Scioto Mile and Greenways
Methods

Research Fellow:
Halina Steiner
Assistant Professor
The Ohio State University

Research Assistant:
Sarah Sanders
MLA Candidate
The Ohio State University

Firm Liaison:
Sarah Richardson, PLA, ASLA, LEED AP
Senior Associate, Project Manager
MKSK

To cite:

The full case study can be found at: https://landscapeperformance.org/case-study-briefs/scioto-mile-and-greenways

Table of Contents

Acknowledgements

Environmental Benefits

- ***Increased riparian edge habitat by 5.4 acres, the size of 4 football fields and an estimated fourfold (200%) increase over previous conditions. Of the riparian habitat plant species, 25% have special value for pollinators, 50% provide food/habitat for birds, 25% provide food/habitat for small mammals, and 39% are attractive to butterflies and moths with 27% being larval host plants.***

Method: AutoCAD drawings were used to calculate the total area of the new habitat. Evaluation of plant species, specified on drawings and confirmed in the field, were evaluated using the plant databases from USDA PLANTS, Missouri Botanical Garden, and the Lady Bird Johnson Wildflower Center to determine special value for insect and animal habitats. Simple percentages were calculated compared to the total number of species. Species which had multiple varieties were only counted one time. Total number of butterflies and moths was simply counted.

An estimation of the riparian edge habitat conditions were made using historical aerial imaging from Google Earth Pro. Three images were chosen because they had the most clarity – imagery dating from 3/6/2002, 12/31/03, and 5/28/10. Other images were discarded due to poor quality or shadow location which limited ability to see vegetated areas. The 5/28/10 image had one section which had been already disturbed by construction, so an image from 2009 was substituted in that area estimate even though it was of lower quality.

Measurements were made using the Google Earth Pro Ruler tool. Polygons were drawn around riverside vegetation which appeared naturalized on images. Screen shots were taken of the

polygons and measurement of area in acres. These sections were added up for each year. The three years were then averaged to come up with the estimated total habitat acreage of 2.72. Pre-construction site surveys were consulted, but did not provide sufficient information about the location and extent of vegetated areas under evaluation to use as comparison.

For the current habitat cover acreage, construction documents were used to establish the area planted with wildlife supporting vegetation, such as grasses, shrubs, and tree groves along the river edge. AutoCAD was used to measure the area of the site designed with this riverside habitat. Additionally, the same procedure using Google Earth Pro was used to evaluate the vegetated areas currently present on site. These two areas were averaged to come up with the current habitat area of 8.12 acres.

 The % difference between these two estimates were then calculated.

Calculations:

Pre-Construction:
3/2002 image: 0.68 + 0.42 + 0.87 + 0.41 + 0.89 = 3.27 acres
12/2003 image: 0.49 + 0.29 + 0.29 + 0.64 + 0.40 = 2.11 acres
5/2010 image: 0.37 + 0.51 + 0.91 + 0.71 + 0.28 = 2.78 acres
Average pre-construction: (3.27 + 2.11 + 2.78)/3 = **2.72 acres**

2021 image: 1.24 + 0.09 + 0.20 + 0.70 + 0.37 + 0.06 + 0.57 + 0.44 + 0.09 + 0.22 + 0.67 +1.04 + 0.89 + 0.44 + 0.31 = 7.33 acres
AutoCad : 8.91 acres
Current Average acres: (7.33 + 8.91)/2 = **8.12 acres**

Difference between: 8.12 - 2.72 = **5.4 acres**
% Difference between: (8.12 - 2.72)/2.72 * 100% = **198.5294117647%**

5.4 acres = 235,224 sq ft
1 football field = 57,600 sq ft.
235,224/57,600 = 4.08
5.4 acres = **4.08 football fields**

% Calculations of plant species:
Total # of identified species = 114 (counts multiple varieties of the same species as 1)
Total # of species with Special Value to Pollinators = 29 (29/114 x 100= 25%)
Total # species that are Larval Hosts: 31 (31/114 x 100 = 27%)
Total # species attractive to Birds: 57 (57/114 x 100 = 50%)
Total # of species attractive to Mammals: 28 (28/114 x 100 = 25%)
Total # of species attractive to Butterflies/Moths: 45 (45/114 x 100 = 39%)

See APPENDIX B for full list of species identified with category designations

Sources:

Google Earth Pro V 7.3.3.7786. (March 6, 2002). Columbus, OH. 39° 57'25.83"N, 83°00'22.30"W, Eye alt 2251 feet. Maxar Technologies 2021. Accessed June 14, 2021

Google Earth Pro V 7.3.3.7786. (December 31, 2003). Columbus, OH. 39° 57'25.83"N, 83°00'22.30"W, Eye alt 1663 feet. Image Landsat Corporation. Accessed June 14, 2021

Google Earth Pro V 7.3.3.7786. (June 4, 2009). Columbus, OH. 39° 57'25.83"N, 83°00'22.30"W, Eye alt 1662 feet. Image USDA Farm Service Agency. Accessed June 14, 2021

Google Earth Pro V 7.3.3.7786. (May 28, 2010). Columbus, OH. 39° 57'25.83"N, 83°00'22.30"W, Eye alt 2302 feet. Image Landsat Corporation. Accessed June 14, 2021

Google Earth Pro V 7.3.3.7786. (2021). Columbus, OH. 39° 57'25.83"N, 83°00'22.30"W, Eye alt 1989 feet. Google 2021. Accessed June 14, 2021

"Native Plants Database." Lady Bird Johnson Wildflower Center - The University of Texas at Austin. Accessed June 29, 2021. https://www.wildflower.org/plants/

"Plant Finder." Missouri Botanical Garden. Accessed June 29, 2021. https://www.missouribotanicalgarden.org/plantfinder/plantfindersearch.aspx

USDA, NRCS. (2021). PLANTS Database (https://plants.sc.egov.usda.gov/, (5/2021). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Foster, Steven, and James A. Duke. *Peterson Field Guide to Medicinal Plants and Herbs of Eastern and Central North America*. Third edition. Peterson Field Guides.
Boston: Houghton Mifflin Harcourt, 2014.

Henn, Robert L. *Wildflowers of Ohio*. 2nd ed. Bloomington, IN: Quarry Books, 2008.

Howell, Catherine Herbert. *Pocket Guide to the Wildflowers of North America*. Washington, D.C: National Geographic, 2014.

Marrone, Teresa. *Common Backyard Weeds of the Upper Midwest*. Cambridge, Minnesota: Adventure Publications, 2017.

White, Annie S. "From Nursery to Nature: Evaluating Native Herbaceous Flowering Plants versus Native Cultivars for Pollinator Habitat Restoration." Ph.D., The University of Vermont and State Agricultural College. Accessed June 30, 2021. https://www.proquest.com/docview/1805944753/abstract/CAC129B671459BPQ/1.

