Environmental Benefits Analysis of Trees for Jamestown, Ohio

T. Davis Sydnor and Sakthi Subburayalu
School of Environment and Natural Resources

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An Analysis of Tree Benefits for Jamestown, Ohio

EXECUTIVE SUMMARY

An inventory of public trees on the streets and in the parks of the City of Jamestown, Ohio was conducted by Ohio State Extension and its Greene County Master Gardeners in 2010. A total of 231 trees were inventoried during this period. A common bid price for this service is $4.00 per tree and thus the inventory represents a value of $925. Most importantly, however, is that the community now has a tree inventory in a form that can be used to better manage the tree resource of Jamestown. Benefits mentioned above do not include the value of the subsequent analysis and report by The Ohio State University's School of Environment and Natural Resources which would conservatively add another $11,500. Analysis of the inventory data was done using iTree, a software suite distributed by the USDA Forest Service. The specific program in the iTree suite used to identify benefits was iStreets. This program allows community leaders interested in making informed decisions about Jamestown's green infrastructure or to explore many aspects including biodiversity and values of environmental services such that environmental benefits can be enhanced to reduce costs and the carbon footprint of Jamestown.

A long standing rule of thumb for taxonomic biodiversity is the 10–20–30 guideline which suggests that no more than 10 percent of trees should be from the same species, no more than 20 percent should be from the same genera, and no more than 30 percent should be from the same family. In Jamestown, maple, Arborvitae and Callery pear exceed one or more guidelines (Table 1). We would recommend against any further plantings of maple until guidelines are met. Ash plantings represent 14 individuals or 6 % of the public trees and 8.8 % of the canopy (Table 3). This represents a noticeable loss of canopy if emerald ash borer (EAB) should destroy all American ash as predicted. Ash removal and/or treatment costs will need to be addressed by informed community leaders. Ohio State Extension can assist in developing considered plans including costs and probabilities of treatment vs. no treatment. There is no single answer for communities facing this problem. Based on the inventory and an earlier study, ash removal costs in Jamestown would likely exceed $16,600 dollars with replacement costs adding another $4,000 for total costs exceeding $20,600.

Larger growing deciduous trees constituting 2% or less of Jamestown's canopy cover that could be used to replace the ash include the Kentucky coffeetree; Shumard, swamp white, and chinquapin oaks; American sycamore, buckeye, basswood, zelkova, and elms.

Under ideal conditions tree numbers among various size classes should be stable and then decline as trees reach their mature size and older trees die. Overall and across mature species size classes, Jamestown shows some adherence but maples, Arborvitaes, oak, pear and ash are concentrated in mature sizes (Tables 2 and 3).

Table 4 shows that fewer maples and ash produce a larger percentage of canopy cover than smaller growing crabapples and pears. This reinforces the need for planting larger statured trees such as preferred in a Toledo, OH resident preference survey whenever possible although maples should be avoided for biodiversity. The importance value is a measure of the overall contribution of the species to the sum of environmental benefits delivered.

A major benefit of urban trees is their ability to intercept rainfall and reduce storm water runoff (Table 5). Storm water runoff is a major cost for Ohio communities. Columbus, OH is embarking on a multi-billion dollar sewer and

storm water upgrade for the community. Public trees, alone, in Jamestown intercept more than 415,000 gallons of storm water annually at a savings to the community of $11,249 dollars per year. This could be could be increased with strategic plantings of larger growing trees.

Carbon sequestration, as reported here, represents the carbon removed from the air and stored in the trees (Table 6). More than 1 million pounds or 515 tons of carbon have been stored by the 231 trees over time. Jamestown's trees currently sequester and avoided 110,000 lbs of CO_2 yearly (Table 8) and would represent carbon credits worth $829 per year if a carbon trading system were in place and if a system for accounting for them were available for community trees. These are net gain figures and include deductions for tree losses and maintenance. Annual CO_2 benefits vary by species and size but average $3.59 per tree per year while larger oaks average $25.90 per tree per year or seven times more. Strategic plantings could increase this substantially and be a significant tool in reducing Jamestown's carbon footprint.

Energy savings by trees are particularly important in view of the citizenry's increasing concern over the nation's energy dependency. Energy is saved by shading structures, evaporating water (evapotranspiration) and reducing wind speed around structures (Table 7). Jamestown trees save the community $3,100 in electricity and $5,600 in natural gas for a total savings of $8,700 or an average of $38 per tree per year. Recent interest in strategic plantings of large trees to enhance energy savings has real potential for savings.

