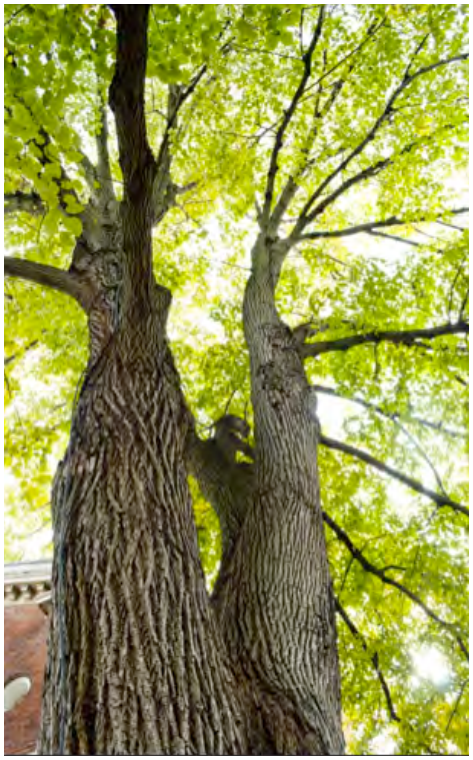

Photo by John Martin, courtesy of Missouri Botanical Garden

St. Louis Urban Tree Canopy Assessment

Forest ReLeaf of Missouri
Donna Coble, Executive Director
Mike Walsh, Forestry Programs Manager

April 2012

ABSTRACT: *Our urban forests are in decline. Among a city's most basic and critical assets are its trees. Trees clean and cool the air, capture and sequester carbon, reduce energy costs, help reduce storm water runoff, minimize erosion, improve water quality, provide habitat for native wildlife, increase home values, beautify our neighborhoods, and enrich our lives. Across the U.S., recent studies have documented significant tree cover decline in urban areas. In 2010, Forest ReLeaf of Missouri (FRM), with funding from Missouri Department of Conservation, and in collaboration with the City of St. Louis, St. Louis County and Metropolitan Sewer District, conducted an Urban Tree Canopy (UTC) Assessment to map tree cover using satellite imagery and GIS technology. For the area studied, UTC was recorded at 26%, significantly lower than the 40% American Forests recommends. The assessment also calculated the ecosystem-services value of the study's trees at more than $70 million and identified capacity to increase UTC by 10 percent. While the 2010 assessment serves as a critical local benchmark of existing UTC and the associated benefits, it covered only the city and portions of St. Louis County. To develop strategic, targeted tree planting and maintenance plans, a more comprehensive assessment of the entire St. Louis region is needed. Notably, once a UTC baseline for the region is established, the East-West Council of Governments can then incorporate this metric into a new Regional Plan for Sustainable Development. Of high priority are low-income, underserved communities in which increased UTC can have immediate, positive social, economic and environmental impacts.*

The Trees Among Us

It's likely that most people don't consider or appreciate the value of trees in their daily lives. Among the hardscapes of the built environment in which we typically live, work and play, extraordinary oaks, birches, magnolias and maples survive silently among us, often going unnoticed unless they get in our way. But together, a city's trees form an urban forest that serves as a life support system for us all.

Specifically, a healthy ecosystem of trees is an integral part of urban infrastructure, as critical to the livability of communities as quality schools, thriving businesses, roads, sidewalks, and sewers. Their role manifests in the daily realities of temperature, water and air. A tree's canopy prevents sunlight and heat from ever reaching the ground, while un-shaded asphalt soaks up thermal energy and radiates it back, causing the dreaded "heat island" effect (Heisler and Brazel, 2010). That same canopy also acts as a natural reservoir protecting us from floods. In some cases, the crown of a large, mature tree can intercept so much rainfall that more than 1,500 gallons a year evaporate instead of hitting the ground (Cray, 2007). And then there's air quality. For every tree that's eliminated from a city's ecosystem, particulate pollution that the tree would have filtered out remains. While replanting with younger trees helps, it pales in comparison to investing in the care and maintenance of the large, mature trees that live among us. Big trees remove 60 to 70 times the pollution of small trees, which will take decades to reach maturity (Koder, 1996).

U.S. Tree Cover: Threats & Trends

These basic ecological functions of trees are not contested. Yet urban deforestation continues. As with many environmental challenges, multiple contributing factors are in play. Natural variables like tree mortality from old age and extreme weather events account for some of the loss. Because of changing climate conditions, invasive pests – bark beetles, gypsy moths, and emerald ash borers – are finding new, welcoming places to call home in our cities, and devastating millions of trees in the process. Increased human development, ranging from urban sprawl to larger single-family homes, squeezes out space needed for large-canopied trees to survive and thrive. Add to this mix the fiscal constraints of city and county governments, which favor swapping large trees with small, low-maintenance shrubs or recreation surfaces. This last trend is regrettably ironic, given that America's shrinking tree cover is estimated to be costing taxpayers billions of dollars, primarily in the form of increased heating and cooling costs (Nowak and Greenfield, 2012).

Satellite imagery, GIS technology and other tools are helping us see and share this loss in new ways. In 2011, a pair of researchers from the USDA Forest Service assessed recent changes in tree cover and impervious cover in 20 U.S. cities. Tree cover in 17 of the 20 analyzed cities had statistically significant declines, while 16 cities had statistically significant increases in impervious cover, including buildings, roads, sidewalks and parking lots. Overall, the study's results indicate that tree cover in U.S. urban areas is on the decline at a rate of about 7,900 ha/year, or about 4 million trees annually (Nowak & Greenfield, 2012).

Growing a New Future for St. Louis

Across the U.S., the socio-economic struggles of cities are well-known, yet environmental sustainability issues are often perceived as peripheral compared to the headline problems of unemployment, home foreclosures, and crime. A city's environmental health and well-being, however, is intimately connected with its social and economic health, its ability to attract and keep citizens, businesses and schools, its home values, its crime rates, its past, present and future.

To remain a vibrant, dynamic and popular place to live and visit, cities know that spurring economic growth and development is critical. In the accounting of that growth, natural resources such as trees and forests, along with the life-supporting ecological services they provide, haven't traditionally shown up on the balance sheets. However, cities across America have begun to integrate trees and forests into their budgets and fiscal operations in new and significant ways, from planting large numbers of trees (New York, Los Angeles) to protecting existing trees (Chapel Hill, Pasadena) to developing long-term tree canopy goals (Seattle).

Closer to home, a recent public-private partnership initiative taking shape across the greater St. Louis region is seeking to advance urban forest management and protection efforts even further. Supported with funding from federal agencies, the East-West Gateway Council of Governments is working on a bold and comprehensive Regional Plan for Sustainable Development (RPSD). Involving numerous stakeholders, including businesses, nonprofit organizations, community leaders, scientists and citizens, the RPSD strives to build local capacity for implementing, measuring, and advancing sustainable practices to strengthen communities and neighborhoods across the St. Louis region. A comprehensive UTC benchmark is a critical baseline metric for the RPSD. The completed *St. Louis Regional UTC Assessment* will not only provide the measurement criteria sought by the RPSD, but also serve as a valuable planning and management tool for regional and municipal planners, city councils, planning and zoning officials, landscape architects, urban foresters, and enabling agencies.

Forest ReLeaf of Missouri: Putting the *St. Louis UTC Assessment* to Work

Forest ReLeaf of Missouri, along with its city, county and community partners, stands ready to respond, deliver and act. With adequate funding and support, FRM is well-equipped to complete a comprehensive *St. Louis Regional UTC Assessment* (including at least St. Louis City and all 91 municipalities within St. Louis County), help develop targeted planting plans, and ultimately, plant thousands of trees.

The *St. Louis Regional UTC Assessment* will build upon work completed in 2010 by FRM, Missouri Department of Conservation, the City of St. Louis, St. Louis County, St. Louis Metropolitan Sewer District, and AMEC Earth & Environmental, a firm specializing in GIS technology. Using satellite imagery, the 2010 assessment analyzed existing tree canopy in St. Louis City and a 30-square mile area of St. Louis County (parts of south and north St. Louis County). For the region studied, existing UTC was calculated at 26.1% (21, 537 acres) of total land cover. The data also concluded that

the area surveyed has the potential for more than 30,000 acres of trees, which would result in a 36.4% UTC. To calculate the urban forest value, the survey team used CITYgreen, a GIS-based software package that quantifies and reports air pollution removal capacity, carbon storage and sequestration, storm-water runoff benefit, and water quality impacts. CITYgreen valued the study's UTC at more than $72 million. This same value will increase by millions as trees are planted.

The data collected in 2010 – and the more comprehensive data to be collected as part of the *St. Louis Regional UTC Assessment* – will together inform the development of a targeted, three-year priority planting plan. Data-informed decisions can be made regarding which species of trees to plant and where. Science-driven choices can be made to plant riparian forests, park forests or other habitat types. Priorities can be set regarding communities most in need of UTC investments. Specifically, underserved and distressed communities throughout St. Louis City and County are of high priority. The data compiled will help zero in on those communities in ways that will accelerate strategic tree plantings, mobilize community engagement initiatives, and generate greater civic pride. Within these high-priority areas, FRM plans to plant 1,800 high quality large trees along the public right-of-way and on public properties over the course of three years.

In addition, FRM and its federal, state, nonprofit and local municipality partners are committed to education and public engagement. They know that the *St. Louis Regional UTC Assessment*, when shared creatively and compellingly with citizens, can help generate and sustain top-of-mind awareness of the value trees provide our cities, communities, neighborhoods and families. FRM and its partners also remain committed to advancing the field of urban forest conservation.

