Chapter 3: Evaluate Regional Context

Introduction

Transportation infrastructure is a foundational structure and system for transporting people and goods. This system supports the economy and directly impacts the competitiveness of the nation and the NOACA region. Over the years, the United States has built one of the world's most extensive transportation systems, representing trillions of dollars of public investment. The transportation system is made up of many individual elements, which, ideally, should be connected to provide ease of movement for all users. These individual elements are roads, bridges, sidewalks, bikeways, transit, rail, waterways, airports, and intermodal connectors. These individual systems are described in this chapter, as well as how each provides an equally important role in providing access and mobility for the NOACA region.

State of Transportation Infrastructure

Roadway Network

Similar to other metropolitan areas with urban and rural configurations, the road network in the NOACA region is the most extensive transportation mode, connecting all the land uses, i.e., activity locations in communities, to each other. This network is also an essential part of supporting the local and regional economy and residents' movements for work, social, educational, and other trip purposes. The NOACA region contains a significant portion of Ohio's interstate total lane miles with local Interstate routes, including IR-71, IR-77, IR-80, IR-90, IR-271, IR-480, and IR-490.

Typically, the interstate and freeway systems carry the highest volume of traffic in the region, requiring more travel lanes. The Interstate system was built in the late 1950's/ early 1960's is now 60+ years old.

Table 3-1 displays the lane miles of the road system except local streets by facility type. The data is based on the 2024 highway network of the NOACA travel forecasting model.

Table 3-1. Road Lengths by Facility Type

Facility Type	Lane Miles	Percent of Total
Freeway / Expressway	1,890	21%
Highway Ramp	316	4%
Major Road (Arterial)	3,898	44%
Minor Road (Collector)	2,762	31%
Total	**8,866**	**100%**

The Federal-Aid Highway Program supports State highway systems by providing financial assistance for the construction, maintenance, and operations of the Nation's 3.9-million-mile highway network, including the Interstate Highway System, primary highways, and secondary local roads. The Federal Highway Administration (FHWA) is charged with implementing the Federal-Aid Highway Program in cooperation with the state and local governments.

Local government – primarily counties, cities and towns, or local Public Agencies (LPAs) – own and operate about 75 percent, or roughly 2.9 million miles, of the Nation's highway network. LPAs build and maintain this network using a variety of funding sources, including the Federal-Aid

Highway Program. An estimated 7,000 LPAs manage about $7 billion annually in federal aid projects, or roughly 15 percent of the total program. Understanding Federal-Aid requirements is so important in the delivery of Federal-aid projects at the local level. Federal-Aid Essentials highlights key components of the program to help LPAs and their State partners successfully manage locally administered Federal-Aid projects.

Federal-Aid System in the NOACA region includes Interstate Routes (IR), US Routes, State Routes (SR), and County Routes (CR). It should be noted that the Ohio Department of Transportation maintains roads such as Interstates, Freeways, and State Routes outside of municipal boundaries, which are excluded from the Federal Aid column of Table 3-2.
Table 3-2 illustrates the road and Federal-Aid system lengths by County.

Table 3-2. Road Lengths by County

County	Lane Miles	Federal Aid Lane Miles	County Percent of Federal Aid Lane Miles
Cuyahoga	4,442	3,155	71.0%
Geauga	700	255	36.4%
Lake	1,091	575	52.7%
Lorain	1,578	747	47.3%
Medina	1,055	353	33.5%
NOACA Region	**8,866**	**5,085**	**57.4%**

Transit Network

Mobility choices are vital to the health and vibrancy of a region. Public transit options reduce congestion, personal transportation costs, and carbon output. A robust public transit system presents residents with a choice to travel within the region. Public transit is a form of alternative transportation for those with automobiles, as well as a primary service for those who do not have other options, primarily lower-income households, the elderly, the young, and people with disabilities. Public transit provides access to employment, healthcare, entertainment, and educational facilities, among other daily activities and destinations.
Similarly to single-occupancy vehicles, public transportation vehicles also operate on the road network. Furthermore, the transit system includes limited miles of a railway network, but the rail system is not comparable in scale to the road network; thus, the bus service is more expansive.

Transit Services

There are five different transit agencies operating within the NOACA region: Geauga County Transit (GCT), the Greater Cleveland Regional Transit Authority (GCRTA), Laketran, Lorain County Transit (LTC), and Medina County Public Transit (MCPT). The additional agencies, the Portage Area Regional Transportation Authority (PARTA), the Akron Metro Regional Transit Authority (Akron METRO), and the Stark Area Regional Transit Authority (SARTA), also operate in the NOACA region. As the region’s population density has declined and the population expanded outward into previously rural areas, serving within the shifting land use patterns has been a challenge. NOACA and the region’s transit systems will need to continue to plan accordingly to meet the needs of the region’s population. It will be necessary to prioritize limited transportation funding. The region must balance transit needs with demands, determining where to expand or reduce service and where to strengthen core service.

Transit Infrastructure

In the NOACA region, bus services, including local, premium, and Bus Rapid Transit (BRT), run through the existing highways and street networks with thousands of bus stops at different levels of passenger comfort. Additionally, rapid transit access is ensured through a network of light and heavy rail operated by the Greater Cleveland Regional Transit Authority (RTA) for passenger services and regional freight rail companies. The passenger rail services comprise three lines: the Red Line, Blue Line, and Green Line.

In addition to the existing highway and rail infrastructure for the bus and rail services, there are currently 36 park-and-ride facilities in the NOACA region. The majority of these intermodal facilities are in Cuyahoga County (27), which are at rail stations (20), premium bus stations (2), shared BRT and Rail stations (2), and BRT stations (3). The other park-and-ride facilities are in Lake (8) and Medina (1) counties and are for premium bus services.

Figures 3-1 and 3-2 show the existing transit services and the locations of the current intermodal facilities in the NOACA region.

Figure 3-1. The Current Transit Network

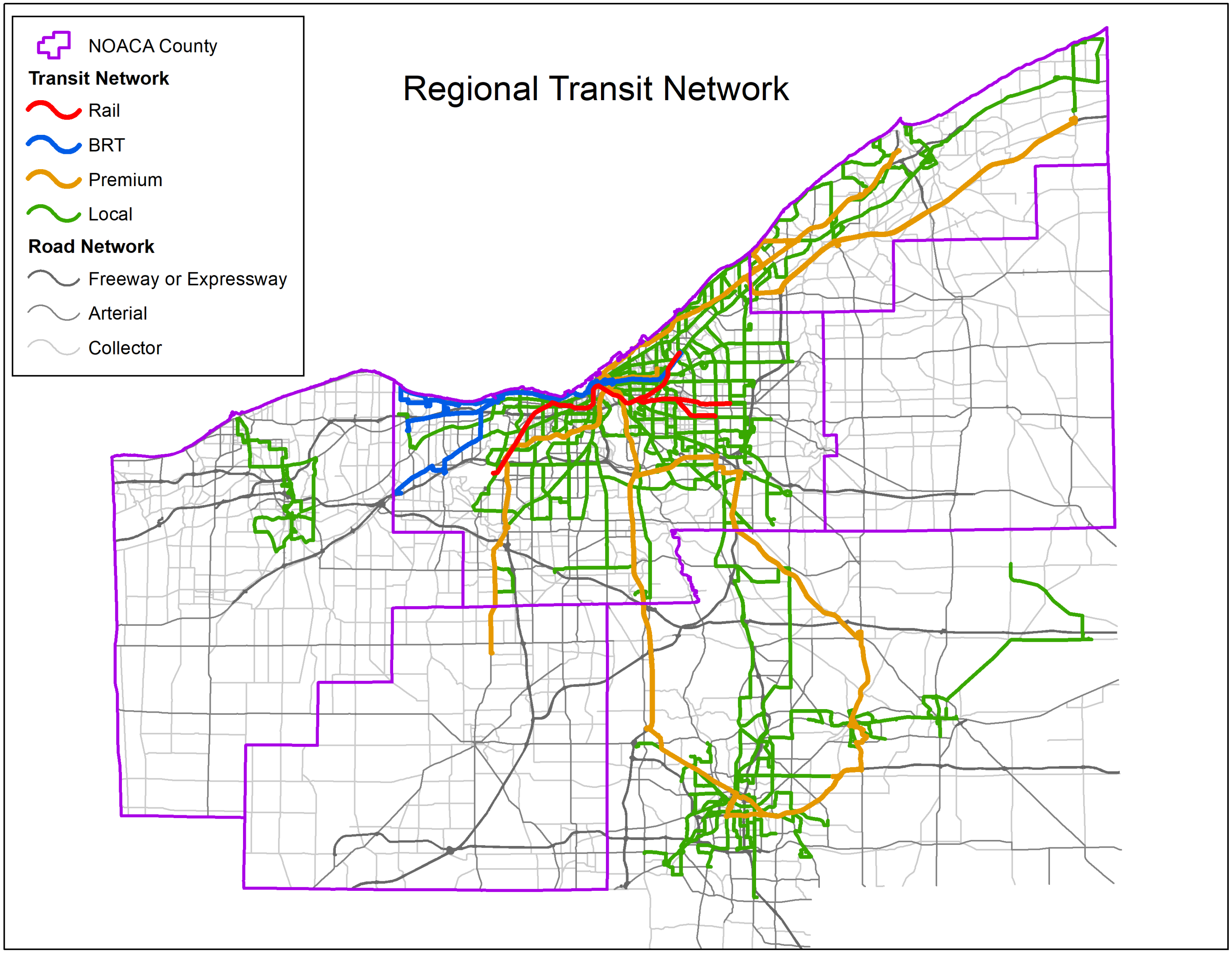
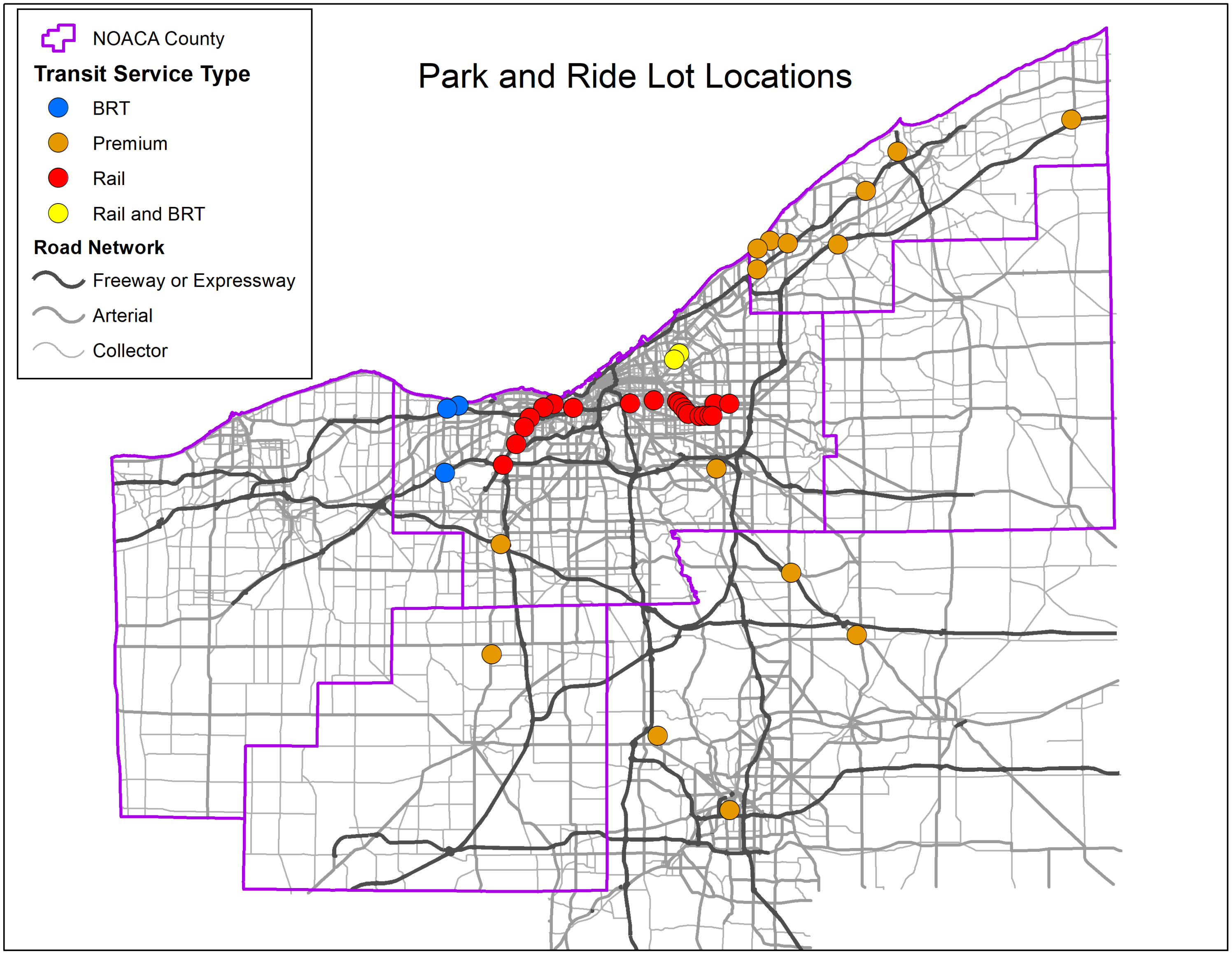


Figure 3-2. The Locations of the Current Intermodal Facilities



A central aspect of transit planning is improving the way that we move around the region and providing access to support development through transportation infrastructure. Choice means increasing both the number of easily accessible destinations and the mode of access to arrive. All of the region's transit systems plan to maintain and possibly expand their respective systems to accommodate these conditions better.
Expanding public transit requires significant capital investment; however, the potential advantages of a well-planned project are often greater than the costs. Public transit benefits include:[1]

- Connecting people and jobs
- Improving mobility for people of all ages
- Stimulating and focusing new development on sites near transit
- Creating and supporting jobs by providing a reliable alternative to driving
- Moving more people in the same amount of road space
- Improving air quality and reducing greenhouse gas emissions
- Reducing household transportation costs

Non-Motorized Transportation

Non-motorized transportation or active transportation refers to being physically active for the purpose of transportation (typically biking and walking) and is distinct from being physically active for recreation. NOACA has been formally planning at the regional level for bicycling as a means of transportation since 1978, with the release of Phase I of a four-phase bicycle planning process that spanned from 1977 to 1989. The NOACA Regional Bicycle Plan has been updated: 1997, 2008, 2013. A new bicycle and pedestrian plan, ACTIVATE, was developed from 2019-2022. This plan provides a vision for increasing the use of bikeways and walkways for transportation and commuting and also serves as a guide for future bicycle and pedestrian improvements. This plan also includes a prioritization model based on a Connectivity Scoring Quantitative System (CSQS) for investing in non-motorized facilities for accessing the transit network.

Planning for bicycling and walking as modes of transportation is important for a variety of reasons. Improving travel safety is always important, but improving the safety of bicycling and walking is especially important because these road users are most vulnerable to fatality and severe injury in a crash. Furthermore, the perceived safety of these modes has a direct effect on how many people are willing to choose biking and walking. With limited federal and state transportation funding, encouraging mode shifts to biking and walking is an important and underused travel demand management strategy that can alleviate traffic congestion. Biking and walking are forms of exercise, so increasing these activities can improve the mode users' health. In addition, because biking and walking are zero-emission modes of transportation, shifting trips to these modes can improve public health more generally by improving air quality. Specifically, biking and walking are ideal modes for replacing short trips (three miles or less), which are more polluting and less efficient per mile by car than longer trips.[2] Moreover, a significant percentage of the population in Northeast Ohio does not have access to a car, and providing viable transportation options is vital. Planning for bicycle and pedestrian travel has also been established as a priority by the federal government. The United States Code requires that bicyclists and pedestrians be given due

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[1] Northeast Ohio Sustainable Communities Consortium (NEOSCC), *Vibrant NEO2040*, - http://vibrantneo.org/wp-content/uploads/2014/04/Vibrant-NEO-Final-Report_3-31-14_lowres_ALL.pdf.
[2] M.L. Grabow, S.N. Spak, T. Holloway, B. Stone, Jr., A.C., Mednick, and J.A. Patz, "Air Quality and Exercise-Related Health Benefits from Reduced Car Travel in the Midwestern United States," National Center for Biotechnology Information Resources PubMed, https://www.ncbi.nlm.nih.gov/pubmed/22049372.

consideration in the comprehensive transportation plans developed by each metropolitan planning organization and state, in accordance with sections 134 and 135, respectively. Bicycle transportation facilities and pedestrian walkways are to be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation facilities, except where bicycle and pedestrian uses are not permitted. Transportation plans and projects must also provide due consideration for safety and contiguous routes for bicyclists and pedestrians.

Bicycle and Pedestrian Infrastructure

Bicycling is an important component of the transportation system. It is an important travel demand strategy that can alleviate traffic congestion and reduce emissions. Improving or increasing the bicycle infrastructure is important to the NOACA region, but especially for the population that does not have access to a personal vehicle.
NOACA, in coordination with partner agencies, maintains an inventory of 821 miles of existing bicycle facilities in all five counties. These facilities can be defined as separated and shared types:

Separated
- All Purpose Trails: Open to bicyclists and are fully separated from the roadways.
- Separated Bike Lanes: On-street bike lanes that are vertically separated from traffic by posts or other barriers.
- Buffered Bike Lanes: are conventional bicycle lanes paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking.

Shared
- Bike Lanes: on-street bike lanes that are marked with a painted line and accompanying signage.
- Bike Routes: on-street, typically marked with sharrows and/or signs.

Table 3-3 summarizes the bike lane lengths by type and county.