Annual air quality savings (reduced ozone, nitrous and sulfur oxides as well as particulate matter) for the public trees is $1,400 (Table 9). This includes both direct savings ($472) from Jamestown's trees and avoided pollution which is much greater at $1,220. Avoided pollution is pollution not generated at power source because energy was not required (avoided) by the community. The total annual air quality benefits are discounted by $267 for the volatile emissions (BVOC) from the trees themselves.

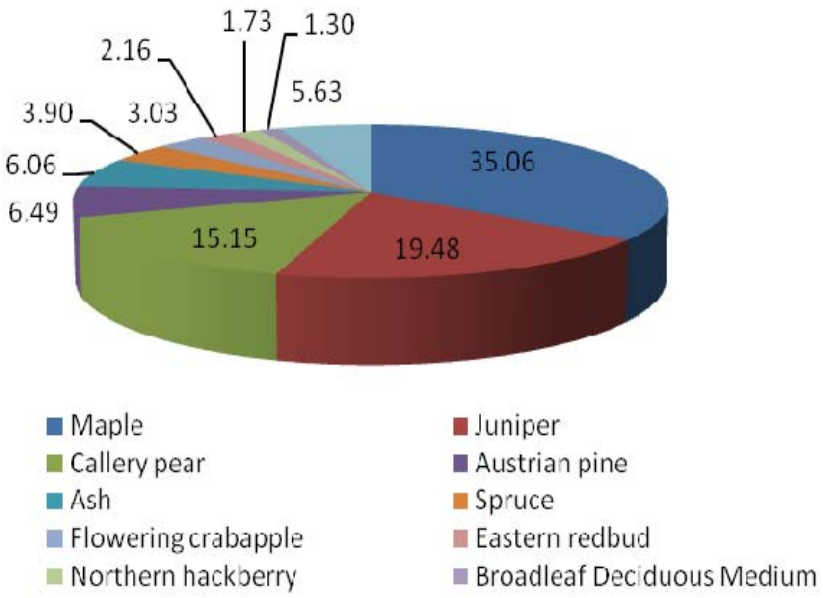
Aesthetic and miscellaneous benefits from trees contribute $5,500 annually to Jamestown in the form of increased property values and enhanced community identity among other things (Table 10). Research in public housing has shown that areas with trees facilitate interaction among residents and lead to reduced domestic violence and more sociable environments. Customer surveys suggest that customers prefer to spend their money and time in commercial streetscapes with trees and are willing to spend up to 11% more in such an environment.

When all benefits are included the 231 trees contribute an average of nearly $133 per tree annually to the Jamestown community (Table 11). Species vary in their annual benefits but mature size, longevity, and maintenance costs are but some of the factors determining annual benefits. This would be well in excess of their maintenance and planting costs for Jamestown's trees.

The Jamestown budget for trees maintenance was estimated to be $3,800 based on the budget of $2 per capita required for Tree City USA status by the National Arbor Day Foundation and Jamestown's population of 1,917. Thus while the 231 trees on the grounds require relatively little care per year they deliver $27,700 in annual benefits from storm water abatement, carbon sequestration, energy savings, air quality, aesthetic benefits, and the like. This is more than a 700% return on investment. Returns here may seem high but Ohio communities studied routinely discover returns on their tree maintenance dollars of 2-300% and Toledo had a 436% annual return with one of the larger tree maintenance budgets in Ohio. Further, unlike most community infrastructure, annual tree benefits per tree continue to increase over a tree's lifetime.

