Monon Boulevard and Midtown Plaza Phases 1 and 2 Methods

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Acknowledgments

We would like to thank the ongoing support from several entities in the City of Carmel, including Michael Klitzing (Director of Parks and Recreation), Michael Allen (Director of Parks and Natural Resources), and Danny Griffin (Park Foreman) with the Carmel Clay Parks and Recreation, Karoyln Brumley (Community Relations Specialist), Nancy Heck (Director of Community Relations and Economic Development), Carol Dixon (Administrative Assistant), David Littlejohn (Alternative Transportation Coordinator), Daren Mindham (Environmental Planner), Jenell Fairman (Deputy Director), Henry Mestetsky (Executive Director) with the Carmel Redevelopment Commission, Jeremy Kashman (Civil Engineer), and Todd Gillian (Urban Forester). They helped us along the way to identify the best available resources for making this report possible.

We also would like to thank staff members, specifically Alan Rosenwinkel (Associate Landscape Architect), Jessica Vonderau (Associate and Director of Marketing), Carl Kincaid (Partner), and Rotina (Yuxin) Tian (Designer) from Rundell Ernstberger Associates (REA), Curtis Holcom (Project Manager) and William Hall (Civil Engineer) from Cross Road Engineering, Purdue IRB, and Purdue Department of Horticulture and Landscape Architecture- who made this research possible.

Research Strategy

The difference this project has brought to the City of Carmel is evident. Due to these contributions and the continual interest various organizations have expressed in the project, a considerable amount of pre-construction data has been preserved. The preservation of the data has helped to maximize the potential for comparison within this performance study. When preexisting data was unavailable the team utilized the adjacent undeveloped site as a means for comparison. Collectively the team was able to produce a holistic performance study- regardless of any gaps in data.

Several of the benefits found in this document stem from the designers and staff, who continually monitor and maintain the landscape. All parties involved, from the local government to project designers, have worked seamlessly with the research team to produce this thorough document. Collaboration was a necessary component of this effort, and without it, the document would not have come to fruition. Researchers acknowledge that certain results may lack rigor due to data unavailability or errors in collection. We are committed to detailing the limitations associated with various benefits, thereby enabling designers and researchers to minimize misunderstandings.

Project Goals:
- Implement green infrastructure techniques to sustain stormwater on-site
- Increase urban tree canopy to offer shade and mitigate the heat island effect in the summer.
- Create an identifiable district that connects the Art and Design District with the City Center District.
- Improve pedestrian and bicycle safety by creating a complete street network.
- Create an array of programmable and inclusive destinations for all seasons that engage a diverse mix of ages and abilities.
- Increase adjacent economic development through the use of recreational elements and programming.

Benefits:

Environmental Benefits

Environmental Benefit #1:
- **Improves soil health, with 3 times the amount of organic matter (8.4% organic matter) as compared to an adjacent area resembling pre-construction conditions (2.8% organic matter). Monon Boulevard's soils are 10% less alkaline, or generally more favorable to plant growth, than the adjacent area.**

Background:

The previous trail was in a light-industrial use zone. Oftentimes, soil quality is poor in industrial zones due to pollution, compaction, and impermeable surfaces, which can lead to poor soil microbiomes, loss of organic matter, poor permeability, and abnormally high soil pH. Within the development of the Monon Boulevard Project, restoration strategies were employed to remediate soil health by removing contaminated topsoil, importing new planting soil, and transplanting more vegetation.

Method:

To the south of the project site there is an area of the Monon trail that is similar to pre-existing site conditions. The research team took three soil samples in this location and three of the remediated soils within the project boundary.

Figure 1.1- Soil sample taken.

The samples were put into sealed soil sampling bags and mailed to Midwest Soil Labs (https://midwestlabs.com/) for soil quality testing. Sample 1 contains the soil gathered in Monon Boulevard and Midtown Plaza, while Sample 2 represents the soil conditions similar to that of pre-construction.

SOIL ANALYSIS REPORT

INFO SHEET: 1585459

LAB NUMBER *416*	SAMPLE IDENTIFICATION	ORGANIC MATTER L.O.I. percent RATE	PHOSPHORUS P₁ (WEAK BRAY) 1:7 ppm RATE	P₂ (STRONG BRAY) 1:7 ppm RATE	OLSEN BICARBONATE P ppm RATE	NEUTRAL AMMONIUM ACETATE (EXCHANGEABLE) POTASSIUM K ppm RATE	MAGNESIUM Mg ppm RATE	CALCIUM Ca ppm RATE	SODIUM Na ppm RATE	pH SOIL pH 1:1	BUFFER INDEX	CATION EXCHANGE CAPACITY C.E.C. meq/100g	PERCENT BASE SATURATION (COMPUTED) % K	% Mg	% Ca	% H	% Na
05075	1	8.4 VH	34 VH	65 VH		131 M	161 M	2549 VH		7.9		14.4	2.3	9.3	88.4	0.0	
05076	2	2.8 M	16 M	23 M		100 L	176 M	2529 H	636 VH	8.8		17.1	1.5	8.6	73.7	0.0	16.2

Figure 1.2- Soil Analysis Report.

Calculations:

As shown above in figure 1.1, the organic matter is significantly greater, from 2.8 percent to 8.4 percent, in fact it is three times greater (2.8 x 3 = 8.4). While the soil PH level has been balanced from original 8.8 (very alkaline) to the current 7.9 (still alkaline, but more normalized), which is a change of -10.22% (rounded) (((7.9 - 8.8)/8.8) x 100 = -10.22%) K, Mg, Ca, have all been slightly evaluated up. Normally, a pH range of 6 to 7 is generally the most favorable for plant growth, and if pH is too low or too high, it can influence the solubility of nutrients in soil (USDA, 1998). Specifically for high pH soils, there may be inadequate availability of iron (K), manganese (Mg), copper, zinc, and phosphorus and boron.

Source:

Midwest Soil Lab. Midwest Laboratories. 13611 B Street. Omaha, Nebraska 68144 https://midwestlabs.com/our-laboratories/soils

USDA Natural Resources Conservation Service. January 1998. Soil Quality Information Sheet: Soil Quality Indicators: pH. Retrieved from https://sswcd.summitoh.net/sites/default/files/2017-06/396_444%20Soil%20PH.pdf

Our team unfortunately was unable to locate data on the project site's soil conditions pre-development. Although the adjacent soil samples were collected in a similar environment to that of pre-development, they are not comprehensively accurate. In addition, three samples were collected per location, but since the site is so extensive, it is difficult to capture data that reflects the entirety of the site. Finally, soil quality improvement occurred through multiple methods, and did not necessarily span the complete entirety of the site, so the figures gathered only reflect certain conditions (within planting beds) as opposed to site-wide conditions.

Environmental Benefit #2:

- **Supports improved tree growth, with trees in a modular suspended pavement system on Monon Boulevard growing 32-35% more annually in comparison to nearby trees in similar conditions without a modular suspended pavement system.**

Background:

Soil volume is often a limiting factor in establishing a full tree canopy within an urban environment. With limited soil volume trees may be prohibited from growing to a mature size. Research from DeepRoot (Key, 2023) suggests a ratio of two cubic feet of soil for every square foot of crown projection. Generally, this recommendation is only met in non-urban settings. Given the design of the trail and limited space for tree pits, a modular suspended paving system was implemented to encourage large and healthy tree specimens.

A modular suspended pavement system is a column-like subterranean support system that holds up overhead hardscape courses and their respective load capacities, while also providing room for tree roots to expand laterally. Their open form grants tree roots access to significantly more soil volume than traditional tree pits. It also permits more direct infiltration of groundwater when combined with permeable paving- as compared to traditional construction methods. In total, there are 140 trees in 810 3x systems, providing more than 27,000ft (764m) of biologically active loamy soil within Monon Boulevard.

810 3X Silva Cells installed within the Monon Greenway.

Over 140 trees planted in Silva Cells in the Monon Greenway. Tree photographed were planted in the first planting phase of 2018 .

Figure 2.1- Installation photos taken by REA.

Method:

Kentucky coffeetrees (the 'Espresso' cultivar) and common hackberry were planted along the Monon greenway with a modular suspended pavement system installed underneath. Meanwhile, the same species were planted using conventional methods in the same timeframe (2019) along Hazel Dell Parkway and Corey Avenue in Carmel. The selected trees were of different size standards at the time of transplant (Carmel City Urban Forestry)- with those along Monon Boulevard being planted at 3" diameter and those along Hazel Dell Parkway and Corey Avenue being planted at 2" diameter.

The research team chose to examine three specimens per species that were directly adjacent to attempt to ensure similar cultural conditions. The three specimens' growth rates were then averaged so that the research team could compare the specimens planted utilizing modular suspended pavement systems and those that were not.

The research team used a Leonard Plastic Pocket Tree caliber to measure the diameter of trees and used an AdirPro 710-11 14-foot aluminum grade rod to measure the height of all trees. The diameter of the trees measured 3.5 feet above the ground. All measurements were collected using the same procedure.

Figure 2.2- Capturing tree measurements

Calculations:

To evaluate the growth rate the current diameter (inches) was subtracted by the original diameter (inches) upon transplanting, then divided by 4, which is the number of years between transplanting to present day (2019-2023). Then the growth rates of each specimen were averaged on a per species basis, for both locations. Espresso Kentucky coffeetrees grew .25 inches per year on average in pits containing a modular suspended pavement system installed underneath (Monon Boulevard), as compared to .19 inches per year on average in a traditional installation method (Hazel Dell Parkway). Common hackberries grew .23 inches per year on average in pits containing a modular suspended pavement system installed underneath, as compared to .17 inches per year on average in a traditional installation. The differences between modular suspended pavement systems versus traditional systems were calculated, yielding 31.6% more growth for Espresso Kentucky Coffeetrees and 35.3% more growth for Common Hackberries.

