URBAN TREE CANOPY ASSESSMENT

TRUCKEE MEADOWS

(RENO-SPARKS, NEVADA)

2012

Prepared for:
Nevada Division of Forestry

Prepared by:
AMEC Environment & Infrastructure

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Urban Tree Canopy Assessment
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Acknowledgements

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Truckee Meadows 2012 Urban Tree Canopy Assessment

Executive Summary

The Nevada Division of Forestry Urban & Community Forestry Program provides technical assistance, grants, and leadership throughout the State. Several tree inventories and tree canopy cover assessments are underway in Nevada to direct better policy and decision making at the local and regional level for the planning and management of urban natural resources.

The Truckee Meadows Urban Tree Canopy (UTC) Assessment provides an analysis of current tree canopy extent and possible planting area (PPA) using geographic information systems (GIS). This data was used to assess some of the environmental and economic benefits of existing and future tree canopy scenarios. Canopy cover goals were evaluated based on recommended UTC goals for the western U.S. and a technique known as the 75th Percentile Rule. This report provides statistical canopy results, current and projected ecosystem benefits, options for setting canopy cover goals, management recommendations for reaching desired goals, and tools for implementation.

Urban Tree Canopy in Truckee Meadows

The area of interest (AOI) for this assessment covered approximately 205 square miles (131,302 acres) of the urbanized areas in the Truckee Meadows Service Area (from now referred to as Truckee Meadows) in Washoe County, Nevada. This included the incorporated areas in Reno and Sparks and unincorporated urbanized areas of Washoe County including University of Nevada-Reno (UNR), Sun Valley General Improvement District (GID), and Spanish Springs.

Based on 128,965 acres of land area, the urban portions of Truckee Meadows have 5,913 acres (4.6%) of tree canopy with 63,346 acres (49%) possible planting area. Additionally, roughly 30% of the region is covered by paved impervious surfaces.

Existing UTC was assessed at 5.2% for Reno, 3.9% for Sparks, and 4.3% for the remaining county areas. Results show that canopy cover ranged from 1.2 - 12.8% for Reno's Neighborhood Advisory Boards, from 2.6 - 6.4% for Wards in Sparks, and from 1.8 - 9.1% in outlying county Commission Districts. Assessing UTC by land use revealed that nearly 75% of the region's tree canopy is found on residential properties with 8% in the public rights of way.

Ecosystem Benefits Analysis

Urban trees provide many "ecosystem services" or direct and indirect economic and environmental benefits such as cleaning the air by removing air pollutants, storing and

sequestering carbon, and mitigating stormwater runoff, to name a few. Using American Forests' CITYgreen software, this assessment quantified each of these benefits for city and unincorporated county boundaries and by land use categories. Results demonstrate that the region's tree canopy provides $1.5M in annual air quality benefit and $40.9M in total stormwater benefit. If tree cover increased to 20% overall, these values would increase to $6.8M and $79.9M, respectively.

Setting Canopy Cover Goals

Tree canopy cover is a critical measure of environmental health and sustainability in cities. Setting realistic goals for different land use types and planning scales in a collaborative way creates a shared vision to ensure that resources are allocated effectively and adaptive management can occur over time. Using this top-down approach of assessing the region's green infrastructure, techniques and tools are presented to evaluate tree canopy goals for urban forest management planning, education & outreach, and policy development.

Using the Results of this Assessment

An assessment report and accompanying GIS data may sit on the shelf underutilized if the information isn't made available in diverse ways to a wide audience. To increase the usefulness of results, a number of tools were provided as part of this project to enable both technical and non-technical application of the data. Showcased in the main body and appendix of this report, these tools include interactive GIS-like Adobe PDFs, a Canopy Calculator "plug-and-play" Excel spreadsheet, and UTC results in GIS and Google Earth format. Additionally, a summary factsheet and public service announcement were created and made available on NDF's Urban and Community Forestry website (see below). Additionally, map examples are provided throughout this report demonstrating ways to use the GIS UTC databases.

Recommendations and Summary

With just under 5% tree canopy cover, Truckee Meadows is behind other dry Western U.S. areas such as Albuquerque, NM (6%), Las Vegas (13%), and Henderson, NV (7%). At a finer scale though, one precinct boundary assessed in Reno has 22% canopy cover, indicating more robust cover is possible in established areas. With 75% of all canopy cover and half (48%) of the total planting area found in residential land use, reaching the public with targeted messages on the benefits of urban trees may enable the greatest amount of stewardship and change. Over time as development expands in Truckee Meadows, the region should expect to see canopy cover increase substantially with proper policy and care. This will be accompanied by increased social, environmental and economic benefits of the urban and community forest. Analysis results of tree canopy benefits from this study offer a compelling argument to promote a sustainable, high-performing urban forest. Reports and other tools provided are available at: http://forestry.nv.gov/forestry-resources/urban-tree-canopy-assessment-projects/.

Introduction

The Truckee Meadows Urban Tree Canopy assessment is a starting point to understanding, managing and preserving local investments in public and private trees. It provides tools to develop local and regional urban forestry goals, policies, and management plans to sustain and enhance the existing urban forest. To date, street and park tree inventories on the ground have been employed to gain understanding on the structure and function of public trees, however a regional canopy analysis that included private tree cover had not been undertaken.

With funding from the U.S. Forest Service and the American Recovery and Reinvestment Act (ARRA), NDF contracted with AMEC Environment & Infrastructure (AMEC) to conduct the region's first urban tree canopy (UTC) assessment. This assessment examines the area and percent cover for existing tree canopy, possible planting area in vegetated grass areas and suitable impervious areas such as parking lots, and areas unsuitable for planting. These metrics were calculated for the entire study area of interest (AOI), 5 entities (Reno, Sparks, UNR, Sun Valley GID, and Washoe County which included Spanish Springs), 3 types of jurisdictions (wards, neighborhood advisory boards, and county commission districts), 7 generalized land use categories, and individual parcel (tax lot) boundaries. Table 1 provides the complete listing excluding parcels.

Table 1. List of UTC Assessment Boundaries

Target Feature Class	No. of Features	Name	Total Acres
AOI	1	Truckee Meadows	131,302
Entities	1	Reno	52,214
	2	Sparks	21,294
	3	Sun Valley	3,275
	4	UNR	1,484
	5	Washoe County	53,035
Jurisdictions	1	Commission District 1	1,828
	2	Commission District 2	22,361
	3	Commission District 3	1,695
	4	Commission District 4	9,616
	5	Commission District 5	22,294
	6	NAB North Valleys	10,225
	7	NAB Northeast	4,490
	8	NAB Northwest	7,419
	9	NAB Old Northwest	2,122
	10	NAB Ward One	7,290
	11	NAB Ward Three	8,329
	12	NAB Ward Two Central	4,897
	13	NAB Ward Two South	7,441
	14	Ward 1	2,758
	15	Ward 2	2,347
	16	Ward 3	6,030
	17	Ward 4	5,940
	18	Ward 5	4,219
Land Use	1	Agriculture	2,540
	2	Commercial	14,256
	3	Industrial	9,415
	4	Public	6,205
	5	Residential	63,449
	6	Right of Way	15,178
	7	Vacant	20,259

The assessment was accomplished using geographic information systems (GIS) and aerial photography. A land cover classification process was performed to map trees, impervious surfaces, grass and open space, bare soil / dry vegetation, and water. Aerial photography from the 2010 National Agricultural Imagery Program (NAIP) was used. The NAIP imagery included natural color and color-infrared with "leaf-on" (summer) conditions at 1 meter pixel resolution.

In this report, tree canopy goals are discussed and compared to the results for Truckee Meadows. The environmental services provided by trees are described and quantified, for existing and future scenarios.

Innovative methods and tools for setting canopy cover goals based on current data are offered to facilitate this process.

Specific objectives of this assessment were to:

- Map 5 classes of land cover across the region
- Determine Existing, Possible, and Unsuitable UTC percentages for each entity, ward, neighborhood advisory board (NAB), commission district boundaries, generalized zoning categories and parcels
- Calculate environmental and economic benefits of the current tree canopy and model scenarios of increasing canopy cover
- Present potential canopy goals using the analysis in a summary report, public service announcement (PSA), factsheet, and final presentation to stakeholders in the region
- Provide technical and non-technical tools for implementing canopy goals

Maps on the following pages illustrate the study area, entities included, and the land cover data mapped across the Truckee Meadows region.

Volunteers plant trees and improve landscaping at Washoe County's Lazy 5 Regional Park in Spanish Springs, Nevada

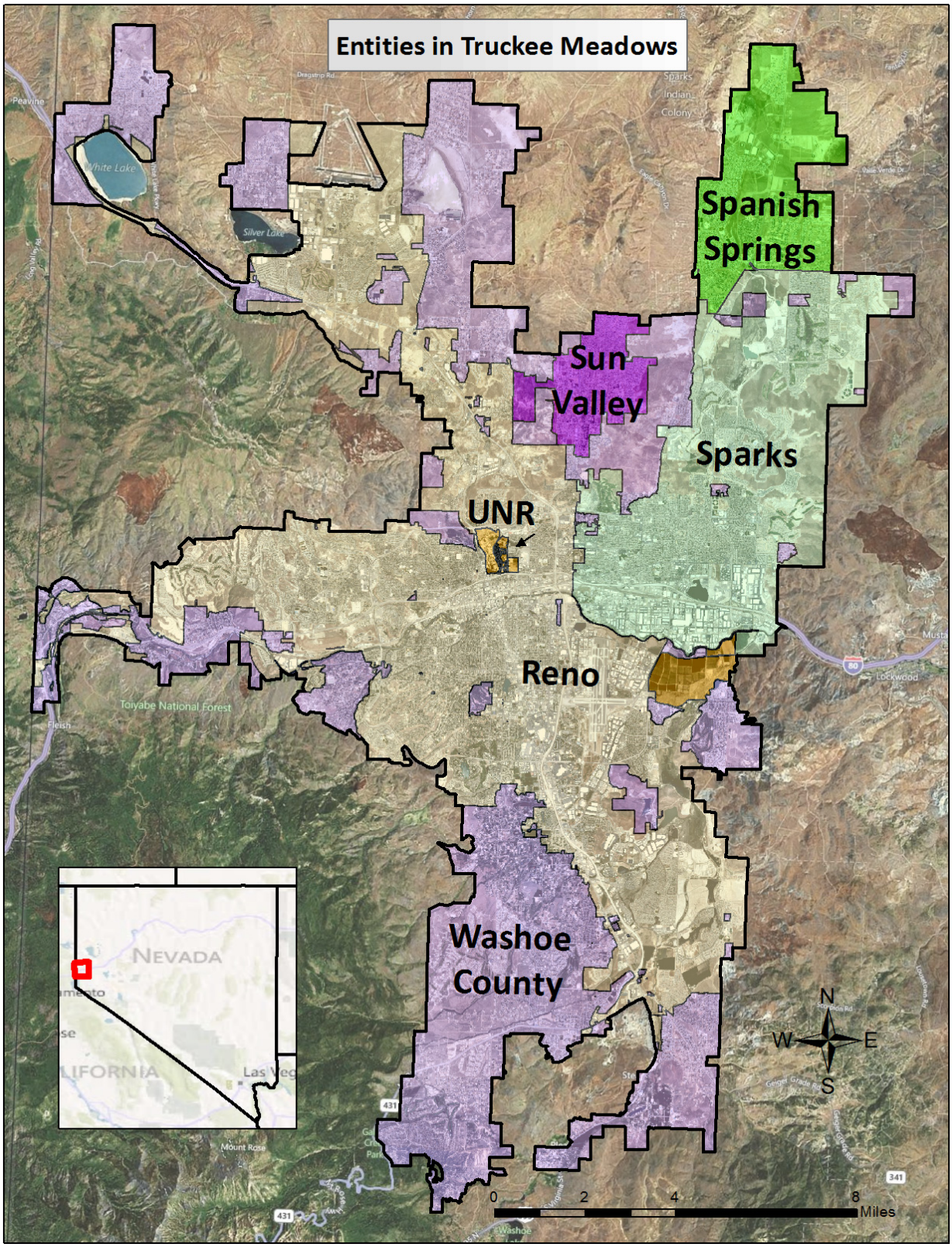


Figure 1. Truckee Meadows (Reno-Sparks, Nevada) UTC Assessment Boundary

Major Findings

Based on the analysis of aerial imagery, land cover, land use and the resulting GIS mapping data, the following represent the major findings from this study:

- ***Truckee Meadows has 4.6% tree canopy and 29% impervious surfaces. The remaining 66% is herbaceous vegetation, bare soil or dry vegetation, and water.***

- ***Tree canopy in Truckee Meadows was estimated to store nearly 255,000 tons of carbon, provides an annual air pollution removal value of $1.5M, and a total stormwater runoff mitigation value of $40.9M.***

- ***75% of the region's urban forest canopy is on residential land, with 8% on public rights of way and 7% on commercial property.***

- ***Residential areas average 9.6% canopy cover in Reno and 7.1% in Sparks.***

- ***Possible planting area such as turf grass and parking lots covers 62,500 acres, almost half (48.6%) of the urban portions of Truckee Meadows.***

- ***Reaching 20% average canopy cover in residential areas is achievable. It would require establishing canopy on 7,500 acres, or ¼ of the 30,000 acres of available planting space in residential land use.***

- ***Public rights of way such as streets and easements cover 11% of Truckee Meadows but represent only 8% of the total UTC.***

- ***With 5.2% UTC citywide, Reno's Neighborhood Advisory Boards (NABs) ranged from 1.2% - 12.3% UTC. One precinct (1033) in NAB One was assessed at 22% UTC, indicating that higher canopy cover is achievable in established residential and mixed use areas.***

- ***With 3.9% UTC citywide, Ward boundaries in Sparks ranged from 2.6% - 6.4% UTC.***

- ***In outlying areas, UTC in Commission Districts range from 1.8% - 9.1%.***

- ***University of Nevada – Reno (UNR) has 9.3% UTC (35.5 acres).***

Methodology

This study included a remote sensing-based land cover classification task, a GIS-based UTC Assessment, and an ecosystem services analysis using CITYgreen software. The main methods and processes involved are described below. More technical descriptions on the data inputs and land cover methodology are provided in the Appendix.

Land Cover Mapping

This UTC assessment required the use of geographic information systems (GIS), remote sensing, aerial imagery, and GIS data provided by Washoe County, Reno, and Sparks. These processes and inputs were used to map 5 land cover types using summer, leaf-on imagery with 1-meter pixel resolution. The land cover classes are; (1) tree canopy and shrubs, (2) other green vegetation, (3) impervious surfaces, (4) water, and (5) soil / dry vegetation. The examples in Figure 2 shows the imagery used in the analysis, the detailed tree canopy layer and all land cover classes mapped. Figure 3 defines each class and includes acres and percent cover. Technical aspects on the data inputs and land cover classification methods are in the Appendix.