Table 1. Species Distribution of the Most Common Trees in Jamestown, Ohio Arranged from Most to Least Commonly Seen

Species	Percent
Maple	35.06
Arborvitae	19.48
Callery pear	15.15
Austrian pine	6.49
Ash	6.06
Spruce	3.90
Flowering crabapple	3.03
Eastern redbud	2.16
Northern hackberry	1.73
Broadleaf Deciduous Med.	1.30
OTHER SPECIES	5.63
Total	**100.00**



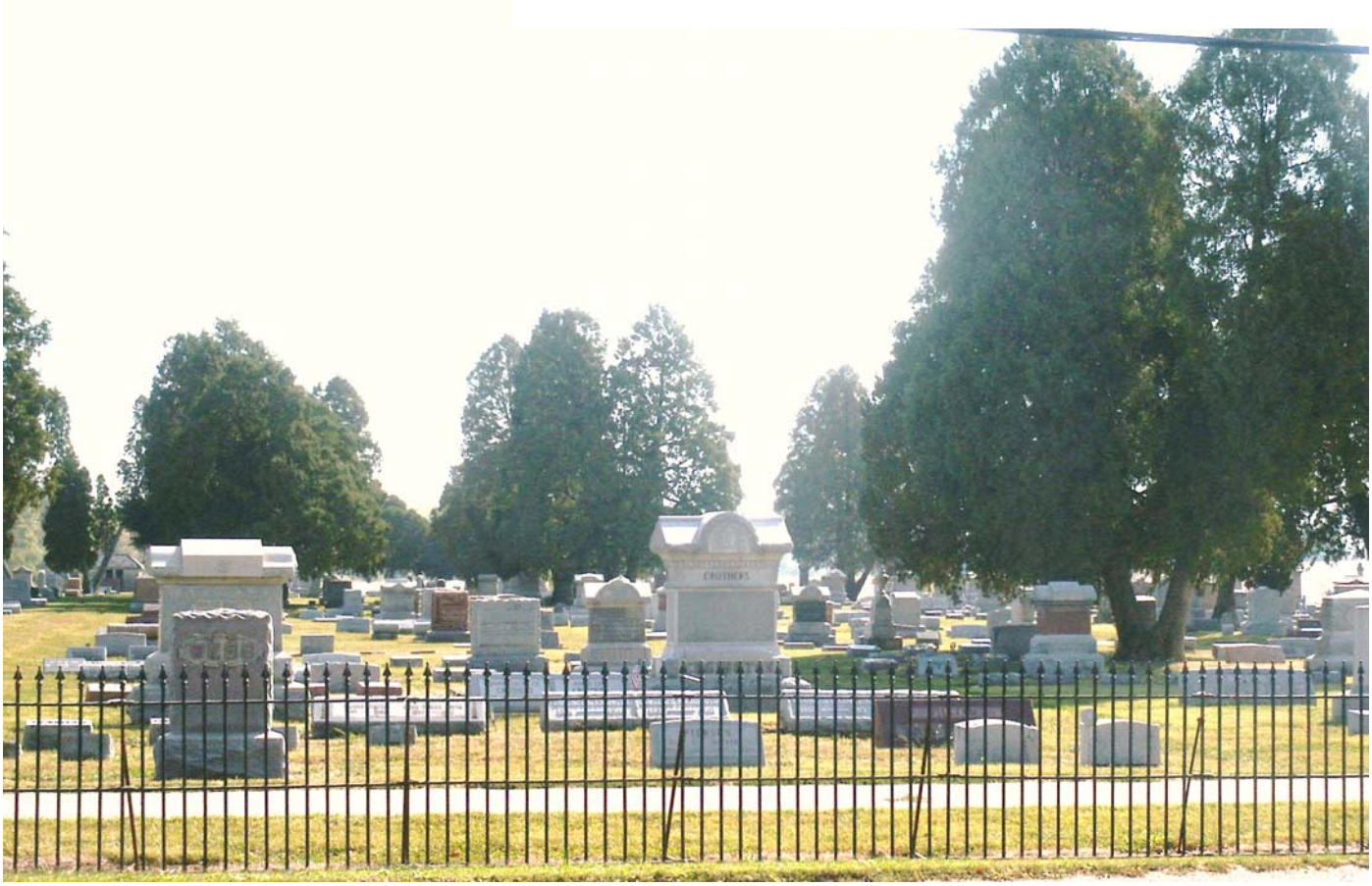
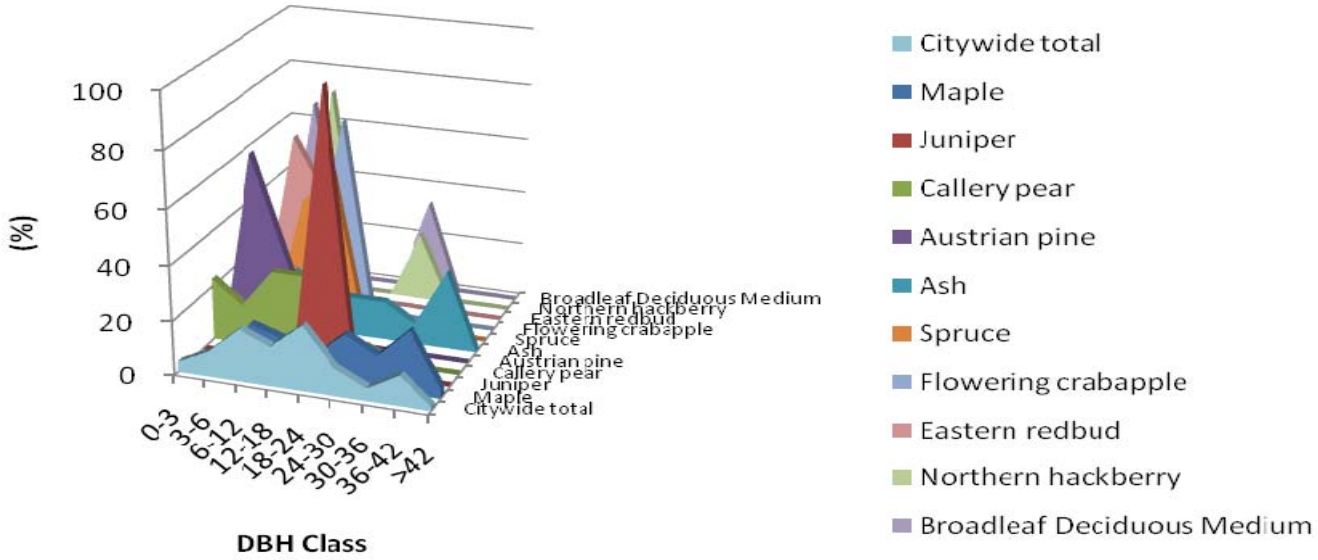


