An Analysis of Street Tree Benefits for Monclova Township

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EXECUTIVE SUMMARY

A full inventory of public street trees was undertaken by Monclova Township employees and Lucas County Master Gardeners and overseen by the Lucas County Extension Office and its Master Gardeners. A total of 4,447 public trees were inventoried. A common bid price for this service is $3.00 per tree and thus the inventory represents a savings of $13,341 for Monclova taxpayers over contracting for this service. Most importantly however, is that the Monclova Township now has a tree inventory that can be used to better manage the street tree resource of the township. Benefits mentioned above do not include the value of the subsequent analysis and report.

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 Shade Tree Resource Analysis Tool for Urban forest Managers (STRATUM) and is available at no charge should this be desired. This program allows individuals interested in making informed decisions about the community tree resource and to explore many aspects including biodiversity and the value of environmental services.

A long standing rule of thumb for 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 twenty percent should be from the same genera, and no more than thirty percent should be from the same family. In Monclova Township, Callery pears exceed the limit for specie, genus and family at 31%, while maples exceed both the genera and family limits at 43% (Table 1). Care should be taken to limit these plant types in future plantings. Ash plantings (green and unknown) represent slightly over 5% of the street trees. Limited numbers and small sizes limit the impact of EAB in Monclova Township. One group that is conspicuously absent is the elms which would be an alternative choice for a large deciduous tree and is currently available in the nursery trade. Also large trees produce markedly more environmental benefits than small ones.

Under ideal conditions tree numbers among smaller size classes should be stable and then decline as tree size increases and older trees die. Few larger trees are found in Monclova's recently developed areas. (Tables 2 and 3). Fortunately, Monclova is planting trees that will mature at larger sizes. A resident preference survey is in progress to confirm this and is expected to be completed later this year.

Street trees are small at present with few trees larger than 6-inch diameter. Importance values as detailed in (Table 4) will be more meaningful later as larger growing trees increase. This demonstrates Monclova's need for planting larger statured trees whenever possible as the importance value is a measure of the overall contribution of the species to the total 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 many communities. Columbus, OH is about to embark on a multi-billion dollar sewer and storm water upgrade for the community. Trees in Monclova intercept more than 134,646 gallons of storm water annually at a savings to the community of nearly 3,649 dollars per year despite their small size. Storm water interception is expected to increase rapidly as tree size increases.

Carbon sequestration, as reported here, represents the carbon removed from the air and stored in the township's trees (Table 6). More than 175,600 pounds or 87 tons of carbon have been stored by Xenia's 4,447 trees over time. Monclova's trees currently sequester and avoid nearly 100,000 lbs of CO_2 yearly (Table 8) and would represent carbon credits worth $731 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. Monclova's numbers will increase as trees grow. A recent analysis in Xenia Ohio showed that the community's 641 larger (average 18-24-inch) maples contributed $4.91 vs Monclova's 20 cents per tree.

Annual air quality savings (reduced ozone, nitrous and sulfur oxides as well as particulate matter) for Monclova trees is $1,091 (Table 9). This includes both direct savings ($38) from the trees and avoided pollution which is much greater ($1,075). Avoided pollution is pollution not generated at power source because energy was not required by the community. The total annual air quality benefits are discounted by $23 for the volatile emissions from the trees themselves. These numbers will increase as trees age.

Energy savings by trees are exceptionally important in view of the citizenry's increasing concern over the nation's energy dependency. Planting trees in our communities may well be more cost effective than building power plants to as an alternative to meeting our energy needs. Energy is saved by shading structures, evaporating water (evapotranspiration) and reducing wind speed around structures (Table 7). Monclova Township saves $2,665 in electricity and $5,624 in natural gas for a total savings in excess of $8,289 or an average of $1.86 per tree. Larger trees will result in greater annual savings per tree in time.

Aesthetic and miscellaneous benefits from trees contribute $6,207 annually to the community 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 commercial settings with trees.