Table 3-3. The Bike Lane Facilities Lengths by Type and County

COUNTY	ALL PURPOSE TRAIL	SEPARATED BIKE LANE	BUFFERED BIKE LANE	BIKE LANE	BIKE ROUTES*	TOTAL
Cuyahoga	279.4	0.9	8.3	83.9	116.8	489.3
Geauga	29.2				0.2	29.4
Lake	62.7			19.4	5.3	87.4
Lorain	97.3			27.3	53.6	178.2
Medina	36.7					36.7
NOACA Region	**505.3**	**0.9**	**8.3**	**130.6**	**175.9**	**821**

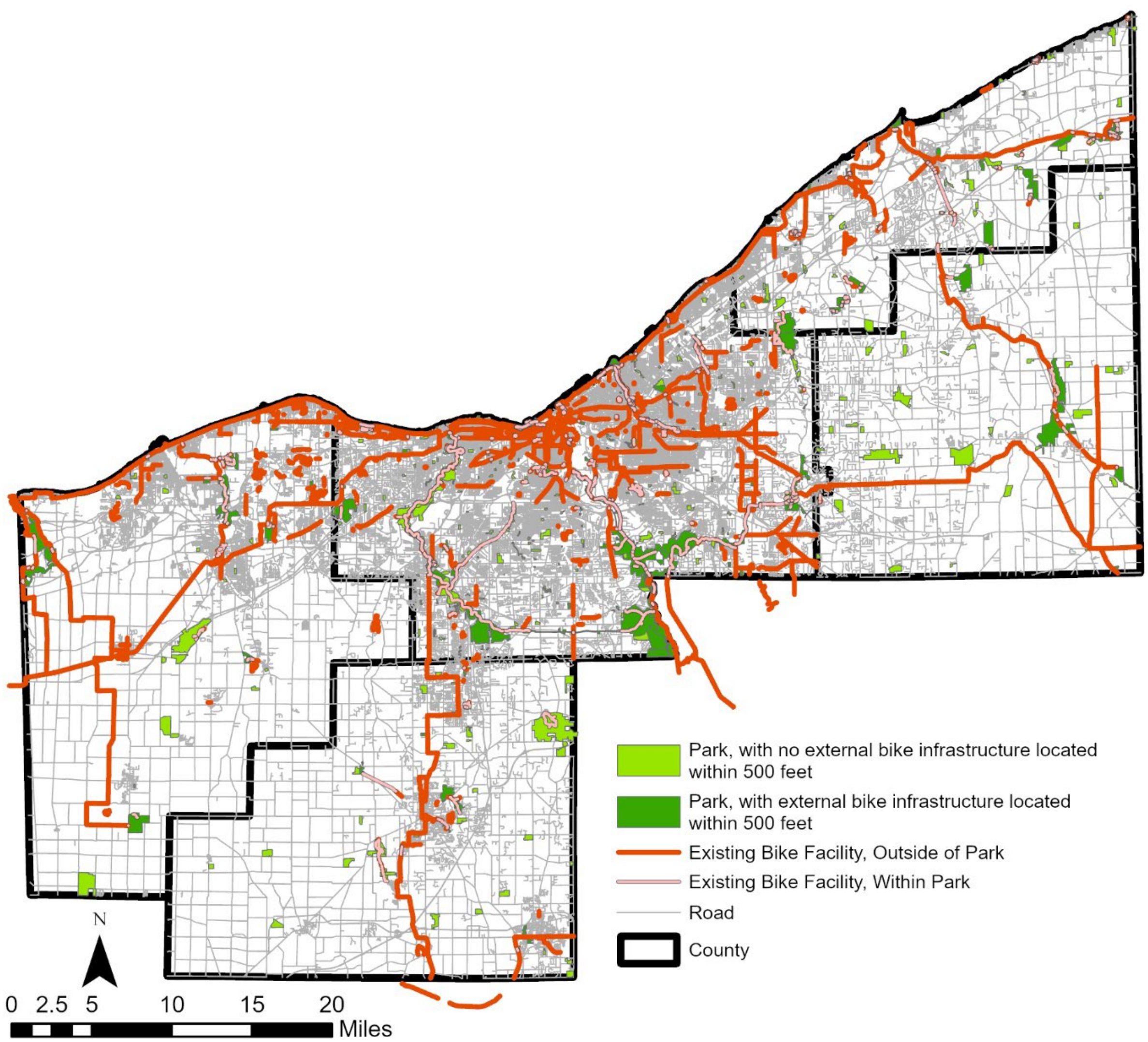
Source: NOACA Regional Bike Network, *Routes are typically marked with sharrows and/or signs

Bicycle Facility and Park Access

Northeast Ohio is home to many recreational biking trails within park facilities, such as the Big Creek Parkway, the Towpath Trail, and the Black River Trail in Elyria. Recreational trails can become transportation assets when they are maintained throughout the year, have adequate lighting, and connect to other bike infrastructure. However, many of the region’s parks do not have bike infrastructure within 500 feet of the park's boundary, which limits access to the park's interior trails and amenities from being used to support active transportation. These same parks often have significant trail infrastructure inside the park itself, such as the Valley Parkway and Rocky River Reservation.

Very few parks in the rural areas of the NOACA region appear to have bike facilities within 500 feet of the park boundary. In total, 231 (41%) of the region's 566 parks have bike facilities located within 500 feet of the park boundary. Figure 3-3 shows the parks in the region according to whether bike facilities are within 500 feet of the boundary of the park.

Figure 3-3. Bike Facilities and Park Access



NOACA conducts bicycle and pedestrian counts throughout the agency's five-county region to gauge regional and local levels of bicycling and walking, identify trends to aid in the planning and design of transportation infrastructure and programming, and calibrate walk and bike modes in the NOACA Travel Forecasting Model.

Manual counts have been conducted biannually since September 2011, and 240 different locations have been counted at least once through 2024. Counts have been conducted along a variety of roadway and bicycle facility types, including bike lanes, all-purpose trails, and roadways without bicycle infrastructure or sidewalks. The majority of counts have been conducted in more populated areas of the region within Cuyahoga County, but counts were also done in smaller towns and rural areas throughout all five counties in the NOACA region. In addition to overall numbers of pedestrians and cyclists, the counts also tracked the number of cyclists by helmet usage, sidewalk usage, and weather conditions.

Automated Bicycle and Pedestrian Counts

NOACA collects data from permanently installed bike and pedestrian counters throughout the region (see Table 3-4). Sixteen counters use Miovision video-based technology, and two counters use EcoCounter infrared and under-pavement loop technology.
NOACA purchased the Miovision counter equipment using an ODOT Active Transportation grant. It was installed and calibrated to collect data in 2020 and has been properly maintained since.

The Miovision counter equipment utilizes a 360-degree view to conduct turning movement counts at intersections, including motor vehicles, bikes, and pedestrians. The counters may also count specific bike and pedestrian-focused zones, including bike lanes and all-purpose trails where a full turning movement count is not possible or desired.

The EcoCounter equipment offers more targeted bike/pedestrian-only counts of specific trails or bike lanes, including a heavily used bridge trail in Downtown Cleveland and a bike lane near Case Western Reserve University.

Data is being collected continuously at these locations, covering a variety of roadway classifications and bike facility types.

Table 3-4. Permanent Automated Counter Equipment

ID	Counter Type	Location	City
1	Miovision TrafficLink	Lake Shore Blvd. and E. 149th St.	Cleveland
2	Miovision TrafficLink	Superior Ave. and E. 21st St.	Cleveland
3	Miovision TrafficLink	E. 105th St. and Euclid Ave.	Cleveland
4	Miovision TrafficLink	Detroit Ave. and W. 65th St.	Cleveland
5	Miovision TrafficLink	Detroit Ave. and W. 25th St.	Cleveland
6	Miovision TrafficLink	Superior Ave. and Huron Rd.	Cleveland
7	Miovision TrafficLink	Overlook Rd. and Cedar Glen Pkwy.	Cleveland Heights
8	Miovision TrafficLink	Madison Ave. and Victoria Ave.	Lakewood
9	Miovision TrafficLink	Hilliard Blvd. and Clague Rd.	Westlake
10	Miovision TrafficLink	Main St. and Wright St.	Wadsworth

11	Miovision TrafficLink	Munson Rd. and Center S.	Mentor
12	Miovision TrafficLink	Lake Rd. west of Shields Rd.	Avon Lake
13	Miovision TrafficLink	South Main St. and Edison St. (North Coast Inland Trail)	Oberlin
14	Miovision TrafficLink	South St. and Maple Highlands Trail	Chardon
15	Miovision TrafficLink	E. 79th St. and Kinsman Rd.	Cleveland
16	Miovision TrafficLink	E. 71st St. and Kinsman Rd.	Cleveland
17	Eco Counter Zelt Loop	Lorain-Carnegie Bridge All Purpose Trail	Cleveland
18	Eco Counter Urban Post	Edgehill Rd. Bike Lane	Cleveland Heights

Level of Traffic Stress (LTS)

Level of Traffic Stress (LTS) is a relatively new means of assessing who may feel comfortable biking on a particular road. LTS seeks to measure the traffic stress present on a roadway and identify the type of bicyclist who is likely comfortable biking on that road. When applied to a community or a region, it can result in a number of analysis tools that can assess the overall connectivity and prevalence of low-stress biking facilities.

NOACA has been developing a regional Level of Traffic Stress analysis as part of its bicycle transportation maps since 2018. The regional analysis was completed for the ACTIVATE plan. The bike maps remain a natural complement to this work, as they seek to make cycling easier and less intimidating by providing information on where there are bike facilities and low-stress routes.

LTS is based on the premise that most people will generally avoid cycling on roads that they perceive are stressful and that traffic (speed, volume, and distance from cyclists) is the key factor in determining cyclist stress. The main source of bicyclist stress changes throughout the day, alternating between volume (during AM and PM peak) and speed (when volumes are low). Researchers have developed a set of measures to broadly capture a road’s stress level by classifying it in one of four levels of traffic stress from low to high. LTS was first developed by the Mineta Transportation Institute in 2012 for the U.S. Department of Transportation in California. NOACA created a customized version of the LTS methodology that fits the region’s characteristics with data that was easier to verify and gather. It also added a fifth LTS, a level to indicate roads that should be avoided by even expert-level cyclists.

Bicycle and Pedestrian Crash Data

The most recent analysis of crashes in the NOACA region (NOACA’s 2024-2025 Community Safety Reports) uses data for only the two-year period from 2022-2023 to exclude COVID-era abnormalities. Due to how the Highway Safety Manual predictive formulas are set up, the same grouping of segments is expected for the highest pedestrian-vehicle and bicycle-vehicle collisions. Therefore, the tables have been combined to show both groups of data in the same table. Tables 3-5 through 3-7 show the top ten expected vehicle-pedestrian and vehicle-bicycle collision arterial segments and pedestrian and bicycle arterial intersections for the NOACA region.

Table 3-5. Top Ten Highest Predicted Pedestrian and Bicycle Arterial Segments

Road Name	From	To	Expected Annual Vehicle-Pedestrian Collisions	Expected Annual Vehicle-Bicycle Collisions	County	City
Bagley Road	Pleasant Avenue	Pearl Road (US 42)	0.86	0.45	Cuyahoga	Middleburg Heights
US 6 (Superior Avenue)	East 55th Street	East 125th Street	0.77	0.40	Cuyahoga	Cleveland
US 42 (Pearl Road)	West 130th Street	Wesley Drive	0.71	0.37	Cuyahoga	Parma Heights
US 20 (Center Ridge Road)	Elyria ECL	Jaycox Road	0.69	0.36	Lorain	North Ridgeville
Carnegie Avenue SE	East 55th Street	Cedar Glen Parkway	0.65	0.34	Cuyahoga	Cleveland
West 150th Street	Puritas Avenue	Lorain Road (SR 10)	0.64	0.33	Cuyahoga	Cleveland
SR 91 (Som Center Road)	S of Maplegrove Road	Euclid Avenue (US 20)	0.60	0.31	Lake	Willoughby
US 20 (Euclid Avenue)	East 214th Street	Cuyahoga County ECL	0.60	0.31	Cuyahoga	Euclid
Cedar Road	Fenway Drive	I-271 Southbound Entrance Ramp	0.60	0.31	Cuyahoga	Beachwood
US 42 (Pearl Road)	Lucerne Drive	West 130th Street	0.58	0.30	Cuyahoga	Middleburg Heights

Table 3-6. Top Ten Highest Predicted Pedestrian Arterial Intersections

Major Road	Minor Road	Expected Annual Vehicle-Pedestrian	County	City
US 20 (W CLIFTON BLVD/SLOANE AVE)	US 6 (CLIFTON BLVD)	0.4710	Cuyahoga	Lakewood
US 20 (CENTER RIDGE RD)	ROOT RD	0.4645	Lorain	North Ridgeville
SR 611 (COLORADO AVE)	LAKE BREEZE RD	0.4628	Lorain	Sheffield
US 20 (EUCLID AVE)	EDDY RD	0.4627	Cuyahoga	East Cleveland
SR 283 (LAKESHORE BLVD)	HEISLEY RD	0.4623	Lake	Mentor
US 6 (CLIFTON BLVD)	WARREN RD	0.4619	Cuyahoga	Lakewood
US 42 (PEARL RD)	MEMPHIS AVE	0.4617	Cuyahoga	Cleveland
CEDAR AVE	CARNEGIE AVE SE	0.4615	Cuyahoga	Cleveland
US 20 (EUCLID AVE)	LEE RD	0.4614	Cuyahoga	East Cleveland
MILES RD	BRAINARD RD	0.4610	Cuyahoga	Orange

Table 3-7. Top Ten Highest Predicted Bicycle Arterial Intersections

Major Road	Minor Road	Expected Annual Vehicle-Bicycle Collisions	County	City
US 422 (Chagrin Boulevard)	SR 87 (Richmond Road)	0.241	Cuyahoga	Beachwood
SR 94 (State Road)	SR 17 (Brookpark Road)	0.237	Cuyahoga	Cleveland
Ridge Road	SR 17 (Brookpark Road)	0.210	Cuyahoga	Cleveland
SR 611 (Colorado Avenue)	Chester Road	0.209	Lorain	Avon
US 322 (Mayfield Road)	SR 91 (Som Center Road)	0.193	Cuyahoga	Mayfield Heights
West 130th Street	SR 17 (Brookpark Road)	0.187	Cuyahoga	Brook Park
West Bagley Road	North Rocky River Drive	0.183	Cuyahoga	Berea
SR 91 (Som Center Road)	Solon Road	0.177	Cuyahoga	Solon
Cedar Glen Parkway	Cedar Road	0.174	Cuyahoga	Cleveland Heights
East 9th Street	Prospect Avenue	0.172	Cuyahoga	Cleveland

Traffic Control Devices

Traffic is the movement of a large number of individual drivers, cyclists, and pedestrians through highways, streets, sidewalks, and transit networks from their origins to their destinations for completing their journeys. A traffic control system manages those journeys through physical networks based on two principles of safety and efficiency and utilizes physical devices such as signs, road markings, traffic signals, etc. See Table 3-8 for the number of signalized intersections by county in the NOACA region.

Table 3-8. Number of Signalized Intersections by County

County	Number of Signalized Intersections	Percent of Region
Cuyahoga	2,621	76%
Lorain	340	10%
Lake	281	8%
Medina	147	4%
Geauga	67	2%
NOACA Region	**3,456**	**100%**

Transportation Safety and Operations

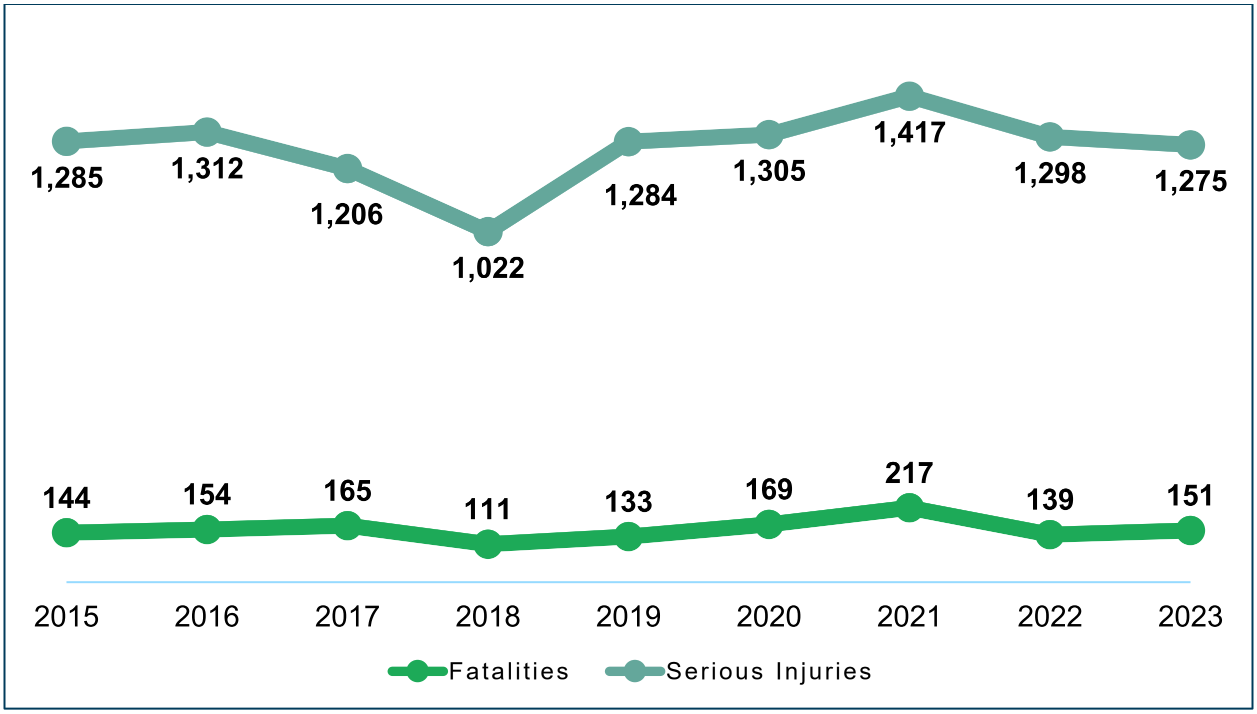
Introduction

One of NOACA's transportation planning goals is to preserve and improve the efficiency and safety of the existing transportation system, prioritize its elements, and ensure it serves homeland security.

In 2023, there were 41,230 roadway crashes in the region, which resulted in 151 fatalities and 1,275 serious injuries (see Figure 3-4 and Tables 3-9 and 3-10). Please note that these are the number of fatalities and serious injuries noted by Ohio Department of Public Safety or Ohio Department of Transportation personnel at the scene. It is not adjusted with hospital data, but does account for crashes where more than one person was seriously hurt or killed. Both fatalities and serious injuries rose gradually after a low in 2018 before significantly increasing during the COVID-19 pandemic, but have begun coming down again, although 2023 fatalities increased from 2022.

- A total of twelve more fatalities occurred in 2023, an 8.6% increase from 2022 but a 30.4% decrease since 2021. This is still a 36% increase from the low of eleven fatalities in 2018, however.
- Twenty-three fewer serious injuries occurred in 2023, a 1.8% decrease from 2022 but a 10% decrease from the high in 2021. However, this is still a 24.8% increase from the low of 1,022 serious injuries in 2018.

