Columbus Crossroads Phase 4 Benefit-Cost Analysis Narrative
2021 INFRA Grant Request

Executive Summary:

Attached as part of the Columbus Crossroads Phase 4 application is a benefit-cost analysis spreadsheet that shows exactly how benefits and costs were calculated for the project. The summary tab is a summary of the net present value of both benefits and costs. Analysis was completed with a discount rate of 7% except for CO2 benefits, which were calculated with a discount rate of 3%.

The benefits of the project are clear and will be discussed in more detail below. Figure 1 shows a summary of the issues the project solves and the benefits that arise from those solutions. The overall benefit cost ratio for the project is 1.10.

Figure 1: Project Benefit Matrix:

Type of Impacts	Economic Benefit	Summary of Results (7% Discount Rate)	Page Reference in BCA (Spreadsheet Tab Name)
Reduced Car & Truck Delay	Monetized value of reduced car and truck travel time	\$140,076,627	"Delay Reduction"
Reduced crashes	Monetized value of crash reduction	\$20,203,516	"Safety Summary"
Reduced car and truck emissions (Non-CO2)	Monetized value of emissions reduction	\$1,123,034	"Other Emission Reduction"
Reduced car and truck emissions (CO2)	Monetized value of emissions reduction	\$5,178,147 *3% Discount Rate	"Other Emission Reduction"
Reduced car and truck operating cost	Monetized value of operating cost savings	\$10,857,241	"Operating Cost Savings"
Property Value Increase	Monetized value of property value increase	\$6,227,497	N/A
Maintenance Cost Savings	Monetized value of maintenance cost savings	\$20,619,457	"Operations and Maintenance"
Street Tree Benefits	Monetized value of street tree benefits (emissions reduction and stormwater runoff reduction)	\$5,357	"Tree"
Reduced VMT from Bike/Ped Mode Shift	Monetized value of reduced VMT from Bike/Ped Mode Shift	\$8,724,072	"BikePed"
Quality of Life	Qualitative	Qualitative	

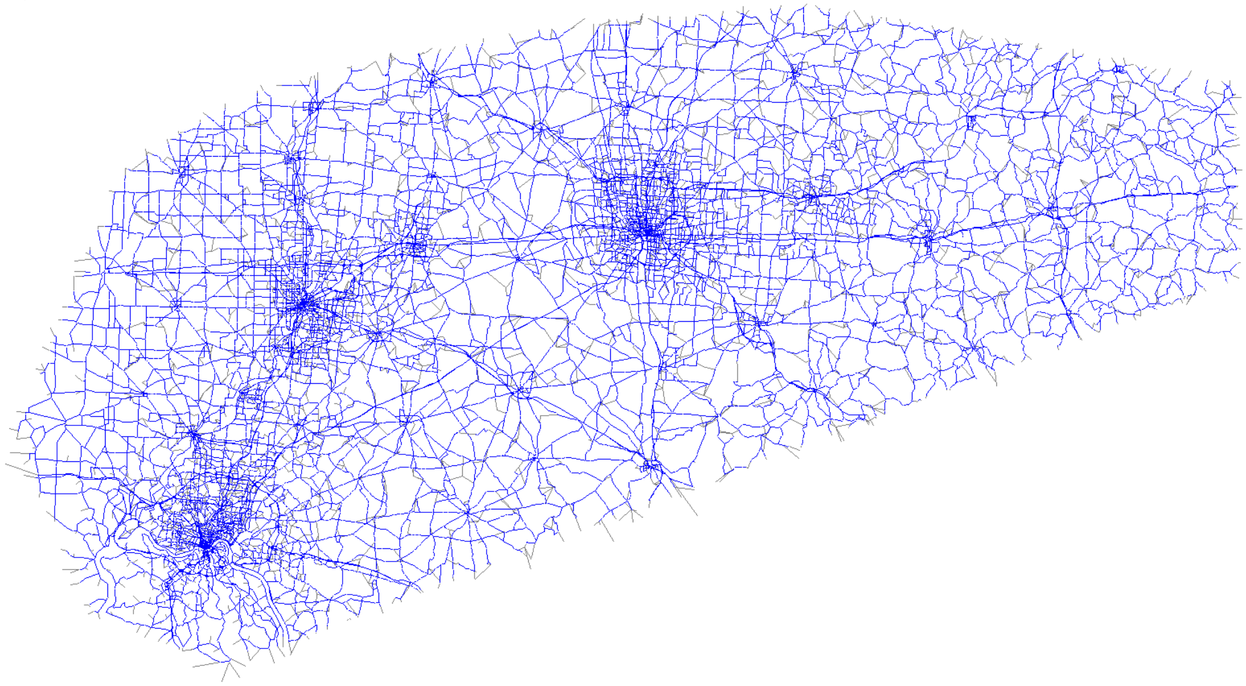
1. **Highway User Benefits Analysis:**

There are a few separate inputs into the benefit-cost analysis. A highway user benefit analysis was conducted comparing the highway road user costs with and without the improvements associated with the Columbus Crossroads Phase 4 project. The analysis was conducted with the Ohio Statewide Travel Demand Model (OSWTDM) and the Congestion Management/Air Quality Analysis (CMAQ) post processor as documented below. The OSWTDM is a peer reviewed advanced travel demand model incorporating the latest innovations including integrated econometric/land use modeling, disaggregate microsimulation of both passenger and local service/delivery/business travel and an aggregate commodity-based approach to long distance freight movements. More information on the OSWTDM can be found at: http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/osmp.pdf

The CMAQ process is ODOT's standard tool for conducting planning level congestion analysis and air quality conformity analysis and can also be adapted to provide user benefits analysis. This tool has been approved via inter-agency consultation with the various transportation stakeholders for these uses. Its primary function is to take travel demand model volumes by model period (usually daily volumes, sometimes peak periods) and disaggregate them to individual hours/directions, calculate revised hourly average speeds for each road segment based on these volumes, and then apply emissions rates and conduct capacity/level of service analysis and summarize the results. More information on the ODOT CMAQ process can be found at:
https://www.transportation.ohio.gov/static/Programs/StatewidePlanning/Modeling-Forecasting/cmaqr8.pdf

To begin, the current base models of record (the model of record is a time series of model runs into the future using the official demographic/employment forecasts and ODOT's STIP/LRP highway projects in the future) for years 2010 and 2030 were used as the basis of the analysis. From these, subarea origin-destination trip tables and networks were extracted as shown in Figure 2.

Figure 2: Subarea Network



The project was coded to the network as shown in Figure 3.

Figure 3A: No-Build Network

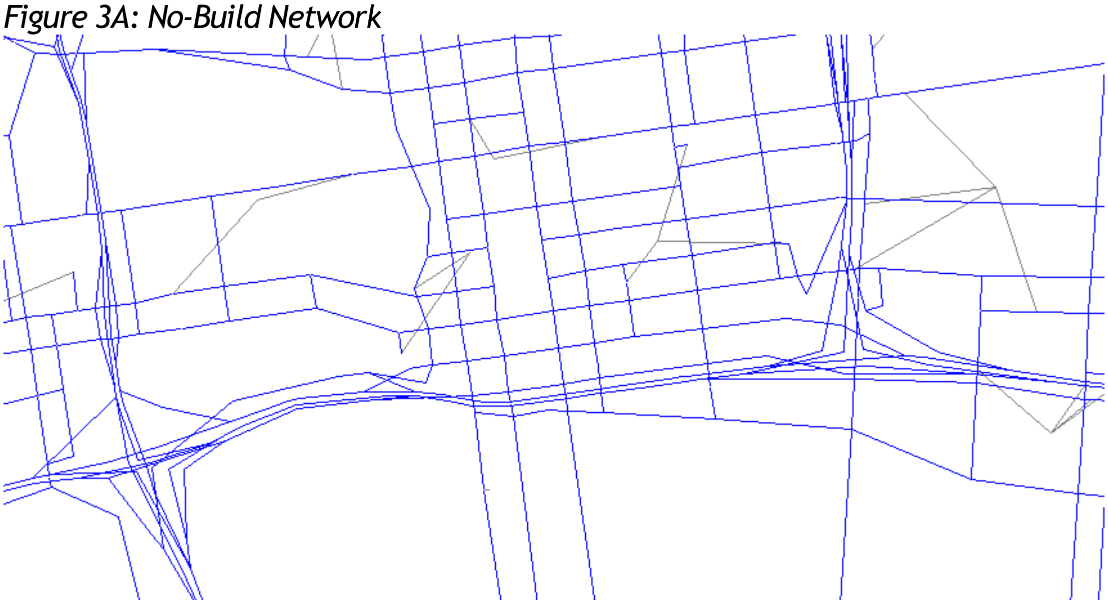
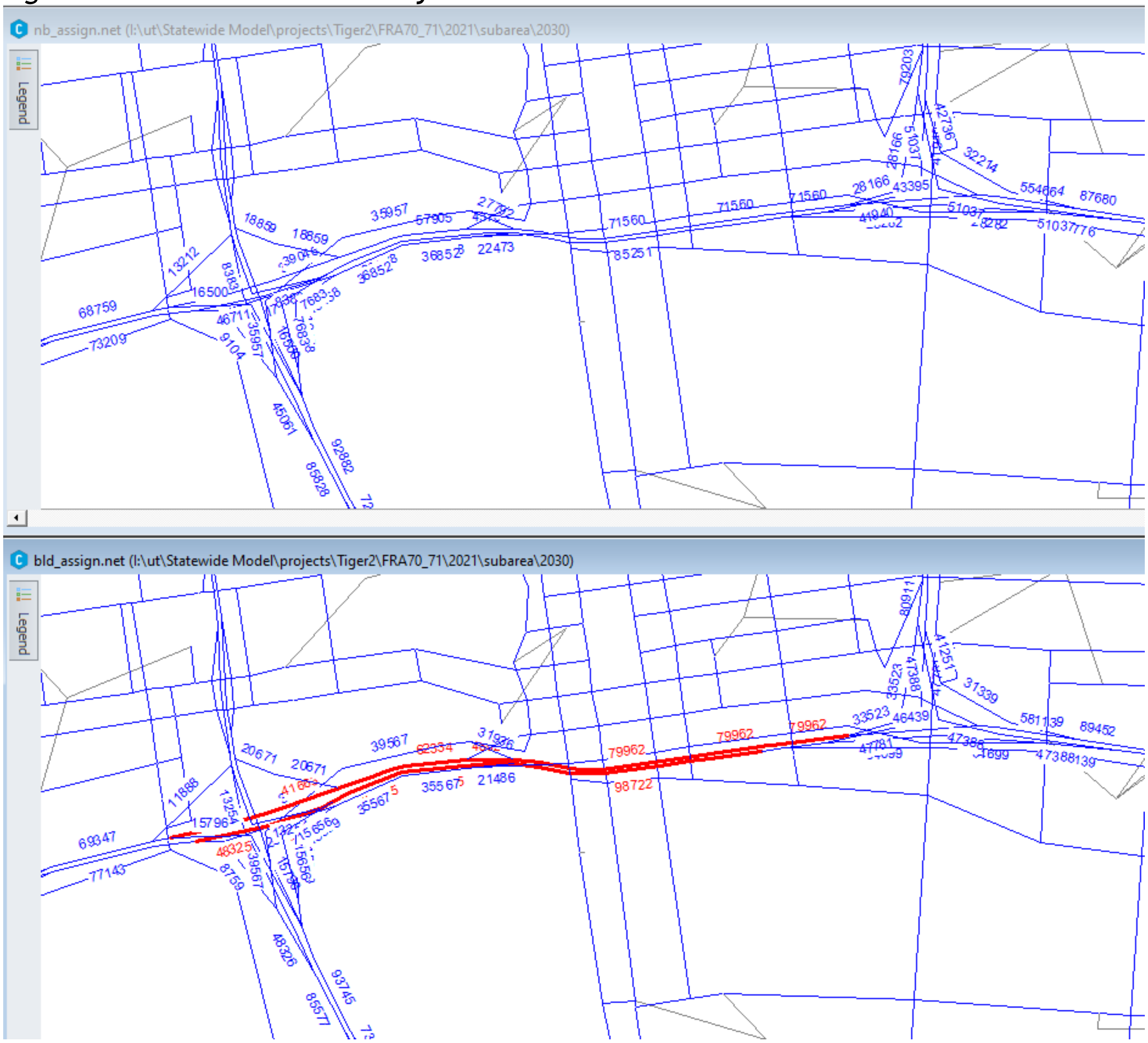


Figure 3B: Build Network

Then high convergence assignments were run for each analysis year for build and no build. The subarea extraction was necessitated by the extremely high convergence needed to compare build/no build for the benefit cost analysis which takes too long to run on the full statewide model (500 model iterations were used which would take about a day for each scenario on the full statewide network). The subareas were selected by first conducting a low convergence run on the full model and then extracting those areas exhibiting non-trivial volume change. Figure 4 shows the difference in freeway volumes for 2030 from the resulting model.