Limitations:

- Habitat value is an estimate based on large groupings of plants and is based primarily upon design intention and known plant characteristics. Actual habitat value of the acreage varies depending upon human recreational activities disturbing creatures, maintenance procedures which disrupt life cycles of insects, or removal of certain species that harm plants or detract from human centric focus of the site. Additionally, these calculations do not take into consideration the concentration or number of

individuals of single plant species and are based on a simple inventory.

- Plant species confirmation was completed on a representative sample of the site. Given the large acreage and the local presence of invasive species, other portions of the site could be providing less habitat than intended by the design.
- Pre-construction estimates of habitat area are based on available Google Earth Pro satellite imaging and measurement tools and the accuracy of this tool is unknown. Clarity of imaging as well as user variability in drawing polygon areas for measurement could have impacted accuracy as well. Averaging measured area over three sets of images was used to help provide as accurate a value as is possible.
- According to research completed by A.S. White, cultivars of native plants do not always have the same value for pollinators as those of the straight species. The resources used to determine the value of the plants on site only relate to the straight species, and little study has been made about the individual 'nativar' characteristics that might impact that value. Although for the purposes of this study, nativars were treated as native plants, the actual value of the cultivated varieties could be less or more than intended.
- Plant identification was made by a graduate research assistant who is not a trained botanist. Misidentification of a plant species is possible and could have impacted percentages and value judgements. Additionally, there were, at minimum, 20 plants that remained unidentified. Identification of these could impact values reported as well.

- ***Achieved high ecological integrity of plant communities observed on the site as demonstrated by an Adjusted Floristic Quality Index (FQI) score of 35, which corresponds to a high quality vegetation status.***

Background: Prior to the project being completed, a large portion of this site was under water and the bank of the river was channelized. Bankside conditions were primarily impervious surfaces with minimal plant material. Some areas were covered with turf grass and some shade trees. This reflects a likely condition of poor biodiversity and a low FQI score.

Method: To evaluate the current ecological integrity of the plant communities of the site, the graduate research assistant completed a representative onsite inventory which was compared with the planting list provided by the firm.

The onsite inventory was completed by walking along the no-mow zone and identifying each individual plant species which occurred within this area. Additionally, the general health and presence of trees, shrubs, and grasses in maintained areas were compared to the planting plan provided by the design team. This plant list was input into the Universal Floristic Quality Assessment Calculator as a site inventory assessment using the Indiana 2019 Database. This resulted in a Total FQI of 30.8, a Native FQI of 34.9 and an adjusted FQI of 35.

Adjusted FQI uses introduced or non-native species in its calculations and includes their contributions. This is best used in sites with high levels of human disturbance like Scioto Mile and Greenways. An FQI score of 35 or above indicates "natural area" quality.

Calculations: See Appendix A for a copy of the FQI report.

Sources:

Freyman, William A., Linda A. Masters, and Stephen Packard. "The Universal Floristic
Quality Assessment (FQA) Calculator: An Online Tool for Ecological Assessment and
Monitoring." *Methods in Ecology and Evolution* 7, no. 3 (2016): 380–83.
https://doi.org/10.1111/2041-210X.12491.

Spyreas, Greg. "Floristic Quality Assessment: A Critique, a Defense, and a Primer."
Ecosphere 10, no. 8 (2019): e02825. https://doi.org/10.1002/ecs2.2825.

Limitations:

- Like all measures of this type there is an element of subjectivity inherent in the tool, despite attempts by the creators to minimize these. One specific limitation this particular tool had for this site is that there is not a plant/coefficient inventory designed for Ohio plant communities. The FQI had to be determined using the closest equivalent which was designed for neighboring state Indiana. Therefore, the FQI may have less applicability for this site.
- Plant identification was made by a graduate research assistant who is not a trained botanist. Misidentification of a plant species is possible and could have impacted percentages and value judgements. Additionally, there were, at minimum, 20 plants that remained unidentified. Identification of these could impact values reported as well.
- Some of the plants indicated on the planting schedule provided by the firm are cultivars of native plants, referred to as nativars. These cultivars are not present in the database used to calculate FQI and so were included by adding the straight species to the calculation. This may mean that the higher FQI is less reflective of the site's biodiversity and habitat value than it may have been otherwise.
- There were 17 identified species which did not exist in the FQA Database and so were not included in this calculation. These species are mostly non-native or highly cultivated cross-species varieties. This affects the FQI validity; however, the relatively small number of these species that were planted along with their inclusion on site in highly maintained areas means that they have less impact on the overall habitat value of the site than were they more widespread.
- A more accurate assessment based on plotted sample and % coverage was attempted as well to gain additional perspective on the habitat quality. However, due to the inability to identify three widespread species an accurate plot assessment was not able to be completed. Some plots showed high coverage of invasive species which suggested that to maintain biodiversity on site increased maintenance and removal should be considered.

- ***Increased macroinvertebrate species from 42 to 66 (sensitive species increased from 2 to 28) and fish species from 23 to 30 (sensitive species increased from 1 to 3), as compared to pre-project conditions, including 5 species considered threatened in the state of Ohio. This led to an improvement in habitat assessment***

by the Ohio Environmental Protection Agency from Very Poor to Very Good for macroinvertebrates and from Fair/Good to Very Good/Exceptional for fish.

Background: Prior to the Greenways project, the Scioto River at this location flowed through a channel which had a modified channel reinforced with concrete, and flood flows were contained by levee construction. Water was also impounded by the Main St. low head dam. It is located in a downtown urban area which receives a high amount of runoff from impervious surfaces carrying high amounts of pollution. It also is the location of two CSO outflow pipes. In 2010 this area was given the Clean Water Act designation MWH-I (Modified Warmwater Habitat-Impounded). The MWH designation is applied to "extensively modified habitats...capable of supporting the semblance of warmwater biological community, but fall short...due to functional and structural deficiencies," (US EPA, 2015).

Method: Reports which document river monitoring, completed by the Ohio EPA, both prior to and after project completion, were reviewed for information on water and habitat quality. Information was directly sourced from these documents.