When all benefits are included the average Monclova street tree contributes $4.49 per tree annually to the 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. Thus Monclova's 4,447 trees contribute nearly $20,000. This would be well in excess of their maintenance and planting costs.

Monclova Township does not currently track costs such as picking up brush following a storm, tree planting, mulching, and mowing as green infrastructure maintenance. Currently some of these costs are hidden in the grey infrastructure costs such as sidewalks, roadways, signage and parking lot maintenance. Let's assume that the township had maintenance costs of $2 per capita as suggested for Tree City USA status. Then Monclova Township's tree budget would be about $18,000 and the return that $18,000 investment would be $19,966 from storm water abatement, CO2 avoidance and storage, energy savings, air quality, aesthetic benefits, and the like. This is a 111% return on investment. Even the small trees in Monclova Township are truly a contributing part of the community. Unlike most community infrastructure, tree benefits per tree continue to increase over a tree's lifetime.

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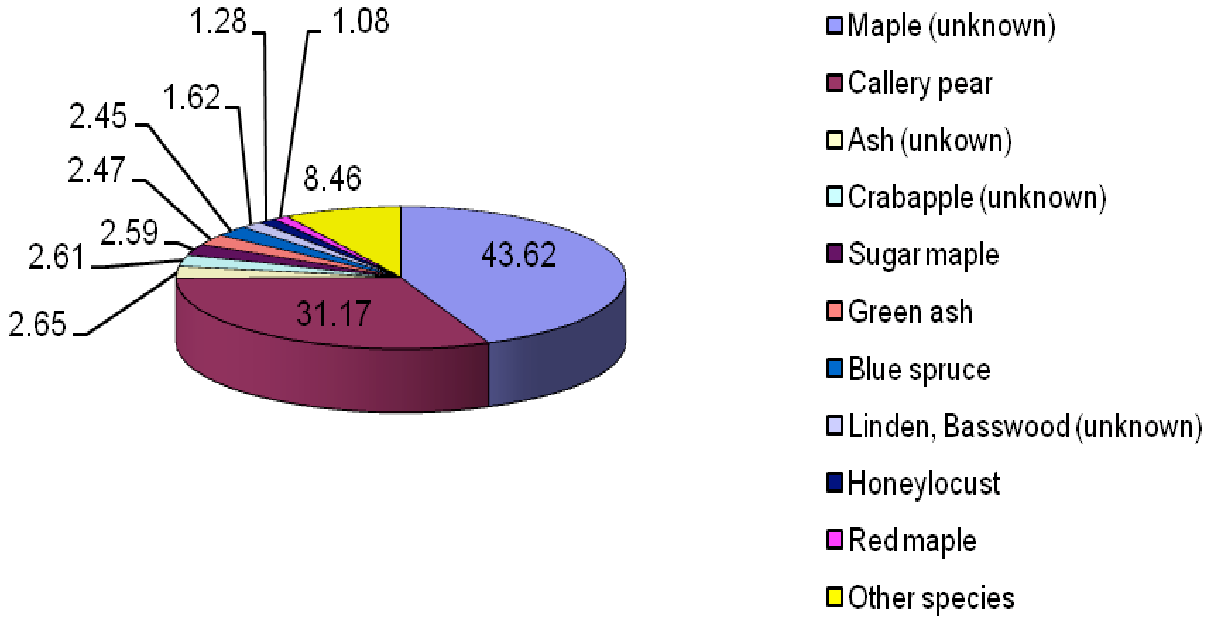
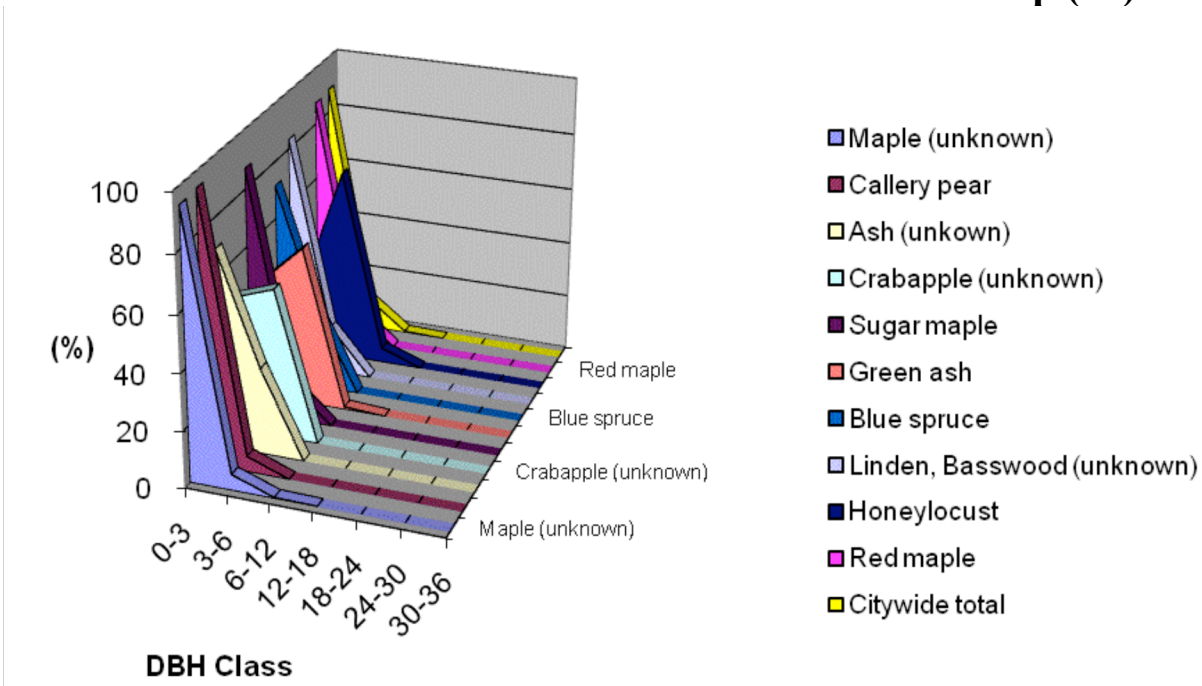
Table 1 Species Distribution of Monclova Township Street Trees (%)