Figure 4: No Build vs Build Freeway Volumes:



The volumes from the travel models were then input to the CMAQ process. To generate the requested emissions, emission factors generated in the USEPA MOVES program were used. These emission factors were generated using the inputs/methodology approved for use in Ohio conformity/State Implementation Plan analyses by the transportation/air quality stake holders via inter-agency consultation. Statewide emission factors do not exist since the required inputs to MOVES are region specific because normal conformity/SIP analyses are conducted for non-attainment regions only, not the entire state. Therefore, for this analysis, emission rates generated for the Columbus area were used. Vehicle based emissions were ignored for this study, since there was no proposal to change the size of the vehicle fleet (this assumption thus provides a conservative estimate of project benefits since we are not taking credit for a vehicle fleet reduction that could occur if the project were built). Because the approved processes in Ohio have slightly different inputs for Ozone versus PM2.5 pollutants, two sets of emission factors were used for each analysis year. The CMAQ process generates various outputs, however, for this analysis two were used. The MOVES emissions summary report (a sample is shown in Appendix A) was used to obtain the daily emissions in short tons for VOCs, NOx, PM2.5 and SO2. CO2 emissions were calculated in US/short tons. The disaggregated link volumes/speeds file was then further processed to monetize user costs for the user benefits analysis. Emissions were converted to metric tons in the BCA spreadsheet by multiplying the short ton amounts by 1.1015.

The CMAQ process does not monetize user costs directly; however, ODOT maintains a process called CMSCOST which does just that. This process uses the hourly volumes (by vehicle class, in this case just car/truck were used) and speeds from the CMAQ process and monetizes them following the methodologies published in AASHTO's "User and Non-User Benefit Analysis for Highways, September 2010". In addition to costs associated with travel time and vehicle operation, this process also estimated crashes/costs using crash rates from ODOT's Highway Safety Program. These crash rates are used in the process to establish calibration factors to the V/C ratio based crash rate equation provided in the AASHTO reference so that the resultant analysis is both sensitive to congestion levels and matches observed crash frequencies by road type in Ohio. Figure 5 shows the crash calibration and monetary parameters utilized by this process.

Figure 5: CMSCOST Parameters

Crash Section

Crash Rate Calibration Factors

SYS	Lanes	Class	Fatal	Inj	PDO
STATE	<4	RUR ART	0.0093	0.8924	1.8063
STATE	<4	URB ART	0.0050	1.2754	3.9365
STATE	<4	FWY	0.0487	4.0330	9.3722
STATE	4-5	RUR ART	0.0599	4.3206	10.1910
STATE	4-5	URB ART	0.0083	1.4810	4.1995
STATE	4-5	FWY	0.0026	0.2122	0.5688
STATE	6+	RUR ART	0.0116	1.0995	2.8540
STATE	6+	URB ART	0.0116	1.0995	2.8540
STATE	6+	FWY	0.0031	0.2703	0.7173
ELSE	<4	RUR ART	0.0222	1.5207	3.6976
ELSE	<4	URB ART	0.0119	2.1734	8.0584
ELSE	<4	FWY	0.1166	6.8725	19.1858
ELSE	4-5	RUR ART	0.1436	7.3626	20.8618
ELSE	4-5	URB ART	0.0200	2.5238	8.5968
ELSE	4-5	FWY	0.0062	0.3616	1.1643
ELSE	6+	RUR ART	0.0277	1.8736	5.8424
ELSE	6+	URB ART	0.0277	1.8736	5.8424
ELSE	6+	FWY	0.0075	0.4606	1.4683

Cost per Crash ($) (2/21)

Fatal Inj PDO

12071000284100. 4500.

Delay per Crash (Hr)

FC	AT	Fatal	Inj	PDO
1	1	7835.	2646.	814.
2	1	7835.	2646.	814.
3	1	3227.	1090.	336.
4	1	3227.	1090.	336.
5	1	71.	24.	7.
6	1	12.	4.	1.
1	ELSE	21749.	7344.	2260.
2	ELSE	16990.	5737.	1766.
3	ELSE	7419.	2506.	772.
4	ELSE	7419.	2506.	772.
5	ELSE	301.	102.	31.
6	ELSE	83.	28.	9.

Time Section

Occupancy (People/Veh) wrk car nw car trk lt com

Class1	Class2	Class3	Class4
1.68	0.00	1.00	0.00

Value of Time ($/Hr) (2/21)

Class1	Class2	Class3	Class4
17.90	0.00	30.80	0.00

Inventory Cost ($/Hr)

Class1	Class2	Class3	Class4
0.00	0.00	0.13	0.00

Vehicle Operating Cost Section

Fuel Consumption (gal/mi) (not impacted by efficiency adj below so use current)

SPD	Class1	Class2	Class3	Class4
5	0.117	0.117	0.503	0.117
10	0.075	0.075	0.316	0.075
15	0.061	0.061	0.254	0.061
20	0.054	0.054	0.222	0.054
25	0.050	0.050	0.204	0.050
30	0.047	0.047	0.191	0.047
35	0.045	0.045	0.182	0.045
40	0.044	0.044	0.176	0.044
45	0.042	0.042	0.170	0.042
50	0.041	0.041	0.166	0.041
55	0.041	0.041	0.163	0.041
60	0.040	0.040	0.160	0.040
65	0.039	0.039	0.158	0.039

Fuel Cost ($/gal) (updated 3/1/21 from AAA web site for Ohio)

Class1	Class2	Class3	Class4
2.70	2.70	2.99	2.99

Operating/Ownership Cost Excluding Fuel & Insurance ($/mile)

Class1	Class2	Class3	Class4
0.39	0.39	0.90	0.90

Annual Factor

Class1	Class2	Class3	Class4
365.	365.	365.	365.

Congestion Time Multiplier

Class1	Class2	Class3	Class4
1.0	1.0	1.0	1.0

1980-Present Fuel Efficiency Adjustment for excess fuel only

Class1	Class2	Class3	Class4
1.550	1.550	1.396	1.550

Input Data PCE

Class1	Class2	Class3	Class4
1.0	1.0	2.0	1.0

Cost parameters were updated from the 2010 report using the "Benefit-Cost Analysis Guidance for Discretionary Grant Programs" published by USDOT in February 2021. Additionally, fuel costs were updated to those on 3/1/21. The process generates a text report which along with the air quality reports mentioned previously were brought into a spreadsheet for final processing.

In the spreadsheet, user cost for 2010 and 2030 were converted to benefits by subtracting build costs from no build costs. Next, benefits for all other analysis years were computed as linear interpolations between 2010 and 2030 (extrapolation for years beyond 2030). Note that emissions past 2035 were held constant. One final note, because ODOT does not currently conduct CO2 analysis with MOVES (and therefore the required inputs have not been prepared), the requested CO2 information was calculated by converting fuel usage to CO2.

Based on the results from the Ohio Statewide Travel Demand Model and CMAQ process described above, benefits for travel time savings, operating cost savings, and emissions reductions are estimated. Figure 6 provide the travel time savings and operating cost savings over the life of the project. Figure 7 provides the emissions reduction benefits over the life of the project.

Figure 6: Travel Time Savings and Operating Cost Savings

Car Delay Reduction (Veh-Hr)	Passenger Delay Reduction	Truck Delay Reduction (Veh-Hr)	Passenger Delay Reduction (7%)	Truck Delay Reduction (7%)	Operating Cost Reduction	Vehicle Operating Cost Reduction (PV) (7%)
12,682,177	21,179,236	818,647	$131,619,841	$8,456,786	$29,140,792	$10,857,241

Figure 7: Emissions Reduction Benefits

NOx Reduction (Metric Tons)	PM Reduction (Metric Tons)	SOx Reduction (Metric Tons)	CO2 Reduction (Metric Tons)	Non-CO2 Emissions Reduction Value (7%)	CO2 Emissions Reduction Value (3%)
21.83	2.17	0.72	126,115.60	$1,123,035	$5,178,147

2. Safety Analysis:

A second source of inputs into the analysis is a crash analysis. The crash analysis applied transportation improvements to the corridor to calculate the change in crashes if the project is built. This analysis utilized ODOT's Economic Crash Analysis Tool (ECAT). ECAT can calculate predicted crash frequencies, complete Empirical Bayes calculations, predict crash frequencies for proposed conditions, conduct alternatives analyses, and complete a benefit-cost analysis. It was developed to help transportation professionals in Ohio complete the calculations contained within the Highway Safety Manual (HSM) Part C (Predictive Methods) and Part D (CMF Selection and Assignment). More details on ECAT can be found here: https://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/HSIP/Pages/ECAT.aspx

The Empirical Bayes formula utilized is:

$$N_{expected} = w * N_{predicted} + (1 - w) * N_{observed}$$

$$w = \frac{1}{1 + k * (\sum_{all\ study\ years} N_{predicted})}$$

Where:

$N_{expected}$ = estimate of expected average crash frequency for the study period

$N_{predicted}$ = predictive model estimate of average crash frequency predicted for the study period under the given conditions

$N_{observed}$ = observed crash frequency at the site over the study period

w = weighted adjustment to be placed on the predictive model estimate

k = overdispersion parameter of the associated SPF (Safety Performance Function) used to estimate $N_{predicted}$

The attached ECAT analysis spreadsheet shows the steps in the crash analysis. The steps are:

1. Project information is entered on the "Project Information" tab. This includes basic information about the proposed changes to the infrastructure.

Figure 9: Project Information entered into ECAT

Project Element ID (Must be Unique)	Site Type	Intersection Control Type	NLFID	Begin Logpoint/ Intersection Midpoint	End Logpoint *(Leave blank for Intersection)*	Length (mi) OR Intersection Radius Buffer (mi)
70EB_Ramp_A1	Ramp Segment		SFRAIR00070**C	0	0.11	0.11
70EB_Ramp_A2	Ramp Segment		SFRAIR00070**C	0.11	0.41	0.3
70EB_Ramp_A3	Freeway Segment		SFRAIR00070**C	0.41	0.77	0.36
70EB_Ramp_A4	Ramp Segment		SFRAIR00070**C	0.77	1.07	0.3
70EB_Ramp_A5	Ramp Segment		SFRAIR00070**C	0.77	0.96	0.19
70EB_Ramp_A6	Ramp Segment		SFRAIR00070**C	1.07	1.13	0.06
70EB_01	Freeway Segment		SFRAIR00070**C	12.66	12.79	0.13
70EB_02	Freeway Segment		SFRAIR00070**C	12.79	12.97	0.18
70EB_03	Freeway Segment		SFRAIR00070**C	12.97	13.23	0.26
70EB_04	Freeway Segment		SFRAIR00070**C	13.23	13.4	0.17
70EB_05	Freeway Segment		SFRAIR00070**C	13.4	13.76	0.36
70EB_06	Freeway Segment		SFRAIR00070**C	13.76	14.36	0.6
70EB_07	Freeway Segment		SFRAIR00070**C	14.36	14.57	0.21
70WB_01	Freeway Segment		SFRAIR00070**N	12.66	14.57	1.91
71NB_Ramp_B1	Ramp Segment		SFRAIR00071**C	0	0.04	0.04
71NB_Ramp_B2	Ramp Segment		SFRAIR00071**C	0.04	0.34	0.3
71NB_Ramp_B3	Ramp Segment		SFRAIR00071**C	0.04	0.31	0.27
71NB_01	Freeway Segment		SFRAIR00071**C	14.86	15.299	0.439
4th Street	No Valid HSM Site Type - Segment		SFRAUS00023**C	10.75	10.807	0.057
4TH INTERSECTION	No Valid HSM Site Type - Intersection	Signalized	SFRAUS00023**C	10.807		#N/A
3RD STREET	No Valid HSM Site Type - Segment		SFRAUS00033**C	17.449	17.498	0.049
3RD INTERSECTION	No Valid HSM Site Type - Intersection	Signalized	SFRAUS00033**C	17.449		#N/A
HIGH STREET	No Valid HSM Site Type - Segment		SFRAUS00023*DC	4.401	4.44	0.039
HIGH INTERSECTION	No Valid HSM Site Type - Intersection	Signalized	SFRAUS00023*DC	4.401		#N/A
FULTON STREET	No Valid HSM Site Type - Segment		SFRAUS00023*DC	4.262	4.396	0.134

2. Crash modification factors are calculated based on the site-specific information entered. Additionally, non-site characteristic based countermeasures are entered. For this project, the following additional countermeasures were applied:

Figure 10: Non-site Characteristic Based Countermeasures Entered Into ECAT

CMF Nbr	Countermeasure	CMF KA Value	CMF B Value	CMF C Value	CMF O Value
CMF 1	Replace 8-inch red signal heads with 12-inch	By Crash Type	By Crash Type	By Crash Type	By Crash Type
CMF 2	Install Pedestiran Countdown Timer	0.912	0.912	0.912	0.912
CMF 3	Install High Visibility Crosswalk	0.6	0.6	0.6	0.6
CMF 4	Install Bike Lanes	0.435	0.435	0.435	0.435

3. A new tab is created for each segment added on the “Project Information” tab.
4. On each of these new tabs, information about proposed conditions of the roadway segment are entered. Based on this information, the countermeasures and project data are analyzed, and a predicted conditions report is produced for each segment on the respective tab for the segment.
5. On the Cost Benefit Analysis tab, crash severity was initially rated using KABCO, but was transferred into MAIS using the guidance provided by USDOT.