Figure 2.3.- Tree locations of traditional systems
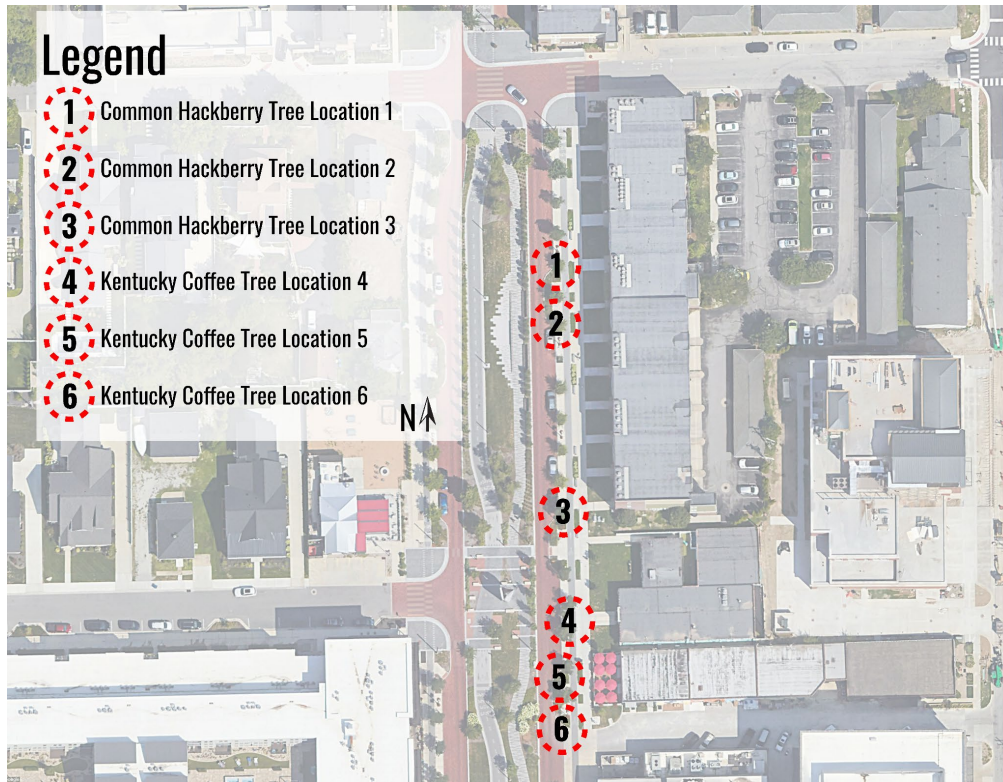
Figure 2.4- Tree locations of modular suspended pavement systems

Table 2.1- Trees Planted in Carmel, Indiana in 2019 Not Modular Suspended Pavement Systems

Number on Coordinating Plan Maps	Address	Tree Species	Diameter When Planted in 2019 (in)	Diameter Currently in 2023 (in)
1	12400 Hazel Dell Pkwy. Carmel, Indiana	Kentucky Coffeetree 'Espresso'	2"	2.26"
2	12400 Hazel Dell Pkwy. Carmel, Indiana	Kentucky Coffeetree 'Espresso'	2"	3.25"
3	12400 Hazel Dell Pkwy. Carmel, Indiana	Kentucky Coffeetree 'Espresso'	2"	2.75"
1	13092 Corey Ave. Carmel, Indiana	Common Hackberry	2"	2"
2	13092 Corey Ave. Carmel, Indiana	Common Hackberry	2"	3.25"
3	13092 Corey Ave. Carmel, Indiana	Common Hackberry	2"	2.75"

Table 1.2- Trees Planted in Carmel, Indiana in 2019 Using Modular Suspended Pavement Systems

Number on Coordinating Plan Maps	Address	Tree Species	Diameter When Planted in 2019 (in)	Diameter Currently in 2023 (in)

1	199-1 Monon Blvd. Carmel, Indiana	Kentucky Coffeetree 'Espresso'	3"	3.5"
2	199-1 Monon Blvd. Carmel, Indiana	Kentucky Coffeetree 'Espresso'	3"	4.75"
3	199-1 Monon Blvd. Carmel, Indiana	Kentucky Coffeetree 'Espresso'	3"	3.75"
4	199-1 Monon Blvd. Carmel, Indiana	Common Hackberry	3"	4.5"
5	199-1 Monon Blvd. Carmel, Indiana	Common Hackberry	3"	3.5"
6	199-1 Monon Blvd. Carmel, Indiana	Common Hackberry	3"	3.75"

Sources:

Marritz, L. (June 4, 2015). Tracking the Performance of Urban Trees in Silva Cells. Retrieved from
https://www.landscapeperformance.org/blog/2015/06/tracking-silva-cell-tree-performance

Key, A. (Jan 11, 2023). How Much Soil Do You Need to Grow a Big Tree? Retrieved from
https://www.deeproot.com/blog/blog-entries/how-much-soil-do-you-need-to-grow-a-big-tree-2/

Carmel Clay Parks and Recreation

Limitations:

A limitation of this study is the absence of same-diameter planting samples among identical tree species planted in Carmel City within the same year. Consequently, our measurements compare growth rates under the assumption that the saplings' growth was uniform in preceding years. Due to the nature of trees, the specimens measured may not have identical genetic compositions, especially the common hackberries as they are not a cultivar, which could result in varied growth rates. In addition, the exact measurements provided are assumed based upon the bid package and may not be fully accurate. Our team collected data from trees that were planted in similar cultural conditions, however, there inevitably are differences between soil composition, wind, shade, moisture, etc. between the two sites. Finally, the growth rates may not be completely accurate since the caliper measurement upon transplanting between the two locations was different.

Environmental Benefit #3:

- **Reduces peak stormwater runoff rates by up to 58% and 72% respectively for 10-year and 100-year, 24-hour storm events. An estimated 133,044 gallons of rainfall are intercepted annually in 334 newly planted trees, totaling an estimated 2.5 million gallons over the next 10 years.**

Background:

During the redevelopment of Monon Boulevard and Midtown Plaza efforts were not only made to increase passive and active recreation, but also increase sustainable stormwater management techniques to help alleviate city-wide stormwater issues. Within the project, 1.06 acres (45,173 sf) of permeable pavement was implemented- used both for roads and on-street parking- to promote stormwater infiltration on-site. Additionally, a 51,000 cubic foot water storage tank was implemented below the Midtown Plaza to capture stormwater from the plaza and beyond.

Method:

According to the Monon Boulevard Stormwater Drainage Technical Report, a total of 12 watersheds can be defined along the Monon Boulevard corridor and adjacent parcels. As indicated by local residents, the area before construction was poorly drained, and after significant rainfall events, the area would flood. During the project, an inlet was placed in a strategic location to allow for positive drainage from the area (Williams Creek, 2019), and a series of BMPs were implemented to allow ponded water to flow into depressed rain garden-like areas in order to direct discharge to the underdrain and treat the watershed for both water quality and quantity.

Table 3.1 Summary of Project Watersheds (adapted from Monon Boulevard Stormwater Drainage Technical Report)

Basin	Area (Ac)	CN
Area 7	0.33	76
Area 8	0.75	94
Area 9	0.49	88
Area 10	0.72	91
Area 11	0.64	90
Area 1	0.62	94
Area 2	0.83	89
Area 3	0.45	94
Area 4	0.36	94
Area 5	0.26	92
Area 6	0.77	93

Table 3.2 - BMP peak Performance Parameters (adapted from Monon Boulevard Stormwater Drainage Technical Report)

	Storm Event	Untreated Peak Discharge (cfs)	Treated Peak Discharge (cfs)

Area 7	10-YR	1.88	0.75
	100-YR	3.18	1.03
Area 11	10-YR	3.62	2.14
	100-YR	6.13	2.92
Area 5	10-YR	1.35	0.98
	100-YR	2.41	1.16
Area 6	10-YR	3.99	1.31
	100-YR	7.06	1.70

Table 3.3- BMP Peak Performance Parameters (Design) *(adapted from Monon Boulevard Stormwater Drainage Technical Report)*

	Storm Event	Peak Discharge Allowed (cfs)	Post-Project Peak Discharge (cfs)
Area 8	10-YR	3.14	2.90
	100-YR	5.33	3.92
Area 9+10	10-YR	0.60	0.60
	100-YR	1.20	0.75
Area 1+2	10-YR	0.72	0.65
	100-YR	1.45	0.76
Area 3+4	10-YR	0.41	0.33
	100-YR	0.81	0.41

Then the professional civil engineers used HydroCAD to calculate the performance of all designed BMPs

and their runoff reduction in 10-YR - 24 HR rainfall, as well as 100-YR-24 HR rainfall in the area. Each of the sub catchments were calculated, then the detailed breakdown of numbers were presented in the *Monon Boulevard Stormwater Drainage Technical Report* (Williams Creek, 2019).

Consulting with the professional engineer who prepared the report, the final numbers support that the redevelopment reduces peak stormwater runoff rates by up to 58% and 72%, in 10-year and 100-year, 24-hour storm events, respectively. The project also provided post-construction water quality benefits in all basins by removing large floatable materials and a minimum of 80% total suspended solids for reaching the downstream receiving system for the entire 6.62-acre footprint.

For information on tree interception, see Environmental Benefit #5 below.

Sources:
National Stormwater Calculator Mobile Web-Based App (Version 3.4.0). United States Environmental Protection Agency, Accessed May 15, 2023.
https://swcweb.epa.gov/stormwatercalculator/
Williams Creek, June 10th, 2019. Monon *Boulevard Stormwater Drainage Technical Report.* Prepared for City of Carmel, Indiana

Limitations:
The Monon Boulevard project was part of a larger watershed that works in combination, so there is overlap with adjacent development when it comes to stormwater treatment especially regarding detention provided. For example, the numbers for four areas (basins 5,6,7,8 and 11) of the eleven in the Monon report won't actually show the full detention benefit that the overall storm system will experience, because that water was treated for detention in combination with the system installed in the adjacent development. So these areas do realize a runoff reduction by this particular project, but there is a further reduction in runoff from these areas due to the adjacent development as well. The difficulty is separating out the benefit when they work in combination with a larger watershed, so the percentage of peak rate reduction that the report provides above can actually be thought of as being on the low side of what is actually provided, but it is backed up by the numbers calculated through the report. The team also acknowledge that the data gathered in this report are drawn from the stormwater drainage technical report, based on model analysis.

Environmental Benefit #4:
- **Lowers surface temperature by an estimated weighted average of 3 to 8.9°F compared to an adjacent area resembling pre-construction conditions.**

Background:
Carmel Indiana has a humid continental climate, which has cold winters and hot, wet summers. According to the U.S. Climate data, the average highest summer (Jun. Jul. Aug.) temperature in Carmel Indiana is 83.67 F. As a rapidly developing city, Carmel may be at risk for rising surface temperatures, which has myriad effects on the environment and public health.
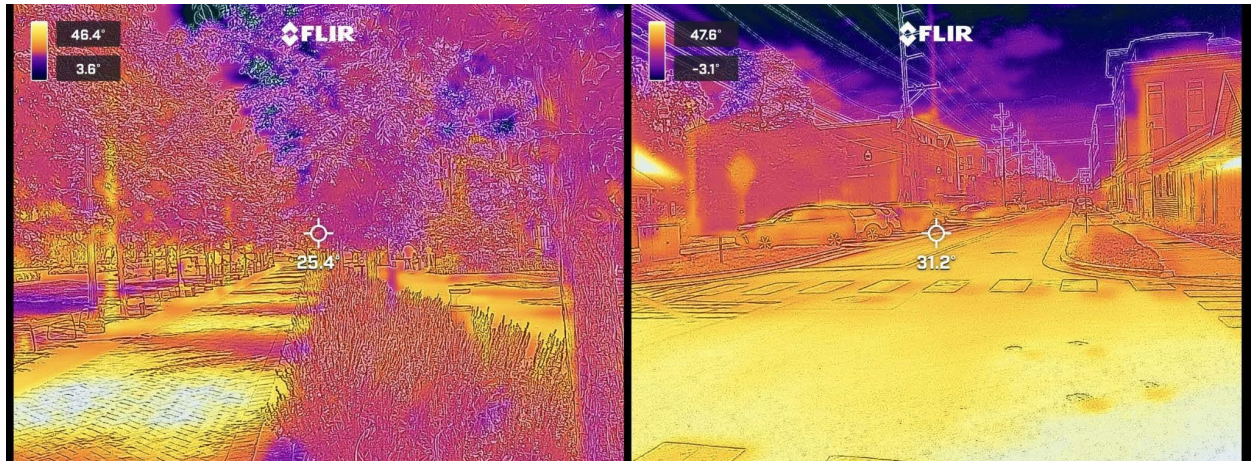
Method:

Figure 5.1 Infrared photographs taken on site using FLIR.