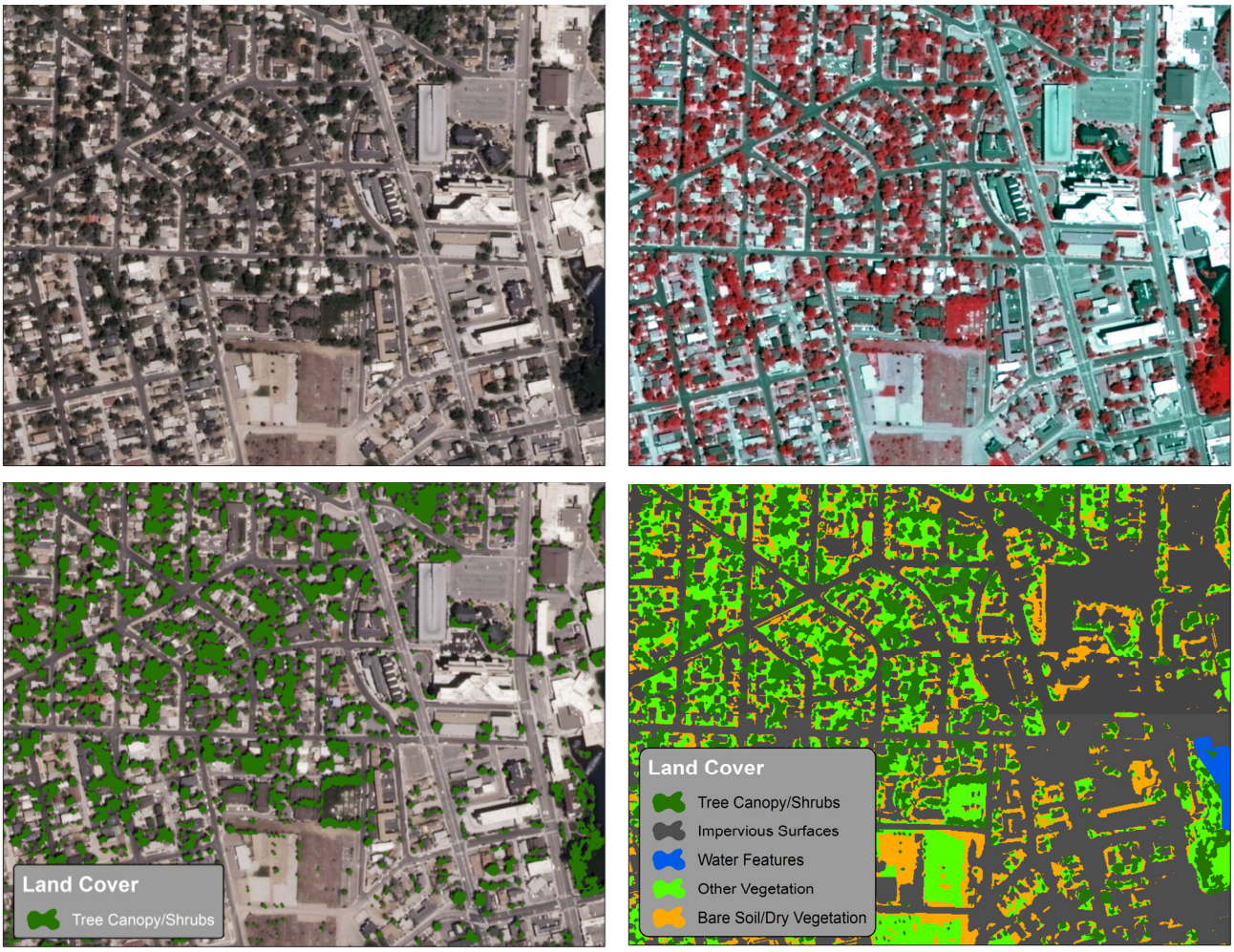
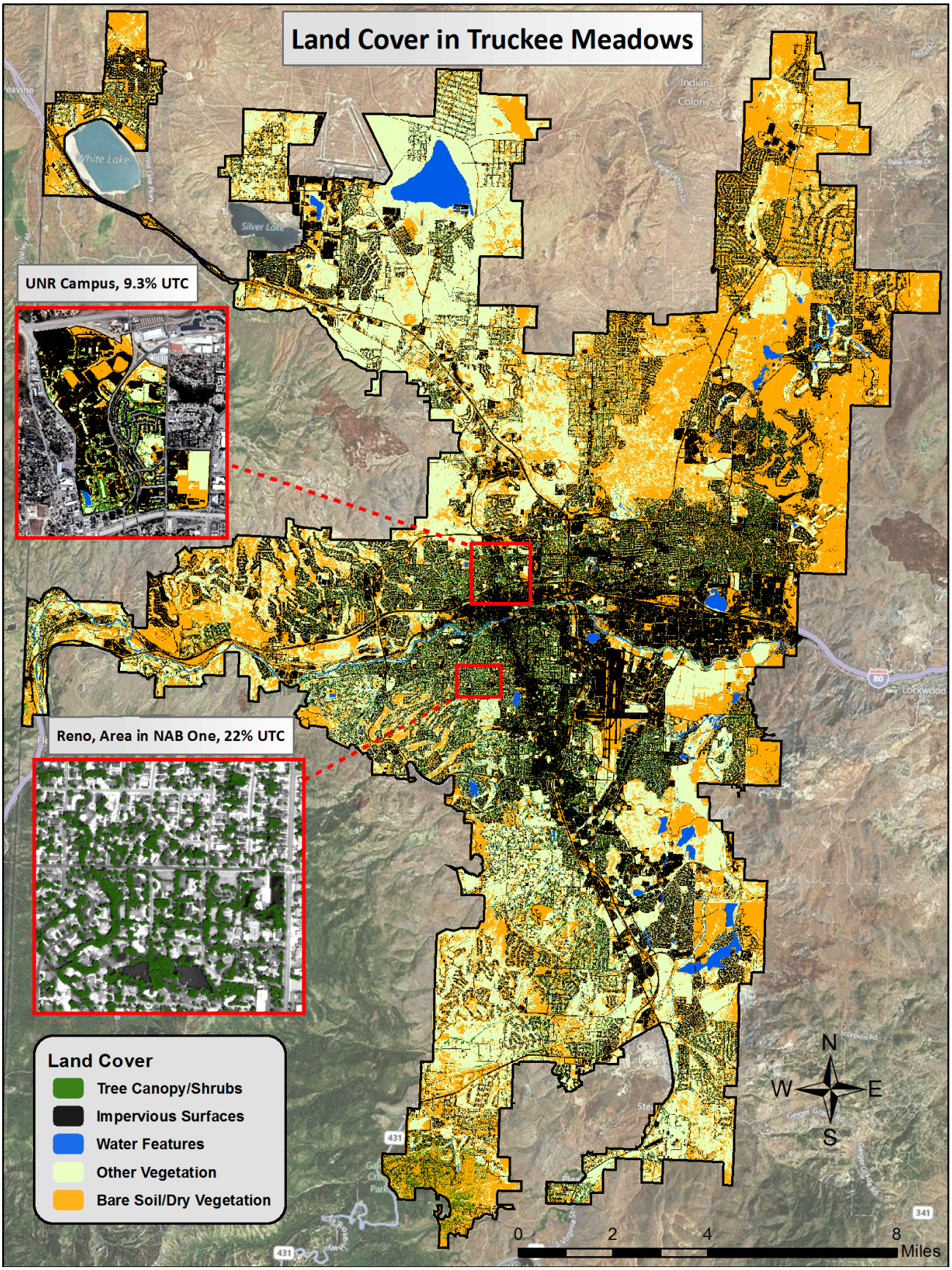


Figure 2: Clockwise from the top left: NAIP image in natural color, NAIP with color infrared band, classification of tree canopy, and five-class land cover dataset.

Land Cover	Definition	Total Acres	Percent of AOI (includes water)	
Impervious	Impervious surfaces including buildings and paved areas	37,800	28.8%	
Trees/Shrubs	Area covered by tree canopy and shrubs as seen from above	5,914	4.5%	
Water	Open water including lakes, streams, and canals	2,336	1.8%	
Vegetation	All low-lying vegetation and irrigated turf	44,759	34.1%	
Soil	Bare soil & dry vegetation	40,494	30.8%	

Figure 3: Definition and distribution of land cover classes in this assessment. Note that land cover percentages in this table are based on the total assessment area including water.

Residential and park landscaping in the Truckee Meadows region



Bing Maps Base Layer

Figure 4. Classified Land Cover Data for Truckee Meadows. Inset map of UNR land cover data.

Urban Tree Canopy Assessment

Central to a UTC assessment is calculating the area and percent of existing, possible, and unsuitable UTC across multiple spatial scales, political boundaries, and development types. For Truckee Meadows, this was done for:

- The entire study area (urbanized areas of Truckee Meadows)
- 5 entities: Reno, Sparks, UNR, Sun Valley GID, and remaining areas of Washoe County
- 18 jurisdictions: 8 Neighborhood Advisory Boards in Reno, 5 Wards in Sparks, and 6 Commission Districts in Washoe County
- 7 broad land use categories: residential, commercial, industrial, agriculture, public lands (including parks), public rights-of-way (defined as land not in a parcel), and vacant.
- Individual parcel (tax lot) boundaries

Using GIS, these assessment boundaries were joined with parcels in order to rapidly summarize and analyze the data at different scales. Reno and Sparks were evaluated separately from unincorporated areas in Washoe County including UNR, Sun Valley, and Spanish Springs. For summary reporting these areas were included with Washoe County and the Commission Districts. Land use types were provided by Washoe County and generalized into the broad categories listed above by AMEC and NDF. See Appendix for a list of land use codes, their description, and the broad category that each was given for this assessment.

Existing urban tree canopy was defined as areas covered by trees and large shrubs. Possible planting area (PPA) was defined as total land area where no tree canopy cover currently exists and where it is biophysically possible to plant trees. In this analysis, total PPA was the combination of non-forest vegetation such as turf grass (Possible Planting Area – Vegetation) and suitable impervious surfaces such as parking lots (Possible Planting Area – Impervious). Bare soil, dry vegetation, roads, building area per parcel, and water were included in Unsuitable UTC. Soil and dry vegetation were considered unsuitable due to lack of maintenance such as irrigation. UTC metrics were calculated based on percentage of land area, excluding water.

Figures 5a – 5c. Local area photos (from left to right) of Existing UTC, Possible Planting Area (Vegetation), and Possible Planting Area (Impervious)

Ecosystem Benefits Analysis

CITYgreen software from American Forests is a GIS-based model that uses land cover data as an input to quantify some of the ecosystem services provided by urban forest canopy cover in dollars and resource units. Reports estimate benefits of tree canopy cover for air pollution removal capacity for 5 common air pollutants (in lbs./yr.), carbon storage and sequestration (in lbs./yr.), stormwater runoff (volume mitigated) and water quality (percent change in contaminant loading) using event mean concentrations. The model does not estimate urban tree canopy benefits related to energy savings or aesthetic/property values and thus represents only a portion of total urban forest benefits.

CITYgreen uses the Curve Number (CN) system and hydrologic soil group (HSG) to estimate stormwater runoff potential. CN ranges from 0 to 100 with a higher number indicating more impervious surface and a higher runoff rate. The value of tree canopy is modeled by replacing trees with other cover types such as buildings, parking lots and other landscapes, often having a higher CN. To better characterize the hydrologic impact of tree canopy, two cover types were added to the 5-class land cover data: trees with an impervious understory and compacted/bladed urban soils which were sub-classified from bare soil/dry vegetation. Additional information on the air quality, carbon storage, stormwater, and water quality models used in CITYgreen software can be found in the Appendix.

CITYgreen reports were generated for the entire study area, each entity, and by land use across the study area and for each entity. Additionally, for each entity, reports were created at 10%, 15% and 20% canopy cover to model the additional benefits at increased amounts of tree canopy cover. Results are shown in this report and complete CITYgreen reports were delivered on disk to stakeholders throughout the TMSA.

The classes and their corresponding curve numbers (CN) based on C type soils were:

- Tree canopy/shrub = Trees: Grass/turf understory: Ground cover > 75% (CN 72)
- Other vegetation/grass = Open Space - Grass/Scattered Trees: Grass cover > 75% (CN 74)
- Impervious = Impervious Surfaces: Paved: Drain to sewer (CN 98)
- Water = water area (CN 100)
- Compacted/bladed urban soil = Impervious Surfaces: Unpaved: Dirt (CN 87)
- Bare soil/dry vegetation = Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70% (CN 63)
- Trees with impervious understory = Trees: Impervious understory (CN 91)

The following were the parameters used in the CITYgreen modeling:

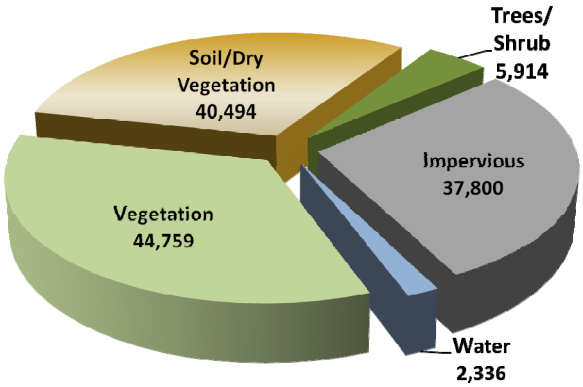
- Hydrologic Soil Group: “C”
- Air Quality Reference City: Salt Lake City
- Stormwater Construction: $3/cubic foot
- Slope: 2% average
- Replacement land cover type: Urban: Western Desert: Natural Landscaping (CN 85)

Results

This section of the report presents the land cover and UTC results, beginning with the entire Truckee Meadows region followed by results for Reno, Sparks, and remaining Washoe County areas. CITYgreen results for current conditions and future canopy scenarios are included by land use type for each entity. Complete UTC tables can be found in the Appendix.

Truckee Meadows Urban Tree Canopy

Figure 6: Distribution of Land Cover in Acres



The urban portions of Truckee Meadows assessed in this study cover 128,967 acres excluding water, of which 5,914 are tree canopy (4.6% average tree cover). With nearly 45,000 acres of non-tree vegetation and nearly 38,000 acres of impervious surfaces, the region's urban forest has room to grow. Figure 7 below shows there are 63,346 acres of total possible planting area. This is the combination of available non-tree vegetation (mainly turf grass) and impervious areas (mainly parking lots) where tree canopy could most easily be established.

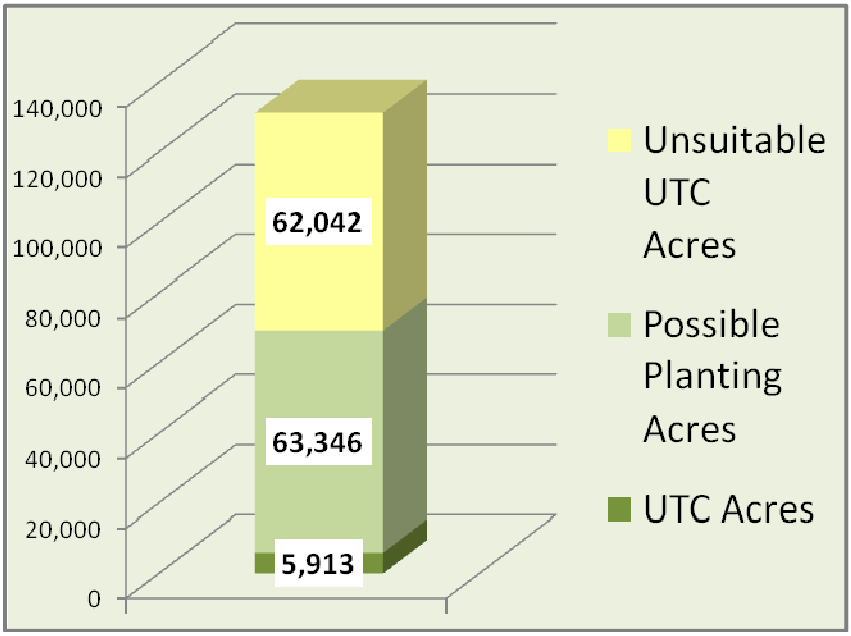


Figure 7: Regional UTC Results in Acres

Did You Know …

- Out of 143,749 parcels assessed, 44,417 have 0% tree cover;
- 20,830 parcels have more than 20% tree cover;
- 78,608 parcels have less than 5% tree cover;
- 14,486 parcels have at least 50% turf grass planting area; and
- 8,167 parcels have at least 50% impervious planting area.

Truckee Meadows Urban Tree Canopy Results by Land Use

The following section maps and quantifies the Existing, Possible, and Unsuitable UTC for 7 land use types. While residential areas have only 7% average canopy cover, this represents 75% of total canopy and nearly 48% of possible planting area. Commercial properties also have large

potential (14% of PPA) due to large parking lots where tree shade provides many benefits. These results by land use type are used for setting canopy cover goals later in this report.

Table 2. Truckee Meadows UTC Results by Land Use

Land Use	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC	Percent of Total Land Use	Possible Planting Acres	Possible Planting %	Percent of Total PPA	Unsuitable UTC Acres	Unsuitable UTC %
Agriculture	2,520	47	1.9	0.8	1.95	1,937	76.9	3.1	556	22.1
Commercial	14,063	440	3.1	7.4	10.90	9,192	65.4	14.5	4,623	32.9
Industrial	9,343	113	1.2	1.9	7.24	4,865	52.1	7.7	4,437	47.5
Public	5,925	170	2.9	2.9	4.59	2,953	49.8	4.7	3,082	52.0
Residential	62,939	4,407	7.0	74.5	48.80	30,278	48.1	47.8	28,764	45.7
Right of Way	14,914	489	3.3	8.3	11.56	5,045	33.8	8.0	9,643	64.7
Vacant	19,262	247	1.3	4.2	14.94	9,076	47.1	14.3	10,936	56.8
TOTALS	128,967	5,914	4.6	100.0	100.0	63,346	49.1	100.0	62,042	48.1

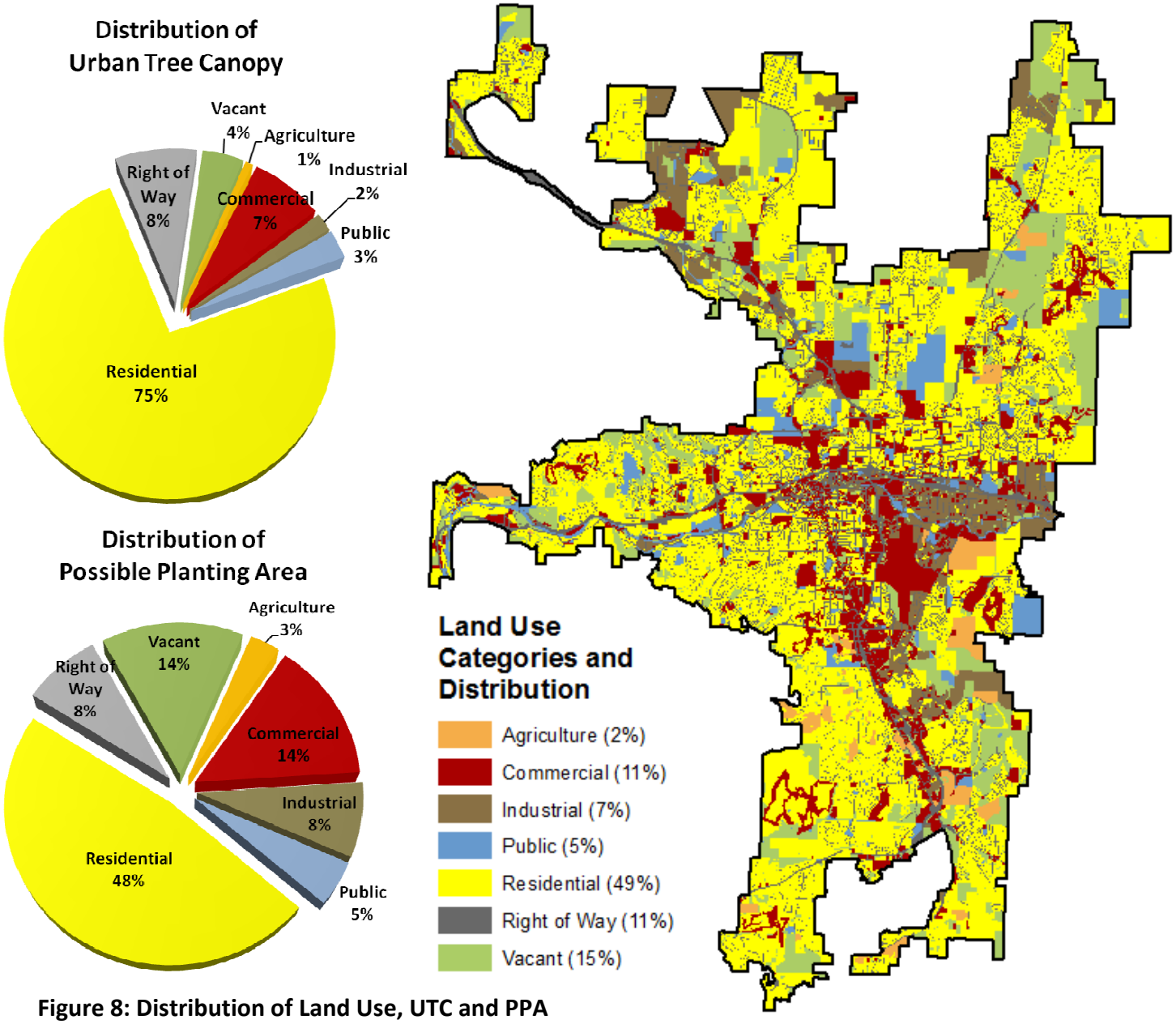


Figure 8: Distribution of Land Use, UTC and PPA

Truckee Meadows Ecosystem Benefits

Based on the region's land use and land cover data analyzed in this study, CITYgreen software was used to estimate the benefits of existing and potential tree canopy. Summary results are presented below in the following way:

- For 7 broad land use categories
- By the type of ecosystem benefit, including: air pollution removal in dollars and pounds per year, total carbon storage and annual carbon sequestration in tons, and mitigated stormwater runoff in dollars and cubic feet (annually and in total). Additionally, water quality benefits are shown as the percent reduction of contaminant loading for numerous water pollutants.
- For both current conditions and future scenarios with increased canopy cover of 10, 15, and 20% regionally.

