

ZERO TRAFFIC
FATALITIES. PERIOD.

VISION **ZERO**
COLUMBUS

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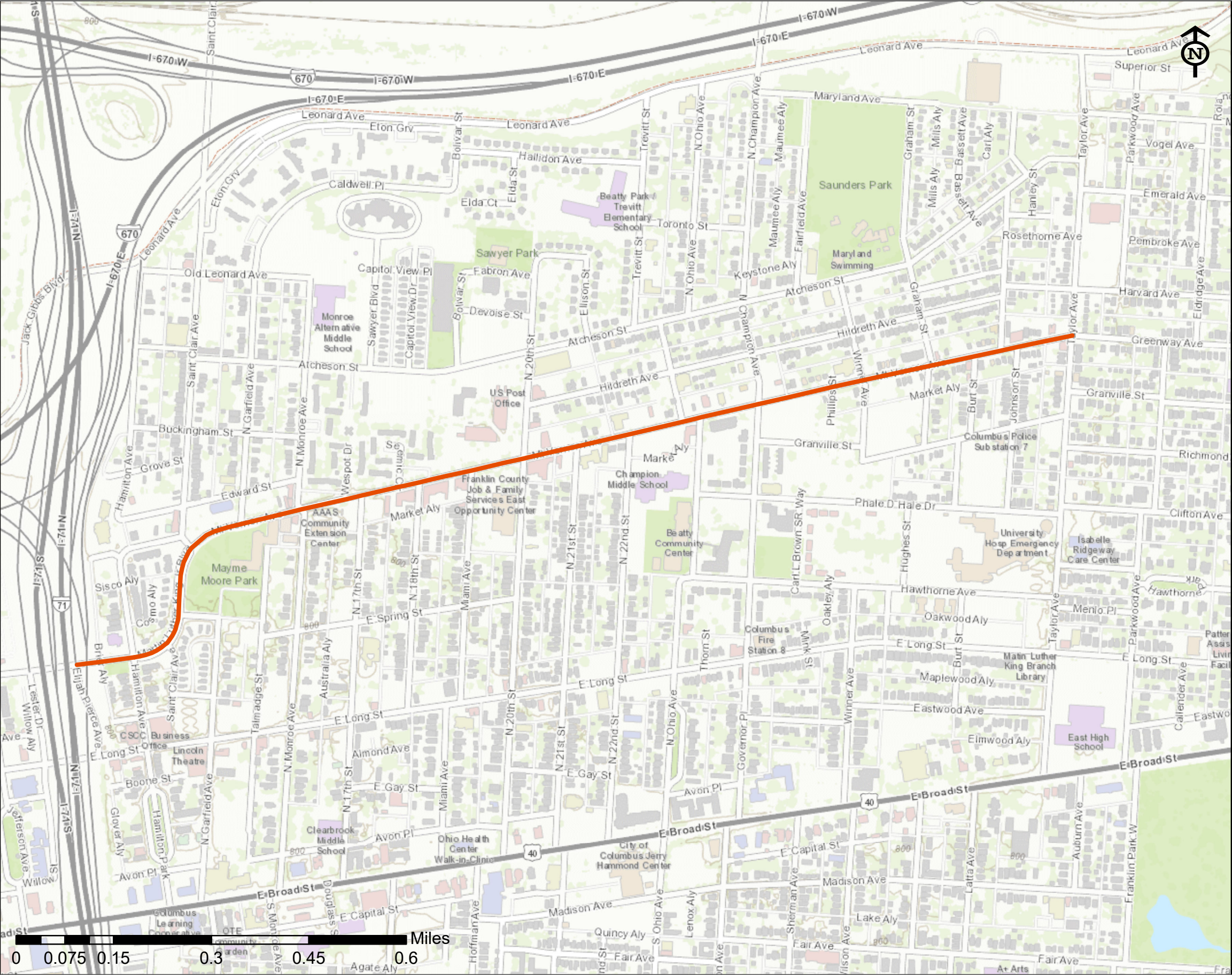
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Project Corridor Map

Legend

Project

Bronzeville/Mt. Vernon Avenue Corridor Improvements

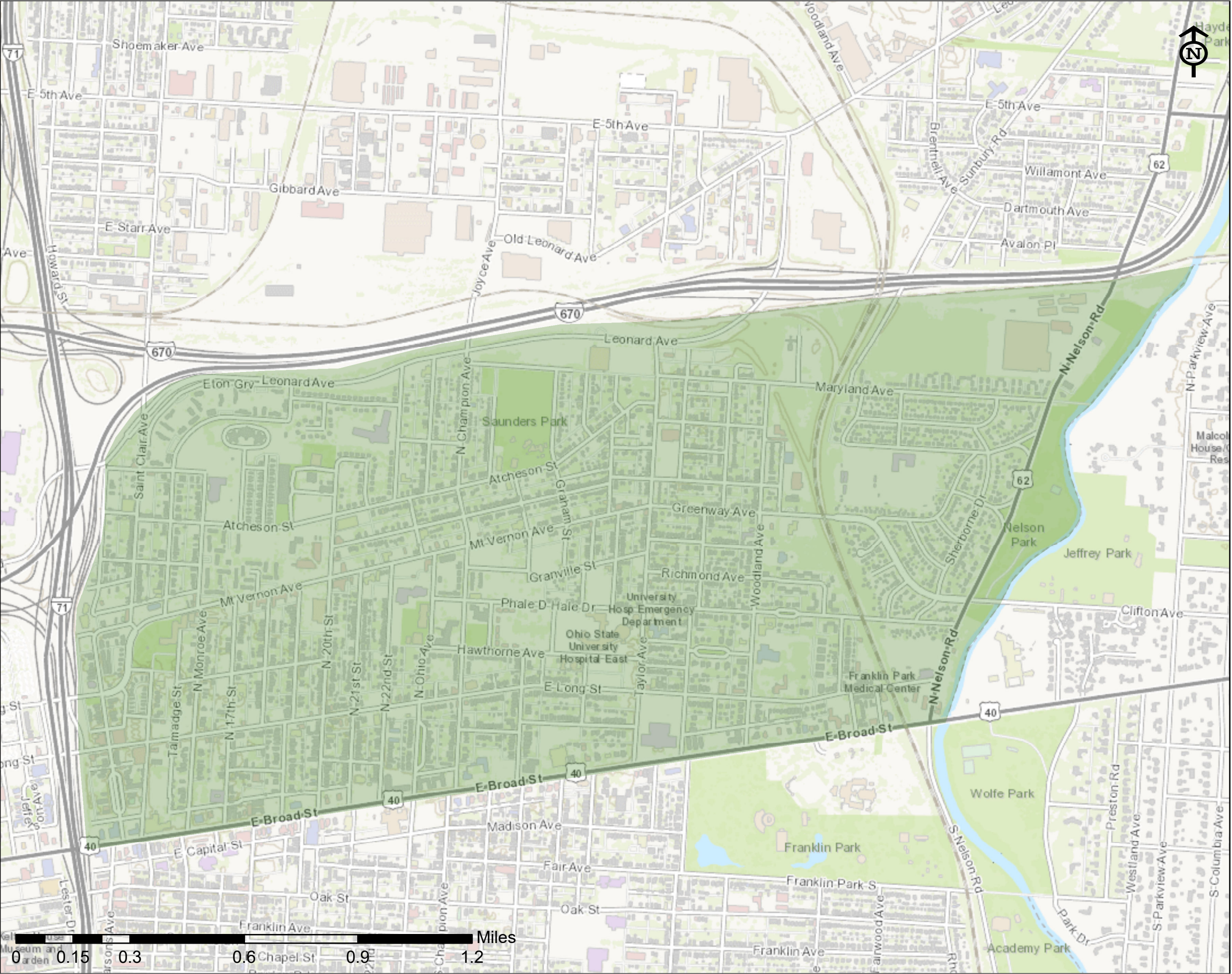


Disclaimer: Distances are approximate. This map has been provided as reference material and does not constitute a legally binding document. Use at your own discretion.

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Project Area Map

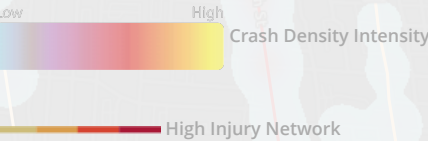


Legend

Project

Project area for lighting upgrades and Neighborhood Slow Zone pilot

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Columbus Vision Zero Definitions:

High Injury Network - Corridors in the City of Columbus that have had the greatest number of fatal, serious injury and/or vulnerable user crashes per half mile segment. Does not include freeways.

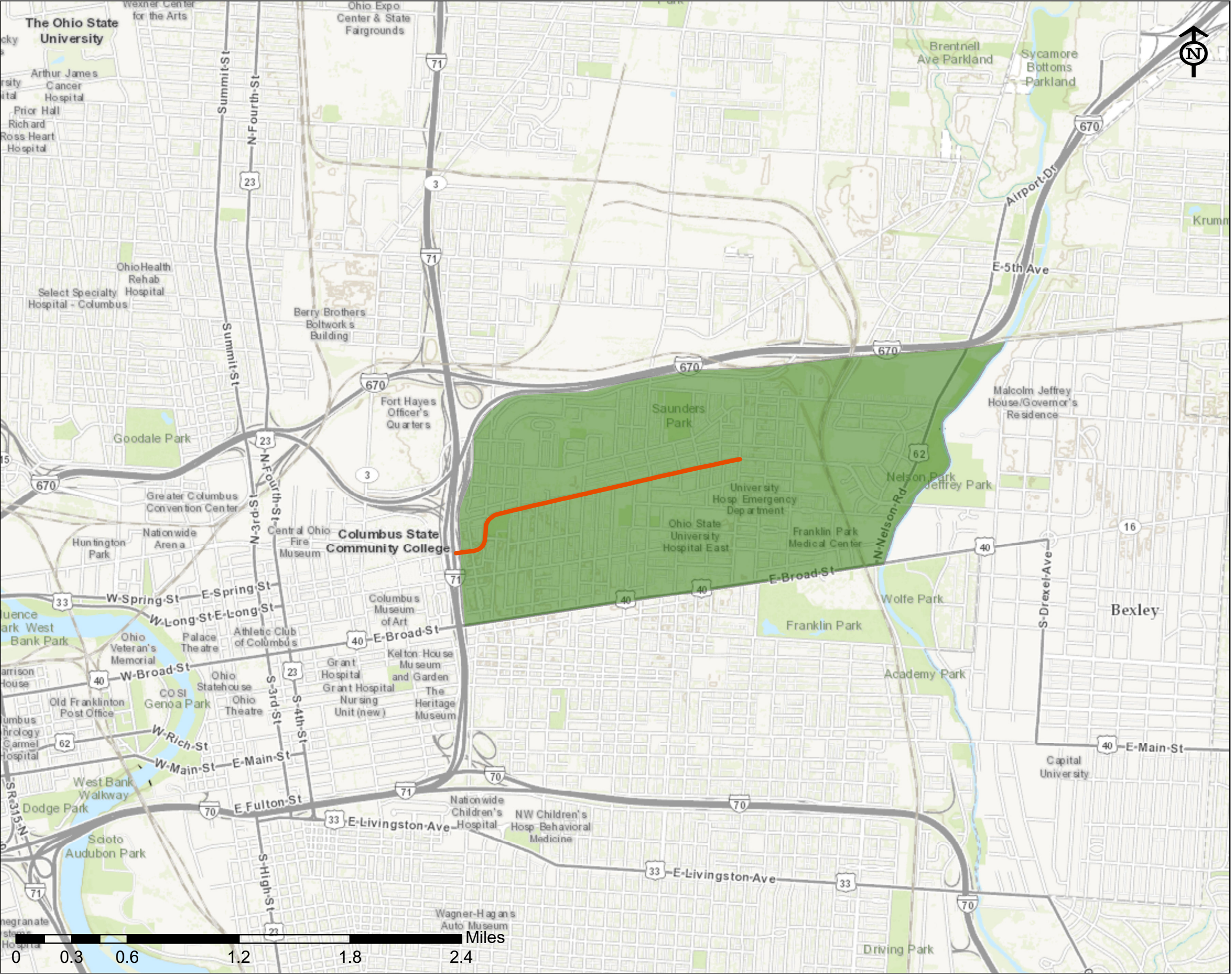
Vulnerable Road Users – pedestrians, bicyclists or motorcyclists – individuals who are inherently more at risk of injury when involved in any traffic crash

Columbus Vision Zero Crash Data:

- currently includes data from 2017-2021
- does not include freeways or crashes outside the City corporation limits where the City has limited authority to make any changes
- includes all fatal or serious injury crashes
- includes all Vulnerable User Crashes of any severity