Figure 3-4. Fatalities and Serious Injuries in the NOACA Region (2015-2023)



NOACA's Safety and Operations Council (SOC) serves as an advisory group on safety planning and provides recommendations regarding regional safety and operations programs to NOACA's Transportation Subcommittee. The SOC comprises local planning and engineering staff, law enforcement, emergency responders, the Ohio Department of Transportation, the Federal Highway Administration, the Greater Cleveland Rapid Transit Authority, the Ohio Traffic Safety Office, and community members.

Table 3-9. All Crashes by County Per Year, with Averages

Year	Cuyahoga	Geauga	Lake	Lorain	Medina	NOACA Region Annual Total
2019	33,990	1,954	4,535	6,176	3,483	50,138
2020	28,661	1,603	3,736	5,501	2,764	42,265
2021	30,711	1,665	4,080	6,136	2,925	45,517
2022	30,840	1,577	4,248	6,020	3,097	45,782
2023	26,867	1,656	3,982	5,665	3,060	41,230
Average	**30,214**	**1,691**	**4,116**	**5,900**	**3,066**	**44,986**

Please note that Table 3-10 is based on the number of *crashes* in which injuries were present (or not present). This table does *not* represent the number of fatalities or serious injuries that occurred since a single crash can cause more than one. It only represents the number of crashes where more than one (or none) fatality or serious injury was present.

Table 3-10. Crashes by Selected Severities (2019-2023)

Year	Fatal Crashes	Fatal Percent	Serious Injury	Serious Injury	Property Damage	Property Damage	All Crashes for the

		of All Crashes	Suspected Crashes	Percent of All Crashes	Only Crashes	Percent of All Crashes	NOACA Region
2019	123	0.25%	1,071	2.14%	36,247	72.29%	50,138
2020	161	0.38%	1,084	2.56%	30,271	71.62%	42,265
2021	200	0.44%	1,154	2.54%	32,628	71.68%	45,517
2022	134	0.29%	1,085	2.37%	33,432	73.02%	45,782
2023	146	0.35%	1,002	2.43%	29,810	72.30%	41,230
Total	**764**	**0.34%**	**5,396**	**2.40%**	**162,388**	**72.19%**	**224,932**

The biannual Community Safety Reports help to prioritize transportation safety concerns. Each community receives a list of the most dangerous arterial segments and intersections of two arterials within their city limits, ranked by predicted average annual crashes using formulas from the Highway Safety Manual. Tables 3-11 and 3-12 show the top high predicted crash corridors and intersections based on 2022-2023 crash data. Years of data were limited to exclude COVID-era abnormalities, but will be expanded to more years of data in the next update.

Table 3-11. Arterial Corridors with More than Fifty Predicted Crashes

Road Name	From	To	Average Predicted Crashes per Year	Average Recorded Crashes (2022 & 2023)	County	City	Regional Rank
US 6 (SUPERIOR AVE)	E 55TH ST	E 125TH ST	83.56	146.50	Cuyahoga	Cleveland	1
SR 91 (SOM CENTER RD)	S OF MAPLEGROVE RD	EUCLID AVE (US-20)	83.10	58.00	Lake	Willoughby	2
US 20 (CENTER RIDGE RD)	ELYRIA ECL	JAYCOX RD	77.13	50.00	Lorain	North Ridgeville	3
SR 10	0.15 MI N OF I-80	LORAIN/CUYAHOGA COUNTY LINE	76.04	50.50	Lorain	North Ridgeville	4
CARNEGIE AVE SE	E 55TH ST	CEDAR GLEN PKWY	71.27	119.50	Cuyahoga	Cleveland	5
BAGLEY RD	PLEASANT AVE	PEARL RD (US-42)	71.27	88.00	Cuyahoga	Middleburg Heights	6
W 150TH ST	PURITAS AVE	LORAIN RD (SR-10)	69.53	73.50	Cuyahoga	Cleveland	7
SNOW RD	RIDGE RD (SR-3)	BROADVIEW RD (SR-176)	66.28	53.00	Cuyahoga	Parma	8
SR 94 (STATE RD)	RIDGEWOOD DR	BROOKPARK RD (SR-17)	62.32	52.50	Cuyahoga	Parma	9
SR 3 (RIDGE RD)	RIDGEWOOD DR	PEARL RD (US-42)	62.31	40.50	Cuyahoga	Parma	10
SR 611 (COLORADO AVE)	LORAIN ECL	ABBE RD (SR-301)	61.20	38.00	Lorain	Sheffield	11
SR 306 (REYNOLDS RD/BROADMOOR RD)	ADKINS RD	LAKESHORE BLVD	60.59	29.00	Lake	Mentor	12
US 42 (PEARL RD)	W 130TH ST	WESLEY DR	58.33	77.00	Cuyahoga	Parma Heights	13
BRAINARD RD	CEDAR RD	RIDGEBURY BLVD	57.36	33.00	Cuyahoga	Lyndhurst	14
SR 611 (COLORADO AVE)	SHEFFIELD ECL	0.14 MILES WEST OF MOORE RD	56.82	50.50	Lorain	Avon	15
SR 57	LORAIN BLVD / SR-113	0.22 MI N OF I-90	56.47	91.00	Lorain	Elyria	16
W 117TH ST	BELLAIRE RD	TRISKETT RD	56.15	72.00	Cuyahoga	Cleveland	17
SR 17 (BROOKPARK RD)	W 130TH ST	W 78TH ST	53.55	74.00	Cuyahoga	Parma	18
PLEASANT VALLEY RD	0.12 MI W OF YORK RD	E OF STATE RD (SR-94)	51.40	34.50	Cuyahoga	Parma	19
US 20 (EUCLID AVE)	E 214TH ST	CUYAHOGA COUNTY ECL	51.14	51.50	Cuyahoga	Euclid	20
CEDAR RD	FENWAY DR	I-271 SOUTHBOUND ENTRANCE RAMP	50.87	89.00	Cuyahoga	Beachwood	21

Table 3-12. Arterial Intersections with More than Twenty-four Predicted Crashes

MAJOR RD	MINOR RD	AVERAGE CRASHES PER YEAR	County	City	Regional Rank
SR 94 (STATE RD)	SR 17 (BROOKPARK RD)	39.50	Cuyahoga	Cleveland	1
SR 611 (COLORADO AVE)	CHESTER RD	35.50	Lorain	Avon	2
RIDGE RD	SR 17 (BROOKPARK RD)	35.09	Cuyahoga	Cleveland	3
US 422 (CHAGRIN BLVD)	SR 87 (RICHMOND RD)	31.28	Cuyahoga	Beachwood	4
SR 306 (REYNOLDS RD/BROADMOOR RD)	SR 84 (JOHNNYCAKE RIDGE RD)	31.06	Lake	Mentor	5
E 9TH ST	PROSPECT AVE	28.75	Cuyahoga	Cleveland	6
E 105TH ST	CARNEGIE AVE SE	28.28	Cuyahoga	Cleveland	7
SR 91 (SOM CENTER RD)	SR 84 (RIDGE RD)	27.77	Lake	Willoughby	8
SR 91 (SOM CENTER RD)	US 20 (EUCLID AVE)	26.64	Lake	Willoughby	9
SR 611 (COLORADO AVE)	SR 301 (ABBE RD N)	26.00	Lorain	Sheffield	10
US 20 (EUCLID AVE)	US 322 (CHESTER AVE)	25.93	Cuyahoga	Cleveland	11
US 20 (EUCLID AVE)	MARTIN LUTHER KING JR DR	25.46	Cuyahoga	Cleveland	12
LORAIN BLVD	SR 57	25.28	Lorain	Elyria	13
SR 306 (REYNOLDS RD/BROADMOOR RD)	US 20 (MENTOR AVE)	25.05	Lake	Mentor	14
SR 306 (REYNOLDS RD/BROADMOOR RD)	TYLER BLVD	24.57	Lake	Mentor	15
SR 14 (BROADWAY AVE)	CARNEGIE AVE SE	24.44	Cuyahoga	Cleveland	16
US 322 (MAYFIELD RD)	SR 91 (SOM CENTER RD)	24.32	Cuyahoga	Mayfield Heights	17

Strategies to Improve Safety

A roadway crash is caused by one or more contributing factors encompassing driver behavior, vehicle faults, or environmental circumstances. A driver could be distracted, the road could have an engineering flaw, the speed limit may be too high, there may be a blinding glare, or countless other factors. Achieving safety on the roads will require a coordinated effort between all aspects of the transportation system. The strategies established in NOACA's SAVE Plan use a comprehensive approach to address safety on the roads by including strategies from all of the six "Es" of transportation safety: Education, Enforcement, Engineering, Evaluation, Emergency Medical Services, and Equity.

The SAVE Plan identifies multiple strategies to reduce crashes in each of the ten emphasis areas:

- Intersection
- Roadway Departure
- Young Driver
- Speed
- Impaired Driving
- Older Driver
- Motorcycle
- Pedestrian
- Distracted Driving
- Bicycle

NOACA utilizes Systemic Safety Management in ongoing safety programs to make a system that protects road users even after mistakes are made. This approach uses crash prediction models based on roadway and traffic characteristics to estimate the expected average crash frequency along arterials and major intersections of arterials. This process is taken from the Highway Safety Manual (HSM), produced by the American Association of State Highway and Transportation Officials (AASHTO). It provides predictive methods for estimating it by road network, facility, or individual site involving vehicles, motorcycles, bicycles, and pedestrians.

Emphasizing the Safe System Approach encourages NOACA to be more proactive about upstream causes of crashes rather than solely focusing on individualistic methods such as driver education. According to the National Highway Traffic Safety Administration, most crashes are caused by human error, but it's only the last failure in the causal chain of events leading to a collision. That doesn't mean it's the driver's fault, but it means that the roads, vehicles, speeds, people, and post-crash care have all failed to protect vulnerable human bodies using the transportation system. Rather than releasing communities from the responsibility of building safer and more forgiving roads, it is even more crucial that we fix system design errors, make our streets slower, and separate users of different modes by space and time. Engineers' focus must be on safety first and vehicle throughput second. Making a mistake shouldn't cost any roadway user their life. Instead, factors like lane widths, lighting, corner radii, and signal timing must be designed and calibrated to provide multiple redundant levels of protection so that someone is seriously hurt or killed only when everything fails. If just one layer fails, the roadway users will still escape with their lives.

NOACA has a Safe Routes to School (SRTS) Assistance Program to provide jurisdictions and school districts with SRTS planning and implementation support. Safe Routes to School (SRTS) is a program focused on making it safe, convenient, and fun for kids and families, including those with disabilities, to walk or bicycle to school and in everyday life. The planning framework is safety-based, following the 6 E's of SRTS – Education, Encouragement, Enforcement, Evaluation, Engineering, and Equity.

Implementation Action

NOACA partners with ODOT, regional safety organizations, and local communities throughout the region to provide information on low-cost countermeasures, strategies to promote safe driving behavior, and educational resources for different audiences. NOACA engages in various efforts to promote safe road-user behavior, including educational campaigns and the support of new legislation to achieve the region's safety targets. Currently, NOACA is working with statewide transportation safety organizations to seek a more flexible and context-sensitive approach to setting speed limits within municipalities to provide greater local control and improved safety.

Additionally, the five-year rolling averages for the following five safety performance measures continue to be tracked as required since the FAST Act:

- Number of fatal crashes.
- Number of serious injury crashes.
- Rate of fatalities per 100 million vehicle miles traveled.
- Rate of serious injuries per 100 million vehicle miles traveled.
- Number of nonmotorized fatal and serious injury crashes.

They are calculated based on the averages of the previous five years, and reductions are chosen through the equal annual reduction method to reach zero by 2050.

Security

Introduction

The transportation system touches everyone in some way: personal mobility, the movement of raw materials or manufactured materials, and the delivery of agriculture and food products are just a few ways the nation depends on transportation for its livelihood and economic stability. The transportation sector has many interdependencies with critical infrastructure sectors, as shown in Figure 3-5.

Figure 3-5. Transportation Sector Interdependencies with Critical Infrastructure Sectors

The Department of Homeland Security has developed a National Infrastructure Protection Plan (NIPP) that sets forth a comprehensive risk management framework and clearly defines critical infrastructure protection roles and responsibilities for the Department of Homeland Security, Federal Sector-Specific Agencies (SSAs), and other Federal, State, local, tribal, and private sector security partners. The NIPP provides a coordinated approach that will be used to establish national priorities, goals, and requirements for infrastructure protection so that funding and resources are applied in the most effective manner.

Protecting and ensuring the continuity of the critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical or virtual assets, systems, and networks so vital to the United States that the incapacity or destruction of such assets, systems, or networks would have a debilitating impact on security, national economic security, public health or safety, or any combination of those matters. The National Infrastructure Protection Plan (NIPP) provides the coordinated approach that is used to establish national priorities, goals, and requirements for CIKR protection so that Federal resources are applied in the most effective and efficient manner to reduce vulnerability, deter threats, and minimize the consequences of attacks and other incidents. It establishes the overarching concepts relevant to all CIKR sectors identified under the authority of Homeland Security Presidential Directive 7 and addresses the physical, cyber, and human considerations required for the effective implementation of protective programs and resiliency strategies.[3]

Northeast Ohio is susceptible to many threats, such as severe winter storms, flooding, tornados, and severe thunderstorms. The region must also prepare for other risks, such as terrorism. The unexpected and complex nature of these incidents requires extensive coordination, collaboration, and flexibility among all the agencies and organizations involved in planning, mitigation, response, and recovery. Regional coordination is critical to security and emergency preparedness. The region's many individual municipalities, villages, and townships, as well as extensive roadways and bridges, wide-ranging mass transit systems, rail, airports, and shipping ports, present significant challenges to coordinating and implementing effective security programs.

Definition of Access and Mobility

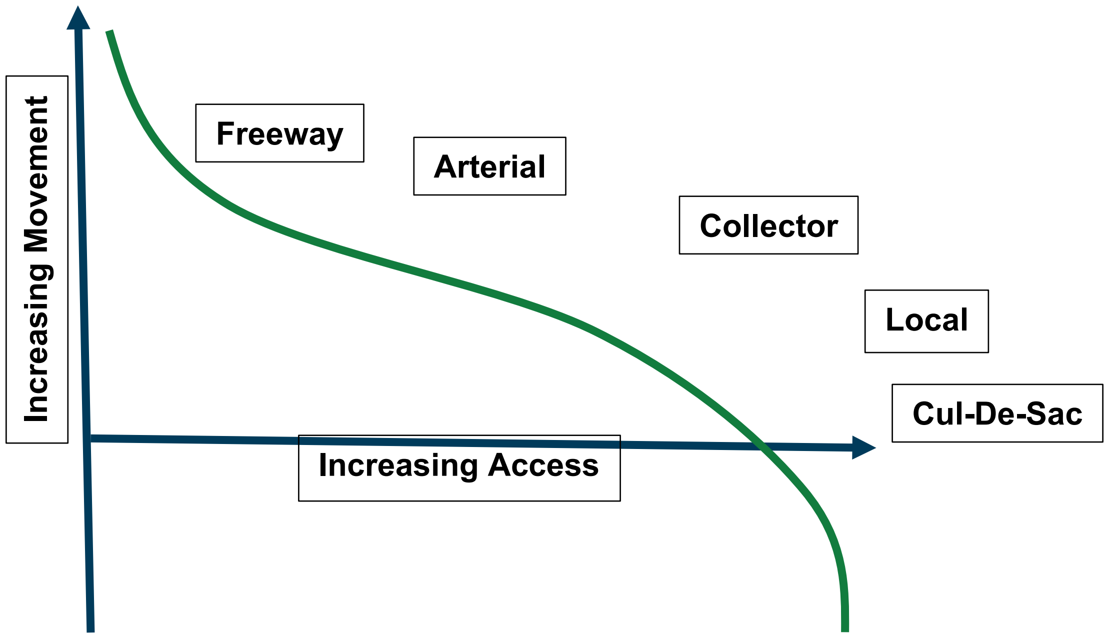
Some transportation modes, such as air transportation, have a clear separation between access and mobility. Access to an aircraft begins with passengers boarding, and once the cabin doors are closed, the aircraft is transferred from an access function to a mobility function. In the highway mode, access and mobility do not have such a clear boundaries. Road and street functional classifications attempt to define these boundaries by grouping roads, streets, and highways in a hierarchy based on the type of highway service they provide.

Generally, how closely a highway or street actually functions compared to the defined service plays a crucial role in reducing congestion, promoting safety, and increasing transportation system efficiency. Streets and highways are part of an interconnected network, and each one moves traffic throughout the system by a specified degree of access and a level of movement.

Figure 3-6 indicates the degree to which different road functional classes should accommodate movement and access. The curve in this figure illustrates the defined relation between access and mobility for each road function class.

Figure 3-6. Relationship between Access and Movement Functions of Roads & Streets

[3] https://www.dhs.gov/xlibrary/assets/NIPP_Overview.pdf



In recent years, travel behavior has substantially changed. Journeys with a single purpose, such as work, shopping, or returning home, have been replaced by trip chains. These new characteristics of travel demand have led to the widespread use of private cars. Combining private motorized vehicle usage with trip chain behavior has affected transportation mode choice and made the access and mobility relationship more complex for road function class.

In the following sections, access to the existing highway and transit systems and the level of mobility through these networks are evaluated as benchmarks for shifting travel demand from a mainly single mode, i.e., private motorized vehicles, to other mode choices in a more equitable transportation system.

Access

People travel from an origin to a destination for the primary purposes of economic, social, recreational, and other activities. Although the physical act of traveling is a secondary function, it is necessary for conducting the primary functions. Traveling is possible if travelers have safe, timely, and affordable access to the existing transportation infrastructure components. Without access to the transportation platform, trips may not be made in a safe and efficient manner.
The following sections attempt to analyze the state of access in the NOACA region. A critical question is who has access to which part of the transportation system. This section summarizes the existing access to the current transportation system in the NOACA region, which will be a benchmark for planning and investing in equitable transportation infrastructure in the next three decades.

Access to Freeway System

In the NOACA road network, highways with controlled access, such as Interstate 71, Interstate 77, Interstate 480, etc., provide a connectivity platform for mainly long regional and inter-county vehicular traffic at a high speed. The controlled access to interstate highways is designed by on-ramps or off-ramps and interchanges. The ramp and interchange spacing is critically important in the origins and destinations of trips traveling through those highways, mobility role, safety, and traffic management.