Macroinvertebrate Assessments:
2009: Total Species: 42 including 2 sensitive species. Narrative Evaluation: Poor. Notes midges predominate
2016: Total Species: 66 including 28 sensitive species
(Note: sensitive species are those that face one or more threats to their populations and/or habitats)

Fish Assessments:
2009: Total Species 23 including 1 intolerant species Narrative Evaluation: Fair
2016: Total Species 30 including 3 intolerant species
(Note: intolerant species are sensitive to small changes in water quality)

Habitat Designation:
2009: MWH-I (Modified Warmwater Habitat-Impounded)
2016: WWH (Warmwater Habitat)

Data from Pre-construction - testing completed in 2009 at river mile 131.8
    Index of Biotic Integrity (IBI): 34
    Invertebrate Community Index (ICI): N/A (due to impoundment)
    Qualitative Habitat Evaluation Index (QHEI): 45 (Fair)
    Narrative Assessment - Fish/Macroinvertebrates: Fair- Good/Very Poor

Data Post-Construction - testing completed in 2016 at river mile 131.4 and 132.1
    IBI: 45
    ICI: 42
    QHEI: 62 (Good)
    Narrative Assessment - Fish/Macroinvertebrates: Very Good- Exceptional/Very Good

Sources:

"Biological and Water Quality Study of the Middle Scioto River and Select Tributaries, 2010 and Appendices." OHIO EPA Technical Report, November 21, 2012. https://www.epa.state.oh.us/Portals/35/documents/MiddleSciotoTSD2010.pdf.

Bolton, Mike. "2016 and 2017 Biological and Habitat Studies of the Rivers and Streams in 33 Section 319(h) and SWIF/GLRI Project Areas in Ohio and Appendices." Ohio EPA Division of Surface Water Ecological Assessment Unit, September 2020. https://www.epa.state.oh.us/Portals/35/documents/DRAFT_2016-2017_319Report.pdf.

US EPA, OW. "Ohio's Tiered Aquatic Life Use Designations Turn 20 Years Old." Collections and Lists, October 28, 2015. https://www.epa.gov/wqc/ohios-tiered-aquatic-life-use-designations-turn-20-years-old.

"USFWS: Endangered and Threatened Species in Ohio." Accessed June 21, 2021. https://www.fws.gov/midwest/endangered/lists/ohio-spp.html.

Limitations:

- There are a multitude of factors which impact the presence and health of fish and macroinvertebrate populations in a river which cannot be wholly ameliorated by improving what amounts to a small portion of river and bank. Other projects, such as new CSO infrastructure completed around the same time, would also impact these communities. Additionally, conditions both up and downstream that limit species migration or impact water quality will limit the effectiveness of this project's impact. More current monitoring is being completed by the Ohio EPA but the data is not yet available for review and could reflect conditions which differ from this assessment.
- This analysis depends on data provided by other researchers and cannot account for variations in collection methods and reporting, or for the skill level of the researcher.

- ***Lowers site surface temperatures by an estimated weighted average of 10 °F compared to previous conditions.***

Method:

Surface testing was completed using a Kintrex Infrared Thermometer IRT0421. The operating temperatures for this device is 32°F to 122°F with a margin of error of +/- 1.8° F. The distance to spot ratio is 12:1.

Temperatures were taken on 7/3/2021 during the period between 1pm-2pm by the graduate assistant. The reported temperature for the area on weather.com started as 77°F. It was partly cloudy, Humidity of 47%, a light wind at 9 mph from the northwest. For this day, solar noon was at 1:36pm. At 2pm when finished, the temp was reported at 78°F, partly cloudy, humidity of 42%, and wind was 11mph.

Temperatures were taken at a total of 29 locations. These occurred on various material types both in and out of shade. All temps were taken at approximately 3 ft off the surface (which

makes target surface measured approx. 3"). Notes were made of the general location within the park, the type of material, if it was in shade or not, and the minimum and maximum temperatures were recorded. Max temperatures were recorded by the device but minimum temps depended upon graduate assistant's memory and attention. At least 15 point temperatures were taken within each subtype location and in most cases many more than this to get a better average of temperatures. These min/max temps were averaged for each location, sun/shade, and material type. To evaluate the current site conditions, the site was divided into categories by material types and the total acreage of each material was calculated using the AutoCAD files provided by the firm.

Actual values for the pre-construction conditions were not available and the original survey done of the site has been lost, therefore pre-construction conditions were estimated by using Google Earth Pro aerial to generate a material type and acreage amount for each type previously on-site.

Most of the current site was previously underwater, and not considered in this calculation. The pre-construction conditions were considered concrete or turf. The temperatures that were recorded in current conditions were used as a proxy for the pre-construction temperatures. The site as it is now has 8 different material types. A weighted temp was made for each type of material by the % amount of space it takes up on the site. These weighted temps were summed as a weighted average temperature for the entire site.

The weighted average pre-construction was 90.83° and the weighted average post construction was 80.86°. This suggests that the material composition of the current site has a significantly cooler surface temp as a whole than the estimated pre-construction conditions.

Calculations:

MATERIAL TYPE	% OF ACREAGE	AVERAGE TEMP FOR MATERIAL IN SUN	WEIGHTED TEMPS
POST - CONSTRUCTION			
RED BRICK	3%	93.75	2.81 +
CONCRETE	14.20%	101.4333333	14.40 +
BLACK BRICK	0.40%	108.75	0.44 +
TURF	59%	79.86666667	47.12 +
NATIVE RIVER EDGE	22%	68.55	14.81 +
RAISED PLANTER BEDS	1.10%	71	0.78 +
PEBBLE AGGREGATE	0.20%	108.4	0.22 +

BLUESTONE	0.26%	108.6	0.28 +
	100%		**= 80.86**
PRE-CONSTRUCTION			
CONCRETE	51.20%	101.4333333	51.93 +
TURF	49%	79.86666667	38.90 +
			= 90.83

90.83 (pre-construction weighted avg) – 80.86 (post-construction weighted avg) = **9.97° F**

Sources:
Google Earth Pro V 7.3.3.7786. (April 30, 2002). Columbus, OH. 39° 57'21.14"N,
83°00'17.32"W, Eye alt 2505 feet. Image U.S. Geological Survey. Accessed July 5, 2021

Limitations:
- The temperatures taken in current site conditions were used as proxy values for pre-construction calculations by material. These may not accurately reflect the true conditions prior to project completion.
- During this study the interactive play fountains were turned off due to the COVID-19 pandemic. It is well documented that water can further cool the surrounding environment, and so the data related to current temperatures may be less reflective of longer term conditions. The hottest areas on site were those on the fountain plaza, so depending on how much the water would cool that area, the overall weighted temp of the site could be lower than estimated.
- These temperatures do not take into consideration the effects of shade on the materials. Due to the changing nature of shade due to reliance on sun position it was not possible to place an acreage amount on shaded areas with any accuracy within the limitations of this study. Additionally, given that many of the trees on site currently are still relatively young, the potential for higher amounts of shade as they grow is significant. Given that temps of all materials were on average about 20°F cooler in the shade than in the sun, their impact on the temperature of the site will increase as the trees grow and shade more area of the site and this benefit will likely show a more dramatic difference from pre-construction.
- Surface temperatures do not always correspond directly to measures of human comfort.

