

# Northeast Ohio Job Hub Connectivity Demonstration Grant

Northeast Ohio Areawide Coordinating Agency

Cleveland, OH

March 21<sup>st</sup>, 2019

US Department of Transportation

Automated Driving Systems Demonstration Grant

The Northeast Ohio Job Hub Connectivity Demonstration Project is a great way to help the regional economy grow and enable all residents to participate. The Brookings Metropolitan Policy Program recently found that Greater Cleveland has seen the biggest decline in the number of jobs near a resident between 2000 and 2012; while this was the study period, it is likely the trend has continued. As a result, it is harder for job seekers to find and maintain employment. This is especially true for people of color and people in poverty. The number of nearby jobs for residents of high-poverty neighborhoods has declined an astonishing 31%, and 25% of African American residents don't own a personal vehicle.

The project seeks to provide services to three of the largest job hubs in the region. NOACA will operate shuttles from rail stations to the job hub, providing a critical link to work. For transit-dependent populations, a lack of a last mile connection from a fixed rail line to places of employment can prevent them from being able to apply for and hold these jobs. Even for residents who do own personal vehicles, transit use is discouraged if they cannot easily access jobs from the transit endpoints. This project will enable them to do so, helping to improve safety, reduce congestion, and improve air quality. It will also help residents of the suburban job hubs access the downtown employment center, which is the largest job hub in the region.

In doing this, the project will help all residents, especially those living in poverty, access and keep good paying jobs – many of the employers in the hub are manufacturers who pay wages much higher than the regional average. Federal funding from this grant will play a key part in reducing poverty by helping residents of job-starved environmental justice areas reach previously inaccessible employment.

Just as importantly, SAVE-NOACA's Plan for Transportation Safety, set for release this year, aspires to reduce fatalities and serious injuries resulting from crashes by 50% by the year 2040 for the five-county region. Over 130 lives per year are currently lost in Northeast Ohio as the result of traffic crashes. Automated vehicles present one of the best opportunities for reducing traffic fatalities since most deaths are the result of human error. This demonstration grant will allow NOACA, other stakeholders, and the public at large to begin turning the SAVE Plan's vision of a safer future into reality.

Initial funding of the NOACA Job Hub Connectivity Demonstration Project could be a springboard to advance automated driving technologies to the greatest extent possible. The region encompasses dense street grids of Cleveland, inner and outer ring suburban collectors and arterials, and rural township roads, even some that are gravel. We have a large and growing cycling network, local roads with over 2,000 tractor-trailers per day, and one of the largest Amish populations in the nation, who travel by horse and buggy. Our weather encompasses four distinct seasons that are able to replicate conditions across most of the country. We will work with USDOT to create the best learning opportunity possible while also providing crucial connections to jobs that help lift residents out of poverty.

<b>Summary Table</b>	
Project Name/Title	Job Hub Connectivity Demonstration Project
Eligible Entity Applying to Receive Federal Funding (Prime Applicant’s Legal Name and Address)	Northeast Ohio Areawide Coordinating Agency 1299 Superior Ave. Cleveland, OH 44114
Point of Contact (Name/Title; Email; Phone Number)	Randy Lane, Director of Programming; <a href="mailto:rlane@mpo.noaca.org">rlane@mpo.noaca.org</a> ; (216) 241-2414
Proposed Location (State(s) and Municipalities) for the Demonstration	Ohio; Cities of Beachwood, Brook Park, Cleveland, North Randall, Shaker Heights, Solon
Proposed Technologies for the Demonstration (briefly list)	Automated shuttle service technology
Proposed duration of the Demonstration (period of performance)	Four years, 2020-2023
Federal Funding Amount Requested	\$6,300,000
Non-Federal Cost Share Amount Proposed, if applicable	\$100,000
Total Project Cost (Federal Share + Non-Federal Cost Share, if applicable)	\$6,400,000

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# Project Narrative and Technical Approach

## Executive Summary

### Vision, Goals, and Objectives

The Northeast Ohio Job Hub Connectivity Demonstration Project is a great way to help the regional economy grow and enable all residents to participate. The Brookings Metropolitan Policy Program recently found that Greater Cleveland has seen the biggest decline in the number of jobs near a resident between 2000 and 2012.<sup>1</sup> This study was conducted with the most recent data as of 2015, but it is likely the trend has continued. As a result, it is harder for job seekers to find and maintain employment. This is especially true for people of color and people in poverty. The number of nearby jobs for residents of high-poverty neighborhoods has declined an astonishing 31%, and 25% of African Americans residents don't own a personal vehicle.

NOACA has identified six main job hubs in the five-county region. "Each hub has at least 10,000 jobs, equivalent to roughly 1% of the Cleveland MSA's total employment of approximately one million jobs. The six hubs equal only 24% of the region's employment, indicating that job sprawl is extensive. Moreover, the residential location of workers for each job hub is also widely distributed throughout the region".<sup>2</sup> By focusing on these locations for our demonstration, we are not just testing technology, we are also providing a vital service to spur economic development.