Species	Percent
Maple (unknown)	43.62
Callery pear	31.17
Ash (unknown)	2.65
Crabapple (unknown)	2.61
Sugar maple	2.59
Green ash	2.47
Blue spruce	2.45
Linden, Basswood (unknown)	1.62
Honeylocust	1.28
Red maple	1.08
Other species	8.46
Monclova Total	**100.00**

Table 2. Relative Age Distribution of the Top 10 Most Commonly Planted Public Tree Taxa in Monclova Township (%)



Species	DBH class (in)						
	0-3	3-6	6-12	12-18	18-24	24-30	30-36
Maple (unknown)	94.07	5.62	0.31	0.00	0.00	0.00	0.00
Callery pear	94.52	5.48	0.00	0.00	0.00	0.00	0.00
Ash (unknown)	69.49	30.51	0.00	0.00	0.00	0.00	0.00
Crabapple (unknown)	47.41	52.59	0.00	0.00	0.00	0.00	0.00
Sugar maple	86.96	13.04	0.00	0.00	0.00	0.00	0.00
Green ash	42.73	56.36	0.91	0.00	0.00	0.00	0.00
Blue spruce	71.56	28.44	0.00	0.00	0.00	0.00	0.00
Linden, Basswood (unknown)	83.33	16.67	0.00	0.00	0.00	0.00	0.00
Honeylocust	26.32	68.42	5.26	0.00	0.00	0.00	0.00
Red maple	87.50	12.50	0.00	0.00	0.00	0.00	0.00
Monclova Totals	**88.22**	**11.38**	**0.40**	**0.00**	**0.00**	**0.00**	**0.00**

Table 3. Population of Monclova Township's Street Trees by Common Name and Size Class.