As seen in Tables 6 and 7, CITYgreen results show that increasing canopy cover to 20% overall would provide $6.8M in annual air quality benefits and $79.9M in total stormwater benefits.

Note that not all results are shown. Complete results can be found in the detailed CITYgreen PDF reports delivered separately from this assessment report.

Table 3. Truckee Meadows Urban Tree Canopy Benefits by Land Use, Current Conditions

Land Use	Area	Tree Canopy	Air Pollution Removal	Air Pollution Removal Value	Carbon Stored	Carbon Sequestered	Total Stormwater Value	Total Stormwater Quantity
	acres	acres	lbs/yr	$	tons	tons	$	cu.ft.
Agriculture	3,087.6	49.9	4,713	12,937	2,146	17	290,678	96,893
Commercial	14,274.9	442.3	41,795	114,727	19,034	148	3,752,391	1,250,797
Industrial	9,414.5	112.9	10,666	29,279	4,858	38	924,090	308,030
Public	6,194.0	168.7	15,944	43,765	7,261	57	946,470	315,490
Residential	63,368.2	4,402.7	416,009	1,141,936	189,455	1,475	29,193,624	9,731,208
Right of Way	15,177.5	490.1	46,306	127,108	21,088	164	4,374,918	1,458,306
Vacant	19,780.3	246.8	23,320	64,012	10,620	83	1,399,981	466,660
Total	**131,297.0**	**5,913.4**	**558,753**	**1,533,764**	**254,462**	**1,982**	**40,882,152**	**13,627,384**

Table 4. Truckee Meadows Urban Tree Canopy Air Quality Benefit, Current Conditions

	Lbs. Removed/yr	Dollar Value/yr
Carbon	15,814	7,761
Ozone:	158,138	$558,708
Nitrogen Dioxide:	84,340	$297,978
Particulate	274,105	$646,572
Sulfur Dioxide:	26,356	$22,746
Totals:	**558,753**	**1,533,765**

Dollar values are based on 2009 dollars

Table 5. Truckee Meadows Urban Tree Canopy Water Quality Benefits, Current Conditions

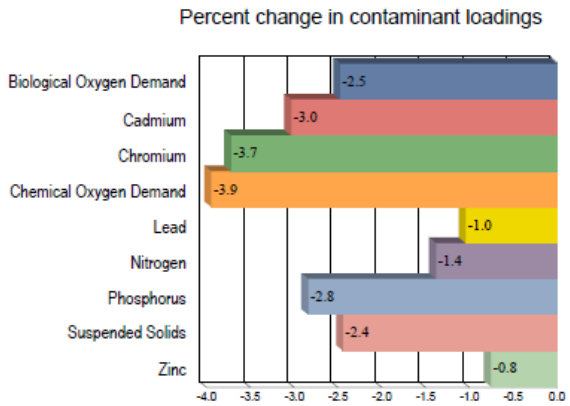


Table 6. Truckee Meadows Urban Tree Canopy Stormwater Benefit at 20% Canopy Cover

2-yr, 24-hr Rainfall in inches:	2.50
Curve Number reflecting existing conditions:	79
Curve Number of replacement land cover:	78
Dominant soil type: C	
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	-13,006,946
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$-39,020,839**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$3,402,015**

* A negative value implies "avoided costs" or a cost savings which is added to the current conditions stormwater value

Table 7. Truckee Meadows Urban Tree Canopy Benefits, Future Scenarios

Truckee Meadows	UTC Acres	Annual AQ Benefit	Annual SW Benefit	Total Annual Benefit	Total Stormwater $-Benefit
Existing	5,913.4	1,533,765	3,592,582	5,126,347	**40,882,152**
10%	13,129.7	3,405,480	4,236,284	7,641,764	**48,265,359**
15%	19,694.6	5,108,220	4,853,428	9,961,648	**55,343,956**
20%	26,259.5	6,810,961	6,994,597	13,805,558	**79,902,991**

* "SW" short for stormwater

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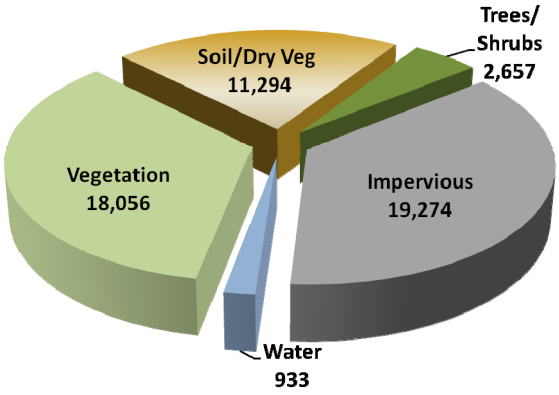
Reno's Urban Tree Canopy

At 5.2%, the City of Reno has a slightly higher percent tree cover than Sparks or outlying Washoe County areas. It was also found to have a higher percentage of potential planting space in non-tree vegetation such as turf grass. Table 8 below shows that canopy cover ranged from 1% to 9.7% in land use types with each having a high proportion of possible planting area, even in the public rights of way along streets.

Figure 9: Reno Land Cover in Acres



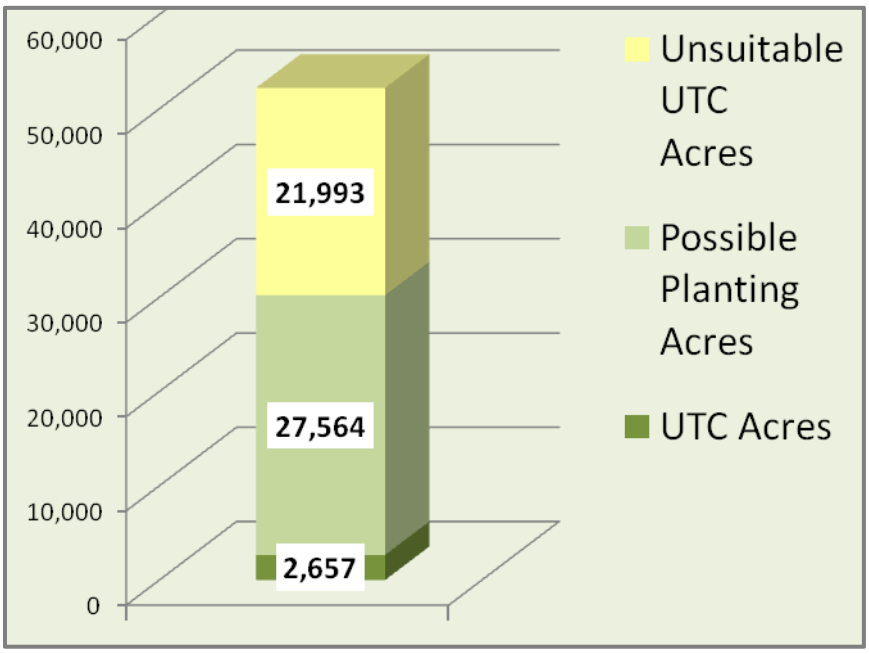


Figure 10. Overall Urban Tree Canopy Results for Reno

Table 8. UTC Results by Land Use in Reno

Land Use	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC in Reno	Possible Planting Acres	Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
Agriculture	1,350	16	1.1	0.6	1,064	78.9	281	20.8
Commercial	8,498	257	3.0	9.7	5,523	65.0	2,815	33.1
Industrial	5,637	76	1.3	2.9	3,506	62.2	2,112	37.5
Public	1,860	77	4.2	2.9	1,180	63.4	714	38.4
Residential	19,374	1,883	9.7	70.9	9,677	49.9	7,986	41.2
Right of Way	7,439	275	3.7	10.4	2,684	36.1	4,608	61.9
Vacant	7,124	73	1.0	2.7	3,930	55.2	3,477	48.8
TOTALS	51,281	2,657	5.2	100.0	27,564	53.8	21,993	42.9

Urban Tree Canopy Results by Neighborhood Advisory Boards

Reno has 8 Neighborhood Advisory Boards (NABs) composed of resident volunteer members appointed by the Reno City Council for two-year terms. Meetings provide an arena for residents to voice concerns and the NABs advise the City Council on policy affecting neighborhoods throughout the community. Each NAB was assessed for existing, possible, and unsuitable UTC.

Table 9. UTC Results in Reno by Neighborhood Advisory Board.

Neighborhood Advisory Boards	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC	Possible Planting Acres	Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
NAB NORTH VALLEYS	10,094	125	1.2	4.7	6,600	65.4	3,500	34.7
NAB NORTHEAST	4,485	203	4.5	7.6	2,407	53.7	1,880	41.9
NAB NORTHWEST	7,390	224	3.0	8.4	3,477	47.1	3,719	50.3
NAB OLD NORTHWEST	2,112	271	12.8	10.2	882	41.8	969	45.9
NAB WARD ONE	7,167	715	10.0	26.9	3,380	47.2	3,195	44.6
NAB WARD THREE	8,113	459	5.7	17.3	4,412	54.4	3,458	42.6
NAB WARD TWO CENTRAL	4,812	519	10.8	19.5	2,486	51.7	1,892	39.3
NAB WARD TWO SOUTH	7,110	142	2.0	5.3	3,920	55.1	3,380	47.5
TOTALS	51,281	2,657	5.2	100.0	27,564	53.8	21,993	42.9

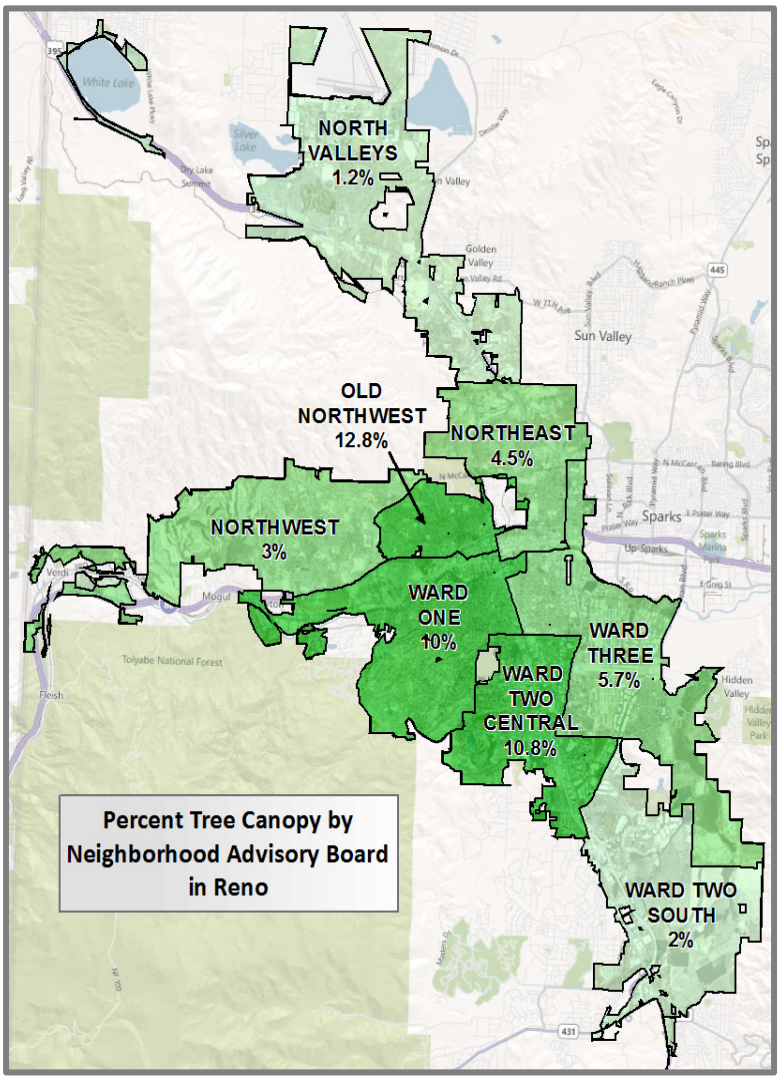


Figure 11: Percent of Existing Tree Canopy in Reno by Neighborhood Advisory Board.

- Existing canopy cover ranged from 1.2% to 12.8% for NABs.
- In order to look at tree cover at a finer scale, one precinct (1033) in Reno with visibly high canopy cover was found to have 22.3% UTC. This offers an achievable target for smaller sub-areas in Reno and in the region.
- Possible planting area ranged from 41.8% to 65.4%. Parcel-level results (next page) provide a closer scale for identifying specific tree planting opportunities.

Reno Urban Tree Canopy Results by Parcel

Tree canopy metrics were mapped in Reno at the individual tax lot, or parcel boundary. Figure 12 illustrates current tree canopy percent per parcel citywide and inset maps of percent possible planting in vegetated areas such as turf grass and impervious areas such as parking lots.

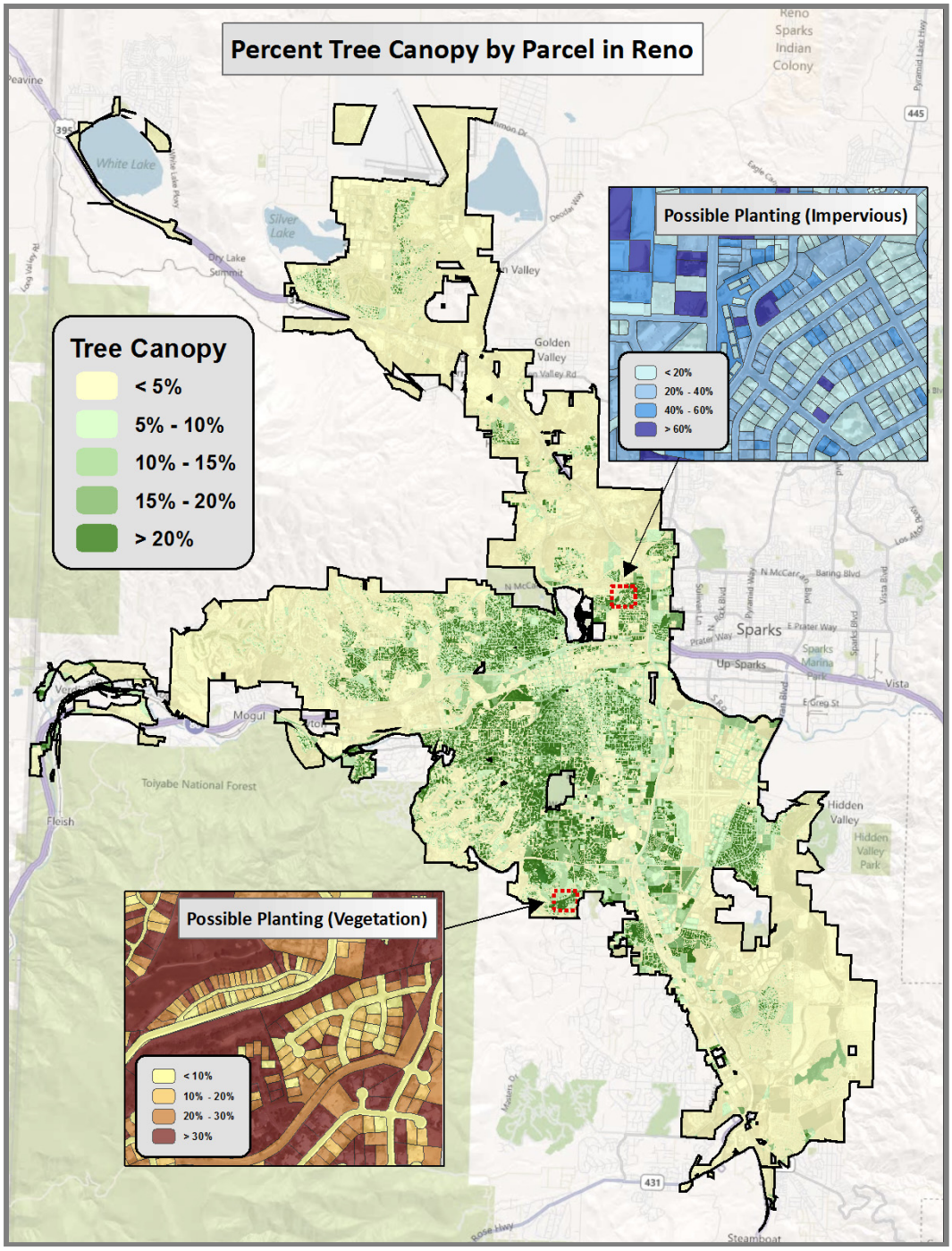


Figure 12: Percent UTC by Parcel including Inset Map Examples Showing Percent Planting Potential for Vegetated Areas and Impervious Areas such as Parking Lots

Reno Ecosystem Benefits

Similar to the Truckee Meadows region shown above, CITYgreen modeling quantified some of the environmental and economic benefits of existing canopy cover and for future scenarios citywide in Reno and by land use type. Summary level results can be found in Tables 10 and 11 below. Complete results can be found in the detailed CITYgreen reports delivered separately from this assessment report.