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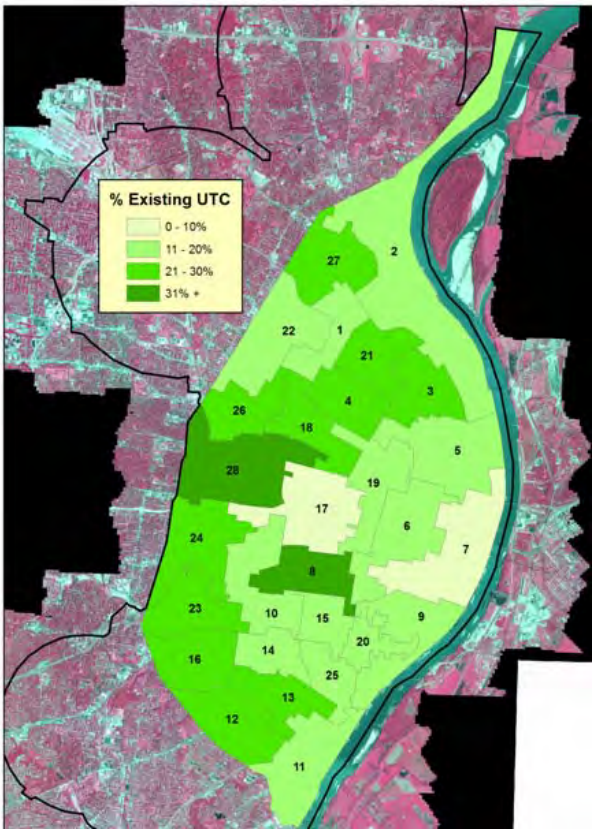
Coder, K.D., 1996. *Identified Benefits of Community Trees and Forests*. University of Georgia.

Nowak, D. J. and Greenfield, E.J., 2012. *Trees and impervious cover change in U.S. cities*. Urban Forestry & Urban Greening 11, 21-30.

Since 1993, Forest ReLeaf of Missouri has served as a catalyst for restoring and sustaining our urban forests. With the help of thousands of volunteers, we are planting trees and enriching communities. Visit moreleaf.org for detailed information on Forest ReLeaf's programs and services.

St. Louis, Missouri
Urban Tree Canopy (UTC) Assessment

January 2010



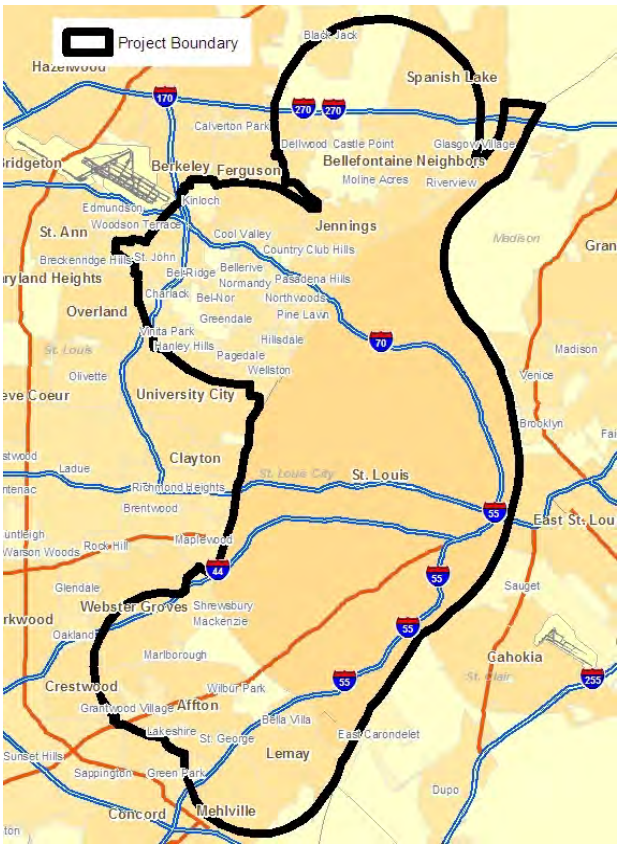
Prepared for:
Forest ReLeaf of Missouri

Prepared by:
Ian Hanou, Senior GIS Project Manager, AMEC Earth & Environmental

Introduction

Forest ReLeaf of Missouri (FRM) initiated this project in the City of St. Louis, Missouri and surrounding suburbs in St. Louis County to map urban tree canopy (UTC) cover and to calculate the value of the urban forest using CITYgreen software. This information will serve as the benchmark from which to measure success of future tree planting and maintenance programs, leverage support from partners, educate the public about the many benefits of trees, and promote community tree planting in underserved communities. The project area of interest (AOI) included the City of St. Louis, Missouri and targeted suburbs, covering a combined area of approximately 130 square miles. See Figure 1 at right.

Figure 1. City & County Project Areas



St. Louis UTC at a Glance

Major Findings:

City & County Current UTC: 26.1% (21,537 ac)

City & County Additional Possible UTC: 36.4% (30,005 ac)

City of St. Louis Current UTC: 18.2% (7,237 ac)

City of St. Louis Additional Possible UTC: 33.9% (13,479 ac)

City & County Urban Forest Value Calculated Using CITYgreen Software: $72.1M

Key Terms:

GIS – Geographic Information Systems
AOI – Area of Interest, referring to the study or project area
Urban tree canopy (UTC)* – the layer of leaves, branches, and stems of trees that cover the ground when viewed from above using aerial or satellite imagery
Land Cover* – features on the earth mapped from aerial or satellite imagery, such as trees, grass, water, and impervious surfaces
Vegetated Additional Possible UTC* – grass or shrub area that is theoretically available for the establishment of tree canopy in addition to existing UTC.
Impervious Additional Possible UTC* – for this project this consisted of parking lots where it is theoretically possible to establish tree canopy in addition to existing UTC
*Source: USDA Forest Service and/or University of Vermont Spatial Analysis Laboratory

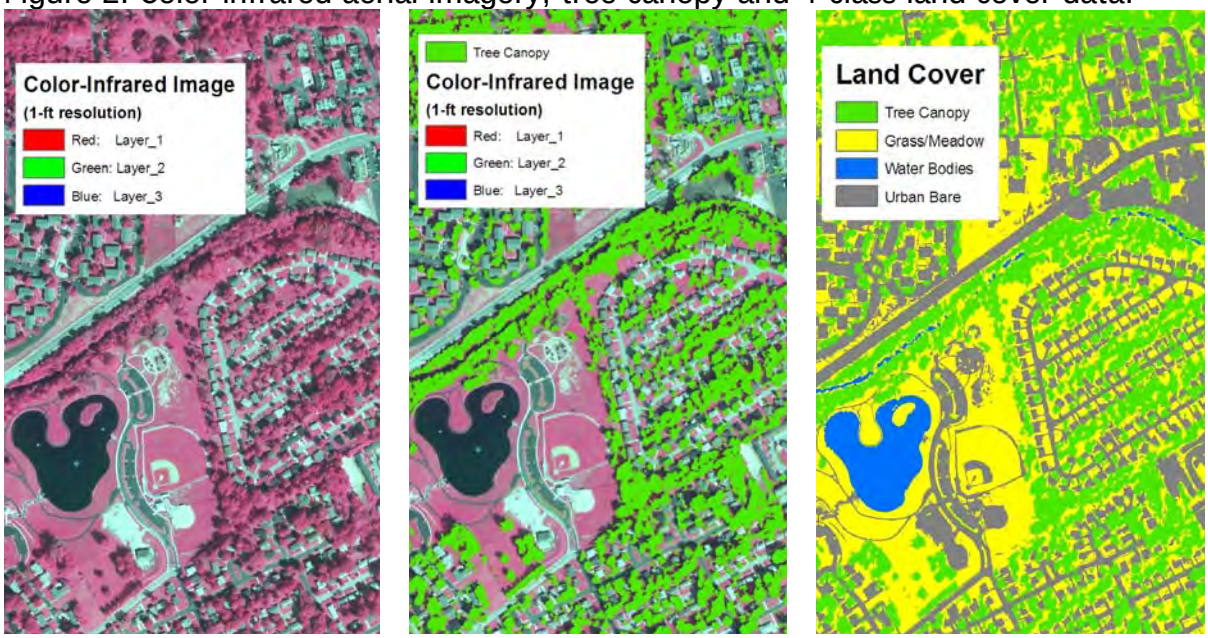
Imagery and Data Requirements

Geographic Information Systems (GIS) and remote sensing technologies offer powerful analysis and decision support tools for managing urban natural resources. All UTC projects have at least 5 main elements in common regarding data inputs and outputs. These are: high-resolution imagery, supporting GIS layers from the community, land cover data, geographic boundaries in which to summarize tree canopy acres and percent cover, and reporting of the results through tables, graphs and maps.

For this project, St. Louis City, St. Louis County and the Metropolitan Sewer District provided AMEC with city boundaries, parcels, land use/zoning, parks, wards, hydrology (lakes/ponds/rivers) and impervious surfaces such as building footprints, transportation, and parking lots. Leaf-on, multispectral aerial imagery acquired in September 2009 was purchased in order to map tree canopy and other land cover.

AMEC analyzed the color-infrared imagery using a technique known as geographic object-based image analysis (GEOBIA) to develop a 4-class land cover dataset that included tree canopy, plantable area (grass/shrubs/open space /agriculture/wetlands), water and an urban bare class, primarily composed of impervious area with some bare soil. This GEOBIA approach allowed AMEC to maximize feature extraction by using spectral, spatial, textural, contextual, and pattern-recognition algorithms in conjunction with the impervious surface datasets provided. The automated classification was refined with a manual quality assurance / quality control (QA/QC) process to finalize the land cover. Figure 2 shows sample results from this process.