The research team took recordings of surface temperature both inside and outside of the Monon Boulevard's project boundaries- with the area "outside" the boundaries being the adjacent streetscape and median. Temperature recordings of different materiality were collected in both collection locations: impervious pavement, permeable hardscapes, vegetated areas, and shaded areas. The collection area outside project boundaries is intended to be used in comparison to the site conditions pre-development. Additional infrared photographs were shot at the same time and same location to validate the temperature readings and provide visual representations of heat differences (see Figure 5.1).

The equipment used includes a KIZEN LaserPro LP 300 (model number) infrared thermometer. Temperatures were recorded on May 101th 2023, between 2:25-2:35 pm EST. The actual temperature was 75 degrees Fahrenheit, and the heat index was 73 degrees Fahrenheit, which accounts for wind speed and air humidity.

Figure 5.2 Temperature capture points (Please note that the numerical points are to indicate the measured surface material example, not the actual measured location)

Calculations

Table 5.1- Open Hardscape temperature (all the measurements are based on an average of 3 reads on the sample surface at the same location. The temperature was taken using an infrared thermometer, measuring the surface of different objects)

Location	Outside the Park 3rd Ave (location) Point 1	Inside the Park (location) Point 8	Inside the Park (location) Point 9	Inside the Park (location) Point 10
Temperature(°F)	98.6	94.3	94.1	98.4
Net Decrease(°F)	0	4.3	4.5	0.2

Table 5.2- Shaded Hardscape temperature

Location	Outside the Park (location) Point 2	Inside the Park (location) Point 7	Inside the Park (location) Point 9	Inside the Park (location) Point 10
Temperature(°F)	67.7	61	50	65.3
Net Decrease(°F)	0	6.7	17.7	2.4

Table 5.3- Vegetated area temperature

Location	Outside the Park (location) Point 4	Inside the Park (location) Point 11	Inside the Park (location) Point 12
Temperature(°F) open area	86.2	80.1	80.4
Temperature(°F) shaded area	63.9	58.5	59
Net Decrease(°F) average	0	5.75	5.35

Sources:

Carmel Indiana weather report (n.d.). Climate and Average Weather Year Round in Carmel. Retrieved from : https://weatherspark.com/y/14746/Average-Weather-in-Carmel-Indiana-United-States-Year-Round

Limitations:

Although multiple samples were collected and averaged for each surface index, there are still limitations within this benefit. Foremost, the time of collection greatly affects surface temperature, as the sun angle and position changes throughout the day. A more rigorous study would analyze the temperatures at multiple collection times.

Also, it is difficult to capture a comprehensive surface temperature using the technology employed. Data was collected based on materiality, however, it does not give insight into the user's experience of heat index or how the site actually "feels", which is more subjective and would require more extensive research and calculations.

Environmental Benefit #5:

- **Projected to save 142,752 kWh of energy consumption for the surrounding buildings over 20 years due to shade provided by trees.**

- **Sequesters an estimated 289,076 lbs of atmospheric carbon dioxide annually in 344 newly planted trees.**

Background:
The site design incorporated a total of 344 newly planted trees thus fostering both user experience and environmental benefits. The research team adopted the i-Tree toolkit for this investigation. This toolkit is featured on the Landscape Architecture Foundation's website, and the research team took advantage of this application due to its compatibility with the project's qualities. The toolkit allows the research team to concentrate on individual trees, offering data on energy conservation and quantifying specific cost savings.

Method:
Our team used the online program, i-Tree, to calculate energy consumption savings which are derived from increased canopy cover within the project. The i-Tree system, specifically i-Tree Design, takes the following cultural conditions into consideration:

-Tree species
-Tree height
-Percent of tree canopy or crown missing
-Percent of crown dieback in the living crown areas
-The direction of the tree in comparison to the building
-The shortest recorded distance from a tree to the nearest building.

The choice of i-Tree Design for this study was largely driven by the nature and requirements of the project. For the purpose of accurate energy conservation calculations, the inclusion of detailed information on tree health, precise positioning, and other factors is imperative. i-Tree Design provides more flexibility on individual plants geared towards residential and small-scale community projects. Compared with i-Tree Eco, which is more suited for forest-level analysis, i-Tree Design works better in the urban environment in which this site is located and fits the end product of the research.

The research team began the analysis by inputting site and individual tree information. i-Tree analysis calculates the amount of carbon avoided in megawatts per hour- which is based on regional climates, the type of buildings in question, and leaf types of the specified trees. The energy-usage data is sourced from the U.S. EPA Emission and Generation Resource Integrated Database.

Calculations:

i-Tree Design v6.0
Tree Benefit Report - 10/29/2019
2nd Ave SW, Carmel, IN 46032, USA
Trees Evaluated: 334
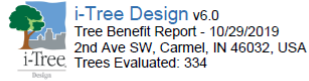
				Benefits			
Tree	**DBH (in)**	**Condition**	**Location to Structure**	**Current Year (2019)**	**Future Year (2029)**	**Projected Total (2019-2029)**	**Total to Date**
1. Elm	4	Excellent	2: Northwest (39 ft) 3: Northeast (54 ft)	$16.34	$45.22	$239	$51
2. Elm	4	Excellent	2: Northwest (38 ft) 3: Northeast (55 ft)	$16.34	$44.96	$238	$51
3. Elm	4	Excellent	2: Northwest (38 ft) 3: East (55 ft)	$15.51	$41.38	$217	$48
4. Elm	4	Excellent	2: West (37 ft) 3: East (56 ft)	$9.90	$35.84	$159	$25
5. Elm	4	Excellent	2: West (37 ft) 3: East (56 ft)	$9.90	$35.84	$159	$25
6. Elm	4	Excellent	2: Southwest (37 ft) 3: East (55 ft)	$6.98	$24.43	$93	$13
7. Elm	4	Excellent	2: Southwest (38 ft) 3: East (55 ft)	$6.98	$24.43	$93	$13
8. Elm	4	Excellent	2: Southwest (39 ft) 3: Southeast (53 ft)	$12.88	$29.82	$153	$37
9. Elm	4	Excellent	2: Southwest (38 ft) 3: Southeast (54 ft)	$6.89	$25.10	$93	$13

Figure 6.1- Example of Individual Tree report:

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Total Projected Benefits (2019-2029) - Over the next 10 years, based on forecasted tree growth, i-Tree Design projects total benefits worth $34,071:

- $15,637 of stormwater runoff savings by intercepting 2,522,049 gallons of rainfall
- $968 of air quality improvement savings by absorbing and intercepting pollutants such as ozone, sulfur dioxide, nitrogen dioxide, and particulate matter; reducing energy production needs; and lowering air temperature
- $6,723 of savings by reducing 289,076 lbs. of atmospheric carbon dioxide through CO_2 sequestration and decreased energy production needs and emissions
- $3,815 of summer energy savings by direct shading and air cooling effect through evapotranspiration
- $6,928 of winter energy savings by slowing down winds and reducing home heat loss
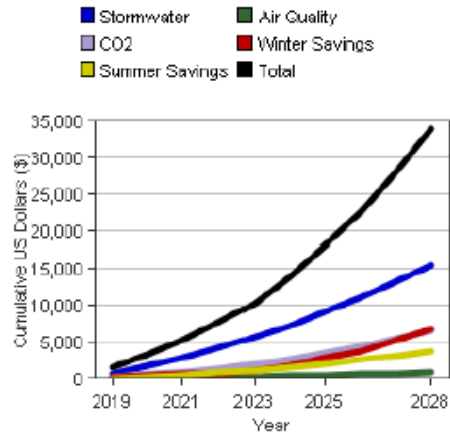
Figure 1. Tree benefit forecast for 10 years
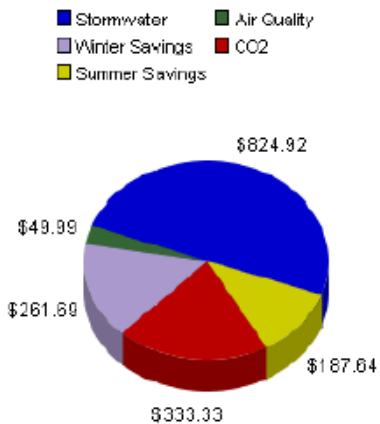
Figure 2. Annual tree benefits for 2019

Current Year - For 2019, i-Tree Design estimates annual tree benefits of $1,657.57:

- $824.92 of stormwater runoff savings by intercepting 133,044 gallons of rainfall
- $49.99 of air quality improvement savings
- $333.33 of carbon dioxide reduction savings
- $187.64 of summer energy savings
- $261.69 of winter energy savings

Figure 6.2- Results' Comprehensive data

Future Year - **In the year 2029, based on forecasted tree growth, i-Tree Design projects annual benefits of $6,352.86:**

- $2,536.68 of stormwater runoff savings by intercepting 409,175 gallons of rainfall
- $161.38 of air quality improvement savings
- $1,280.88 of carbon dioxide reduction savings
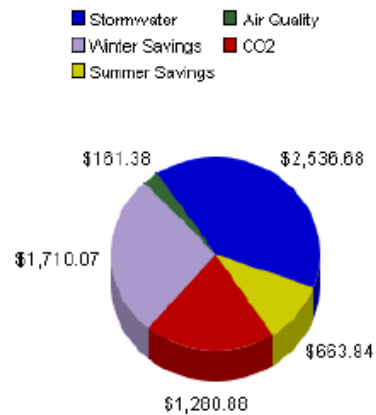- $663.84 of summer energy savings
- $1,710.07 of winter energy savings
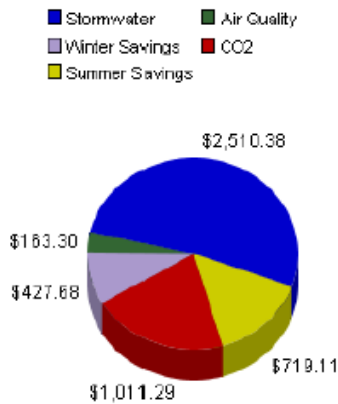

Figure 3. Annual tree benefits for the year 2029

Figure 4. Total benefits to date

Total Benefits to Date - **Over the life of the tree(s) so far, i-Tree Design calculates total benefits worth $4,832:**

- $2,510 of stormwater runoff savings by intercepting 404,784 gallons of rainfall
- $163 of air quality improvement savings
- $1,011 of carbon dioxide reduction savings
- $719 of summer energy savings
- $428 of winter energy savings