Table 10. Reno Urban Tree Canopy Benefits by Land Use, Current Conditions

Land Use	Area	Tree Canopy	Air Pollution Removal	Air Pollution Removal	Carbon Stored	Carbon Sequestered	Total Stormwater Value	Total Stormwater Quantity
	acres	acres	lbs/yr	$	tons	tons	$	cu.ft.
Agriculture	1,360.7	15.5	1,466	4,025	668	5	77,597	25,866
Commercial	8,594.9	257.0	24,283	66,657	11,059	86	2,370,930	790,310
Industrial	5,693.4	75.7	7,150	19,627	3,256	25	595,980	198,660
Public	1,970.5	77.3	7,308	20,061	3,328	26	486,486	162,162
Residential	19,454.4	1,883.2	177,941	488,444	81,036	631	14,233,691	4,744,564
Right of Way	7,567.8	275.6	26,039	71,477	11,859	92	2,412,967	804,322
Vacant	7,479.6	72.5	6,853	18,812	3,121	24	457,645	152,548
Total	**52,121.3**	**2,656.8**	**251,040**	**689,103**	**114,327**	**889**	**20,635,296**	**6,878,432**

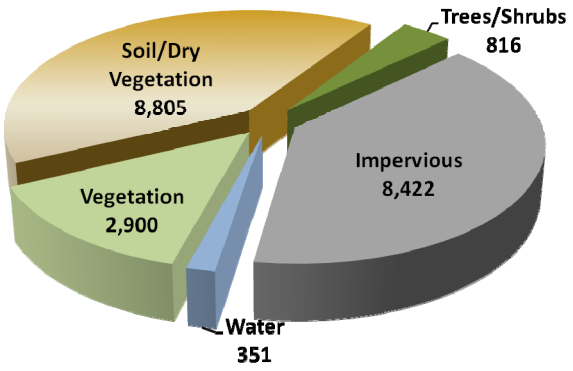
Table 11. Reno Urban Tree Canopy Benefits, Future Scenarios

Reno	UTC Acres	Annual AQ Benefit	Annual SW Benefit	Total Annual Benefit	Total Stormwater $-Benefit
Existing	2,656.8	689,103	1,799,207	2,488,310	**20,635,296**
10%	5,221.3	1,354,244	2,129,325	3,483,569	**24,421,723**
15%	7,831.9	2,031,366	2,405,237	4,436,603	**27,586,415**
20%	10,442.5	2,708,488	3,367,976	6,076,464	**38,628,947**

Sparks Urban Tree Canopy

Sparks has a total of 816 acres of tree canopy, or 3.9% average cover citywide. The land cover classification results illustrate that there is less non-tree vegetation such as turf grass than in Reno, not just in total acres but also in percent (13.8% compared to 35.2% in Reno). Looking at the UTC results, there is a combined 34.6% total possible planting area when considering both turf grass areas and suitable impervious surfaces such as parking lots.

Figure 13: Sparks' Land Cover in Acres



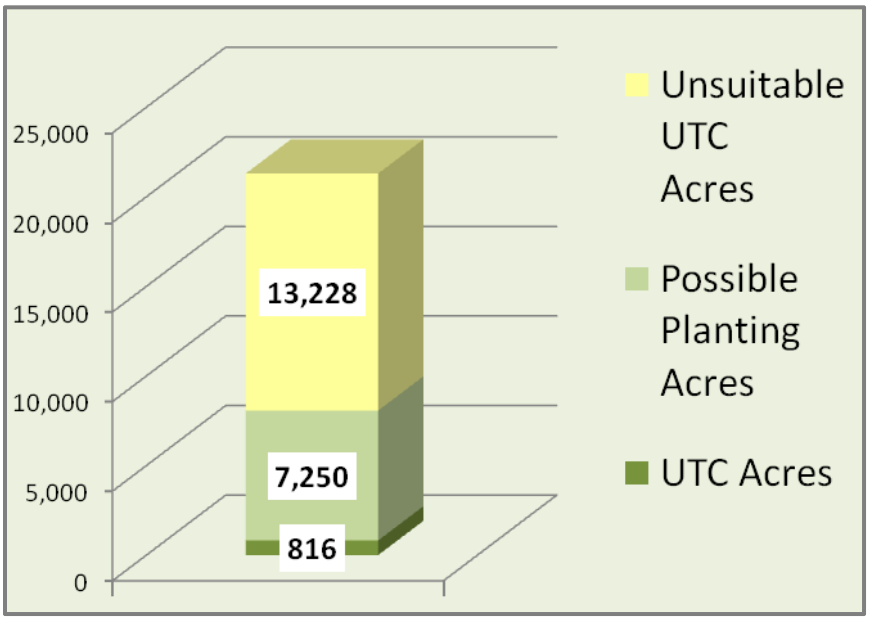


Figure 14. Overall Urban Tree Canopy Results for Sparks

Table 12. UTC Results by Land Use in Sparks

Land Use	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC in Sparks	Possible Planting Acres	Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
Agriculture	346	3	0.9	0.4	196	56.8	149	43.1
Commercial	2,536	63	2.5	7.7	1,625	64.1	919	36.2
Industrial	1,959	33	1.7	4.1	895	45.7	1,041	53.1
Public	1,052	30	2.8	3.7	283	26.9	834	79.3
Residential	8,105	579	7.1	71.0	2,412	29.8	5,135	63.4
Right of Way	3,011	101	3.3	12.3	1,095	36.4	1,854	61.6
Vacant	3,934	7	0.2	0.9	744	18.9	3,295	83.8
TOTALS	20,943	816	3.9	100.0	7,250	34.6	13,228	63.2

Sparks Urban Tree Canopy Results by City Council Ward

The City of Sparks has five City Council Wards each with an elected city council representative. The ward boundaries change based on population and the redistricting process from the census. 2011 ward boundaries were used to assess existing, possible, and unsuitable UTC.

Table 13. UTC Results in Sparks by Ward

Sparks City Council Wards	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC	Possible Planting Acres	Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
Ward 1	2,739	168	6.1	20.6	1,283	46.9	1,307	47.7
Ward 2	2,337	149	6.4	18.3	989	42.3	1,209	51.7
Ward 3	5,904	207	3.5	25.4	1,942	32.9	3,881	65.7
Ward 4	5,861	150	2.6	18.4	1,773	30.3	4,017	68.5
Ward 5	4,101	141	3.5	17.3	1,263	30.8	2,814	68.6
TOTALS	20,943	816	3.9	100.0	7,250	34.6	13,228	63.2

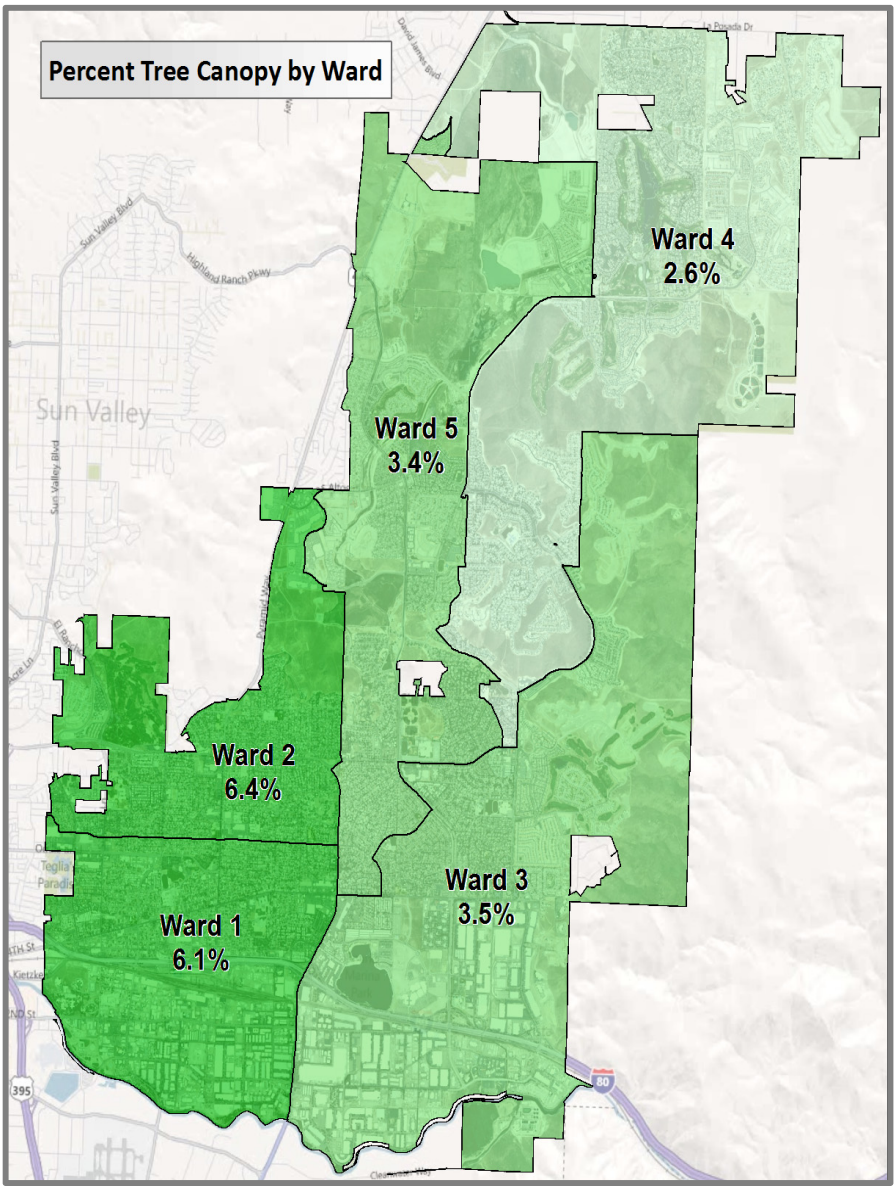


Figure 15: Percent of Existing Urban Tree Canopy in Sparks by Wards.

Sparks Urban Tree Canopy Results by Parcel

Tree canopy metrics were generated in Sparks at the individual tax lot, or parcel boundary. Figure 16 shows current tree canopy percent per parcel citywide and inset maps of percent possible planting in vegetated areas such as grass and impervious areas such as parking lots.

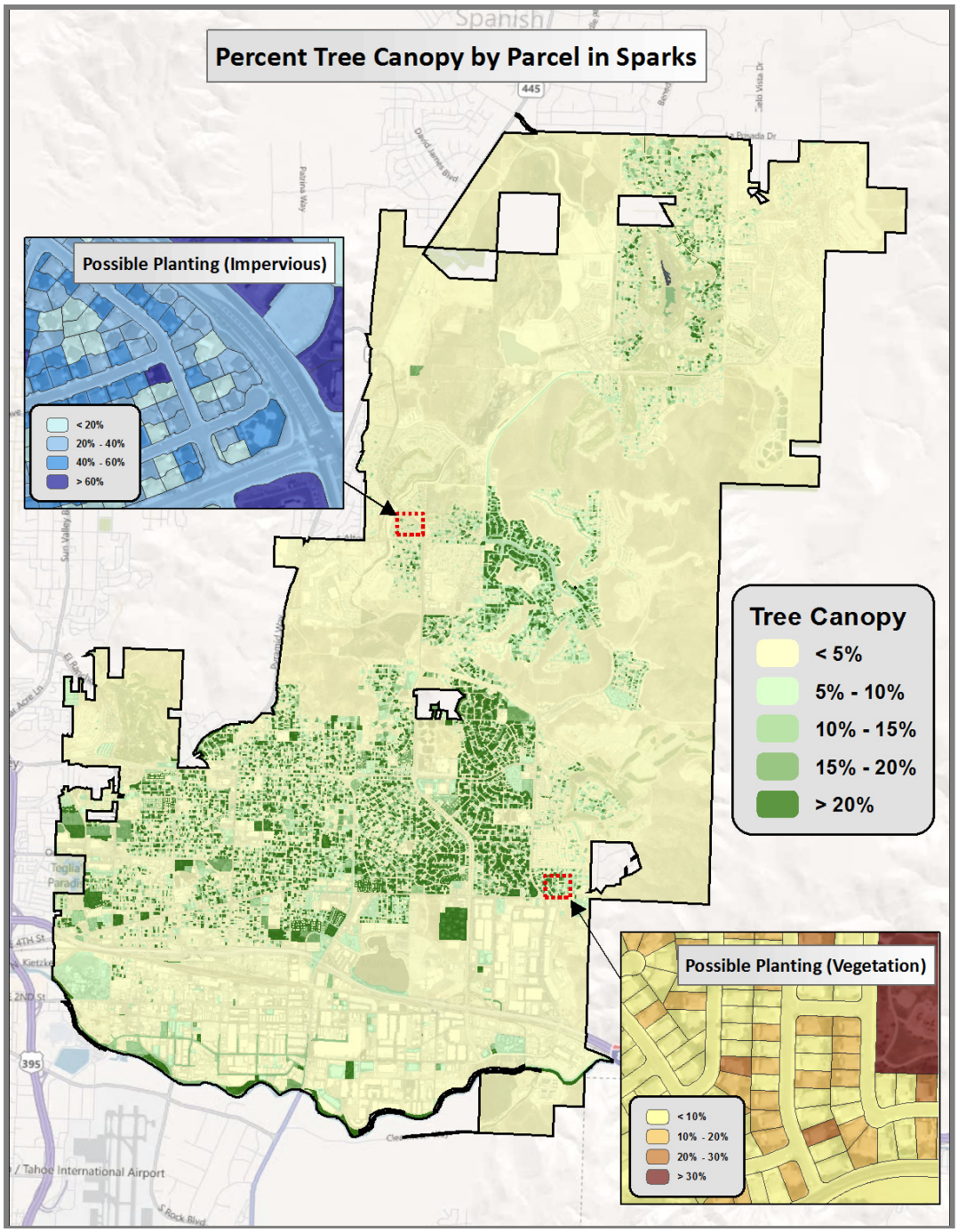


Figure 16: Percent UTC by Parcel including Inset Map Examples Showing Planting Potential for Vegetated Areas and Impervious Areas such as Parking Lots

Sparks Ecosystem Benefits

Similar to the Truckee Meadows region and City of Reno shown above, CITYgreen modeling quantified some of the environmental and economic benefits of existing canopy cover and for future scenarios citywide in Sparks and by land use type. Summary level results can be found in Tables 14 and 15 below. Complete results can be found in the detailed CITYgreen reports delivered separately from this assessment report.

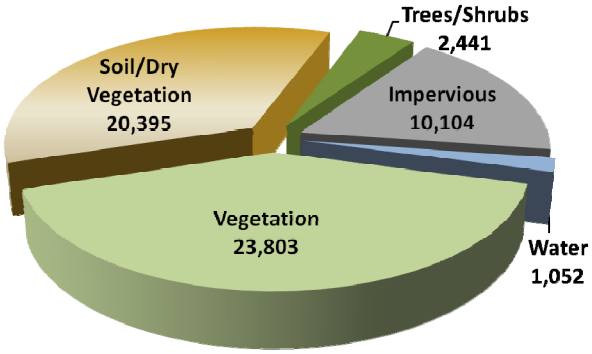
Table 14. Sparks Urban Tree Canopy Benefits by Land Use, Current Conditions

Land Use	Area	Tree Canopy	Air Pollution Removal	Air Pollution Removal Value	Carbon Stored	Carbon Sequestered	Total Stormwater Value	Total Stormwater Quantity
	acres	acres	lbs/yr	$	tons	tons	$	cu.ft.
Agriculture	348.6	3.0	282	775	129	1	18,475	6,158
Commercial	2,606.6	62.9	5,942	16,311	2,706	21	560,207	186,736
Industrial	1,969.5	33.5	3,169	8,699	1,443	11	451,474	150,491
Public	1,146.6	29.8	2,818	7,735	1,283	10	173,037	57,679
Residential	8,126.3	578.5	54,663	150,050	24,894	194	4,092,305	1,364,102
Right of Way	3,048.8	101.1	9,549	26,212	4,349	34	1,024,948	341,649
Vacant	4,046.5	7.1	670	1,839	305	2	32,277	10,759
Total	**21,292.9**	**815.9**	**77,093**	**211,621**	**35,109**	**273**	**6,352,723**	**2,117,574**

Table 15. Sparks Urban Tree Canopy Benefit Scenarios, Future Scenarios

Sparks	UTC Acres	Annual AQ Benefit	Annual SW Benefit	Total Annual Benefit	Total Stormwater $-Benefit
Existing	815.9	211,621	535,293	746,914	**6,352,723**
10%	2,129.3	552,277	672,178	1,224,455	**7,922,784**
15%	3,193.9	828,416	780,288	1,608,704	**9,162,802**
20%	4,258.6	1,104,554	1,155,387	2,259,941	**13,465,154**

Figure 17: Washoe County Land Cover in Acres



Washoe County's Urban Tree Canopy

Washoe County extends far outside and to the north of the Truckee Meadows region. In this study, only the urban portions of the county were assessed. At the parcel level, UTC metrics were calculated for Spanish Springs, Sun Valley, the UNR campus, and other unincorporated areas in the county. Results in this section however represent the collective summary metrics for areas outside of Reno and Sparks, covering 56,743 acres with 4.3% UTC overall. Interestingly, nearly 80% of the tree canopy is on residential properties (10% more than Reno and Sparks) where there are 18,188 acres of possible planting area (PPA). Additionally, commercial properties have 67.5% possible planting space. In total, there are 28,532 acres of PPA.