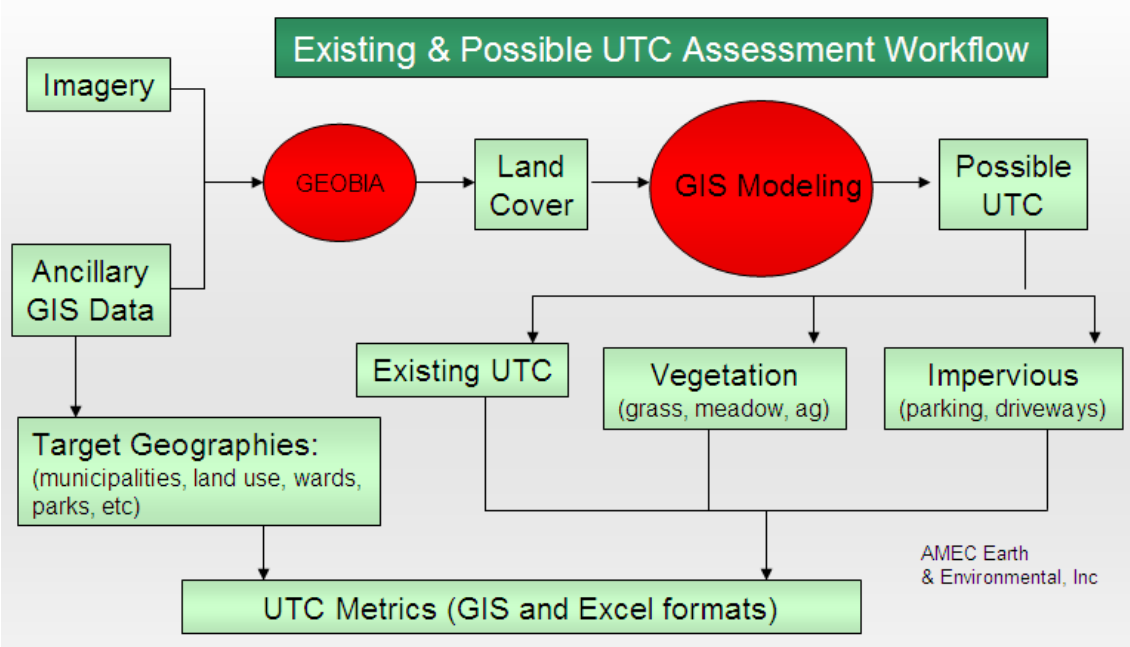
Figure 2. Color infrared aerial imagery, tree canopy and 4-class land cover data.



Methodology and Assumptions

FRM requested that UTC metrics be summarized for the project AOI as a whole, for St. Louis City vs. outlying County areas, unincorporated areas, each municipal boundary contained in the project, for wards in the City of St. Louis, for aggregated land use categories, and for individual parcels in the City and County. Using the land cover classes extracted in the previous step, AMEC developed a series of geoprocessing models to calculate the area and percent of Existing and Additional Possible UTC in both GIS and Excel format (see Figure 3 below). Existing UTC was defined as all area covered by trees and forest. Additional Possible UTC, split into Possible Vegetation UTC and Possible Impervious UTC, was defined as the areas where it is biophysically possible to plant trees, meaning all grass and open space (non-tree) vegetation, as well as parking lots. Portions of this model were developed by the US Forest Service Northern Research Station and the University of Vermont Spatial Analysis Laboratory.

Figure 3. UTC GIS modeling workflow



Results of the UTC Process

The area and percent of Existing UTC, Possible Vegetation UTC and Possible Impervious UTC was calculated for the different geographic boundaries listed above. Existing UTC in St. Louis City was found to be 18%, however throughout the entire project area Existing UTC was 26%. The full results can be accessed through the attribute table of each GIS layer or through the UTC Spreadsheet delivered as part of the project. Tables 1-4 and Figures 4-11 below provide examples of the results in tabular, graph and map-based format.

Table 1. UTC Metrics for the City of St. Louis, Outlying County Areas and the Entire Project

Area	Total Acres	Acres Not Suitable	Existing UTC Acres	Existing UTC %	Possible UTC Veg Acres	Possible UTC Veg %	Possible UTC Imperv Acres	Possible UTC Imperv %	Total Possible UTC Acres	Total Possible UTC %
Project AOI	82,363	30,821	21,537	26.1	23,461	28.5	6,544	7.9	30,005	36.4
City of St. Louis	39,776	19,060	7,237	18.2	9,472	23.8	4,007	10.1	13,479	33.9
County Areas	42,587	11,761	14,300	31.5	13,989	32.8	2,537	6.0	16,527	38.8

Figure 4. Overall Summary of UTC Assessment

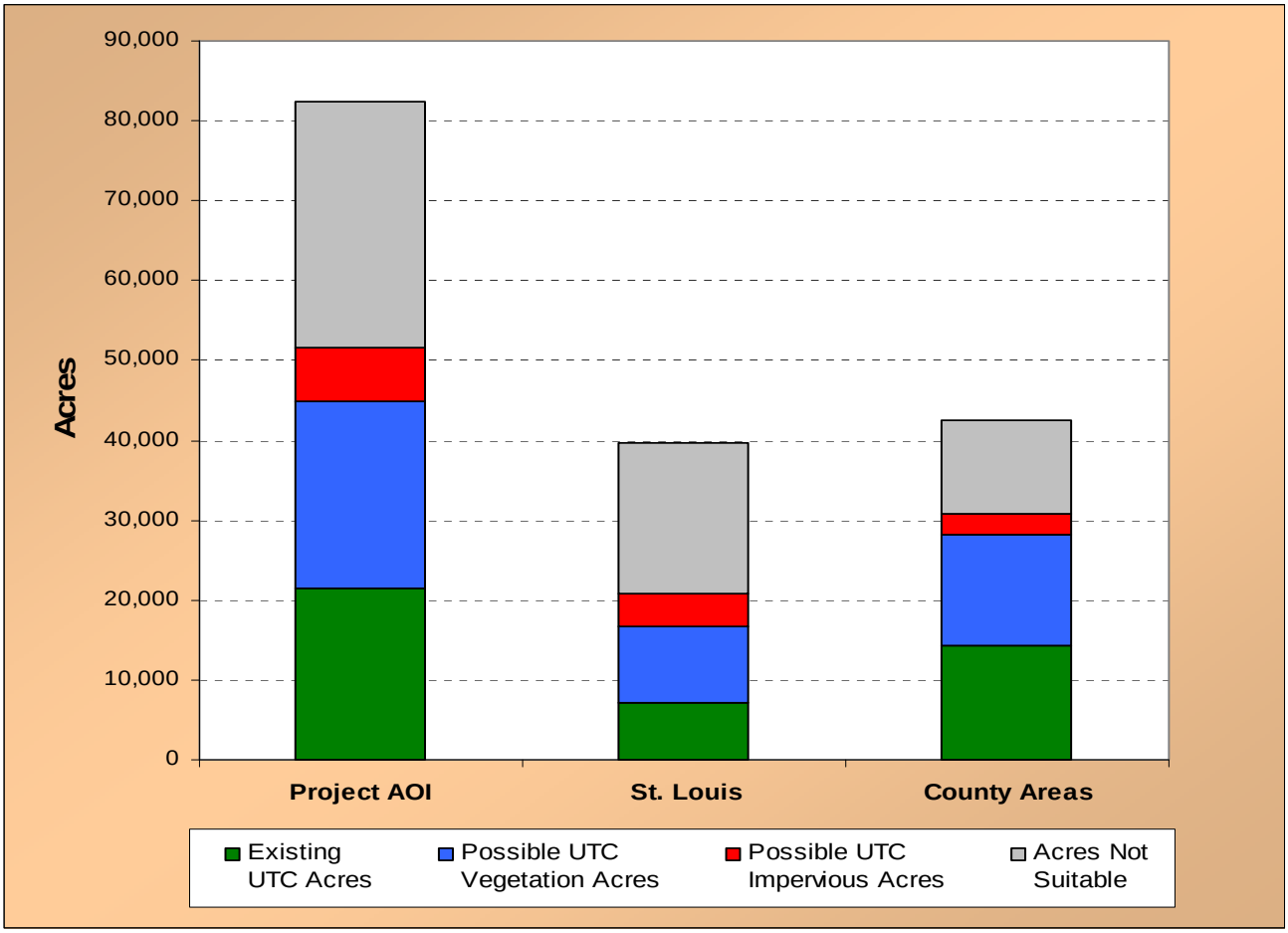


Table 2. Public Right-of-Way UTC Metrics for the City of St. Louis, Outlying County Areas and the Entire Project

Area	Total Acres	Acres Not Suitable	Existing UTC Acres	Existing UTC %	Possible UTC Vegetation Acres	Possible UTC Vegetation %
Project Public Right-of-Way	16,392	10,381	3,282	20.0	2,730	16.7
City of St. Louis Right-of-Way	9,146	6,366	1,616	17.7	1,164	12.7
County Areas Right-of-Way	7,247	4,015	1,665	23.0	1,566	21.6

Table 3. Existing & Additional Possible UTC for Municipalities Wholly Contained in the Project