- ***Sequesters an estimated 5.25 tons of atmospheric carbon annually in 924 newly-planted trees, equivalent to driving a single passenger vehicle approximately 11,790 miles.***

Method: Planting plans provided by the firm were used to determine species of trees and how

many were planted on site. Given the large total number of trees, a full inventory of each tree was not possible and it was determined that a sampling would not be very accurate, as this type of sampling is more suited to a denser planting type not found on this site. Therefore, a single tree of each variety on site was identified and measured. The tree measured was selected because it was noted as being of an average size in comparison to the others on site. These values were entered in the i-Tree Eco software. i-Tree provides a cost and benefit for each tree variety based on measurements. These values were multiplied by the number of each tree variety that was planted on site to provide an estimated total. Some varieties did not exist in the i-Tree Eco database and these were calculated based on the straight species information.

Calculations: See Appendix F for copy of i-Tree summary

Common Name	Total Planted	Gross Carbon Sequestration (lb/yr)	Total GCS(lb/yr)
Red Pointe Red Maple	22	9	198
Sun Valley Red Maple	43	12.9	554.7
Sugar Maple	6	8.4	50.4
Fall Fiesta Sugar Maple	19	19.4	368.6
Green Mountain Sugar Maple	36	19.4	698.4
Autumn Blaze Red Maple	23	19.5	448.5
Marmo Maple	24	25.6	614.4
Ohio Buckeye	19	15.6	296.4
Heritage River Birch	11	10.1	111.1
Whitespire Birch	26	2.8	72.8
Frans Fontaine European Hornbeam	6	15.9	95.4
American Hornbeam	17	7.6	129.2
Northern Catalpa	7	6.3	44.1
Prairie Pride Common Hackberry	31	2.1	65.1
Katsura	6	2.2	13.2
Eastern Redbud	69	4.3	296.7
American Yellowwood	13	3.5	45.5
Winter King Green Hawthorn	25	5.5	137.5
Skyline Honeylocust	9	17.6	158.4
Kentucky Coffeetree	3	1.5	4.5
Espresso Kentucky Coffeetree	7	1.5	10.5
Moraine Sweetgum	12	7.1	85.2

Rotundiloba Sweetgum	31	4.3	133.3
Tuliptree	48	7.6	364.8
Cucumbertree Magnolia	19	6.8	129.2
Sycamore	17	8.2	139.4
London Planetree	66	18.2	1201.2
Bloodgood London Planetree	70	13.9	973
Swamp White Oak	65	14.8	962
Shingle Oak	11	8.1	89.1
Bur Oak	6	6.2	37.2
Chinkapin Oak	4	12	48
Pin Oak	2	10.9	21.8
Northern Red Oak	38	4.6	174.8
Shumard Oak	5	10.5	52.5
Common Bald Cypress	11	4.2	46.2
Princeton American Elm	63	20.2	1272.6
Lacebark Elm	1	19.9	19.9
Frontier Elm	33	10.2	336.6
TOTAL	**924**		**10,500.2 lb/yr = 5.25 U.S.tons/yr**

To calculate the equivalent in miles driven the following information was used:

- The average passenger vehicle emits about 404 grams of CO_2 per mile.
- 5.25 U.S. tons = 4.76272 Metric tons = 4762720 grams.

4762720/404 = **11,788.91** miles

Sources:

"Greenhouse Gas Emissions from a Typical Passenger Vehicle Fact Sheet." U.S. Environmental Protection Agency Office of Transportation and Air Quality. Accessed July 21, 2021. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100U8YT.pdf.

"I-Tree Eco | i-Tree." https://www.itreetools.org/tools/i-tree-eco.

Nowak, David J. "Understanding I-Tree: Summary of Programs and Methods." General Technical Report. USDA Forest Service- Northern Research Station: United States Department of Agriculture, November 2020. https://www.itreetools.org/documents/650/Understanding_i-Tree.gtr_nrs200.pdf.

Limitations:
- Multiple factors impact a tree's effectiveness in sequestering atmospheric carbon such as species, age, size, and health of the specimen, water availability, nitrogen availability, temperature, and concentrations of atmospheric gases. Therefore, this benefit is only an estimate based on assumptions related to these factors.
- Each individual tree was not measured, so the numbers represent general estimate of the overall site benefit. The actual total amount of carbon sequestration is likely to be of a higher/lower value than demonstrated here.
- i-Tree calculations are based on many factors over which the researcher had no control. Accuracy of the numbers provided are unable to be authenticated.
- This benefit does not include any trees which were previously on site and retained, only new tree plantings. Additional carbon sequestration would be expected from shrubs and other plants growing on site.
- This benefit only relates to the current tree conditions. Increased amounts are expected given growth of trees over time. i-Tree Eco has the capability of estimating growth and carbon sequestration over time, but not on an individual tree level so an accurate estimate is not possible without completing a more detailed inventory.

Social Benefits

- ***Attracts an estimated 40,000 people per week in summer months to engage in more than 35 types of recreational activities***.

Background: Prior to construction this park was primarily under water and so was unusable to people. The former site had limited use due to aging infrastructure and the disconnected nature of various sections that are now connected. Numbers pre-construction therefore could not be compared.

Method: A group of 4 undergraduate and graduate landscape architecture students were given a 15 min training on how to utilize the modified SOPARC observational protocol. Each student, along with the primary researcher and graduate research assistant, was assigned a designated location to observe and document users. These observations occurred for 30 minutes, 3x per day, on two separate days (one weekend, one weekday) occurring on June 16 and June 26, 2021. Observation started at 9:15am, 1:15pm, and 5:15pm each day. Three primary locations were observed which included Bicentennial Park, the Scioto Mile Promenade, and the Greenways Trail. Observational data was then collated into a spreadsheet from which further calculations and lists were created.

Each location observed was completed in a slightly different fashion given the nature of the site and activities it supported. Bicentennial Park was observed from a single vantage point and note was made of each individual that entered the space during the 30 min session. The Scioto Mile Promenade is unable to be fully viewed from a single vantage point, and so the observer would

start at the south end of the promenade, walk to the other end making note of those using the path and seating areas, stand for 10 min at the far end, walking back to the south end and stand in one place for the remaining time of the 30 min session. For the Greenways trail, the graduate assistant completed all sessions of this area using a modified version of the Neighborhood Predictors of Urban Trail Use Survey of Trail Use. A single location was chosen on the side of the trail and every person who crossed in front of the graduate assistant during the 30-minute window was noted. Additionally, any who used the turf hill area on the edge of the trail within visible range were counted.

Although the SOPARC protocol has specific scanning procedures for observation, the limited number of users on the site allowed for individual categorization and notation. SOPARC protocol categorizes activities by exertion level i.e. Sedentary, Walking, or Vigorous. All activities were given one of these designations, but all Vigorous activities were noted more specifically as well, such as running or cycling. Those using scooters were placed under the Walking designation, but note was made of scooter use. Additionally, specifics out of the ordinary were also noted, such as if someone was taking photographs, walking with a pet, or sleeping. This helped capture a wider understanding of the activities taking place on site.