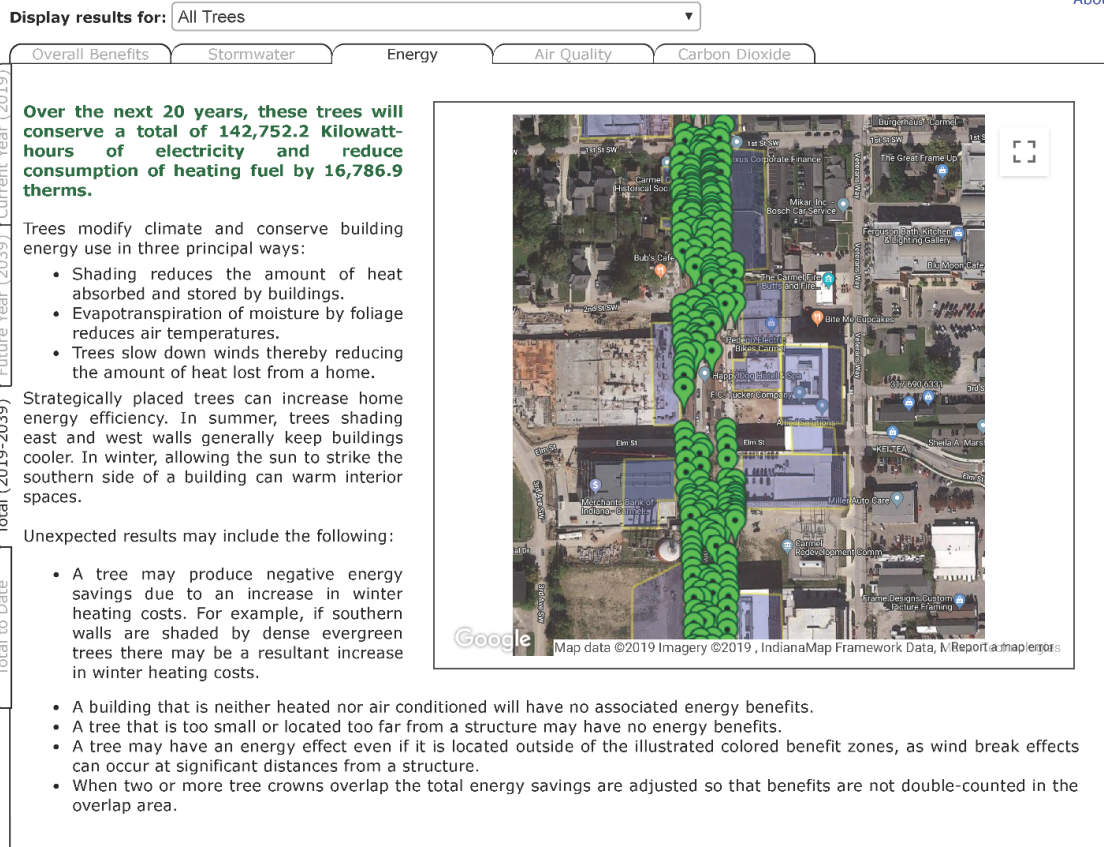*Figure 6.3- Results' Comprehensive data continued*

Figure 6.4 - Results' Comprehensive data continued

Sources:

McPherson, E.G.; Simpson, J.R. 1999. Carbon dioxide reduction through urban forestry: Guidelines for professional and volunteer tree planters. Gen. Tech. Rep. PSW-171. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 237 p. **https://doi.org/10.2737/PSW-GTR-171.**

Limitations:

The i-Tree program calculates energy simulations and estimates which are referenced amongst a large database of information that includes a variety of plants species and climates across the United States.

Due to the indeterminate nature, energy and emission values may fluctuate, so these calculations can only be used as estimates, not exact values. There are many external factors, such as human error when inputting into the program, that produce results that are not accurate.

Social Benefits

Overall strategies for social benefits:

      While some portions of the data in the social benefit section were retrieved from archives, online sources, or city open public data, the majority of data were directly gathered on-site from community members and park users. The team used a combination of counting and tracing, community engagement, survey, behavior mapping, and informal interviews. In total, six on-site visits were made, spanning from February 2023 to July 2023. On June 9th and June 15th respectively, 42 survey responses were retrieved during the on-site engagement event. The detailed survey questions can be found in Appendix A. The beginning of the survey asked some respondents' details, and the breakdown of the information is below. According to U.S. demographic data, Carmel Indiana has 29.4% residents under the age of 18; 30.5% with age 18 to 44, and then 40.1% over the age of 65. Since we did not collect any data from children under 18 years old, our collection sample seems to align with the general age division.
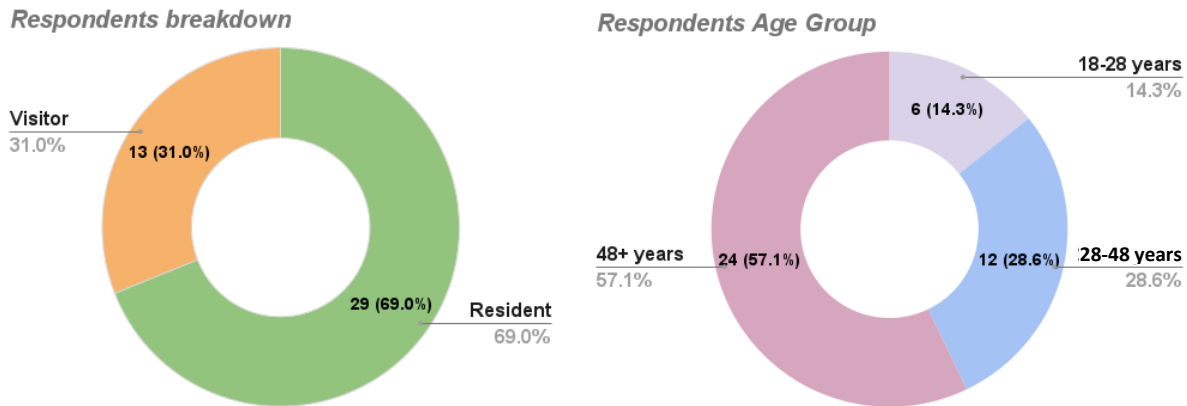

Figure 7.1 Respondent details

Social Benefit #1:

- **Increases trail use by pedestrians, joggers, and cyclists by 118%, from an average of 341,574 people per year in the 3-year period before redevelopment (2014-2016) to 742,830 after (2020-2022).**

Background:

      Before redevelopment, the Monon Boulevard and Midtown Plaza was a well-used greenway and rail trail with many recreational users. Since the project's completion in 2019, the upgraded trail has sparked an increase in activity, drawing in users with more enticing features. It now serves as a publicly-accessible greenspace for those residing in the newly built adjacent apartments and those who work in the district. The trail provides an accessible route to the Carmel Art and Design District, Carmel City Center and the Carmel Bike Share Program Station.

Method:

Data was collected using a city-installed bike/pedestrian counter that captures data. A bike/pedestrian counter was installed before the redevelopment, keeping data all the way back to 2010. When the project got redeveloped in 2019, a new bike/pedestrian counter was installed on site (see Figure 7.1). The bike/pedestrian counter is located at the corner of Main Street and Monon Boulevard-

which is the northern entrance to the renovated section of Monon Boulevard. The counter sends signals to a nearby real-time tracking display any time someone passes by it. The Carmel City staff make note the yearly number of the counter and reset it to zero when the new year begins.

Figure 7.2- Pedestrian/bike counter on site

Calculations:

Data from the counter was retrieved from official archives, which were provided by the Carmel Clay Parks and Recreation team. The bike + pedestrian counter indicates that there were a total of 300,000 to almost 400,000 passerby annually in the three years before the project (2014-2016) and around 650,000 to 800,000 passerby in 2020 (after project completion). The team then averaged the visitors' number across a period of 3 years, once pre-development and once post-development.

Table 7.1- Pre-development vs post-development visitor numbers

Before new development (people per year)			After new development (people per year)		
2014	2015	2016	2020	2021	2022
398,280	322,557	303,884	651,832	809,231	767,428

Average before development annual passerby = (398,280+322,557+303,884)/3= 341,574
Average after development annual passerby = (651,832 + 809,231 + 767,428)/3 = 742,830

The increase of passerby = (742,830-341,574)/341,574=117.5%

Data is directly collected from Carmel Clay Parks and Recreation (archival data).

Limitations:
With the onset COVID-19 pandemic in early 2020, the data captured by the counter may be abnormal throughout that time period. Many municipalities witnessed record increases in outdoor recreation within the initial lockdown period. In addition, the data collected may not be fully accurate as users of the site may have not passed through the threshold in which the counter is located.

Social Benefit #2:

- **Supports increased visitor numbers in amenity-rich areas and attendance at community events. The mixed-use development area attracts 125% more walkers than other areas of the trail, and over 27,500 residents and visitors attended 124 programmed events at Midtown Plaza in 2021.**

Background:
Prior to the renovation, the site was simply a trail that facilitated bicyclists and pedestrians but lacked other amenities. After renovation, the project has more recreational amenities and is a destination for community gatherings. Specifically, Monon Boulevard has the following amenities:
• Spray Plaza, Playground Area, Interactive Public Art, Bocce Ball and Shuffleboard Courts, Ping-Pong Tables, Green Spaces, Community Tables and Other Gathering Places
Midtown Plaza has the following amenities:
• Monumental Video Screen Wall, Performance Stage, Large Lawn Area, Shade / Swing Structures, Fire Pit and Heaters, Ping-Pong and Billiard Tables, Outdoor Furniture and Other Gathering Places
One of the project's goals is to "create an array of programmable and inclusive destinations for all seasons that engage a diverse mix of ages and abilities," hence measuring the popularity of the redevelopment and its provided amenities to the community is significant.

Method:
To understand the visitorship of amenities within the project, the research team compared the user data of passerby to user data for programmed areas. The "passerby" are people who utilize the trail, but do not stay for the recreational amenities. The research team collected data on-site, using tally counters to understand the quantities of activities taking place, while simultaneously tracking qualitative behaviors.

The in-person data collection took place at three designated locations, one at the beginning of Monon Boulevard, one near the middle, and finally, another at an unrenovated section of the Monon Trail. The researchers tallied the users frequenting the site simultaneously. Both made observations within the same 30-minute period - they remained in their respective areas throughout the duration of the period. This process was repeated twice more on other days to ensure credibility and eliminate other impacting factors.

Figure 8.1 Tally counter used on site.

Besides tally counters, the research team also interviewed city staff and retrieved the number of programmed events happening on the project after it was open to the public.

Calculations:

Figure 8.2. Tally counters' read for three different locations (30 minutes)

Table 8.1- Tally Counter Results

Tally reading	Walkers	Joggers	Bikers
Point A (beginning of Monon Blvd)	107	18	24
Point B (Midtown Plaza)	115	10	24
Point C (North trail, comparison group)	51	5	24

When reading the tally, bikers were consistently the same, from the north trail (beyond the redevelopment), to Monon Boulevard, and to the Midtown Plaza area. However, the amount of walkers dramatically increased, due to the increased amenities along Monon. In the Midtown area especially, the walkers peaked at 115. The ratio of difference = (115 - 51)/51 = 125%

When interviewing the Carmel city staff, the research team recorded that over 27,500 residents and visitors attended 124 programmed events at Midtown Plaza in 2021, which is a 51% increase from the 82 events in 2020.

Limitations:
- The tally readings are conducted by three team members in the same 30-minute period. There could be inconsistencies and miscategorization of walkers and joggers among the three.
- Some joggers may become walkers in certain parts of the trail.
- Due to limitations in the time and number of experiments, the test results cannot be generalized to all situations at all times.