The project seeks to provide automated shuttle services to three of the largest job hubs in the region. NOACA will operate shuttles from rail stations to the job hub, providing a critical link to work. For transit-dependent populations, a lack of a last mile connection from a fixed rail line to places of employment can prevent them from being able to apply for and hold these jobs. Even for residents who do own personal vehicles, transit use is discouraged if they cannot easily access jobs from the transit endpoints. This project will enable them to do so, helping to improve safety, reduce congestion, and improve air quality.

In doing this, the project will help all residents, especially those living in poverty, access and keep good paying jobs – many of the employers in the hub are manufacturers who pay wages much higher than the regional average. Federal funding from this grant will play a key part in reducing poverty by helping residents of job-starved environmental justice areas reach previously inaccessible employment.

Specifically, NOACA will operate shuttles from the eastern termini of the Greater Cleveland Regional Transit Authority (GCRTA) rail, known as the Blue Line. This route runs from Downtown Cleveland through many east-southeast neighborhoods that are predominantly

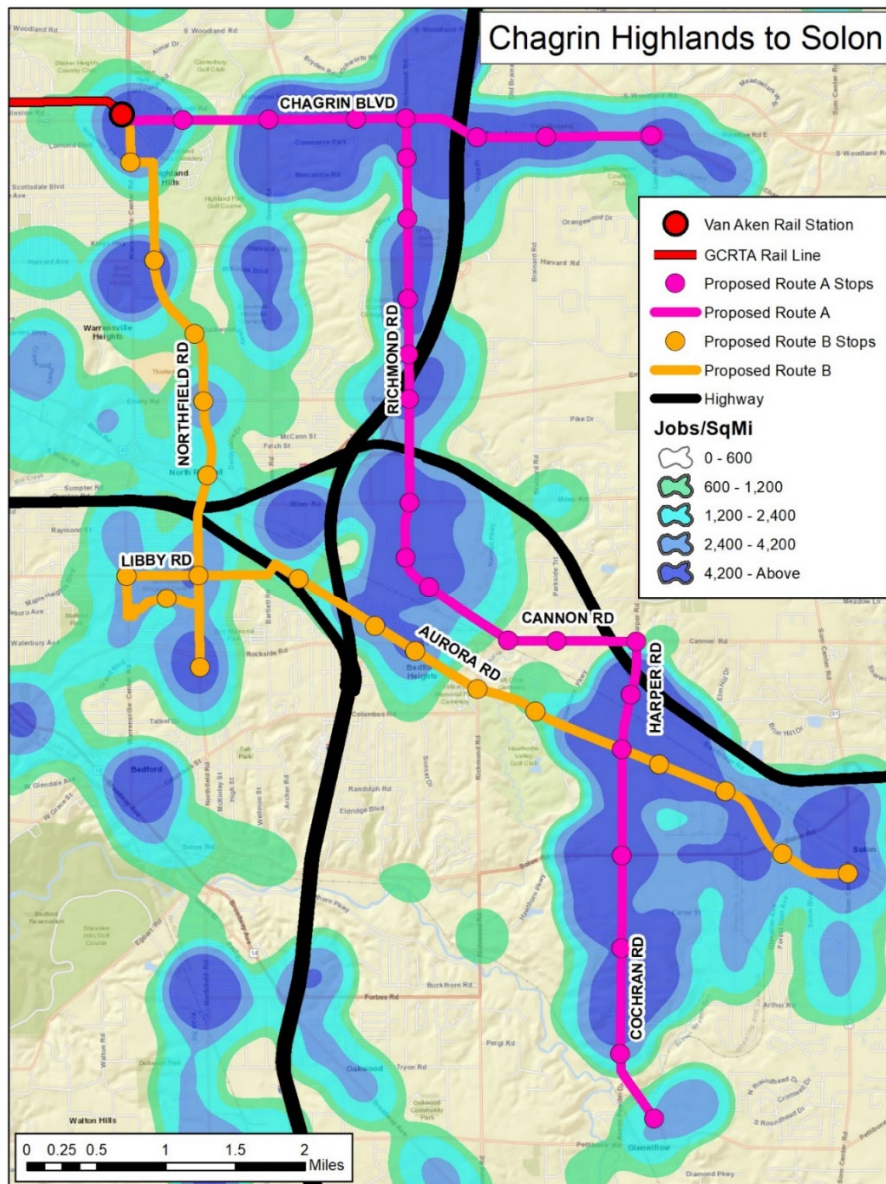
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<sup>1</sup> Kneebone, Elizabeth. *Job Sprawl Stalls: The Great Recession and Metropolitan Employment Location*. The Brookings Metropolitan Policy Program. [https://www.brookings.edu/wp-content/uploads/2016/06/Srvy\\_JobSprawl.pdf](https://www.brookings.edu/wp-content/uploads/2016/06/Srvy_JobSprawl.pdf). April 2013. (pdf accessed 3/15/19)

<sup>2</sup> NOACA Research Brief: Major Employment Hubs in the Cleveland MSA. <http://noaca.org/modules/showdocument.aspx?documentid=19855>. December 2016. (pdf accessed 3/15/19).