Table 2. Relative Age Distribution of the 10 Most Commonly Planted Trees in Jamestown, Ohio as a Percentage (%) of each Tree by Common Names



Species	Diameter 4.5 feet (DBH) class (in)								
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Maple	0.0	2.5	17.3	13.6	8.6	18.5	12.3	23.5	3.7
Arborvitae	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Callery pear	22.9	14.3	28.6	28.6	0.0	5.7	0.0	0.0	0.0
Austrian pine	0.0	66.7	33.3	0.0	0.0	0.0	0.0	0.0	0.0
Ash	0.0	0.0	21.4	14.3	14.3	14.3	7.1	28.6	0.0
Spruce	0.0	0.0	44.4	55.6	0.0	0.0	0.0	0.0	0.0
Flowering crabapple	14.3	0.0	14.3	71.4	0.0	0.0	0.0	0.0	0.0
Eastern redbud	0.0	60.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern hackberry	0.0	0.0	75.0	0.0	0.0	25.0	0.0	0.0	0.0
Broadleaf Deciduous Medium	0.0	66.7	0.0	0.0	0.0	33.3	0.0	0.0	0.0
Citywide total	**3.9**	**9.5**	**19.5**	**14.7**	**24.2**	**10.4**	**4.8**	**11.3**	**1.7**

Table 3. Population of Jamestown Trees by Common Name, Tree Type and Size (DBH) Class.