Species	DBH Class (in)							
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	Total
Broadleaf Deciduous Large (BDL)								
Acer species	1,825	109	6	0	0	0	0	1,940
Acer saccharum	100	15	0	0	0	0	0	115
Fraxinus pennsylvanica	47	62	1	0	0	0	0	110
Tilia species	60	12	0	0	0	0	0	72
Acer rubrum	42	6	0	0	0	0	0	48
Ulmus species	35	5	1	0	0	0	0	41
Fraxinus americana	31	6	1	0	0	0	0	38
Quercus species	31	6	1	0	0	0	0	38
Platanus xacerfolia	29	0	0	0	0	0	0	29
Taxodium distichum	14	1	0	0	0	0	0	15
Quercus alba	14	0	0	0	0	0	0	14
Populus species	0	2	4	0	0	0	0	6
Acer saccharinum	0	3	0	0	0	0	0	3
Quercus rubra	1	2	0	0	0	0	0	3
Fagus grandifolia	2	0	0	0	0	0	0	2
Gymnocladus dioicus	0	0	1	0	0	0	0	1
Liquidambar styraciflua	1	0	0	0	0	0	0	1
BDL Subtotal	**2,232**	**229**	**15**	**0**	**0**	**0**	**0**	**2,476**
Broadleaf Deciduous Medium (BDM)								
Pyrus calleryana	1,310	76	0	0	0	0	0	1,386
Fraxinus species	82	36	0	0	0	0	0	118
Gleditsia triacanthos	15	39	3	0	0	0	0	57
Tilia cordata	14	2	0	0	0	0	0	16
Acer platanoides	2	0	0	0	0	0	0	2
Carpinus caroliniana	1	0	0	0	0	0	0	1
Salix species	1	0	0	0	0	0	0	1
BDM Subtotal	**1,425**	**153**	**3**	**0**	**0**	**0**	**0**	**1,581**
Broadleaf Deciduous Small (BDS)								
Malus species	31	10	0	0	0	0	0	41
Crataegus species	14	6	0	0	0	0	0	20
Pyrus species	12	6	0	0	0	0	0	18
Cercis canadensis	14	0	0	0	0	0	0	14
Prunus species	7	1	0	0	0	0	0	8
Prunus cerasifera	2	3	0	0	0	0	0	5
Crataegus viridis	0	2	0	0	0	0	0	2
Acer palmatum	1	0	0	0	0	0	0	1
Crataegus phaenopyrum	0	1	0	0	0	0	0	1
Prunus serrulata	1	0	0	0	0	0	0	1
BDS Subtotal	**137**	**90**	**0**	**0**	**0**	**0**	**0**	**227**

Table 3. Population of Monclova Township's Street Trees by Common Name and Size Class (Continued).

Species	DBH Class (in)							
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	Total
Conifer Evergreen Large (CEL)								
Picea species	26	2	0	0	0	0	0	28
Pinus strobus	10	0	0	0	0	0	0	10
Pinus sylvestris	8	1	0	0	0	0	0	9
Picea abies	4	0	0	0	0	0	0	4
Pinus nigra	3	0	0	0	0	0	0	3
CEL Subtotal	**51**	**3**	**0**	**0**	**0**	**0**	**0**	**54**
Conifer Evergreen Medium (CEM)								
Picea pungens	78	31	0	0	0	0	0	109
CEM Subtotal	**78**	**31**	**0**	**0**	**0**	**0**	**0**	**109**
Monclova Grand Totals	**3,923**	**506**	**18**	**0**	**0**	**0**	**0**	**4,447**