Overall Urban Tree Canopy Results for Washoe County

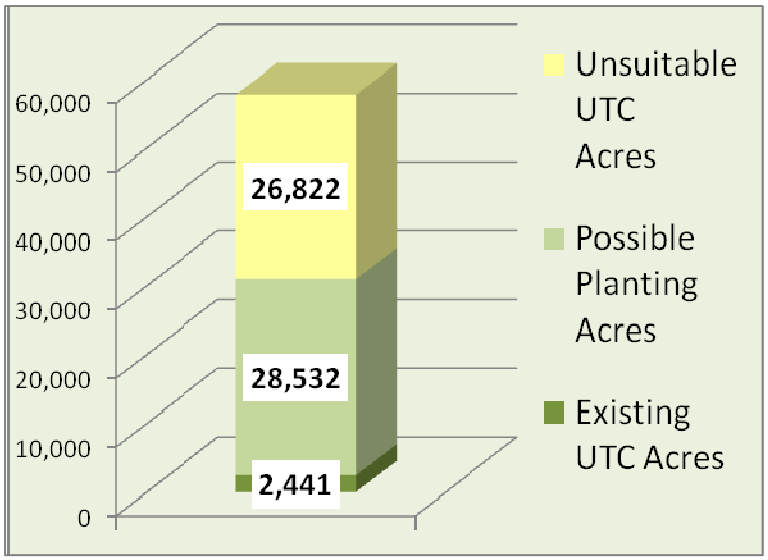


Figure 18. Overall Urban Tree Canopy Results for Washoe County Areas

Table 16. UTC Results by Land Use in Washoe County Areas

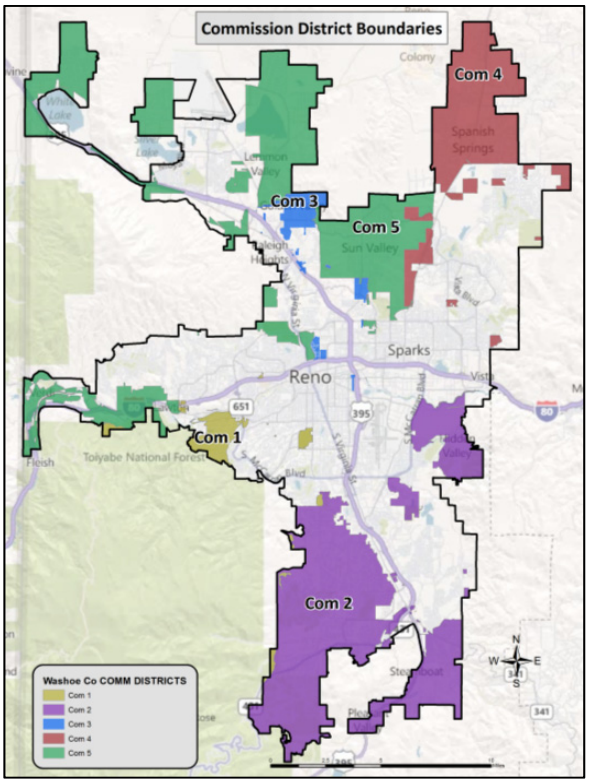
Land Use	Total Acres Excluding Water	Existing UTC Acres	Existing UTC %	Percent of Total UTC in Washoe	Possible Planting Acres	Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
Agriculture	824	28	3.4	1.2	676	82.1	126	15.3
Commercial	3,029	121	4.0	4.9	2,045	67.5	889	29.4
Industrial	1,747	4	0.2	0.1	464	26.5	1,284	73.5
Public	3,014	63	2.1	2.6	1,491	49.5	1,534	50.9
Residential	35,460	1,945	5.5	79.7	18,188	51.3	15,642	44.1
Right of Way	4,464	113	2.5	4.6	1,266	28.4	3,181	71.3
Vacant	8,205	167	2.0	6.9	4,402	53.6	4,164	50.7
TOTALS	56,743	2,441	4.3	100.0	28,532	50.3	26,822	47.3

Washoe County Urban Tree Canopy Results by Commission District

There are 5 Commission Districts in Washoe County. The remaining areas outside of Reno and Sparks were used to assess existing, possible, and unsuitable UTC in each district. Existing tree canopy ranged from 1.8% to 9.1%. Table 17 and Figures 19a and 19b illustrate the UTC results.

Table 17. UTC Results by Commission District in Washoe County Areas

Washoe County Commission Districts	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC	Possible Planting Acres	Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
Com 1	1,786	163	9.1	6.7	946	53.0	719	40.2
Com 2	22,212	1,425	6.4	58.4	11,752	52.9	9,184	41.3
Com 3	1,695	84	4.9	3.4	1,019	60.1	592	34.9
Com 4	9,609	174	1.8	7.1	2,991	31.1	6,452	67.1
Com 5	21,441	596	2.8	24.4	11,822	55.1	9,876	46.1
TOTALS	56,743	2,441	4.3	100.0	28,532	50.3	26,822	47.3



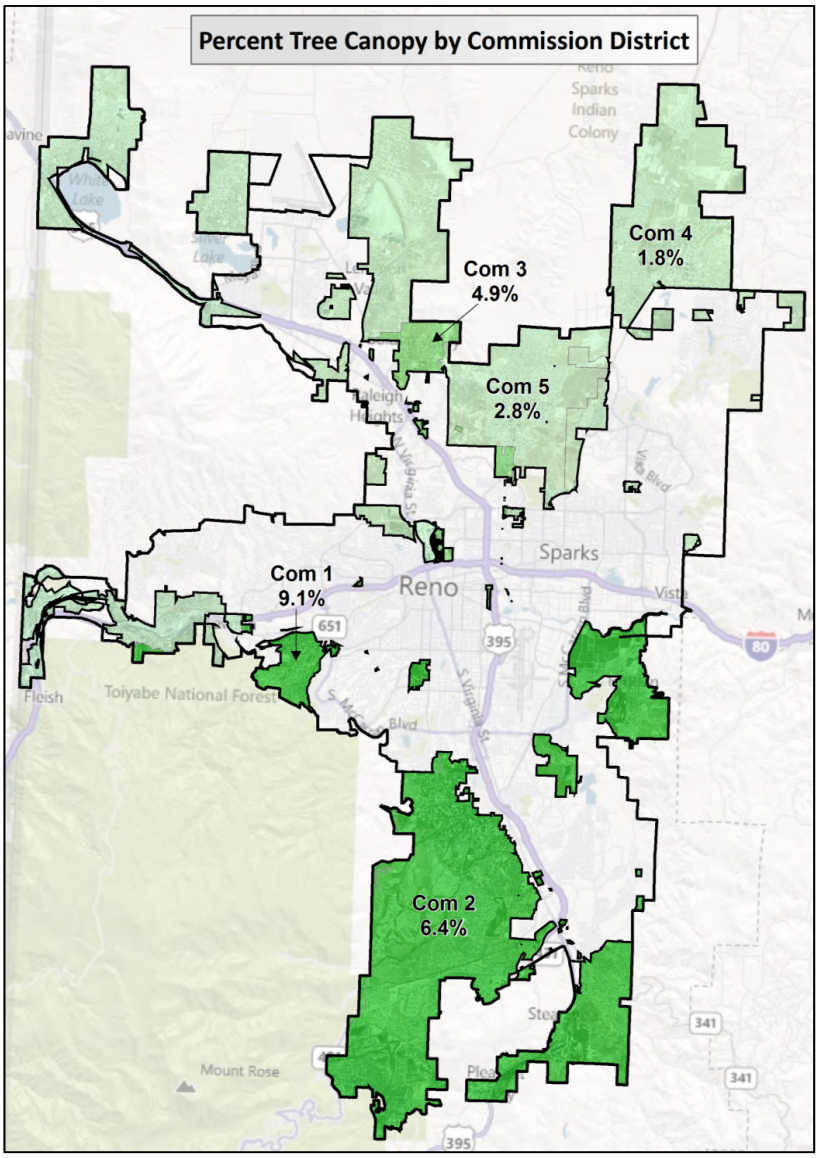


Figure 19a: Maps showing the remaining areas of each Commission District after excluding Reno and Sparks

Figure 19b: Percent of Existing UTC by Commission District in the Urban Portions of Washoe County Assessed in this Study

Washoe County UTC Ecosystem Benefits

Similar to the Truckee Meadows region, Reno, and Sparks shown above, CITYgreen modeling quantified some of the environmental and economic benefits of existing canopy cover and for future scenarios in outlying Washoe County areas and by land use type. Summary level results can be found in Tables 18 and 19 below. Complete results can be found in the detailed CITYgreen reports delivered separately from this assessment report.

Table 18. Washoe County Urban Tree Canopy Benefits by Land Use

Landuse	Area	Tree Canopy	Air Pollution Removal	Air Pollution Removal Value	Carbon Stored	Carbon Sequestered	Total Stormwater Value	Total Stormwater Quantity
	acres	acres	lbs/yr	$	tons	tons	$	cu.ft.
Agriculture	830.9	28.2	2,668	7,323	1,215	9	183,010	61,003
Commercial	3,054.2	120.8	11,410	31,321	5,196	40	779,215	259,738
Industrial	1,751.4	3.6	342	940	156	1	19,995	6,665
Public	3,087.7	62.7	5,921	16,252	2,696	21	323,085	107,695
Residential	35,774.2	1,944.5	183,737	504,355	83,676	651	11,832,704	3,944,235
Right of Way	4,560.8	113.4	10,718	29,420	4,881	38	969,780	323,260
Vacant	8,732.6	167.4	15,821	43,429	7,205	56	917,119	305,706
Total	**57,791.8**	**2,440.6**	**230,617**	**633,040**	**105,025**	**816**	**15,024,908**	**5,008,302**

Table 19. Washoe County Urban Tree Canopy Benefit Scenarios

Washoe County	UTC Acres	Annual AQ Benefit	Annual SW Benefit	Total Annual Benefit	Total Stormwater $-Benefit
Existing	2,440.7	633,041	1,307,503	1,940,544	**15,024,908**
10%	5,779.2	1,498,959	1,552,934	3,051,893	**17,839,978**
15%	8,668.8	2,248,438	1,789,909	4,038,347	**20,558,062**
20%	11,558.4	2,997,918	2,611,936	5,609,854	**29,986,647**

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Setting Urban Tree Canopy Goals

Results from this study were used to offer potential tree canopy goals in Truckee Meadows, Reno, Sparks, and outlying Washoe County areas. There are three underlying assumptions in this type of goal setting, as taken from the American Planning Association's "Planning the Urban Forest: Ecology, Economy, and Community Development" (Planning Advisory Service Report No. 555). These are:

- Current canopy cover is either not adequate, is declining, or could be improved in a way that would benefit the community
- The goal is an increase that's achievable in a projected timeframe
- The outcomes of the goal would result in a positive cost-benefit ratio – that the investment required will yield even greater dividends and value over time

With this in mind, potential goals are presented in this report to help NDF and local and regional stakeholders in envisioning their urban forest and promote effective use of resources. Initially, tree canopy goals from American Forests for the western U.S. were compared to canopy cover in Truckee Meadows (see Table X). Given the large gap between American Forests goals and actual canopy cover in Truckee Meadows (25% and 4.6% respectively), these goals are not recommended at this time for the region. Additionally, the land uses provided by American Forests did not directly match the categories assessed in this study.

Table 20. American Forest Goals by Land Use in the dry Western U.S.

All Land Uses	25%
Suburban	35%
Urban Residential	18%
Central Business Districts	9%

In an effort to develop more realistic, near-term canopy cover goals, AMEC applied a technique known as the "75th Percentile Rule" (Poracsky and Lackner, 2003. Urban Forest Canopy Cover in Portland, OR, 1972-2002). The canopy goal is determined by sorting parcels by existing UTC percentages from lowest to highest in a given land use and choosing the value at the 75th percentile. As an example, if a city has 10,000 parcels and they were ranked from low to high percent UTC, the goal would equal the canopy percent of the 7,500th parcel in the sorted list. Only parcels 10 years and older were included to avoid an underestimation. The goal is based on a canopy cover percent that 25% of a community has already met, therefore it provides a realistic, locally-specific, and defensible method when American Forests goals are not applicable. Additionally, 75th percentile goals can be augmented based on PPA metrics and local climate, soils, and land use distribution to establish realistic, final goals.

This process was completed by land use type for each entity and each jurisdiction (NABs, wards, and commission districts). Results for Truckee Meadows by land use type can be seen in Figure 20 on the next page. Ranking residential parcels by percent UTC identified the 75th percentile goal at 18.6% canopy cover. Also included are the number of acres of canopy required to meet each goal and total possible planting area. This was calculated by using AMEC's Tree Canopy

Calculator tool, an Excel-based spreadsheet tool that NDF and local foresters and planners can use in considering canopy cover goals.

The UTC Calculator dynamically updates to illustrate the effects of tree planting on canopy cover by land use type and citywide. It can also be used to determine the number of trees needed to reach a canopy goal. Average tree crown diameter can be adjusted and a mortality rate can be entered. An example of the UTC Calculator is provided in the Appendix and one was provided for each entity in this study. Note that a 30-foot tree crown diameter was used in the tables below for estimating the number of trees needed to reach the identified goal.

Table 21. UTC Goals in Truckee Meadows by Land Use including Acres and Trees Needed

Land Use	UTC %	75th Percentile Goal	% Below Goal	Acres of UTC Required to Meet Goal	# of Trees Needed to Meet Goal	Total Possible Planting Acres
Agriculture	1.9%	5.4%	-3.5%	136	5,506	1,937
Commercial	3.1%	6.7%	-3.6%	942	30,933	9,192
Industrial	1.2%	3.0%	-1.8%	280	10,321	4,865
Public	2.9%	8.1%	-5.2%	480	19,113	2,953
Residential	7.0%	18.6%	-11.6%	11,707	450,058	30,278
Right of Way	3.3%	4.5%	-1.2%	671	11,203	5,045
Vacant	1.3%	7.2%	-5.9%	1,387	70,282	8,355
Total	**4.6%**	**12.1%**	**-7.5%**	**15,603**	**597,416**	**62,625**

* Total goal of 12.1% was determined based on 75th percentile rule for each land use weighted by the proportional area of each land use type

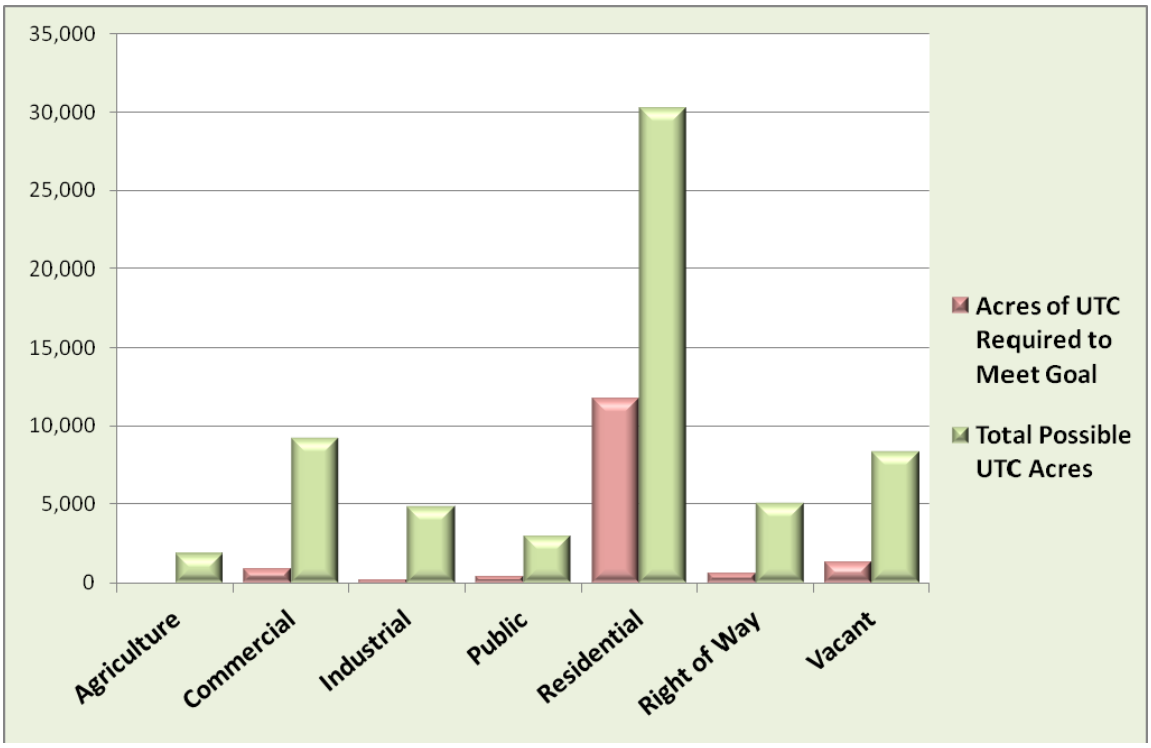

Figure 20: Available and Required Acres for UTC Goals in Truckee Meadows by Land Use

Using the 75th percentile rule and processes described above, Tables Xa-c show the goals by land use in Reno, Sparks, and outlying Washoe County areas compared to current canopy cover.