SS4A Implementation Project Location Map



Legend

Project

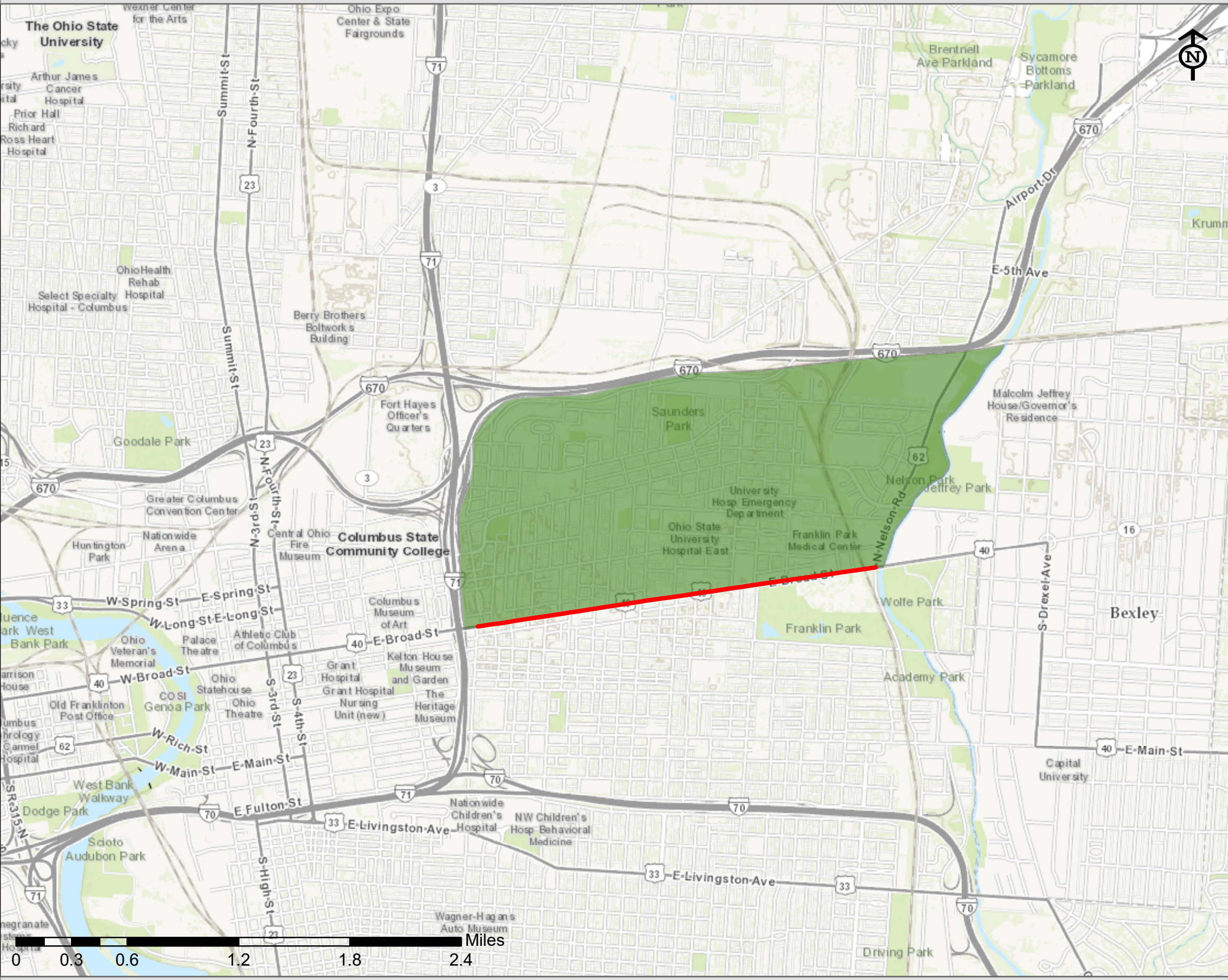
- Bronzeville/Mt. Vernon Avenue Corridor Improvements
- Project area for the Near East LED Smart Street Light Upgrades

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SS4A Supplemental Planning and Demonstration Project Location Map



Legend

Projects Seeking Implementation Funding

- Broad Street Lane Reallocation Demonstration Project
- Project area for Neighborhood Slow Zones Near East Pilot

* The third project seeking supplemental planning and demonstration funding is not mapped, as the surveys and focus groups would be conducted citywide.

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Legend

Project

— Bronzeville/Mt. Vernon Avenue Corridor Improvements

Maintenance Responsibilities

———— Not Columbus maintenance responsibility

———— Columbus maintenance responsibility

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From: [Young, James D.](#)
To: [Nittle, Timothy O.](#)
Subject: FW: ODOT 2022 Civil Rights Transportation Symposium- award winner
Date: Thursday, June 9, 2022 12:56:54 PM

FYI

James D. Young, P.E.
City Engineer/Division Administrator
Division of Design and Construction
111 North Front Street, [6th Floor](#)
[Columbus, Ohio 43215](#)
W: [614-645-3915](#)
C: 614-327-2788

From: Lynnette.Stevens@dot.ohio.gov [mailto:Lynnette.Stevens@dot.ohio.gov]
Sent: Thursday, June 9, 2022 12:42 PM
To: Brian.Davidson@dot.ohio.gov
Cc: Deborah.Green@dot.ohio.gov; Andrea.Stevenson@dot.ohio.gov; Young, James D. <JDYoung@columbus.gov>
Subject: [EXTERNAL] Re: ODOT 2022 Civil Rights Transportation Symposium- award winner

Hi Brian,

No press release was issued, sorry. I sent the emails out and that was it. We haven't sent press releases in the past but maybe we can do that starting next year? Thank you for the idea!

Sincerely,

Lynn Stevens
Administrator, Office of Outreach
Ohio Department of Transportation
614-578-0513 (cell)

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From: Davidson, Brian <Brian.Davidson@dot.ohio.gov>
Sent: Thursday, June 9, 2022 11:45:16 AM
To: Woods-Stevens, Lynnette <Lynnette.Stevens@dot.ohio.gov>
Cc: Green, Deborah <Deborah.Green@dot.ohio.gov>; Stevenson, Andrea <Andrea.Stevenson@dot.ohio.gov>; jdyoung@columbus.gov <jdyoung@columbus.gov>
Subject: RE: ODOT 2022 Civil Rights Transportation Symposium- award winner

Hi Lynnette.

Was there any sort of press release other than this email for the LPA of the Year Award? City of

Columbus is working on a grant application and was interested in including it as an attachment.

Thanks,

Brian Davidson

Local Programs Manager

District 6 Planning & Engineering

400 E. William Street, Delaware, Ohio 43015

(p)740.833.8397 (m)740.360.0687

transportation.ohio.gov

From: Woods-Stevens, Lynnette <Lynnette.Stevens@dot.ohio.gov>

Sent: Monday, April 18, 2022 12:25 PM

To: JDYoung@columbus.gov

Cc: Davidson, Brian <Brian.Davidson@dot.ohio.gov>

Subject: ODOT 2022 Civil Rights Transportation Symposium- award winner

Hello Mr. Young,

This is Lynn Stevens with the Ohio Department of Transportation (ODOT). As you may know, ODOT is hosting the 5th Annual Civil Rights Transportation Symposium April 25 – 26, 2022 at the Center of Science & Industry (COSI) located in downtown Columbus. Eight awards are given each year to individuals, companies, and organizations who exhibit exceptional commitment to the principles of civil rights and diversity and inclusion in the transportation industry. The award categories are as follows:

1. Director's Award for Diversity & Inclusion Advocacy
2. DBE Contractor of the Year
3. DBE Consultant of the Year
4. Prime Contractor of the Year
5. Prime Consultant of the Year
6. Local Public Agency of the Year
7. Transit System of the Year
8. Business Development Award

I would like to let you know that the City of Columbus, Department of Public Service was nominated for the Local Public Agency of the Year Award by Brian Davidson with ODOT's District 6 Headquarters and was selected as the winner! **CONGRATULATIONS!!**

Here is a description of the award criteria:

- **Local Public Agency of the Year Award**

This award recognizes an outstanding Local Public Agency (LPA) that has excelled in upholding the requirements of the federal program and has a demonstrated track record of partnering with ODOT and DBE firms, while also encouraging the utilization of DBE firms on local-let, federally funded Department of Transportation (DOT) projects.

We will present the award during the luncheon on **Tuesday, April 26, 2022 (12:15p – 1:30p)**. Would you like to send someone to accept the award in person? If so, please provide his/her name at your very earliest convenience. If no one can attend, we can mail the award to you. FYI- Patricia Fought will be a speaker at the Symposium on April 26th and she can probably accept the award on your behalf, if desired.

Also, we'd like to display the city's logo during the PowerPoint presentation where we will announce the nominees and winners. Would you mind sending the logo at your very earliest convenience?

Congratulations again and we look forward to hearing from you! Have a great day.

Sincerely,

Lynn Stevens

Administrator, Office of Outreach

Ohio Department of Transportation

Division of Opportunity, Diversity, and Inclusion

1980 W. Broad Street, 2nd floor, Columbus, Ohio 43223

(p) 614-644-8436 (m) 614.578-0513

transportation.ohio.gov



Intersection of Spring Street and Hamilton Avenue, looking east towards Martin Luther King Boulevard.



Heading east/north on Martin Luther King Jr Boulevard



Heading east/north on Martin Luther King Jr Boulevard. Mayme Moore Park to the right.



Martin Luther King Jr Boulevard, looking north at new housing under construction.



Transition of Martin Luther King Jr Boulevard to Mt. Vernon Avenue, looking east.



Heading east past Commercial properties fronting Mt. Vernon Avenue.



Intersection of Mt. Vernon Avenue and 17th Street. Signal will be removed during project construction.



Residential housing on the north side of Mt. Vernon Avenue.



Heading east on Mr. Vernon Avenue past commercial properties.



Commercial properties with residential apartments behind it on the north side.



Heading east towards intersection of Mt. Vernon Avenue and 20th Street.



At the intersection of Mt. Vernon Avenue and 20th Street, heading east. Signal infrastructure to be replaced during project.



Heading east on Mount Vernon Avenue.



Heading east on Mt. Vernon Avenue.



Intersection of Mt. Vernon Avenue and Ohio Avenue, heading east. Legacy Pointe at Poindexter apartments are on the south side of the street, commercial on the north.



Intersection of Mt. Vernon Avenue and Champion Avenue, heading east. Champion MS and Legacy Pointe at Poindexter are to the south.



Heading east on Mt. Vernon Avenue. On-street facility and phase 1 of the project will terminate in this area, approximately by Winner Avenue.



Mt. Vernon Avenue, approaching the intersection with Winner Avenue.



Mt. Vernon Avenue, approaching the intersection with Winner Avenue.



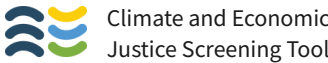
Mt. Vernon Avenue, heading east towards Taylor Avenue.



Mt. Vernon Avenue, heading east towards Taylor Avenue.



Mt. Vernon Avenue, approaching intersection with Taylor Avenue.



Explore the map

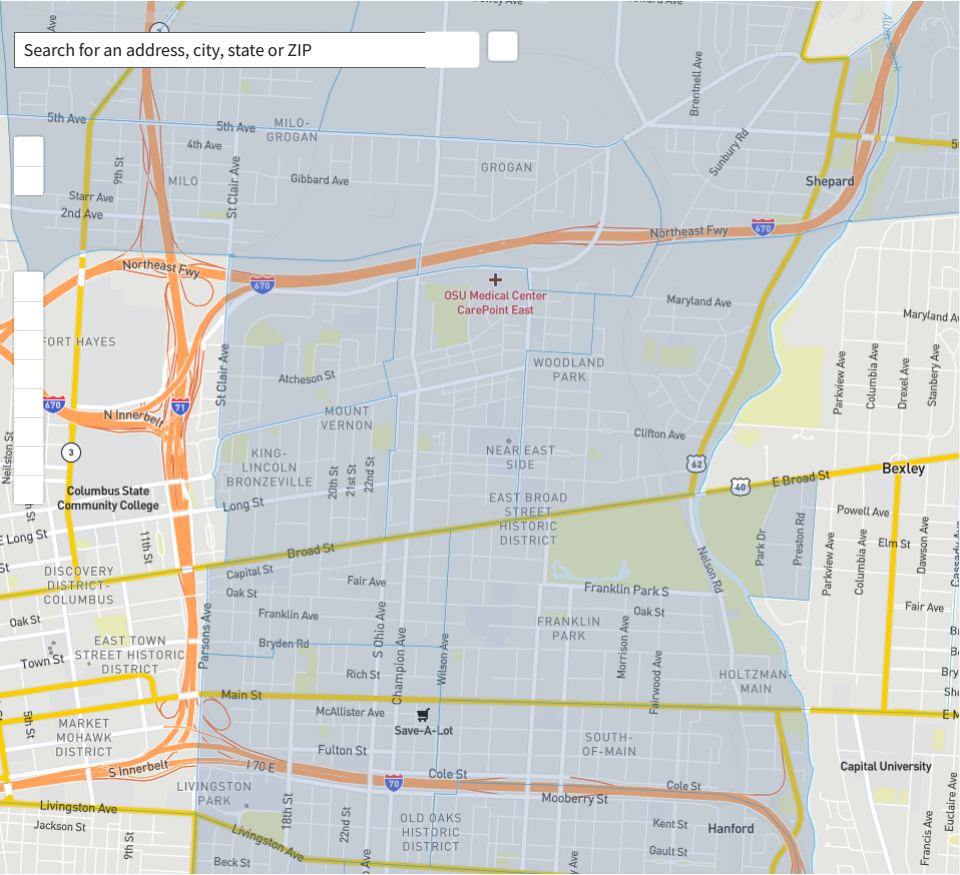
[Share data sources with CEQ](#)

Census tracts that are overburdened and underserved are highlighted as being disadvantaged on the map. Federally Recognized Tribes, including Alaska Native Villages, are also considered disadvantaged communities.

Zooming in and selecting shows information about each census tract.

Get the data

Download the data with documentation and shapefile from the [downloads](#) page.



How to use the map:

Zoom in + , search 🔍 , or locate yourself 📍 and select to see information about any census tract.