Table 4. Importance Values for Monclova's Most Abundant Public Tree Species

Species	Number of Trees	% Total Trees %	Leaf Area (ft2)	% Total Leaf Area %	Canopy Cover (ft2)	% Total Canopy Cover %	Importance Value %
Maple (unknown)	1,940	43.6	13416	18.20	46529	33.7	31.9
Callery pear	1,386	31.2	6548	8.88	31050	22.5	20.9
Ash (unknown)	118	2.7	5406	7.33	7922	5.7	5.2
Crabapple (unknown)	116	2.6	2262	3.07	6397	4.6	3.4
Sugar maple	115	2.6	1697	2.30	3585	2.6	2.5
Green ash	110	2.5	14189	19.25	8050	5.8	9.2
Blue spruce	109	2.5	10599	14.38	5499	4.0	6.9
Linden, Basswood (unk.)	72	1.6	1144	1.55	1832	1.3	1.5
Honeylocust	57	1.3	4382	5.94	10122	7.3	4.9
Red maple	48	1.1	425	0.58	1534	1.1	0.9
Other trees	376	8.5	13659	18.53	15427	11.2	12.7
MonclovaTotals	**4,447**	**100.0%**	**73727**	**100.00**	**137947**	**100.0**	**100.0**

Table 5. Annual Storm Water Benefits of Monclova Township's Street Trees by Species

Species	Total Rainfall Interception (Gal)	Total ($)	% Total Tree Numbers	% Total $	Avg. $/tree
Maple (unknown)	40,020.22	$1,085	43.62	29.72	$0.56
Callery pear	25,726.38	$697	31.17	19.11	$0.50
Ash (unknown)	8,294.91	$225	2.65	6.16	$1.91
Crabapple	4,597.57	$125	2.61	3.41	$1.07
Sugar maple	3,192.70	$87	2.59	2.37	$0.75
Green ash	12,088.82	$328	2.47	8.98	$2.98
Blue spruce	10,923.64	$296	2.45	8.11	$2.72
Linden, Basswood (unknown)	1,901.27	$52	1.62	1.41	$0.72
Honeylocust	9,221.72	$250	1.28	6.85	$4.38
Red maple	1,313.90	$36	1.08	0.98	$0.74
Other street trees	17,364.96	$471	8.46	12.90	$1.25
Monclova totals	**134,646.09**	**$3,649**	**100.00**	**100.00**	**$0.82**

Table 6. Stored CO2 Benefits of Monclova Township's Street Trees by Species

Species	Total Stored CO2 (lbs)	Total ($)	% Total Tree Numbers	% Total Dollars	Average $/tree
Maple (unknown)	61,147	$459	43.62	34.81	$0.24
Callery pear	38,662	$290	31.17	22.01	$0.21
Ash (unknown)	7,674	$58	2.65	4.37	$0.49
Crabapple	11,603	$87	2.61	6.61	$0.75
Sugar maple	4,961	$37	2.59	2.82	$0.32
Green ash	13,105	$98	2.47	7.46	$0.89
Blue spruce	1,504	$11	2.45	0.86	$0.10
Linden, Basswood (unknown)	2,992	$22	1.62	1.70	$0.31
Honeylocust	9,864	$74	1.28	5.62	$1.30
Red maple	2,018	$15	1.08	1.15	$0.32
Other street trees	10,034	$166	8.46	12.59	$0.44
Monclova totals	**175,651**	**$1,317**	**100.00**	**100.00**	**$0.30**

Table 7. Annual Energy Benefits of Monclova's Public Trees by Species ($/tree)

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	% Total Tree Numbers	% Total $	Avg. $/tree
Maple (unknown)	11.98	$909	2012.3	$1,972	$2,881	43.62	34.76	$1.49
Callery pear	8.04	$610	1361.7	$1,334	$1,945	31.17	23.46	$1.40
Ash (unknown)	2.01	$153	301.8	$296	$448	2.65	5.41	$3.80
Crabapple	1.54	$117	265.9	$261	$377	2.61	4.55	$3.25
Sugar maple	0.92	$70	139.8	$137	$207	2.59	2.49	$1.80
Green ash	2.02	$153	264.4	$259	$412	2.47	4.97	$3.75
Blue spruce	1.38	$105	243.9	$239	$344	2.45	4.15	$3.15
Linden/Basswood (unk.)	0.51	$38	84.9	$83	$122	1.62	1.47	$1.69
Honeylocust	2.46	$187	376.5	$369	$556	1.28	6.70	$9.75
Red maple	0.39	$29	62.3	$61	$90	1.08	1.09	$1.88
Other street trees	3.88	$294	624.9	$612	$907	8.46	10.94	$2.41
Monclova totals	**35.11**	**$2,665**	**5738.5**	**$5,624**	**$8,289**	**100.00**	**100.00**	**$1.86**