An excessive number of access facilities, such as interchanges in a freeway network, diverts many short trips from the arterial and collector street network to the freeway system. This diversion has two negative impacts:

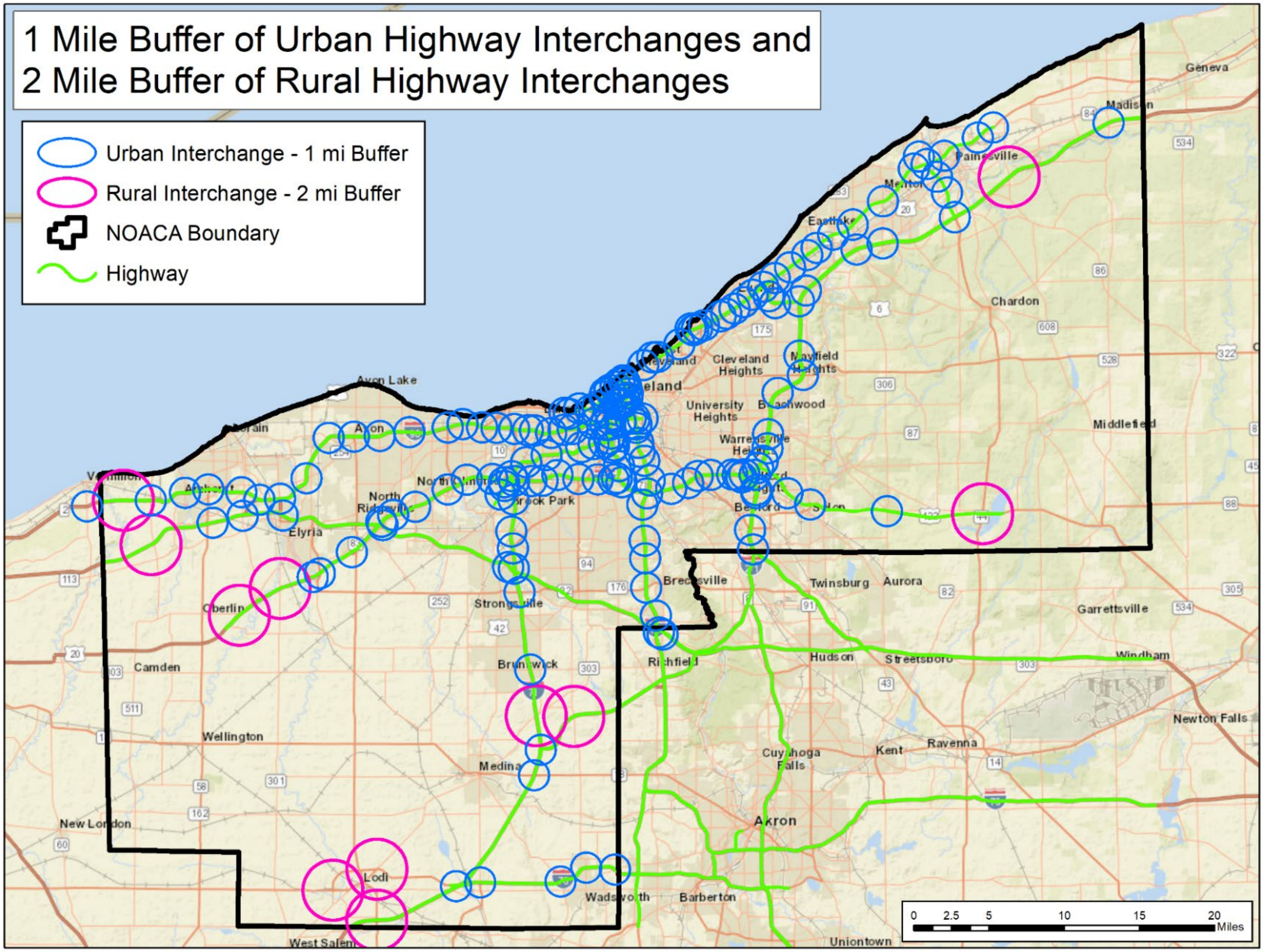
- Freeways will be congested by short vehicular trips entering from one interchange and leaving the freeway system at the next interchange,
- Reduces street network throughput, and streets operate under capacity and consequently seem over-invested.

The American Association of Highway Transportation Officials' (AASHTO's) design guidelines (Green Book) recommend the following passage regarding interchange spacing:

In areas of concentrated urban development, proper spacing usually is difficult to attain because of traffic demand for frequent access. Minimum spacing of arterial interchange (distance between intersecting streets with ramps) is determined by interchange form, lane configuration, weaving volumes, signing, signal progression, and lengths of speed-change lanes. A general rule of thumb for minimum interchange spacing is 1 mi [1.5 km] in urban areas and 2 mi [3.0 km] in rural areas. In urban areas, spacing of less than 1 mi [1.5 km] may be developed by grade-separated ramps or by adding collector-distributor roads.

In response to the trip chain travel demand over the last decades and the implications of the above guideline, as illustrated in Figure 3-7, the existing interchange locations in the NOACA region indicate that there may have been overinvestments in providing access to the freeways rather than paying attention to their mobility purposes.

Figure 3-7. Existing Interchange Spacing in the NOACA Region



In the literature, transportation accessibility is mainly measured by three components: trip coverage, spatial coverage, and temporal coverage. In this section, each facility access point is measured by a circular buffer with a specific radius to identify its existing coverage area and analyze the future requirements for a transportation facility.

Figures 3-8 and 3-9 depict the five-mile travel distance coverage for each freeway access point and access coverage in relation to the urban area.

Figure 3-8. Access to Highway System

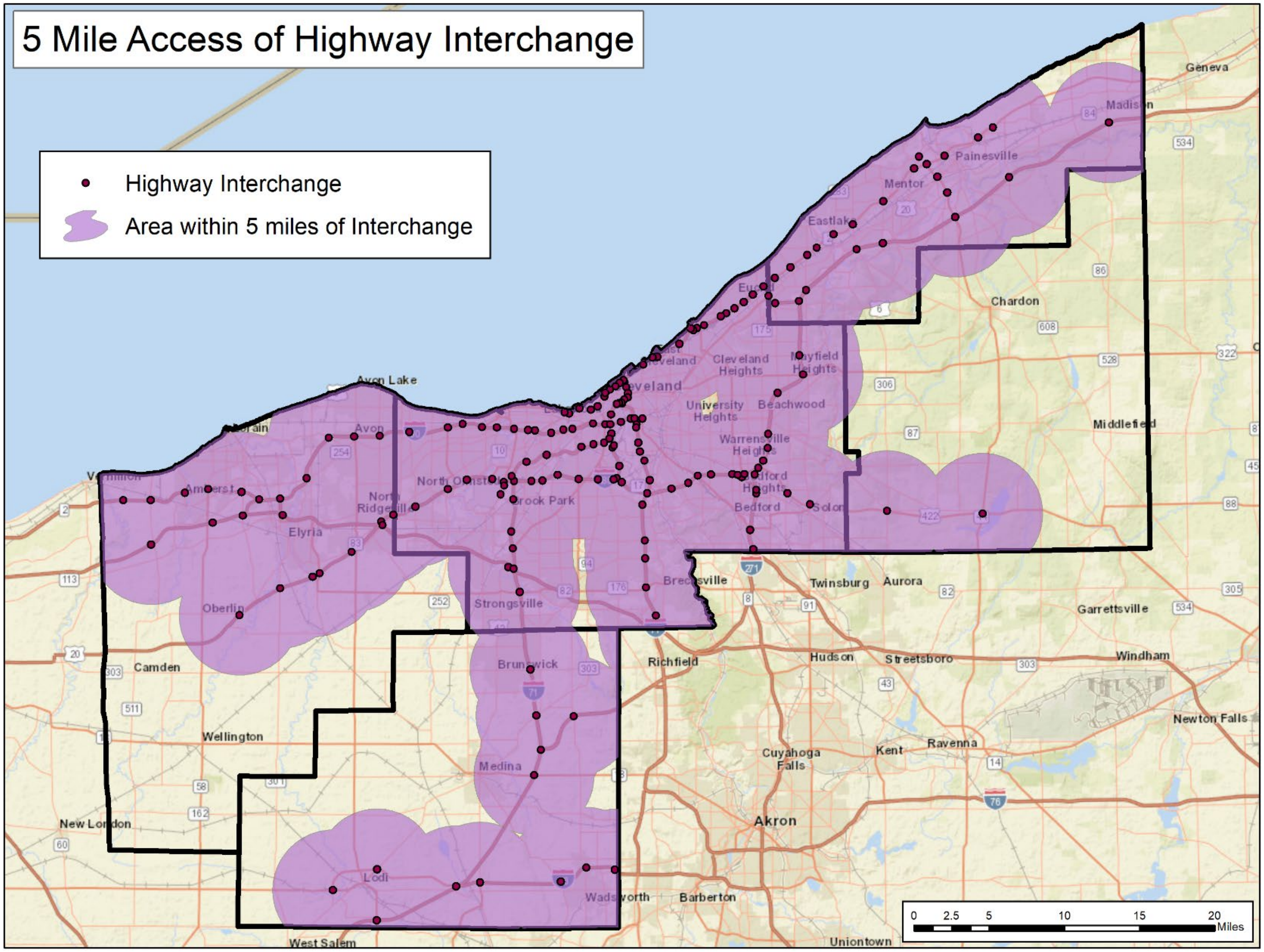
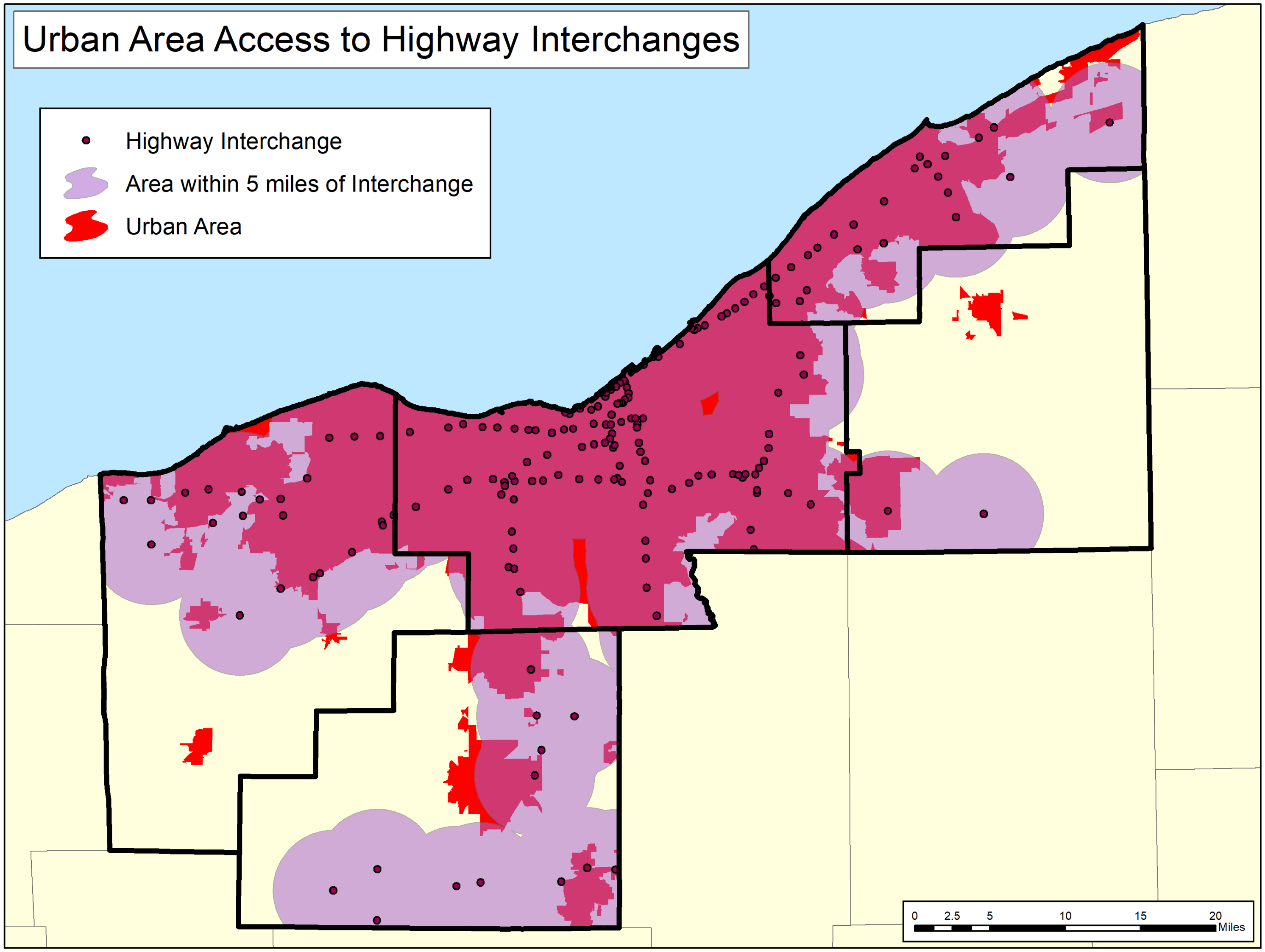


Figure 3-9. Urban Area Access to Highway System



As illustrated, most of the urban area has quick access to the freeway system. The overlapping areas of the 5-mile circles may be assumed to indicate excessive access and overinvestments. Currently, over 1.8 million of the total NOACA region population reside within a 5-mile driving distance of an interchange. This is over 90 percent of the residents, and it indicates that the freeway network is accessible within a short distance regardless of one's neighborhood.

Arterial Network Accessibility

The arterial network consists of major (or principal) and minor arterials. The major arterial network consists of roads and streets that serve large amounts of traffic traveling relatively long distances at higher speeds. Considering its function class, this network may play an alternative role to the freeway network in reducing traffic congestion. Arterials generally connect residential areas to many employment centers and intersect with freeways.

Major arterials are usually congested, and the Level of Service (LOS) measure indicates overcapacity and is calculated as:

$$\frac{\text{Volume}}{\text{Capacity}} > 1$$

This means that the traffic volume is higher than the road capacity, and improvement strategies generally aim to improve the capacity (i.e., increase the denominator) to alleviate congestion.

On the contrary, the LOS measures for the exiting arterial corridors in the NOACA region are generally under capacity.

$$\frac{\text{Volume}}{\text{Capacity}} < 1$$

Capacity-improving strategies, such as signal timing optimization, attempt to increase capacity, not to reduce the ratio above, but to attract more through traffic. This would increase the use of the road and restore it as an alternative to congested highways.

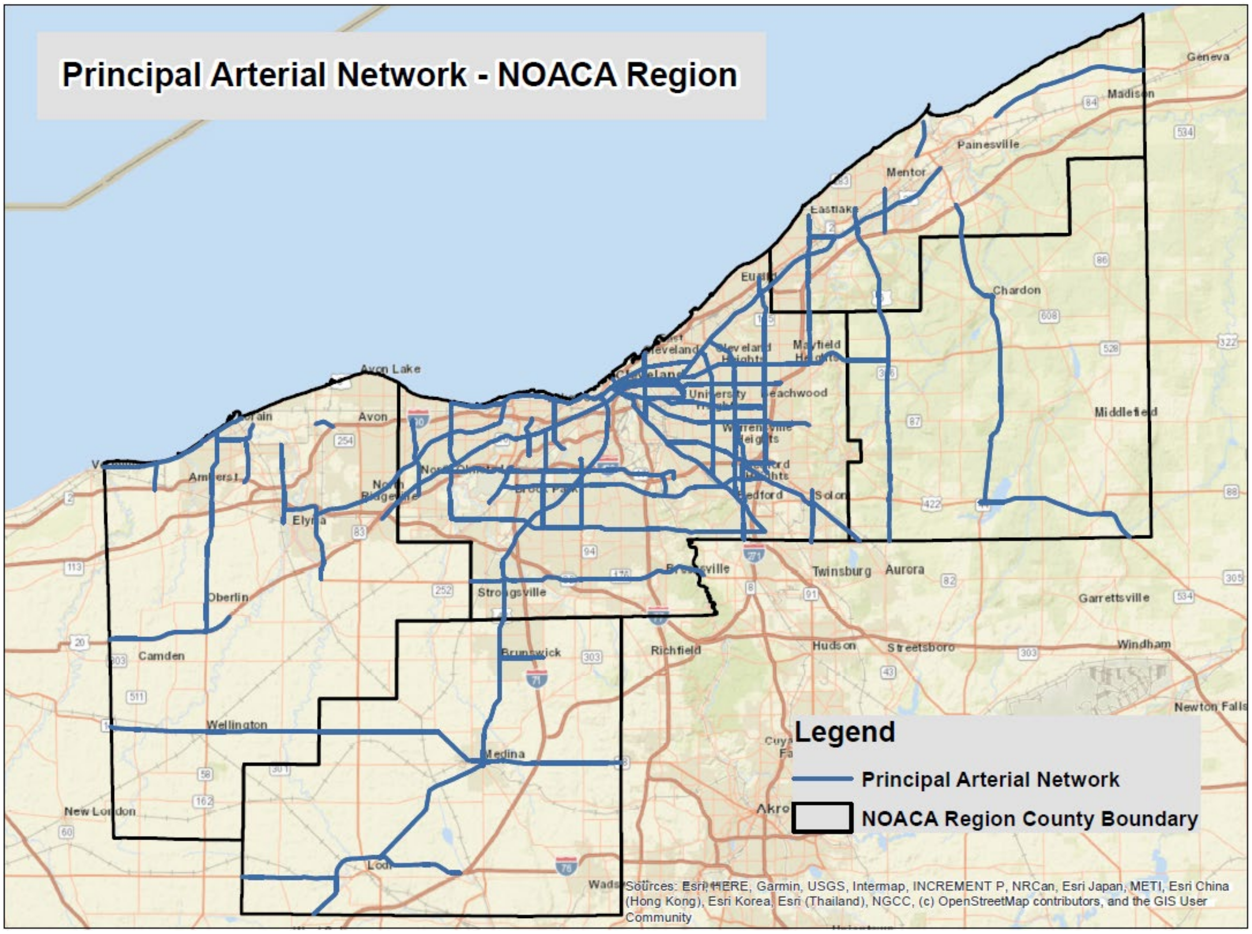
Generally, the arterial corridors are radial (originating from the center of Cleveland) or tangential (running “around” the periphery of downtown Cleveland at increasingly distant intervals). At further distances, the radial and tangential corridors tend to intersect with the centers of other large communities in the NOACA region.