Things to know:

The tool uses census tracts 🗺️ . Census tracts are a small unit of geography. They generally have populations 🧑 of between 1,200 - 8,000 people.

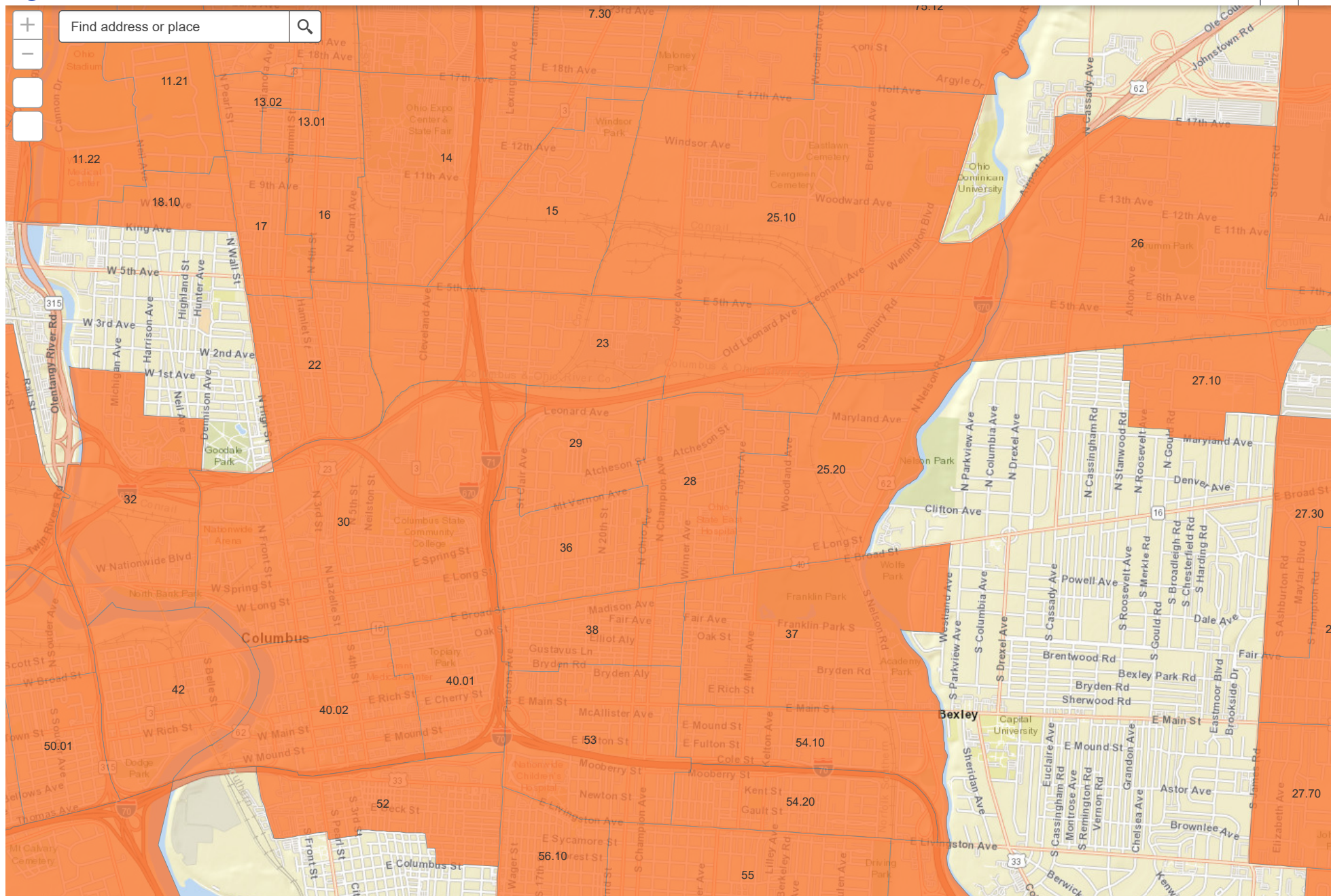
Communities that are disadvantaged live in tracts that experience burdens. These tracts are highlighted 🟡 on the map.

The tool ranks most of the burdens using percentiles 📊 . Percentiles show how much burden each tract experiences when compared to other tracts.

Thresholds 📏 , or cutoffs, are used to determine if communities in a tract are disadvantaged. Certain burdens use percentages 📊 or a simple yes/no ✓ .



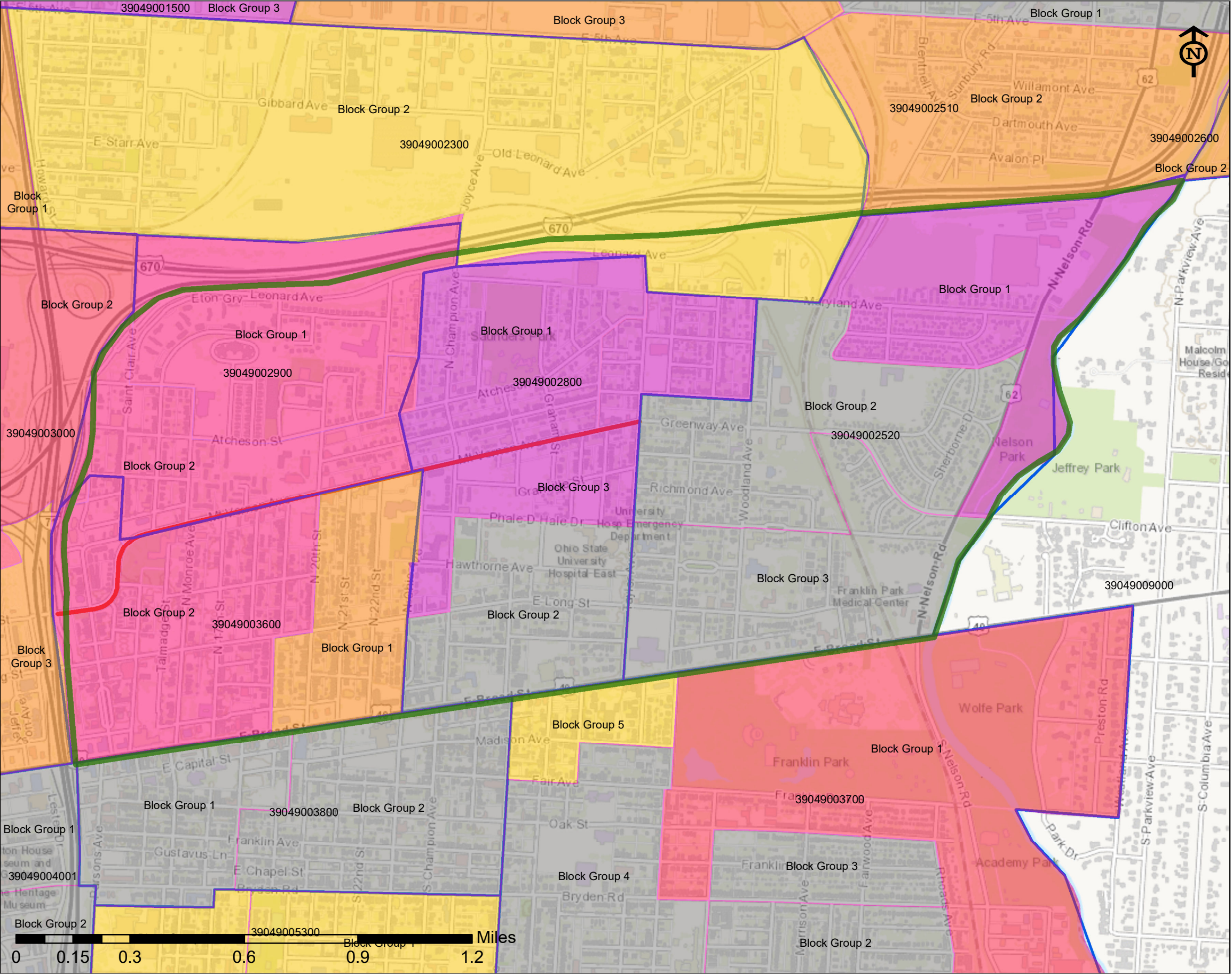
Areas of Persistent Poverty Map



0.4mi

-82.883 39.982 Degrees

VZ COI Map



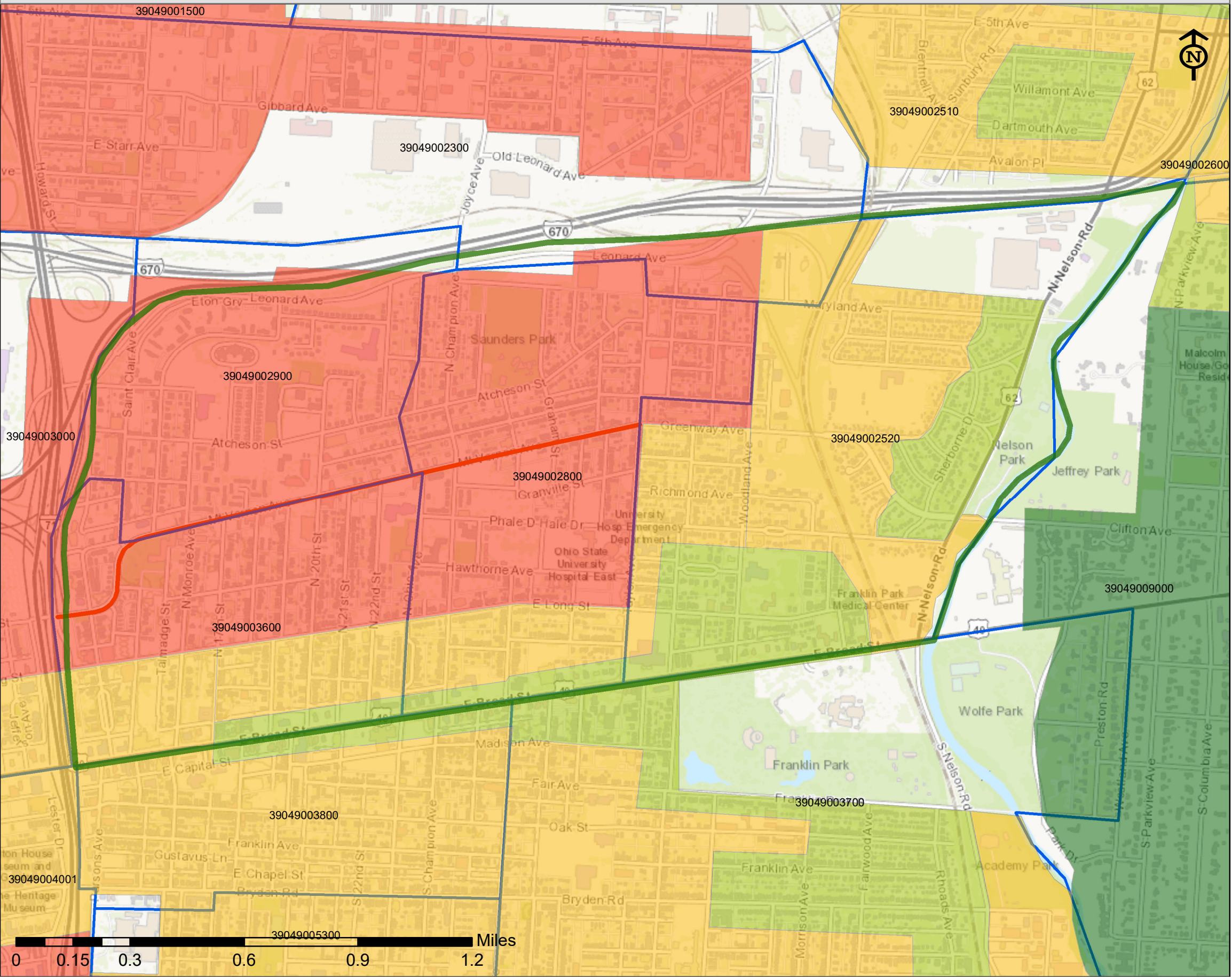
Legend

Columbus VZ Communities of Interest

- Not a COI
- coi_count
 - COI - 1.5
 - COI - 2
 - COI - 2.5
 - COI - 3
 - COI - 3.5
 - COI - 4
- Project
 - Bronzeville/Mt. Vernon Avenue Corridor Improvements
 - Project area for lighting upgrades and Neighborhood Slow Zone pilot

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Project Area HOLC Map



Legend

Columbus HOLC Information

HOLC Grade

- A
- B
- C
- D

Project

- Bronzeville/Mt. Vernon Avenue Corridor Improvements
- Project area

Census Tracts

- Census Tract Boundaries

Disclaimer: Distances are approximate. This map has been provided as reference material and does not constitute a legally binding document. Use at your own discretion.

High Recycled Content Asphalt Pavement



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City of Columbus Supplemental Specification 1505

High Recycled Asphalt Pavement Content

Supplemental Specification 1505 appends the following sections of the City of Columbus, Construction and Material Specifications to provide for the incorporation of Recycled Asphalt Pavement materials exceeding twenty-five percent (25%) in Type I Surface, forty percent (40%) in Type II Intermediate and fifty-five percent (55%) in 301 Base in the job mix formulas for City of Columbus projects where this Supplemental Specification is provided.

Revised RAP by Dry Weight of Mix, (Max) = 60%



Standard Paving Year- RAP Usage

It's a little less tonnage than previous years since 18-2/18-3 did not get all the paving completed.