Figure 11: KABCO to MAIS Conversion Table

KABCO to AIS Conversion Table

AIS Code	K	A	B	C	O	U
AIS 0	0.00000	0.03437	0.08347	0.23437	0.92534	0.21538
AIS 1	0.00000	0.55449	0.76843	0.68946	0.07257	0.62728
AIS 2	0.00000	0.20908	0.10898	0.06391	0.00198	0.10400
AIS 3	0.00000	0.14437	0.03191	0.01071	0.00008	0.03858
AIS 4	0.00000	0.03986	0.00620	0.00142	0.00000	0.00442
AIS 5	0.00000	0.01783	0.00101	0.00013	0.00003	0.01034
AIS 6	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000

6. The crash reduction benefit was then calculated using the MAIS monetized values in the Benefit Cost Analysis Guidance and the results are found on the "Safety Summary" tab.

Based on this analysis, the predicted yearly crash reductions from implementing this project are presented in Figure 12.

Figure 12: Expected Annual Crash Adjustment

Expected Annual Crash Adjustment	
Number of Fatal & Incapacitating Injury Crashes	**-1.009**
Number of Injury Crashes	**-1.443**
Number of Total Crashes	**-65.202**

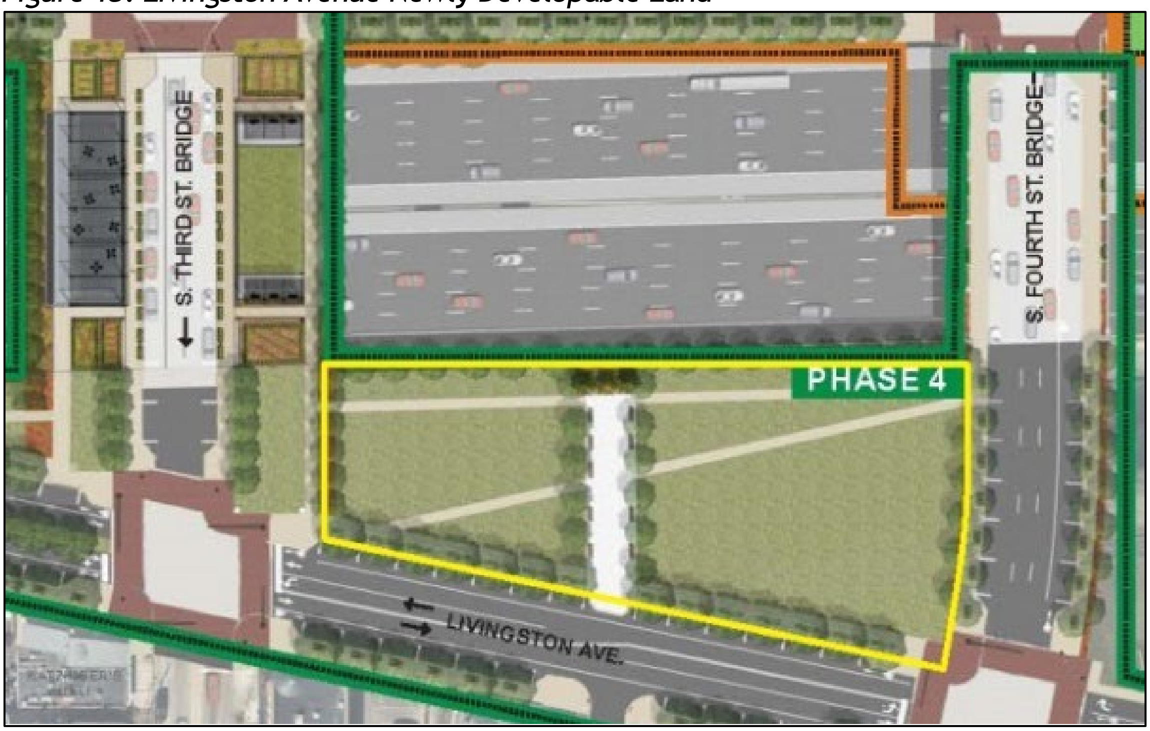
When monetized utilizing the values provided in the USDOT benefit-cost analysis guidance, these crash reductions provide a benefit of $20,203,516 at a 7% discount rate over the life of the analysis.

3. Property Value Increase Benefits:

As part of the project, 2.5 acres of previously undevelopable land will become available. The land is located at 3 different locations as described below.

3.1: Third Street Bridge/Livingston Avenue:
The construction of a retaining wall on the southern edge of I-70/71 during Phase 4 will create 1.5 acres of newly developable land on Livingston Avenue, shown in Figure 13, and made accessible by Phase 4's urban avenue improvements to the Third Street Bridge, the Fourth Street Bridge; and Columbus' related Livingston Avenue projects. The site is between German Village and Downtown Columbus, near Nationwide Children's Hospital, and next to the potential commercial cap on the Third Street Bridge. This location is highly desirable for development. A site to the east sold for nearly $15 million, roughly $4 million an acre.

Figure 13: Livingston Avenue Newly Developable Land



3.2: Third Street Bridge:
Columbus' High Street Cap over I-670, seen in figure 14, was one of the very first commercial caps constructed in the country. This cap, which seamlessly reconnected Downtown Columbus to the Short North neighborhood, has become a case study for other cities looking for creative ways to restore and reconnect neighborhoods. The High Street Cap over I-670 also provides Columbus with its own case study on how to develop additional commercial caps across the South Innerbelt Trench, including how to navigate some of the related legal challenges such as obtaining title to the land beneath the commercial cap and leasing the air space to be

developed as a commercial cap. Columbus is targeting the Third Street Bridge for the development of a commercial cap in conjunction with the development of new land fronting Livingston Avenue. The bridge will have .25 acres of newly developable land on each side of the bridge.

Figure 14: High Street Cap Over I-670

3.3: High Street Bridge:

The new bridge will be a civic gateway between Downtown, German Village, and the Brewery District. It will feature sidewalks at least 10 feet wide and 60-foot-wide green caps on both sides with significant public green space and enhanced pedestrian accommodations. These new green caps provide .25 acres of parkland on each side of the bridge.

All three of the locations described above are not developable without the Phase 4 improvements. These improvements total 2.5 acres of newly developable land. The adjacent site to the east of the newly developable land on Livingston Avenue recently sold for nearly $15 million, roughly $4 million an acre. Applying $4 million an acre to the 2.5 newly developable acres that result from this project provides a benefit of $10 million. After discounting this benefit at a 7% rate the newly developable land provides a $6,227,497 benefit.

4. Street Tree Benefits:

As part of Columbus Crossroads Phase 4, 90 street trees will be planted. Figure 15 details the types of trees, their caliper, and the annual benefit of one tree of that type utilizing the National Tree Benefit Calculator. The National Tree Benefit Calculator is based on i-Tree's Street tool, which is a product of the USDA Forest Service.

Figure 15: Street Tree Types and Per Tree Benefit

			Per Tree Annual Benefit		
Amount	Caliper	Type	CO2 Pounds Reduced	Stormwater Runoff Gallons	Stormwater Runoff Benefit
29	4	Lacebark Elm	103	146	$3.96
15	4	Ginko Biloba	44	69	$1.88
20	4	Exclamation London Plane Tree	135	138	$3.73
21	3	Maacknificent Maackia	86	87	$2.37
3	3	Pacific Sunset Maple	54	74	$2.02
2	4	Swamp White Oak	103	146	$3.96

Figure 16 documents the total annual benefit for all 90 trees. The emissions reduced in pounds was converted to metric tons by multiplying the pounds reduced by 0.000453592.

Figure 16: Total Annual Tree Benefit

			Total Tree Type Benefit			
Amount	Caliper	Type	Stormwater Runoff Benefit	CO2 Pounds Reduced	CO2 Reduction Metric Tons	Stormwater Runoff Reduced
29	4	Lacebark Elm	$114.84	2,987	1.3548793	4,234
15	4	Ginko Biloba	$28.20	660	0.29937072	1,035
20	4	Exclamation London Plane Tree	$74.60	2,700	1.2246984	2,760
21	3	Maacknificent Maackia	$49.77	1,806	0.81918715	1,827
3	3	Pacific Sunset Maple	$6.06	162	0.0734819	222
2	4	Swamp White Oak	$7.92	206	0.09343995	292
			$281.39	**8,521**	**3.86505743**	**10,370**

When monetized at a 7% discount rate over the life of the project, the street trees provide $5,357 of benefit. A printout of each tree type from the National Tree Benefit Calculator and plan sheets showing what trees will be planted can be found in Appendix B.

5. Maintenance Benefits:

The difference in operations and maintenance costs between the Build and No Build scenarios is presented in the "Operations and Maintenance" tab of the BCA spreadsheet. Maintenance costs were broken into four categories: Annual pavement maintenance, annual bridge inspection, repave, and bridge redecking. The numbers presented are the difference between the Build and No Build scenarios. Each category will be detailed below.

5.1: Annual Pavement Maintenance:

By completing the improvements associated with Columbus Crossroads Phase 4, two existing ramps will be eliminated. This eliminates the annual pavement maintenance associated with those ramps. Additional pavement also will be added to I-70 Eastbound, which increases the amount of pavement that will need annual maintenance. Figure 17 shows the breakdown of the overall changes in pavement maintenance. A cost of $100,000 to maintain one lane mile per year was used. The changes presented in Figure 17 only show the difference between the build and no build scenarios, not the total maintenance cost.

Figure 17: Pavement Maintenance Changes

	Pavement Changes			
Facility	Length	Lanes	Lane-Feet	Value
I-70 EB	3200	2	6400	$(121,212)
Third Ramp	-1100	1	-1100	$20,833
Fourth Ramp	-1250	1	-1250	$23,674
				$(76,705)

The overall change in pavement maintenance leads to an annual increase of $76,705 in maintenance cost, which is shown as a negative number in Figure 17 as it is a disbenefit.

5.2: Annual Bridge Inspection:

As part of the project, both the High Street and Third Street bridges are being widened to allow for caps. In doing so, the annual bridge inspection cost will increase as shown in Figure 18. The estimated additional inspection cost is $4,000 for each bridge, which is shown as a negative number in Figure 18 as it is a disbenefit.

Figure 18: Annual Bridge Inspection Cost Increase

Bridge	Value
High	$(4,000)
Third	$(4,000)
	$(8,000)

5.3: Repave:

By completing the project, 563,000 square feet of pavement will no longer need to be repaved in 2023. Figure 19 shows the locations that would have needed to be repaved in 2023. A cost of $1 per square feet was used and then it was multiplied by 10% for design, 25% for construction engineering, and 3% for contingencies.

Figure 19: 2023 Repave Savings

Section	Length	Lanes	Lane Width	Shoulders	Shoulder Width	Area	Cost
SR315 to Scioto R	600	4	12	2	10	40,800	$57,783
Scioto R to RR	825	8	12	4	10	112,200	$158,903
RR to Short	625	8	12	4	10	85,000	$120,381
Short to End Proj	3125	6	12	4	8	325,000	$460,281
						563,000	$797,349

There is also a net increase in the amount of pavement between the Build and No Build scenarios that will increase the cost of future repaving. Future repaving is scheduled for 2033 and 2043. Figure 20 shows the calculations associated with the change in pavement between the Build and No Build Scenario. A cost of $1 per square feet was used and then it was multiplied by 10% for design, 25% for construction engineering, and 3% for contingencies.

Figure 20: Net Change in Pavement for Repaving Between Build and No Build

Location	Square Feet	Cost
I-70 EB	(140,800)	$(199,408.00)
Third Ramp	35,200	$49,852.00
Fourth Ramp	40,000	$56,650.00
	(65,600)	$(92,906.00)

5.4: Bridge Redecking:

By completing the project, 8 bridges will no longer need to be redocked. The cost of a bridge redecking is estimated as $120 per square feet. Figure 21 shows the bridges, the year of the benefit, and the value of the benefit before discounting.

Figure 21: Bridge Redecking Savings:

Bridge	Length	Width	Area (Square Feet)	Redeck Year	Cost Savings
Souder	65	72		2033	$561,600
High	240	70		2023	$2,016,000
Third	122	65		2023	$951,600
Fourth	215	50		2023	$1,290,000
Over Scioto River			104,962	2023	$12,595,440
Over Rail Road			21,728	2023	$2,607,360
FRA-70-1301L – WB			31,095	2023	$3,731,400
FRA-70-1301R – EB			30,218	2023	$3,626,160

When discounted, the savings from not redecking the bridges listed in Figure 21 provides $20,677,091 in benefits.