Municipality	Total Acres	Acres Not Suitable	Existing UTC Acres	Existing UTC %	Possible UTC Vegetation Acres	Possible UTC Vegetation %	Possible UTC Impervious Acres	Possible UTC Impervious %	Total Possible UTC Acres	Total Possible UTC %
Bella Villa	80	31	24	29.5	23	29.4	2	2.0	25	31.4
Bellefontaine Neighbors	2,805	577	871	31.1	1,247	44.5	109	3.9	1,356	48.3
Bellerive	213	63	67	31.6	68	31.7	16	7.4	83	39.1
Bel-Nor	399	388	3	0.7	2	0.6	6	1.6	9	2.2
Bel-Ridge	513	204	143	27.8	130	25.3	37	7.1	167	32.5
Beverly Hills	58	25	14	23.6	13	22.7	6	9.9	19	32.6
Charlack	168	154	1	0.5	1	0.5	12	6.9	12	7.4
Cool Valley	309	93	81	26.2	106	34.2	29	9.4	135	43.6
Country Club Hills	115	39	40	34.4	33	28.7	3	3.0	37	31.7
Flordell Hills	76	26	28	36.5	20	25.8	3	3.3	22	29.1
Glen Echo Park	21	5	9	44.9	6	30.2	0	0.0	6	30.2
Greendale	129	25	63	48.3	41	31.5	1	0.9	42	32.4
Hillsdale	224	70	72	32.2	58	26.0	23	10.4	81	36.3
Mackenzie	15	5	5	35.2	5	29.4	0	0.1	5	29.5
Marlborough	147	61	24	16.0	27	18.5	35	23.8	62	42.3
Moline Acres	354	89	130	36.7	114	32.2	22	6.1	136	38.3
Normandy	1,173	496	290	24.7	317	27.1	69	5.9	387	33.0
Norwood Court	96	25	24	25.1	39	40.3	8	8.8	47	49.1
Pagedale	772	613	27	3.5	34	4.5	97	12.6	131	17.0
Pasadena Hills	137	34	66	47.9	36	26.3	2	1.1	38	27.4
Pasadena Park	60	18	27	45.4	15	25.3	0	0.0	15	25.3
Pine Lawn	390	150	102	26.2	107	27.4	31	7.8	137	35.3
St. George	118	40	34	28.5	40	33.7	5	4.3	45	38.0
Unincorporated (County)	18,300	5,243	5,958	32.6	6,122	33.5	977	5.3	7,099	38.8
Uplands Park	43	17	12	28.3	14	31.7	0	0.6	14	32.2
Velda City	107	44	31	29.3	29	27.1	3	2.8	32	29.9
Velda Village Hills	77	29	24	31.3	23	30.4	0	0.1	23	30.5
Vinita Terrace	40	21	12	30.4	5	13.5	2	4.6	7	18.1

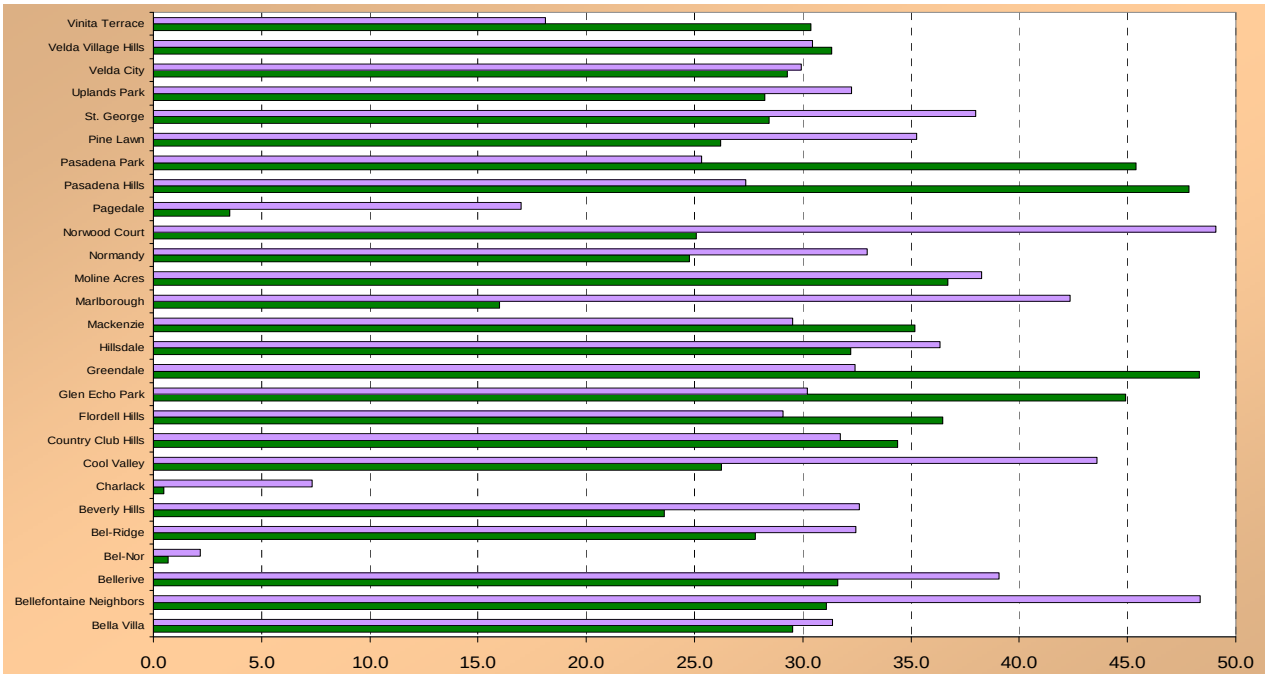
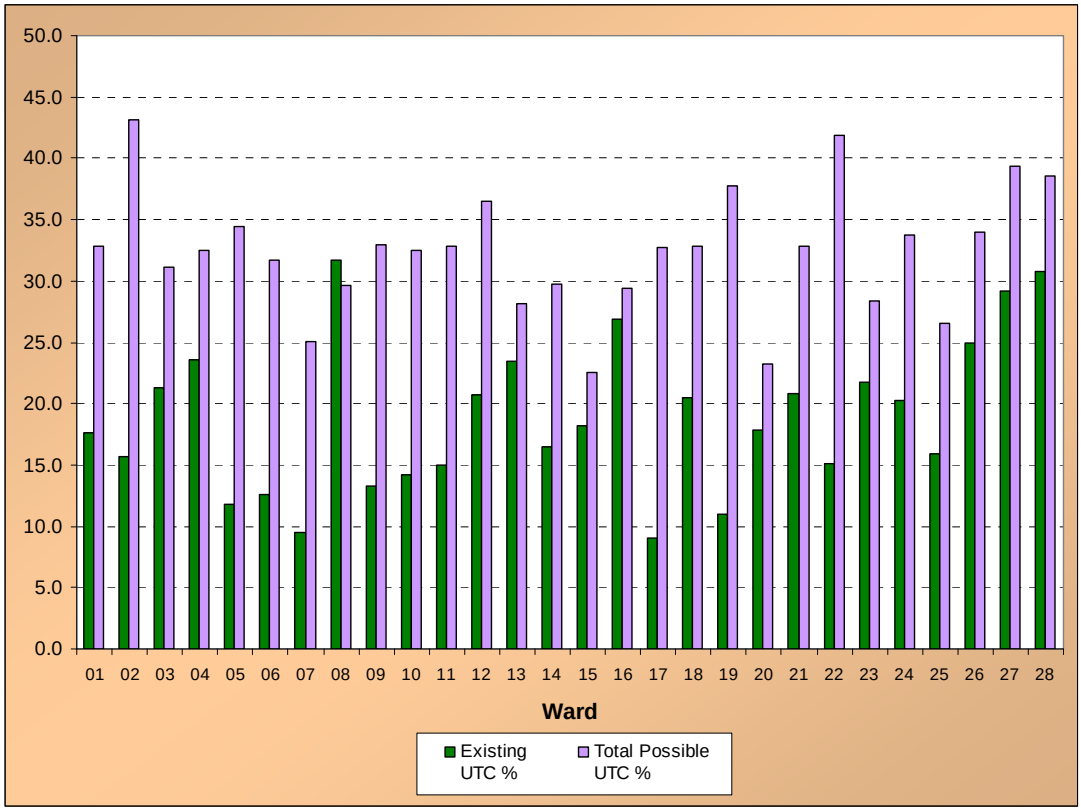
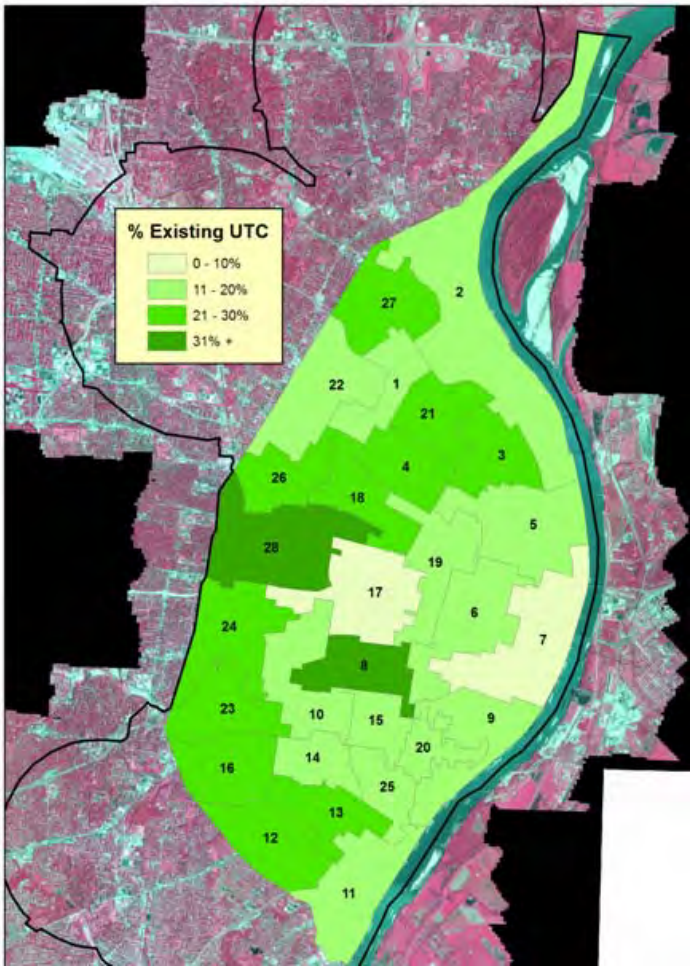