African-American and have many residents in poverty; every stop on the Blue Line is in or adjacent to an environmental justice community. The shuttles will run south to the job hubs known as Chagrin Highlands and Solon-Cochran Corridor. Three of the six job hubs showed job growth from 2004-2014 despite the Great Recession, and these are two of them. Solon-Cochran is the third largest hub and grew by 28% over the period. Chagrin-Highlands is the fourth largest hub and grew by 12.5%.<sup>3</sup> These hubs have benefited from proximity to interstates, with many employers growing or relocating in them. However, this easy highway access does not help residents who lack reliable personal vehicles. Our shuttle service will connect these disadvantaged residents with previously inaccessible high-paying suburban job opportunities.

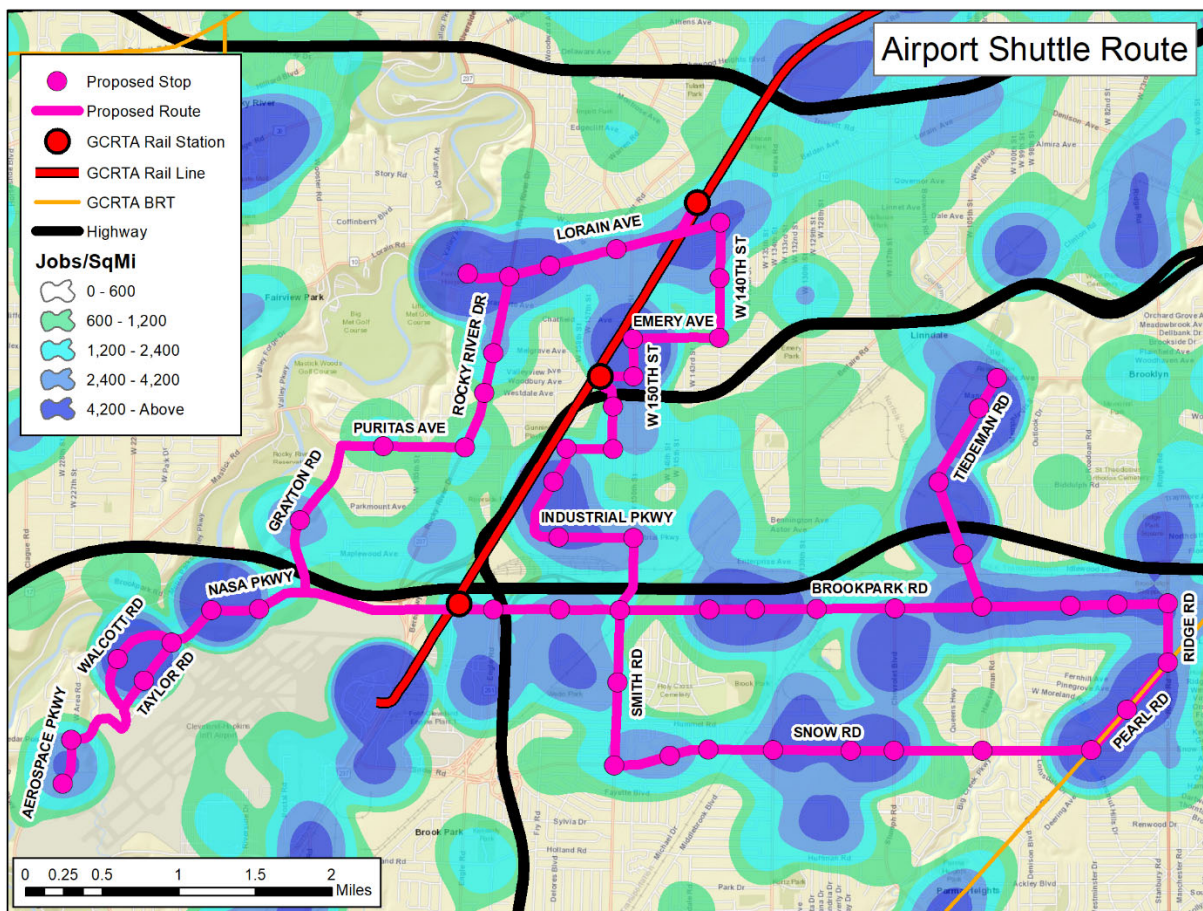
Map 1: Eastern Job Hub Shuttle – Chagrin Highlands / Solon



<sup>3</sup> Ibid 2. P17,19.

On the west-southwest side of Cleveland, we will run a shuttle around Cleveland-Hopkins International Airport, connecting the GCRTA Red Line with several employers in the area. Like the Blue Line, the Red Line runs from Downtown Cleveland through several environmental justice communities where residents may lack access to personal vehicles. This shuttle service will connect rail stations with manufacturing and other jobs around the airport. The Aerozone Alliance, which is a collaboration between the airport itself, NASA Glenn Research Center, and the cities of Berea, Brook Park, Cleveland, Fairview Park, and North Olmsted, is already exploring opportunities to better connect workers and jobs in the vicinity of the airport and may be able to financially contribute to a shuttle route in the future; NASA actually run its own shuttle. The airport job hub unfortunately shrank by 16.3% from 2004-2014, with manufacturing accounting for two-thirds of all job losses. This was due to a variety of factors – continued automation and outsourcing in the industry, as well as the recession being particularly harmful for these industries. An automated shuttle that better connects the hub and area residents could help reverse this decline.<sup>4</sup>

Map 2: Western Job Hub Shuttle – Cleveland Hopkins International Airport



The Aerozone Alliance is working with the Cuyahoga County Workforce Development Board; Team NEO, a regional economic development organization; and the Greater Cleveland Partnership, a regional chamber of commerce. These organizations are leveraging the airport,

<sup>4</sup> Ibid 2. P23.