The overall maintenance benefits broken down by year can be seen in Figure 22. The Annual column combines both annual pavement maintenance and annual bridge inspection. The redecking column shows the bridge redecking savings and the repave column shows the repaving benefits and disbenefits.

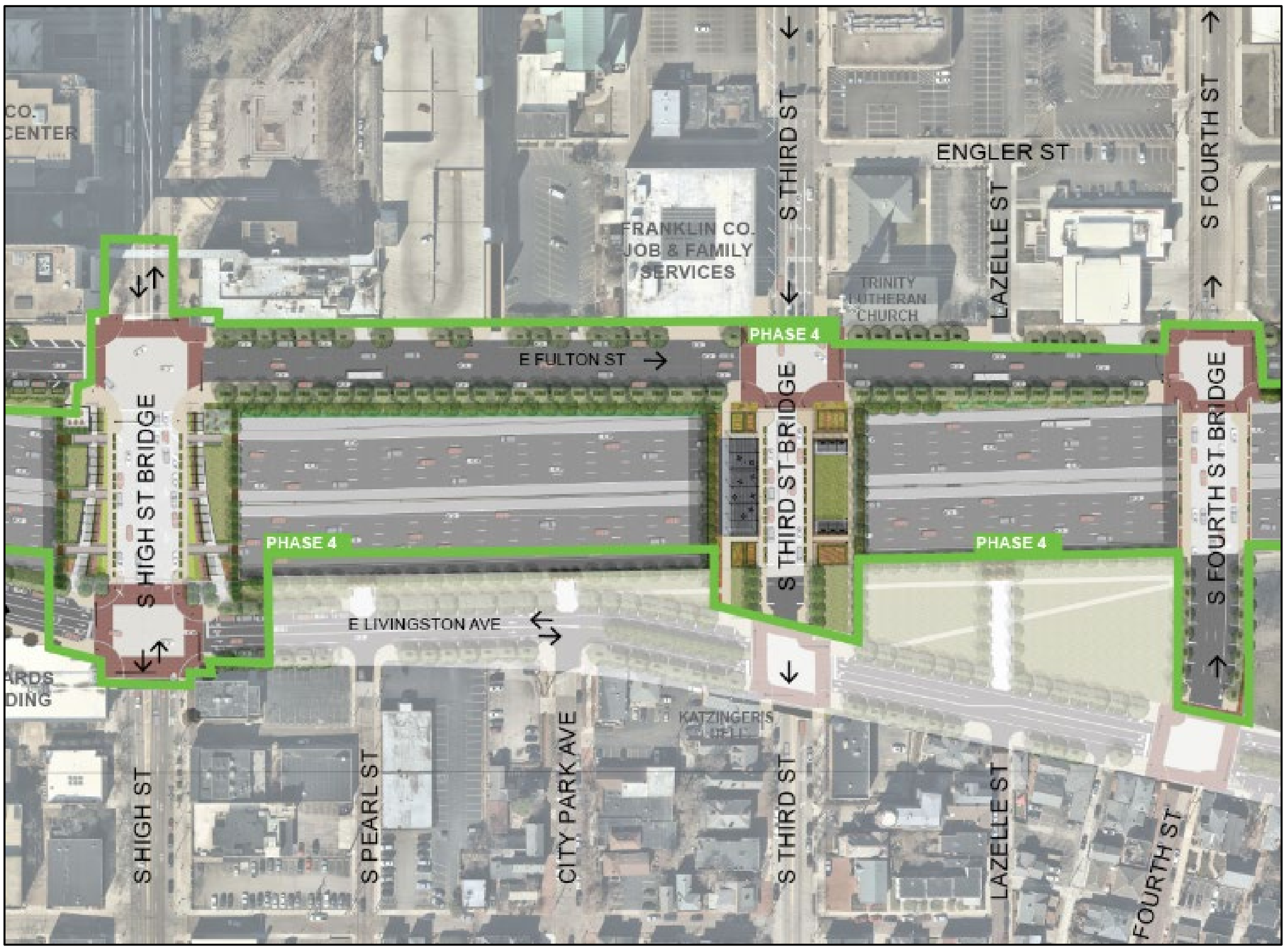
Figure 22: Overall Maintenance and Operations Benefits by Year

Period	Year	Annual	Redecking	Repave	Total Maintenance Benefit	Maintenance Benefit (7%)
1	2020	$ -			$ -	$ -
2	2021	$ -			$ -	$ -
3	2022	$ -			$ -	$ -
4	2023	$ -	$ 26,817,960	$ 797,348.75	$ 27,615,308.75	$ 21,067,586.82
5	2024	$ -			$ -	$ -
6	2025	$ -			$ -	$ -
7	2026	$ (84,705)			$ (84,704.55)	$ (52,749.73)
8	2027	$ (84,705)			$ (84,704.55)	$ (49,298.82)
9	2028	$ (84,705)			$ (84,704.55)	$ (46,073.66)
10	2029	$ (84,705)			$ (84,704.55)	$ (43,059.50)
11	2030	$ (84,705)			$ (84,704.55)	$ (40,242.52)
12	2031	$ (84,705)			$ (84,704.55)	$ (37,609.83)
13	2032	$ (84,705)			$ (84,704.55)	$ (35,149.37)
14	2033	$ (84,705)	$ 561,600.00	$ (92,906.00)	$ 383,989.45	$ 148,917.73
15	2034	$ (84,705)			$ (84,704.55)	$ (30,700.83)
16	2035	$ (84,705)			$ (84,704.55)	$ (28,692.36)
17	2036	$ (84,705)			$ (84,704.55)	$ (26,815.29)
18	2037	$ (84,705)			$ (84,704.55)	$ (25,061.02)
19	2038	$ (84,705)			$ (84,704.55)	$ (23,421.51)
20	2039	$ (84,705)			$ (84,704.55)	$ (21,889.26)
21	2040	$ (84,705)			$ (84,704.55)	$ (20,457.26)
22	2041	$ (84,705)			$ (84,704.55)	$ (19,118.93)
23	2042	$ (84,705)			$ (84,704.55)	$ (17,868.16)
24	2043	$ (84,705)		$ (92,906.00)	$ (177,610.55)	$ (35,015.32)
25	2044	$ (84,705)			$ (84,704.55)	$ (15,606.74)
26	2045	$ (84,705)			$ (84,704.55)	$ (14,585.74)
27	2046	$ (84,705)			$ (84,704.55)	$ (13,631.53)
		$ (1,778,795)	$ 27,379,560	$ 611,537		$ 20,619,457.17

6. Bike and Pedestrian Mode Shift

As part of the Columbus Crossroads Phase 4 project, bicycle and pedestrian infrastructure is being added to 3 bridges that reconnect communities that were severed by the development in the Interstate System. Figure 23 shows the three bridges and the improvements that will be added.

Figure 23: Bike and Pedestrian Enhancements to Bridges



The current infrastructure on these bridges is not inviting for bicycle and pedestrian use. Figure 24 shows a current picture of the High Street bridge and a rendering of what it will look like when Phase 4 is completed.

Figure 24: High Street Bridge Before and After

These improvements are expected to increase bicycle and pedestrian usage of the bridge which reconnects multiple neighborhoods to Downtown Columbus. A recent analysis completed for Walk.Bike.Ohio, ODOT's first statewide bicycle and pedestrian plan, analyzed the impact of reducing VMT and increasing walking and biking. Figure 25 shows the predicted monetary benefits of reducing each vehicle mile traveled.

Figure 25: Walk.Bike.Ohio Transportation Benefits Multiplier

Transportation Benefit Multiplier	Value
Household Transportation Cost Savings	$0.40 per VMT Reduced
Traffic Congestion Cost Savings	$0.09 per VMT Reduced
Roadway Maintenance Cost Savings	$0.15 per VMT Reduced
Collision Cost Savings	$0.17 per VMT Reduced
Total Transportation Cost Savings	$0.81 per VMT Reduced

Additionally, a biking and walking demand analysis was completed as part of Walk.Bike.Ohio. The demand analysis is an objective, data-driven process that estimates the cumulative demand for active transportation and recreation depending on where people live, work, play, shop, learn, and access transit. This is accomplished by quantifying factors that generate bicycle and pedestrian movement. Figure 26 presents the factors that were quantified as well as the data source and scoring.

Figure 26: Walk.Bike.Ohio Demand Analysis Factors

DEMAND INDICATOR	RATIONALE	METRIC	SCORING
Employment Density	A measure of where people work	2015 Longitudinal Employer-Household Dynamic (LEHD), Work-Area Characteristics	0: Employment = 0 1-5: Assigned score by quantile
Population Density	A measure of where people live	2012-2017 American Community Survey (US Census)	0: Population = 0 1-5: Assigned score by quantile
Walk/Bike Commute Mode Share	A measure of existing active transportation usage	2012-2017 American Community Survey (US Census)	0: Bike/Ped Mode Share = 0 1-5: Assigned score by quantile
Park Density	A measure of parkland expressed as acreage per Census Tract	Park data obtained from ESRI dataset; calculated according to parkland acreage per Census Tract	0: Park Acres = 0 1-5: Assigned score by quantile
Presence of College/ Universities	A measure of where people attend college	College/university data obtained from ESRI dataset; calculated based on whether or not a Census Tract contains a college/ university location	Score of 0 if there are no College/University locations within a census tract and score of 5 if there is at least one College/ University location within a census tract
Retail Employment Density	A measure of where people shop and are employed by retail industries	2015 Longitudinal Employer-Household Dynamic (LEHD), Work-Area Characteristics	0: Retail = 0 1-5: Assigned score by quantile
Number of People 200% Below Poverty Line	A measure of concentrated poverty. Equity factors, including poverty, should be included in planning decisions to enable an equitable distribution of transportation resources	2012-2017 American Community Survey (US Census)	0: Poverty = 0 1-5: Assigned score by quantile

When the Walk.Bike.Ohio demand analysis was applied, the neighborhoods on both sides of Columbus Crossroads Phase 4 registered in the highest demand quantile. A map showing the results of the demand analysis zoomed into the project level can be found in Appendix C.

To determine current usage of the three bridges we conducted select link analysis using StreetLight 2019 data. StreetLight combines big location data from vast resources to provide transportation metrics available on-demand to inform transportation decisions, and is becoming a popular data source replacing the traditional data collections such as manual traffic counts, roadside survey, etc.

All vehicular trips passing through the three bridges were extracted and classified into 7 different trip length bins (breaks at 1, 2, 3, 5, 10 miles) using the features available on the StreetLight data platform. According to the StreetLight Data, there were about 63,700 vehicle-trips in total passing through the three bridges every day in 2019. Those trips contributed 296,000 vehicle-miles-traveled (VMT) daily.

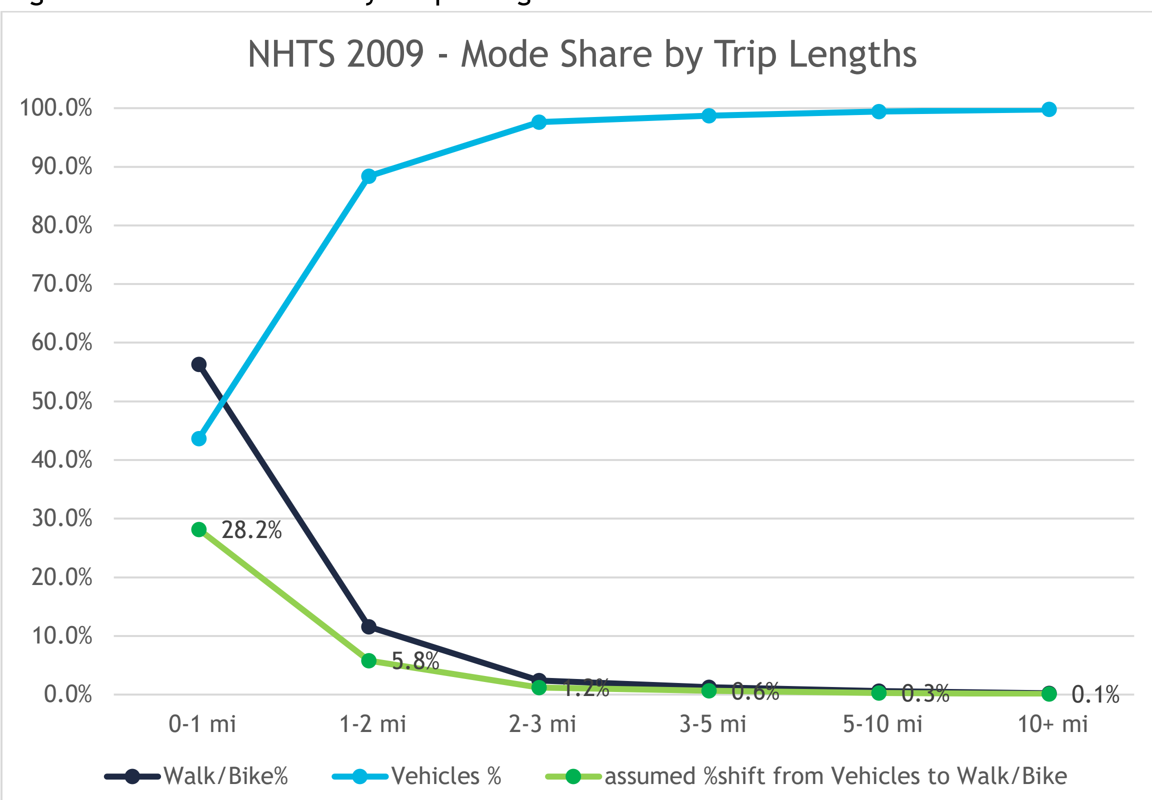
With the proposed improvements on the walk and bike facilities, modal shift percentages were predicted from vehicles to walk/bike, varied by trip length. Figure 27 shows the mode shift percentages for the trip length bins.