Figure 5. Existing & Additional Possible UTC Percent by Municipality

Figures 6-8. Existing & Additional Possible UTC Percent by Ward





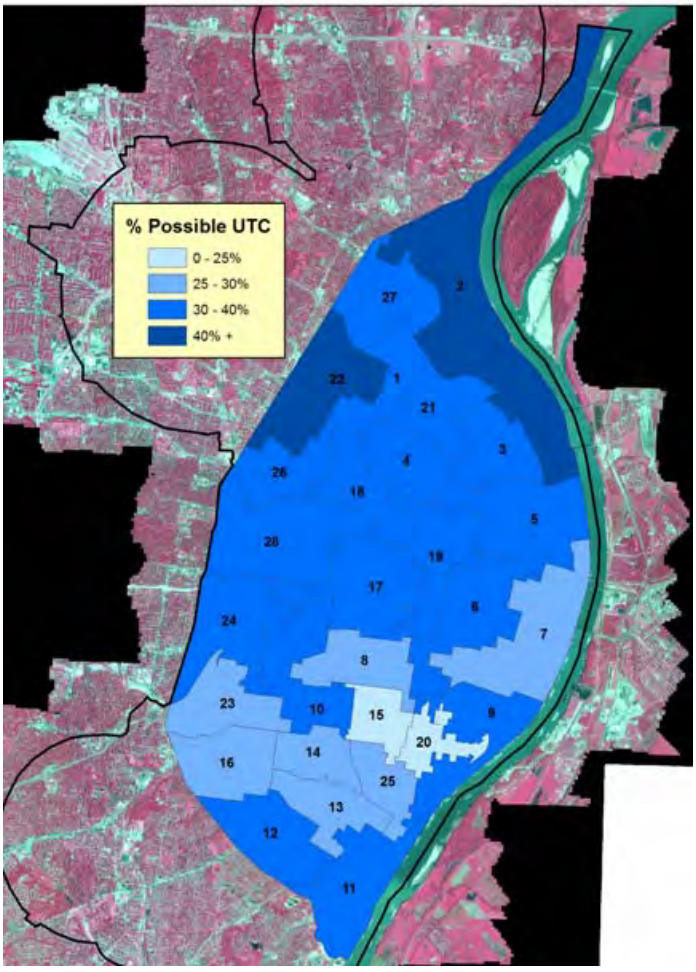


Figure 9. Symbolizing Existing and Additional Possible UTC Metrics by Parcel and an Accompanying Screenshot of the Parcels Attribute Table.

Figure 10. Existing and Additional Possible UTC Metrics by Land Use District in St. Louis City

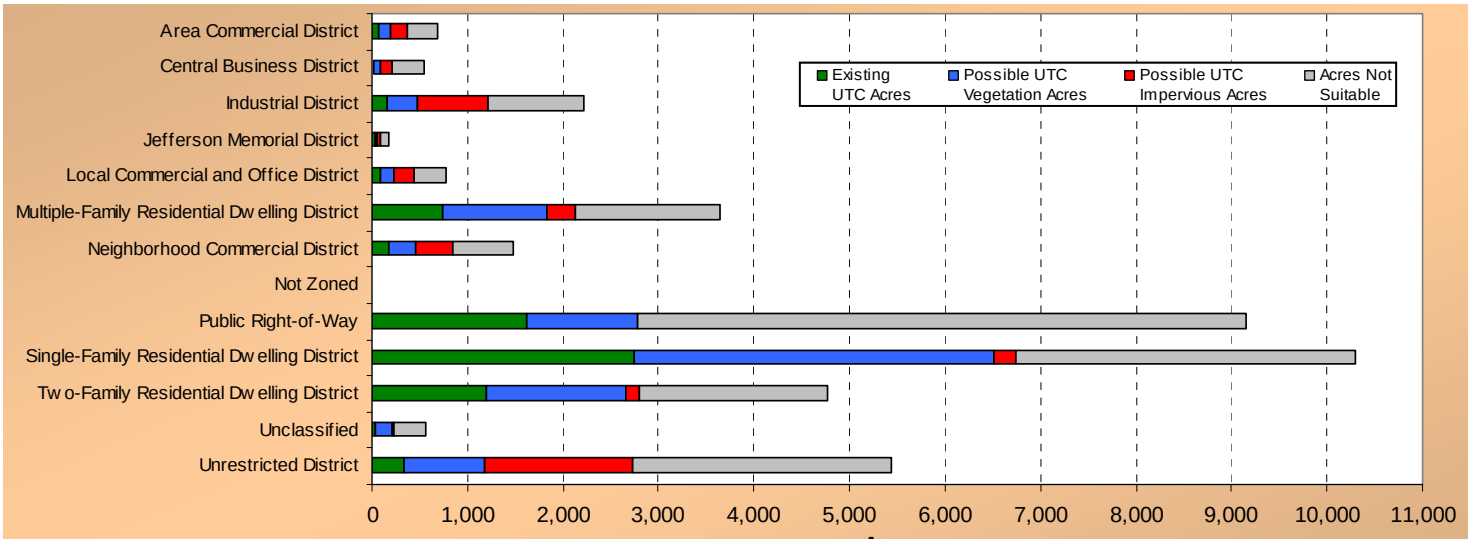
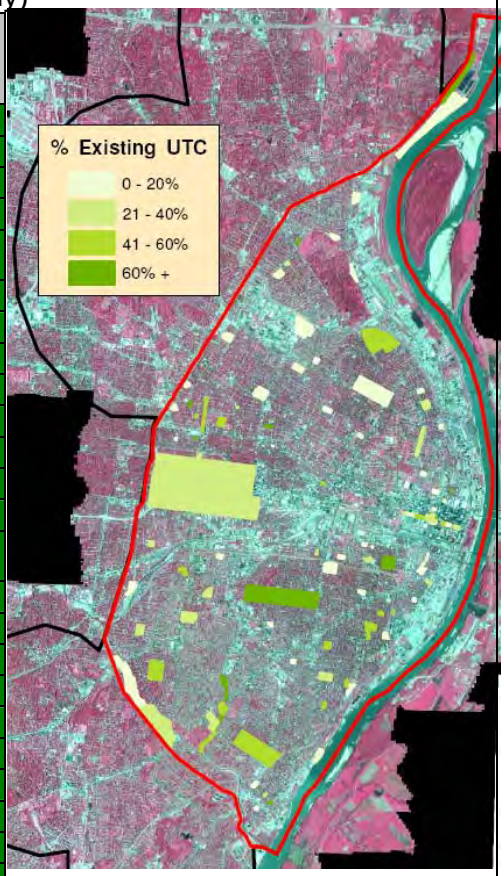


Table 4 and Figure 11. Existing UTC per Park (City of St. Louis only)

Park	Existing UTC Acres	Existing UTC %	Park	Existing UTC Acres	Existing UTC %
Aboussie Park	0.15	36.9	Garrison Park	0.01	0.2
Adams Playground	0.12	5.2	Gateway Mall Plaza	0.62	18.4
Alaska Park	0.70	15.0	Giles Park	0.86	18.9
Aloe Plaza	0.43	18.5	Gravois Park	3.05	37.2
Aloe Plaza West Extension	0.36	28.0	Handy Park	1.29	10.9
Amberg Park	0.46	16.3	Hickey Park	1.32	9.7
Amherst Park	0.66	18.6	Hyde Park	2.70	22.7
Barret Brothers Park	1.57	11.2	Interco Plaza	0.07	11.6
Beckett Playground	0.26	7.5	Jackson Place Park	0.09	5.5
Bellerive Park	1.41	15.7	Jackson Place Park	0.01	1.8
Benton Park	5.32	35.8	Kaufmann Park	0.81	41.2
Berra Park	0.63	13.8	Kennedy Park	0.01	10.5
Bradley Park	0.54	13.9	Kiener Plaza	0.34	21.7
Buder Park	0.30	13.9	Kingsbury Square Park	0.26	40.4
Busche Park	0.51	13.0	Laclede Park	1.24	39.6
Busche Park	0.14	6.2	Lafayette Park	14.73	48.8
Carnegie Playground	0.67	34.1	Leisure, Joseph Park	5.79	39.3
Carondelet Lions Park	0.24	12.3	Leisure, Ray Park	0.96	13.7
Carondelet Park	61.95	37.3	Lindenwood Park	3.75	26.6
Carr Square Park	0.61	15.1	Lucas Garden Park	0.17	16.3
Chain of Rocks Park	50.14	78.1	Lucier Park	0.24	6.2
Chambers Park	0.43	6.9	Lyon Park	0.72	7.5
Cherokee Park	0.94	16.2	Marquette Park	3.68	20.9
Christy Park	6.79	52.0	May Amphitheater	0.43	27.6
Christy Park	2.25	35.2	McDonald Park	0.38	16.5
Civic Center	1.96	25.8	Memorial Plaza	1.32	32.2
Clifton Heights Park	2.14	32.1	Mestres Parkway	0.19	19.2
Columbus Square Piazza	0.15	47.6	Mestres Parkway	0.09	18.6
Compton Hill Reservoir Park	5.00	17.9	Minnesota & Hill Park	0.05	3.4
Davis Park	1.53	15.8	Minniewood Park	1.17	17.8
DeSoto Park	0.38	3.2	Mount Pleasant Park	1.29	39.0
Dickman Park	0.60	9.3	Murphy Park	0.45	17.4
Eads Park	0.92	23.4	North Riverfront Park	18.66	12.5
Ellendale/Arsenal Park	2.82	19.7	O'Fallon Park	43.99	33.7
Fairground Park	18.05	14.2	Parkland Park	0.97	40.1
Fanetti Park	0.15	26.6	Penrose Park	5.29	9.3
Father Filipiac Park	0.08	5.2	Perry Park	4.10	36.6
Forest Park	389.78	29.2	Poelker Park	0.33	25.2
Forest Park (detached)	3.05	14.3	Pontiac Square Park	0.32	17.0
Fountain Park	1.49	54.1	Porter Park	2.85	30.2
Four Corners Park	0.09	13.9	River Des Peres Extension	4.14	39.9
Fourteenth Street Mall	0.00	0.0	River Des Peres Park	15.58	17.4
Fowler Park	0.10	26.0	Rumbold Park	0.36	14.1
Fox Park	0.57	16.9	Russell Park	0.41	38.3
Francis Park	21.29	37.3	Seay Park	0.10	3.3
Franz Park	1.02	22.0	Serra Sculpture Park	0.37	32.4
Freemont Park	0.77	31.9	Sherman Park	4.92	18.2