Transit riders are often divided into two categories: “choice” riders (individuals who own cars but choose to ride transit) and “captive” riders (individuals who do not own cars and must use transit). In these corridors, transit routes operate through the arterial network, providing an alternative travel mode for passenger vehicles for residents’ daily commutes. Some of these corridors run through the EJ neighborhoods, which are likely to have a high concentration of zero-vehicle households. Therefore, public transportation along these corridors is a travel necessity for some of the residents.

Most travelers are concerned about the length of their travel time on the major arterial network, which is generally affected by intersection delays and posted speed limits. However, higher accessibility of these corridors has the potential to attract more motorists to travel through the arterial network as an alternative to the existing congested freeways during the morning and afternoon peak periods. This would benefit the businesses along these corridors and also reduce traffic congestion on freeways.

Figure 3-10 displays the major arterial network in the NOACA region.

Figure 3-10. Major Arterial Network in the NOACA Region

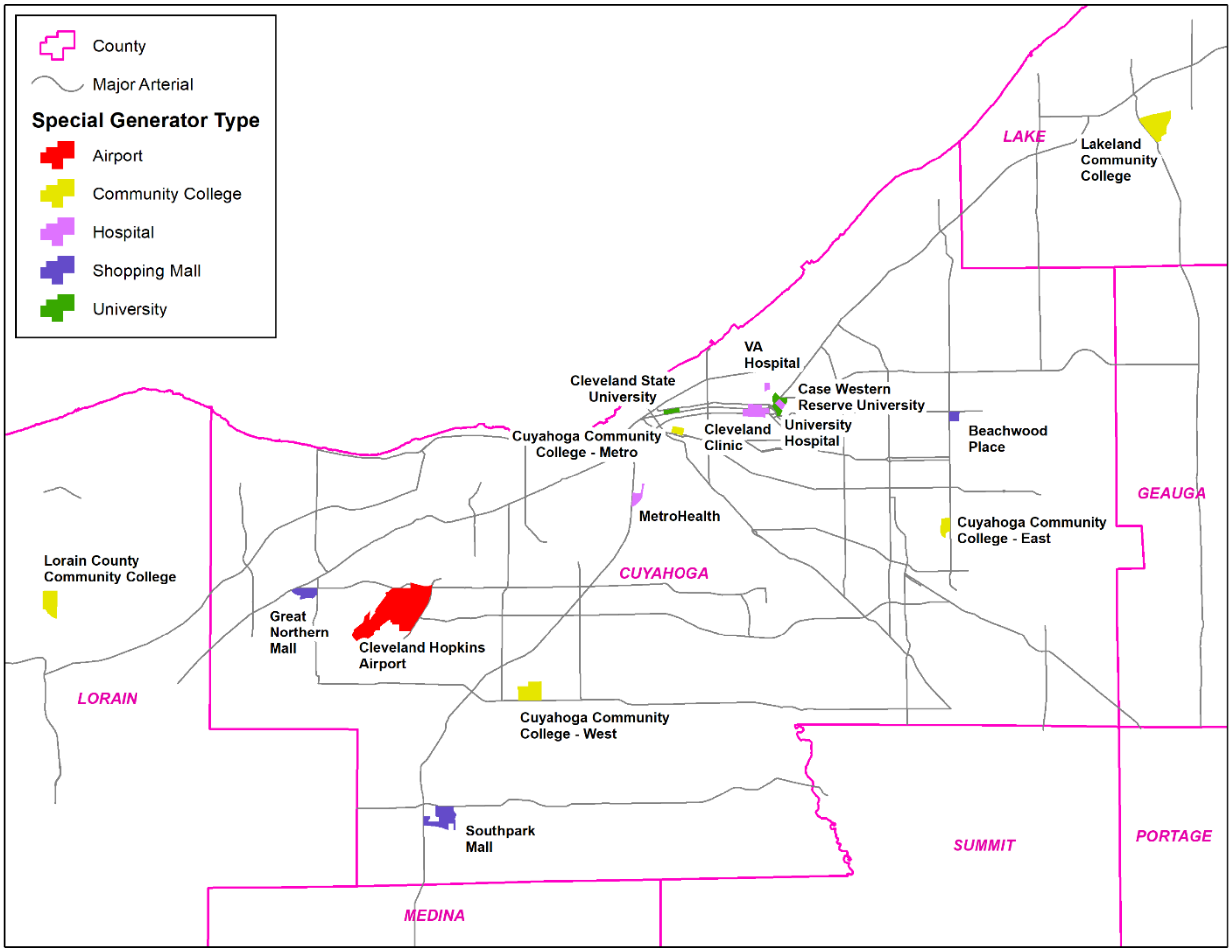


Access to Important Trip Generators

Access to regionally significant origins/ destinations, such as healthcare, education, and shopping, is highly dependent upon the major arterial network. Many of the regionally significant locations for healthcare, education, and shopping are found along major arterials. As previously discussed, arterials are used for both mobility and access. Therefore, it makes sense that many regionally significant trip generators would be located on major arterials, as these roadways provide transportation assets for residents traveling from near or far.

The NOACA travel forecasting model takes into account all different types of land uses, and those that are regionally significant in terms of employment and person trips have been identified as "Special Generators". These locations are unique in the fact that they attract and generate many more trips from much farther distances compared to other similar land uses. Almost all of the special generators fall into the major trip generator categories of healthcare, education, and shopping (with Cleveland Hopkins Airport being the lone exception). As can be seen in Figure 3-11, all of the special generators are located on or near a major arterial, with many being located near the intersection of two major arterials. Therefore, the reinvigorating of the arterial network is important for accessing the major and minor activity locations.

Figure 3-11. Special Generators and the Major Arterial Network



Access to Transit Network

Bicycle and pedestrian access to transit is an important aspect of a cohesive, multimodal transportation network. These connections to the transit network are often referred to as “first mile-last mile trips,” those short trips that get commuters from their homes to a bus or train or from the bus or train to their place of work. Because bus routes and rail stations cannot pick all riders up right at their front doors, most people must travel some distance before boarding a bus or train. Riders should be able to safely and conveniently get to and from transit stops and stations via a well-connected system of pedestrian and bicycle infrastructure.

The potential connectivity of residents and commuters to the regional transit network via walking and biking can be gauged by the presence and prevalence of quantifiable characteristics. For example, intersection density is an established indicator of walkability and connectivity. Grid pattern development with many intersecting perpendicular streets usually offers multiple routes between origins and destinations, while cul-de-sac developments or areas with fewer roadways and intersections can hinder direct shortest-distance movement. Similarly, a high density of low-stress roadways offers pedestrians and cyclists a greater number of safer and more comfortable opportunities to move along roadways and through intersections, while a greater proportion of higher-stress roadways may discourage pedestrian and cyclist travel.

Measuring the quality and quantity of access to transit services is important in evaluating existing transit services, travel demand, allocating transportation investments, and making decisions on land use development. In this regard, the ability to walk to transit is important for access to jobs and vital services, like education and healthcare, especially for those who do not have access to a car. To measure accessibility, a distance of three-quarters of a mile or equivalent to 15 minutes of walking time (assuming 3 miles per hour as walking speed) is often utilized to represent a reasonable walking distance/time to reach a transit stop.

Currently the walk accessibility to transit is not evenly distributed throughout the five counties of the NOACA region. In many counties, access to transit by walking is sparse and very limited. Geauga County has no fixed-route transit and, as a result, none of its population is within a reasonable walking distance. When the entire NOACA region is taken into account, just over two-thirds of the regional population is within a reasonable walking distance of a transit stop.

Lorain and Medina counties only have a few transit lines within their counties and thus have a small percentage of their population within a reasonable walking distance, coming in at approximately 28% and 10%, respectively. Lake County has more transit lines within its large population centers, and that results in around two-thirds of its population being within 15 minutes of walking distance of a transit stop (71%). Cuyahoga County has the most extensive transit network covering most of the county and thus has a large majority of its population (87%) within a reasonable walk to transit.

Table 3-14 displays the existing transit stop coverage by numbers and percentages of people living within a 15-minute walking distance from transit stops.

Table 3-14. Transit Walk Accessibility Measure by County

County	Population within 15 Minutes' Walk to Transit Stop	Walk Accessibility to Transit Percentage
Cuyahoga	1,074,218	87%
Geauga	0	0%
Lake	163,284	71%
Lorain	88,043	28%
Medina	18,189	10%
NOACA Region	**1,343,734**	**66%**

Figures 3-12 and 3-13 display the current regional and zero-car-household transit walk accessibility. In these maps, neighborhoods are considered Traffic Analysis Zones (TAZ).

Figure 3-12. Transit Walk Accessibility in the NOACA Region

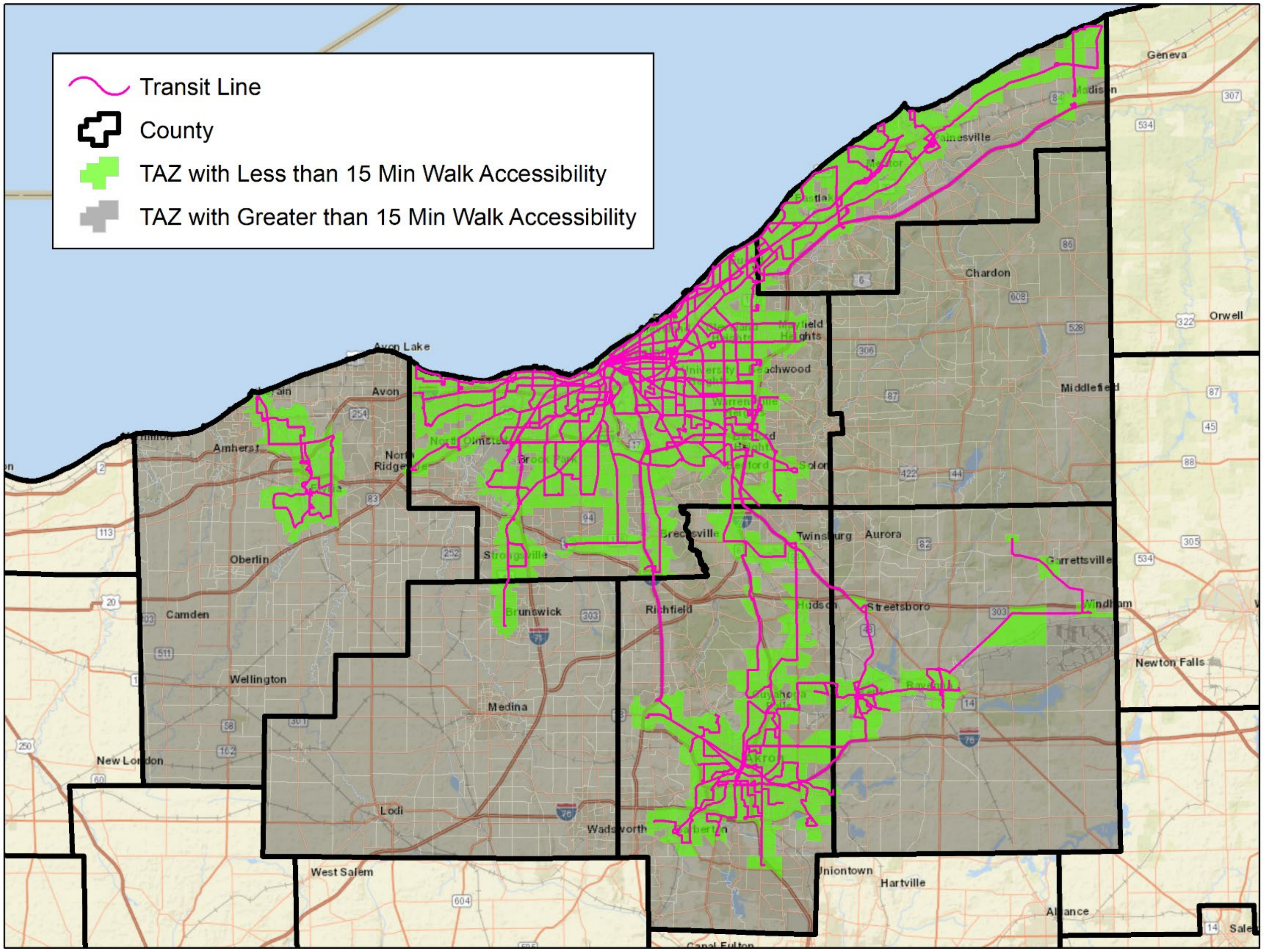
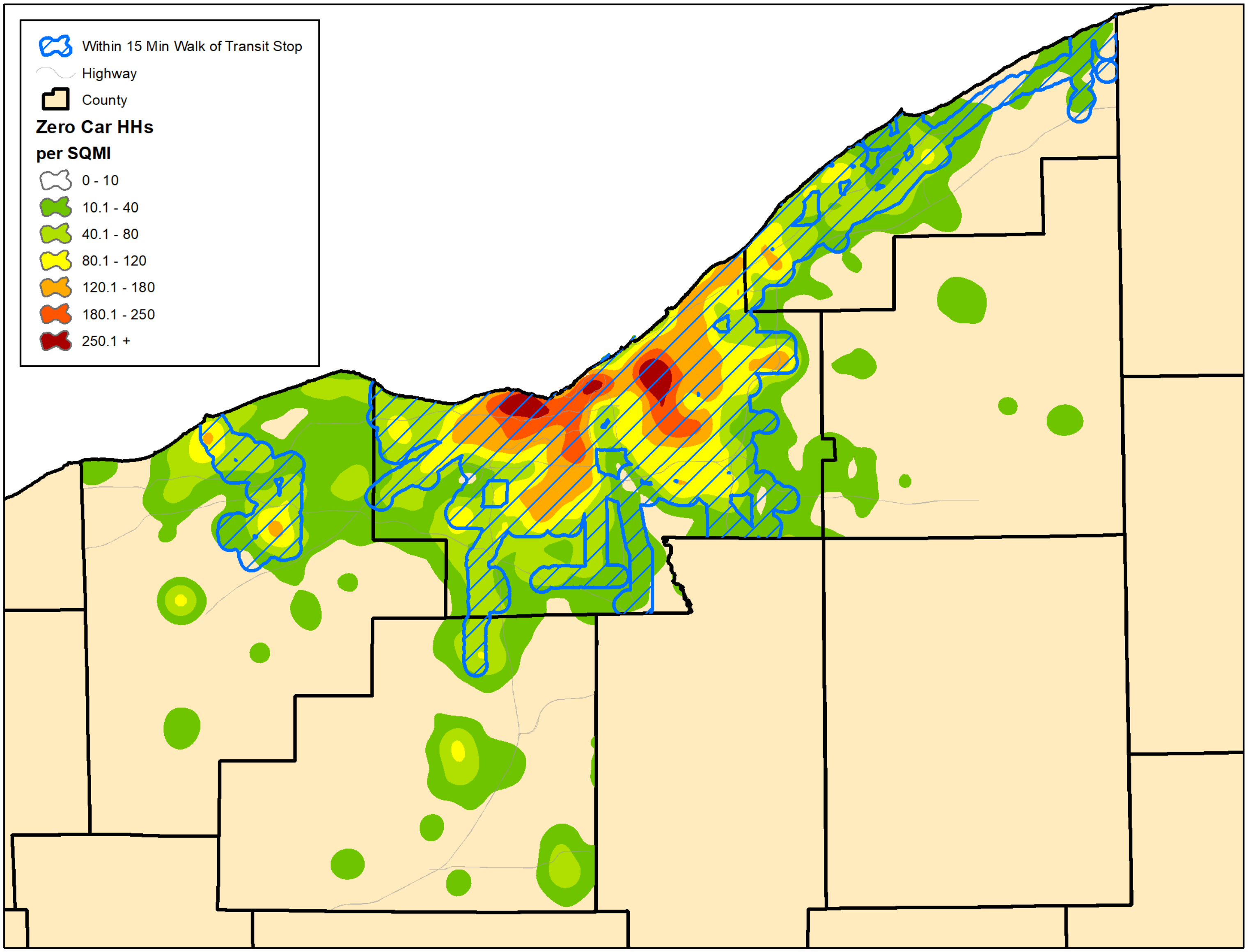


Figure 3-13. Zero Car Household Walk Accessibility to Transit Stops



The Location Quotient (LQ) method is a useful quantitative screening tool for assessing the potentially disparate impacts of indicators associated with particular geographic areas, such as zero-car households.

The LQ for the zero-car households within a 15-minute walking distance from a transit stop is calculated by applying the following formula:

$$LQ = \frac{\frac{Zero\ Car\ HHs\ within\ \ 15\ min\ Walking\ Distance\ from\ a\ Transit\ Stop}{All\ HHs\ within\ \ 15\ min\ Walking\ Distance\ from\ a\ Transit\ Stop}}{\frac{Total\ Zero\ Car\ HHs\ in\ the\ NOACA\ Region}{Total\ HHs\ in\ the\ NOACA\ Region}}$$

The LQ for zero-car households within a short walking distance of a transit stop is 1.09, which indicates that the concentration of zero-car households in the 15-minute transit coverage area is slightly higher relative to the entire population in the NOACA region.

Table 3-15 summarizes LQ values for the EJ population and workers' access to two different types of transit stations.

Table 3-15. LQ Values for Zero Car Households

Access Type	Zero Car Households
15 Minutes Walking Distance to any Transit Stop	1.09
15 Minutes Walking Distance to a Rail Station	1.25

All the rail stations are in Cuyahoga County, as is the highest concentration of zero-car households. As indicated in Table 3.15, zero-car households that are within a short walking distance of rail stations are overrepresented relative to the total zero-car households in the NOACA region.

However, a high concentration of zero-car households around the transit stations does not guarantee a reasonable work commute time by transit. The long work journey is due to low transit service frequencies and, consequently, long waiting and transfer times for riders. The next section will illustrate the long transit commute times to job hubs.

Access to Jobs

In a region, trips are categorized by their purposes: work trips, school trips, shopping trips, social trips, etc. The work trip category includes the most important mandatory trips, and reducing work commute time from workers' residences to employment locations is a major transportation planning challenge. A region's economic vitality is an important factor in the current competitive global economy, and providing access to jobs for workers at any income level improves the entire region socially and economically.