NASA research, and the Red Line connection to Downtown Cleveland to grow the job hub focusing on new technologies. Additionally, NOACA is currently engaged in a public-private partnership with Hyperloop Transportation Technologies, a California-based but worldwide organization, on a first of its kind hyperloop feasibility study. One objective of the study is to determine if the airport job hub could be the location of a hyperloop station. It makes perfect sense that the new technology of automated vehicles should be tested here, as it may create further opportunities for collaboration among researchers and engineers to create a mobility hub of the future with brand new technologies.

Just as importantly, SAVE, NOACA's Plan for Transportation Safety, set for release this year, aspires to reduce fatalities and serious injuries resulting from crashes by 50% by the year 2040 for the five-county region. Over 130 lives per year are currently lost in Northeast Ohio as the result of traffic crashes. Automated vehicles present one of the best opportunities for reducing traffic fatalities since most deaths are the result of human error. This demonstration grant will allow NOACA, other stakeholders, and the public at large to begin turning the SAVE Plan's vision of a safer future into reality. Our project provides unique opportunities to advance the safety mission, explained below.

For this demonstration grant, the "last mile" connecting rail transit service to job hubs is actually as much as twelve miles. Existing automated shuttle services across the country are typically in the one mile range. With these existing short distances, there are naturally fewer turning points, intersections, and opportunities for interaction with pedestrians, cyclists, and the built environment. This project will therefore present USDOT with an opportunity to gather data on automated vehicles at unprecedented scale. With these longer distances, we will also be seeking to utilize faster automated vehicles than currently in use. Since we are proposing a four year project period, this gives the vehicle manufacturers an opportunity to further develop and refine the technology that will enable these higher speeds.

Additionally, the region has a variety of seasonal climates that will help advance the knowledge of automated vehicle operations in inclement weather. An average year has 161 days with precipitation of some sort. Cleveland typically sees 39 inches of rain per year. Northeast Ohio is known as the "snow belt" due to heavy snowstorms that often happen as the result of being on the shore of Lake Erie; Cleveland averages 68 inches of snow per year.<sup>5</sup> Due to the geography, this is even truer on the east side, where one of our demonstrations will take place – it is not uncommon to see several additional feet of snow. Cleveland weather, depending on the season, provides a microcosm of most climatic regions across the country. Testing automated vehicles in these varied conditions will provide USDOT with the best opportunity to collect the data necessary for the national implementation of automated vehicles.

To best ensure success of the project, study different elements of the technology, and provide crucial linkages to jobs, we are seeking funding for a four year project. The first six months will be used for extensive planning, further stakeholder engagement, and modeling simulations of the shuttle service. We will use this period to issue a public request for proposals to select a

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<sup>5</sup> Data comes from the National Weather Service Forecast Office, a division of the National Oceanic and Atmospheric Administration. The data station is at Hopkins International Airport, one of our hubs <https://w2.weather.gov/climate/xmacis.php?wfo=cle>



highly qualified automated vehicle provider who is able to collect and share data from the vehicles with us and USDOT. This planning period will enable us to design routes that are best tailored to help USDOT collect more data on the technology itself while still connecting workers with job hubs. We will consider specific roads based on factors such as traffic volume, speed limits, lane width, signal density, opportunity for bicycle and pedestrian interaction, and other relevant factors. We will then determine specific stops that optimize the number of riders.

The remaining time will then be used to implement the results of this analysis and collect data through the physical demonstration of running shuttles. The longer period will enable learning that allows both the public and private sectors to further refine methods and technologies that lead to the greatest gains in safety and automated vehicle deployment. As an additional benefit, over three years of reliable access to good-paying jobs may enable many of the shuttle riders to maintain continuous employment, secure affordable and stable housing, save wages, and invest in their future. Our goal is to run shuttles during the morning and peak period commutes to best connect workers and jobs, but we will work with USDOT to run at other times of the day to the extent that is valuable from a data collection standpoint.

After the four year project period, we then hope to eventually expand the demonstration into a permanent offering both for these job hubs and possibly others. Additionally, the NOACA region covers a diversity of landscapes and development patterns. The six job hubs identified in our analysis are the largest in the region, and they are all in Cuyahoga County. In many other parts of the five county region there are smaller hubs that are nonetheless very important to those communities, especially in rural areas – essentially all or a large part of three of the five counties are outside the urbanized area boundary. These areas are not suitable for traditional transit services due to their low population densities and greater distances. However, targeted shuttles on one or two key routes may provide a vital lifeline to connect people and jobs, particularly low-income rural residents. NOACA, if desired, would continue to work with USDOT and share data on these diverse projects.

Initial funding of the NOACA Job Hub Connectivity Demonstration Project could be a springboard to advance automated driving technologies to the greatest extent possible. The region encompasses dense street grids of Cleveland, inner and outer ring suburban collectors and arterials, and rural township roads, even some that are gravel. We have a large and growing cycling network, local roads with over 2,000 tractor-trailers per day, and one of the largest Amish populations in the nation, who travel by horse and buggy. Our weather encompasses four distinct seasons that are able to replicate conditions across most of the country. This initial project will not cover all of these elements, but we will work with USDOT to create the best learning opportunity possible while also providing crucial connections to jobs that help lift residents out of poverty.