Type	Tons	% RAP	RAP Tons
301 Base	18415.58	50.00%	9207.79
64-22 (Medium)	25210.02	20.00%	5042.004
70-22M (Medium)	19703.65	20.00%	3940.73
70-22M (Heavy)	4723.80	10.00%	472.38
	68053.05		18662.904

It comes out to about 27% RAP average for the entire year's asphalt on 2018 Resurfacing Projects.



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Extended RAP Timeline

- April 2016 Received Proposals via ORIL for “*Optimizing the Effective Use of RAP in Local Roadways*”
- September 2018 Placed extended RAP test sections on Hall Road 2018-P3
- October 2018 Presented ORIL extended RAP to OTEC
- November 2018 Contacted by RAP Management and provided tour of new asphalt plant on Fifth Avenue
- December 2018 Presentation to Public Service Management
- May 2019 ORIL Report Issued “*Optimizing the Effective Use of RAP in Local Roadways*”
- June 2020 Received and approved first High RAP asphalt mix design from RAP Management
- July 2020 High RAP asphalt placed on Wright Road
- February 2021 RAP Management Presentation to City NPPC

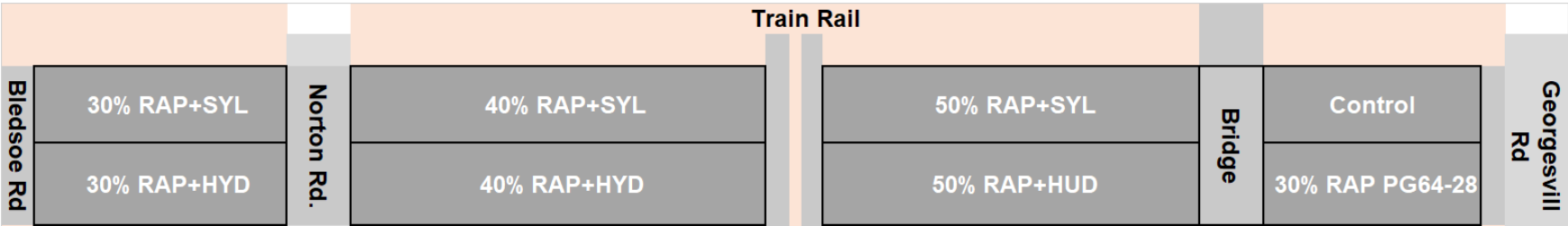
ORIL Summary

Optimizing the Effective Use of RAP in Local Roadways

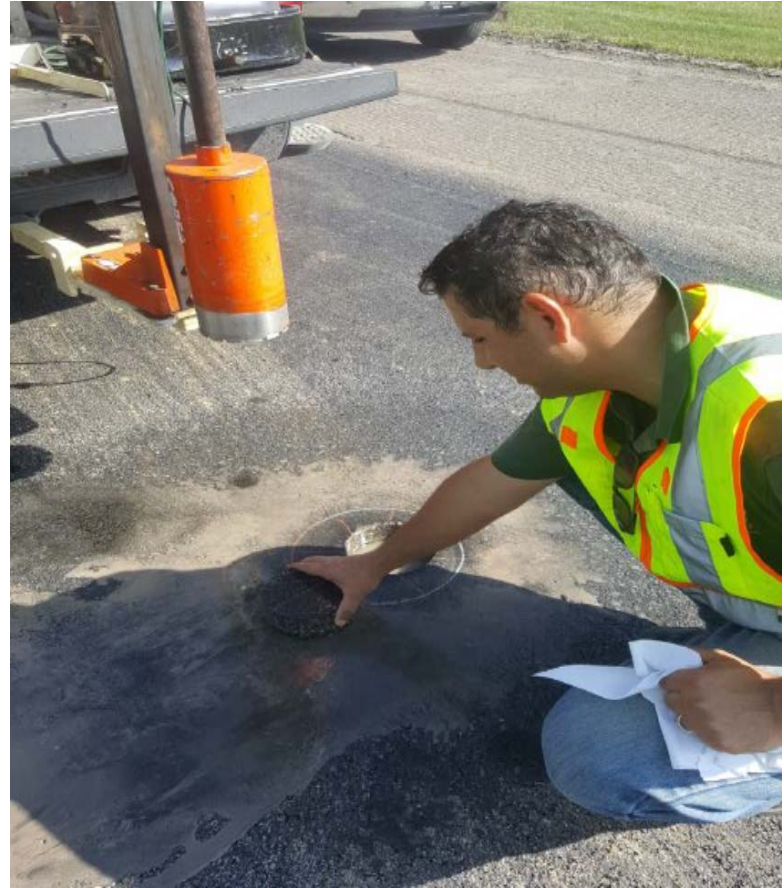
This presentation will provide an update on an Ohio's Research Initiative for Locals (ORIL) research study aimed at assessing the feasibility of using higher percentage of reclaimed asphalt pavement (RAP) in surface course mixtures of local roadways. Phase 1 of this study included conducting a comprehensive laboratory testing program to identify the factors that affect the performance asphalt mixtures with RAP. To this end, several mixtures were designed with different RAP contents: 0%, 20%, 30%, 40, and 50% RAP. Two RAP materials that have binders with different rheological properties were selected. The laboratory testing program also evaluated the effect of using recycling agents on the performance of asphalt mixtures with high RAP content. Three different types of recycling agents (rejuvenators) were used, namely, Hyrolene, Sylvaroad, and soybean. Laboratory tests were conducted to evaluate the propensity of the designed asphalt mixtures to fatigue cracking, low-temperature cracking, moisture-induced damage, and rutting. This presentation will discuss the results of the comprehensive testing program conducted in Phase 1 of this study. In addition, the presentation will highlight the method that was developed to design and construct cost-effective, well-performing, and durable asphalt mixtures with higher RAP contents to be used in the surface course of local roadways in Ohio.



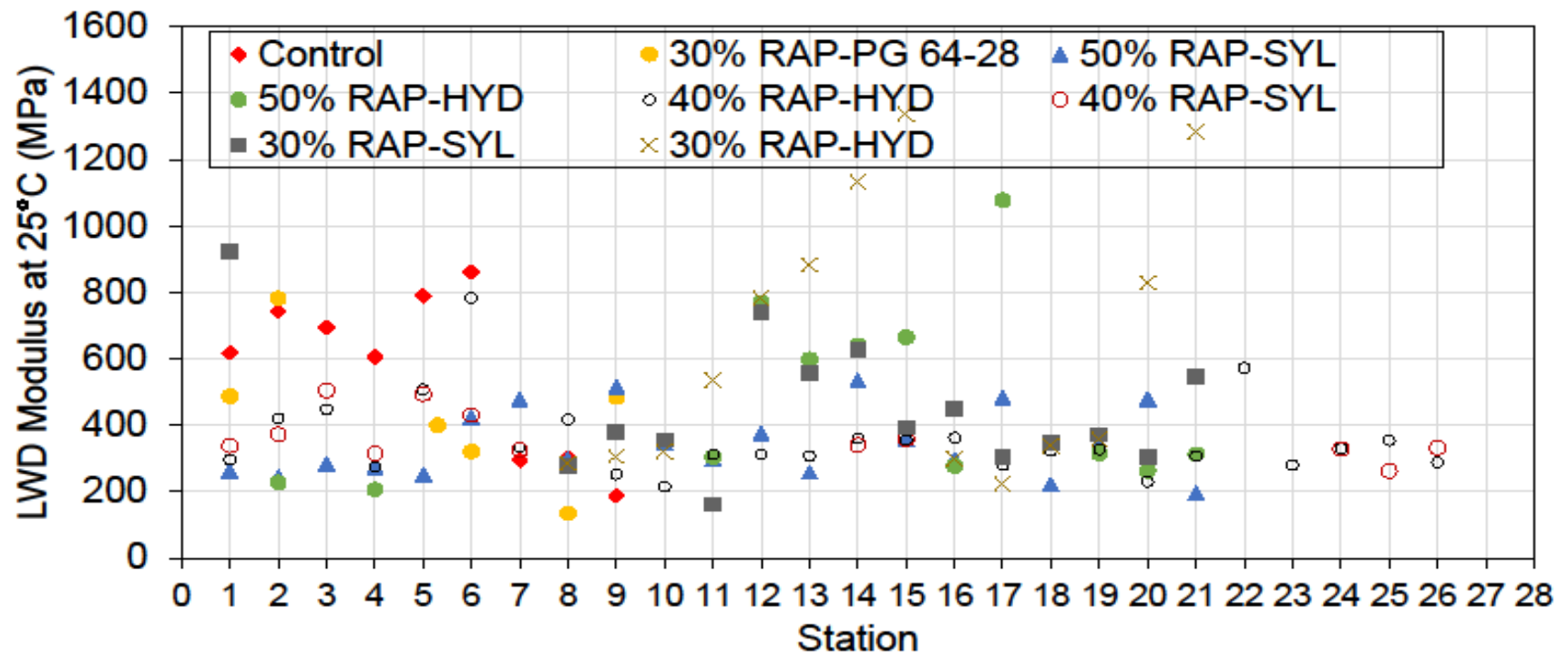
Hall Road Test Sections via ORIL



Hall Road Test Sections via ORIL



Sections Pre-Construction Evaluation



OHIO
UNIVERSITY

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2018 Resurfacing Project 3

Item #	Description	Quantity	Unit	KOKOSING			ENG EST
				2018 Price	2018 Extended		
46	Asphalt Concrete Surface Course, Type 1, (448), PG64-22, (1.5")	95.00	CY	\$ 310.00	\$ 29,450.00	\$ 128.00	\$ 12,160.00
47	Asphalt Concrete Surface Course, Type 1, (448), PG64-22, 30% RAP w/Rejuvenator Type A (1.5"), APP	181.00	CY	\$ 255.00	\$ 46,155.00	\$ 136.00	\$ 24,616.00
48	Asphalt Concrete Surface Course, Type 1, (448), PG64-22, 30% RAP w/Rejuvenator Type B (1.5"), APP	158.00	CY	\$ 255.00	\$ 40,290.00	\$ 136.00	\$ 21,488.00
49	Asphalt Concrete Surface Course, Type 1, (448), PG64-22, 40% RAP w/Rejuvenator Type A (1.5"), APP	174.00	CY	\$ 227.00	\$ 39,498.00	\$ 136.00	\$ 23,664.00
50	Asphalt Concrete Surface Course, Type 1, (448), PG64-22, 40% RAP w/Rejuvenator Type B (1.5"), APP	235.00	CY	\$ 227.00	\$ 53,345.00	\$ 136.00	\$ 31,960.00
51	Asphalt Concrete Surface Course, Type 1, (448), PG64-22, 50% RAP w/Rejuvenator Type A (1.5"), APP	162.00	CY	\$ 223.00	\$ 36,126.00	\$ 136.00	\$ 22,032.00
52	Asphalt Concrete Surface Course, Type 1, (448), PG64-22, 50% RAP w/Rejuvenator Type B (1.5"), APP	211.00	CY	\$ 223.00	\$ 47,053.00	\$ 136.00	\$ 28,696.00
53	Asphalt Concrete Surface Course, Type 1, (448), PG64-28, 30% RAP (1.5")	112.00	CY	\$ 308.00	\$ 34,496.00	\$ 136.00	\$ 15,232.00
54	Contractor Mix Design, Recycled Asphalt Pavement, APP	1.00	LS	\$ 50,000.00	\$ 50,000.00	\$ 8,500.00	\$ 8,500.00
TOTAL					\$ 376,413.00		\$ 188,348.00

**This price includes design & placing surface course on Hall Rd
 -Note that the rejuvenators were donated to KMI for this research project

DIFFEREN	\$
CE	(188,065.00)

2020 Resurfacing Project 1

- SPECIAL ASPHALT CONCRETE SURFACE COURSE, TYPE 1, (448), 60% RAP w/
REJUVENATOR, (1.5"), AS PER PLAN CU YD 1,792.00
- Performed on six streets:
 - HAZELMERE DR
 - CROSSBROOK BLVD
 - GLENWILLOW BLVD
 - JOHNSON RD
 - WRIGHT RD
 - BIG RUN SOUTH RD



SUSTAINABLE ASPHALT MATERIALS

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ABOUT US

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WHY CHOOSE US ??



High quality. Recycling means precision manufacturing and the highest quality pavement materials.



Save money. We can recycle and lower our cost to manufacture while still providing industry leading pavement materials.



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HMA - HOT MIX ASPHALT

- 448 Type 1 Asphalt Concrete
- Commercial Surface Asphalt Concrete
- 448 Type 2 Asphalt Concrete
- 402 Surface Mix Asphalt Concrete
- 302 Bituminous Aggregate Base
- 301 Bituminous Aggregate Base



FSB - FOAM STABILIZED BASE

Heavy duty pavement base material or construction working surface.



CMA - COLD MIX ASPHALT

Temporary asphalt patching material. An asphalt repair product used for patching of potholes, cracks and other defects in asphalt and concrete.



1-614-484-7120



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HMA MATERIALS AVAILABLE:

- 448 Type 1 Asphalt Concrete
- Commercial Surface Asphalt Concrete
- 448 Type 2 Asphalt Concrete
- 402 Surface Mix Asphalt Concrete
- 302 Bituminous Aggregate Base
- 301 Bituminous Aggregate Base

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Utilizing new technology we can lower the environmental cost while still providing industry leading pavement materials.



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We create the most rigorously tested precision engineered asphalt on the market, using up to 70% Recycled Asphalt Product (RAP).