Figure 27: Mode Shift to Walking and Biking by Distance

	0-1 mi	1-2 mi	2-3 mi	3-5 mi	5-10 mi	10+ mi
Mode Shift to Walk/Bike due to Dedicated Facilities	28.2%	5.8%	1.2%	0.6%	0.3%	0.1%

The above percentages were half of nationwide averages of walk/bike share percentages compared to vehicles in the 2009 National Household Travel Survey. To account for the already existing pedestrians and cyclists using the bridges, though the walk/bike facilities are in really poor conditions, we chose conservatively to halve the nationwide averages of walk/bike shares as the potential modal shift percentages from vehicles to walk/bike. This would have resulted in a modest 1.3% reduction in VMT passing through the three bridges, i.e., 3,770 VMT daily, or 1,376,00 VMT annually, in 2019. Figure 28 shows the NHTS mode share percentages by trip length and the estimated mode shift as a result of this project.

Figure 28: Mode Share by Trip Length



Then, MORPC’s regional travel demand model were utilized to estimate the VMT growth for trips passing through the three bridges. The resulted annual linear growth rate is 1.5%, which can be used to linearly grow the 2019 VMT numbers all the way to 2050.

This method provides a conservative estimate of the benefit of VMT reduction due to the improved bicycle and pedestrian facilities that will be added as part of Columbus Crossroads Phase 4. The Walk.Bike.Ohio analysis provided collision cost reduction savings that were not applied to the VMT reduction. As part of the safety analysis for this project, bicycle and pedestrian crash mitigation factors were applied. The collision cost savings was therefore withheld from the calculation to avoid double counting. A value of $.64 per VMT reduced was utilized rather than a value of $.81 per VMT reduced.

Additionally, the Walk.Bike.Ohio analysis included emission reduction factors that were applied to the VMT reduced. However, the analysis also included emissions that did not have monetized values in the USDOT Benefit-Cost Analysis Guidance. The benefits associated with these emissions reductions were not included in the analysis and therefore present a conservative estimate of the benefits. Figure 29 shows emissions reduction factors in metric tons for each VMT reduced and whether it was able to be monetized in this analysis.

Figure 29: Emissions Reduction Factors from Walk.Bike.Ohio

Emissions	Metric Ton Reduced Per VMT	Monetized
NOx	0.00000069	Yes
CO2	0.00042047	Yes
PM	0.00000005	No
SO	0.00000001	No
VOC	0.00000103	No

Applying the methodology above, VMT reduced along with NOx and CO2 reduced by mode shift are show in Figure 30.

Figure 30: Mode Shift VMT, NOx, and CO2 Reduction

Year	Term	VMT Reduced**	NOx Reduced	CO2 Reduced
2019	0	1,376,114.42		
2020	1	1,396,756.14		
2021	2	1,417,707.48		
2022	3	1,438,973.10		
2023	4	1,460,557.69		
2024	5	1,482,466.06		
2025	6	1,504,703.05		
2026	7	1,527,273.59	1.05381878	642.172728
2027	8	1,550,182.70	1.06962606	651.805319
2028	9	1,573,435.44	1.08567045	661.582399
2029	10	1,597,036.97	1.10195551	671.506135
2030	11	1,620,992.52	1.11848484	681.578727
2031	12	1,645,307.41	1.13526211	691.802408
2032	13	1,669,987.02	1.15229105	702.179444
2033	14	1,695,036.83	1.16957541	712.712135
2034	15	1,720,462.38	1.18711904	723.402817
2035	16	1,746,269.32	1.20492583	734.25386
2036	17	1,772,463.36	1.22299972	745.267667
2037	18	1,799,050.31	1.24134471	756.446683
2038	19	1,826,036.06	1.25996488	767.793383
2039	20	1,853,426.60	1.27886436	779.310283
2040	21	1,881,228.00	1.29804732	790.999938
2041	22	1,909,446.42	1.31751803	802.864937
2042	23	1,938,088.12	1.3372808	814.907911
2043	24	1,967,159.44	1.35734001	827.13153
2044	25	1,996,666.83	1.37770011	839.538502
2045	26	2,026,616.83	1.39836562	852.13158
2046	27	2,057,016.09	1.4193411	864.913554

When monetized, the mode shift benefits from this project provide $8,724,072 in benefits at a 7% discount rate (3% for CO2).

7. Quality of Life Benefits

Additional quality of life benefits arise from reconnecting underserved communities. While not quantifiable, the Long Street Cultural Wall that was completed as part of a previous phase of Columbus Crossroads is an excellent example of the benefits that arise from reconnecting communities.

8. Project Cost:

Future project costs are broken down by year on the “Future Project Costs” tab of the BCA spreadsheet. Any previously expended costs can be found on the “Previous Costs” tab of the BCA spreadsheet. Overall, there are $21,260,000 in previously expended costs and $247,200,000 in future project costs. The $21,260,000 include project development costs that will occur in 2021 and 2022 before an INFRA grant would be obligated.

Figure 31 below shows costs by year. Costs expended prior to 2019 were converted to 2019 dollars utilizing the GDP Deflator values presented in the USDOT Benefit-Cost Analysis Guidance. Future costs were discounted to 2019 dollars utilizing a 7% discount rate.

Figure 31: Previous and Future Project Cost

Period	Year	Cost	Multiplier to Adjust to $2019	Cost in $2019	PV Costs (7%)
	2012	$1,000,000	1.1227	$1,122,700	
	2013	$1,000,000	1.1033	$1,103,300	
	2014	$2,000,000	1.0832	$2,166,400	
	2015	$2,000,000	1.073	$2,146,000	
	2016	$2,000,000	1.0619	$2,123,800	
	2017	$2,000,000	1.0423	$2,084,600	
	2018	$2,500,000	1.0179	$2,544,750	
0	2019	$2,500,000	1	$2,500,000	$15,791,550
1	2020	$2,260,000			$2,112,150
2	2021	$2,000,000			$1,746,877
3	2022	$2,000,000			$1,632,596
4	2023	$61,800,000			$47,146,924
5	2024	$74,160,000			$52,875,055
6	2025	$74,160,000			$49,415,939
7	2026	$37,080,000			$23,091,560
					$193,812,652

9. Benefit Summary:

The Columbus Crossroads Phase 4 project produces benefits in excess of cost. At a 7% discount rate the benefits exceed the costs by more than $19 million with a benefit cost ratio of 1.10. Figure 32 below shows a summary of the project benefits and costs.

Figure 32 Project Benefits and Costs

Type of Impacts	Benefits (7% Discount Rate)	Costs (7% Discount Rate)
Travel Time Savings	$140,076,627	
Crash Reduction	$20,203,516	
Operations and Maintenance Savings	$20,619,457	
Operating Cost Savings	$10,857,241	
Mode Shift VMT Reduction	$8,724,072	
Emissions Reduction	$6,301,181	
Property Value Increase	$6,227,497	
Street Tree Benefits	$5,357	
Quality of Life Benefits	Qualitative	
Project Cost		$193,812,652
TOTAL	**$213,014,951**	**$193,812,652**
Benefit-Cost Ratio	**1.10**	

Appendix A: Sample CMAQ MOVES Emission Report

MOVES BASED EMISSIONS REPORT
2010 Build OZ
Loaded Network: I:\ut\Statewide Model\projects\Tiger2\CUY_Innerbelt\2010\bld_assign.net
Network Emission Factors: I:\ut\Statewide Model\projects\Tiger2\CUY_Innerbelt\2010\2008SUM_ozone_3source_rpd.csv
Vehicle Emission Factors: I:\ut\Statewide Model\projects\Tiger2\CUY_Innerbelt\2010\2008SUM_ozone_3source_rpv.csv
Vehicle Population : I:\ut\Statewide Model\projects\Tiger2\CUY_Innerbelt\2010\STP2008SUM.csv
Intrazonal Trips :
Area File (sq mi):
Volume Field Used: VOL24_TOT
Truck Volume Field Used: NONE
Capacity Field Used: CAP24

CMS/AQ REPORT
POSTCMS10, UPDATED DEC 2009, GTG
DATE:03/14/2012 TIME:08:40:23

PARAMETER FILE DUMP (DAILY.DAT FILE)

HOUR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
PCTADT																								
URB FWY	0.9	0.6	0.5	0.6	0.9	2.2	5.2	7.3	6.4	5.2	4.9	5.1	5.3	5.5	6.1	7.2	8.0	7.9	5.8	4.2	3.4	2.9	2.2	1.5
URB ART	0.7	0.4	0.3	0.3	0.6	1.5	3.5	5.7	5.5	5.1	5.3	6.2	6.5	6.4	6.8	7.6	8.2	8.1	6.2	4.8	4.0	3.0	1.9	1.3
RUR FWY	1.4	1.1	0.9	1.0	1.3	2.2	3.7	5.2	5.4	5.4	5.6	5.6	5.7	6.0	6.5	7.1	7.5	7.0	5.6	4.5	3.8	3.2	2.5	2.0
RUR ART	0.8	0.5	0.4	0.5	1.0	2.4	4.8	6.2	5.5	5.3	5.5	5.8	6.0	6.0	6.7	7.6	8.1	7.7	5.6	4.2	3.5	2.8	1.9	1.3
PCTADT TRK																								
URB FWY	2.1	1.9	1.8	2.0	2.4	3.0	3.9	4.6	5.3	6.0	6.3	6.4	6.4	6.4	6.3	5.8	5.2	4.6	4.1	3.7	3.4	3.1	2.8	2.4
URB ART	1.1	0.9	1.0	1.2	1.6	2.3	3.9	5.9	6.9	6.7	7.1	7.6	7.4	7.2	7.4	7.2	6.0	5.0	3.7	2.8	2.3	1.9	1.5	1.3
RUR FWY	2.6	2.2	2.1	2.3	2.6	3.1	3.5	4.0	4.5	5.1	5.6	5.8	5.8	5.8	5.8	5.6	5.3	4.9	4.6	4.3	4.0	3.8	3.5	3.1
RUR ART	1.5	1.3	1.4	1.6	2.2	3.0	4.2	5.3	6.1	6.7	7.0	7.1	7.0	6.9	6.8	6.3	5.5	4.6	3.8	3.1	2.6	2.3	2.1	1.7
PCTDIR																								
URB FWY	38	40	40	46	56	64	70	70	68	62	58	52	52	52	50	46	38	38	46	52	46	42	42	40
URB ART	44	46	44	48	54	62	66	68	64	56	54	52	50	50	50	46	40	38	46	52	48	46	46	46
RUR FWY	44	46	48	54	60	68	68	64	58	54	52	50	50	52	52	48	42	40	44	48	48	44	46	44
RUR ART	40	42	44	48	58	66	72	68	60	56	54	50	50	50	50	46	40	38	46	50	46	44	44	44