### **Key Partners**

NOACA proposes to engage a number of partners and stakeholders within the county, cities, and other organizations to make the demonstration project a success.

### **Primary and Secondary Stakeholders**

**Cuyahoga County** – Cuyahoga County is the county government in which NOACA and all stakeholders involved are located. Cuyahoga County is included in the Cleveland-Elyria, OH

Metropolitan Statistical Area. The county will serve as a convener with NOACA as well as a data source as project tasks get underway.

**City of Cleveland** – The city of Cleveland is the largest city that is part of the footprint of this project. It is the County seat for Cuyahoga County. The Cleveland Hopkins Airport is owned and operated by the city. This project looks to connect more city of Cleveland residents to the East and West job hubs.

**City of Brook Park** – The city of Brook Park is home to the International Exposition Center and the NASA Glenn Research Center. Both of these locations along with the airport are major employment drivers in the western job hub. Input from the city will be critical for decision making about shuttle stops and placement.

**City of Shaker Heights** – Shaker Heights is an inner-ring streetcar suburb of Cleveland, abutting the eastern edge of the city's limits and where the Blue Line Rapid stop being identified on Map 1 is located. The city is a key stakeholder due to the fact that the location of the transit stop to connect to the shuttle service is located here.

**City of Beachwood** - The City of Beachwood is an outer ring suburb of Cleveland, abutting the southeastern edge of the city's limits. The city is a key stakeholder because some of the proposed stops are located here.

**City of Solon** – The city of Solon is an outer suburb of Cleveland. It is part of Northeast Ohio's combined Cleveland-Akron-Canton metropolitan area, the 15th-largest Combined Statistical Area in the country. Solon has grown rapidly over the years due to residential and economic development. As a result of this growth, Solon has become a southeast job hub between Cleveland and Akron, and it has become necessary to make this job hub more accessible than it is currently.

**DriveOhio** – DriveOhio is an initiative of the Ohio Department of Transportation that facilitates collaboration between the public and private sectors, serving as the single point of contact for all things autonomous and connected in Ohio. It works to advance smart mobility in Ohio and being a one-stop shop for those looking to develop, test, and deploy advanced mobility solutions. DriveOhio will serve as technical expertise for the duration of the project.

**ODOT** - The Ohio Department of Transportation is the administrative department of the Ohio state government responsible for developing and maintaining all state and federal roadways in the state of Ohio with exception of the Ohio Turnpike. In addition to highways, the department also helps develop public transportation and public aviation programs. ODOT is a partner to ensure and allow the pilot shuttles to move along state owned and maintained thoroughfares.

**The Aerozone Alliance** - The alliance is a regional partnership created to drive job growth and wealth creation in Northeast Ohio. The partnership includes Cuyahoga County, Cleveland-Hopkins International Airport, NASA Glenn Research Center, as well as the communities of Berea, Brook Park, Cleveland, Fairview Park and North Olmsted. This stakeholder organization is to ensure the communities of the western cities as mentioned above are properly represented.

**Team NEO** - Team NEO is a business development organization focused on creating jobs for Northeast Ohio residents. It leads the region's business attraction efforts, supports business retention and expansion work as Northeast Ohio's JobsOhio affiliate. In addition, Team NEO provides tools to assist employers in attracting talent to the region. This partnership will help NOACA and other stakeholders with accurate data preparation and identifying businesses with workforce needs.

NOACA will form a consortium of all stakeholders that will elicit comments, discussion and guidance during the duration of the project. Some stakeholders may be added later to cover any gaps in representation and/or geography. All partnerships have not been fully vetted at the time of this submission. However, if the project is funded, cooperative agreements and/or memorandums of understanding will be executed.

### Issues and Challenges

As explained throughout this application, we hope not just to test vehicle automation but also connect workers and jobs. In the 1950s, Cleveland was one of the largest cities in the country, with 914,808 people. By 2017, this was down to 385,525, a decline of nearly 58%. Conversely, the Cuyahoga County population in that same time period declined less than 8%, from 1,389,532 down to 1,280,122. In other words, the county population is far more spread out than it once was. The city has been in a cycle where job losses lead to population losses which lead to further job losses. The result is that people and jobs are now much more dispersed throughout the county.

NOACA has both a Business Advisory Council and a Community Advisory Council. These are stakeholders from across the private and public sectors – businesses, economic development officials, developers, workforce agencies, unions, and others – who provide NOACA with input on priorities, plans, and policies. Both councils have been repeatedly stressing that an inability to hire and retain workers is a lag on the regional economy that prevents businesses from growing, and a lack of worker mobility is a big reason for this. The Job Hub Connectivity Demonstration Grant is just one way in which NOACA hopes to address the problem, and it has the potential to be the most impactful.

This project will demonstrate automated and connected, self-driving shuttle technology to solve the mobility challenges identified in this proposal. Deploying this technology will allow significantly increased access to employment opportunities for northeast Ohio residents, to major job hubs. The project will primarily benefit those residents that cannot afford, or do not have the ability, to drive a personal vehicle to their place of employment.