ASSURANCE YOU CAN TRUST

Our regular testing ensures compliance with any specification.



- Aggregate Gradation
- Binder Volume
- Binder Performance Grade
 - Resistant to rutting
 - Resistant to cracking
- Workability



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2020 Resurfacing Project 1

- Add'l Quality Control requirements in Lab and field
- Requirement of using Asphalt Concrete Rejuvenating Agent
- Method 3 shall be produced from a High Recycle Technology (HRT) plant
- HRT plant is comprised of a batch tower to heat, dry and reclassify the virgin aggregate and a gravimetrically fed continuous parallel flow dryer to heat and dry the recycling aggregate materials.
- SS 1505 will eventually transition into 441 Method 3 (High RAP);
(Method 1 = Standard RAP and Method 2= Extended RAP)



2019 CONSTRUCTION SEASON

SUSTAINABILITY REPORT



**AVERAGED 56%
RECYCLED CONTENT**

THAT'S ALMOST 3X
THE INDUSTRY AVERAGE
IN THE UNITED STATES.

3X



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Additional Sustainability Items

- 2015 Resurfacing Project 1-Reclaimed Shingle Asphalt (RAS)



Additional Sustainability Items

- 2017 ORIL study Analysis of Ground Tire Rubber in Mix Design on Local Roadways Ground Tire Rubber Asphalt (GTR)

PROJECT SUMMARY

GTR is a recycled product produced from old vehicle tires. It can be used as an additive to asphalt mixtures, in place of polymers, to improve the durability, longevity and performance of pavements. While GTR has the potential for positive environmental impacts, historically the initial cost of using GTR in asphalt mixes can be so high that many city, townships and counties simply cannot afford to use it. However, over time, advances in technology have increased the options available in regards to products and application methods. This research was initiated to assess the true life-cycle cost of GTR mixes and identify opportunities for GTR to be more affordable and cost-competitive with traditional polymer modified mixes without compromising performance.

Researchers identified three GTR modified binders that, based on lab tests, can be used to promote performance equal to or better than that of traditional polymer modified asphalt mixes at a comparable cost. Each of the binders tested were compared to a PG 70-22 polymer modified binder. A draft specification, designed specifically for use on local roads, was developed along with supplemental QC/QA testing and acceptance criteria. Test sections were constructed in Columbus, OH and Akron, OH for long-term evaluation of their performance.

Additional Sustainability Items

- 2018 Recycled Glass Aggregate worked with Tom Bolon of Novotec



Additional Sustainability Items

- 2020 Resurfacing Project 1- Cold in Place Recycling (CIR) PARTIAL DEPTH ASPHALT PAVEMENT COLD IN PLACE RECYCLING (CIR) SQ YD 52,570.00



Questions?



CLEVELAND, OH – 12/22/2020 – FOR IMMEDIATE RELEASE

Pavement Technology, Inc. Becomes Sustaining Partner in GCCA's Newly Launched "Cool Roadways Partnership"

Westlake Ohio-based Pavement Technology, Inc. (PTI) is proud to be a sustaining partner of the newly launched "Cool Roadways Partnership," which includes major municipalities in AZ, CA, KY, MO, MS, NC, NM, PA, and TX. This initiative, launched on December 8, 2020, is an offshoot of the Global Cool Cities Alliance (GCCA), which is a consortium of foundations and corporations committed to accelerating a world-wide transition to cooler, healthier cities. The "Cool Roadways Partnership" consists of 20 jurisdictions, non-profits and industry representatives actively engaged in accelerating the development and scaled deployment of pavement-related materials that reduce surface and air temperatures and build resilience to rising heat.

For nearly have a century, PTI executives have been deeply engaged with environmentally responsible pavement preservation solutions, sitting on the board of The National Center for Pavement Preservation (NCP) at Michigan State University, and holding memberships in U.S. Green Building Council (USGBC) and the Institute for Sustainable Infrastructure (ISI). Colin Durante, PTI founder and president reports, "We saw the need nearly half a century ago for public agencies and the pavement industry to come together to promote best practices in order to ensure superior roadway maintenance and long-term sustainability while extending scarce municipal and county capital resources and reducing society's carbon footprint. This newest initiative is consistent with our long-term commitment to improving the quality of life of the communities we serve."

Although pavements make-up nearly one-third of urban land surfaces, society has historically lacked a vehicle that integrates government and industrial efforts nationwide in an effort to combat rising urban temperatures commonly referred to as the Urban Heat Island (UHI) effect. Excessive heat adversely affects the health and well-being of our communities, reduces the quality of air and water, increases dependence on the fossil fuels needed to cool our buildings, and damages pavements and related infrastructure. In addition, the health and economic burdens of excess heat are borne disproportionately by "at risk" communities, jeopardizing the equity goals of America's societal compact.

As a Silver Partner of the newly formed "Cool Roadways Partnership," PTI reports that the partnership anticipates investing \$4.75 billion to add, maintain, replace or upgrade as many as 70,000 lane-miles over the next ten years to engage in this critical fight. The company's innovative **PlusTi™** family of photocatalytic pavement solutions, specifically targeted at reducing mobile-sourced pollution and mitigating UHI, is one of the many toolsets government agencies and transportation authorities will be deploying in this effort.

The newest **PlusTi** product line has been successfully applied and tested in the field for more than three years now with startling results, demonstrating NOx emission reductions as high as 50 percent, and more than tripling pavement solar reflectivity, meeting USGBC, LEED and APWA/ASCE Envision standards. PTI's vice president of strategic planning, Michael Durante, concludes: "This exciting technology will enable our public agency partners to cost-effectively attack climate change one road at a time, providing a scalable and sustainable solution to improve the quality of life in our communities and the sustainability and resilience of our urban infrastructure."

For more information, visit www.smogeatingroads.com, call Michael Durante at 972-974-6037 mdurante@pavetechinc.com or visit <https://globalcoolcities.org>.



Pavement Technology, Inc.

24144 Detroit Rd.
Westlake, Ohio 44145
Phone: 800-333-6309

Cincinnati - TiO₂-Bearing Pavement Field Results

**To: Chris M. Ertel, P.E.,
Principal Transportation Design Engineer**

**Jennifer Russell, P.E., P.S., Supervising Engineer
Joe Flading, P.E., Senior Engineer**

**Department of Transportation and Engineering
City of Cincinnati
801 Plum Street, Suite 450
Cincinnati, Ohio 45202**

**Dave Helm, Technical Representative
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From: Michael Durante, Vice President Finance & Strategic Planning

**Re: Test Results: Photocatalytic Pavements – Pollution Remediation; Heat (Absorption)
Reduction; and Hydrophilic Improvement**

Date: 30 July 2020

Pavement Technology's (PTI) photocatalytic pavement solutions for pollution removal, pavement preservation, Heat Island (UHI) mitigation and other photo-induced properties beneficial to air quality, pavement life-cycle extension and heat sink management now are into scale piloting.

On May 11, 2020, PTI completed a pilot application of **A.R.A.-1 Ti[®]** TiO₂ enhanced Maltene Asphalt Rejuvenator on a newly paved section of Montgomery Road. The test section was three lanes of new

pavement approximating 62,000 sq/yds and 16,000 linear feet. The application rate was 0.05 gallons per square yard with 3.5% photocatalytic grade TiO_2 ¹ by volume concentrate.

A.R.A.-1 Ti[®] Trial
Montgomery Road, Cincinnati, Ohio
May 11, 2020



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A.R.A.-1 Ti[®] is a specialized version of a **Maltene Replacement Technology (MRT)** product enhanced to impart both the **regenerative properties** of a maltene rejuvenator and the beneficial sustainability and environmental properties of imbedded photocatalytic grade **Titanium Dioxide (TiO_2)**.

As a photocatalyst material (semiconductor), TiO_2 is a multifaceted photo-responsive material² rapidly gaining increased scientific and commercial interest for near-roadway microenvironments as it advances a host of preservation and environmental benefits, including:

- **Depolluting** near-pavement air (or water) cleaning applications, where TiO_2 reacted surfaces are able to oxidize a variety of pollutants and contaminants such as those emitted by vehicles, especially NO_x and VOCs, and even worn tire residue (microplastic) reducing ozone pollution and mitigating acid rain formation
- **“Cool Pavement”** applications where TiO_2 treated surfaces provide a solar-reflective top boundary, which lessens pavement related radiative forcing (RF) by reducing the convective re-release or

¹ n-type semiconductor containing >99.5% TiO_2 content comprised of no less than 80% anatase crystallite by weight (plus or minus 5%) in a particle size averaging 21nm (plus or minus 5nm) with a small portion of rutile crystalline content.

² *Polymers, Light and the Science of TiO_2* , DuPont[™] Ti-Pure[®] Titanium Dioxide, DowDuPont, www.dow-dupont.com.

emissivity of solar radiation that leads to the undesired UHI effects and enhances the life-cycle assessment of pavements by slowing-down oxidation³

- **Super-Hydrophilic** surfaces, which provide a rapid **water-desorbing pavement**, which is self-cleaning to remove contaminants (e.g., mold) and staining; protects against water intrusion; and is indicated for inclement weather-related safety (rain displacing; ice inhibiting) improvements for roadways⁴

As a radiant heat mitigator, photocatalytic grade TiO₂ simultaneously absorbs solar radiation away from the pavement substrate and efficiently redirects the energy back into the atmosphere, thereby protecting the pavement from oxidative deterioration and eliminating excess pavement emissivity (especially in asphalts), creating a so-called – “**cool pavement**” which greatly slows-down oxidative damage while improving air quality.⁵

TiO₂-bearing pavements also exhibit a **Photoinduced Superhydrophilicity State** when exposed to sunlight (UV radiation), which enables water to more efficiently disperse and desorb across a TiO₂-treated surface.⁶

⁷ This not only protects the substrate from damaging water intrusion, it holds significant highway safety improvement implications including reduced hydroplaning, less windshield visibility impairment, and possibly ice formation mitigation. A PSH is why TiO₂ treated surfaces are mechanically “self-cleaning” and both anti-mold and antimicrobial.⁸

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Cincinnati Test Results:

Core samples (2 = 1 treated and 1 untreated) from the Montgomery Road test site were sent to the Texas A&M Transportation Institute to complete laboratory testing of these field samples for photocatalytic oxidation for pollution removal (NO_x Reduction %); solar reflectance index for heat absorption or Urban Heat Island effect mitigation; water contact angle for hydrophilic analysis; and X-ray Fluorescence for TiO₂ load and dispersion efficiency under:

³ Gopalakrishnan K, et al.

⁴ Arainpour F and Farzaneh M, On Hydrophobic and Icephobic Properties of TiO₂-Doped Silicon Rubber Coatings, Department of Applied Sciences, Universite du Quebec, *International Journal of Theoretical and Applied Nanotechnology*, 2012.

⁵ EPA, *Reducing Urban Heat Islands: Compendium of Strategies, Urban Heat Island Basics*, www.epa.org.

⁶ Mechanism of Photoinduced Superhydrophilicity on the Photocatalyst Surface, *The Journal of Physical Chemistry*, American Chemistry Society, 2005, Masato T, et al.

⁷ Vassilia Z, *Hydrophilic TiO₂ Surface Without Photocatalytic Activation*, Lawrence Berkeley National Laboratory, University of California at Berkeley.

⁸ Kubacka A, Suarez Diez M, et al., Understanding the Antimicrobial Mechanism of TiO₂- based Nanocomposite Films in a Pathogenic Bacterium, *Nature Journal*, 2014.

JIS TR Z 0018 *Photocatalytic Materials – Air Purification Test Procedure*;

ASTM E1980 - 11 *Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces*;

ASTM C1549-16 *Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer*.

ASTM D7334 - 08(2013) *Standard Practice for Surface Wettability of Coatings, Substrates and Pigments by Advancing Contact Angle Measurement*

Cincinnati Cores Results – Photocatalytic Properties

Date	Sample ID #	Treatment	NO Reduction (%)	Titanium Concentration (ppm)	SRI Values	Water Contact Angle (WCA)	Specification
6/9/20	1	A.R.A.-1Ti	30.21	3205	0.1442	56.34	6325 Montgomery Rd. (Center Lane) South of untreated test
	2	A.R.A.-1Ti	31.55	3104	0.1345	66.17	6325 Montgomery Rd. (Center Lane) South-west of untreated test
	Control	Untreated	9.18	-	0.0821	76.86	6325 Montgomery Rd. (Center Lane)

Source: Texas A&M Transportation Institute (TTI)

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The Montgomery Road **A.R.A.-1 Ti[®]** trial results were successful; exceeded PTI performance specifications; and were consistent with PTI's expected results. All photocatalytic properties tested were validated. Based on the field test results, PTI recommends the City of Cincinnati expand **A.R.A.-1 Ti[®]** to full use.

X-ray Fluorescence (TiO₂ Delivery)

The Montgomery Road TiO₂ concentrations were observed at efficient photo-reactivity levels (e.g., >2000 parts per million and a dielectric constant reading ≥ 5) through wearing-course depth, producing the expected PCO activity. The Montgomery Road TiO₂ loads averaged **150% of PTI's performance specifications**, which call for:

TiO₂ Penetration Test: A non-destructive analytical procedure shall be used to determine the percent of Titanium Dioxide nanoparticles present in each two-millimeter (2mm) layer of the field core sample matrix for a total depth of six millimeters (6mm) from the top of the treated sample core. The method of measurement shall be by fluorescent X-ray emitted from the surface when excited by a principal X-ray source that is exceptional for the given element. A hand-held XRF analyzer is acceptable for this testing.