Species	Diameter 4.5 feet (DBH) class (in)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Broadleaf Deciduous Large (BDL)										
Maple	0	2	14	11	7	15	10	19	3	81
Northern hackberry	0	0	3	0	0	1	0	0	0	4
Oak	0	0	0	0	0	0	0	3	0	3
Black maple	0	0	0	0	0	1	0	0	0	1
Black walnut	0	0	0	0	1	0	0	0	0	1
Sweetgum	0	0	1	0	0	0	0	0	0	1
Tulip tree	0	0	0	0	0	1	0	0	0	1
Total	**0**	**2**	**18**	**11**	**8**	**18**	**10**	**22**	**3**	**92**
Broadleaf Deciduous Medium (BDM)										
Callery pear	8	5	10	10	0	2	0	0	0	35
Ash	0	0	3	2	2	2	1	4	0	14
Broadleaf Deciduous Medium	0	2	0	0	0	1	0	0	0	3
Ginkgo	0	0	0	0	0	0	0	0	1	1
Honeylocust	0	0	1	0	0	0	0	0	0	1
Littleleaf linden	0	0	0	1	0	0	0	0	0	1
Zelkova	0	0	0	0	1	0	0	0	0	1
Total	**8**	**7**	**14**	**13**	**3**	**5**	**1**	**4**	**1**	**56**
Broadleaf Deciduous Small (BDS)										
Flowering crabapple	1	0	1	5	0	0	0	0	0	7
Eastern redbud	0	3	2	0	0	0	0	0	0	5
Mulberry	0	0	1	0	0	1	0	0	0	2
Total	**1**	**3**	**4**	**5**	**0**	**1**	**0**	**0**	**0**	**14**
Conifer Evergreen Large (CEL)										
Austrian pine	0	10	5	0	0	0	0	0	0	15
Spruce	0	0	4	5	0	0	0	0	0	9
Total	**0**	**10**	**9**	**5**	**0**	**0**	**0**	**0**	**0**	**24**
Conifer Evergreen Small (CES)										
Arborvitae	0	0	0	0	45	0	0	0	0	45
Total	**0**	**0**	**0**	**0**	**45**	**0**	**0**	**0**	**0**	**45**
Zone 1 Total	**9**	**22**	**45**	**34**	**56**	**24**	**11**	**26**	**4**	**231**

Table 4. Jamestown, Ohio Trees Listed by Common Name from Greatest to Least Importance Value.

Species	Number of Trees	% of Total Trees	Leaf Area (ft2)	% of Total Leaf Area	Canopy Cover (ft2)	% of Total Canopy Cover	Importance Value
Maple	81	35.1	289299	44.6	95397	50.8	43.5
Arborvitae	45	19.5	160683	24.8	27276	14.5	19.6
Callery pear	35	15.2	37169	5.7	16236	8.6	9.8
Austrian pine	15	6.5	5785	0.9	2108	1.1	2.8
Ash	14	6.1	55809	8.6	16543	8.8	7.8
Spruce	9	3.9	14068	2.2	3122	1.7	2.6
Flowering crabapple	7	3.0	4030	0.6	3700	2.0	1.9
Eastern redbud	5	2.2	543	0.1	915	0.5	0.9
Northern hackberry	4	1.7	7823	1.2	3449	1.8	1.6
Broadleaf Deciduous Medium	3	1.3	6396	1.0	1888	1.0	1.1
Oak	3	1.3	39892	6.2	7936	4.2	3.9
OTHER TREES	10	4.3	26522	4.1	9271	4.9	4.5
Total	**231**	**100.0**	**648022**	**100.0**	**187842**	**100.0**	**100.0**

Table 5. Annual Storm Water Benefits of Jamestown, Ohio Trees by Species Ordered by Decreasing Benefits/Tree

Species	Total Rainfall Interception (Gal)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
Oak	19234	$521	1.3	4.6	$173.76
Ash	35883	$972	6.1	8.7	$69.46
Arborvitae	104049	$2,820	19.5	25.1	$62.66
Maple	181476	$4,918	35.1	43.7	$60.72
Northern hackberry	5471	$148	1.7	1.3	$37.07
Broadleaf Deciduous Medium	4089	$111	1.3	1.0	$36.94
Spruce	10074	$273	3.9	2.4	$30.34
Callery pear	28388	$769	15.2	6.8	$21.98
Flowering crabapple	3604	$98	3.0	0.9	$13.95
Austrian pine	5105	$138	6.5	1.2	$9.22
Eastern redbud	735	$20	2.2	0.2	$3.98
OTHER STREET TREES	16952	$459	4.3	4.1	$45.94
CITYWIDE TOTAL	**415061**	**$11,249**	**100.0**	**100.0**	**$48.70**

Table 6. Stored CO_2 Benefits in the Trees in Jamestown, Ohio by Species Ordered by Decreasing Benefits per Tree