Sister Marie Charles Park	0.37	14.7
Soulard Playground	0.69	29.0
South St. Louis Square	0.78	47.2
St. Louis Place Park	3.24	21.6
St. Marcus Park	6.64	26.4
Strauss Park	0.30	35.2
Strodtman Park	0.22	12.8
Sublette Park	2.42	21.2
Tambo Park	0.03	9.1
Tandy Park	0.63	11.4
Terry Park	0.37	9.7
Thekla Park	0.37	27.7
Tiffany Park	0.37	29.7
Tilles Park	6.72	22.6
Tower Grove Park	131.54	49.0
Turner Playground	0.08	5.5
Turtle Playground	1.10	21.1
Vivian Astra Park	0.53	48.3
Walnut Park	0.06	2.9
Washington Square Park	0.24	14.9
Willmore Park	35.53	21.1
Windsor Park	0.35	10.1
Yeatman Square Park	0.06	1.5

Ecosystem Services Analysis using CITYgreen Software Reporting

CITYgreen software from American Forests was used to analyze and calculate the ecological and economic benefits provided by trees and other green space. The models use GIS-based tree canopy and other land cover layers to quantify and report air pollution removal capacity, carbon storage and sequestration, stormwater runoff benefit and water quality impact of the urban forest. Reports were generated for four different areas: the entire project area, the City of St. Louis, a northwest County area, and a southwest County area. An additional report modeled benefits using a 10% increase in tree canopy in the City of St. Louis (28% vs. 18%). This replacement scenario was used to model urban forest benefits at 28% canopy cover (up from 18%) to demonstrate the benefit of increased urban tree canopy cover. CITYgreen modeling calculated a $72,100,000 value of the urban forest for the entire project area. More detailed information is provided below, or please visit http://www.americanforests.org/productsandpubs/citygreen/.

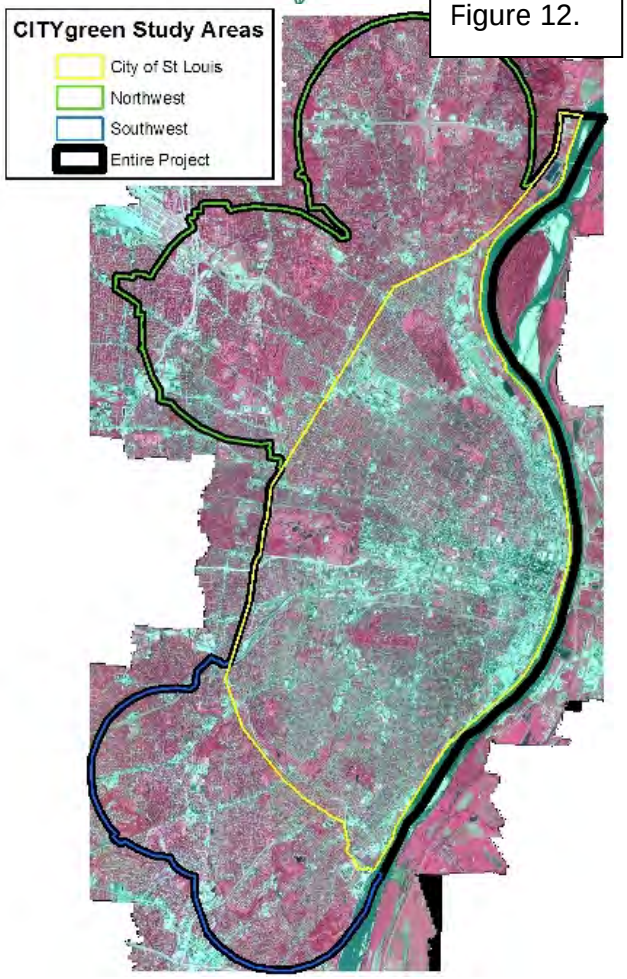


Figure 12.

Table 5. CITYgreen Results by Study Area

CITYgreen Study Area	UTC	Air Pollution Removal Capacity (Lbs./yr)		Tons of Carbon Stored (Total)	Tons of Carbon Sequestered (Annually)	Total Stormwater Savings	Total Value
SW County	31%	431,461	$969K	194,656	1,515	$13.3M	$14.2M
NW County	35%	929,121	$2.09M	419,177	3,263	$21.1M	$23.2M
St. Louis City	18%	690,298	$1.5M	311,431	2,425	$39.8M	$41.3M
Entire Project Area	26%	2.05M	$4.6M	925,154	7,203	$67.5M	$72.1M
Modeled Potential: City of St. Louis @ 28% UTC *(up from 18% now)*	28%	1.06M	$2.4M *(Note: not in addition to current $1.5M value with 18% UTC)*	479,175	3,731	$37.6M *(additional avoided stormwater cost with 10% more tree canopy)*	$79.8M *(Note: not in addition to current $41.3M value with 18% UTC)*

While there are parameters available within CITYgreen to incorporate local soils, precipitation and air quality data, this type of information was not available for this project and many of the default values that are setup and used by American Forests were chosen. St. Louis was chosen as the Air Quality Reference City and default values were used for carbon storage and sequestration, slope (2%), stormwater facilities construction cost ($2/cu.ft.) and rainfall (3.25" for a 2-year, 24-hour storm event).

After studying the CITYgreen Curve Number (CN) spreadsheet and running numerous reports for each study area, where the soil type and replacement land cover type were modified, AMEC chose to apply more conservative modeling assumptions. This is in part due to the fact that CITYgreen modeling for stormwater is best applied prior to development rather than in developed sites such as the St. Louis metro area that already has stormwater retention facilities in place. Additionally, the $2/cu.ft. construction cost used is conservative: American Forests reported "recent local stormwater construction costs of $10-11 per cubic foot in Bellevue, WA" (October 2008) but similarly applied the $2/cu.ft. cost.

Type C "somewhat impervious" soils were used for all study areas. Given the urban nature of the project area and combined impervious/soil land cover class, impervious land cover was assigned an "Urban" category (CN 95) in the City of St. Louis rather than the "Paved" category (CN 98). The most realistic modeling scenario for the project as a whole and the two smaller AOIs was to use the less impervious "Urban: Bare" category (CN 91) given the absence of a highly impervious area like downtown St. Louis. For all four scenarios, using the replacement land cover type of "Open Space - Grass/Scattered Trees: Grass cover 50% - 75%" produced changes in curve number and water benefits that were realistic given the real-world limitations involved in changing land use, land cover and green infrastructure on the ground.

AMEC also modeled the urban forest value at an increase in canopy cover. Two modeling scenarios failed to show additional stormwater benefit, but curve number change and thus benefits were realized when a 10% increase in overall canopy (from 18% to 28%) was applied, where 50% of the new canopy replaced impervious surfaces. Even with conservative modeling assumptions, CITYgreen reporting illustrates tremendous benefits from the use of trees and other green infrastructure.

The following figures represent various inputs and outputs of the CITYgreen modeling.

Figure 13. Land cover data configured to CITYgreen Features

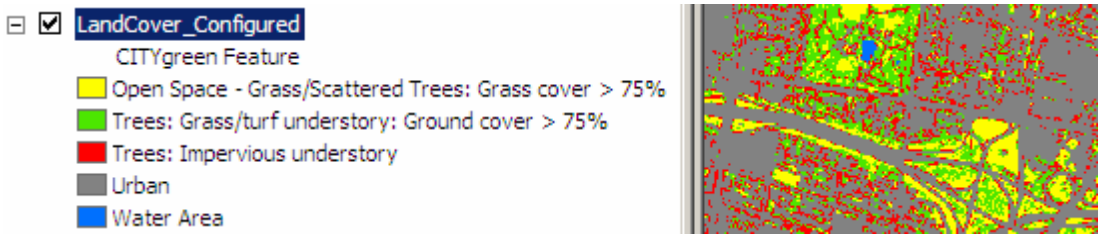


Figure 14. Southwest Study Area Air Pollution Removal Capacity Results

Nearest Air Quality Reference City: **Saint Louis**

	Lbs. Removed/yr	Dollar Value
Carbon Monoxide:	12,097	$5,163
Ozone:	133,068	$408,812
Nitrogen Dioxide:	60,485	$185,824
Particulate Matter:	153,229	$314,300
Sulfur Dioxide:	72,582	$54,470
Totals:	**431,461**	**$968,569**

Figure 15-16. Northwest Study Area Water Quantity (volume of runoff mitigated by trees) and Quality Results (percent change in contaminant loading of various pollutants due to trees impact on curve numbers)

Water Quantity (Runoff)

2-yr, 24-hr Rainfall: 3.25 in.