Table 8. Annual Carbon Dioxide Benefits of Monclova's Street Trees by Species

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Release ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	% Total Tree Numbers	% Total $	Avg. $/tree
Maple (unknown)	10350.6	$77.63	-293.5	-378.3	-$5.04	20096.3	$150.7	29775.1	$223.31	43.62	30.57	$0.12
Callery pear	6631.2	$49.73	-185.6	-270.3	-$3.42	13490.8	$101.2	19666.1	$147.50	31.17	20.19	$0.11
Ash (unknown)	2828.7	$21.22	-36.8	-23.0	-$0.45	3372.8	$25.3	6141.7	$46.06	2.65	6.30	$0.39
Crabapple	2791.9	$20.94	-55.7	-22.6	-$0.59	2577.3	$19.3	5290.9	$39.68	2.61	5.43	$0.34
Sugar maple	2720.3	$20.40	-23.8	-22.4	-$0.35	1539.5	$11.6	4213.5	$31.60	2.59	4.33	$0.27
Green ash	4929.9	$36.97	-62.9	-21.5	-$0.63	3381.1	$25.4	8226.7	$61.70	2.47	8.45	$0.56
Blue spruce	507.6	$3.81	-7.2	-21.3	-$0.21	2311.0	$17.3	2790.2	$20.93	2.45	2.86	$0.19
Linden, (unknown)	612.1	$4.59	-14.4	-14.0	-$0.21	848.3	$6.4	1432.0	$10.74	1.62	1.47	$0.15
Honeylocust	2511.0	$18.83	-47.3	-11.1	-$0.44	4128.1	$31.0	6580.7	$49.36	1.28	6.76	$0.87
Red maple	350.6	$2.63	-9.7	-9.4	-$0.14	647.7	$4.9	979.3	$7.34	1.08	1.01	$0.15
Other street trees	5995.7	$44.97	-106.2	-73.3	-$1.35	6502.0	$48.8	12318.1	$92.39	8.46	12.65	$0.25
Monclova totals	**40,229.6**	**$301.72**	**-843.1**	**-867.2**	**-$12.83**	**58895.0**	**$441.71**	**97414.3**	**$730.61**	**100.00**	**100.0**	**$0.16**