Tables 22a-c. UTC Goals in Reno, Sparks and Washoe County by Land Use including Acres and Trees Needed

Entity	Land Use	UTC %	75th Percentile Goal	% Below Goal	Acres of UTC Required to Meet Goal	# of Trees Needed to Meet Goal	Total Possible Planting Acres
Reno	Agriculture	1.1%	4.9%	-3.8%	51	3,120	1,064
	Commercial	3.0%	7.5%	-4.5%	380	23,454	5,523
	Industrial	1.3%	3.4%	-2.1%	116	7,146	3,506
	Public	4.2%	11.5%	-7.3%	137	8,416	1,180
	Residential	9.7%	21.5%	-11.8%	2,282	140,705	9,677
	Right of Way	3.7%	4.4%	-0.7%	52	3,200	2,684
	Vacant	1.0%	7.4%	-6.4%	455	28,029	3,930
	Total	**5.2%**	**12.0%**	**-6.8%**	**3,472**	**214,070**	**27,564**

Entity	Land Use	UTC %	75th Percentile Goal	% Below Goal	Acres of UTC Required to Meet Goal	# of Trees Needed to Meet Goal	Total Possible Planting Acres
Sparks	Agriculture	0.9%	3.1%	-2.2%	8	475	196
	Commercial	2.5%	4.4%	-1.9%	49	3,009	1,625
	Industrial	1.7%	2.7%	-1.0%	19	1,196	895
	Public	2.8%	15.4%	-12.6%	132	8,145	283
	Residential	7.1%	19.1%	-12.0%	969	59,751	2,412
	Right of Way	3.3%	4.0%	-0.7%	20	1,215	1,095
	Vacant	0.2%	4.4%	-4.2%	166	10,235	744
	Total	**3.9%**	**10.4%**	**-6.5%**	**1,363**	**84,026**	**7,250**

Entity	Land Use	UTC %	75th Percentile Goal	% Below Goal	Acres of UTC Required to Meet Goal	# of Trees Needed to Meet Goal	Total Possible Planting Acres
Washoe County	Agriculture	3.4%	5.4%	-2.0%	16	999	676
	Commercial	4.0%	5.3%	-1.3%	40	2,454	2,045
	Industrial	0.2%	0.8%	-0.6%	10	641	464
	Public	2.1%	5.0%	-2.9%	88	5,426	1,491
	Residential	5.5%	12.8%	-7.3%	2,594	159,936	18,188
	Right of Way	2.5%	5.1%	-2.6%	114	7,054	1,266
	Vacant	2.0%	7.5%	-5.5%	448	27,622	4,402
	Total	**4.3%**	**10.1%**	**-5.8%**	**3,311**	**204,132**	**28,532**

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Recommendations

Based on this assessment, NDF and AMEC offer the following recommendations for achieving tree canopy goals in Truckee Meadows:

1. Using the information gained from this study, form a committee or use existing regional groups to consider local and regional tree cover goals in a collaborative process.

2. Locally and regionally, community forestry advocacy boards should use this report to guide:
    - Community forestry projects, tree planting ordinances (new development, public street and park trees, tree protection) and;
    - Development of best management practices (BMPs) such as for low impact development (LID) in parking lot design.

3. Conduct an audit of local ordinances to simplify or streamline tree-related policies and identify where codes are working against local goals. Additionally:
    - Collaborative planning across entities can reduce costs and provide consistency for developers during permitting;
    - Explore developing or expanding existing codes to enhance tree canopy cover through Community Develop Standards and Landscaping Requirements.

4. Utilize the information gained from this assessment and other inventories to create a regional urban forest management or master plan.

5. Assess tree canopy every 5 to 10 years to monitor trends and assess the effectiveness of public education & outreach campaigns, policies, codes, and ordinances.

6. Expand upon the ecosystem services analysis from this study by incorporating benefit values from local i-Tree studies into education/outreach campaigns with targeted messages. Make the benefits relevant for residents, businesses and decision-makers. The Public Service Announcement (PSA) from this study provides an example of this.

7. Utilize the land cover data from this project while it is current for other applications such as water supply and water conservation analysis and stormwater modeling.

8. Recommend that UNR, through the Arboretum Board, become a Tree Campus USA.

9. Use the products from this study to target tree planting priorities and funding opportunities:
    - As an example, with nearly 50% possible planting area in the region, if 20% was converted to tree canopy (increasing overall UTC to 15%), this would provide nearly $10M in annual air quality and stormwater benefits. Parcel-level UTC metrics can help target where trees are needed most.

10. Explore all potential partnerships to achieve urban forest goals: public/private including corporate and academic sponsors, council representatives, air quality and stormwater associations, volunteers, non-profit organizations, and neighborhood associations.

11. Target specific land use or zoning types in areas most in need of additional tree planting.

12. Promote hardy, drought-tolerant, and long-lived tree species that are appropriate for the environment to insure investments in trees achieve maximum tree benefits.
    - Proper irrigation is key to maintaining and increasing canopy cover. Lack of watering trees by private tree owners and those adjacent to the public rights-of way is the most limiting factor to tree longevity in the Truckee Meadows.

13. Understand the limitations of urban tree canopy assessment data:
    - As an example, there may be a substantial amount of right-of way that cannot be planted with trees due to a variety of factors, such as not enough set back, vehicle sight distance issues, and adjacent vacant private land with no landowner to maintain and irrigate trees. This should be discussed when considering canopy cover goal setting, using the goals in this report as a starting point.
    - Additional analysis of priority planting areas should be done using GIS technologies at the local and regional level.

Summary

With just under 5% regional tree canopy cover, it is apparent that the urban forest of the Truckee Meadows is in its infancy but that development patterns are adding trees and canopy cover to the area. Trees from new development, tree preservation and additional tree planting will be needed to substantially increase canopy cover and associated ecological and economic benefits. This study highlights many opportunities for education, management and planning.

Results show that residential areas comprise an overwhelming portion of all trees, indicating that education and outreach on the benefits of urban tree canopy will be one of the most cost-effective means to advancing urban forestry in the region. Inventories and assessments such as this one provide information for better management of urban natural resources and should be used to direct policy including ordinances for tree planting, tree preservation, and landscaping.

The climate and soils in Truckee Meadows make for a challenging environment for trees, but like any urbanized area, trees are a fabric of the community and can thrive with proper planning, management, education and advocacy. Results from this study offer effective tools and compelling arguments to continue to expand the urban forest.

Figure 21 below compares tree canopy in other western U.S. cities. Note that different datasets and methodologies were used, for example, the value for Boise, Idaho is based on 81 i-Tree Eco plots within the city.

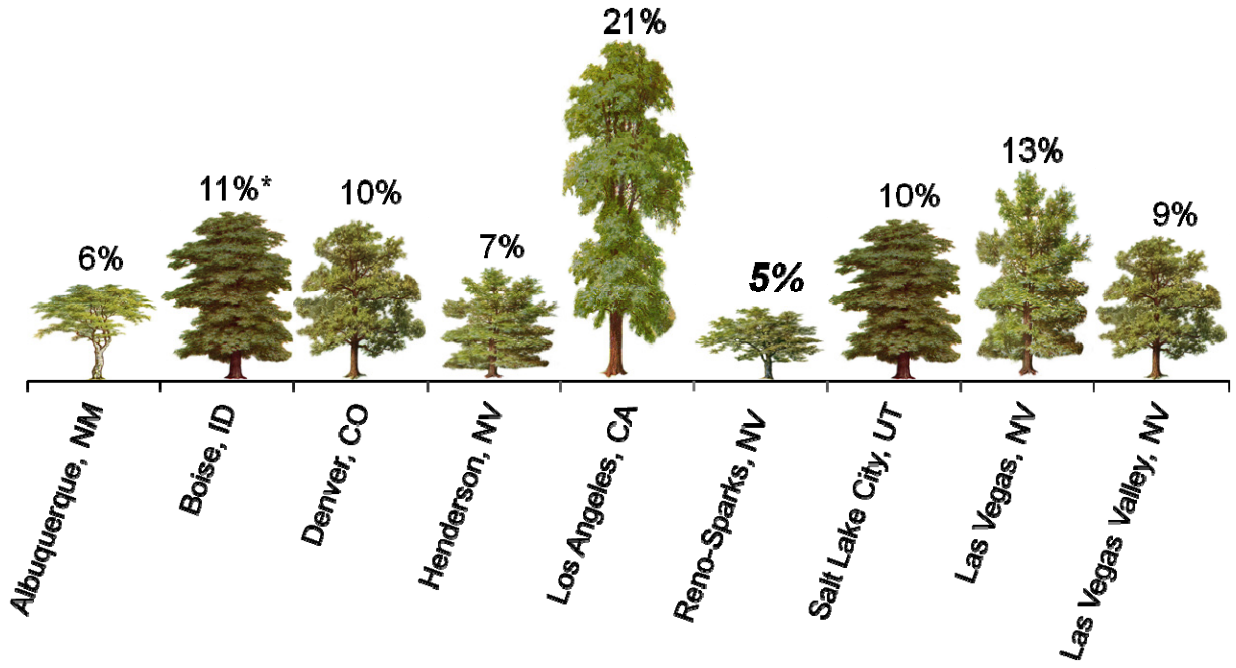

Figure 21: Comparing Urban Tree Canopy (UTC) Percent in Truckee Meadows to Similar Areas

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Appendix

Included in the Appendix of this report are additional details of the methods and processes used in the analysis, a complete list of deliverables, full tables not included above, and additional examples of some of the products provided.

Data Inputs, Land Cover Methodology, and Accuracy

The land cover classification task was conducting using a remote sensing process known as geographic object-based image analysis (GEOBIA). This technology leverages the texture, shape, pattern and color of features in satellite and aerial imagery to produce highly accurate and cost-effective geospatial data. Figure 22 below illustrates the workflow and data integration for land cover classification, UTC assessment and ecosystem services analysis.

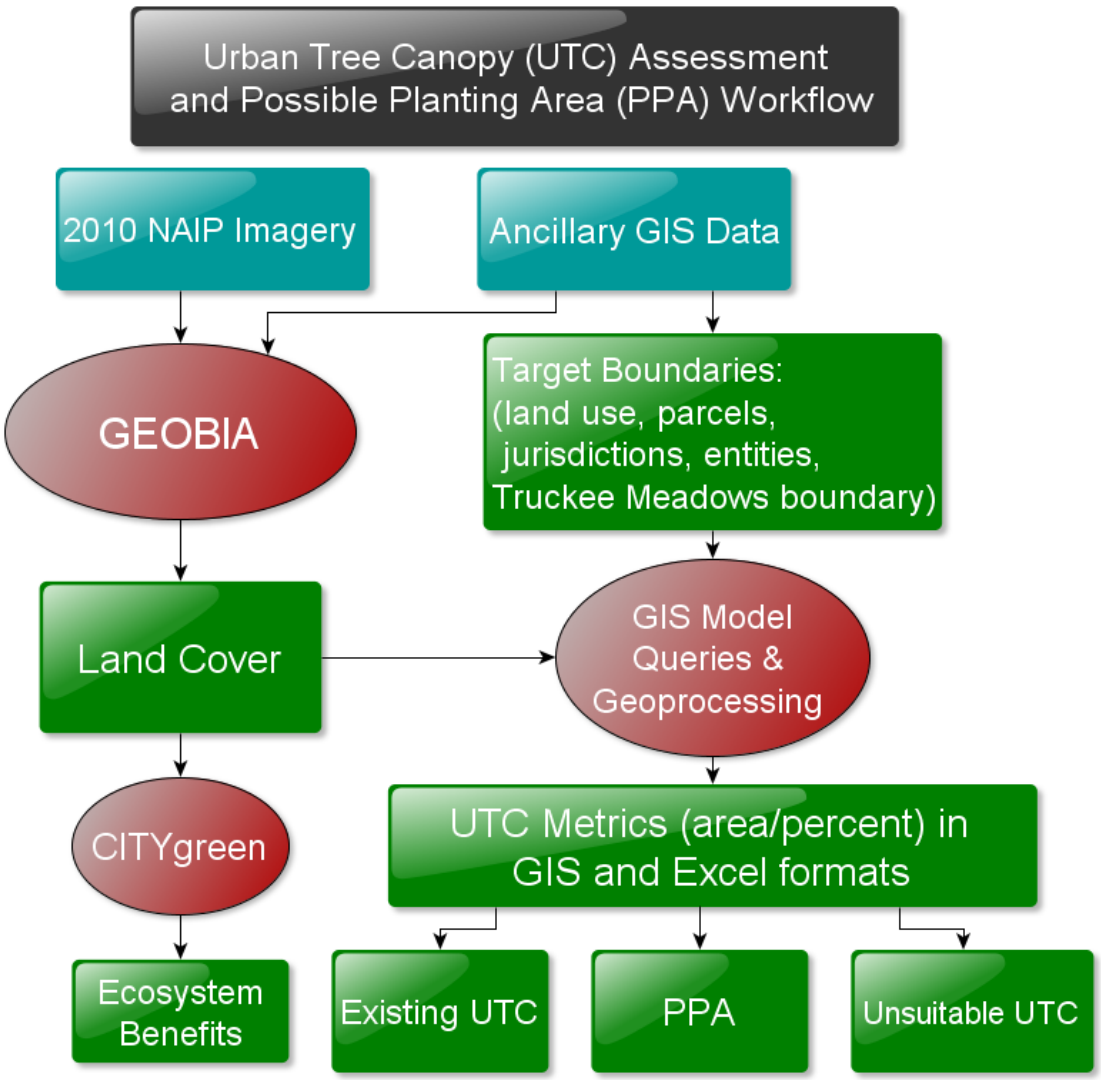


Figure 22: UTC Assessment Workflow

AMEC performed a quality assurance/quality control (QA/QC) process to further improve the accuracy of the land cover data and then conducted a point-based accuracy assessment yielding 94% overall accuracy. The results of the assessment can be seen in the table below.

Table 23. Accuracy assessment of land cover data for Truckee Meadows.

	Trees/Shrubs	Impervious	Water *	Other Vegetation	Soil/ Dry Veg	Total (i)	Accuracy (ii)
Trees/Shrubs	57	2	0	0	0	**59**	**96.61**
Impervious	1	59	0	0	0	**60**	**98.33**
Water	0	1	39	5	1	**46**	**84.78**
Other Vegetation	0	2	0	55	0	**57**	**96.49**
Soil/Dry Veg	1	2	0	1	47	**51**	**92.16**
Column Total	**59**	**66**	**39**	**61**	**48**	**273**	**93.67**
Columns x	**3,481**	**3,960**	**1,794**	**3,477**	**3,481**	**3,960**	

Sum Diagonal Counts	**257**
N =	**273**
Overall Accuracy	**94.14**

* Water class was not derived from remote sensing. Only existing data provided to AMEC was used such as digitized water boundaries which included dry lake beds. Overall accuracy excluding water is 96.0%.

Complete List of Deliverables

The following products were included on DVD along with hard copy reports and are available at http://forestry.nv.gov/forestry-resources/urban-tree-canopy-assessment-projects:

- Land cover data (GIS vector and raster formats, ArcGIS v10 geodatabase)
- UTC assessment boundaries (GIS vector format, ArcGIS v10 geodatabase)
- UTC assessment spreadsheet (MS Excel)
- Interactive UTC maps (GeoPDFs)
- Tree Canopy Calculator (MS Excel-based spreadsheet tool)
- Report summarizing the results, methods, goals and recommendations (MS Word and Adobe PDF format)
- PowerPoint presentation to regional managers and stakeholders
- Public Service Announcement (PSA) and Factsheet

Generalizing Land Use Categories

AMEC and NDF used land use and zoning codes at the parcel level from the Washoe County Assessor's office to create 7 broad land use types seen below. *Individual indicates the land use category was determined by zoning code. If the zoning was mixed use or unknown, individual parcels were visually examined and assessed with help from the County.