In order to measure the current job accessibility in the NOACA region, six major job hubs were identified based on a research brief produced by NOACA in 2016 entitled "Major Employment Hubs in the Cleveland MSA." These employment areas have the highest employment density compared to other areas in the region, and they are:

1. Downtown/Near East Side
2. University Circle, including Midtown between E. 105th Street and E. 83rd Street
3. Solon Cochran Corridor
4. Chagrin Highlands
5. I-77 and Rockside Road Area
6. Hopkins Airport Area

The regional characteristics of a job hub, including the number of jobs and its centralized or decentralized location, are important factors in the accessibility measure. There are many local job centers, as well as jobs not within any hub or center throughout the region, but the regional job hubs account for 30% of the jobs in the region. The six major job hubs include about one-quarter (25%) of current jobs in the region. Workers commute to these regional job hubs from various distances: short, medium, and long distances from across the region. The majority of work trips to local and minor job hubs are generally only short trips, and generally, trip time data to these job hubs are biased. Therefore, this section discusses work commute times to the major regional job hubs as representative of all the work trip times. A pilot analysis for legacy and minor job hubs was completed for Medina County at the same time as the regional hubs, with an analysis for the remaining three counties still underway but yet to be completed. To summarize, Figure 3-14 shows the locations of the regional job hubs (major, minor, and legacy) in the NOACA region. In addition to regional job hubs, there are also local job centers that have been considered but cannot be reliably modeled for various transportation analyses due to their disjointed characteristics and, therefore, not included in this work.

Figure 3-14. Locations of the Major Regional Job Hubs

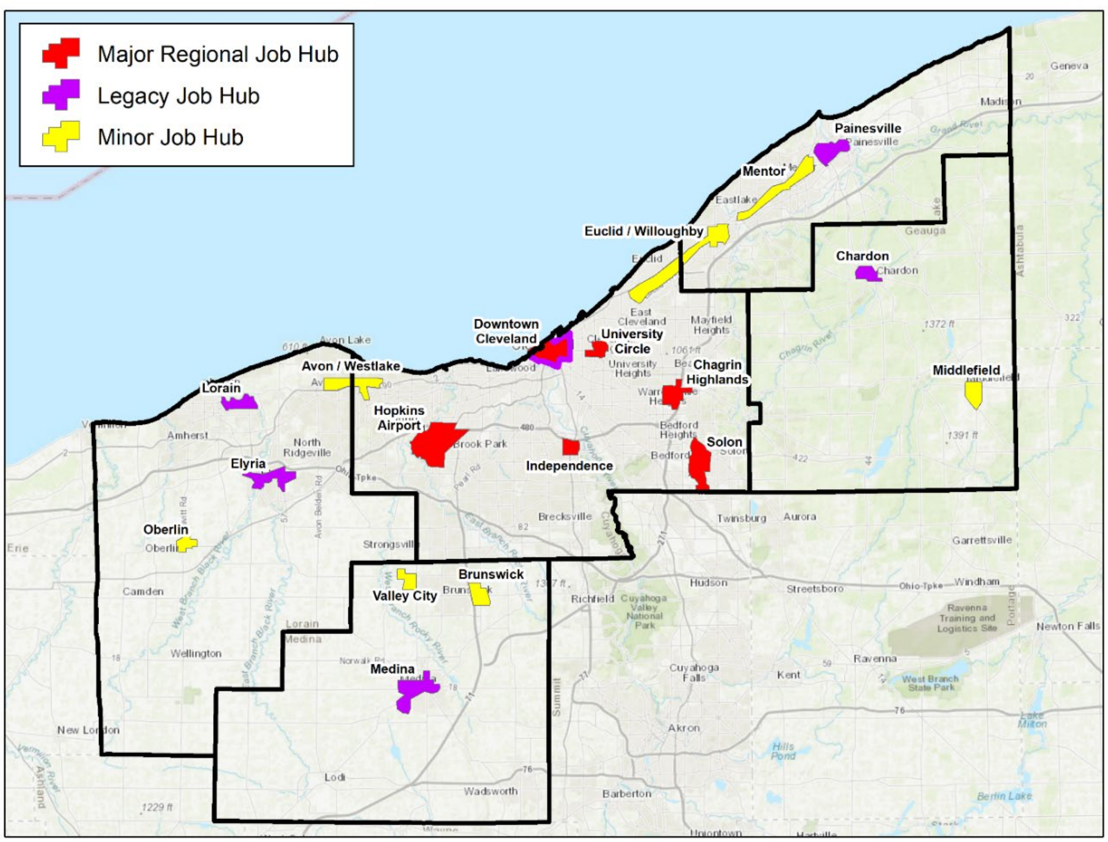


Table 3-16 illustrates the minimum, maximum, and average commute times of the current work trips during the morning peak period of a typical day from workers' homes to the major regional job hubs by auto and transit.

Table 3-16. Regional Statistical Values of Morning Work Commute Times by Auto and Transit

Auto & Transit Work Commute Times During 2020 AM Peak Period		Origin					
		Region					
		Morning Work Commute Time by Transit (Minutes)			Morning Work Commute Time by Auto (Minutes)		
Destination	Major Job Hub	Min	Average	Max	Min	Average	Max
	Cleveland Downtown	16	73	245	3.3	31	87
	University Circle	16	68	264	2.7	37	93
	Solon	28	107	315	3.4	36	79
	Chagrin Highlands	28	86	288	3.0	32	76
	Independence	41	99	301	2.0	29	77
	Hopkins Airport Area	38	98	309	4.0	31	85

Source: NOACA Travel Forecasting Model

As discussed previously, the transit system has an acceptable level of coverage in Cuyahoga County. However, due to the low frequency of transit services, low speed on the arterial streets, and long waiting and transfer times, work commute time is still much higher than that of the auto mode. All the statistical values of the minimum, average, and maximum of the transit mode are more than twice those of the auto mode.

Most people seem to enjoy a certain amount of personal travel, about 30 minutes a day, and dislike devoting more than about 90 minutes a day. Adding travel times of the return home trips similar to the average transit travel time shown in the above table results in daily work trip travel time outside an acceptable range for most residents in the NOACA region. Therefore, high transit travel time is a critical factor in choosing private vehicle mode for daily work trips. The implications of this analysis are far-reaching. On the workforce development side, the analysis and data could be used to identify undersupplies of worker types residing in areas with good accessibility to major job hubs. In order to reduce the worker and employer locations mismatch in this region, more frequent transit services to the major job hubs, more park-and-ride locations throughout the region, implementation of low-cost traffic engineering to remove arterial bottlenecks, and more bike facilities to access major transit stations.

Mobility

Typically, the interstate and freeway systems carry the highest volume of traffic in the region, requiring more travel lanes. In the NOACA region, the lane-miles length of the existing freeway/expressway system is about 2,200 miles, which is about 25% of total roadway lane-miles.

Vehicle Miles Traveled (VMT) is a measure used extensively in transportation planning for various purposes. It is the leading measure of both personal and commercial vehicle travel demand. VMT data are also useful in policy decisions for infrastructure investment. Since VMT measures travel demand, it is useful in determining where resources are most needed, and it is an important measure to monitor and forecast.

The current VMT percent of the freeway/expressway system is about 56 based on the typical daily vehicle trips in the NOACA region (Source: NOACA Travel Forecasting Model).

The VMT per capita illustrates the relationship between population growth and the length of travel in the NOACA region. The current annual personal VMT estimate per capita is about 6,600, and the annual commercial VMT per capita is about one-tenth of that.

Comparing the lane-miles percentages of the freeway/expressway system with the major arterial, shown in Table 3-17, indicates that although the total lane miles are less, the VMT percent of the freeway network is over 60% more than that of the major arterial network. This is additional evidence to reinforce the argument that the major arterial network, as a mobility alternative to the freeway system, is currently underutilized in the NOACA region.

Table 3-17. Percentages of Lane Miles, VMT, and Delay by Facility Type

Facility Type	Main Function	Lane Miles Percent	Personal & Commercial Vehicles VMT Percent	Daily Delay Percent
Freeway/ Expressway/ Ramp	Mobility	25%	56.2%	31.7%
Major Road (Arterial)	Mobility & Access	44%	33.5%	49.2%
Minor Road (Collector)	Access	31%	10.3%	19.1%

Traffic Congestion

Following the access to the transportation facilities, a journey begins from an origin to a destination. The journey may be measured qualitatively and quantitatively by various travel attributes: travel time, delays due to routine or unexpected congestion, travel mode, journey route, safety, trip quality, etc.

It is expected that large numbers of people are all trying to reach their destinations at the same time, usually during peak hours, which causes congestion and delay. If congestion and delay are a daily routine, most travelers accept and plan for them. However, unexpected delays are less tolerated. Delay is a quantity that indicates where the problems are, what the solutions might be, and how beneficial the investment will be.

Transportation authorities continuously take actions to benefit travelers by balancing land use access and mobility and reducing travel time. On the contrary, actions in pursuit of other goals, such as improving safety, may also have the unintended or unavoidable consequence of slowing travel. The purpose of this section is to evaluate reductions or increases in passenger and goods travel time that result from such actions.

As discussed in previous sections, accessibility, mobility, and congestion are the main measures for evaluating the performance of the highway system in terms of how efficiently users can traverse it. Mobility and congestion represent similar concepts, and the same metrics, such as travel time, may be used to measure them.

Congestion describes the travel conditions on facilities, and the Federal Highway Administration (FHWA) defines seven sources for traffic congestion and unreliable travel time:

Category 1: Traffic Influencing Events

- Traffic incidents,
- Work zones,
- Weather

Category 2: Traffic demand

- Fluctuation in normal traffic
- Special events

Category 3: Physical Highway Features

- Traffic control devices
- Physical bottleneck ("Capacity")

Congestion spreads in time and space. In some areas of the NOACA region, congestion now lasts longer than the traditional morning and evening peak hours, and queues from physical bottlenecks are extended to a mile or two. The following section documents the existing recurring freeway, interchange, and intersection bottlenecks in the NOACA region as sources of congestion and ranks them based on their localized congestion severity. This discussion also examines the relationship between the demand and supply sides of the highway system.

Bottlenecks

FHWA offers the following definitions for a traffic bottleneck:

- A critical point of traffic congestion evidenced by queues upstream and free-flowing traffic downstream
- A location of a highway where there is a loss of physical capacity, surges in traffic volumes, or both
- A point where traffic demand exceeds the normal capacity
- A location where demand for usage of a highway section periodically exceeds the section's physical ability to handle it and is independent of traffic-distributing events that can occur on the roadway

The highway network in the NOACA region was assessed by using the NOACA travel forecasting model and the following congestion criteria to identify the bottleneck locations. Only "over capacity" freeway segments (a volume over capacity (V/C) ratio above 1) were considered when identifying highway bottleneck locations.

Congestion Criteria

Volume-over-Capacity Ratio (V/C)
The volume-over-capacity ratio during peak periods is one of the primary criteria for evaluating traffic congestion characteristics. The Highway Capacity Manual (HCM) provides different measures for various road classifications and intersection control types; however, these measures are generally divided into six ranges and assigned a Level-Of-Service (LOS) category A through F, with LOS F being indicative of severe congestion. LOS is a qualitative measure used to relate the quality of traffic service. Table 3-18 shows highway LOS ranges that have been used to locate the intensity of traffic congestion.

Table 3-18. Volume over Capacity Ranges

Volume over Capacity Ratio (V/C)	LOS	Description
V/C < 0.3	A	Free Flow Condition
V/C < 0.5	B	Reasonably Free Flow Condition
V/C < 0.7	C	Under Capacity
V/C < 0.85	D	Near Capacity
V/C = < 1	E	At Capacity
V/C > 1	F	Over Capacity

Travel Time Index (TTI)
The Travel Time Index (TTI) is one of the primary metrics used to measure congestion. It is the ratio of the actual travel time divided by the travel time under free-flow conditions. A TTI of 1.2 means that a trip takes 20 percent longer than it would under ideal conditions.

Speed and Travel Time
Speed is the distance traveled per unit of time. In traffic operations, two measures of average speed are Space Mean Speed (SMS) and Time Mean Speed (TMS). SMS is the average speed of all vehicles occupying a defined section of roadway at a point in time. TMS is the average speed of all vehicles passing a point on a roadway for a defined period of time.

NOACA Congestion Assessment

Figures 3-14 and 3-15 present the existing freeway bottleneck locations during the AM and PM peak periods.

Figure 3-14. Existing Freeway Bottleneck Locations during the AM Peak Period

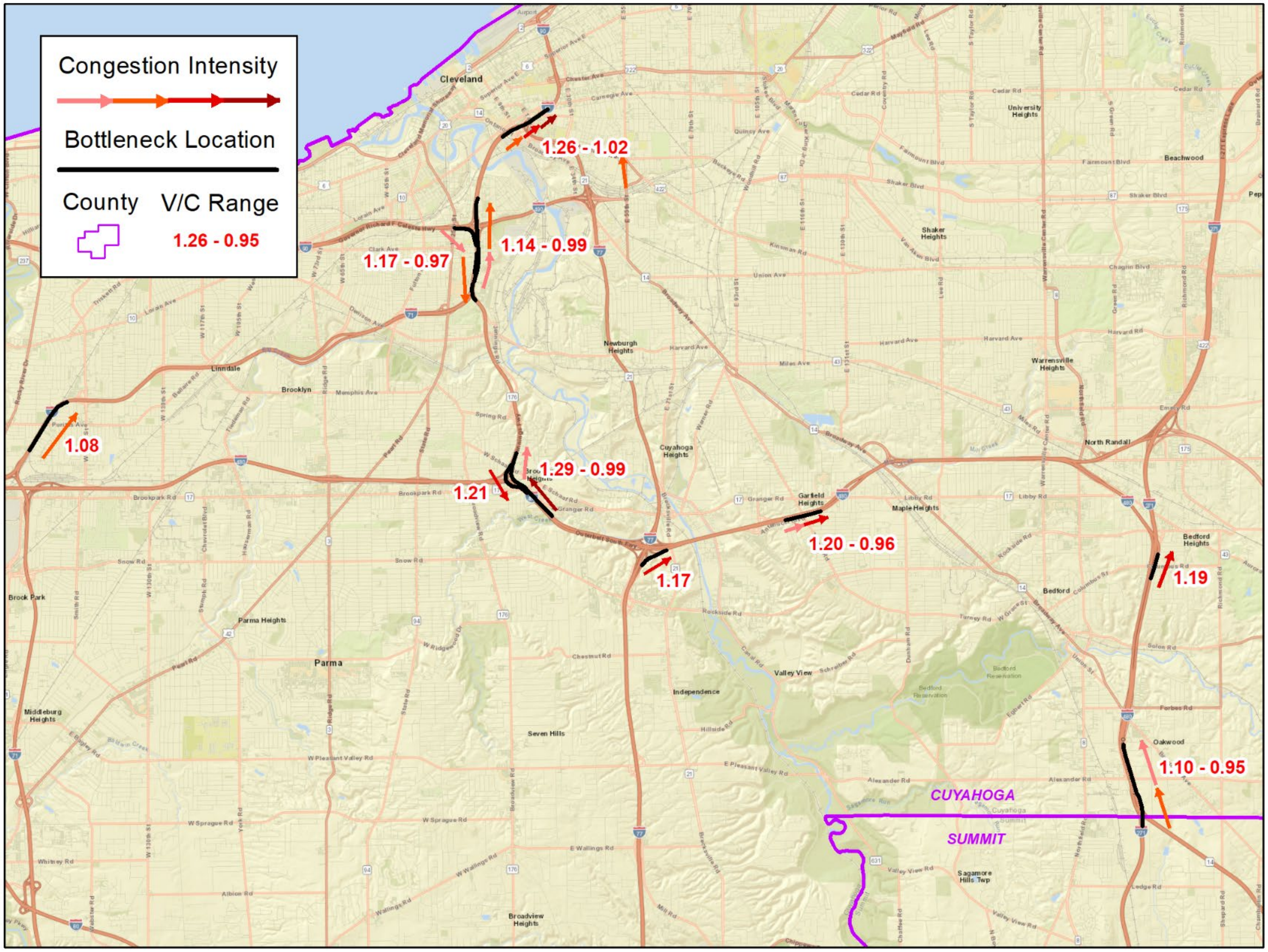
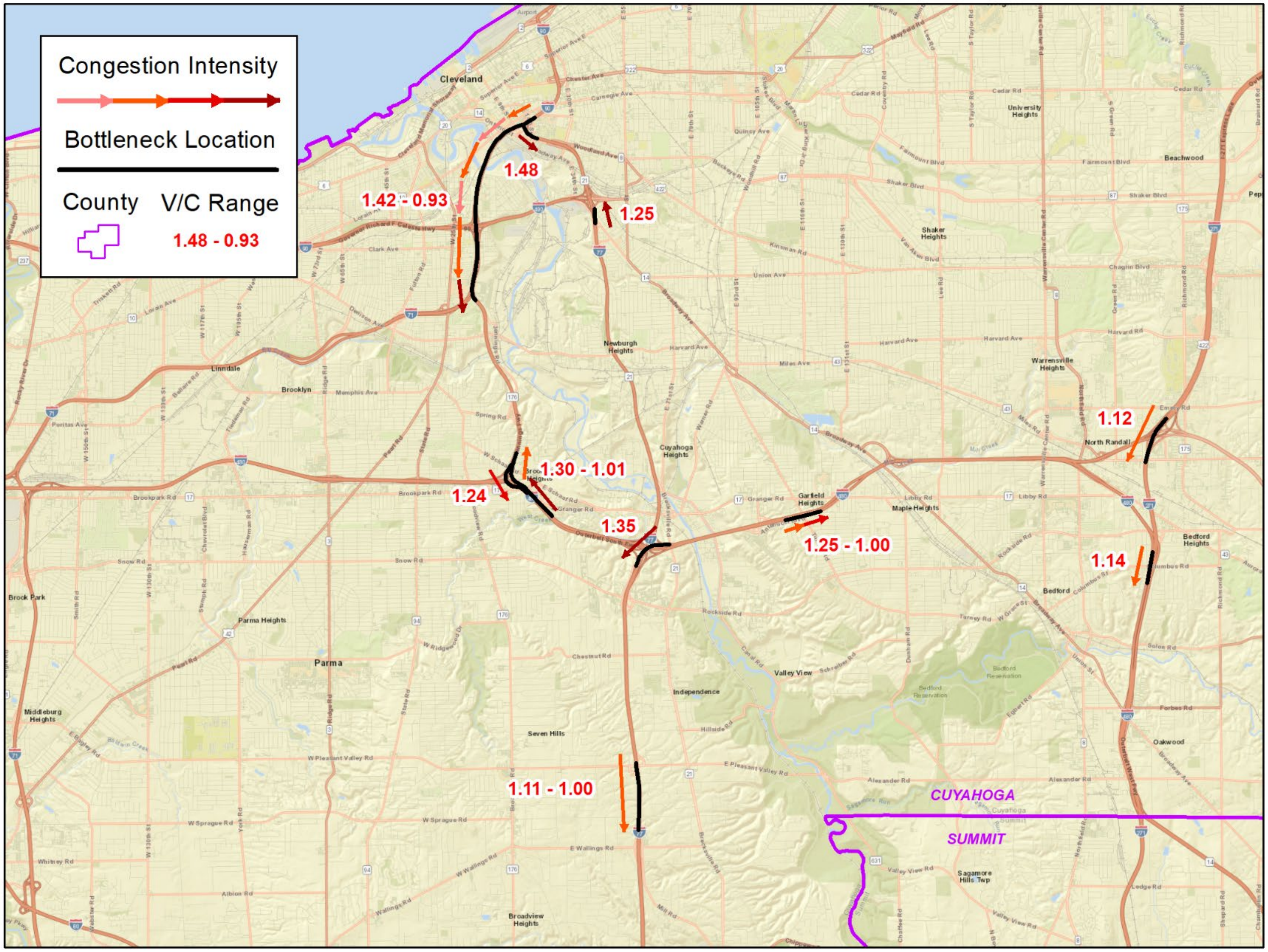


Figure 3-15. Existing Freeway Bottleneck Locations during the PM Peak Period



Tables 3-19 and 3-20 present the V/C, TTI, and speed ranges for the identified freeway bottleneck locations during the AM and PM peak periods.