Species	Total stored CO2 (lbs)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
Oak	112848	$846	1.3	11.0	$282.12
Ash	126402	$948	6.1	12.3	$67.72
Maple	484758	$3,636	35.1	47.0	$44.88
Broadleaf Deciduous Medium	14717	$110	1.3	1.4	$36.79
Arborvitae	119756	$898	19.5	11.6	$19.96
Northern hackberry	9324	$70	1.7	0.9	$17.48
Flowering crabapple	16107	$121	3.0	1.6	$17.26
Callery pear	77036	$578	15.2	7.5	$16.51
Spruce	6878	$52	3.9	0.7	$5.73
Eastern redbud	2349	$18	2.2	0.2	$3.52
Austrian pine	1665	$12	6.5	0.2	$0.83
OTHER STREET TREES	26818	$443	4.3	5.7	$44.34
CITYWIDE TOTAL	**1030963**	**$7,732**	**100.0**	**100.0**	**$33.47**

Table 7. Annual Energy Benefits of Jamestown, Ohio Trees by Common Name and Decreasing Dollars/Tree

Species	Total Electricity (KWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
Oak	1301	$99	169	$165	$264	1.3	3.0	$87.97
Ash	3558	$270	521	$510	$780	6.1	9.0	$55.73
Maple	19801	$1,503	2727	$2,672	$4,175	35.1	47.9	$51.54
Northern hackberry	728	$55	111	$109	$164	1.7	1.9	$41.05
Flowering crabapple	997	$76	137	$134	$210	3.0	2.4	$29.96
Arborvitae	6239	$474	878	$861	$1,334	19.5	15.3	$29.65
Broadleaf Deciduous Medium	398	$30	60	$59	$89	1.3	1.0	$29.60
Callery pear	4272	$324	596	$584	$908	15.2	10.4	$25.94
Spruce	870	$66	111	$109	$175	3.9	2.0	$19.44
Eastern redbud	215	$16	37	$36	$53	2.2	0.6	$10.52
Austrian pine	507	$38	87	$85	$124	6.5	1.4	$8.26
OTHER STREET TREES	2031	$154	295	$289	$443	4.3	5.1	$44.30
CITYWIDE TOTAL	**40918**	**$3,106**	**5728**	**$5,613**	**$8,719**	**100.0**	**100.0**	**$37.74**

Table 8. Annual Carbon Dioxide Benefits of Jamestown, Ohio Trees by Common Name and Ordered by Decreasing Benefits per Tree

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release(lb)	Maintenance Release (lb)	Total Release ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
Oak	8736	$66	-542	-15	-$4.18	2183	$16	10362	$78	1.3	9.4	$25.90
Ash	3124	$23	-607	-41	-$4.86	5968	$45	8443	$63	6.1	7.6	$4.52
Maple	14170	$106	-2327	-186	-$18.85	33214	$249	44871	$337	35.1	40.6	$4.15
Northern hackberry	735	$6	-45	-7	-$0.39	1222	$9	1905	$14	1.7	1.7	$3.57
Flowering crabapple	1461	$11	-77	-11	-$0.66	1672	$13	3044	$23	3.0	2.8	$3.26
Callery pear	7360	$55	-374	-43	-$3.12	7166	$54	14110	$106	15.2	12.8	$3.02
Broadleaf Deciduous Medium	561	$4	-72	-5	-$0.58	668	$5	1152	$9	1.3	1.0	$2.88
Arborvitae	6617	$50	-575	-123	-$5.23	10466	$78	16385	$123	19.5	14.8	$2.73
Spruce	788	$6	-33	-14	-$0.36	1460	$11	2201	$17	3.9	2.0	$1.83
Eastern redbud	342	$3	-11	-4	-$0.12	360	$3	686	$5	2.2	0.6	$1.03
Austrian pine	443	$3	-8	-12	-$0.15	850	$6	1274	$10	6.5	1.2	$0.64
OTHER STREET TREES	3005	$23	-284	-24	-$2.31	3407	$26	6104	$46	4.3	5.5	$4.58
CITYWIDE TOTAL	**47342**	**$355**	**-4954**	**-486**	**-$40.80**	**68635**	**$515**	**110537**	**$829**	**100.0**	**100.0**	**$3.59**

Table 9. Annual Air Quality Benefits of Jamestown, Ohio Trees by Species' Common Names and Ordered by Decreasing Total Air Pollution Benefits per Tree

