5	0.14%
Columnar	8	0.23%
Grand Total	**3515**	**100.00%**

Table 19: Tree Count of Asset Types

Asset Type	Count
Available Planting Space*	8
Landmark Tree	11
Street Tree	3504
Stump	16
Grand Total	**3539**

*Available Planting Space is any cutout that had no stump and had the capacity for a street tree. This does not include all places trees could potentially be installed, such as free-form planters, strips and medians.

Table 20: Count of Curb Damage Measured from Trees in all Planter Types.

Curb Displacement in inches	Tree Count
0.5	14
1	8
1.5	14
2	7
2.5	10
3	41
Grand Total	**94**

*Height difference between curb and sidewalk.

Table 21: Count of Sidewalk Damage Measured from Trees in all Planter Types.

Sidewalk Displacement in inches	Tree Count
0.25	6
0.5	277
0.75	14
1	110
1.5	59
2	41
2.5	18
3	24
4	3
5	3
Grand Total	**555**

*Height difference between two section of sidewalk, could be two sections of sidewalk panel or a cracked single panel of sidewalk.

Table 22: Tree Count by Maintenance Task Recommendations

Maintenance Task Recommendation	Tree Count	Percent of Maintenance Tasks	Percent of Total Trees (3,515)
Risk Evaluation	18	1.61%	0.51%
Vehicle Clearance	851	76.25%	24.21%
Pedestrian Clearance	58	5.20%	1.65%
Casual Sign Clearance	19	1.70%	0.54%
Critical Sign Clearance	8	0.72%	0.23%
Previously Topped (Replace)	12	1.08%	0.34%
Recommend Removal	43	3.85%	1.22%
Improper Mulching	23	2.06%	0.65%
Remove Tree Supports	72	6.45%	2.05%
Tree Grate Maintenance	12	1.08%	0.34%
Total	**1116**	**100.00%**	**31.75%**

8. URBAN TREE CANOPY DATA SUMMARY

Table 23: Urban tree canopy assessment results by land uses, including 2011 and 2017 analysis, percent land cover and distribution of UTC across UGA.

LAND USE	LAND AREA		2011 URBAN TREE CANOPY			2017 URBAN TREE CANOPY			2040 GOAL
	ACRES	%	ACRES	%	DIST.	ACRES	%	DIST.	
PORT OF OLYMPIA - OLYMPIA REGIONAL AIRPORT	806	5.8%	21	3%	<1%	24	3%	<1%	3%
PORT OF OLYMPIA - INDUSTRY	690	5.0%	242	35%	5%	290	42%	5%	35%
INDUSTRIAL	2442	17.6%	722	30%	14%	822	34%	15%	35%
CITY CORE MIXED USE	526	3.8%	114	22%	2%	141	27%	3%	28%
OTHER MIXED USE	139	1.0%	32	24%	<1%	38	27%	<1%	30%
GENERAL COMMERCIAL	723	5.2%	250	35%	5%	317	44%	6%	35%
SINGLE-FAMILY RESIDENTIAL	6311	45.3%	2686	14 %	53%	3011	48%	53%	55%
MULTIFAMILY RESIDENTIAL	813	5.9%	287	35%	6%	322	40%	6%	40%
OPEN SPACE & GREEN BELT	1450	10.4%	678	47%	14%	710	49%	13%	65%
TUMWATER URBAN GROWTH AREA	**13,900**	**100%**	**5,032**	**36%**	**100%**	**5,675**	**40%**	**100%**	**43%**