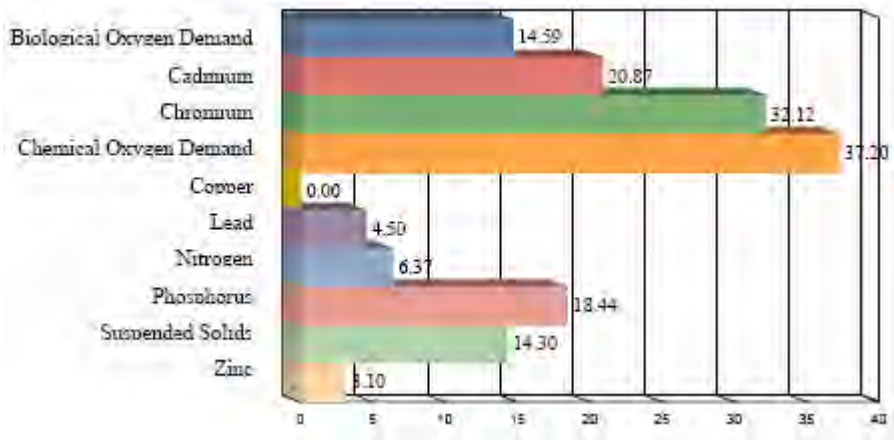
Curve Number reflecting existing conditions: 70

***Curve** Number using default replacement landcover:* 72

Additional stormwater storage volume needed: 10,553,351 cu. ft.

Construction cost per cu. ft.: $2.00

Total Stormwater Savings: $21,106,701



Conclusion

With 18% Existing UTC, St. Louis City has average or slightly below-average tree canopy cover compared with other cities in the eastern United States (see Appendix). This canopy does provide significant social, environmental and economic benefits, some of which have been assessed through this project. We recommend that Forest ReLeaf of Missouri, St. Louis City and St. Louis County, and other stakeholders involved in green infrastructure development use these results as a starting point for more detailed studies, GIS analyses and targeted implementation programs. UTC summaries at the ward- and parcel-level, as well as for individual parks, provide a platform for collaborative, transparent program & policy development aimed at setting a UTC goal by land use categories and overall citywide. Incorporating social data such as income, crime, or obesity rates in addition to the GIS UTC information can further target planting programs.

Noteworthy opportunities for increasing UTC in the City of St. Louis include:

- Public right-of way, with 17% Existing UTC and 13% Additional Possible UTC
- Residential district types range from 20-27% Existing UTC however still contain 33-39% Possible UTC (Vegetation and Impervious UTC)
- Parking lots, or Additional Possible Impervious UTC for this project, with low Existing UTC represent a significant proportion of area within Commercial and Industrial land uses (15-33%) and establishing UTC in these locations has proven to improve water quality, lower the urban heat island effect and even improve business
- Approximately 25 parks have less than 10% Existing UTC but significant Possible UTC, while roughly 70 parks have less than 20% Existing UTC

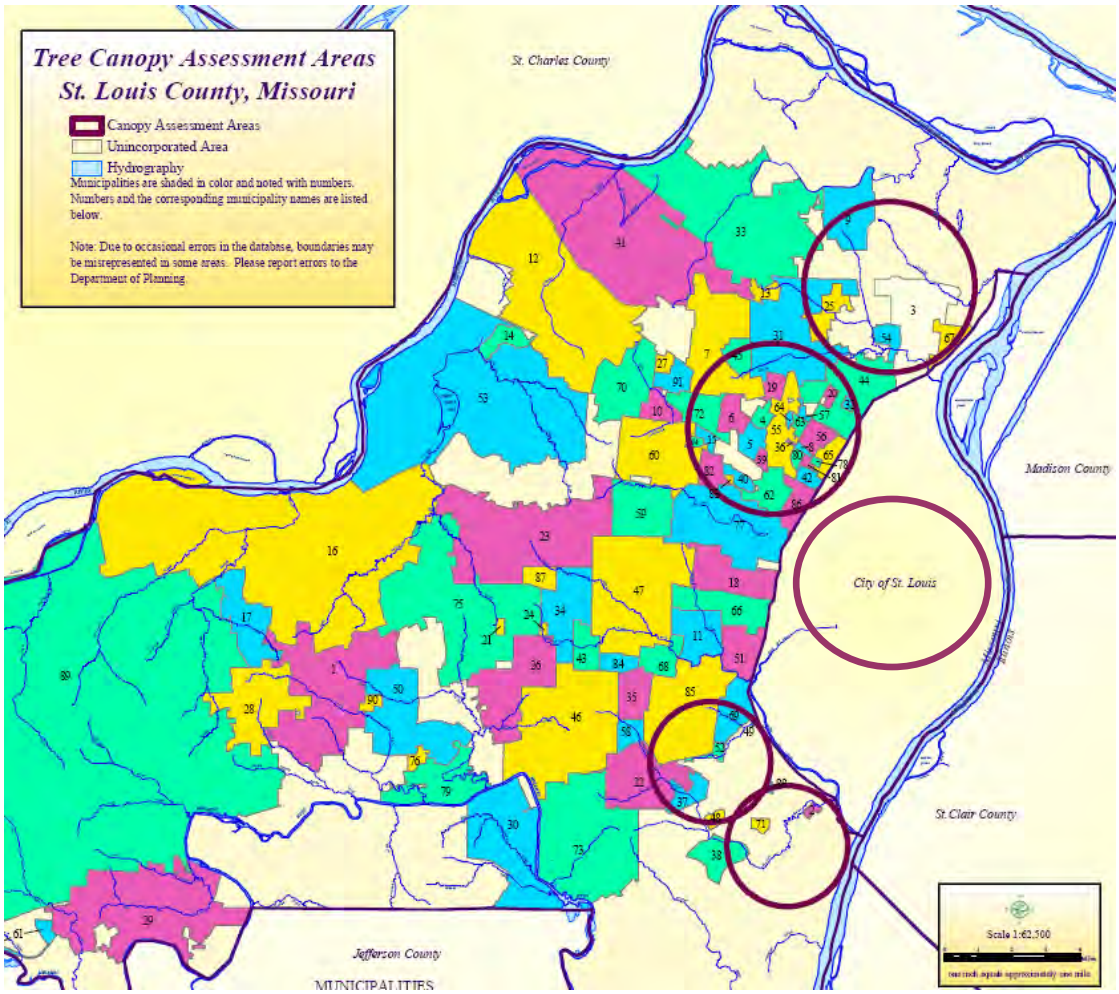
There are several benefits of UTC projects, including low cost, rapid turnaround, integration with existing GIS resources and resulting datasets that meet multiple agency and department needs. A UTC project will never replace the more detailed information collected through a traditional street tree inventory as specific species are not identified and no attempt is made to qualify the existing canopy in terms of its sustainable and diverse species. Nonetheless, it is an effective method for establishing canopy cover goals, assessing ecosystem services, and planning for the urban forest in ways that are easily communicated with project stakeholders and the community at large.

Acknowledgements

Forest ReLeaf of Missouri would like to thank the Missouri Department of Conservation as the major funding source for this project. Forest ReLeaf also recognizes the City of St. Louis Planning and Urban Design Agency, St. Louis County Department of Planning GIS staff, and St. Louis Metropolitan Sewer District (MSD) for contributing GIS data layers and their time to this project. Without their support, this project and an increased understanding of green infrastructure in St. Louis would not have been possible.