Species	Deposit O3 (lb)	Deposit NO2 (lb)	Deposit PM10 (lb)	Deposit SO2 (lb)	Total Deposit ($)	Avoided NO2 (lb)	Avoided PM10 (lb)	Avoided VOC (lb)	Avoided SO2 (lb)	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	% Total Tree Number	Avg. $/tree
Oak	4.0	0.7	2.0	0.2	$22	6.1	0.9	0.9	5.9	$38	-7.2	-$27	13.4	$33	1.3	$10.96
Ash	7.6	1.3	3.7	0.3	$41	17.3	2.5	2.4	16.1	$107	-1.8	-$7	49.6	$142	6.1	$10.12
Maple	45.1	7.7	20.9	2.0	$240	94.6	13.8	13.1	89.7	$589	-14.9	-$56	271.9	$773	35.1	$9.54
Northern hackberry	0.7	0.1	0.4	0.0	$4	3.6	0.5	0.5	3.3	$22	0.0	$0	9.1	$26	1.7	$6.43
Broadleaf Deciduous Medium	0.9	0.2	0.4	0.0	$5	2.0	0.3	0.3	1.8	$12	-0.2	-$1	5.6	$16	1.3	$5.33
Flowering crabapple	1.1	0.2	0.5	0.0	$6	4.8	0.7	0.7	4.5	$30	0.0	$0	12.5	$35	3.0	$5.06
Callery pear	4.5	0.8	2.4	0.2	$25	20.5	3.0	2.8	19.4	$128	-1.2	-$4	52.5	$148	15.2	$4.23
Arborvitae	15.8	3.1	12.7	1.9	$103	29.9	4.3	4.1	28.2	$186	-40.0	-$150	60.2	$139	19.5	$3.10
Spruce	1.0	0.2	0.9	0.1	$7	4.1	0.6	0.6	3.9	$26	-3.4	-$13	8.1	$20	3.9	$2.22
Eastern redbud	0.1	0.0	0.1	0.0	$1	1.1	0.2	0.1	1.0	$7	0.0	$0	2.6	$7	2.2	$1.44
Austrian pine	0.3	0.1	0.4	0.0	$3	2.6	0.4	0.3	2.3	$16	-1.4	-$5	5.0	$13	6.5	$0.86
OTHER STREET TREES	3.1	0.5	1.5	0.1	$17	9.8	1.4	1.4	9.2	$61	-1.1	-$4	26.0	$73	4.3	$7.34
CITYWIDE TOTAL	**84.2**	**14.9**	**45.9**	**5.1**	**$472**	**196.3**	**28.5**	**27.2**	**185.4**	**$1,220**	**-71.1**	**-$267**	**516.3**	**$1,425**	**100.0**	**$6.17**

Table 10. Annual Aesthetic or Other Benefits of Trees by Species in Jamestown, Ohio

Species	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
Oak	$617	1.3	11.2	$205.74
Northern hackberry	$136	1.7	2.5	$34.08
Spruce	$223	3.9	4.1	$24.81
Maple	$1,921	35.1	34.8	$23.71
Callery pear	$803	15.2	14.6	$22.94
Ash	$306	6.1	5.5	$21.86
Arborvitae	$899	19.5	16.3	$19.97
Broadleaf Deciduous Medium	$57	1.3	1.0	$19.08
Flowering crabapple	$84	3.0	1.5	$11.98
Austrian pine	$145	6.5	2.6	$9.70
Eastern redbud	$19	2.2	0.3	$3.80
OTHER STREET TREES	$308	4.3	5.6	$30.83
CITYWIDE TOTAL	**$5,519**	**100.0**	**100.0**	**$23.89**