LOS E VC 0 0.625 1.25 1.875 2.5 3.125 3.75 4.375 5 5.625 6.25 6.875 7.5 8.125 8.75 9.375 10 10.625 11.25 11.875 12.5 13.125 13.75 14.375
SPEEDVC

curve1	75	75	75	75	75	75	74.9	74.8	74.6	74.2	73.5	72.3	70.5	67.8	64.2	59.5	54	47.7	41.2	34.9	28.9	23.7	19.2	15.5
curve2	70	70	70	70	70	70	70	69.9	69.8	69.6	69.2	68.4	67.1	65.1	62.2	58.2	53	47	40.5	33.9	27.7	22.2	17.6	13.8
curve3	65	65	65	65	65	65	65	65	65	64.9	64.8	64.4	63.8	62.6	60.5	57	52	45.4	37.8	29.9	22.7	16.7	12.1	8.6
curve4	60	60	60	60	60	60	60	60	60	59.9	59.8	59.6	59.1	58.2	56.7	54.3	50.8	46.1	40.3	33.8	27.3	21.3	16.2	12.2
curve5	55	55	55	55	55	55	55	55	55	55	55	54.9	54.7	54.3	53.6	52.3	50	46.5	41.5	35.3	28.5	21.9	16.1	11.5
curve6	60	60	60	60	60	60	60	60	59.9	59.8	59.7	59.4	59.1	58.5	57.7	56.5	55	53.1	50.7	47.9	44.7	41.1	37.3	33.4
curve7	55	55	55	55	55	55	55	55	54.9	54.9	54.7	54.5	54.2	53.8	53.1	52.2	50.9	49.3	47.3	44.9	42.1	39	35.7	32.2
curve8	50	50	50	50	50	50	50	50	49.9	49.9	49.8	49.6	49.4	49	48.5	47.7	46.7	45.4	43.8	41.8	39.5	36.8	33.9	30.9
curve9	45	45	45	45	45	45	45	45	45	44.9	44.8	44.7	44.4	44.1	43.6	43	42.1	40.9	39.4	37.6	35.5	33.1	30.5	27.8
curve10	50	50	50	50	49.9	49.8	49.7	49.4	49	48.4	47.5	46.5	45.1	43.5	41.7	39.6	37.3	34.9	32.4	29.8	27.3	24.9	22.6	20.4
curve11	50	50	50	50	50	49.9	49.7	49.4	48.9	48	46.7	44.9	42.5	39.6	36.2	32.6	28.7	25	21.4	18.2	15.3	12.9	10.8	9
curve12	50	50	50	50	50	49.9	49.8	49.6	49.1	48.2	46.8	44.5	41.4	37.5	32.9	28	23.1	18.7	14.9	11.8	9.2	7.2	5.7	4.5
curve13	40	40	40	40	40	40	39.9	39.8	39.5	39.2	38.6	37.8	36.7	35.3	33.5	31.4	29	26.4	23.7	21.1	18.5	16.1	13.9	12
curve14	40	40	40	40	40	39.9	39.8	39.6	39.1	38.5	37.5	36.1	34.3	32.1	29.4	26.5	23.5	20.5	17.7	15.1	12.8	10.7	9	7.6
curve15	40	40	40	40	40	39.9	39.7	39.4	38.8	37.9	36.5	34.7	32.3	29.5	26.4	23.2	20	17	14.3	11.9	9.9	8.2	6.8	5.6
curve16	35	35	35	35	35	34.9	34.8	34.5	34	33.2	32.1	30.5	28.5	26.1	23.5	20.6	17.9	15.2	12.8	10.7	8.9	7.4	6.1	5.1
curve17	35	35	35	35	35	34.9	34.7	34.4	33.9	33.1	32	30.3	28.3	25.8	23.1	20.3	17.5	14.9	12.5	10.4	8.6	7.2	5.9	4.9
curve18	35	35	35	35	35	34.9	34.6	34.2	33.5	32.4	30.9	28.8	26.3	23.4	20.4	17.4	14.6	12.1	9.9	8.1	6.6	5.4	4.4	3.6
curve19	30	30	30	30	30	29.9	29.8	29.5	29	28.2	27.1	25.6	23.7	21.5	19.1	16.6	14.2	12	10	8.3	6.8	5.6	4.6	3.8
curve20	30	30	30	30	30	29.9	29.7	29.4	28.9	28.1	26.9	25.3	23.4	21.1	18.6	16.1	13.6	11.4	9.5	7.8	6.4	5.3	4.3	3.6
curve21	30	30	30	30	30	29.9	29.7	29.3	28.7	27.7	26.2	24.4	22.1	19.6	17	14.4	12	9.9	8.1	6.6	5.4	4.4	3.6	2.9

VC RATIO TO LOS CONVERSION (VALUE SHOWN IS LOWER LIMIT FOR THAT LOS)(URBAN ROADS USE SPEED BREAKS BELOW FOR LOS DETERMINATION) (ALL USE THE BASE VC'S TO DETERMINE EXCEEDANCE)

	BASE	RUR2	FWY
A	0.00	0.00	0.00
B	0.30	0.00	0.25
C	0.50	0.10	0.40
D	0.70	0.30	0.60
E	0.90	0.50	0.80
F	1.00	1.00	1.00
F+	1.10	1.10	1.10
F++	1.30	1.30	1.30

SPEED VC RATIO BREAKS FOR URBAN STREETS (HIGHEST SPEED FOR GIVEN LOS & FF SPEED)

FFS	B	C	D	E	F
>47	42.	34.	27.	21.	16.
>37	35.	28.	22.	17.	13.
>32	30.	24.	18.	14.	10.
<33	25.	19.	13.	9.	7.

LEVEL OF SERVICE THRESHOLD BY AREA

NUM	LOS	DEFINITION
1	F	CINCINNATI,CLEVELAND,COLUMBUS CENTRAL MPO COUNTIES (CUY,FRA,HAM)
2	E	OTHER TMA MPOS (AKRON,CANTON,DAYTON,TOLEDO,YOUNGSTOWN + NON-CENTRAL COUNTIES FROM 1)
3	E	OTHER MPOS & PARTS OF AREAS 1 & 2 OUTSIDE URBANIZED AREA
4	E	RURAL NON MPO COUNTIES

PEAK SPREADING MODEL INFO (SET MAX ITERATIONS TO 0 TO DISABLE PEAK SPREADING)
MAX VC RATIO FWY: 1.30
MAX VC RATIO ART: 1.30
MAX ITERATIONS : 1000

TRUCK PCE: 2.0

AQ SEASON FACTOR: 1.00

MODEL CLASS PARAMETERS (MAX 4 CLASSES, HOURS 0-23 W/ NO OVERLAP IN CLASS, ALLOCATE ENTIRE CLASS AS TRUCK(1) OR NOT(0))

CLS TRK	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLS BEG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLS END	23	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLS NUM	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MOVES NETWORK LINK EMISSIONS OUTPUT

COUNTY	MONTH	VMT	HC	NOX	SO2	PM2.5
ADA	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
ALL	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
ASD	JANUARY	5640.	0.0000	0.0000	0.0000	0.0000
ATB	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
ATH	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
AUG	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
BEL	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
BRO	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
BUT	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
CAR	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
CHP	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
CLA	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
CLE	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
CLI	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
COL	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
COS	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
CRA	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
CUY	JANUARY	29197408.	0.0000	0.0000	0.0000	0.0000
DAR	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
DEF	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
DEL	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
ERI	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
FAI	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
FAY	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
FRA	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
FUL	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
GAL	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
GEA	JANUARY	1151937.	0.0000	0.0000	0.0000	0.0000
GRE	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
GUE	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HAM	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HAN	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HAR	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HAS	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HEN	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HIG	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HOC	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HOL	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
HUR	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
JAC	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
JEF	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
KNO	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
LAK	JANUARY	4874405.	0.0000	0.0000	0.0000	0.0000
LAW	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
LIC	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
LOG	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
LOR	JANUARY	1581703.	0.0000	0.0000	0.0000	0.0000
LUC	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MAD	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MAH	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MAR	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MED	JANUARY	4181448.	0.0000	0.0000	0.0000	0.0000
MEG	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MER	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MIA	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MOE	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MOT	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MRG	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MRW	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
MUS	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
NOB	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
OTT	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
PAU	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
PER	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
PIC	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
PIK	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
POR	JANUARY	2226359.	0.0000	0.0000	0.0000	0.0000
PRE	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
PUT	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
RIC	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
ROS	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
SAN	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
SCI	JANUARY	0.	0.0000	0.0000	0.0000	0.0000

SEN	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
SHE	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
STA	JANUARY	3096.	0.0000	0.0000	0.0000	0.0000
SUM	JANUARY	12904378.	0.0000	0.0000	0.0000	0.0000
TRU	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
TUS	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
UNI	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
VAN	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
VIN	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
WAR	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
WAS	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
WAY	JANUARY	753584.	0.0000	0.0000	0.0000	0.0000
WIL	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
WOO	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
WYA	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
XXX	JANUARY	0.	0.0000	0.0000	0.0000	0.0000
TOT	JANUARY	56867300.	0.0000	0.0000	0.0000	0.0000
ADA	APRIL	0.	0.0000	0.0000	0.0000	0.0000
ALL	APRIL	0.	0.0000	0.0000	0.0000	0.0000
ASD	APRIL	5640.	0.0000	0.0000	0.0000	0.0000
ATB	APRIL	0.	0.0000	0.0000	0.0000	0.0000
ATH	APRIL	0.	0.0000	0.0000	0.0000	0.0000
AUG	APRIL	0.	0.0000	0.0000	0.0000	0.0000
BEL	APRIL	0.	0.0000	0.0000	0.0000	0.0000
BRO	APRIL	0.	0.0000	0.0000	0.0000	0.0000
BUT	APRIL	0.	0.0000	0.0000	0.0000	0.0000
CAR	APRIL	0.	0.0000	0.0000	0.0000	0.0000
CHP	APRIL	0.	0.0000	0.0000	0.0000	0.0000
CLA	APRIL	0.	0.0000	0.0000	0.0000	0.0000
CLE	APRIL	0.	0.0000	0.0000	0.0000	0.0000
CLI	APRIL	0.	0.0000	0.0000	0.0000	0.0000
COL	APRIL	0.	0.0000	0.0000	0.0000	0.0000
COS	APRIL	0.	0.0000	0.0000	0.0000	0.0000
CRA	APRIL	0.	0.0000	0.0000	0.0000	0.0000
CUY	APRIL	29197408.	0.0000	0.0000	0.0000	0.0000
DAR	APRIL	0.	0.0000	0.0000	0.0000	0.0000
DEF	APRIL	0.	0.0000	0.0000	0.0000	0.0000
DEL	APRIL	0.	0.0000	0.0000	0.0000	0.0000
ERI	APRIL	0.	0.0000	0.0000	0.0000	0.0000
FAI	APRIL	0.	0.0000	0.0000	0.0000	0.0000
FAY	APRIL	0.	0.0000	0.0000	0.0000	0.0000
FRA	APRIL	0.	0.0000	0.0000	0.0000	0.0000
FUL	APRIL	0.	0.0000	0.0000	0.0000	0.0000
GAL	APRIL	0.	0.0000	0.0000	0.0000	0.0000
GEA	APRIL	1151937.	0.0000	0.0000	0.0000	0.0000
GRE	APRIL	0.	0.0000	0.0000	0.0000	0.0000
GUE	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HAM	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HAN	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HAR	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HAS	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HEN	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HIG	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HOC	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HOL	APRIL	0.	0.0000	0.0000	0.0000	0.0000
HUR	APRIL	0.	0.0000	0.0000	0.0000	0.0000
JAC	APRIL	0.	0.0000	0.0000	0.0000	0.0000
JEF	APRIL	0.	0.0000	0.0000	0.0000	0.0000
KNO	APRIL	0.	0.0000	0.0000	0.0000	0.0000
LAK	APRIL	4874405.	0.0000	0.0000	0.0000	0.0000
LAW	APRIL	0.	0.0000	0.0000	0.0000	0.0000
LIC	APRIL	0.	0.0000	0.0000	0.0000	0.0000
LOG	APRIL	0.	0.0000	0.0000	0.0000	0.0000
LOR	APRIL	1581703.	0.0000	0.0000	0.0000	0.0000
LUC	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MAD	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MAH	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MAR	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MED	APRIL	4181448.	0.0000	0.0000	0.0000	0.0000
MEG	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MER	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MIA	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MOE	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MOT	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MRG	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MRW	APRIL	0.	0.0000	0.0000	0.0000	0.0000
MUS	APRIL	0.	0.0000	0.0000	0.0000	0.0000
NOB	APRIL	0.	0.0000	0.0000	0.0000	0.0000
OTT	APRIL	0.	0.0000	0.0000	0.0000	0.0000
PAU	APRIL	0.	0.0000	0.0000	0.0000	0.0000
PER	APRIL	0.	0.0000	0.0000	0.0000	0.0000
PIC	APRIL	0.	0.0000	0.0000	0.0000	0.0000
PIK	APRIL	0.	0.0000	0.0000	0.0000	0.0000
POR	APRIL	2226359.	0.0000	0.0000	0.0000	0.0000
PRE	APRIL	0.	0.0000	0.0000	0.0000	0.0000
PUT	APRIL	0.	0.0000	0.0000	0.0000	0.0000
RIC	APRIL	0.	0.0000	0.0000	0.0000	0.0000
ROS	APRIL	0.	0.0000	0.0000	0.0000	0.0000
SAN	APRIL	0.	0.0000	0.0000	0.0000	0.0000
SCI	APRIL	0.	0.0000	0.0000	0.0000	0.0000