Table 3-19. Existing Freeway Bottleneck during the AM Peak period

No.	Freeway	Direction	From	To	V/C Range	TTI Range	Actual Speed (mph) Range
1	I-480 Ramp to SR-176	WB / NB	E. Granger Rd. Exit Ramp	SR-176 NB	0.99 - 1.29	1.18 - 2.57	18 - 39
2	I-90	EB	Carnegie Ave. Exit Ramp	Ontario St. Exit Ramp	1.02 - 1.26	1.23 - 2.25	22 - 41
3	SR-176 Ramp to I-480	SB / EB	I-480 WB Ramp	Tuxedo Ave. Bridge	1.21	1.93	24
4	I-480	EB	Transportation Blvd. Entrance Ramp	Granger Rd. Exit Ramp	0.96 - 1.20	1.43 - 4.00	16 - 45
5	I-480	WB	I-271 Split	Rockside Rd. Exit Ramp	1.19	1.8	26
6	I-77 Ramp to I-480	NB / EB	Ramp from I-77 NB to I-480 WB	Ramp from I-77 SB to I-480 EB	1.17	1.69	28
7	I-90 Ramp / I-71 / SR-176 Ramp	EB / SB	Ramp from I-90 EB to I-71 SB	Ramp to SR-176 SB	0.97 - 1.17	1.16 - 1.68	23 - 36
8	I-71	NB	Ramp to W. 14th St.	I-90 Merge	0.99 - 1.14	1.37 - 1.89	23 - 45
9	I-271 / I-480	NB / WB	I-271 / I-480 Merge	Fairoaks Rd. / Broadway Ave. Exit Ramp	0.95 - 1.10	1.27 - 1.92	32 - 49
10	I-71	NB	Ramp from I-480 EB / SR-237 NB	W. 150th St. Exit Ramp	1.08	2.23	28

Note: NB: Northbound, SB: Southbound, WB: Westbound, and EB: Eastbound

Table 3-20. Existing Freeway Bottleneck during the PM Peak period

No.	Freeway	Direction	From	To	V/C Range	TTI Range	Actual Speed (mph) Range
1	I-90 Ramp to I-77	WB / SB	E. 14th St. Entrance Ramp	Bridge over E. 22nd St.	1.48	5.71	6
2	I-90 / I-71	WB / SB	I-77	SR-176	0.93 - 1.42	1.11 - 4.21	11 - 47
3	I-480 Ramp to I-77	WB / SB	Ramp from I-480 WB to I-77 NB	Ramp from I-480 EB to I-77 SB	1.35	3.23	18
4	I-480 Ramp to SR-176	WB / NB	E. Granger Rd. Exit Ramp	SR-176 NB	1.01 - 1.30	1.21 - 2.68	17 - 38
5	I-77 Ramp to I-490	NB	Broadway Ave. Bridge	I-490 EB and WB Ramps	1.25	2.23	16
6	I-480	EB	Transportation Blvd. Entrance Ramp	Granger Rd. Exit Ramp	1.00 - 1.25	1.60 - 5.47	12 - 41
7	SR-176 Ramp to I-480	SB / EB	I-480 WB Ramp	Tuxedo Ave. Bridge	1.24	2.12	22
8	I-480	EB	Rockside Rd. Entrance Ramp	I-271 Merge	1.14	1.56	30
9	I-271	SB	I-271 Express Lane Merge	Ramp from I-480 WB	1.12	2.06	29
10	I-77	SB	Pleasant Valley Rd. Exit Ramp	Wallings Rd. Exit Ramp	1.00 - 1.11	1.39 - 2.00	31 - 45

Note: NB: Northbound, SB: Southbound, WB: Westbound, and EB: Eastbound

In order to identify the top interchange and intersection bottleneck locations, a calculation based on the following equation, was performed to average the volume over capacity (V/C) values for all approaches of a given interchange or intersection.

$$WVC = \frac{\sum_{i=1}^{n} VOL_i \times (V/C)_i}{\sum_{i=1}^{n} VOL_i}$$

Where:

WVC = Weighted V/C values
n = Number of approaches
VOL = Approach traffic volume (weighting factor)

For example, a four-legged intersection has four approaches, each with its own V/C value. A weighted average of each approach's V/C value was calculated, using the total volume of each approach as the weighting factor. Weighting was used to give a more heavily traveled roadway's congestion level more influence over the intersection's final calculated value. The locations with the highest weighted V/C values were then identified as the top bottleneck interchanges and intersections in the region.

A number of the bottleneck locations were grouped together based on their proximity and interactions with each other. For example, in Medina County, three bottleneck locations were identified along the SR-94 corridor (Ridge Rd.). Since these locations are located along the same corridor, congestion at one location leads to increased congestion at a nearby location. It was determined that these locations should be grouped together and discussed as one due to these inter-relationships. Similar groupings can be seen on the map (indicated with black circles), showing bottleneck locations that have some relationship with each other, such as neighboring interchanges along the same freeway and intersections in a similar geographic area, like downtown Cleveland.

Figures 3-16 and 3-17 present the existing interchange and intersection bottleneck locations during the AM and PM peak periods.

Figure 3-16. Existing Interchange/ Intersection Bottleneck Locations during the AM Peak Period

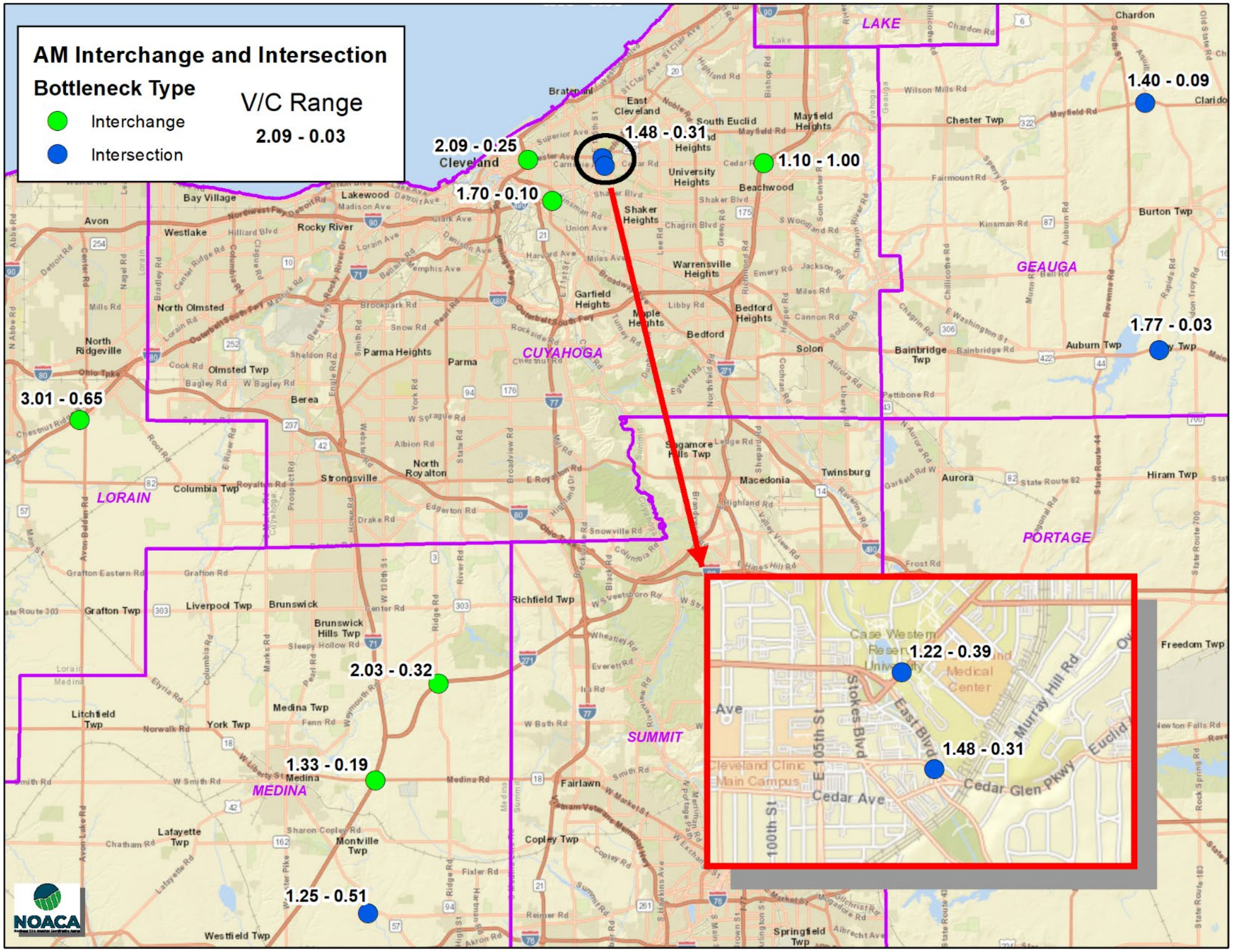
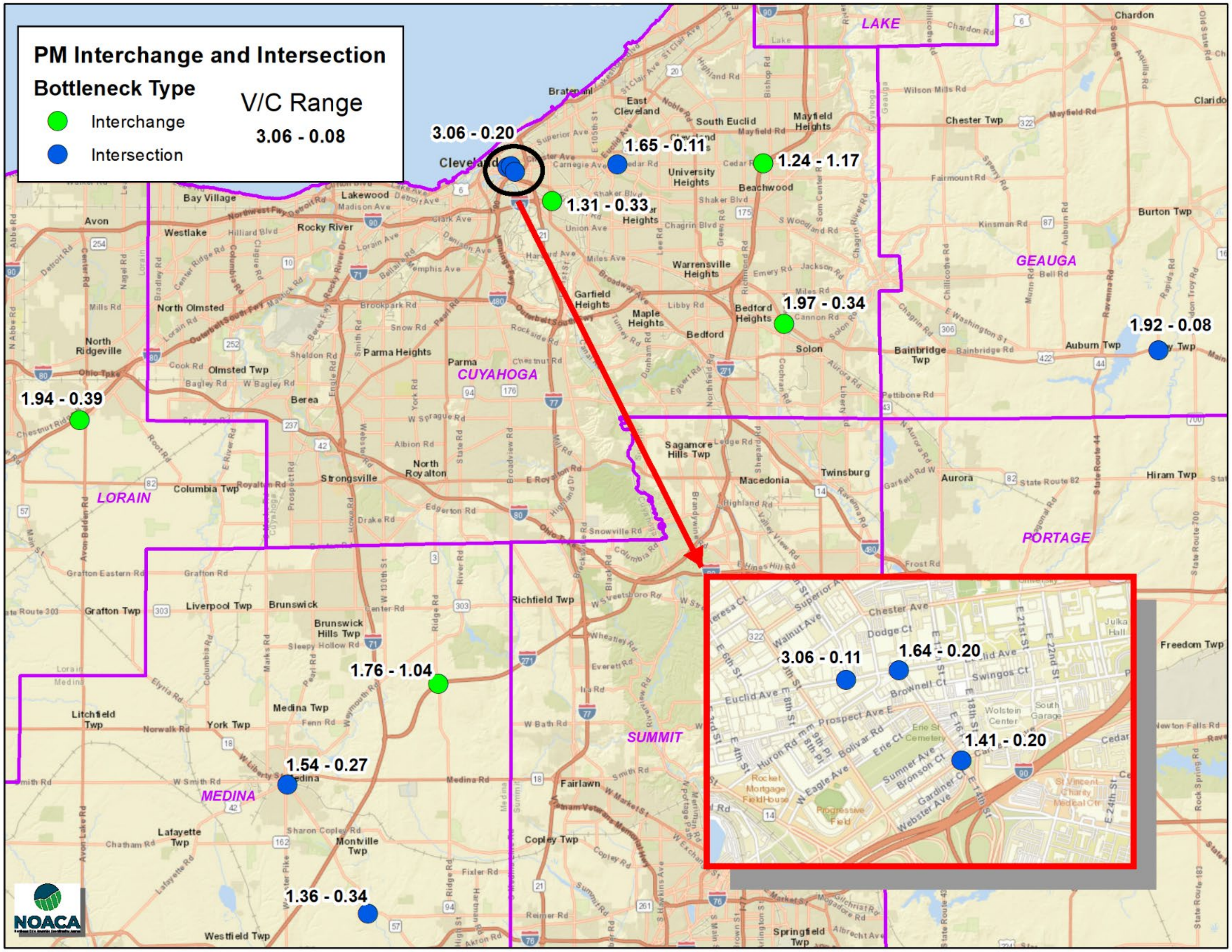


Figure 3-17. Existing Interchange/ Intersection Bottleneck Locations during the PM Peak Period



Tables 3-21 and 3-22 present the V/C values for the identified interchanges and intersection bottleneck locations during the AM and PM peak periods.

Table 3-21. Existing Interchange/ Intersection Bottleneck during the AM Peak Period

No.	Location	County	Type	AM Peak Period (6AM - 9AM)		
				Volume Weighted Average of V/C for Intersection Approaches	Volume over Capacity (V/C) Ratio Range	Number of Approaches over 0.85 V/C Ratio
1	SR-10 NB Ramps / Butternut Ridge Rd. / Chestnut Ridge Rd.	Lorain	Interchange	1.78	3.01 - 0.65	2
2	I-90 EB Exit / Chester Ave. (US-322)	Cuyahoga	Interchange	1.67	2.09 - 0.25	1
3	I-271 SB Ramps / Ridge Rd. (SR-94)	Medina	Interchange	1.47	2.03 - 0.32	1
4	I-490 / Opportunity Corridor (SR-10) / E. 55th St.	Cuyahoga	Interchange	1.46	1.70 - 0.10	2
5	Main Market Rd. (US-422) / Rapids Rd.	Geauga	Intersection	1.44	1.77 - 0.03	2
6	I-71 NB Ramps / Medina Rd. (SR-18)	Medina	Interchange	1.12	1.33 - 0.19	2
7	University Circle Area	Cuyahoga	Intersection	1.08 - 1.07	1.48 - 0.31	4
-	*MLK Jr. Dr. / Carnegie Ave.*	*Cuyahoga*	*Intersection*	*1.08*	*1.48 - 0.31*	*2*
-	*Euclid Ave. (US-20) / East Blvd.*	*Cuyahoga*	*Intersection*	*1.07*	*1.22 - 0.39*	*2*

Table 3-21 Continued. Existing Interchange/ Intersection Bottleneck during the AM Peak Period

No.	Location	County	Type	AM Peak Period (6AM - 9AM)		
				Volume Weighted Average of V/C for Intersection Approaches	Volume over Capacity (V/C) Ratio Range	Number of Approaches over 0.85 V/C Ratio
8	Mayfield Rd. (US-322) / Aquilla Rd.	Geauga	Intersection	1.06	1.40 - 0.09	1
9	I-271 SB Ramp / Cedar Rd.	Cuyahoga	Interchange	1.05	1.10 - 1.00	2
10	Wadsworth Rd (SR-57) / Styx Hill Rd. / River Styx Rd.	Medina	Intersection	1.03	1.25 - 0.51	3

Table 3-22. Existing Interchange/ Intersection Bottleneck during the PM Peak period

No.	Location	County	Type	PM Peak Period (3PM - 7PM)		
				Volume Weighted Average of V/C for Intersection Approaches	Volume over Capacity (V/C) Ratio Range	Number of Approaches over 0.85 V/C Ratio
1	**Downtown Cleveland Area**	**Cuyahoga**	**Intersection**	**1.86 - 1.15**	**3.06 - 0.20**	**5**
-	*Euclid Ave. (US-20) / E. 12th St.*	*Cuyahoga*	*Intersection*	*1.86*	*3.06 - 0.11*	*1*
-	*Euclid Ave. (US-20) / E. 14th St.*	*Cuyahoga*	*Intersection*	*1.28*	*1.64 - 0.20*	*1*
-	*Carnegie Ave. / E. 14th St.*	*Cuyahoga*	*Intersection*	*1.15*	*1.41 - 0.20*	*3*
2	**Main Market Rd. (US-422) / Rapids Rd.**	**Geauga**	**Intersection**	**1.58**	**1.92 - 0.08**	**2**
3	**I-271 SB Ramps / Ridge Rd. (SR-94)**	**Medina**	**Interchange**	**1.37**	**1.76 - 1.04**	**3**
4	**Cedar Glen Pkwy. / Cedar Rd. / Euclid Heights Blvd**	**Cuyahoga**	**Intersection**	**1.28**	**1.65 - 0.11**	**1**
5	**I-271 SB Ramp / Cedar Rd.**	**Cuyahoga**	**Interchange**	**1.20**	**1.24 - 1.17**	**2**
6	**US-422 / Harper Rd.**	**Cuyahoga**	**Interchange**	**1.20**	**1.97 - 0.34**	**1**

Table 3-22 Continued. Existing Interchange/ Intersection Bottleneck during the PM Peak period

No.	Location	County	Type	PM Peak Period (3PM - 7PM)		
				Volume Weighted Average of V/C for Intersection Approaches	Volume over Capacity (V/C) Ratio Range	Number of Approaches over 0.85 V/C Ratio
7	SR-10 NB Ramps / Butternut Ridge Rd. / Chestnut Ridge Rd.	Lorain	Interchange	1.19	1.94 - 0.39	2
8	Wadsworth Rd. (SR-57) / S Broadway St. / Lafayette Rd.	Medina	Intersection	1.16	1.54 - 0.27	2
9	I-490 / Opportunity Corridor (SR-10) / E. 55th St.	Cuyahoga	Interchange	1.15	1.31 - 0.33	2
10	Wadsworth Rd (SR-57) / Styx Hill Rd. / River Styx Rd.	Medina	Intersection	1.14	1.36 - 0.34	3

The next paragraphs discuss the identified freeway, interchanges, and intersection bottleneck locations and their congestion severity.