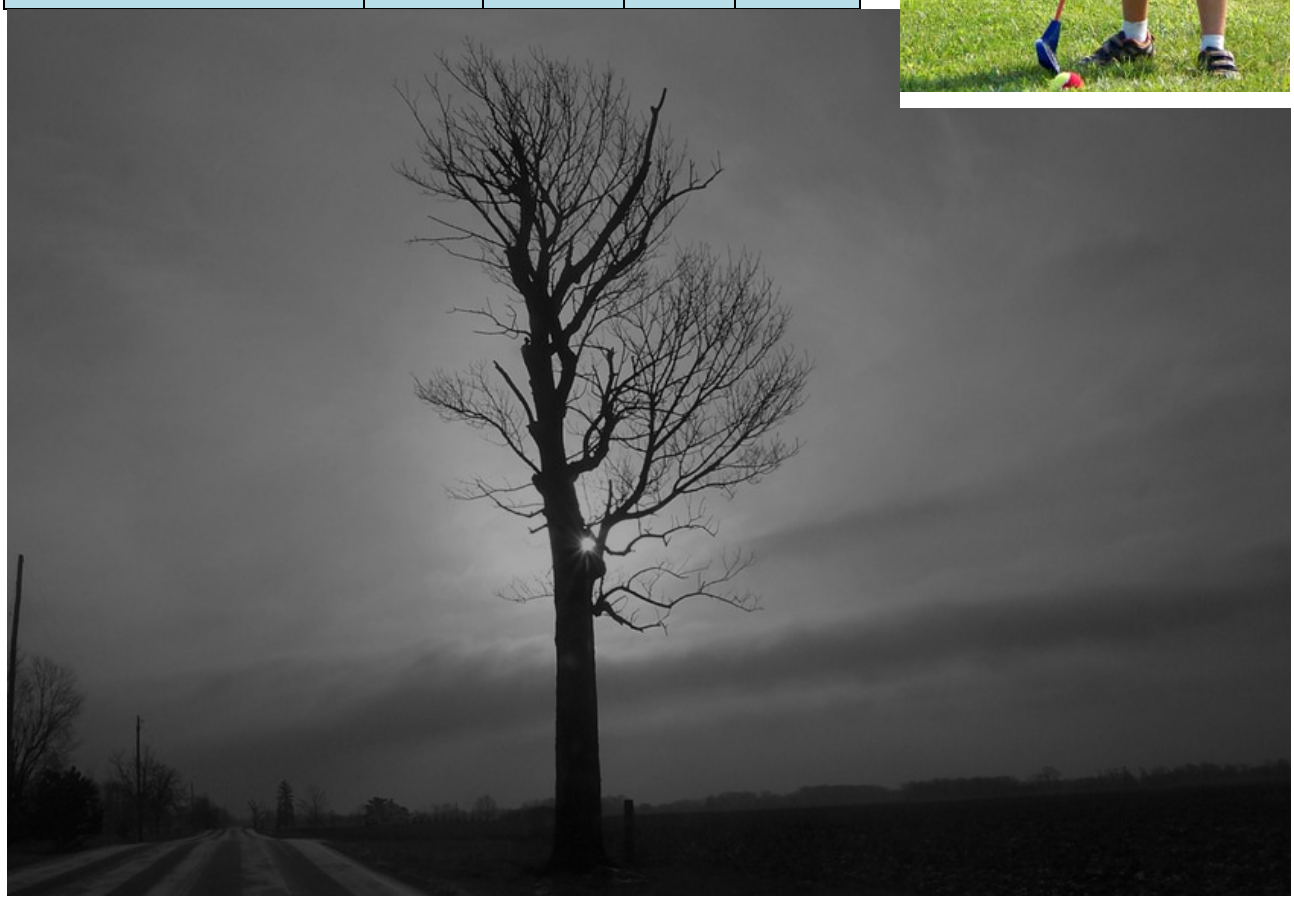


Table 11. Annual Benefits and Total Annual Benefits per Tree by Common Name for Jamestown Street Trees

Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total
Oak	$88	$26	$11	$174	$206	$504.33
Ash	$56	$5	$10	$69	$22	$161.69
Maple	$52	$4	$10	$61	$24	$149.67
Northern hackberry	$41	$4	$6	$37	$34	$122.21
Arborvitae	$30	$3	$3	$63	$20	$118.11
Broadleaf Deciduous Medium	$30	$3	$5	$37	$19	$93.84
Spruce	$19	$2	$2	$30	$25	$78.65
Callery pear	$26	$3	$4	$22	$23	$78.12
Flowering crabapple	$30	$3	$5	$14	$12	$64.22
Austrian pine	$8	$1	$1	$9	$10	$28.68
Eastern redbud	$11	$1	$1	$4	$4	$20.77
OTHER STREET TREES	$44	$5	$7	$46	$31	$132.98

Table 12 Environmental Benefits from Five Benefit Categories for Jamestown Street Trees

Benefits	Total ($)	$/tree
Stormwater	$11,249	$48.70
Energy	$8,719	$37.74
Aesthetic/Other	$5,519	$23.89
Air Quality	$1,425	$6.17
CO2	$829	$3.59
Total Benefits	**$27,741**	**$120.09**