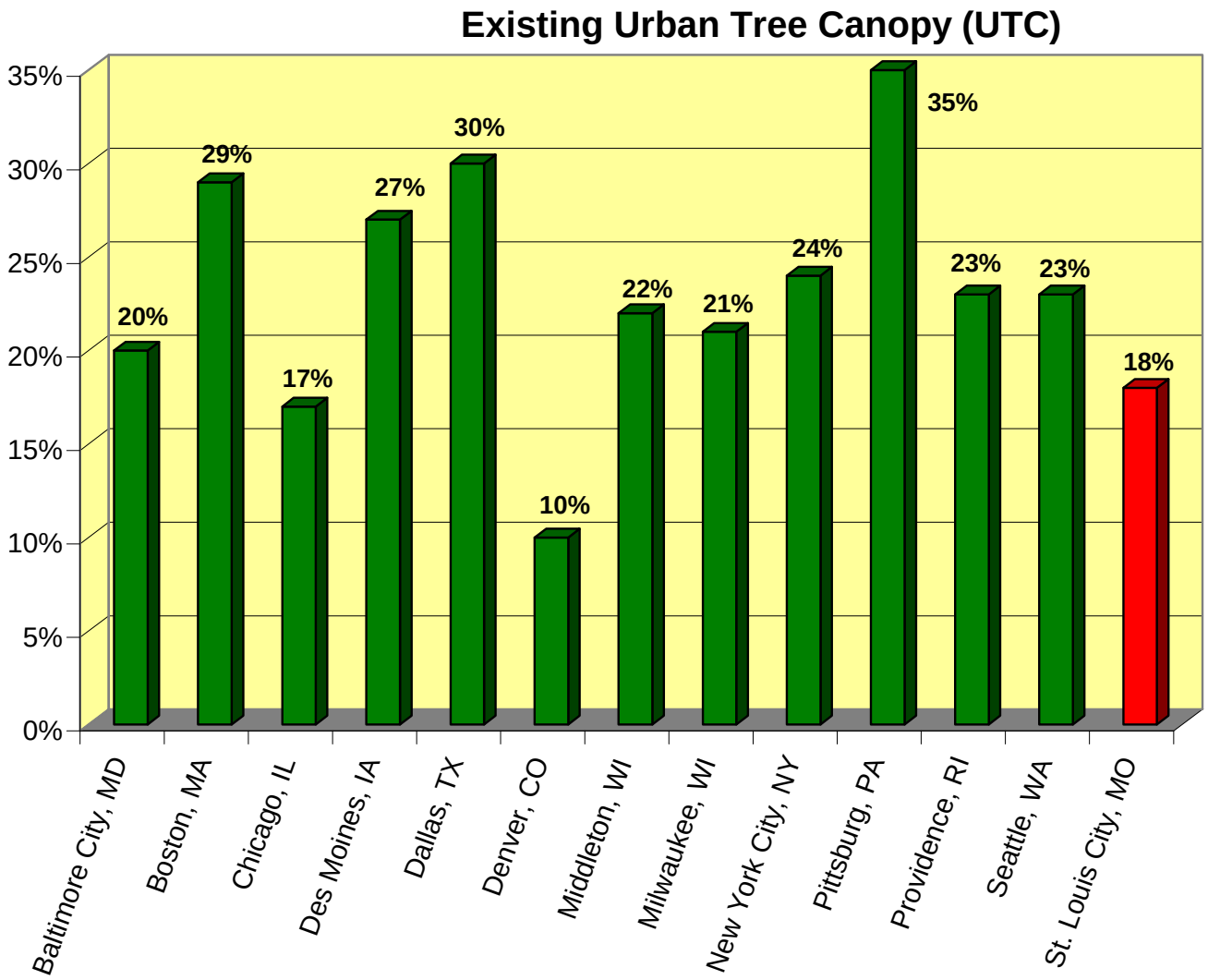
APPENDIX

Original map of targeted assessment areas provided to AMEC by FRM



Note: the project area of interest (AOI) was developed together with FRM based on the map shown above, including the entire City of St. Louis and a list of municipalities provided. Some larger municipalities are only partially contained within the project, however the majority that intersect the red circular AOIs were able to be captured in their entirety without increasing the project size substantially. The following municipalities were fully covered; Bella Villa, Bellefontaine Neighbors, Bellerive, Bel-Nor, Bel-Ridge, Beverly Hills, Charlack, Cool Valley, Country Club Hills, Floridell Hills, Glen Echo Park, Greendale, Hillsdale, Mackenzie, Malborough, Moline Acres, Normandy, Norwood Court, Pagedale, Pasadena Hills, Pasadena Park, Pine Lawn, St George, Uplands Park, Velda City, Velda Village Hills, Vinita Terrace. The following municipalities were only partially contained; Berkeley, Black Jack, Crestwood, Dellwood, Ferguson, Florissant, Grantwood Village, Green Park, Jennings, Kinloch, Lakeshire, Northwoods, Overland, Shrewsbury, St John, Sycamore Hills, Vinita Park, Webster, Groves, Wellston, Wilbur Park.

Comparing St. Louis' Existing UTC to other U.S. Cities



Project Profile – St. Louis County

Plan-It Geo's Urban Forest Services:

- Urban Tree Canopy (UTC) Assessment & Analysis
- Tree Inventory and Ecosystem Services Cost/Benefit Analysis
- Data Management, GIS, Remote Sensing, Decision Support Tools, 3D Visualization
- Strategic Tree Management, Conservation, & Implementation Plans & Stakeholder Involvement
- ***Urban Forest Cloud®*** web-based tools, ***Tree Plotter®*** and ***Canopy Planner®*** software apps

Additionally:

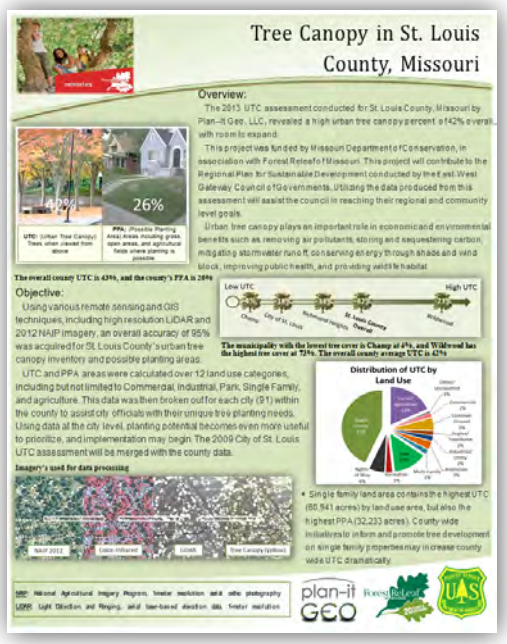
- Custom Application Development
- Land Use / Land Cover Mapping
- Scenario Planning, Landscape Architecture, & Conceptual Design
- Statistical Analysis & Forestry / Ecosystem Research

Project Title: St. Louis County, Missouri Urban Tree Canopy Assessment (500 square miles) & Training Workshop

Client: Forest ReLeaf of Missouri

Timeframe: June 2012 – April 2013

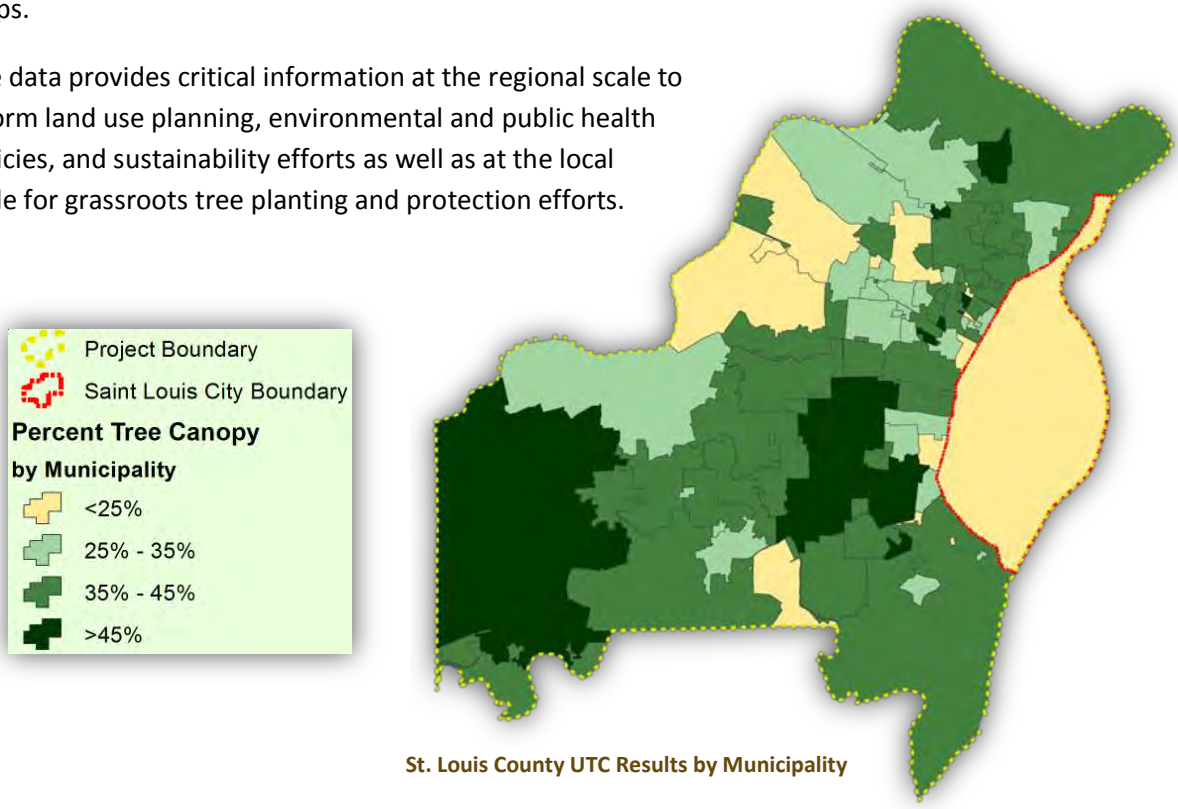
Description: Using remote sensing and GIS technologies, Plan-It Geo conducted an Urban Tree Canopy (UTC) assessment in St. Louis County. Based on 1-meter resolution 2012 LiDAR and aerial imagery, the analysis provided canopy cover metrics and tree planting opportunities for 91 municipalities. Land cover metrics were also summarized for land use categories and down to the individual parcel level.



St. Louis County UTC Factsheet

Plan-It Geo used the results to develop interactive PDF tree canopy maps for the County and the City of Richmond Heights, a close partner on the project. We provided a UTC fact sheet template and hands-on training workshop for municipalities to customize locally specific UTC fact sheets and GIS-based maps.

The data provides critical information at the regional scale to inform land use planning, environmental and public health policies, and sustainability efforts as well as at the local scale for grassroots tree planting and protection efforts.



St. Louis County UTC Results by Municipality

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