Table 9. Annual Air Quality Benefits of Xenia's Public Trees by Species

Species	Deposition				Total Deposition ($)	Avoided				Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	% Total Tree Number	Avg. $/tree
	O3 (lb)	NO2 (lb)	PM10 (lb)	SO2 (lb)		NO2 (lb)	PM10 (lb)	VOC (lb)	SO2 (lb)							
Maple (unk.)	1.5	0.3	2.1	0.1	$12.08	60.5	8.6	8.1	54.4	$368.97	-0.7	-$2.59	134.9	$378.46	43.6	$0.20
Callery pear	0.7	0.1	1.3	0.0	$6.64	40.7	5.8	5.5	36.5	$248.10	-0.3	-$1.27	90.3	$253.47	31.2	$0.18
Ash (unknown)	0.1	0.0	0.3	0.0	$1.22	9.8	1.4	1.3	9.1	$60.56	0.0	$0.00	22.1	$61.79	2.7	$0.52
Crabapple	0.3	0.0	0.3	0.0	$1.78	7.8	1.1	1.0	7.0	$47.43	0.0	-$0.01	17.5	$49.20	2.6	$0.42
Sugar maple	0.1	0.0	0.1	0.0	$0.63	4.5	0.6	0.6	4.2	$27.72	-0.1	-$0.35	10.0	$28.00	2.6	$0.24
Green ash	0.2	0.0	0.3	0.0	$1.55	9.5	1.4	1.3	9.1	$59.28	0.0	$0.00	21.8	$60.82	2.5	$0.55
Blue spruce	0.5	0.1	0.8	0.1	$4.20	7.1	1.0	0.9	6.2	$42.84	-2.6	-$9.88	14.0	$37.16	2.5	$0.34
Linden (unk.)	0.0	0.0	0.1	0.0	$0.31	2.6	0.4	0.3	2.3	$15.61	-0.1	-$0.28	5.6	$15.65	1.6	$0.22
Honeylocust	0.6	0.1	0.5	0.0	$3.64	12.1	1.7	1.6	11.2	$74.41	-0.3	-$1.13	27.5	$76.93	1.3	$1.35
Red maple	0.1	0.0	0.1	0.0	$0.41	1.9	0.3	0.3	1.8	$11.79	0.0	-$0.08	4.3	$12.12	1.1	$0.25
Other street trees	0.8	0.1	0.9	0.0	$5.70	19.3	2.8	2.6	17.6	$118.32	-1.9	-$7.00	42.2	$117.03	8.5	$0.31
Monclova totals	**4.7**	**0.8**	**6.8**	**0.2**	**$38.18**	**175.8**	**25.0**	**23.7**	**159.2**	**$1,075.03**	**-6.0**	**-$22.59**	**390.2**	**$1,090.62**	**100.00**	**$0.25**

Table 10. Annual Aesthetic or Other Benefits of Monclova's Street Trees by Species

Species	Total ($)	% Total Tree Numbers	% Total $	Avg. $/tree
Maple (unknown)	$1,039.97	43.6	16.8	$0.54
Callery pear	$601.68	31.2	9.7	$0.43
Ash (unknown)	$583.85	2.7	9.4	$4.95
Crabapple	$127.40	2.6	2.0	$1.10
Sugar maple	$158.17	2.6	2.5	$1.38
Green ash	$1,189.35	2.5	19.2	$10.81
Blue spruce	$774.09	2.5	12.5	$7.10
Linden, Basswood (unknown)	$158.38	1.6	2.5	$2.20
Honeylocust	$397.39	1.3	6.4	$6.97
Red maple	$45.24	1.1	0.7	$0.94
Other street trees	$1,131.63	8.5	18.2	$3.01
Monclova wide totals	**$6,207.14**	**100.0**	**100.0**	**$1.40**

Table 11. Average Annual Benefits of Monclova's Street Trees by Species in Dollars/tree

Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/ Other	Total ($)	% of Total $
Maple (unknown)	$2,881.44	$223.31	$378.46	$1,084.62	$1,039.97	$5,607.80	28.09
Callery pear	$1,944.87	$147.50	$253.47	$697.23	$601.68	$3,644.75	18.25
Ash (unkown)	$448.39	$46.06	$61.79	$224.81	$583.85	$1,364.90	6.84
Crabapple	$377.22	$39.68	$49.20	$124.60	$127.40	$718.11	3.60
Sugar maple	$206.70	$31.60	$28.00	$86.53	$158.17	$510.99	2.56
Green ash	$412.14	$61.70	$60.82	$327.63	$1,189.35	$2,051.64	10.28
Blue spruce	$343.60	$20.93	$37.16	$296.05	$774.09	$1,471.82	7.37
Linden, Basswood (unk.)	$121.57	$10.74	$15.65	$51.53	$158.38	$357.86	1.79
Honeylocust	$555.74	$49.36	$76.93	$249.93	$397.39	$1,329.34	6.66
Red maple	$90.34	$7.34	$12.12	$35.61	$45.24	$190.65	0.95
Other street trees	$906.65	$92.39	$117.03	$470.62	$1,131.63	$2,718.31	13.61
Monclova wide totals	**$8,288.65**	**$730.61**	**$1,090.62**	**$3,649.16**	**$6,207.14**	**$19,966.17**	**100.00**