Freeway Bottlenecks

I-90/I-77 Interchange Area

Many trips heading to downtown Cleveland, as well as through traffic from west to east and vice-versa, travel along I-90 through the central interchange area where I-77 and I-90 meet. These two major interstates meeting near a downtown area creates many congested segments in the immediate area, with one of the top congested segments in the AM peak period being I-90 EB from Carnegie Ave. to Ontario St. This segment's AM peak period V/C ratio ranges from 1.02 to 1.26, a TTI range from 1.23 to 2.25, and an actual speed range of 22 to 41 mph. In the PM peak period, traffic wanting to exit to I-77 from I-90 WB creates a bottleneck situation at this southbound ramp. This segment's PM peak period V/C ratio is 1.48, its TTI is 5.71, and the actual speed is 6 mph.

I-90/I-71/SR-176 Interchange Area

The I-90/I-71/SR-176 interchange area is a highly traveled corridor leading to and from downtown Cleveland. In particular, I-71 and SR-176, heading northbound, feed into I-90, heading towards downtown Cleveland, creating a bottleneck situation in the AM peak period. Conversely, in the PM peak period, traffic heading towards these two freeways creates a lot of congestion upstream before splitting into their separate directions. In the AM peak period, the I-71 NB segment between W. 14th St. and I-90 EB has a V/C ration range of 0.99 to 1.14, a TTI range of 1.37 to 1.89, and an actual speed range of 23 to 45 mph. Also, in the AM peak period, the opposite direction along I-71 SB from I-90 EB to SR-176 SB has a V/C range of 0.97 to 1.17, a TTI range from 1.16 to 1.68 and an actual speed range of 23 to 36 mph. In the PM peak period, this southbound section of I-71 is also congested and actually begins upstream along I-90 WB, starting at the I-77 interchange. This segment has a V/C ratio range of 0.93 to 1.42, a TTI range of 1.11 to 4.21, and an actual speed range of 11 to 47 mph.

I-480/SR-176 Interchange Area

The ramps between I-480 and SR-176 are used by many commuters during both the AM and PM peak periods to travel to downtown Cleveland, as well as the job hubs along I-480, such as the Hopkins Airport area and Independence. More specifically, the ramps from I-480 WB to SR-176 NB and SR-176 SB to I-480 EB are the most congested during both peak periods. In the AM peak period, the I-480 WB Ramp to SR-176 NB has a V/C ratio ranging from 0.99 to 1.29, a TTI range from 1.18 to 2.57, and an actual speed range from 18 to 39 mph. In the PM peak period, this same segment is also congested with a V/C ratio range of 1.01 to 1.30, a TTI range of 1.21 to 2.68, and an actual speed range of 17 to 38 mph. The ramp in the opposite direction, from SR-176 SB to I-480 EB, is congested in both the AM and PM peak periods. In the AM peak period, the V/C ratio is 1.21, the TTI is 1.93, and the actual speed is 24 mph. In the PM peak period, the V/C ratio is 1.24, the TTI is 2.12, and the actual speed is 22 mph.

I-71/I-480 Interchange Area

Many trips destined for downtown Cleveland travel along I-71 and transfer from I-480 or SR-237, creating a lot of congestion where these three highways meet. In particular, the segment along I-71 NB just north of I-480 to W. 150th St. is quite congested because all traffic from I-71, I-480, and SR-237 converge on an NB path to downtown Cleveland. In the AM peak period, this segment has a V/C ratio of 1.08, a TTI of 2.23, and an actual speed of 28 mph.

I-77 between I-480 and I-80

I-77 between I-480 and I-80 is a busy portion of the interstate system, with many trips traveling NB to job hubs such as Independence and downtown Cleveland or heading SB to the I-80 turnpike and points outside the NOACA region. In particular, the SB segment of I-77 between Pleasant Valley Rd. and Wallings Rd. is quite congested in the PM peak period. It has a V/C ratio range of 1.00 to 1.11, a TTI range of 1.39 to 2.00, and an actual speed range of 31 to 45 mph.

I-480 between I-77 and I-271
I-480, between I-77 and I-271, is a highly traveled east-west highway corridor connecting eastern and western suburbs to nearby job hubs, such as Independence, Chagrin Highlands, and Solon. In the AM peak period, the ramp from I-77 NB to I-480 EB is congested with a V/C ratio of 1.17, a TTI of 1.69, and an actual speed of 28 mph. Not far to the east, there is another highly congested segment in the AM peak period along I-480 EB, specifically between Transportation Blvd. and Granger Rd. This segment has a VC ratio range of 0.96 to 1.20, a TTI range of 1.43 to 4.00, and an actual speed range of 16 to 45 mph. This same segment is also congested in the PM peak period with a V/C ratio range of 1.00 to 1.25, a TTI range of 1.60 to 5.47, and an actual speed range of 12 to 41 mph. Traveling back westward to the I-480 / I-77 interchange, the ramp from I-480 WB to I-77 SB is congested, with a V/C ratio of 1.35, a TTI of 3.23, and an actual speed range of 18 mph.

I-480/I-271 Corridor Area
I-480 and I-271 merge in southeastern Cuyahoga County to form one combined highway corridor for about a 4-mile stretch. Due to the convergence of these two major and highly-traveled highways, this area has many congested segments in both the AM and PM peak periods. In the AM peak period, the NB/WB segment between the I-480/I-271 merge and Broadway Ave. has a V/C range ratio of 0.95 to 1.10, a TTI range of 1.27 to 1.92, and an actual speed range of 32 to 49 mph. A few miles to the north, I-480 WB between the I-271 split and Rockside Rd. is also congested. This segment has a V/C ratio of 1.19, a TTI of 1.8, and an actual speed of 26 mph. In the PM peak periods, the SB/EB sections of this corridor become more congested. In particular, I-271 SB between the express lanes and the ramp from I-480 WB has a V/C ratio of 1.12, a TTI of 2.06, and an actual speed of 29. A short distance to the south, the I-480 EB segment between Rockside Rd. and I-271 merge is congested, with a V/C ratio of 1.14, a TTI of 1.56, and an actual speed of 30 mph.

I-77/I-490 Area
The I-77/I-490 interchange area is just south of the I-90/I-77 interchange area near downtown Cleveland. As a result, this area has many trips that lead to and from the downtown interchanges to the north. There are other trips that are seeking destinations to the east and west, such as points along the Opportunity Corridor to the east or I-490 to the west. In the PM peak period, the ramp from I-77 NB to the I-490 EB and WB ramps is quite congested. This segment has a VC ratio of 1.25, a TTI of 2.23, and an actual speed of 16 mph.

Interchange/Intersection Bottlenecks

Downtown Cleveland Area
Downtown Cleveland is the largest job hub in the NOACA region. With many workers traveling to and from the area in the AM and PM, as well as a growing residential population, traffic congestion is present at peak travel times. One such area of downtown Cleveland that has higher levels of congestion during peak times is the area near Playhouse Square and Cleveland State University on the eastern side of downtown Cleveland. In particular, four signalized intersections have high levels of congestion: two located on the city's traffic grid and two on the innerbelt freeway. The intersection of E 12th St and Euclid Ave is congested in the PM peak period with one approach,

southbound E. 12th St., having a V/C ratio value of above 3. In the AM peak period, none of the approaches are congested at this intersection. Just to the east, the intersection at E. 14th St. and Euclid Ave. is also congested in the PM peak period, with the eastbound approach having a V/C ratio of above 1.5. In the AM peak period, none of the approaches are congested at this intersection. Just to the south and adjacent to ramps leading to/from the innerbelt freeway, the intersection at E. 14th St. and Carnegie Ave is congested in the AM and PM peak periods. In the AM peak period, the northbound approach along E 14th St has a V/C ratio value of above 1.25. In the PM peak period, three approaches at this intersection have V/C ratio values above 1: northbound on E. 14th St., southbound on E. 14th St., and westbound on Carnegie Ave. On the eastern edge of downtown, the intersection of the eastbound I-90 exit ramp and Chester Ave. is also congested in both the AM and PM peak periods. In the AM peak period, the eastbound exit ramp has a V/C ratio above 2. In the PM peak period, this same ramp has a V/C ratio above 1.

University Circle Area

Like Downtown Cleveland, the University Circle area is one of the region's largest job hubs, and with that distinction comes traffic congestion during peak travel times. In particular, two signalized intersections are quite congested in the AM peak period: MLK Jr. Dr./Carnegie Ave. and Euclid Ave./East Blvd. At the MLK Jr. Dr./Carnegie Ave. intersection, two approaches are congested with V/C ratios above 1, specifically westbound Carnegie Ave. and northbound MLK Jr. Dr. At the Euclid Ave./East Blvd. intersection, two approaches are congested with V/C ratios above 0.85, specifically westbound Euclid Ave and eastbound Euclid Ave. In the PM peak period, one of the main entry points into the University Circle area, the Cedar Glen Pkwy./Cedar Rd./Euclid Heights Blvd. intersection, is congested. This signalized intersection has one approach with a V/C ratio above 0.85, specifically Cedar Glen Pkwy. eastbound. In the AM peak period at this intersection, Euclid Heights Blvd. westbound is congested, with a V/C value of 0.88.

I-271/Cedar Rd. Interchange

The I-271/Cedar Interchange is located along the border of the cities of Lyndhurst and Beachwood in eastern Cuyahoga County. This interchange is near large retail areas to the west, such as Beachwood Place and Legacy Village, as well as large office parks to the east. In the AM and PM peak periods, the signalized intersection at Cedar and the southbound ramp to I-271 is congested. In both time periods, both the eastbound and westbound approaches on Cedar Rd have V/C values above 0.85.

I-490/Opportunity Corridor/E. 55th St. Interchange

I-490 terminates at E. 55th St. in the City of Cleveland. At this location east-west highway turns into the Opportunity Corridor that leads to and from the University Circle job hub. In both the AM and PM peak periods, the signalized intersection of I-490/Opportunity Corridor/ramp to E. 55th St. is congested. Specifically, both the eastbound and westbound approaches along I-490 and Opportunity Corridor have V/C values above 0.85.

US-422/Harper Rd. Interchange

The US-422/Harper Rd. interchange, located in the City of Solon in southeastern Cuyahoga County, is the main entry point from the highway system to the Solon job hub along the Harper Rd./Cochran Rd. corridor. Large employers, such as Nestle, are located in close proximity to the interchange, which creates traffic congestion conditions. The signalized intersection where Harper Rd. meets the eastbound ramps is particularly congested in the PM peak period. Specifically, the northbound approach on Harper Rd has a V/C value of 1.97, indicating high levels of congestion. In the AM peak period, one approach has a V/C value above 0.85, specifically the eastbound exit ramp, and one approach has a V/C value close to 0.85, specifically northbound Harper Rd at 0.81.

US-422/Rapids Rd Intersection
The US-422/Rapids Rd intersection is located in Troy Township in southern Geauga Twp. This intersection is near where US-422 changes from a 4-lane divided highway to a 2-lane roadway. In both the AM and PM peak periods, this intersection is congested, with 2 approaches having high levels of congestion. Specifically, in both time periods, the eastbound and westbound approaches on US-422 have V/C values above 0.85.

US-322/Aquilla Rd Intersection
The US-422/Rapids Rd. intersection is located in Claridon Township in northern Geauga Twp. This is a signalized intersection where two one-lane roads meet in a rural area. In the AM peak period, this intersection has 1 congested approach, which is US-322 westbound. None of the approaches are congested in the PM peak period.

I-271/Ridge Rd. Interchange
The I-271 / Ridge Rd. Interchange is located in northeastern Medina County in Granger Township. This interchange mostly serves rural areas of the county, being located a few miles away from the largest urban areas in the county, such as the cities of Brunswick and Medina. In both the AM and PM peak periods, the intersection at the southbound exit ramp has congestion issues. In the AM peak period, the southbound approach on Ridge Rd. has a V/C ratio value above 2, which indicates an extremely congested situation during that time frame. In the PM peak period, all three approaches have V/C ratios above 1 (southbound and northbound on Ridge Rd. and the southbound exit ramp from I-271).

I-71/SR-18 Interchange
The I-71/SR-18 interchange is located in central Medina County along the Medina Township and Montville Township border, just east of the City of Medina. This interchange is one of the main access points to and from the City of Medina and thus has high traffic volumes along its ramps and along SR-18. In particular, the intersection at the northbound exit ramp is congested in both the AM and PM peak periods. In the AM peak period, this signalized intersection has two approaches with V/C ratios above 0.95, both on SR-18. The same two approaches are also congested in the PM peak period, with V/C ratio values above 1.

SR-10 /Butternut Ridge Rd./Chestnut Ridge Rd. Interchange
The SR-10/Butternut Ridge Rd./Chestnut Ridge Rd. interchange is located in southeastern Lorain County near the border of North Ridgeville and Eaton Township. Butternut Ridge Rd. and Chestnut Ridge Rd. run parallel to SR-10, with an access road connecting the interchange ramps to the two roadways. The unsignalized intersection of the eastbound ramps and the access road is congested in both the AM and PM peak periods. In the AM peak period, two approaches (the eastbound exit ramp and northbound access road) have V/C values above 0.85. The same two approaches have V/C values above 0.85 in the PM peak period as well.

SR-57/Styx Hill Rd./River Styx Rd. Intersection
The SR-57/Styx Hill Rd./River Styx Rd. Intersection is located in Guilford Township in southern Medina County, just northwest of the City of Wadsworth. This location is a 4-way intersection with multiple congested approaches in both the AM and PM peak periods. In the AM peak period, three out of four approaches have V/C values above 0.85 (SR-57 westbound, River Styx southbound, and River Styx northbound). In the PM peak period, traffic congestion is worse, with the same three approaches having V/C values above 1.

SR-57/S. Broadway St./Lafayette Rd.

The SR-57/S. Broadway St./Lafayette Rd. intersection is a 4-way stop located in the City of Medina, just south of Medina's historic square. In the PM peak period, two approaches have V/C values above 0.85 and 1 approach just below 0.78. The two congested approaches are Lafayette Rd. eastbound and Broadway St. southbound, and the approach at near congested levels is SR-57 westbound. In the AM peak period, the situation is somewhat improved but still congested, with only one approach, SR-57 westbound, having a V/C value of over 0.85.

Fuel, Delay, and Congestion Costs

As demand approaches the capacity of a freeway (or of the interchanges along the highway), extreme traffic congestion sets in. Traffic congestion impacts the operation and performance of the freeway, causing longer trip times, slower speeds, and increased delays. As traffic engineering and financial performance indicators, the combination of travel delay and wasted fuel due to congestion is considered the congestion cost.

This combined measure was calculated based on the following;

- Average fuel cost per gallon; this measure may be considered as the quotient of total daily Vehicle Miles Traveled (VMT) divided by total daily gasoline consumption.
- Median value of time per hour: According to the US Department of Transportation and other sources, the value of time measure is 30 to 60 percent of average earnings.
- Average Auto occupancy during peak and off-peak periods of a day.

Congestion Cost Estimation Procedure

The following steps are used to calculate the total congestion cost for the road segments in the influence subarea being considered.

- The ***average road segment delay*** is the difference between the estimated travel time under actual (often congested) conditions and uncongested conditions.

$$Average\ Road\ Segment\ Delay\ (hr) = \frac{Length\ of\ the\ road\ Segment\ (miles)}{Road\ Segment\ congestedspeed\ (mph)} - \frac{Length\ of\ the\ road\ Segment\ (miles)}{Free\ Flow\ Speed\ (mph)}$$

- The ***total delay on a road segment*** is the product of the average delay and total vehicles traveling this segment.

$$Road\ Segment\ Delay\ (hr) = Average\ Road\ Segment\ Delay\ \times Total\ Traffic\ Volume$$

- The ***road segment delay cost*** is calculated by multiplying the estimated road segment delay by the average passenger car occupancy and the occupants' average value of time.

$$Road\ Segment\ Delay\ Cost\ (\$) = Road\ Segment\ Delay\ \times Average\ auto\ occupancy\ \times Average\ Value\ of\ time$$

- Vehicles waste additional fuel when they are in congested conditions. The ***additional fuel consumed cost*** can be estimated using the delay and auto operating cost calculated below.

$$Road\ Segment\ Fuel\ Cost\ (\$) = Road\ Segment\ Delay \times Road\ Segment\ Congested\ Speed \times auto\ Operating\ cost$$

- The ***average auto operating cost*** is estimated by dividing the fuel cost per gallon by the average miles a vehicle can travel on one gallon of fuel.

$$Average\ Auto\ Operating\ Cost\ (\$) = \frac{Fuel\ Cost\ per\ gallon}{Average\ miles\ a\ vehicle\ can\ travel\ on\ one\ gallon\ of\ fuel}$$

- Finally, the ***total road segment congestion cost*** comprises two elements: delay cost and fuel cost.

$$Road\ Segment\ Congestion\ Cost\ (\$) = Road\ Segment\ Delay\ Cost + Road\ Segment\ Fuel\ Cost$$

Table 3-23 displays the estimated 2024 daily and annual congestion costs.

Table 3-23. Estimated 2024 Daily and Annual Congestion Costs

Cost Item	Unit	Estimated 2024 Value
Daily Wasted Fuel	Gallon	79,000
Daily Wasted Fuel Cost	2024$	223,000
Total Daily Delay	Hour	74,000
Total Daily Delay Cost	2024$	1,445,000
Total Daily Congestion Cost	2024$	1,668,000
Total Annual Congestion Cost	2024$	485,273,000

<u>Assumptions</u>
Fuel Cost per Gallon (2024$): 2.83
Average Traveled Miles per Gallon: 20.65
Average Values of Time (2024$): 15.50