Data was entered into an Excel spreadsheet from which data was collated and analyzed with graphs demonstrating both data specific to observational data only and the extrapolated averages. Extrapolation was based on the posted hours that the park is open, which is 7am to 11pm - or 16 hours per day.

Calculations: Calculations completed in Excel. Straight data counts were completed based on data input.

For # of activities engaged in: Observational data was used to identify 22 activities happening on site. This # was combined with 10 additional reported uses identified during the public survey. (See Appendix D.) Three additional activities were added based on usages observed by the research assistant while on site completing other research data collection (included running a business, plein air painting, and a group playing badminton). (22+10+3 = **35**)

Extrapolated # of visitors were calculated by the following process:

Average # weekday Visitors observed in 30 min: (Visitors at 9am location A 6/16 + Visitors at 9am location B 6/16 + Visitors at 9am location C 6/16) + (Visitors at 1pm location A 6/16 + Visitors at 1pm location B 6/16 + Visitors at 1pm location C 6/16) + (Visitors at 5 pm location A 6/16 + Visitors at 5 pm location B 6/16 + Visitors at 5 pm location C 6/16)/3 = **X (**X was calculated separately for category male and category female)

Average # weekend Visitors observed in 30 min: (Visitors at 9am location A 6/26 + Visitors at 9am location B 6/26 + Visitors at 9am location C 6/26) + (Visitors at 1pm location A 6/26 + Visitors at 1pm location B 6/26 + Visitors at 1pm location C 6/26) + (Visitors at 5 pm location A 6/26 + Visitors at 5 pm location B 6/26 + Visitors at 5 pm location C 6/26) = **Y (**Y was calculated

separately for category male and category female)

Xf = female weekday average 30 min = 72
Xm = male weekday average 30 min = 110
Yf = female weekend average 30 min = 66
Ym= male weekend average 30 min = 98

30 min averages were multiplied by 32 to gain an extrapolated 16 hr day # for each category
$32Xf = 32(72) = 2304 = $ **A**
$32Xm = 3520 = $ **B**
$32Yf = 2112 = $ **C**
$32Ym = 3136 = $ **D**

For a weekly extrapolated #, again calculated by sex
A + A + A + A + A + C + C = weekly female average # users = 15744
B + B + B + B + B + D + D = weekly male average # users = 23872

Total numbers of users = 15744 +23872 = 39616. This is rounded up to **40,000** for ease of reporting.

See Appendix C for averages by other reported categories and accompanying graphs and two day totals table.

Sources:

Byrne, Jason. "Neighborhood Predictors of Urban Trail Use: Survey of Trail Use." University of Southern California, 2004. https://activelivingresearch.org/core-measures-trail-use.

Cohen, MD, MPH, Deborah, and Bing Han, Ph.D. "Measuring the Use of Public Neighborhood Parks." National Recreation and Park Association. Accessed July 1, 2021.https://www.nrpa.org/parks-recreation-magazine/2018/march/measuring-the-use-of-public-neighborhood-parks/.

McKenzie, Ph.D., Thomas L., and Deborah A. Cohen, MD, MPH. "SOPARC: System for Observing Play and Recreation in Communities." Active Living Research, January 2006.https://activelivingresearch.org/soparc-system-observing-play-and-recreation-communities.

Limitations:

- Data collection is subject to many factors which could limit accuracy of information. Data collection was done by minimally trained students, in a limited number of locations on the site, and during a limited number of days/times. Actual usage and recreational activities could differ if a larger sample was conducted during multiple seasons.
- Data collection was completed during summer 2021 with some restrictions of the COVID-19 pandemic still in place. Some features of the park, such as the fountains,

were not in operation due to this which will likely alter how this space is used and the number of users of the site. Historical anecdotal accounts and photos suggest that the fountains alone can see thousands of visitors daily. Further study in the future would improve understanding of this benefit.

- One survey responder reported using the park for rock climbing, which is not an activity this park supports. A nearby park, Scioto Audubon Park, has a rock wall and it is likely that this responder was confused by which park we were referring to. Therefore, this respondents' answers were excluded from all analysis.

- ***Increased navigable riverway for paddle sport recreation by 1.3 miles due to the removal of the dam and addition of water entry points.***

Background: Prior to the low head dam removal this area of the river was dangerous for paddle sports and there were no rental companies operating on this section of the Scioto River.

Method:
Length of riverway increase was measured using Google Earth Pro line measuring tool. Distance was measured from the location of where the Main St. dam used to be to the next portage point at the Scioto Audubon Park. The line was drawn as close to the center of the river as possible.

Boat entry points were gathered from construction documents.

Contact was made with the owners of Olentangy Paddle (https://www.olentangypaddle.com/) and Windrose (https://windroseoutdoor.com/). Olentangy Paddle opened in 2014 and reports approximately 1000 kayak rentals annually. Exact numbers were not available. Windrose Outdoor started business in 2021 and has only been in business for about one month and therefore does not have figures to provide for annual usage.

Sources:
> Google Earth Pro V 7.3.3.7786. (2021). Columbus, OH. 39° 57'23.67"N, 83°00'10.28"W, Eye alt 11183 feet. Google 2021. Accessed July 2, 2021

Limitations:
- Length of river section measured using Google Earth Pro satellite imaging and measurement tools and the accuracy of this tool is unknown. Clarity of imaging as well as user variability in drawing lines and estimating starting and end points could impact accuracy as well.

- ***Improves quality of life according to 94% of 69 surveyed users. 100% of 67 surveyed users self-reported an increase of mood and 65% of 69 surveyed users reported an increase in physical activity since the site opened to the public.***

Method: A public survey was conducted to gather individual use and experience of the site. A

14-question online survey was created using a free trial account at Qualtrics.com. The survey included display logic which adjusted question display based on previous responses.

The survey was disseminated in several ways. Signs asking for participation were placed in several locations and businesses near the site. The posters included a QR code that linked to the questionnaire. Additionally, posts were made on Instagram from the Knowlton Landscape and MKSK accounts. These were tagged with other related accounts such as Columbus Recreations and Parks. A survey invitation was also posted on the Events page of the Columbus Underground (a popular online local news and information site).

A total of 102 completed surveys were received with a single responder who declined consent. Qualtrics provides a basic report with all response data, which is included in appendix D. Additional statistical analysis was also completed with the Qualtrics software. These show that although 50% of responders were familiar with the site prior to construction, there were no statistical significant differences in other responses from those who were unfamiliar with the site. This suggests that prior knowledge of the site does not impact usage or perception of the current site.