SEN	APRIL	0.	0.0000	0.0000	0.0000	0.0000
SHE	APRIL	0.	0.0000	0.0000	0.0000	0.0000
STA	APRIL	3096.	0.0000	0.0000	0.0000	0.0000
SUM	APRIL	12904378.	0.0000	0.0000	0.0000	0.0000
TRU	APRIL	0.	0.0000	0.0000	0.0000	0.0000
TUS	APRIL	0.	0.0000	0.0000	0.0000	0.0000
UNI	APRIL	0.	0.0000	0.0000	0.0000	0.0000
VAN	APRIL	0.	0.0000	0.0000	0.0000	0.0000
VIN	APRIL	0.	0.0000	0.0000	0.0000	0.0000
WAR	APRIL	0.	0.0000	0.0000	0.0000	0.0000
WAS	APRIL	0.	0.0000	0.0000	0.0000	0.0000
WAY	APRIL	753584.	0.0000	0.0000	0.0000	0.0000
WIL	APRIL	0.	0.0000	0.0000	0.0000	0.0000
WOO	APRIL	0.	0.0000	0.0000	0.0000	0.0000
WYA	APRIL	0.	0.0000	0.0000	0.0000	0.0000
XXX	APRIL	0.	0.0000	0.0000	0.0000	0.0000
TOT	APRIL	56867300.	0.0000	0.0000	0.0000	0.0000
ADA	JULY	0.	0.0000	0.0000	0.0000	0.0000
ALL	JULY	0.	0.0000	0.0000	0.0000	0.0000
ASD	JULY	5640.	0.0018	0.0091	0.0000	0.0000
ATB	JULY	0.	0.0000	0.0000	0.0000	0.0000
ATH	JULY	0.	0.0000	0.0000	0.0000	0.0000
AUG	JULY	0.	0.0000	0.0000	0.0000	0.0000
BEL	JULY	0.	0.0000	0.0000	0.0000	0.0000
BRO	JULY	0.	0.0000	0.0000	0.0000	0.0000
BUT	JULY	0.	0.0000	0.0000	0.0000	0.0000
CAR	JULY	0.	0.0000	0.0000	0.0000	0.0000
CHP	JULY	0.	0.0000	0.0000	0.0000	0.0000
CLA	JULY	0.	0.0000	0.0000	0.0000	0.0000
CLE	JULY	0.	0.0000	0.0000	0.0000	0.0000
CLI	JULY	0.	0.0000	0.0000	0.0000	0.0000
COL	JULY	0.	0.0000	0.0000	0.0000	0.0000
COS	JULY	0.	0.0000	0.0000	0.0000	0.0000
CRA	JULY	0.	0.0000	0.0000	0.0000	0.0000
CUY	JULY	29197408.	14.4373	56.6625	0.0000	0.0000
DAR	JULY	0.	0.0000	0.0000	0.0000	0.0000
DEF	JULY	0.	0.0000	0.0000	0.0000	0.0000
DEL	JULY	0.	0.0000	0.0000	0.0000	0.0000
ERI	JULY	0.	0.0000	0.0000	0.0000	0.0000
FAI	JULY	0.	0.0000	0.0000	0.0000	0.0000
FAY	JULY	0.	0.0000	0.0000	0.0000	0.0000
FRA	JULY	0.	0.0000	0.0000	0.0000	0.0000
FUL	JULY	0.	0.0000	0.0000	0.0000	0.0000
GAL	JULY	0.	0.0000	0.0000	0.0000	0.0000
GEA	JULY	1151937.	0.4778	2.0390	0.0000	0.0000
GRE	JULY	0.	0.0000	0.0000	0.0000	0.0000
GUE	JULY	0.	0.0000	0.0000	0.0000	0.0000
HAM	JULY	0.	0.0000	0.0000	0.0000	0.0000
HAN	JULY	0.	0.0000	0.0000	0.0000	0.0000
HAR	JULY	0.	0.0000	0.0000	0.0000	0.0000
HAS	JULY	0.	0.0000	0.0000	0.0000	0.0000
HEN	JULY	0.	0.0000	0.0000	0.0000	0.0000
HIG	JULY	0.	0.0000	0.0000	0.0000	0.0000
HOC	JULY	0.	0.0000	0.0000	0.0000	0.0000
HOL	JULY	0.	0.0000	0.0000	0.0000	0.0000
HUR	JULY	0.	0.0000	0.0000	0.0000	0.0000
JAC	JULY	0.	0.0000	0.0000	0.0000	0.0000
JEF	JULY	0.	0.0000	0.0000	0.0000	0.0000
KNO	JULY	0.	0.0000	0.0000	0.0000	0.0000
LAK	JULY	4874405.	2.1380	9.0386	0.0000	0.0000
LAW	JULY	0.	0.0000	0.0000	0.0000	0.0000
LIC	JULY	0.	0.0000	0.0000	0.0000	0.0000
LOG	JULY	0.	0.0000	0.0000	0.0000	0.0000
LOR	JULY	1581703.	0.6402	2.8395	0.0000	0.0000
LUC	JULY	0.	0.0000	0.0000	0.0000	0.0000
MAD	JULY	0.	0.0000	0.0000	0.0000	0.0000
MAH	JULY	0.	0.0000	0.0000	0.0000	0.0000
MAR	JULY	0.	0.0000	0.0000	0.0000	0.0000
MED	JULY	4181448.	1.5908	7.4290	0.0000	0.0000
MEG	JULY	0.	0.0000	0.0000	0.0000	0.0000
MER	JULY	0.	0.0000	0.0000	0.0000	0.0000
MIA	JULY	0.	0.0000	0.0000	0.0000	0.0000
MOE	JULY	0.	0.0000	0.0000	0.0000	0.0000
MOT	JULY	0.	0.0000	0.0000	0.0000	0.0000
MRG	JULY	0.	0.0000	0.0000	0.0000	0.0000
MRW	JULY	0.	0.0000	0.0000	0.0000	0.0000
MUS	JULY	0.	0.0000	0.0000	0.0000	0.0000
NOB	JULY	0.	0.0000	0.0000	0.0000	0.0000
OTT	JULY	0.	0.0000	0.0000	0.0000	0.0000
PAU	JULY	0.	0.0000	0.0000	0.0000	0.0000
PER	JULY	0.	0.0000	0.0000	0.0000	0.0000
PIC	JULY	0.	0.0000	0.0000	0.0000	0.0000
PIK	JULY	0.	0.0000	0.0000	0.0000	0.0000
POR	JULY	2226359.	0.9393	4.0439	0.0000	0.0000
PRE	JULY	0.	0.0000	0.0000	0.0000	0.0000
PUT	JULY	0.	0.0000	0.0000	0.0000	0.0000
RIC	JULY	0.	0.0000	0.0000	0.0000	0.0000
ROS	JULY	0.	0.0000	0.0000	0.0000	0.0000
SAN	JULY	0.	0.0000	0.0000	0.0000	0.0000
SCI	JULY	0.	0.0000	0.0000	0.0000	0.0000

SEN	JULY	0.	0.0000	0.0000	0.0000	0.0000
SHE	JULY	0.	0.0000	0.0000	0.0000	0.0000
STA	JULY	3096.	0.0012	0.0050	0.0000	0.0000
SUM	JULY	12904378.	5.6739	23.9310	0.0000	0.0000
TRU	JULY	0.	0.0000	0.0000	0.0000	0.0000
TUS	JULY	0.	0.0000	0.0000	0.0000	0.0000
UNI	JULY	0.	0.0000	0.0000	0.0000	0.0000
VAN	JULY	0.	0.0000	0.0000	0.0000	0.0000
VIN	JULY	0.	0.0000	0.0000	0.0000	0.0000
WAR	JULY	0.	0.0000	0.0000	0.0000	0.0000
WAS	JULY	0.	0.0000	0.0000	0.0000	0.0000
WAY	JULY	753584.	0.2669	1.3197	0.0000	0.0000
WIL	JULY	0.	0.0000	0.0000	0.0000	0.0000
WOO	JULY	0.	0.0000	0.0000	0.0000	0.0000
WYA	JULY	0.	0.0000	0.0000	0.0000	0.0000
XXX	JULY	0.	0.0000	0.0000	0.0000	0.0000
TOT	JULY	56867300.	26.1627	107.2967	0.0000	0.0000

MOVES VEHICLE BASED EMISSIONS OUTPUT

MONTH	VEHICLES	HC	NOX	SO2	PM2.5
JANUARY	514412.	0.0000	0.0000	0.0000	0.0000
APRIL	514412.	0.0000	0.0000	0.0000	0.0000
JULY	514412.	13.5566	15.3045	0.0000	0.0000

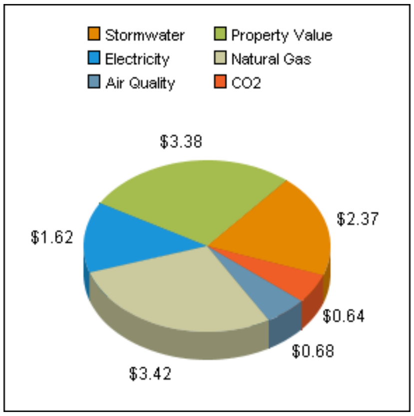
Appendix B: Street Tree Benefits

Home Calculate another tree

National Tree Benefit Calculator

Beta

Overal Benefits | Storm Water | Property Value | Energy | Air Quality | CO2 | About the Model



Breakdown of your tree's benefits
Click on one of the tabs above for more detail

This **3 inch Broadleaf Deciduous Medium Other** provides overall benefits of: $12 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations—a general accounting of the benefits produced by urban street-side plantings.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

If this tree is cared for and grows to 8 inches, it will provide $50 in annual benefits.

Broadleaf Deciduous Medium Other
Broadleaf Deciduous Medium Other

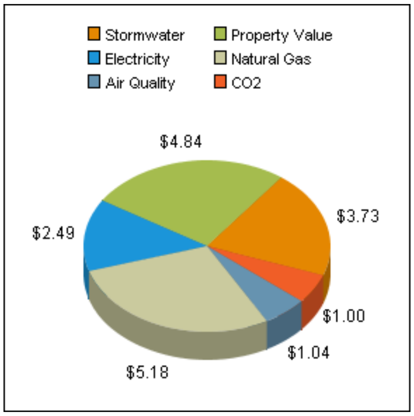
The National Tree Benefit Calculator was conceived and developed by Casey Trees and Davey Tree Expert Co.

Home Calculate another tree

National Tree Benefit Calculator

Beta

Overal Benefits | Storm Water | Property Value | Energy | Air Quality | CO2 | About the Model



Breakdown of your tree's benefits
Click on one of the tabs above for more detail

This **4 inch Broadleaf Deciduous Medium Other** provides overall benefits of: $18 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations—a general accounting of the benefits produced by urban street-side plantings.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

If this tree is cared for and grows to 9 inches, it will provide $58 in annual benefits.

Broadleaf Deciduous Medium Other
Broadleaf Deciduous Medium Other

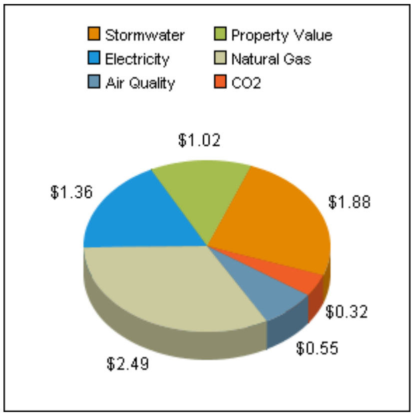
The National Tree Benefit Calculator was conceived and developed by Casey Trees and Davey Tree Expert Co.

Home Calculate another tree

National Tree Benefit Calculator

Beta

Overal Benefits | Storm Water | Property Value | Energy | Air Quality | CO2 | About the Model



Breakdown of your tree's benefits
Click on one of the tabs above for more detail

This **4 inch Ginkgo** provides overall benefits of: $8 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations—a general accounting of the benefits produced by urban street-side plantings.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

If this tree is cared for and grows to 9 inches, it will provide $29 in annual benefits.

Ginkgo
Ginkgo biloba

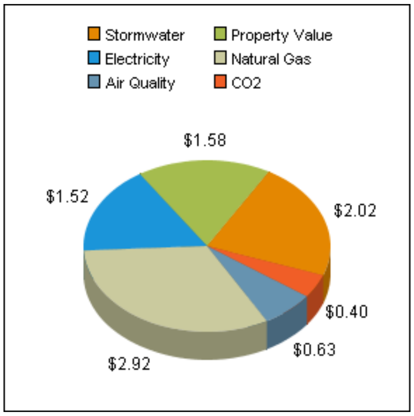
The National Tree Benefit Calculator was conceived and developed by Casey Trees and Davey Tree Expert Co.

Home Calculate another tree

National Tree Benefit Calculator

Beta

Overal Benefits | Storm Water | Property Value | Energy | Air Quality | CO2 | About the Model



Breakdown of your tree's benefits
Click on one of the tabs above for more detail

This **3 inch Maple** provides overall benefits of: $9 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations—a general accounting of the benefits produced by urban street-side plantings.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

If this tree is cared for and grows to 8 inches, it will provide $51 in annual benefits.