Social Benefit #3:
- **Promotes place attachment, with 81% of 42 surveyed Carmel residents agreeing that the site strengthens place identity, 74% agreeing that it strengthens natural bonding, and 69% agreeing that it enhances family and friend bonding.**

Background:
Since the redevelopment of Monon Greenway, the Monon Boulevard and Midtown Plaza has become the heart of Carmel City and strengthened residents' attachment and identity towards the city. The research team searched through social media and frequently saw comments like "so much fun walking along the Monon Greenway," or "Such a great place to call home!". Additionally, Carmel was honored with a 2019 Community Placemaking Award for its Monon Boulevard project (Koenig, 2019). Hence, place attachment and place identity produced by the Monon Boulevard and Midtown Plaza has been a key for the success of this project.

Method:

According to a critical research piece, "*The measurement of place attachment: Personal, Community, and environmental connections*," Raymond, Brown, and Weber (2010) outlined a three-pole and four-dimensional conceptual model of place attachment, specifically, by evaluating the place attachment from residents to a place. From this research, there are key components that are needed to represent personal, community, and environmental dimensions, and should be represented by: place identity, natural bounding, place dependence, friend bonding, and family bonding (see Table 2 of the 2010 article). Our research team adapted these measurement frameworks in the survey sent out to residents, Question 6 specifically asked about place attachment measures.

What do you identify as important due to the construction of Monon Boulevard and Midtown Plaza to the city of Carmel (select all that apply):

☐   It has become the landmark for the city of Carmel

☐   I am proud that Monon Boulevard is part of Carmel and I will introduce Monon Boulevard to my friends and families who visit the area

☐   When I spend time on the renovated trail system, I notice the surrounding plants and environment, and I feel at peace with myself

☐   Doing my activities on Monon Boulevard is more important to me than doing them in any other place (I like using Monon Boulevard trail system more than other trails elsewhere)

☐   I am willing to spend my time doing volunteer work associated with Monon Boulevard if I can make it a better place

☐   This trail system and green space helps with family harmony and neighborhood building

☐   I have met acquaintances or ran into old neighbors at this park and trail

☐   This green space makes me feel good physically and mentally

Figure 9.1- Community engagement activity and survey recruitment [Picture credits: REA (left) Lauren Chapman (right).]
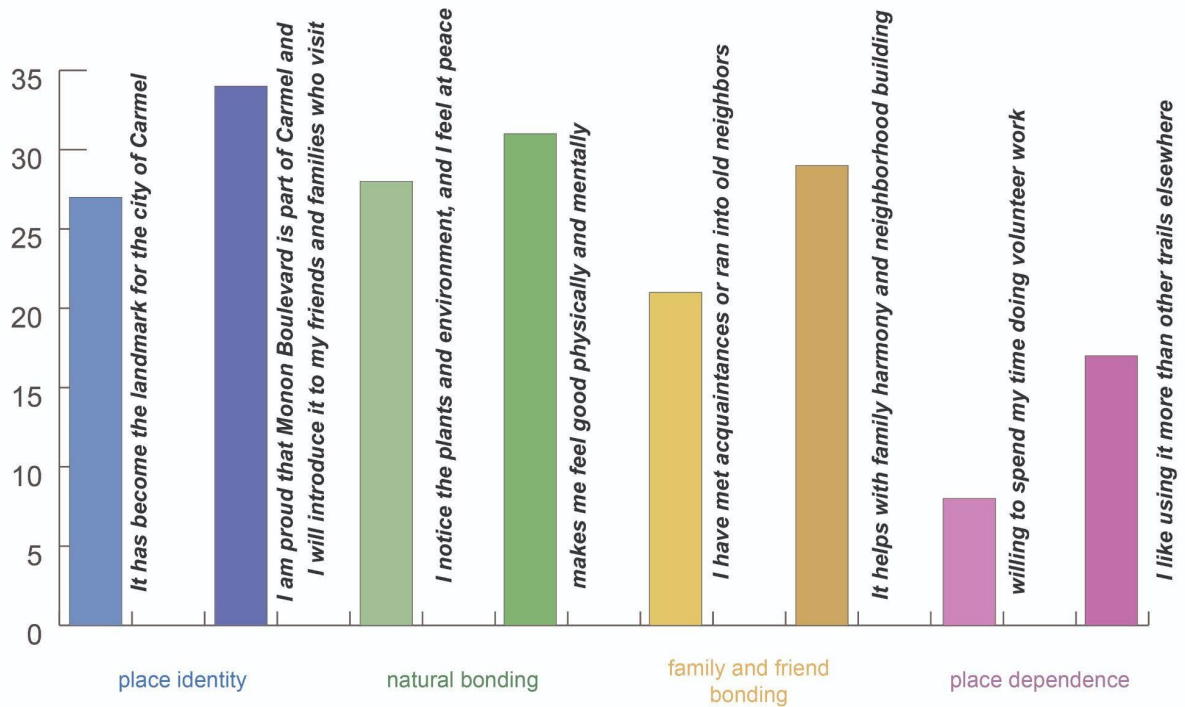
Figure 9.2- Place attachment dimensions break down per survey respondents.

According to the survey results the team collected, among all 42 respondents, each person chose at least one out of the six different place attachment dimensions, indicating that they all believe the Monon Boulevard Project has played some role in enhancing place attachment. Specifically, more people agree that the project helps shape Carmel's place identity; that they believe it either has become the landmark for the city, or that they are proud that the project is part of Carmel, and that they will introduce this project to their friends and families (81%). The questions related to natural bonding also received high acknowledgment, people agree the plants and environment in this new design is recognizable, and that the new surroundings make them feel good physically and mentally (74%). Friends and family bonding also received some acknowledgement, more than half of respondents agree they have met other acquaintances or run into old neighbors, and that the project helps family harmony and community building (69%).

Source:

Koenig, E.J., Aug 28th, 2019. VIDEO Carmel's Monon Boulevard project to receive Community Placemaking Award. Aim Indiana. Retrieved from https://aimindiana.org/terminal/video-carmels-monon-boulevard-project-receive-community-placemaking-award/

Raymond, C. M., Brown, G., & Weber, D. (2010). The measurement of place attachment: Personal, community, and environmental connections. *Journal of environmental psychology*, *30*(4), 422-434.

Limitations:
- The place attachment measurement method introduced here is one of many methods. The result can be different if another framework/method of place attachment is being used.
- The place attachment phrases in the survey are generated by the research team according to literature reference. If directly asking the residents, they may not come up with the same statements if the question is open ended.

Social Benefit #4:

- **Supports a variety of age groups, with 100% of 42 surveyed site users agreeing that the site is friendly to a variety of age groups. This is supported by systematic site observation and social media postings.**

Background:

One of the goals of this project was to create an array of passive and active programs and inclusive destinations for all seasons that engage a diverse mix of ages and abilities. Hence, measuring age friendliness, inclusivity, is key to this report on project performance.

Method:

The research team utilized three different, complementary methods to evaluate age friendliness. The first method is behavior mapping. Team members counted 8 recreational amenities on-site through observation. Subsequent behavior mapping was conducted by three research members simultaneously at the following times: May 10th for a period of 10-minutes from 2:30 pm-2:40 pm, and June 9th for 3 periods of 10-minutes from 12:00 pm-12:10 pm, 2:30 pm-2:40 pm, and 4:20 pm-4:30 pm. Each research member categorized the site user into one of the assumed age categories: 18 years or younger, 18-30 years old, 30-60 years old, and 60+ years old. The age readings were based on subjective judgment on appearance. These sets of data were trying to evaluate whether each group is free to explore any part of the site with no problem (or frame it in another way, there is no part of the site that would be only dominated by one particular group). The behavior mappings done at different times of the day and on different days of the week support this hypothesis.

Figure 10.1 Programs on the new development

May 10th, 2:30pm behavior mapping

June 9th, 12pm behavior mapping

June 9th, 2:30pm behavior mapping

June 9th, 4:20pm behavior mapping

Figure 10.2- Series of behavior mapping taken in different times of the day, different days of the week.

In addition to behavioral mapping, a question was also embedded into the survey that received 42 responses. The question asks, "Do you agree that Monon Boulevard is friendly to a variety of age groups"? Among 42 collected responses, 42 reported "Yes I agree" to this question. The positive rate is 42/42=100%.
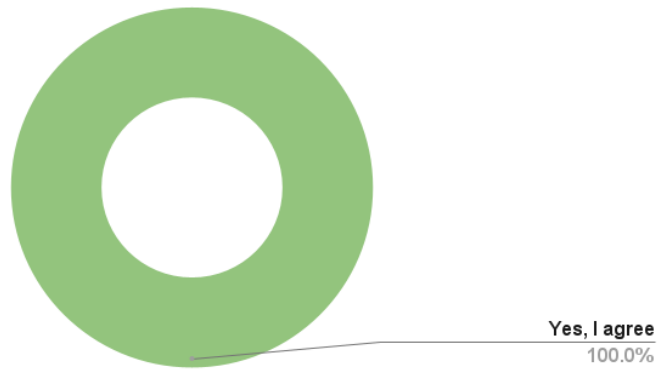

Figure 10.3 Survey response of question, whether Monon Blvd is friendly to a variety of age groups

Lastly, for method 3, the team also searched open social media posts related to Monon Boulevard and Midtown Plaza, related to age-friendliness and family inclusivity. Many social media posts also indicated the story of age friendly of this place, and here are a few quotes for demonstration:

"*Wonderful outdoor area with a ton of activities for both adults and kids...There are many enjoyable possibilities for all types of activities in the tranquil environment.*"

"*...Parking are free just be safe and drive safely as they are kids, adolescents, and adults pedestrians everywhere....*"

"Had a great evening here, so much to see and explore. Fun for the whole family."

"Attracts a family friendly atmosphere."

"Great for families or just take a look around. Honestly, one of the coolest places I've been in Indiana...!"

"Great for the kiddos…gets a little crowded, but it's great"

Limitations:
- The behavior mapping age interpretation is a subjective appraisal. If the appearance of the observed person does not match their actual age, it may interfere with the experimental data result.
- The social media reviews are only from the open source data from Google Reviews. We assume that since it's a public space, and not a private business, all the posts are based on one's own interest.

Social Benefit #5:
- **Promotes physical health, with 71% of 42 surveyed site users agreeing that they have spent more time outdoors after Monon Boulevard and Midtown Plaza was constructed.**
- **Improves walking safety, with 88% of 42 surveyed site users agreeing that the construction of Monon Boulevard and Midtown Plaza has made the pedestrian experience safer.**
- **Enhances visual quality, with 93% of 42 surveyed site users agreeing that art and the renovation have enhanced the visual quality of the former greenway trail.**

Background:
The transformation of the site has prioritized the experience of bicycle users and pedestrians and enhanced the city's connectivity, while still allowing vehicular traffic to safely pass through. Additionally, the pedestrian and biking experience, multiple art pieces, wayfinding systems, beautiful plantings and more, have changed visual experiences for passerby. Due to the design features and elements, survey questions related to physical health, walking safety, and visual quality were proposed.