The project will create a seamless and integrated transportation solution that acts to extend existing public transit rail lines, at a fraction of the capital and operating cost of new rail or fixed route transit lines. Furthermore, the success of this project will serve as a model for connecting other job centers in the region and beyond, while showcasing for visitors a hands-on educational experience with self-driving technology.

## Geographic Area

NOACA is proposing shuttle routes on the west and east sides of the Greater Cleveland region, in Cuyahoga County. The downtown area is already extensively served by the hub and spoke transit network of both bus and rail. The proposed routes connect several existing and/or underdeveloped employment centers to the existing rail stations. In fact, the shuttles will function as feeder transit lines to the existing main rail lines and provide walking access to riders from the major job hubs to transit rail lines.

Specifically, the east side shuttle will potentially operate on streets in the cities of Beachwood, Bedford Heights, Shaker Heights, Solon, and Warrensville Heights, and the villages of Highland Hills, Orange, and Woodmere, although it will not necessarily stop in all of these. The GCRTA blue rail line currently is terminated in Shaker Heights at the Van Aken rail station in the Chagrin Highland area. The Solon manufacturing job hub is one of six major job hubs in the NOACA region and located a few miles south of this Van Aken rail station. The proposed shuttle service will provide a connection from this station to the Solon job hub. In addition to connecting this job hub to the existing rail lines, the shuttle service will be used by low income workers living in this area and working in the Solon job hub. The other existing employment centers, shown on Map 1, such as an Amazon distribution center, Eaton Corporation headquarters, University Hospitals, and Thistledown Racino will be connected and their employees will be able to use the shuttle service for their daily commute.

Similar to the Chagrin Highlands –Solon shuttle route, the Hopkins International Airport shuttle service will connect another major job hub to the rail line network. The route will possibly pass through or have stops in the cities of Brooklyn, Brookpark, Cleveland, and Parma. This shuttle route will connect several vital employment and industrial centers such as NASA Glenn Research Center, aerospace facilities, a Ford engine plant, a General Motors facility, and other major employers to three rail line stations. This shuttle service will function as an internal transit service for the Airport job hub, provide services to employers, and connecting their employees to other major job hubs via the existing rail network.

NOACA is planning to implement a route simulation task during the first six months of the project. This task will simulate traffic along the proposed shuttle routes to analyze the interaction between the shuttle services and other vehicles and also other traffic characteristics such as speed, delay, etc. along the shuttle route. Outputs of the NOACA travel forecasting model will be utilized to extract a set of necessary data for simulating traffic. NOACA will use the VISSIM platform to simulate and analyze the before and after traffic situations and impacts of the shuttle services.

## Period of Performance

NOACA is seeking a four year demonstration grant and will adhere to the milestones and deliverables put forth by USDOT starting on page nine of the NOFO.

Year 1 Summary – Complete the Project Management Plan (PMP), Data Management Plan, Project Evaluation Plan, Request for Proposals (RFP), Vendor Operator Agreement, Implementation Plan.

Year 2-4 Summary – Physical Demonstration, operation of shuttles at identified location in accordance with implementation plan.

The proposed detailed schedule for the project performance period and required milestones and deliverables is contained below. This schedule assumes an ADS funding award announcement of May 1, 2020 and will be adjusted accordingly based on the actual date.

<b>Task / Deliverable</b>	<b>Estimated Time frame</b>	<b>Duration</b>
ADS Program Funding Announcement	May 1, 2019	1 day
Kick-off Meeting with USDOT	May 1, 2019 – May 22, 2019	3 weeks
Project Management Plan (PMP)	May 23, 2019 – June 6, 2019	2 weeks
Data Management Plan	May 1, 2019 – July 1, 2019	60 days
Project Evaluation Plan	May 1, 2019 – August 1, 2019	90 days
Develop a Request for Proposals (RFP) for Shuttle Operator	August 1, 2019 – September 1, 2019	30 days
Advertise RFP in accordance with federal procurement requirements (21 days) and contract with Vendor Operator	September 1, 2019 – November 1, 2019	60 days
Develop Implementation Plan with Selected Vendor Operator. Plan will finalize routes, frequency, data collection and reporting, stakeholder involvement, sponsor responsibilities, and procedures for operation.	November 1, 2019 – May 1, 2020	6 months
Physical Demonstration – Begin Shuttle Operation	May 1, 2020 – May 1, 2023	3 years
Quarterly Progress Reports	Quarterly, from May 1, 2019 – May 1, 2023	Within 30 Days of the end of each Quarter
Annual Budget Review and Program Plan	March 1, 2020; March 1, 2021; March 1, 2022; March 1, 2023	60 days prior to Anniversary date of Award

## Goals

### Safety

NOACA intends to test safe integration of ADS into the Nation’s on-road transportation system by partnering with an autonomous vehicle manufacturer that will provide 12-15 person shuttles able to operate lawfully on public roads where service is proposed. NOACA anticipates that the

grant will demonstrate how challenges related to operating speeds, lane changes, turning conflicts, recognition of signal phasing, and conflicts with other modes such as cyclists and pedestrians will be identified and processed with absolute reliability. By operating autonomous vehicles on heavily-traveled street networks around the region's job hubs, it is anticipated that shuttles will experience the full range of real-world challenges faced by human drivers.