Calculations:

See Appendix D for full survey questions and response data as well as results from statistical analysis. Numbers are lifted directly from this report. Appendix E has statistical analysis completed in Qualtrics for additional information only and is not reflected specifically in benefits statements.

Reported numbers and percentages are based on respondents who checked the "somewhat agree" or "strongly agree" boxes.

For the statement "Visiting Scioto Mile and Greenways improves my mood" there were 67 responses. Of these 25 (37.31%) answered "somewhat agree" and 42 (62.69%) answered "Strongly agree". This is a total of **67 (100%)**

For the statements "Scioto Mile and Greenways has increased my physical activity" there were 69 responses. 25 (36.23%) answered "somewhat agree" and 20 (28.99%) answered "Strongly agree. This is a total of **45 (65.22%)**

For the statement "Visiting Scioto Mile and Greenways improves my quality of life/well being" there were 69 responses. 31 (44.93%) answered "somewhat agree" and 34 (49.28%) answered "strongly agree". This is a total of **65 (94.2%).**

Sources:

Qualtrics. "Qualtrics XM - Experience Management Software." Accessed July 2, 2021. https://www.qualtrics.com/.

Limitations:

- Given the large number of people who use this space, the respondent value of 102 is a

low sample size which will impact the statistical validity of results. Further study should be made with a significantly larger sample size.
- Respondents were self-selected which can bias data to those who have the time and inclination to answer surveys. This was further limited due to the distanced manner of engaging responses and lack of personal appeal for participation.
- The use of an online survey and the use of QR codes does place a limitation in regards to survey access. It would self-limit users who do not have ready internet or smart phone access. This likely causes an underrepresentation in lower income or more elderly users for whom this technology is less prevalent.
- Restrictions that the Covid-19 pandemic has placed on site usage is not fully captured in respondent numbers, survey questions, or responses. Further study should be completed in a non-pandemic situation to improve accuracy.

- ***Created 36 acres of new park space in the Downtown Columbus and Franklinton neighborhoods, a total increase of 30% and a 2.3-acre increase per 1,000 residents. Of the 15,698 residents in the neighborhoods, approximately 33% are minorities and approximately 15% live in poverty.***

Background: The site is bordered primarily by two neighborhoods, Franklinton and Downtown Columbus. In the recent past, Downtown Columbus has had minimal residential occupancy. The population of Franklinton has been predominantly minorities with high rates of poverty and unemployment and low educational attainment. Since the completion of the 2004 floodwall, demographics have shifted some as new development started.

Method:
See Appendix G for GIS map representations of data.

GIS datasets were downloaded from the National Historical Geographic Information System. Data was from the 2010 U.S. Census. Data on racial makeup was downloaded at the Census block and block group levels. Poverty status was only available at the block group level. Additionally, shape files for Franklin County Ohio Census blocks and block groups were gathered. Additional shape files for surface water came from TIGER/Line file of U.S. Census Bureau. Neighborhood Boundaries and Park Boundaries shapefiles came from Columbus Ohio Open GIS data website.

To determine the park acreage increase, QGIS was used to isolate the parks that are within the two neighborhoods. Using information from the Columbus Recreation and Parks website, it was determined which parks had been present prior to the construction of this site and what the total acreage of those parks were. Additionally, parks which only lay partially within the boundary were modified to include the acreage only within the boundary. This resulted in a finding the pre-construction there was approximately 121 acres of public park space within the two neighborhoods. Some of this acreage was rebuilt during this project, but a total of 36 acres of new parkland was developed during the course of the mile and greenway projects.

To determine the demographics of those living in these neighborhoods QGIS software was used. First, base maps were created at the block and block group levels. A half mile radius was created using the Park Boundaries of the Mile/Greenways park sections. A neighborhood boundary for Franklinton and Downtown was also identified. Using the database information and standard GIS spatial analysis tools, overview maps of racial makeup and poverty levels were created (see appendix G).

Again, using QGIS, a statistical analysis was completed with the data isolated to the neighborhood and half mile radius scales to determine the total % of people which fall into the minority and poverty categories. Analysis was completed at both the neighborhood and ½ mile radius scales, and the results were close to the same in both categories. Therefore, for ease of reporting, the neighborhood scale was retained for benefit.

Calculations:
% Increase in Parkland = [(Post - Pre)/Pre] 100
Pre-construction park acreage= ~121 acres
New acreage = 36 acres, so post acreage = 121 + 36 = 157
[(157-121)/121] 100 = **30%**

Population numbers from Census 2010:
> Total in neighborhoods of Franklinton and Downtown: 15698
> Total within a ½-mile radius of the Mile/Greenways: 5888

Parkland per 1000 residents: (36 new acres)/(15698 total pop/1000) = 36/15.698 = **2.3 acres per 1000 people**.

Sources:
> Bureau, US Census. "TIGER/Line Shapefiles." The United States Census Bureau. Accessed July 21, 2021. https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html.
>
> "GIS Open Data Columbus, OH." Accessed July 21, 2021. https://opendata.columbus.gov/.
>
> Manson, Steven, Schroeder, Jonathan, Van Riper, David, Kugler, Tracy, and Ruggles, Steven. "National Historical Geographic Information System: Version 15.0." Minneapolis, MN: IPUMS, 2020. https://doi.org/10.18128/D050.V15.0.
>
> QGIS.org, 2021. QGIS Geographic Information System. QGIS Association. http://www.qgis.org
>
> QGIS.org, 2021. QGIS 3.16. Geographic Information System User Guide. QGIS Association. Electronic document: https://docs.qgis.org/3.16/en/docs/user_manual/index.html

Limitations:
● This method relies on accuracy of demographic and residency data provided by the

government and is subject to the inaccuracies present within this data. It could be subject to data entry error, methods of data collection errors, or incomplete data that we cannot account for.

- 2020 Census data was not yet available at the time of the study and more current data since 2010 is not available at this scale. Therefore it is unknown how the population and demographics of the area has changed since the additional park space has been created.

Economic Benefits

- ***Supports local businesses, with 78% of 82 survey respondents reporting patronizing local businesses. 48% reported spending $15-20 and 30% reported spending less than $15 per visit.***

Method: A public survey was conducted to gather individual use and experience of the site. A 14-question online survey was created using a free trial account at Qualtrics.com. The survey included display logic which adjusted question display based on previous responses.

The survey was disseminated in several ways. Signs asking for participation were placed in several locations and businesses near the site. The posters included a QR code that linked to the questionnaire. Additionally, posts were made on Instagram from the Knowlton Landscape and MKSK accounts. These were tagged with other related accounts such as Columbus Recreations and Parks. A survey invite was also posted on the Events page of the Columbus Underground (a popular online local news and information site).