Method and Calculations:
Survey Question 4: I/my family have spent more time outside since this boulevard/plaza was built?
☐ Strongly agree 19 ☐ Somewhat agree 11 ☐ Neither agree nor disagree 10 ☐ Somewhat disagree 0
☐ Strongly disagree 2

I/my family have spent more time outside

Strongly disagree
4.8%

Neither agree nor disagree
23.8%

Strongly agree
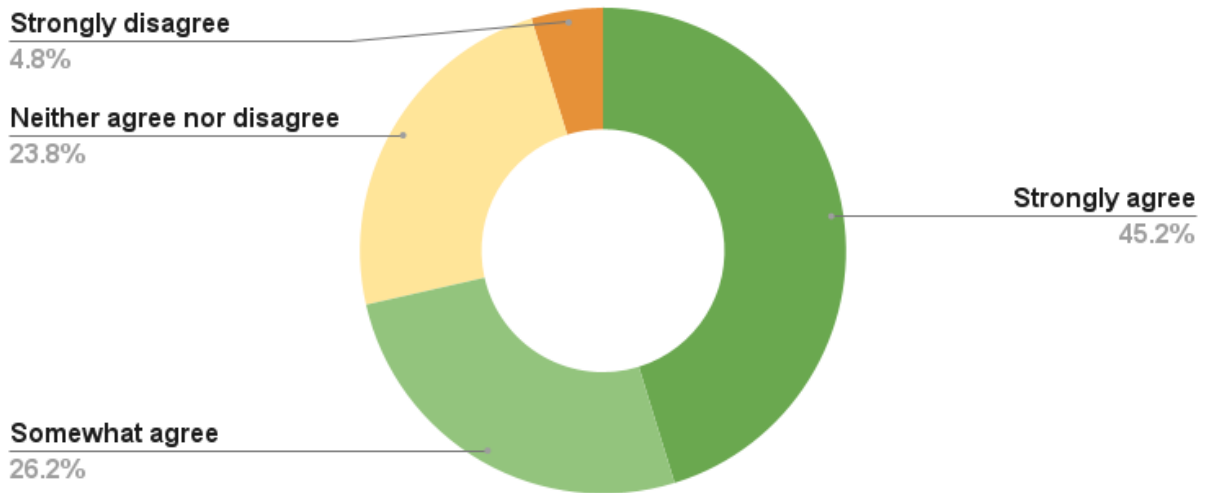45.2%

Somewhat agree
26.2%

Figure 11.1. Survey Result for Survey Question 4.

The positive ratio to agree that park users have spent more time outside since the boulevard/plaza was built = (19+11)/42 = 71.4%

Survey Question 5: The construction of the Monon Boulevard/Midtown Plaza has made the pedestrian experience safer than before:
☐ Strongly agree 25 ☐ Somewhat agree 12 ☐ Neither agree nor disagree 4 ☐ Somewhat disagree 1 ☐ Strongly disagree 0

The project has made the pedestrian experience safer

Somewhat disagree
2.4%

Neither agree nor disagree
9.5%

Somewhat agree
28.6%

Strongly agree
59.5%

Figure 11.2. Survey Result for Survey Question 5.

The positive ratio to agree that park users believe that the construction of the Monon Boulevard/Midtown Plaza has made the pedestrian experience safer than before = (25+12)/42 = 88%

Survey Question 8 Does art and the reconstruction of the Monon Boulevard and Midtown Plaza enhance the visual quality of the trail?

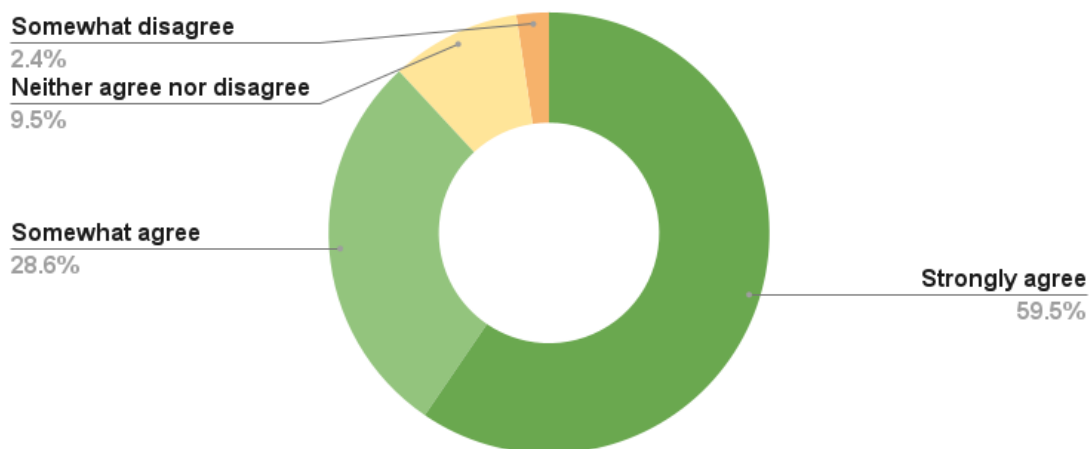☐Strongly agree 35 ☐Somewhat agree 4 ☐Neither agree nor disagree 3 ☐Somewhat disagree 0 ☐Strongly disagree 0
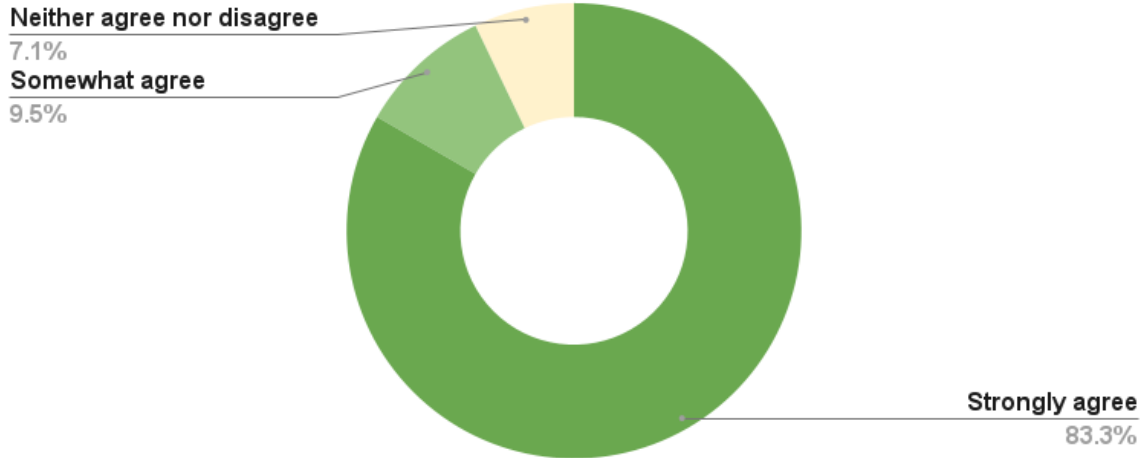

Figure 11.3. Survey Result for Survey Question 8.

The positive ratio to agree that park users believe that the reconstruction of the Monon Boulevard and Midtown Plaza enhance the visual quality of the trail = (35+4)/42 = 92.8%

Limitations:
- The survey results are based on a limited number of participants who voluntarily participated in the study. The ratio could change if the survey pool changes.

Economic Benefits

Economic Benefit #1:
- **Contributed to an estimated 26% higher assessed value of residences within a quarter mile of the trail within 3 years of project completion when compared to other residences further along the trail.**

Background:
    The City of Carmel has experienced rapid development in recent times. The development of the Monon Trail and adjacent projects has been planned for development for many years, thus many of the surrounding developments had already been secured prior to the announcement of the Midtown Plaza Project. Many of the residences within close proximity to the project site have benefitted in terms of assessed property value as there are more amenities nearby.

Method:

The research team analyzed the relationship of residences near the project site (less than .25 miles) to residences further along the trail at a greater distance (1 mile or greater). These distances were chosen, as typically traveling less than a 1/4th of a mile is considered "walking distance" to amenities, while 1 mile further and beyond constitutes a less accessible amenity.

All residences selected were located less than +/- 0.1 miles from the Monon trail, however, the **'Checkpoint'** describes the approximate distance it would take to travel along trail to the Midtown Plaza. In other words, the project site is being treated as a trailhead, and the 'Checkpoint' describes the distance, north or south, from the trailhead. Homes closest to the trail (Checkpoint: .25mi or less) were used as a baseline for comparison, which allowed the team to draw conclusions about the trail performance and project adjacency. This is opposed to a less-direct citywide analysis, which would not compare homes along the trail.

To narrow down the selection, some checkpoint distances were voided (1 mi) as there were no comparable residential properties adjacent to that distance along the trail- to the north or south. Also, no homes directly neighboring another were chosen- which helps to diversify the data set and eliminate assessment bias from neighboring properties. If given the option, more closely sized parcels were chosen for comparison, as the calculations were adjusted for total acreage. All residences were single family homes.

Data was compiled from the City of Carmel's GIS Tool. This tool was only able to provide data within the past three years, so preoccupancy data was unavailable. Data was pulled for three years, instead of two, to help further validate findings and analyze rate of growth. Our team used 'Assessed Value' as our metric of choice, which is derived from public assessors. It provided more insight into the methods of collection as opposed to figures from private sources (Zillow, Redfin).

Figure 11.1: Properties Compared + Distance from Midtown Plaza Project

Address:	Checkpoint	Acres:	Year 1: 2021	Year 2: 2022	Year 2: 2023
331 1st St SW	.25 mi or less	0.24	384,000.00	485,100.00	630,800.00
311 1st St Sw	.25 mi or less	0.33	682,800.00	757,000.00	964,000.00
245 1st St SW	.25 mi or less	0.30	690,500.00	762,200.00	972,600.00
1385 Jeffrey Ct	1.5 mi	0.32	329,300.00	351,100.00	415,600.00
529 Kent Ln	1.5 mi	0.46	219,400.00	230,900.00	256,300.00
505 Kent Ln	1.5 mi	0.38	321,900.00	342,600.00	403,900.00

Figure 11.2: Price Per Acre Values + Total Increases

Address:	Checkpoint:	Acres:	PPA #1:	PPA #2:	PPA #3:	TOTAL INCREASE % 2021-23	TOTAL INCREASE AVERAGED
331 1st St SW	.25 mi or less	0.24	1,600,000.00	2,021,250.00	2628333.333	64.27083333	48.76954975

311 1st St Sw	.25 mi or less	0.33	2,069,090.91	2,293,939.39	2921212.121	41.18336262	
245 1st St SW	.25 mi or less	0.3	2,301,666.67	2,540,666.67	3242000	40.85445329	
1385 Jeffrey Ct	1.5	0.32	1,029,062.50	1,097,187.50	1298750	26.20710598	
529 Kent Ln	1.5	0.46	476,956.52	501,956.52	557173.913	16.81859617	22.83315059
505 Kent Ln	1.5	0.38	847,105.26	901,578.95	1062894.737	25.47374961	

Calculations:

After the properties selected for comparison were indexed, the assessment prices were divided by the parcel acreage, thus yielding the "Price Per Acre" (PPA). Then the final PPA (#3) was subtracted by the initial PPA (#1), divided by the final (PPA #3), and multiplied by 100, which resulted in the percentage increase of PPA from 2021-2023. Finally the Total Increases from 2021-23 were grouped respectively by the checkpoint value, and averaged, providing the 'Total Increase Averaged'. Then the difference between the target group and comparison group was calculated via subtraction (48.76954975%-22.83315059= 26% (rounded)).