Table 24. Original Land Use and Zoning Codes Generalized into 7 Broad Categories

CODE	DESCRIPTION	IN_CATEGORY	Land_Use_Category
10	Vacant-Unknown/Other	VACANT	Vacant
11	Vacant-Development	VACANT	Vacant
12	Vacant-Single Family	VACANT	Residential
13	Vacant-Multi Res	VACANT	Residential
14	Vacant Commercial	VACANT	Commercial
15	Vacant Industrial	VACANT	Industrial
16	Unbuildable-Splinter	VACANT	Vacant
17	Unbuildable other	VACANT	Vacant
18	Minor Improvements	VACANT	Vacant
19	Public Parks	VACANT	Public
20	Single Family Res	SINGLE FAMILY	Residential
21	Condo/Townhouse	SINGLE FAMILY	Residential
22	Mobile Home Real Property	SINGLE FAMILY	Residential
23	Mobile Home Personal Property	SINGLE FAMILY	Residential
24	Common Area, Etc	SINGLE FAMILY	Residential
25	Condo/Twn-Apt Use	SINGLE FAMILY	Residential
30	Duplex	MULTI-RESIDENTIAL	Residential
31	2 Single Family Units	MULTI-RESIDENTIAL	Residential
32	3-4 Units	MULTI-RESIDENTIAL	Residential
33	5-9 Units	MULTI-RESIDENTIAL	Residential
34	10 or more units	MULTI-RESIDENTIAL	Residential
35	Mobile Home Park	MULTI-RESIDENTIAL	Residential
36	Multi Res-Parking	MULTI-RESIDENTIAL	Residential
40	General Commercial	COMMERCIAL	Commercial
41	Office Commercial	COMMERCIAL	Commercial
42	Casino	COMMERCIAL	Commercial
43	Hotel-Motel	COMMERCIAL	Commercial
44	Resort Commercial	COMMERCIAL	Commercial
50	General Industrial	INDUSTRIAL	Industrial
51	Commercial Industrial	INDUSTRIAL	Industrial
52	Heavy Industrial	INDUSTRIAL	Industrial
60	Agricultural Deferred	RURAL	Agricultural
62	Open Space Qualif	RURAL	*Individual
63	Patented Mine	RURAL	Industrial
64	Mines and Mills	RURAL	Industrial
67	Aggregates, Quar Etc	RURAL	Industrial
70	Central Assessed Public Utility	UTILITIES	Public
71	Intra/Cnty Public Utility	UTILITIES	Public
72	Centrally Assessed/Loc	UTILITIES	Public
CUL1	Cultivation 1		Agriculture
CUL2	Cultivation 2		Agriculture
CUL3	Cultivation 3		Agriculture
CUL4	Cultivation 4		Agriculture
GRZ1	Grazing 1		Agriculture
GRZ2	Grazing 2		Agriculture
GRZ3	Grazing 3		Agriculture
GRZ4	Grazing 4		Agriculture
HAY1	Hay Land 1		Agriculture
HAY2	Hay Land 2		Agriculture
INTU	Intensive Use		*Individual
PAS1	Pasture 1		Agriculture
PAS2	Pasture 2		Agriculture
PAS3	Pasture 3		Agriculture
PAS4	Pasture 4		Agriculture
PBRD	Public Road		Right of Way
MULT	Multiple Use		*Individual

UTC GIS Database Format

GIS data layers such as parcels, wards, NABs, and commission districts were delivered with fields that include UTC metrics as shown below.

JURISDICTION DATABASE FIELD KEY

NS_Pct — Percent of unsuitable UTC
NS_Acres — Acres of unsuitable UTC
Tot_PPA_Pct — Percent total possible planting area
Tot_PPA_Acres — Acres of total possible planting area
Tot_Imp_Pct — Percent impervious area
Tot_Imp_Acres — Acres of impervious area
PPA_Veg_Pct — Percent of possible planting vegetation area
PPA_Veg_Acres — Acres of possible planting vegetation area
UTC_Pct — Percent existing UTC
UTC_Acres — Acres of existing UTC
Land_Acres — Acres of land area
Total_Acres — Acres in jurisdiction
Jurisdiction — Name of jurisdicton

Jurisdiction	Total_Acres	Land_Acres	UTC_Acres	UTC_Pct	PPA_Veg_Acre	PPA_Veg_Pct	PPA_Imp_Acres	PPA_Imp_Pct	Tot_PPA_Acres	Tot_PPA_Pct	NS_Acres	NS_Pct
Ward 5	4218	4101	141	3.4	616	15	647	15.8	1263	30.8	2814	66.7
Ward 4	5940	5861	150	2.6	964	16.5	809	13.8	1773	30.3	4017	67.6
Ward 3	6030	5904	207	3.5	555	9.4	1387	23.5	1942	32.9	3881	64.4
Ward 2	2347	2337	149	6.4	524	22.4	465	19.9	989	42.3	1209	51.5
Ward 1	2758	2739	168	6.1	241	8.8	1042	38.1	1283	46.8	1307	47.4
NAB WARD TWO SOUTH	7441	7110	142	2	2733	38.4	1187	16.7	3920	55.1	3380	45.4
NAB WARD TWO CENTRAL	4897	4812	519	10.8	1142	23.7	1344	27.9	2486	51.7	1892	38.6
NAB WARD THREE	8329	8113	459	5.7	2085	25.7	2327	28.7	4412	54.4	3458	41.5
NAB WARD ONE	7290	7167	715	10	2192	30.6	1188	16.6	3380	47.2	3195	43.8
NAB OLD NORTHWEST	2122	2112	271	12.8	467	22.1	415	19.7	882	41.8	968	45.6
NAB NORTHWEST	7419	7389	224	3	2429	32.9	1048	14.2	3477	47	3719	50.1
NAB NORTHEAST	4490	4485	203	4.5	1623	36.2	784	17.5	2407	53.7	1880	41.9
NAB NORTH VALLEYS	10225	10094	125	1.2	5386	53.4	1215	12	6600	65.4	3500	34.2
Com 5	22294	21440	596	2.8	9927	46.3	1896	8.8	11822	55.1	9876	44.3

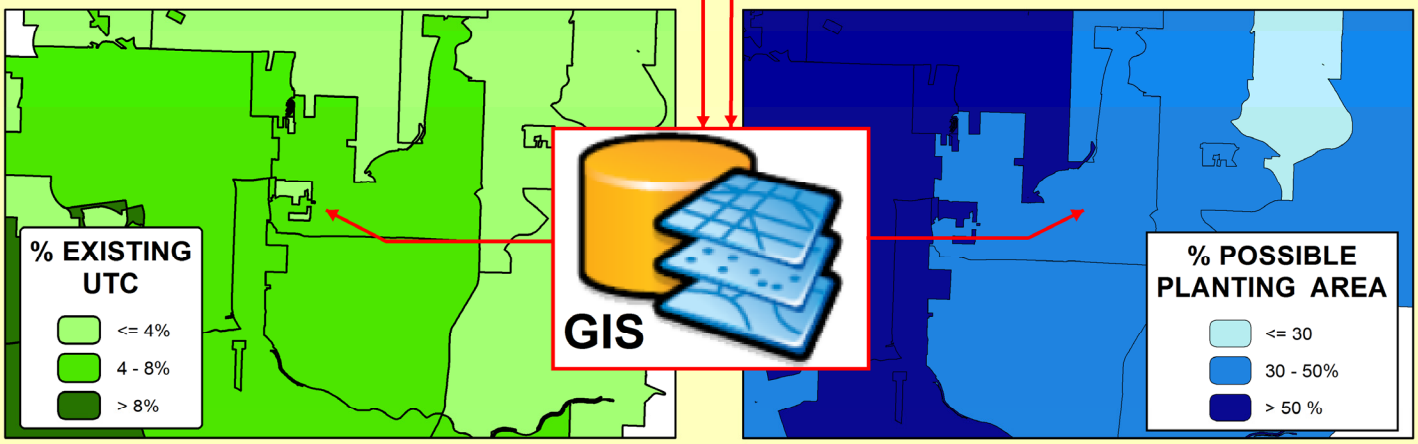


Figure 23: UTC Assessment GIS Database Field Key

Comparing UTC Results by Entity

Table 25. Urban Tree Canopy in Truckee Meadows by Entity.

Entities	Total Acres Excluding Water	Percent of Total Area	Existing UTC Acres	Existing UTC %	Percent of Total UTC	Possible Planting Acres	Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
Reno	51,281	39.8	2,657	5.2	45.0	27,565	53.8	21,993	42.9
Spanish Springs	7,762	6.0	138	1.8	2.3	2,404	31.0	5,224	67.3
Sparks	20,941	16.2	816	3.9	13.8	7,250	34.6	13,228	63.2
Sun Valley	3,275	2.5	143	4.4	2.4	1,320	40.3	1,812	55.3
UNR	1,466	1.1	39	2.6	0.7	854	58.3	591	40.3
Washoe County	44,240	34.3	2,121	4.8	35.9	23,953	54.1	19,194	43.4
TOTALS	128,965	100.0	5,913	4.6	100.0	63,346	49.1	62,042	48.1

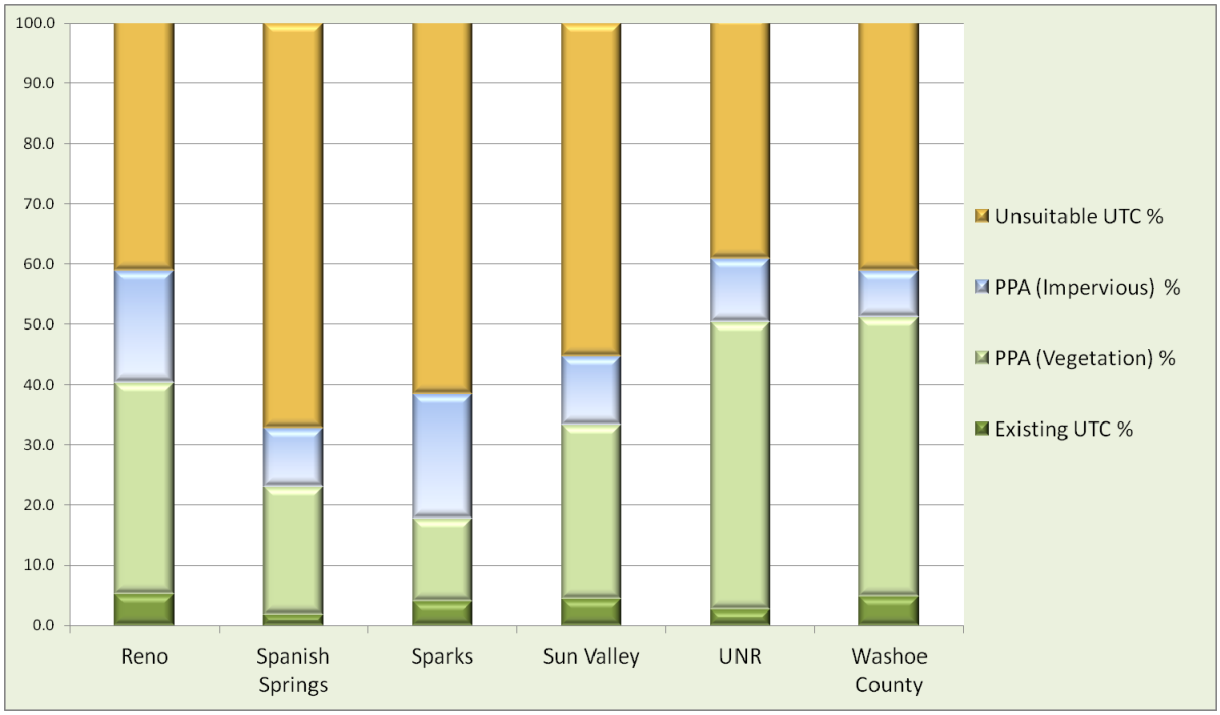


Figure 24: Percent of Existing UTC, Possible Vegetation, Possible Impervious, and Unsuitable UTC in each Entity

Figure 25: Distribution of Land Area by Entity

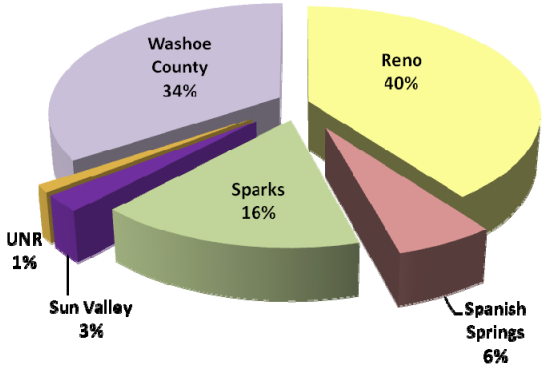
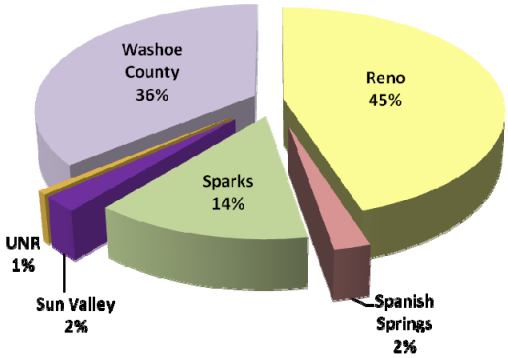


Figure 26: Distribution of Urban Tree Canopy by Entity



Complete UTC Results for Wards, NABs, and Commission Districts

The table below show complete UTC results including acres and percent of Possible Planting Area (PPA) Vegetation and PPA Impervious, and Total PPA. Tables in the main body only included Total PPA metrics.

Table 26. UTC Results for NABs in Reno

Neighborhood Advisory Boards	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC	PPA (Vegetation) Acres	PPA (Vegetation) %	PPA (Impervious) Acres	PPA (Impervious) %	Total Possible Planting Acres	Total Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
NAB NORTH VALLEYS	10,094	125	1.2	4.7	5,386	53.4	1,215	12.0	6,600	65.4	3,500	34.7
NAB NORTHEAST	4,485	203	4.5	7.6	1,623	36.2	784	17.5	2,407	53.7	1,880	41.9
NAB NORTHWEST	7,390	224	3.0	8.4	2,429	32.9	1,048	14.2	3,477	47.1	3,719	50.3
NAB OLD NORTHWEST	2,112	271	12.8	10.2	467	22.1	415	19.7	882	41.8	969	45.9
NAB WARD 1	7,167	715	10.0	26.9	2,192	30.6	1,188	16.6	3,380	47.2	3,195	44.6
NAB WARD 3	8,113	459	5.7	17.3	2,085	25.7	2,327	28.7	4,412	54.4	3,458	42.6
NAB WARD 2 CENTRAL	4,812	519	10.8	19.5	1,142	23.7	1,344	27.9	2,486	51.7	1,892	39.3
NAB WARD 2 SOUTH	7,110	142	2.0	5.3	2,733	38.4	1,187	16.7	3,920	55.1	3,380	47.5
TOTALS	51,281	2,657	5.2	100.0	18,056	35.2	9,508	18.5	27,564	53.8	21,993	42.9

Table 27. UTC Results for Wards in Sparks

Sparks City Council Wards	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC	PPA (Vegetation) Acres	PPA (Vegetation) %	PPA (Impervious) Acres	PPA (Impervious) %	Total Possible Planting Acres	Total Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
Ward 1	2,739	168	6.1	20.6	241	8.8	1,042	38.1	1,283	46.9	1,307	47.7
Ward 2	2,337	149	6.4	18.3	524	22.4	465	19.9	989	42.3	1,209	51.7
Ward 3	5,904	207	3.5	25.4	555	9.4	1,387	23.5	1,942	32.9	3,881	65.7
Ward 4	5,861	150	2.6	18.4	964	16.5	809	13.8	1,773	30.3	4,017	68.5
Ward 5	4,101	141	3.5	17.3	616	15.0	647	15.8	1,263	30.8	2,814	68.6
TOTALS	20,943	816	3.9	100.0	2,900	13.8	4,349.8	20.8	7,250	34.6	13,228	63.2

Table 28. UTC Results for Commission Districts in Washoe County

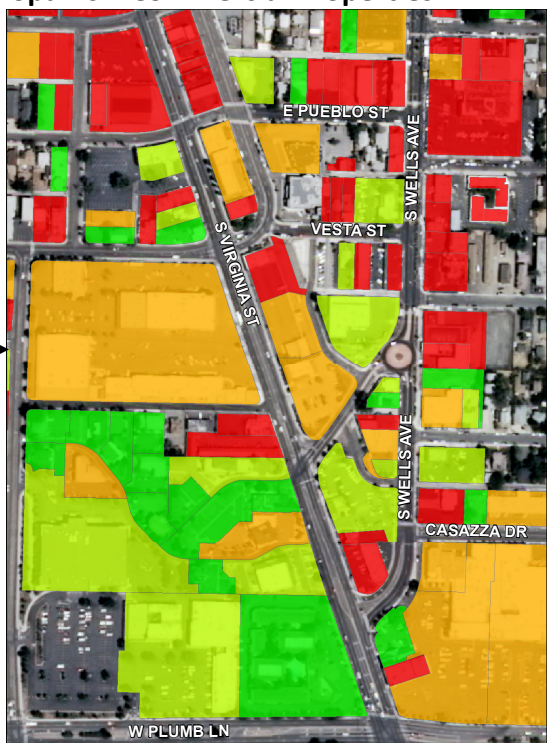
Washoe County Commission Districts	Total Acres Excluding Water	UTC Acres	UTC %	Percent of Total UTC	PPA (Vegetation) Acres	PPA (Vegetation) %	PPA (Impervious) Acres	PPA (Impervious) %	Total Possible Planting Acres	Total Possible Planting %	Unsuitable UTC Acres	Unsuitable UTC %
Com 1	1,786	163	9.1	6.7	841	47.1	106	5.9	946	53.0	719	40.2
Com 2	22,212	1,425	6.4	58.4	10,038	45.2	1,715	7.7	11,752	52.9	9,184	41.3
Com 3	1,695	84	4.9	3.4	858	50.6	162	9.5	1,019	60.1	592	34.9
Com 4	9,609	174	1.8	7.1	2,140	22.3	851	8.9	2,991	31.1	6,452	67.1
Com 5	21,441	596	2.8	24.4	9,927	46.3	1,896	8.8	11,822	55.1	9,876	46.1
TOTALS	56,743	2,441	4.3	100.0	23,803	41.9	4,729	8.3	28,532	50.3	26,822	47.3

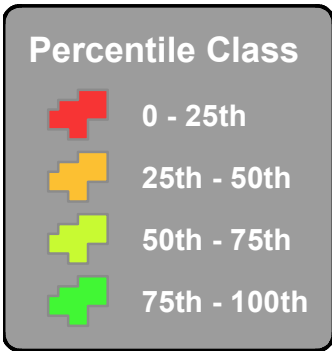
Table 29. Truckee Meadows UTC Goals by Land Use using the 75th Percentile Rule

UTC Percent and Percentile Class					
Land Use	0 - 25th Percentile	25th - 50th Percentile	50th - 75th Percentile	75th - 100th Percentile	Goal (rounded)
Agriculture	0 - 0.3%	0.4 - 1.5%	1.6- 5.3%	**5.4** - 23%	**5%**
Commercial	0%	0.1 - 2%	2.1 - 6.6%	**6.7** - 89%	**7%**
Industrial	0%	0.1 - 0.9%	1 - 2.9%	**3** - 60%	**3%**
Public	0%	0.1- 1.6%	17 - 8%	**8.1** - 69%	**8%**
Residential	0 - 1.5 %	1.6- 7.7%	7.8 - 18.5%	**18.6** - 100%	**19%**
Right of Way	0%	0.1 - 0.9%	1 - 4.4%	**4.5** - 100%	**5%**
Vacant	0%	0.1 - 1.3%	1.4 - 7.1%	**7.2** - 100%	**7%**

Sun Valley – Residential Properties

Sparks – Commercial Properties





Reno – Industrial Properties

CITYgreen Software

CITYgreen is a GIS software developed by American Forests and the U.S. Forest Service. Information on the various models and databases included in CITYgreen are provided below. Note that CITYgreen does not model benefits of trees related to energy savings from shade and wind block or aesthetic/property values. Additionally, CITYgreen only operates in ESRI ArcGIS version 9x, it has not been upgraded to run in ArcGIS version 10x. The following information is included in each CITYgreen report delivered to NDF and other stakeholders.