The minimum required concentration of Titanium Dioxide nanoparticles per each two-millimeter (2mm) section shall be 2000 parts per million (ppm).

Photocatalytic Oxidation (PCO) of NO_x

The PCO rate reflected the initial test protocol TiO₂ delivery and impregnation consistent with the XRF results. **NO (nitric oxide) reduction effectiveness was 30%-32%** which correlated to the photocatalyst material concentration and **A.R.A.-1 Ti[®]** application rate. The pollution reduction rate was **125% of PTI's performance specifications**, which call for:

NO_x Reduction Effectiveness: Verification of the effectiveness of the air pollution remediation of the Titanium Dioxide nano-particle portion of the TiO₂ Enhanced Asphalt Rejuvenating Agent shall be by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4") in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

NO_x Reduction Test: A photo reactor test chamber shall be employed that allow for the evaluation of the efficient photocatalytic reduction of introduced NO_x gas of a known and controlled concentration within the chambers volume. The chamber light source shall be a UV lamp having a wavelength of 375 nanometers. The interior chamber environment shall be at 77°F with a constant humidity of 55% ±5%. The test total duration shall be five hours. The analysis test system shall be based on a Japanese Industrial Standard (JIS) TR Z0018 "Photocatalytic Materials-Air purification test procedure". NO removal efficiency shall be measured using a Model 42i Chemiluminescence NO-NO₂-NO_x Analyzer (Thermo Fisher Scientific Inc.).

The minimum NO reduction following the heretofore outlined test procedure evaluating field core samples shall average 25% for all cores tested.

Solar Reflectance

The SRI value also reflected the impact of the TiO₂ penetration and dispersion consistent with the XRF results. The **solar reflectance index readings were 0.13-0.14** which were a 70% improvement to the untreated test section and correlated to the photocatalyst material concentration and material application rate of 0.05 gallons per sq/yd. The Montgomery Road pilot area met the US Green Building Council (USGBC) minimum threshold of 50% x 0.29 for LEED credits as well as American Public Works Association (APWA) ISI Envision credits.

PTI's performance specifications call for:

Solar Reflectance Effectiveness: Verification of the effectiveness of the solar reflectivity the Titanium Dioxide nano-particle portion of the TiO₂ Enhanced Asphalt Rejuvenating Agent shall be by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4") in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

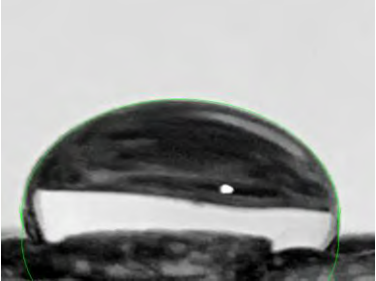
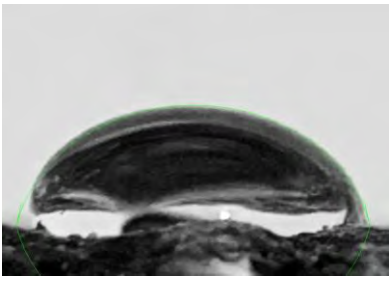
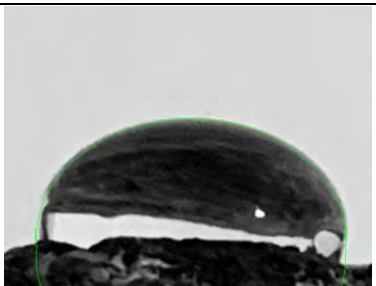
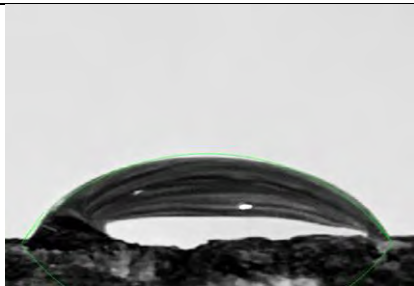
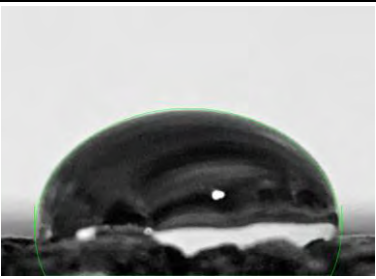
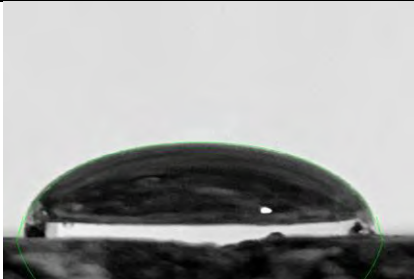
Solar Reflectance Test(s): Solar reflectivity shall be determined by measuring the treated core samples for a Solar Reflectance Index (SRI) value. SRI is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100.

The minimum SRI value following the heretofore outlined test procedure(s) evaluating field core samples shall average 0.29 for all cores tested, which meet the minimum standard ($\geq 50\%$ 0.29 SRI) for the U.S. Green Building Council (USGBC) hardscape threshold for Leadership in Energy and Environmental Design (LEED) credit or the minimum standard for the American Public Works Association (APWA) / Institute for Sustainable Infrastructure (ISI) Envision Superior ($\geq 60\%$ 0.29 SRI) level of achievement credit.

Hydrophilic Improvement

The WCA observed on the **A.R.A.-1 Ti[®]** pilot section cores reflected the impact of the TiO₂ penetration and dispersion consistent with the XRF results as well. The **water contact angle improved to 56 °-66°** which correlated to the photocatalyst material concentration and 0.05 gallons per sq/yd application rate. The untreated (control) section of asphalt recorded a 77° WCA or 30%-40% higher than the TiO₂ treated section. At a higher TiO₂ content of 4.0% to 4.5% by volume concentrate (at an 0.05 rate), the Montgomery Road test area would see as much as 50% or more improvement in WCA, approaching technical superhydrophilicity ($\leq 25^\circ$).

Water Contact Angle of Core Samples

#	Contact Angle under Visible Light	Contact Angle under UV Irradiation
C		
	$\theta=86.65^\circ$	$\theta=76.86^\circ$
#1		
	$\theta=87.31^\circ$	$\theta=59.34^\circ$
#2		
	$\theta=89.22^\circ$	$\theta=66.17^\circ$

Source: Texas A&M Transportation Institute (TTI)

PTI's performance specifications call for:

Hydrophilic Improvement: Verification of the improvement in hydrophilic property of the Titanium Dioxide nano-particle portion of the TiO₂ Enhanced Asphalt Rejuvenating Agent shall be by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4") in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

Wettability Test: Hydrophilic improvement shall be determined by measuring the treated core samples for Water Contact Angle (WCA). WCA is a common measurement of a constructed surface's ability to improve wettability or the ability of water to develop a stronger boundary (less resistance) with the surface as shown by a decline in water contact angle. A WCA of > 90° is considered hydrophobic or high resistance while a WCA < 90° is considered hydrophilic or low resistance.

The minimum WCA reduction following the heretofore outlined test procedure evaluating field core samples shall average 20% for all cores tested.

Rheological Improvement

Rheology tests on the A.R.A.-1 Ti[®] pilot section on Montgomery Road was completed by APART. Those reports are available separately ([table provided is an abstract](#)).

Summary of Testing:

The top 3/8-inch of each core was removed for testing. The asphalt from each core was extracted and recovered as prescribed by California Test Method 365. Viscosities, phase angles, and moduli were determined on the recovered asphalt binder of each sample using a DSR as prescribed by AASHTO T315. Test data are as follows:

Sample	Viscosity 60°C, P	Phase Angle, °	MODULUS, 60°C, Pa		
			Complex	Elastic	Viscous
6325 Montgomery Road					
Untreated	19983	68.2	20226	7420	18555
Treated	10592	70.8	10677	4919	9651

Source: APART

A.R.A.-1 Ti[®] binder rejuvenation efficacy was validated. The test section showed a 47% reduction in viscosity; an improvement in phase angle; and improvement in modulus, all meeting or exceeding specification.

Conclusion and Recommendation

Based on the validation of the Montgomery Road **A.R.A.-1 Ti[®]** photocatalytic property field tests for the City of Cincinnati, PTI recommends the city consider **A.R.A.-1 Ti[®]** for scale deployment citywide for the indicated beneficial regenerative, preservation and environmental impacts of photocatalytic pavement retrofits.

Included as an addendum is the full **A.R.A.-1 Ti[®]** performance specification for additional reference.

Pollution-Remediating Polymerized Maltene Asphalt Rejuvenator

Description: TiO₂ Enhanced Asphalt Rejuvenating Agent

The work specified in this section shall consist of furnishing all labor, material, and equipment necessary to perform all operations for the application of a penetrating polymerized asphalt rejuvenating agent to asphaltic concrete surface courses. The asphalt binder rejuvenation shall be affected through the petroleum Maltene Replacement Technology method. In addition, and with the same penetrating carrier liquid, apply photocatalytic-grade titanium dioxide (TiO₂) to create a pollution reducing pavement microenvironment. The rejuvenation of surface courses shall be by spray application of a polymerized maltene based cationic rejuvenating agent composed of petroleum oils and resins emulsified with water and containing photocatalytic titanium dioxide in a minimum parts per million at a minimum depth as hereafter specified.

All work shall be in accordance with the specifications, the applicable drawings, and subject to the terms and conditions of this contract.

Figure 2.1 A.R.A.-1 Ti® Application



Source: Pavement Technology, Inc.; Cary, NC 2019

1 Materials and Performance: TiO₂ Enhanced Asphalt Rejuvenating Agent

The TiO₂ Enhanced Asphalt Rejuvenating Agent shall be a cationic emulsion composed of a petroleum resin oil base uniformly emulsified with water. Each bidder must submit a bid with a certified statement from the TiO₂ enhanced asphalt rejuvenating agent manufacturer showing that the asphalt rejuvenating emulsion conforms to the required physical and chemical requirements.

Table 1 Test of Emulsion and on Residue

	Test Methods		Requirements	
	ASTM	AASHTO	Min	Max
Tests on Emulsion				
Viscosity @ 25°C, SFS	D-244	T-59	15	40
Residue, %W¹	D-244(Mod.)	T-59(Mod)	60	65
Miscibility Test²	D-244(Mod.)	T-59(Mod)	No Coagulation	
Sieve Test, %W³	D-244(Mod.)	T-59(Mod)		0.1
Particle Charge Test	D-244	T-59	Positive	
Percent Light Transmittance⁴				80
Tests on Residue from Distillation:				
Flash Point, COC, °C	D-92	T-48	196	
Viscosity @ 60°C, cSt	D-445	-	100	200
Asphaltenes, %w	D-2006-70	-		1.00
Maltene Dist. Ratio⁵	D-2006-70	-	0.3	0.6
PC/S Ratio⁵	D-2006-70	-	0.5	
Saturated Hydrocarbons, S⁵	D-2006-70	-	21	28

¹ ASTM D-244 Modified Evaporation Test for percent of residue is made by heating 50-gram sample to 149°C (300°F) until foaming ceases, then cool immediately and calculate results.

² Test procedure identical with ASTM D-244-60 except that .02 Normal Calcium Chloride solution shall be used in place of distilled water.

³ Test procedure identical with ASTM D-244 except that distilled water shall be used in place of two percent sodium oleate solution.

⁴ Procedure for Determining Percent Light Transmittance on Asphalt Rejuvenating Agent:

a. Scope: This procedure covers the determination of percent light transmittance of the asphalt rejuvenating agent.

b. Apparatus:

1. Container may be glass, plastic or metal having a capacity of 6,000 ml.
2. Graduated cylinder, 1,000 ml, or greater
3. Light transmittance measuring apparatus, such as Bausch and Lomb or Lumberton spectrophotometer
4. Graduated pipette having 1 ml capacity to 0.01 ml accuracy
5. Suction bulb for use with pipette
6. Test tubes compatible with spectrophotometer, 3/4" X 6, Bausch and Lomb, Catalog No. 33-17- 81, (B&L)

c. Calibration of spectrophotometer:

1. Calibrate spectrophotometer as follows:

- a. Set wavelength at 580 mμ,
- b. Allow spectrophotometer to warm-up thirty minutes,
- c. Zero percent light transmittance (%LT) scale,
- d. Rinse test tube three times with tap water and fill to top of circle marking on B&L test tube or approximately 2/3 full,
- e. Place tube in spectrophotometer and set %LT scale at 100, and,

f. Repeat steps (c) (e) two times or until no further adjustments necessary.

d. Procedure:

1. Shake, stir or otherwise thoroughly mix emulsion to be tested. Place sample of emulsion in beaker and allow to stand one minute.
2. Place 2,000 ml tap water in container.
3. Suck 1.00 ml emulsion into pipette using suction bulb. Wipe off outside of pipette.
4. Using suction bulb, blow emulsion into container.
5. Rinse pipette by sucking in diluted emulsion solution and blowing out.
6. Clean pipette with soap or solvent and water. Rinse with acetone.
7. Stir diluted emulsion thoroughly.

8. Rinse out tube to be used with the diluted emulsion three times and fill to top of circle.
9. Calibrate spectrophotometer.
10. Place diluted emulsion sample tube in spectrophotometer, cover and read %LT to nearest tenth.
11. Repeat steps 9 and 10 until three identical consecutive readings are achieved.
12. The elapsed time between addition of emulsion to dilution of water and final %LT reading should not exceed 5 minutes.