Calculations were also performed to evaluate the <u>rate</u> of increase in PPA from years 2021-2022 and 2022-2023. Although these calculations were not included in the final benefit- it was important to confirm that the properties experienced positive growth during each period and filter out any possible outliers.

Sources:

City of Carmel. "Engineering GIS Viewer" [Basemap]. Scale Not Given. Engineering GIS Viewer" 2023. https://carmelgis.carmel.in.gov/maps/apps/webappviewer/. (June 23rd, 2023).

Limitations:

Firstly, it should be stated that with any economic data there are outlying factors that have an influence on the results collected. Most importantly in this benefit, the greatest limitation is that assessed property values can possess bias and are an approximation. Not every investment captured within the assessed value can be easily quantified or tracked- such interior renovations or exterior landscape features. Therefore the range of assessed property values can vary greatly even within a neighborhood, especially those with varying architectural styles.

Efforts were taken to help normalize the assessed value data by scaling it based on the parcel size. This helped to make the values more comparable to another, because within the same neighborhood there was a wide range of parcel sizes and respective assessed values. This method considers parcel size - which is important to assessed value but offers no details on the architectural details or age of the home. In this sense, a 1 bed + 1 bathroom home could be scaled equally to a 4 bed + 1 bathroom home if both were situated on a parcel of equal size. However, most of the addresses chosen were of near-identical architectural proportion, character, and age, to the other nearby properties within their grouping, as they were in the same planned subdivision.

Finally, the fact that data was only collected from the past three years means that no comparison can be drawn from pre-development to post-development of the project. However, having entirely post-development data is still valid, as long as the rate of growth of properties adjacent to the

project is greater than those it is being compared to.

Economic Benefit #2:

- **Increases gross customer visitation after project completion according to all 5 interviewed businesses within 2 blocks of the trail, with 1 business estimating a 20% increase in sales.**

Background:

The Monon Boulevard Project has created a more robust and vibrant space for certain economic activities. There are a handful of existing businesses that were established prior to the renovation of the Midtown Plaza.

Method:

The research team surveyed local businesses that existed in their current location prior to the completion of the Midtown Plaza Project. These businesses, which were no further than approximately 2 blocks from the trail, were of varying industries. The initial effort to contact them was via email, however the response rate for this was low. The research team then decided to conduct in-person interviews on a weekday evening, at around 4 pm.

When interviewed in person, businesses were much more responsive and receptive. In total 5 businesses were interviewed. The research team spoke to both employees and business owners to gather information. Some people interviewed were hesitant to speak confidently about the business's performance; however, they agreed with the statement that overall there have been more customers after the development of the plaza. It was difficult for some businesses to give approximations or estimations, as the COVID-19 pandemic had significant impacts, and it aligned with the construction of the plaza. Therefore the research team referred to asking more generalized statements with yes/no responses. Only one business reported an approximate figure of a 20% increase in customers after renovation.

Calculations:

Figuratively our research team had hoped to gather specific insights on local business performance from existing businesses. However, due to the limited information that was provided, it has proven difficult to highlight the quantitative values the Midtown Plaza has brought. Instead, the benefit has been framed around the fact that all businesses reported experiencing a generalized increase in traffic.

Limitations:

The research team interviewed both business owners and employees. Gathering information from the owners only may have been more accurate, as they have access to records and business insights. However, it could be equally biased, if the owners do not want to report a decrease in customers.

Additionally, the research team only interviewed the businesses once. It would have been more rigorous to interview the businesses multiple times, and speak with multiple representatives, to confirm these findings across the board. Due to the limited capacity of the businesses to speak with the research team, it was important to not be overly intrusive or overwhelm them.

Economic Benefit #3:

- **Increased revenues by an estimated 66% for Tax Increment Funding (TIF) districts directly adjacent to Midtown Plaza from 2020-2021.**

Background:

      The development of the Midtown Plaza and adjacent buildings brought a significant change to the urban fabric of the area. The denser, more user-friendly atmosphere has helped to increase the success of surrounding businesses. One tool that the City of Carmel frequently utilizes is Tax Increment Funding (TIF) districts, which is a public financing method that helps to subsidize projects for community improvement. The City of Carmel proudly retains records on the performance of TIF districts, several of which are directly adjacent to the Midtown Plaza project.

Method:

      In order to locate the TIF districts adjacent to the Midtown Plaza project, the research team utilized the City of Carmel's Engineering GIS viewer. This viewer provided an informative layer that described the position of these districts in relation to the trail. The names of each district were manually recorded, and then referenced in the Gateway TIF Viewer (http://gateway.ifionline.org/TIFviewer/). Only data from reported years 2020 and 2021 were available on the viewer. Their revenues were subsequently recorded.

Figure 12.1- TIF Figures Near Monon Boulevard (2020-2021)

TIF Name:	TIF ID:	2020 Revenues:	2021 Revenue:
Monon and Main	91649	$181,674	$232,921
Gunstra TAA	91626	$0	$0
Arts District Lofts and Shoppes	91631	$892,862	$907,277
Old Town	91610	$255,433	$268,988
Midtown West	91646	$38,173	$795,389
Midtown	91644	$654,315	$1,143,851
Concourse	91674	$0	$0
Monon Square North	91670	$0	$0

Figure: 12.2 - Composite TIF Figures Near Monon Boulevard

2020 Revenue Total:	2021 Revenue Total:	Gross Increase:	% Change:
$2,022,457	$3,348,426	$1,325,969	65.56%

Figure: 12.3 - TIF Districts Adjacent to Monon Boulevard
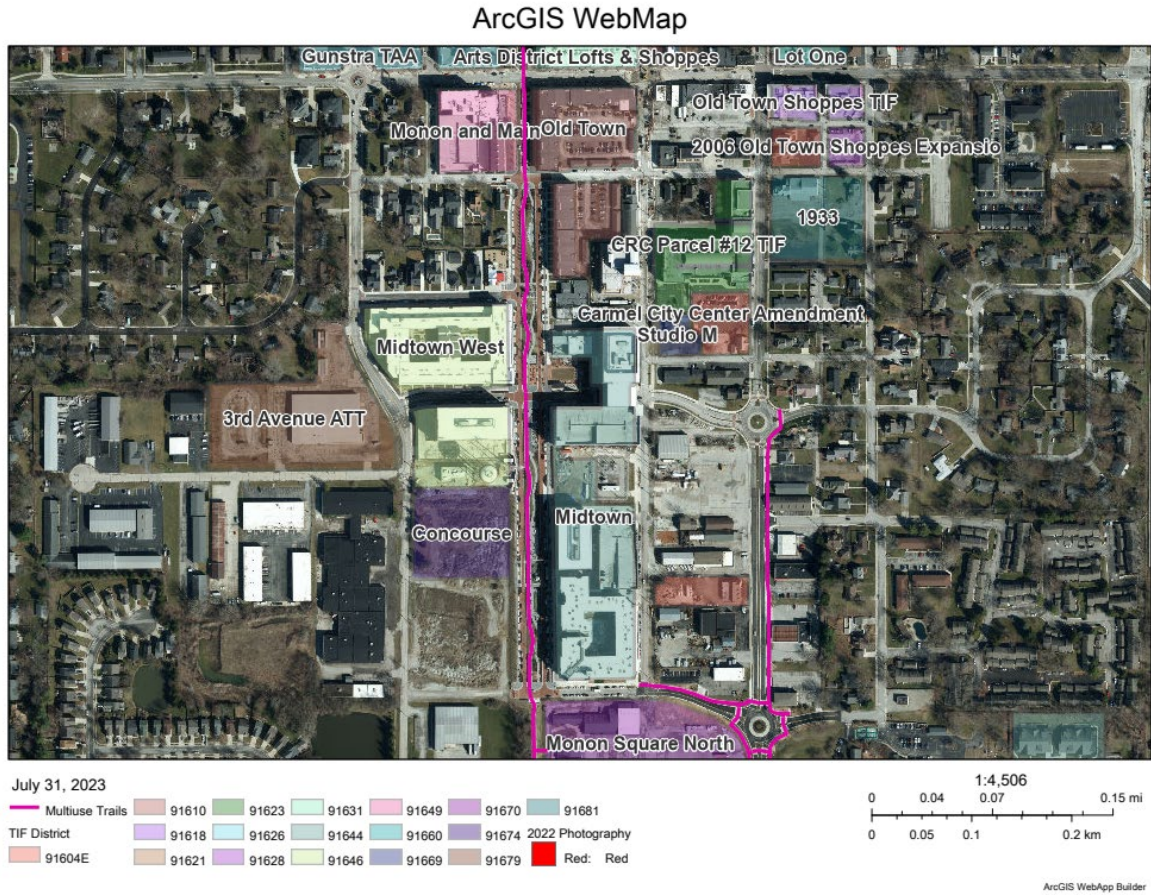
Calculations:

After the research team indexed the reported revenues, the total revenues were calculated by adding each individual district's reported revenues, for years 2020 and 2021. The gross increase was then calculated by subtracting 2021 Revenue Total from the 2020 Revenue Total, which resulted in $1,325,969. Then to calculate percentage increase, the difference was divided by the base year's revenue (2020), which was $2,022,457, and subsequently multiplied by 100, yielding an increase of 65.56%.

Sources:

City of Carmel. "Engineering GIS Viewer" [Basemap]. Scale Not Given. Engineering GIS Viewer" 2023. https://carmelgis.carmel.in.gov/maps/apps/webappviewer/. (June 23rd, 2023).

Gateway Indiana. (n.d.). *TIF Viewer*. TIF Viewer. http://gateway.ifionline.org/TIFviewer/

Limitations:

Although the data collected stems from reputable sources, and Carmel keeps throughout documentation on TIF performance, there is always room for errors when gathering data from secondary sources. Additionally, only information from 2020 to 2021 was publicly accessible, meaning that pre-development data could not be compared to post-development data. In addition, the

"revenue" value for a given year is not fully indicative of the TIF districts' performance- as there are multiple other figures such as expenses and assessed values, which contribute to performance.

Economic Benefit #4:

- **Catalyzed an estimated $167 million in private investment in the Midtown Plaza area.**

Background:

  The Midtown Plaza Project secured a reported $34 million in public investment and $167 million in private investment in order to reach project completion. The whopping initial investment in the project has led to a plethora of economic activity within the area- providing significant returns on investment.

Method:

  The following figures concerning the Midtown Plaza's performance were provided by the City of Carmel:

- 55,000 sf of Retail/Commercial space
- 950 new jobs
- $167M in private investment
- $115M increase in Total Assessed Value

  These figures were calculated by the project's consultants and City officials jointly. Our research team was unable to locate the primary source of where the data came from that was used to calculate these metrics. However, the team was able to research the reported private investments from secondary sources, such as news articles, to help validate these figures.

Table 13.1- Sources Reporting on Private Investment

Reporting Source:	Source:	Reported Private Investment:
Carmel Monthly Magazine	https://carmelmonthlymagazine.com/monon-boulevard-and-midtown-plaza-project-earns-national-recognition-for-excellence-in-development-from-urban-land-institute/	$850 million of investment surrounding the project post-completion
Choose Carmel	https://www.choosecarmelin.com/redevelopment-projects/midtown/midtown-east	$87 million
Indy Star	https://www.indystar.com/story/news/local/hamilton-county/2018/08/13/midtown-carmel-development-	$231 million

	update/918222002/	
City of Carmel	City of Carmel/ Consultants	$167M

Calculations:

An estimation was calculated based on the ranges from reported investments within the article. With the minimum being $87 million and the maximum being $850 it is safe to assume that the reporting of $167 million in private investment is valid. In specific, the Indy Star article gives a breakdown of several of the private investment sources- disclosing both the names and investment amounts.