A total of 102 completed surveys were received, with a single responder who declined consent. Qualtrics provides a basic report with all response data, which is included in appendix D. Additional statistical analysis was also completed with the Qualtrics software.

Calculations:
See Appendix D for full survey questions and response data as well as results from statistical analysis. Numbers are lifted directly from this report. Appendix E has Statistical analysis completed in Qualtrics for interest only and not reflected specifically in benefits statements.

82 respondents answered the question "When visiting Scioto Mile and Greenways, how frequently do you patronize nearby businesses or restaurants?". 2 of these answered "First visit" and 18 answered "Never". Of the remaining, 52 (63.41%) answered "Once in a while", 9 (10.98%) answered "Regularly", and 1 (1.22%) answered "Always".
To calculate % survey respondents who patronize businesses- 2+ 52 + 9 + 1 = 64/82(100) = **78%**

Only respondents who answered in the affirmative were shown the following question and 63

responded to "On average, approximately how much do you spend at nearby businesses or restaurants during a single trip?". 4 (6.25%) answered "$0", 19 (30.16%) answered "under $15", 30 (47.62%) answered "$15-49", 9 (14.29%) answered "$50-74", 0 answered "$75-99" and 1 (1.59%) answered 100+.

To come up with average spent, the first thing was each category was given a value that is reflective of an average for that category using the following formula $(X_a + X_e + ...X_n/n)$
This results in averages for each category= 0, 7.5, 32, 62, 87, 150

Using this a weighted average was calculated:
$[4(0) + 19 (7.5) + 30 (32) + 9 (62) + 1 (150)]/63 =$
$(0 + 142.5 + 960 + 558 + 150) / 63 =$
$$1,810.5 / 63 = \textbf{\$29 average}$$

Sources:
Qualtrics. "Qualtrics XM - Experience Management Software." Accessed July 2, 2021.
    https://www.qualtrics.com/.

Limitations:
- Given the large number of people who use this space, the respondent value of 102 is a low sample size which will impact the statistical validity of results. Further study should be made with a significantly larger sample size.
- Respondents were self-selected which can bias data to a particular type of person who has the time and inclination to answer surveys. This was further limited due to the distanced manner of engaging responses and lack of personal appeal for participation.
- The use of an online survey and the use of QR codes does place a limitation in regards to survey access. It would self-limit users who do not have ready internet or smart phone access. This likely causes an underrepresentation in lower income or more elderly users for whom this technology is less prevalent.
- Restrictions that the COVID-19 pandemic has placed on site usage is not fully captured in either respondent numbers, survey questions or answers. Further study should be completed in a non-pandemic situation to improve data.

- ***Contributes to the economic development of downtown Columbus and the East Franklinton neighborhood within a half-mile radius of the site, with 584 apartment units constructed and more than 2,200 planned. 214,000 sf of commercial space was added to the area with at least 243,200 sf planned. In total $320 million in investment capital has been injected into the area, with an additional $620 million in planned investments.***

Background: The Scioto Mile and Greenways projects are only one part of a long-term plan for revitalization of the Downtown and East Franklinton neighborhoods. They were some of the first implemented as the city felt that the public greenspace would serve as an anchor for future investment. Until a floodwall was completed in 2004, East Franklinton had limited

developmental potential due to legal status of the land as a floodplain, with very strict development restrictions in place. Developers started buying land speculatively when the floodwall was nearing completion.

Method: Online sources, including development websites, local newspaper articles, and Franklin Co Auditor's parcel search were reviewed to find information about development that has been completed or planned since Scioto Mile/Greenways was completed. This information was compiled and added up to determine a total amount. The developments counted were limited to the radius demonstrated in Figure 1. This radius represents a ½ mile distance from the Scioto Mile and Greenways.
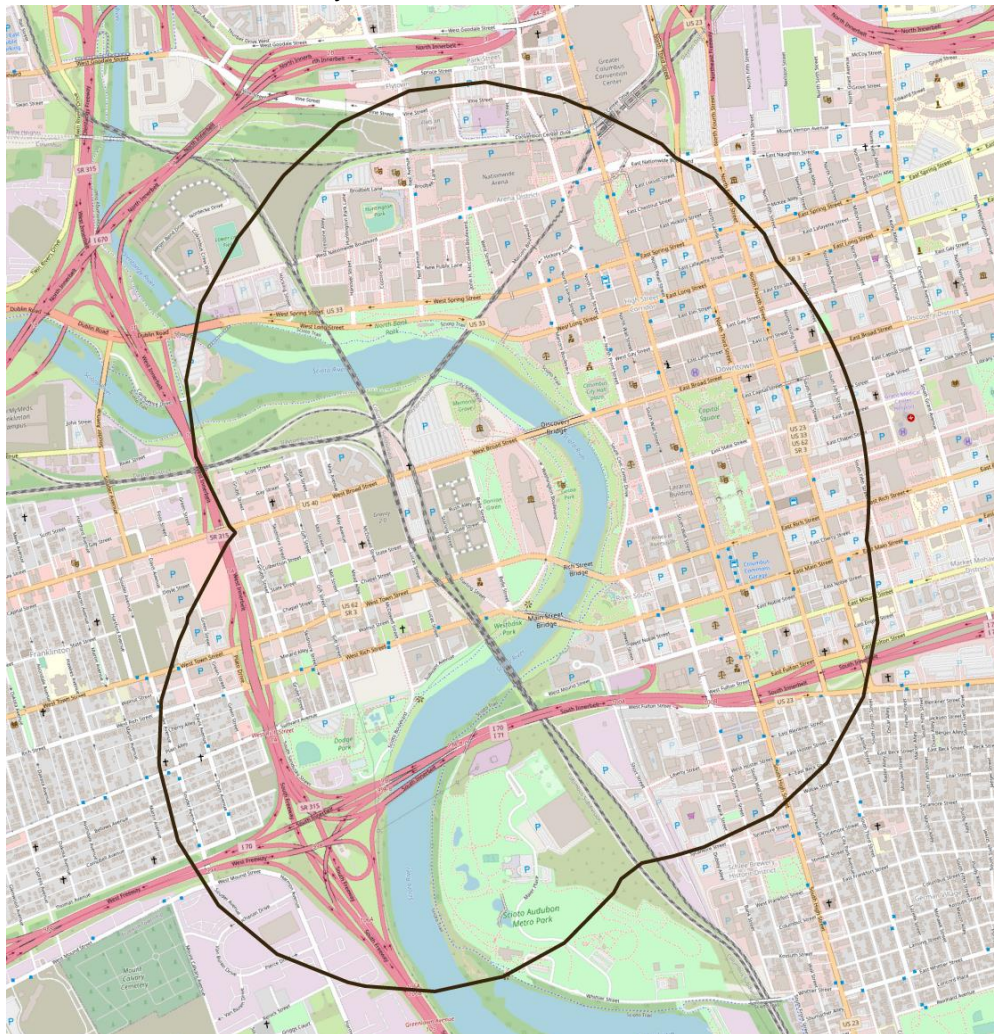

Figure 1. ½ mile radius from Scioto Mile and Greenways.