#### Data for Safety Analysis and Rulemaking

NOACA understands one of the primary purposes of this grant is to generate significant data gathering for the purposes of sharing it with USDOT and the general public, in order to leverage USDOT's investment in ADS by allowing others to analyze and learn concurrently from the data created by the project to further innovation in this rapidly changing field. Data and information will be provided to identify risks, opportunities, and insights relevant for USDOT safety and rulemaking priorities that will be needed to remove governmental barriers to the safe integration of ADS technologies. Ohio has taken a step forward in promoting ADS testing with the signing of an Executive Order by former Governor John Kasich on May 9, 2018, authorizing autonomous vehicle testing in Ohio.

Safety metrics characterizing the safety risk of ADS must consider the range of sensing needed to automate the driving task. The safety performance metrics need to monitor the number of correctly (safely) processed inputs from the vehicles sensors over an extremely large number of repetitions in order confirm the sensory metric is reliably safe. The ultimate safety metric will be the comparative crash rate per million miles traveled for the vehicles traveling in autonomous mode versus normal human drivers. It is expected that once autonomous driving systems are perfected, that they will outperform human drivers.

Data must be collected to measure the performance of each one the autonomous vehicles sensory input systems to verify the input has been successfully identified. If successful, NOACA intends to partner with the manufacturer of autonomous shuttles and the vendors supplying their sensory subsystems to determine what data can be collected in order to determine safety metrics that support the overall performance metric reflecting the vehicles crash performance, particularly when the autonomous vehicle is at fault.

By adding to the number of vehicle-miles logged by the autonomous shuttles, the demonstration will generate a data set that can be used to establish a baseline for human safety, based on the number and severity of crashes involving the autonomous vehicles and its co-pilot/passengers in instances where the co-pilot does not override the vehicles controls, or doesn't override them quickly enough to avoid a collision. The demonstration will also generate data to track the performance of all the input systems feeding into the autonomous driving tasks to identify unreliable performance of sensory systems during certain driving conditions, such as driving on snow-covered roads when lane markings and edge lines are obscured.

By analyzing the operational data of the autonomous vehicles systems, it is expected that troublesome conditions for reliable operation will emerge, and the identification of these conditions would enhance future safety analyses by directing more resources into the research

and development of better systems, ultimately leading to full autonomy in operation of vehicles.

This demonstration is expected to focus on light duty vehicles, considering 12-15 passenger shuttles more like conventional vehicles than heavier trucks and commercial vehicles.

#### Collaboration

As seen in our stakeholder list, our demonstration project includes a variety of public and private stakeholders. DriveOhio is leading efforts across the state related to automated vehicles. We will work closely with them to apply lessons already learned in other parts of the state while using their wide network to share our own data and analysis.

Team NEO and other economic development organizations, such as local and regional chambers of commerce, may help connect us with individual businesses or industrial parks. We can learn where their existing employees are coming from and identify areas of need. As mentioned earlier, NOACA has Business and Community Advisory Councils. They were specifically created to represent business, workforce, non-profit, and other agencies in the transportation planning process. The councils have quarterly meetings, and NOACA will use these as opportunities to regularly engage stakeholders, share progress, identify challenges and opportunities, and refine shuttle routes if needed.

The NOACA Intelligent Transportation System (ITS) architecture is currently being updated and will play a role as well, as one of the key components is fostering the safe adoption of autonomous vehicles. The ITS Steering Committee includes, among others, the Cuyahoga County Emergency Management Agency, Cuyahoga County Fire Chief's Association, State Highway Patrol, the US Department of Homeland Security, and multiple county sheriffs from the region. We will lean on their expertise to ensure shuttles operate safely and can communicate with first responders if necessary.

NOACA has both a Transit Planner and a Mobility Manager who are key members of this project team. They will work regularly with seniors, disabled residents, and all transportation-challenged populations to ensure their needs are being met and that shuttle services are accessible for them.

The 2018 NOACA Annual Meeting had a presentation from an engineering professor at Cleveland State University titled "Educating Transportation Engineers as Vehicle Technology Advances" that was focused on the implementation and adoption of automated vehicles. Case Western Reserve University, also located in Cleveland, launched the Institute for Smart, Secure, and Connected Systems (ISSACS) in 2016 that is specifically engaged in developing advanced technologies like those used by connected vehicles and infrastructure. During the first six months of the project, NOACA will engage these educational institutions to discuss opportunities for collaborating on the rest of our demonstration.