Maple
Acer species

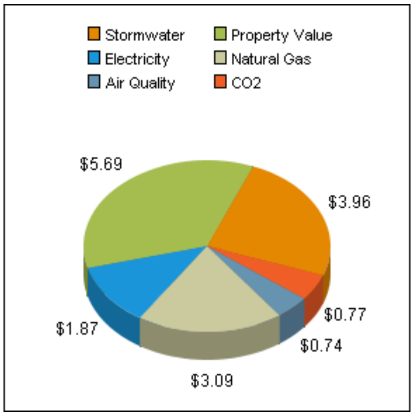
The National Tree Benefit Calculator was conceived and developed by Casey Trees and Davey Tree Expert Co.

Home Calculate another tree

National Tree Benefit Calculator

Beta

Overal Benefits | Storm Water | Property Value | Energy | Air Quality | CO2 | About the Model



Breakdown of your tree's benefits
Click on one of the tabs above for more detail

This **4 inch White oak** provides overall benefits of: $16 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations—a general accounting of the benefits produced by urban street-side plantings.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

If this tree is cared for and grows to 9 inches, it will provide $55 in annual benefits.

White oak
Quercus alba

The National Tree Benefit Calculator was conceived and developed by Casey Trees and Davey Tree Expert Co.

LANDSCAPE GENERAL SUMMARY - URBAN AVENUES

PLAN SHEET NUMBER							PARTICIPATION 09/MPO/OT	ITEM	ITEM EXT.	GRAND TOTAL	UNIT	DESCRIPTION	DETAIL SHEET NO.
185	186	188	189	190	191	192							
					8		8	661	40141	8	EACH	DECIDUOUS TREE 6, 4" CALIPER, GINGKO BILOBA 'PRINCETON SENTRY' - 'PRINCETON SENTY' MAIDENHAIR TREE	194 - 197
						2	2	661	40141	2	EACH	DECIDUOUS TREE 7, 4" CALIPER, QUERCUS BICOLOR - SWAMP WHITE OAK	194 - 197
					30		30	661	30061	30	EACH	EVERGREEN SHRUB, 15" HEIGHT, TAXUS X MEDIA 'EVERLOW' - EVERLOW YEW	194 - 197
					280	118	398	661	14001	398	EACH	PLANTING, MISC.: HEDERA HELIX - ENGLISH IVY	194 - 197
					824		824	661	14001	824	EACH	PLANTING, MISC.: CAREX PENSYLANICA - OAK SEDE	194 - 197
		139	22				161	SPECIAL	69098700	161	CY	TREE AND PLANTS SOIL MIX FURNISHED & PLACED, AS PER PLAN (24" DEPTH UPPER HORIZON)	193
		52	8				60	SPECIAL	69098700	60	CY	TREE AND PLANTS BASE MIX FURNISHED & PLACED, AS PER PLAN (9" DEPTH LOWER HORIZON)	193
		183	147				330	SPECIAL	69098700	330	CY	SAND-BASED STRUCTURAL SOIL FURNISHED & PLACED, AS PER PLAN (24" DEPTH UPPER HORIZON)	193
		69	55				124	SPECIAL	69098700	124	CY	SAND-BASED STRUCTURAL SOIL BASE MIX FURNISHED & PLACED, AS PER PLAN (9" DEPTH LOWER HORIZON)	193

SITE FURNISHINGS GENERAL SUMMARY - URBAN AVENUES

PLAN SHEET NUMBER									PARTICIPATION 09/MPO/OT	ITEM	ITEM EXT	GRAND TOTAL	UNIT	DESCRIPTION	DETAIL SHEET NO.
			185	186	311	312									
			5		5				10	SPECIAL	68014550	10	EACH	BIKE RACK	364
			1		1				2	SPECIAL	68014550	2	EACH	TRASH (LITTER) RECEPTACLE	364
			160	228	98	148			634	SPECIAL	69098100	634	FT	PLANTER CURB, GRANITE	193 - 197

MKSK
LANDSCAPE ARCHITECTURE + URBAN PLANNING

R/W DESIGNER LHW/AH
R/W REVIEWER JRB

LANDSCAPE GENERAL SUMMARY

FRA-70-14.05C

3524-E

P:\2013\c13811.06-70-71 4R & 4H\CADD\Current\Sheets\105596pn000.dwg

LANDSCAPE GENERAL SUMMARY - URBAN AVENUES

PLAN SHEET NUMBER										PARTICIP.	ITEM	ITEM EXT	GRAND TOTAL	UNIT	DESCRIPTION	DETAIL SHEET NO.
		525	526	527	528	529	530	531								
			630	630	210	490	490				661	11001	2450	EACH	GROUNDCOVER AND VINES, 1 YR, CLUMP, AS PER PLAN, HEDERA HELIX - ENGLISH IVY, AS PER PLAN	532
								74			661	20021	74	EACH	DECIDUOUS SHRUB, 24" HT, RIBES ALPINUM 'GREEN MOUND' - GREEN MOUND ALPINE CURRANT, AS PER PLAN	532
			65	58	10	25	22				661	20021	180	EACH	DECIDUOUS SHRUB, 18" HT, RHUS AROMATIC 'GRO-LO' - GROW LOW FRAGRANT SUMAC, AS PER PLAN	532
			87	65	17	56	27				661	20041	252	EACH	DECIDUOUS SHRUB, 24" HT, ROSA 'RADTKO' - DOUBLE RED KNOCKOUT ROSE, AS PER PLAN	532
			69	76	21	43					661	30071	209	EACH	EVERGREEN SHRUB, 24" HT, BUXUS X 'GREEN VELVET' - GREEN VELVET BOXWOOD, AS PER PLAN	532
			82	50	22	36	35				661	30071	225	EACH	EVERGREEN SHRUB, 30" SPD., JUNIPERUS SABINA 'BUFFALO' - BUFFALO JUNIPER, AS PER PLAN	532
			11	13	5						661	40141	29	EACH	DECIDUOUS TREE, 4" CALIPER, ULMUS PARVIFOLIA- LACEBARK ELM	532
		5	2								661	40141	7	EACH	DECIDUOUS TREE, 4" CALIPER, GINKGO BILOBA 'PRINCETON SENTRY', AS INDICATED	532
						7	7	6			661	40141	20	EACH	DECIDUOUS TREE, 4" CALIPER, PLATANUS AC. 'EXCLAMATION'- EXCLAMATION LONDON PLANE TREE, AS INDICATED	532
			9	9	3						661	40141	21	EACH	DECIDUOUS TREE, 3" CALIPER, MAACKIA AMURENSIS ' MAACKNIFICENT - MAACKNIFICENT MAACKIA, AS INDICATED	532
						3					661	40141	3	EACH	DECIDUOUS TREE, 3" CALIPER, ACER TRUNCATUM x PLATANOIDES 'WARRENRED' - PACIFIC SUNSET MAPLE, AS INDICATED	532

SITE FURNISHINGS GENERAL SUMMARY - URBAN AVENUES

PLAN SHEET NUMBER										PARTIC.	ITEM	ITEM EXT	GRAND TOTAL	UNIT	DESCRIPTION	DETAIL SHEET NO.
		493	494	495	496	497	498	499								
					5	3					SPECIAL	68014550	8	EACH	BIKE RACK	764
					1	1	1	1			SPECIAL	68014550	4	EACH	TRASH (LITTER) RECEPTACLE	764
		5	4	4	2						SPECIAL	69098000	15	EACH	TREE GRATE, 4' X 8'	534 - 535
			360	360	120	280	280				SPECIAL	69098100	1400	FT	PLANTER CURB, GRANITE	533 - 534

SOILS GENERAL SUMMARY - URBAN AVENUES

PLAN SHEET NUMBER										PARTIC.	ITEM	ITEM EXT	GRAND TOTAL	UNIT	DESCRIPTION	DETAIL SHEET NO.
		508	509	510	511	512	513	514								
		11.85	254.12	254.44	83.05	140.85	86.98	60.64			SPECIAL	69098700	831.29	CY	TREE AND PLANTS SOIL MIX FURNISHED & PLACED, AS PER PLAN (24" DEPTH UPPER HORIZON)	532 - 535
		4.44	95.30	95.44	31.14	52.82	32.62	22.74			SPECIAL	69098700	311.73	CY	TREE AND PLANTS BASE MIX FURNISHED & PLACED, AS PER PLAN (9" DEPTH LOWER HORIZON)	532 - 535
		127.68	314.19	361.23	155.33	114.59	102.09				SPECIAL	69098700	1175.11	CY	SAND-BASED STRUCTURAL SOIL MIX FURNISHED & PLACED, AS PER PLAN (24" DEPTH UPPER HORIZON)	532 - 535
		47.88	117.82	135.46	58.25	42.97	38.28				SPECIAL	69098700	440.66	CY	SAND-BASED STRUCTURAL SOIL BASE MIX FURNISHED & PLACED, (9" DEPTH LOWER HORIZON)	532 - 535

MKSK
LANDSCAPE ARCHITECTURE + URBAN PLANNING

R/W DESIGNER LHW/AH
R/W REVIEWER JRB

LANDSCAPE GENERAL SUMMARY

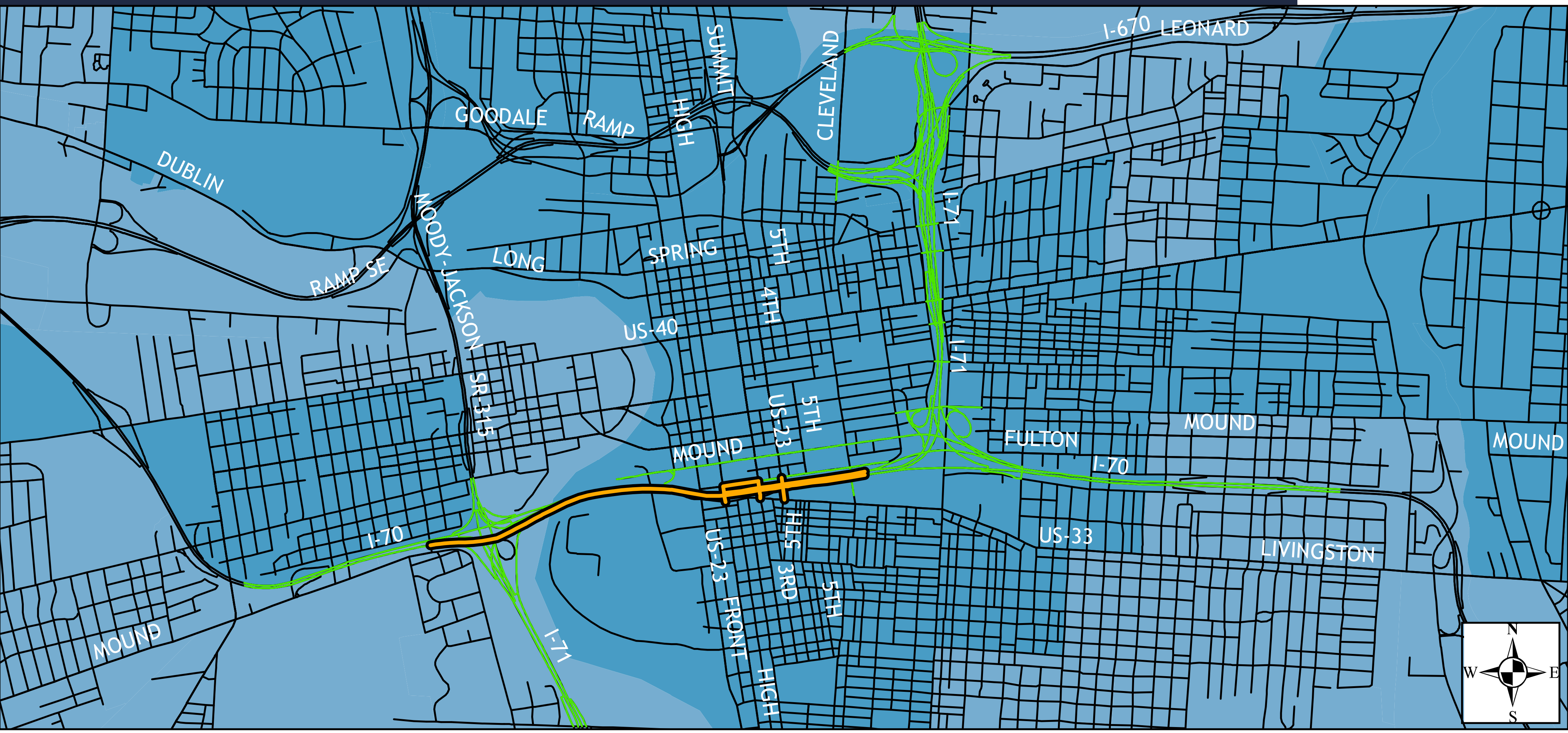
FRA-70-14.05

3555-E

Appendix C: Walk.Bike.Ohio Demand Analysis Map

Columbus Crossroads Phase 4

Walk.Bike.Ohio Demand Analysis



0 0.425 0.85 1.7 Miles

Columbus Crossroads Phase 4

Columbus Crossroads Entire Project

Demand

transportation.ohio.gov

COLUMBUS