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use "externality" costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state's Public Services Commission.

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree's dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Stormwater Runoff Volume

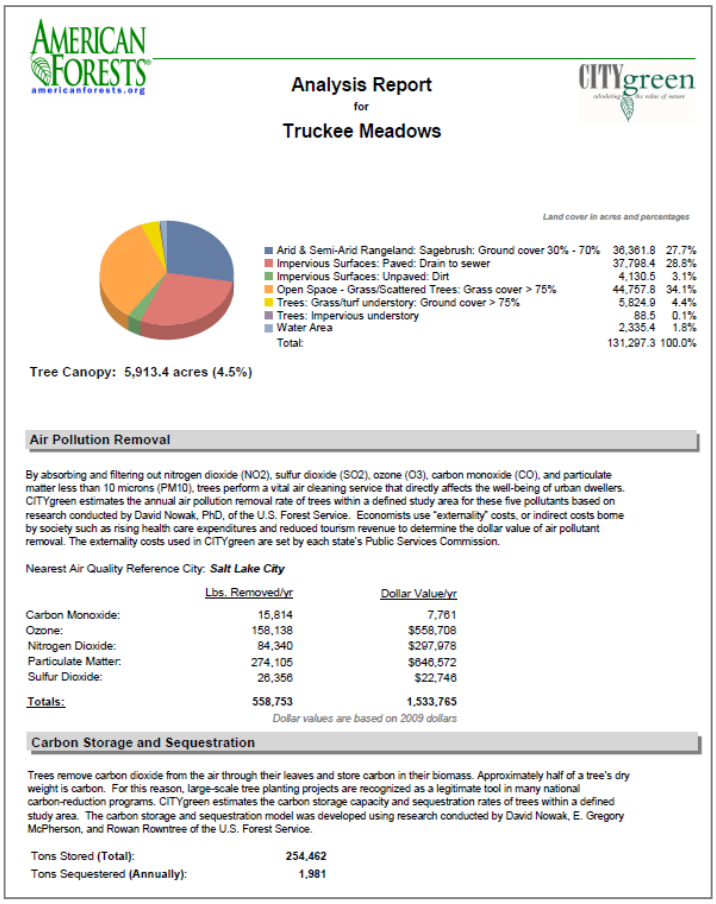
Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

Figures 27a and 27b: CITYgreen Report for Current Conditions in the Truckee Meadows



AMERICAN FORESTS americanforests.org

Analysis Report
for
Truckee Meadows

CITYgreen

Land cover in acres and percentages

Arid & Semi-Arid Rangeland: Sagebrush: Ground cover 30% - 70%	36,361.8	27.7%
Impervious Surfaces: Paved: Drain to sewer	37,798.4	28.8%
Impervious Surfaces: Unpaved: Dirt	4,130.5	3.1%
Open Space - Grass/Scattered Trees: Grass cover > 75%	44,757.8	34.1%
Trees: Grass/turf understory: Ground cover > 75%	5,824.9	4.4%
Trees: Impervious understory	88.5	0.1%
Water Area	2,335.4	1.8%
Total:	131,297.3	100.0%

Tree Canopy: 5,913.4 acres (4.5%)

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use "externality" costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state's Public Services Commission.

Nearest Air Quality Reference City: ***Salt Lake City***

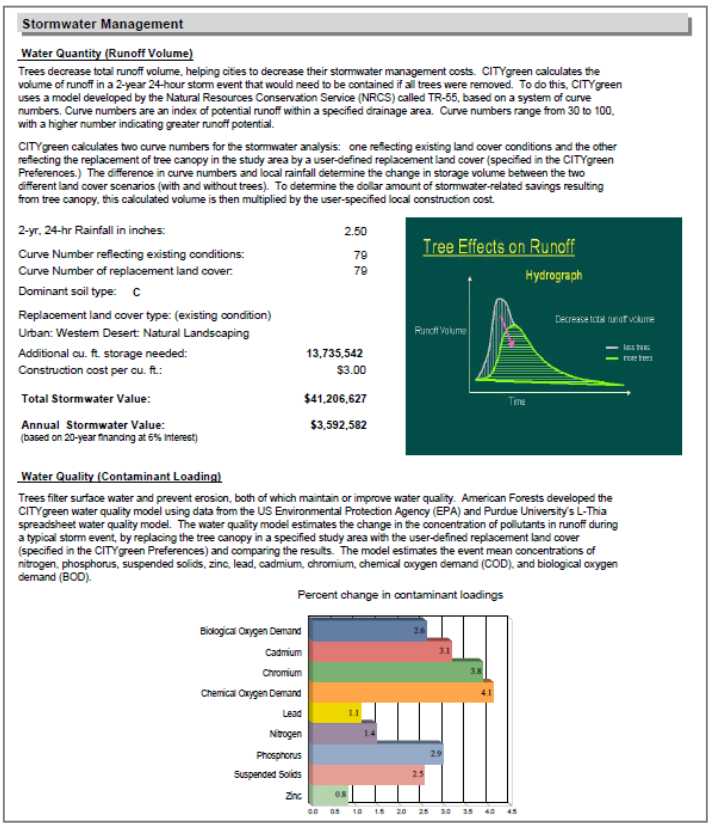
	Lbs. Removed/yr	Dollar Value/yr
Carbon Monoxide:	15,814	7,761
Ozone:	158,138	$558,708
Nitrogen Dioxide:	84,340	$297,978
Particulate Matter:	274,105	$646,572
Sulfur Dioxide:	26,356	$22,746
Totals:	**558,753**	**1,533,765**

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree's dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored **(Total)**:	**254,462**
Tons Sequestered **(Annually)**:	**1,981**



Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

2-yr, 24-hr Rainfall in inches:	2.50
Curve Number reflecting existing conditions:	79
Curve Number of replacement land cover:	79
Dominant soil type:	C
Replacement land cover type: (existing condition)	
Urban: Western Desert: Natural Landscaping	
Additional cu. ft. storage needed:	13,735,542
Construction cost per cu. ft.:	$3.00
Total Stormwater Value:	**$41,206,627**
Annual Stormwater Value: (based on 20-year financing at 6% interest)	**$3,592,582**

Tree Effects on Runoff
Hydrograph
Runoff Volume
Decrease total runoff volume
less trees
more trees
Time

Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

Percent change in contaminant loadings

Examples of Other Tools Provided in this Study

Interactive GeoPDFs were provided for stakeholders without GIS software or experience. Map layers appear in a Table of Contents. They can be turned on and off to show the UTC results vs. the imagery backdrop. Several versions at varying resolutions were provided.

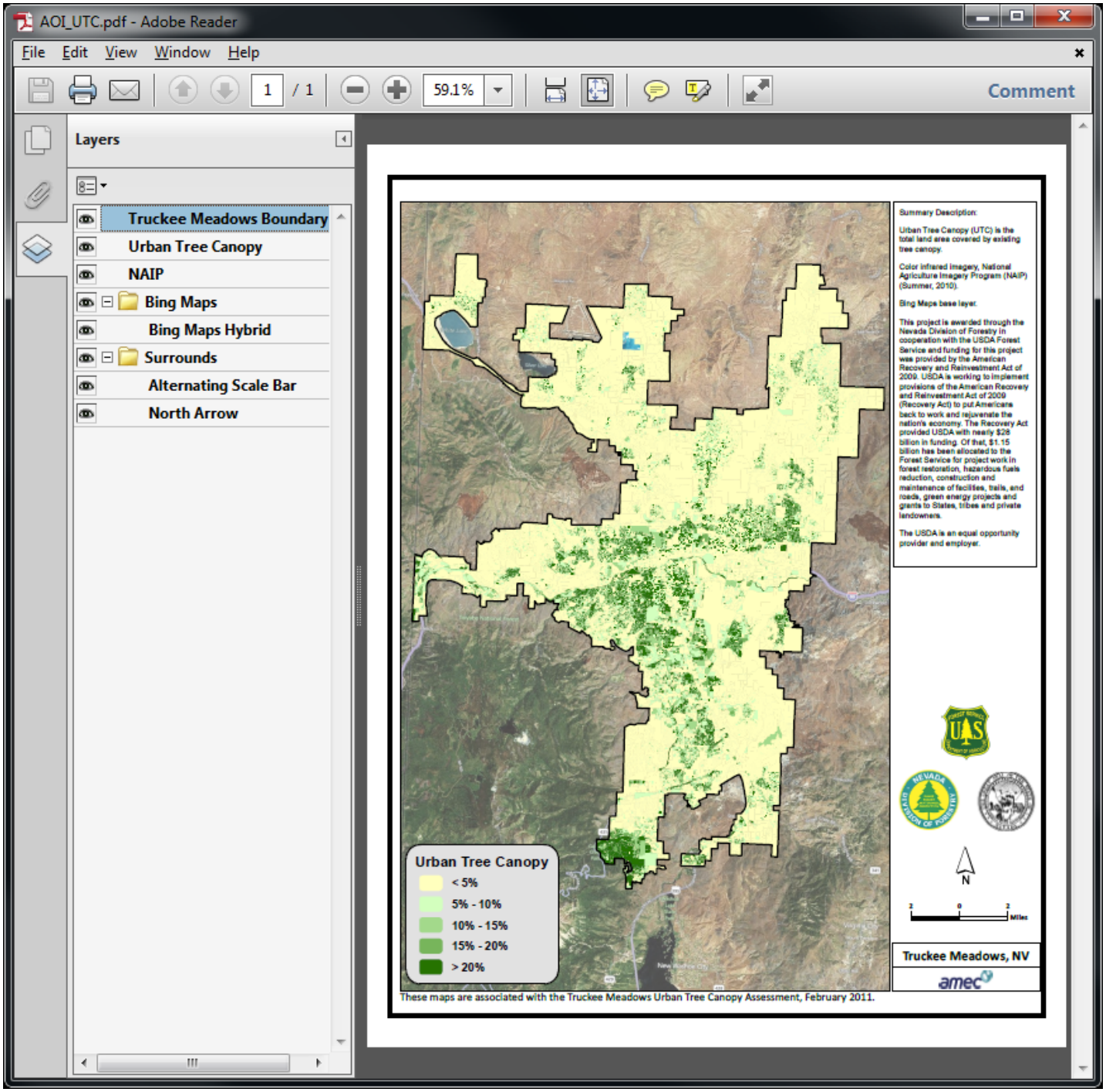


Figure 28: Example GeoPDF showing UTC results in Truckee Meadows

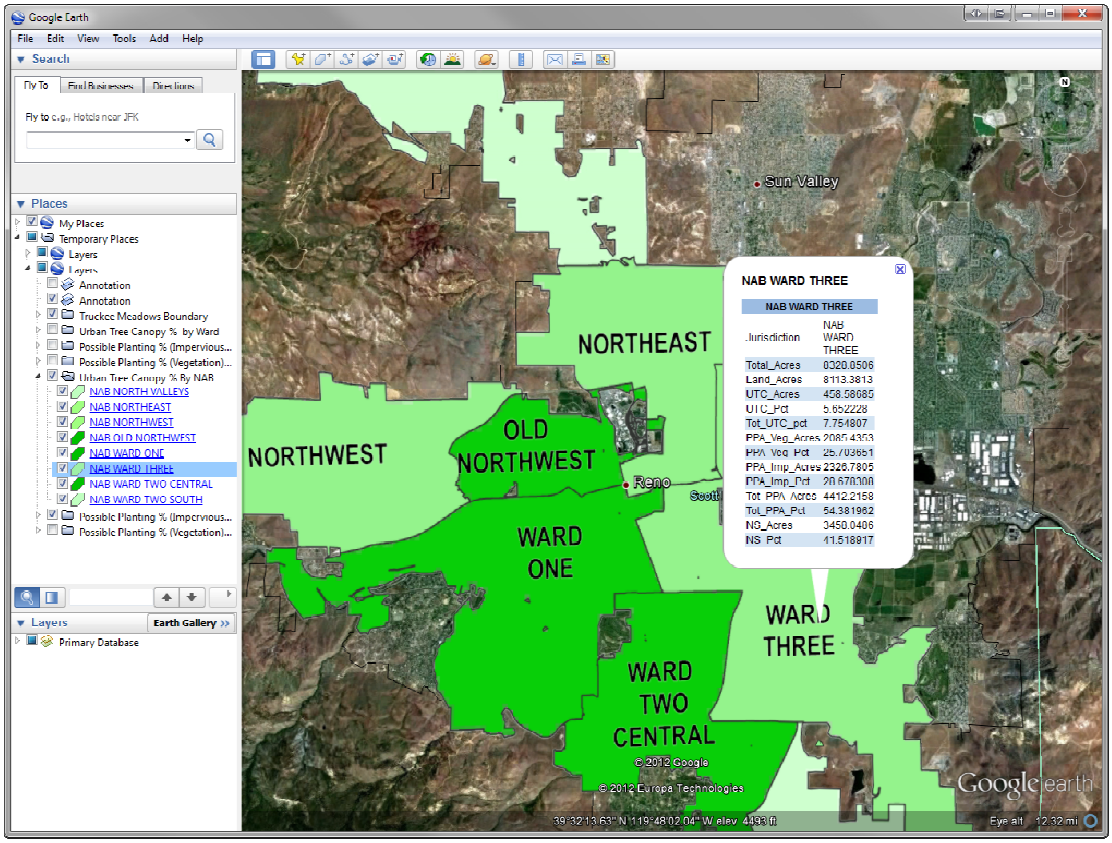


Figure 29: Google Earth Format for Land Cover and UTC GIS Data Layers

Truckee Meadows Full AOI Land Use

User Inputs	Increase UTC % By	Update UTC % To	Update Number of Trees by:
Agricultural		5.4%	
Commercial		6.7%	
Industrial		3.0%	
Public		8.1%	
Residential		18.6%	
Right of Way		4.5%	
Vacant		7.2%	
Average Crown Diameter (ft):	30		
Crown Areas (Acres):	0.016219		

Reset Cells

Warnings and Errors
Average Crown Diameter set to Default

Optional

Size of Tree	Crown Diameter (ft)	% Distribution by Size	Weighted Diameter (ft)
Small			-
Medium			-
Large			-
Weighted Average Crown Diameter (ft):			0.00

Tree Mortality Rate (annually)
10%

**Note: Reset Cells clears all user inputs and reverts "Average Crown Diameter" to 30ft*

**Note: Only one of entry is acceptable per row, per column. For example, Commercial may not have entries in "Increase UTC % By" and "Increase UTC % To."*

Results

Land Use	Total Acres Excluding Water	Existing UTC Acres	Existing UTC %	Possible Plantable Acres	Total Additional Possible UTC %	Raw % Change	Updated Relative %	Updated UTC Acres	UTC Acreage Change	Number of Trees Required	Updated Number of Trees Including Mortality
Agricultural	2,520	46.8	1.9	1,937.1	76.9	3.5	5.4	136.1	89.3	5,506	6,056
Commercial	14,063	440.5	3.1	9,192.4	65.4	3.6	6.7	942.2	501.7	30,933	34,026
Industrial	9,343	112.9	1.2	4,864.6	52.1	1.8	3.0	280.3	167.4	10,321	11,353
Public	5,925	169.9	2.9	2,953.3	49.8	5.2	8.1	479.9	310.0	19,113	21,025
Residential	62,939	4,407.2	7.0	30,277.7	48.1	11.6	18.6	11,706.7	7,299.5	450,058	495,064
Right of Way	14,914	489.4	3.3	5,045.2	33.8	1.2	4.5	671.1	181.7	11,203	12,323
Vacant	19,262	247.0	1.3	8,355.1	43.4	5.9	7.2	1,386.9	1,139.9	70,282	77,310

Summary

Target Geography Totals	Geographic Area (Acres)	Existing UTC (Acres)	Existing %	Total Trees Added	Trees Added Including Mortality	Total Trees Added Acres	New UTC Acres	New %
Land Use	128,966.8	5,913.6	4.6%	597,416	657,157	9,689.5	15,603.1	12.1%

Figure 30: AMEC's Tree Canopy Calculator, a Plug and Play Spreadsheet for Canopy Goal Setting