⁵ Chemical Composition by ASTM Method D-2006-70 -- (Free) Maltene Distribution Ratio (MDR) can be defined as:

$$\frac{PC + A_1}{S + A_2}$$

Where:

PC = Polar Compounds A₁ = First Acidaffins

A₂ = Second Acidaffins S = Saturated Hydrocarbons

2 Maltene Replacement (“Rejuvenation”) Test

The TiO₂ Enhanced Asphalt Rejuvenating Agent shall have the capability to penetrate the asphalt pavement surface and shall be absorbed and incorporated into the asphalt binder. Verification that said incorporation of the TiO₂ Enhanced Asphalt Rejuvenating Agent into the asphalt binder has been effected shall be by the petroleum maltene fraction replacement method and analysis of the chemical properties of said asphalt binder therein i.e., viscosity shall be reduced by said method.

For pavements less than two-years old and receiving the original application of TiO₂ Enhanced Asphalt Rejuvenating Agent, the viscosity shall be reduced by a minimum of twenty (20%) percent as determined by the dynamic shear rheometer (DSR) method for asphalt testing in accord with AASHTO T315-05. For treatments of pavements older than two-years and/or after an initial treatment with a petroleum maltene asphalt rejuvenator, the viscosity shall be reduced by petroleum maltene replacement method a minimum of thirty percent (30%) in accord with same. This analysis shall apply to extracted asphalt binder, taken from cores extracted fifteen to thirty days following application, in the upper 3/8” of pavement. The treated areas shall be densified or resistant in depth to the intrusion of air and water.

The TiO₂ Enhanced Asphalt Rejuvenating Agent shall have a record of at least two years of satisfactory service as a TiO₂ enhanced petroleum maltene based emulsion asphalt rejuvenating agent and in-depth densifier. Satisfactory service shall be based on the capability of the material to decrease the viscosity of the asphalt binder by the petroleum maltene replacement method and provide an in-depth seal. **A.R.A.-1 Ti[®]**, a Pavement Technology, Inc. product manufactured by D&D Emulsions, Inc., Mansfield, Ohio, is a product of known quality and accepted performance.

The bidder must submit with his bid the manufacturer's certification that the material proposed for use is in compliance with the specification requirements. The bidder must submit with his bid previous use documentation and test data conclusively demonstrating that; the TiO₂ Enhanced Asphalt Rejuvenating Agent has been used successfully for a period of two years by government agencies such as state, county and municipal governments or "SCMs", etc.; and that the enhanced rejuvenating agent has been proven to perform, as heretofore required, through field testing by government agencies as to the required change in asphalt binder rheology and photocatalytic properties as hereinafter detailed. Testing data shall be submitted indicating such product performance on a sufficient number of projects to insure product consistency. In addition, field testing data shall be submitted to indicate said product performance over a minimum testing period of two years to insure reasonable sustainability.

The Engineer may require that untreated and treated core samples, a minimum of four inches in diameter, be removed by the Contractor at locations indicated by the Engineer. The treated core sample shall be taken in the same lane in close proximity to each untreated sample. A minimum of one untreated and treated core sample shall be taken for each pavement group or one per 50,000 square yards of treated pavement in each pavement group.

3 Photocatalytic Properties Testing

3.1 TiO₂ Penetration Test: The TiO₂ Enhanced Asphalt Rejuvenating Agent shall have a non-destructive analytical procedure applied to determine the percent of Titanium Dioxide nanoparticles present in each two-millimeter (2mm) layer of the field core sample matrix for a minimum depth of six millimeters (6mm) from the top of the treated sample core. The method of measurement shall be by fluorescent X-ray emitted from the surface when excited by a principal X-ray source that is exceptional for the given element. A hand-held XRF analyzer is acceptable for this testing.

The minimum required concentration of Titanium Dioxide nanoparticles per each two-millimeter (2mm) section up to the minimum depth of 6mm shall average 2000 parts per million (ppm).

3.2 NO₂ Reduction Effectiveness: The TiO₂ Enhanced Asphalt Rejuvenating Agent shall be verified for the effectiveness of the air pollution remediation of the Titanium Dioxide nanoparticle portion by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4") in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

3.3 NO₂ Reduction Test: A photo reactor test chamber shall be employed that allow for the evaluation of the efficient photocatalytic reduction of introduced NO_x gas of a known and controlled concentration within the

chambers volume. The chamber light source shall be a UV lamp having a wavelength of 375 nanometers. The interior chamber environment shall be at 77°F with a constant humidity of 55% ±5%. The test total duration shall be five hours. The analysis test system shall be based on a Japanese Industrial Standard (JIS) TR Z0018 “Photocatalytic Materials-Air purification test procedure”. NO removal efficiency shall be measured using a Model 42i Chemiluminescence NO-NO₂-NO_x Analyzer (Thermo Fisher Scientific Inc.).

The minimum NO reduction following the heretofore outlined test procedure evaluating field core samples shall average 25% for all cores tested.

3.4 Solar Reflectance Effectiveness: Verification of the effectiveness of the solar reflectivity the Titanium Dioxide nano-particle portion of the TiO₂ Enhanced Asphalt Rejuvenating Agent shall be by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4”) in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

3.5 Solar Reflectance Test(s): Solar reflectivity shall be determined by measuring the treated core samples for a Solar Reflectance Index (SRI) value. SRI is a measure of the constructed surface’s ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100. The relevant standards for measuring solar reflectance are:

Table 2 Test of Solar Reflectance

Value	Test Method
Solar Reflectance	ASTM C1549 – Standard Test Method for Determination of Solar Reflectance
Solar Reflectance Index	ASTM E 1980 – Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces

Based on these standards, the SRI is a measure of the relative steady-state temperature of a surface with respect to a standard white surface (SRI=100) and a standard black surface (SRI=0) under standard solar and ambient conditions.

Under normal ambient conditions, the steady-state temperature for the black and white reference surfaces is 355.61 kelvin (K) or 180°F and 317.76 K (110°F), respectively.

A Solar Reflectance Index (SRI) can be defined as:

$$SRI = \frac{T_b - T_s}{T_b - T_w}$$

Where:

- Steady-state Surface Temperature (Ts)—the temperature of the surface, in K, under the standard solar conditions. The surface temperature Ts (°C)=Ts (K)-273

- Reference Black Surface Temperature (T_b)—the steady-state temperature of a black surface with a solar reflectance of 0.05 and infrared emittance of 0.9, under the standard solar and ambient conditions
- Reference White Surface Temperature (T_w)—the steady-state temperature of a white surface with a solar reflectance of 0.80 and infrared emittance of 0.9, under the standard solar and ambient conditions
- Sky Temperature (T_{sky})—the temperature of a black body that would radiate the same power in the thermal infrared spectrum (5 to 40 nm) toward the earth as does the sky

The minimum SRI value following the heretofore outlined test procedure(s) evaluating field core samples shall average 29 (or 0.29) for all cores tested, which meet the minimum standard ($\geq 50\%$ 29 SRI) for the U.S. Green Building Council (USGBC) hardscape threshold for Leadership in Energy and Environmental Design (LEED) credit or the minimum standard for the American Public Works Association (APWA) / Institute for Sustainable Infrastructure (ISI) Envision Superior ($\geq 60\%$ 29 SRI) level of achievement credit.

3.6 Hydrophilic Improvement: Verification of the improvement in hydrophilic property of the Titanium Dioxide nano-particle portion of the TiO₂ Enhanced Asphalt Rejuvenating Agent shall be by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4") in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

3.7 Wettability Test: Hydrophilic improvement shall be determined by measuring the treated core samples for Water Contact Angle (WCA). WCA is a common measurement of a constructed surface's ability to improve wettability or the ability of water to develop a stronger boundary (less resistance) with the surface as shown by a decline in water contact angle. A WCA of $> 90^\circ$ is considered hydrophobic or high resistance while a WCA $< 90^\circ$ is considered hydrophilic or low resistance. The relevant standard for measuring WCA is:

Table 3 Test of Water Contact Angle

Value	Test Method
Water Contact Angle	ASTM D7334 - 08(2013) Standard Practice for Surface Wettability of Coatings, Substrates and Pigments by Advancing Contact Angle Measurement

The minimum WCA reduction following the heretofore outlined test procedure evaluating field core samples shall average 20% for all cores tested.

2 Equipment

2.1 Distributor: The distributor for spreading the emulsion shall be self-propelled and shall have pneumatic tires. The distributor shall be designed and equipped to distribute the asphalt rejuvenating agent uniformly on variable widths of surface at readily determined and controlled rates from 0.04 to 0.10 gallons per square yard of surface, and with an allowable variation from any specified rate not to exceed 5% of the specified rate.

Distributor equipment shall include full circulation spray bars, pump tachometer, volume measuring device and a hand hose attachment suitable for application of the emulsion manually to cover areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the emulsion within the tank.

The rate of application shall be controlled by an onboard computer control system designed to control the selected application rate uniformly and consistently in gallons per square yard regardless of the forward speed of the distributor truck.

A check of distributor equipment as well as application rate accuracy and uniformity of distribution shall be made when directed by the Engineer.

2.2 Aggregate Cover Truck: The truck used for cover aggregate application shall be equipped with a spreader that allows the aggregate to be uniformly distributed onto the pavement. The spreader shall be able to apply 1/2 pound to 3 pounds of cover aggregate per square yard in a single pass. The spreader shall be adjustable so as not to broadcast cover aggregate onto driveways or to lawns.

The cover aggregate to be used shall be free flowing, without any leaves, dirt, stones, etc. Any wet aggregate shall be rejected from the job site.

Any equipment that is not maintained in full working order, or is proven inadequate to obtain the results prescribed, shall be repaired, or replaced at the direction of the Engineer.

2.3 Calibration: Distributor- prior to construction, calibrate the distributor in accordance with ASTM D2995-99 in the presence of the Engineer. The distributor shall be moving forward at the proper application speed at the time the spray bar is opened. If at any time a nozzle becomes clogged or not spraying a proper pattern, the operation shall be immediately halted until repairs are made.

3 Construction

3.1 Layout: The Contractor will be responsible for the lay out of the roadway and project planning and sequencing to meet traffic control requirements prior to paving.

3.2 Weather and Seasonal Limitations: The TiO₂ Enhanced Asphalt Rejuvenating Agent shall not be applied to a wet surface or when rain is occurring, or the threat of rain is present immediately before placement. The surface treatment shall not be applied when the temperature is less than 40° in the shade. When applying emulsions, the temperature of the surface shall be a minimum of 45°F, and no more than 150°F.

If unexpected rain occurs prior to material penetration and cover aggregate application, the agent shall be reapplied at no cost to the agency. Further, the contractor's traffic control and project monitoring shall continue until the application has penetrated, area has been sanded and the resultant surface is acceptable to the Engineer for vehicular travel.

3.3 Preparation of Surface: The contractor will be responsible for blowing or sweeping the road immediately ahead of the application operation to make sure the road is free of standing water, dirt, loose aggregate, and other debris. The surface shall be clean and dry prior to the application.

3.4 Application of TiO₂ Enhanced Asphalt Rejuvenating Agent: The TiO₂ Enhanced Asphalt Rejuvenating Agent shall be applied by a distributor truck at the temperature recommended by the manufacturer and at the pressure

required for the proper distribution. The emulsion shall be so applied that uniform distribution is obtained at all points of the areas to be treated. Distribution shall be commenced with a running start to ensure full rate of spread over the entire area to be treated. Areas inadvertently missed shall receive additional treatment as may be required by hand sprayer application.

3.5 Material Placement of TiO₂ Enhanced Asphalt Rejuvenating Agent: Application of TiO₂ Enhanced Asphalt Rejuvenating Agent shall be on one-half width of the pavement at a time. When the second half of the surface is treated, the distributor nozzle nearest the center of the road shall overlap the previous application by at least one-half the width of the nozzle spray. In any event the centerline construction joint of the pavement shall be treated in both application passes of the distributor truck.

Before spreading, the TiO₂ Enhanced Asphalt Rejuvenating Agent shall be blended with water at the rate of two parts rejuvenating agent to one-part water, by volume or as specified by the manufacturer. The combined mixture of asphalt rejuvenating agent and water shall be spread at the rate of 0.04 to 0.10 gallons per square yard, or as approved by the Engineer following field testing.

Where more than one application is to be made, succeeding applications shall be made as soon as penetration of the preceding application has been completed and the Engineer grants approval for additional applications. Grades or super elevations of surfaces that may cause excessive runoff, in the opinion of the Engineer, shall have the required amounts applied in two or more applications as directed.

The Contractor shall furnish a quality inspection report showing the source, manufacturer, and the date shipped, for each load of TiO₂ Enhanced Asphalt Rejuvenating Agent. When directed by the Engineer, the Contractor shall take representative samples of material for testing.

3.6 Test Strip for Application Rate: Prior to start of the project, the contractor shall perform test strip applications as directed by the engineer. Test strips shall be performed for each pavement group of similar age and type within the project area.

The test strips shall be applied at a minimum width of 6 feet and for a length of 50 feet. A total of three test strips shall be applied at application rates of 0.04, 0.08 and 0.10 gallons per square yard, respectively. The time, in minutes, for essentially complete absorption of the asphalt rejuvenating emulsion shall be recorded for each test strip. The optimal rate to be used in a given area shall be that rate essentially absorbed within 20 minutes.

In the event that all three of the standard test rates are absorbed completely within the 20-minute timeframe, then the Contractor and the Engineer shall agree on a fourth test strip application rate.