Sources:

Lucas, L. (2022, July 22). *Monon Boulevard and Midtown Plaza Project Earns National Recognition for "excellence in development" from Urban Land Institute*. Carmel Monthly Magazine - Carmel, Indiana. https://carmelmonthlymagazine.com/monon-boulevard-and-midtown-plaza-project-earns-national-recognition-for-excellence-in-development-from-urban-land-institute/

Midtown East - Carmel, IN. Midtown East. (n.d.). https://www.choosecarmelin.com/redevelopment-projects/midtown/midtown-east

Sikich, C. (2018, August 15). *Carmel's Midtown is rising: 8 projects totaling $231M*. The Indianapolis Star. https://www.indystar.com/story/news/local/hamilton-county/2018/08/13/midtown-carmel-development-update/918222002/

Limitations:

The original data could not be found to validate these claims. Due to the nature of private investment, there is no obligation to publicly disclose how much or from whom the investment came from. Also, there is a chance of biased reporting from secondary sources (news articles), however, cross-comparing different reports helps to reduce the risk of false information.

Inconclusive Benefits

Environmental Benefit:

- **Has the potential to support an estimated maximum of 434 different species of butterflies and moths (*Lepidoptera*) indigenous to Carmel with over 3,900 individual native Indiana plants in the Midtown Plaza planting.**

Background:

The Midtown Plaza project utilized various native species within the project.

Method:

The planting schedule information was gathered from CAD files from the Landscape Architect consultant, REA. The final schedule was then transferred to a spreadsheet where each plant species was divided into two categories, "Native to Indiana" and "Non-Native". The research team chose these two categories as it can be difficult to identify specifically what species are indigenous to solely the project site/ Carmel. If necessary, the BONAP North American Plant Atlas was referenced, which provides approximations as to where the native ranges are for certain species.

Once all native species were identified, the spreadsheet was condensed. The research team then used the Native Plant Search Tool by National Wildlife Federation, which allows the user to view the number of pollinators a plant genus supports by an individual zip code. It is important to note here, that although a plant species may be native to the state, it may not register as native to the site's specific zip code. Therefore the list has to be reduced again.

Each species was reviewed individually, and the amount of lepidoptera that the genus supports was recorded. Below are the research team's final criteria of what specimens were included in the supporting lepidoptera calculations:

- Cultivars and specimens that are hybrids of two native species were both included
- Hybrids that had one parent of non-native origin were excluded
- If the species was native to the state, and not the project's zip code, then they were excluded
- If the species was native to the state, and the genus registered with the database, then the species was included. Unfortunately, the team is unable to determine if all species native to the state were also native to the project's zip code, as it is categorized by genus (ex.: *Asclepias incaranata*, *A.syriaca*, *A. purpurescens*, all are native, however, the tool does not specify which are indigenous to the zip code)
- Species native to the state, and not the project zip code, were excluded. Look for the highlighted red specimens in Table 4.2.

Calculations:

Once the number of supported *lepidoptera* was indexed for each plant, it was then added amongst all species present, totaling to 434. This resulted in the total number of *lepitdoptera* species that could be supported at maximum- since there is likely overlap in the supported species for each genus. It is important to note that this maximum value is an estimation because non-native and near-native plants not included can support *lepidoptera*. The '*3,900 individual plants*' was calculated by referencing the initial spreadsheet that had all species native to Indiana, not just to the project's zip code.

Table 4.1- Lepidoptera Supported by Plant Species Native to Project Zip Code

Quantity	Lepidoptera supported by Genus	Plant botanical name
5	252	Acer saccharum `Endowment`
4	68	Carpinus caroliniana 'Palisade'
12	46	Celtis occidentalis
12	18	Liriodendron tulipifera `Emerald City`
6	81	Ostrya virginiana
16	434	Quercus rubra
15	23	Cercis canadensis
59	102	Cornus sericea `Farrow`
9	38	Ilex verticillata `FarrowBPop`
2	38	Ilex verticillata `FarrowMrP`
8	90	Viburnum trilobum `Alfredo`
96	21	Panicum virgatum `Northwind`
305	21	Panicum virgatum `Shenandoah`
82	2	Sporobolus heterolepis
133	11	Monarda bradburiana
442	17	Rudbeckia fulgida speciosa `Viette`s Little Suzy`
222	11	Symphyotrichum novae-angliae `Vibrant Dome`
161		Echinacea purpurea 'Pow Wow Wild White'
87	13	Asclepias tuberosa
174	2	Sporobolus heterolepis
90	69	Heliopsis helianthoides 'Summer Sun'

Table 4.2- Plant Species Native to Indiana in Project Boundaries

Quantity	Lepidoptera supported by Genus	Plant Botanical Name
5	252	Acer saccharum `Endowment`
10		Betula nigra `Cully`
4	68	Carpinus caroliniana 'Palisade'
12	46	Celtis occidentalis
21		Gymnocladus dioicus `Espresso`
12	18	Liriodendron tulipifera `Emerald City`
6	81	Ostrya virginiana
16	434	Quercus rubra
2		Amelanchier x grandiflora `Autumn Brilliance`
15	23	Cercis canadensis
59	102	Cornus sericea `Farrow`
9	38	Ilex verticillata `FarrowBPop`
2	38	Ilex verticillata `FarrowMrP`
41		Itea virginica `Little Henry`
8	90	Viburnum trilobum `Alfredo`
981		Deschampsia cespitosa `Goldtau`
96	21	Panicum virgatum `Northwind`
305	21	Panicum virgatum `Shenandoah`
82		Schizachyrium scoparium `Carousel`
82	2	Sporobolus heterolepis
133	11	Monarda bradburiana
442	17	Rudbeckia fulgida speciosa `Viette`s Little Suzy`
222	11	Symphyotrichum novae-angliae `Vibrant Dome`
161		Echinacea purpurea 'Pow Wow Wild White'
106		Liatris spicata 'Kobold'
244		Echinacea purpurea 'Kim's Knee High'
87	13	Asclepias tuberosa

174	2	Sporobolus heterolepsis
93		Echinacea x 'Tiki Torch'
47		Schizachyrium scoparium 'Carousel'
90	69	Heliopsis helianthoides 'Summer Sun'

Sources:

Kartesz, J.T., The Biota of North America Program (BONAP). 2015. *North American Plant Atlas.* (http://bonap.net/napa). Chapel Hill, N.C. [maps generated from Kartesz, J.T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)]. Retrieved from http://www.bonap.org/citation.html

National Wildlife Federation. Native Plants By Zip Code. (2023). Reston. Retrieved August 2, 2023. https://www.nwf.org/NativePlantFinder/Plants/Flowers-and-Grasses

Limitations:

As discussed prior, one of the greatest limitations of the Native Plant Search tool is that it is only able to provide information on plant genus, not species. So the research team had to generalize species down to genus. Also, it is important to consider that some species native to the state and not in the National Wildlife Federation's database, may actually be present in the zip code- it can be difficult to determine the exact endemic range of a species on such a nuanced scale.

Likely, the species native to the state of Indiana that are not included within the calculations do provide ecological value, as well as some plants that are hybridized with native species, and plants that are indigenous to North America. Even non-native species are able to provide support to native *lepidoptera*, although it is typically of much less value.

In terms of ecological value it is difficult to determine an exact number of species that can be supported. The landscape architecture consultant utilized many cultivars of native species within this project. Some cultivars may provide less, or more, ecological value than the straight species it derives from. Ornamental factors such as the following can affect the responsiveness *lepidoptera* have to cultivars:

-Leaf size and color
-Flower color, shape, and size
-Flowering time

In general there is an indeterminate number of factors can affect *lepidoptera* behavior, some of which is unknown. Therefore this benefit is best left as an approximation.

Appendix A.

Monon Boulevard and Midtown Plaza Questionnaire Survey

Hello, residents! We, Purdue landscape architecture students, are working with the design firm of Monon Boulevard and Midtown Plaza to conduct a survey on the use of the park in Carmel to assess the impact of the design on the life and culture of local residents. Please take five minutes of your time to take a questionnaire for us. The summary of questionnaire results will be published through the Landscape Architecture Foundation (https://www.lafoundation.org/) as a showcase for the successful performance of this project. Purdue landscape architecture professor, Yiwei Huang (yiweihuang@purdue.edu), is overseeing the validity and ethics concerns for the questionnaire questions. This study has been reviewed by the Purdue IRB, number IRB 2023-526. Thank you for your participation and your love of this open space!

1. Are you a resident of Carmel, Indiana, or a visitor？

☐ Local Resident

*If yes please fill in your travel time: _____minutes and transportation method _____

☐ Visitors

*If yes please fill in where you came from_____city and how long you are staying

     in Carmel   for _____days

2. Which age range do you fall into？

☐18-28 years   ☐28-48 years ☐48 years+

3. Do you agree that Monon Boulevard is friendly to a variety of age groups?

☐Yes, I agree

☐No, I disagree. I think it is not friendly to _____ age group.

4. I/my family spent more time outside since this boulevard/plaza was built?

☐ Strongly Agree   ☐ Somewhat Agree   ☐ Neither Agree Nor Disagree

☐ Somewhat Disagree   ☐ Strongly Disagree

5. The construction of the Monon Boulevard/Midtown Plaza has made the pedestrian experience safer than before:

☐ Strongly Agree   ☐Somewhat Agree   ☐ Neither Agree Nor Disagree

☐ Somewhat Disagree   ☐ Strongly Disagree

6. What do you identify as important due to the construction of Monon Boulevard and Midtown Plaza to the city of Carmel (select all that apply):

☐ It has become the landmark for the city of Carmel

☐I am proud that Monon Boulevard is part of Carmel and I will introduce Monon Boulevard to my friends and families who visit the area

☐When I spend time on the renovated trail system, I notice the surrounding plants and environment, and I feel at peace with myself

☐Doing my activities on Monon Boulevard is more important to me than doing them in any other place (I like using Monon Boulevard trail system more than other trails elsewhere)

☐I am willing to spend my time doing volunteer work associated with Monon Boulevard if I can make it a better place

☐This trail system and green space helps with family harmony and neighborhood building

☐I have met acquaintances or have run into old neighbors at this park and trail

☐This green space makes me feel good physically and mentally

7. What do you typically do in this green space? And how do you benefit from the Monon Boulevard and Midtown Plaza (Check all that apply)?

☐ Playable spaces   ☐ Event gathering   ☐Transportation connection   ☐Active Lifestyle

☐Social Networking   ☐ Retail and Commercial   ☐Other (please specify)_____

8. **Does art and the reconstruction of the Monon Boulevard and Midtown Plaza enhance the visual quality of the trail?**

☐ Strongly Agree   ☐Somewhat Agree   ☐ Neither Agree Nor Disagree

☐ Somewhat Disagree   ☐ Strongly Disagree