Calculations:

Development	$ Investment	Housing Units	Office sf	Retail sf	Parking spaces

303 S. Front	$12 mil	89	NA	NA	NA
Millennial Tower	$90 mil	189	150,000	40,000	700
LC Riversouth	$30 mil	106	NA	NA	NA
River & Rich	$65 mil	200	NA	24,000	300
Totals	**$197 mil**	**584**	**150,000 sqft**	**64,000 sqft**	**1000**

Planned Development	$ Investment Potential	Planned Housing Units	Planned Office sf	Planned Retail sf	Planned Parking Spaces
LC Riversouth Phase II		137			
River & Rich Phase II		180	48,000		288
Gravity Phase II	$120 mil	12 story residential, 5 story townhome/apartment, 5 story "co-living"	195,200 combined office and retail		899
Peninsula (phase 1 construction started)	$500 mil	1800	2,000,000	400 hotel rooms	Not known
Totals	**$620 mil**	**2,117 +**	**2,243,200 + sf**		**1,187 +**

Cultural Amenity Added	$ Investment	Park Size	Building sf	Parking Spaces
National Veterans Memorial and Museum	$82 mil	2.5 Acre Memorial Grove	53,000	
American Museum of Natural History Dino Gallery at COSI	$7 mil		22,000 (part of COSI main floor)	
Dorrian Green	$34 mil	6.5 acre atop underground parking structure		600
Totals	**$123 mil**	**9 acres**	**75,000 sf**	**600**

Sources:

5837071. "The Transformation of the Downtown Columbus Riverfront 1998-2020." Issuu.
Accessed July 4, 2021. https://issuu.com/mksk/docs/1998-
2020_downtowncolumbusriverfronttransformation.

"Announcing 303 South Front Street | Borror." Accessed July 4, 2021.
https://borror.com/2016/03/announcing-303-south-front-street/.

"Columbus Downtown Development Corporation + Capitol South | CDDC." Accessed July
4, 2021. https://www.columbusddc.com/.

Columbus Underground. "Designing The Scioto Peninsula in Columbus, Ohio | CU," May
29, 2021. https://www.columbusunderground.com/designing-the-scioto-peninsula-in-
columbus-ohio-mksk/.

Columbus Underground. "Development Update: LC RiverSouth," December 2, 2016.
https://www.columbusunderground.com/development-update-lc-riversouth-bw1/.

"Downtown Columbus Apartments for Rent | 303." Accessed July 4, 2021.
https://www.the303columbus.com/.

Columbus Business First. "Downtown Columbus Apartments: Here Are 3 New Projects and
What They Cost." Accessed July 4, 2021.
https://www.bizjournals.com/columbus/news/2018/04/25/looking-for-a-downtown-
apartment-here-are-3-new.html.

Columbus Underground. "Gravity II Update: Demolition Begins, OhioHealth Facility
Planned," February 10, 2020. https://www.columbusunderground.com/gravity-ii-
update-demolition-begins-ohiohealth-facility-planned-bw1/.

Columbus Business First. "Kaufman Development's Gravity 2.0 Starts in Franklinton."
Accessed July 4, 2021. https://www.bizjournals.com/columbus/news/2020/02/10/120m-
franklinton-projectlands-first-tenant-starts.html.

Columbus Underground. "LC RiverSouth Design Updated, Construction to Start in
November," August 9, 2013. https://www.columbusunderground.com/lc-riversouth-
design-updated-construction-to-start-in-november/.

"Marketing BrochureFlyer.Pdf." Accessed July 4, 2021.
https://images1.loopnet.com/d2/CWGvJK6ZwWTPqSH6VWKoT3bEoqhkLvJzNez36Jq
KJ7I/Marketing%20BrochureFlyer.pdf.

"Millennial Tower – Elford Realty." Accessed July 4, 2021.
https://elfordrealty.com/featured_properties/millennial-tower/.

"National Veterans Memorial and Museum: Columbus Downtown Development Corp."
Accessed July 4, 2021. https://www.columbusddc.com/projects/NVMM.

River & Rich. "Residential Apartments | Retail Space." Accessed July 4, 2021.
https://riverandrichcolumbus.com/.

"River & Rich Apartment Building in Franklinton to Open This Weekend - Business - The Columbus Dispatch - Columbus, OH." Accessed July 4, 2021. https://www.dispatch.com/business/20190501/river-amp-rich-apartment-building-in-franklinton-to-open-this-weekend.

Columbus Underground. "Second LC Riversouth Building May Rise Up to 10 Stories Tall," March 23, 2015. https://www.columbusunderground.com/second-lc-riversouth-building-may-rise-up-to-10-stories-tall/.

"The Julian | Sullivan Bruck Architects." Accessed July 4, 2021. https://www.sbarch.com/gallery/multi-family/julian.

"The Peninsula: Columbus Downtown Development Corporation." Accessed July 4, 2021. https://www.columbusddc.com/projects/scioto-peninsula.

Weiker, Jim. "As Apartment Complexes Pop up in Downtown Columbus, so Do Rents." The Columbus Dispatch. Accessed July 4, 2021. https://www.dispatch.com/business/20180523/as-apartment-complexes-pop-up-in-downtown-columbus-so-do-rents.

"Next up for River & Rich Development in Franklinton: A 12-Story Tower." The Columbus Dispatch. Accessed July 4, 2021. https://www.dispatch.com/business/20190919/next-up-for-river-amp-rich-development-in-franklinton-12-story-tower.

"Work Begins on Second Phase of Gravity Development in Franklinton." The Columbus Dispatch. Accessed July 4, 2021. https://www.dispatch.com/business/20200210/work-begins-on-second-phase-of-gravity-development-in-franklinton.

Limitations:
- This number focuses on positive economic and building growth provided by development and does not account for negative effects that could be caused by gentrification of the area. Nor does it account for any loss of local small businesses that may occur through this development activity.
- Relies on publicly available information and likely does not account for all planned development or economic activity in the area. Further development of restaurants, art galleries and studio space, and other businesses are not considered here, but are significant for the area.
- The growth of the Downtown and Franklinton neighborhoods cannot be attributed only to the Scioto Mile and Greenways projects. The development is only one part of an overall long-term plan to revitalize this part of the city.

Appendix A: FQI Report

Appendix B: Plant List and Habitat Value Table

Appendix C: Observational Data Analysis

Appendix D: Survey Questions and Data

Appendix E: Statistical Analysis of Survey Data

Appendix F: i-Tree Summary

Appendix G: Maps of Race and Poverty