Upon completion of the test strips for each pavement group, the Engineer will determine the final application rate to be applied to each pavement group.

3.7 Cover Aggregate Application: After the TiO₂ Enhanced Asphalt Rejuvenating Agent emulsion has penetrated, and when recommended by the Contractor and approved by the Engineer, a coating of dry cover aggregate shall be applied to the surface in sufficient amount to protect the traveling public as required.

All cover aggregate used during the treatment must be removed no later than 24 hours after treatment of a roadway. This shall be accomplished by a combination of hand and mechanical sweeping. All turnouts, cul-de-sacs, etc. must be cleaned of any material to the satisfaction of the Engineer. Street sweeping will be included in the price bid per square yard for asphalt rejuvenating emulsion.

If, after the cover aggregate is swept and in the opinion of the Engineer a hazardous condition exists on the roadway, the contractor must apply additional cover aggregate and sweep same no later than 24 hours following reapplication. No additional compensation will be allowed for reapplication and removal of materials.

3.8 Handling of TiO₂ Enhanced Asphalt Rejuvenating Agent: Contents in tank cars or storage tanks shall be circulated at least 45 minutes before withdrawing any material for application. The distributor truck will be cleaned of all of its asphalt materials and washed out to the extent that no discoloration of the emulsion may be perceptible. Cleanliness of the spreading equipment shall be subject to the approval of the Engineer.

3.9 Street Sweeping: The Contractor shall be responsible for sweeping and cleaning the streets after treatment. All cover aggregate used during the treatment must be removed no later than 24 hours after treatment of the street. This shall be accomplished by a combination of hand and mechanical sweeping. All turnouts, cul-de-sacs, etc. must be cleaned of any material to the satisfaction of the Engineer.

If, after cover aggregate is swept and in the opinion of the Engineer a hazardous condition exists on the roadway, the contractor must apply additional cover aggregate and sweep same no later than 24 hours following reapplication. No additional compensation will be allowed for reapplication and removal of cover aggregate.

3.10 Resident Notification: The contractor shall distribute by hand, a typed notice to all residences and businesses on the street to be treated. The notice will be delivered no more than 24 hours prior to the treatment of the road. The notice will have a local phone number that residents may call to ask questions. The notice shall be of the door hanger type, which secures to the door handle of each dwelling. Unsecured notices will not be allowed. The contractor shall also place the notice on the windshield of any parked cars on the street. Hand distribution of this notice will be considered incidental to the contract.

3.11 Traffic Control: The Contractor shall furnish all necessary traffic control, barricades, signs, and flagmen, to ensure the safety of the traveling public and to all working personnel. Traffic shall not travel on fresh TiO₂ Enhanced Asphalt Rejuvenating Agent until penetration, in the opinion of the Engineer, has become complete and the area is suitable for traffic. The Contractor shall submit an M.O.T plan indicating all facets of traffic control for the project area. The M.O.T. plan must be approved in writing by the Engineer prior to commencing any work. All traffic control shall be in accordance with the DOT Roadway Design Standards (most current edition). Traffic control devices shall be checked daily and periodically throughout the project for compliance; and where adjustments or corrections are needed, prompt revisions shall be made.

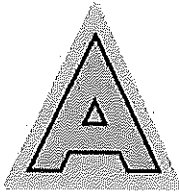
3.12 Method of Measurement: The TiO₂ Enhanced Asphalt Rejuvenating Agent emulsion shall be paid at the Contract bid unit prices for the actual square yards of pavement treated as field measured. Said payment is compensation in full for all costs of furnishing and applying the material as specified, including cleaning the existing pavement, purchase of cover aggregate, delivery of cover aggregate, all labor, equipment, and materials necessary for the placement of the TiO₂ Enhanced Asphalt Rejuvenating Agent emulsion, sweeping of any loose material after construction and other requirements as specified. Traffic control for maintaining traffic for constructing TiO₂ Enhanced Asphalt Rejuvenating Agent emulsion shall be considered incidental.

Payment for removal of untreated and treated cores shall be paid for as each at the unit price bid for Test Core Removal.

3.13 Basis of Payment:

<u>Pay Item</u>	<u>Unit</u>
• TiO ₂ Enhanced Asphalt Rejuvenating Agent	Per Sq/Yd
• Field Core Removal*	Each
• Field Core Laboratory Analysis – Viscosity*	Each
• Field Core Laboratory Analysis -Titanium Dioxide Penetration*	Each
• Field Core Laboratory Analysis - Titanium Dioxide NO ₂ Reduction*	Each
• Field Core Laboratory Analysis - Titanium Dioxide Solar Reflectance Index (SRI)*	Each
• Field Core Laboratory Analysis - Titanium Dioxide Water Contact Angle (WCA)*	Each
• Mobilization	Per Project

*When required by the Engineer



ANDERSON CONCRETE CORPORATION

400 FRANK ROAD, COLUMBUS, OHIO 43207

(614) 443-0123

February 16, 2022

To: Anderson Concrete Customers

Re: Portland Limestone Cement

This letter is regarding the Central Ohio ready-mix concrete market switch from Portland Cement (PC) to Portland Limestone Cement (PLC). In order to reduce carbon emissions, cement producers across the United States have been switching from PC to PLC, resulting in around a 10% reduction in carbon emissions. PC allows for up to 5% ground limestone while PLC allows for a range of 5% to 15% ground limestone. This change will inevitably occur in every market across our country and has already resulted in the reduction of CO₂ emissions by hundreds of thousands of tons. Cement producers have completed extensive testing and their PLCs are able to replace PCs at a 1:1 ratio. PLCs are recognized in the ACI 301 and ACI 318 building codes. ASTM C595 and AASHTO M240 standards allow for the use and specification of PLCs.

More information on this can be found at www.greencement.com.

Anderson Concrete Corp. (ACC) has led the Central Ohio ready-mix concrete market in quality mixes and innovation for decades. ACC is fully committed to our mixes exceeding project requirements for every performance requirement specified. The ACC quality control department is the largest and most experienced in the market, and our team has been extensively testing thousands of our mix designs using PLC. This testing will continue until all our design data has been tested using PLCs. To date, our testing has shown that performance with PLC equals that of PC.

ACC is a proud partner in reducing carbon emissions and we assure you that the performance of our products will not change. To allow for the seamless transition to PLC on your projects, our ownership, sales, production and quality control groups are available to assist you in any way possible (#614-443-0123). We are fully committed to working with our customers, general contractors and specifiers as we begin this transition. It is important to stress that, in the near future, there will no longer be the option to purchase PC in the Central Ohio market. ACC lab testing has led us to concur with the cement industry that ongoing projects should accept PLC as an equivalent to PC. The failure of our industry to adopt this approach could lead to widespread construction delays across our market. It is crucial for all parties involved in the Central Ohio concrete market to understand this and take steps to ease the period of transition. Many markets around the world have accomplished this change without disruption, and we should strive to achieve the same results.

Respectfully,

Anderson Concrete Corp.

Rod Jenkins

Vice President of Production

National Ready Mix Concrete Association Concrete Technologist Level 3

American Concrete Institute Concrete Quality Technical Manager

www.andersonconcrete.com

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Legislation Details (With Text)

File #: 1652-2023 **Version:** 1

Type: Ordinance **Status:** Passed

File created: 5/25/2023 **In control:** Public Service & Transportation Committee

On agenda: 6/12/2023 **Final action:** 6/14/2023

Title: To adopt the Vision Zero Columbus Action Plan 2.0, as described herein, as the continued framework for reducing traffic deaths and serious injuries to zero; to authorize the Director of Public Service, on behalf of the City of Columbus, to prepare and submit applications for grant opportunities; and to declare an emergency (\$0.00)

Sponsors:

Indexes:

Code sections:

Attachments: 1. COLS 3735_Vision Zero 2.0_Full Booklet_V05a

Date	Ver.	Action By	Action	Result
6/14/2023	1	CITY CLERK	Attest	
6/13/2023	1	MAYOR	Signed	
6/12/2023	1	COUNCIL PRESIDENT	Signed	
6/12/2023	1	Columbus City Council	Approved	Pass
6/5/2023	1	Columbus City Council	Postponed to Date Certain	Pass

1. BACKGROUND

The Department of Public Service is continuing to actively pursue the City initiative to reduce traffic deaths and serious injuries to zero, while increasing safe, healthy, equitable mobility for all through the Vision Zero Columbus Action Plan 2.0. This ordinance demonstrates the commitment by the City of Columbus and City Council to the overall well-being of the City's residents.

Fatal and serious injury crashes have been on the rise annually. Every person has the right to get to their destination safely. The Columbus Vision Zero Action Plan 2.0 is a five-year plan (2023-2028) committed to achieving our goal of zero deaths and serious injuries on Columbus streets by 2035

In this phase of our Action Plan, pursuit of this goal will be just as strong. More safety-prioritizing strategies are outlined to guide these efforts during the next five years. The Department of Public Service plans to pursue and submit applications for grant opportunities to implement the action plan. No specific grant opportunities have been identified at this time.

In this Action Plan 2023-2028, Vision Zero partners have identified many strategies to slow speeds, focus on safe street design, and foster community engagement and a culture change that prioritizes protecting lives above all else, for all forms of travel along our city streets for walking, biking, rolling, driving and using transit. Eliminating the worst crashes is a responsibility shared by our transportation system users, designers and decision makers.

2. FISCAL IMPACT

No financial participation is required at this time. City funds will be approved in the form of design contracts, right of way acquisitions, and/or construction contracts that will be submitted for Council's approval at a later date

3. EMERGENCY

Emergency action is requested in order to adopt the Vision Zero Action Plan 2.0 at the earliest possible time in order to continue current initiatives to achieve our committed goal of zero deaths and serious injuries on Columbus streets.

To adopt the Vision Zero Columbus Action Plan 2.0, as described herein, as the continued framework for reducing traffic deaths and serious injuries to zero; to authorize the Director of Public Service, on behalf of the City of Columbus, to prepare and submit applications for grant opportunities; and to declare an emergency (\$0.00)

WHEREAS, sixty-five percent of fatal and severe injury crashes in the City occur on ten percent of City streets; and

WHEREAS, between 2018 and 2022, fatal injury crashes have increased annually with a total of 310 people killed in crashes on City streets; and

WHEREAS, fatalities and serious injuries on our streets are unacceptable and crashes are preventable; and

WHEREAS, Vision Zero Columbus makes protecting lives the #1 priority of our transportation system; and

WHEREAS, Vision Zero provides a framework for reducing traffic deaths and serious injuries to zero, while increasing safe, healthy, equitable mobility for all; and

WHEREAS, in March 2020 the Mayor announced the intent to pursue Vision Zero for the City of Columbus and to develop an action plan; and

WHEREAS, 2035 has been the year selected to reach the goal of eliminating all fatal and serious injury crashes; and

WHEREAS, this ordinance to adopt the Vision Zero Columbus Action Plan 2.0 is a continued step necessary to meet the goal to eliminate fatal and serious injury crashes; and

WHEREAS, the Mayor's Office directed a multi-departmental effort spearheaded by the Department of Public Service, along with community representatives and stakeholders to lead this initiative; and

WHEREAS, the Director of Public Service has the authority to apply for grants aligned with the delivery or completion of the Vision Zero Columbus Action Plan 2.0 between April 1, 2023 and March 31, 2028; and

WHEREAS, the Director of Public Service has the authority to make modifications to the Vision Zero Columbus Action Plan 2.0 as necessary; and

WHEREAS, an emergency exists in the usual daily operation of the Department of Public Service in that it is immediately necessary for the City to adopt the Vision Zero Action Plan 2.0 in order to continue current initiatives and meet grant application deadlines, to ensure the safety of the traveling public thereby preserving the public health, peace, property, safety and welfare; **NOW, THEREFORE**

BE IT RESOLVED BY THE COUNCIL OF THE CITY OF COLUMBUS:

SECTION 1. That by the year 2035, the goal is to eliminate all fatal and serious injury crashes on City streets.

SECTION 2. That Vision Zero Columbus and the goal to eliminate serious crashes has been adopted by the City with the commitments of the Mayor's Office, the Department of Public Service, Columbus Public Health, the Department of Public Safety, and the Department of Neighborhoods as a necessary step in meeting the 2035 goal;

SECTION 3. That the Vision Zero Columbus Action Plan 2.0 has been developed for the purpose of continuing to put a plan in motion to meet the 2035 goal, with a focus on being data driven, equitable, and including community input.

SECTION 4. That key City departments, including Public Service, Public Health, Public Safety, and the Mayor's Office, are actively engaged as leaders and partners in the process of developing the Vision Zero Columbus Action Plan 2.0, implementing it, and evaluating and sharing progress.

SECTION 5. That the Director of Public Service has the authority to apply for grants aligned with the delivery or completion of the Vision Zero Columbus Action Plan 2.0 between April 1, 2023 and March 31, 2028.

SECTION 6. That the Director of Public Service has the authority to make modifications to the Vision Zero Columbus Action Plan 2.0 as necessary.

SECTION 7. That the Vision Zero Core Team, consisting of City staff, will continue to meet regularly to implement the Action Plan, with semiannual updates and evaluation by the Working Groups and the Executive Advisory Committee.

SECTION 8. That for the reasons stated in the preamble hereto, which is hereby made a part hereof, this ordinance is hereby declared to be an emergency measure and shall take effect and be in force from and after its passage and approval by the Mayor or ten days after passage if the Mayor neither approves nor vetoes the same.