## Focus Areas

### Significant Public Benefit

Automated vehicles have the potential to bring about transformative safety, mobility, energy, and environmental benefits to our nation's surface transportation system. These benefits could include crash avoidance, reduced energy consumption and vehicle emissions, reduced travel times, improved travel time reliability and multi-modal connectivity, and improved transportation system efficiency and accessibility, particularly for persons with disabilities and the growing aging population.<sup>6</sup>

In Northeast Ohio these benefits can provide:

- Last mile connection to East and West job hubs that are currently difficult to access
- Increase efficiency of transit systems by not stretching the system out so far that travel time is excessive
- Congestion reduction – fewer cars on the road during high commute times
- Broader access to job and shopping opportunities due to the combined effects of lessened congestion
- Energy, security, and environmental benefits with reductions in gasoline and diesel consumption from reduced congestion
- Improved opportunities could lead to higher earnings and improve quality of life
- Increased mobility for Seniors and individuals with disabilities

These public benefits should be the basis for public policies to support and accelerate deployment of AVs.<sup>7</sup>

### Market Failure and Other Needs

Transportation costs are second only to housing for the average household in the United States, and are a greater burden for individuals travelling long distances to and from work. For zero-car households, providing access to alternative modes of transportation is vital not only to job access, but to overall quality of life. Metropolitan development and land-use patterns have created a rise in decentralized job hubs while most affordable housing remains in urban neighborhoods and inner ring suburbs. In turn, households without personal vehicles must weigh public transit access alongside housing affordability and job location.

First and last-mile links to public transit are essential in increasing accessibility to more homes, jobs, and other destinations. Distance from public transit stops to destinations is a major barrier for many users, while gaps in sidewalk networks, lack of crosswalks or bike lanes, and unsafe waiting areas contribute to additional accessibility concerns. Without solutions to these issues, transit-dependent populations (which disproportionately include minorities, seniors, and individuals with disabilities) can face long-term social and economic exclusion.<sup>8</sup> Traditionally

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<sup>6</sup> <https://www.its.dot.gov/factsheets/AutomationUSDOT.htm>

<sup>7</sup> Public and Private Benefits of Autonomous Vehicles, W David Montgomery, PhD June 2018

<sup>8</sup> Center for Transit-Oriented Development. (2014) "Creating Connected Communities: A Guidebook for Improving Transportation Connections for Low and Moderate-Income Households in Small and Mid-Sized Cities." U.S. Department of Housing and Urban Development, Washington, DC.



transportation systems’ performance was measured by a singular indicator: congestion mitigation. But from an equity standpoint, safety, environmental impact and accessibility must be evaluated as well.<sup>9</sup>

### Economic Vitality

As a so-called “Rust Belt” region, Cleveland has long been a manufacturing powerhouse. Even today, despite decades of automation and outsourcing, Cleveland and its suburbs are still places where things are made. The central city and the suburbs at either end of our proposed automated shuttles all have significantly more workers engaged in manufacturing than the nation as a whole.

Table 1: Manufacturing Workforce

Location	Percentage of Workforce in Manufacturing
United States	10.3%
Brookpark (west side termini)	14.4%
Cleveland	13.5%
Solon (east side termini)	13.9%

Source: American Communities Survey 5-Year Estimates 2013-2017. United States Census Bureau.

Importantly, manufacturing businesses pay wages far higher than the regional average, so connecting workers and potential workers with them is a great way of reducing poverty and improving quality of life, especially for residents currently in poverty. The NOACA Multimodal Regional Freight Plan, written in 2017, took an in-depth look at wages by industry and explained how manufacturing jobs, even though less prevalent than they used to be, still play a key role in the region. Using data from the Census Bureau and Ohio Department of Jobs & Family Services, we see that the average earnings for a regional resident were \$30,561. However, the annual wages across manufacturing industries was \$59,498.<sup>10</sup>

Unfortunately, residents of all communities do not share equal access to these jobs. Cleveland residents are unemployed at more than double the rate of residents of the western end of our proposed shuttle, and as six times the rate of the eastern end.

Table 2: Unemployment Rate

Location	Unemployment Rate
United States	6.6%
Brookpark (west side termini)	7.2%
Cleveland	16.0%
Solon (east side termini)	2.7%

Source: American Communities Survey 5-Year Estimates 2013-2017. United States Census Bureau.

<sup>9</sup> Karner, Alex, Dana Rowangould and Jonathan London. (2016). “We Can Get There from Here: New Perspectives on Transportation Equity.” National Center for Sustainable Transportation.

<sup>10</sup> NOACA Multimodal Regional Freight Plan. <http://noaca.org/modules/showdocument.aspx?documentid=21293>. July 2017. P43-44. (pdf accessed 3/18/19).

One reason for the high unemployment rate in Cleveland is an inability of residents to reliably get to job sites, which have become increasingly suburban over the past decades for a variety of reasons. Roughly six and a half times as many Clevelanders, as a percentage of the population, lack access to a personal vehicle.

Table 3: Population without a Vehicle

Location	Percentage of Residents without a Vehicle
United States	4.4%
Brookpark (west side termini)	1.5%
Cleveland	9.7%
Solon (east side termini)	1.6%

Source: American Communities Survey 5-Year Estimates 2013-2017. United States Census Bureau.

This is further reflected in data on commuting characteristics, which show that far more Clevelanders use public transportation to get to work (Table 4). This difference is particularly stark for workers of color (Table 5). This is partly due to the greater density of the central city making public transit more feasible, but it is also a reflection of a lack of car ownership. The Greater Cleveland Regional Transit Authority (GCRTA) has fairly extensive coverage throughout Cuyahoga County, yet driving remains far more convenient since it is door to door service. This is especially true with fixed rail transit – it can't be easily relocated or expanded to reflect that job centers have moved since the rail was built. Our automated shuttle service will therefore provide a critical lifeline to adapt to the spatial mismatch between workforce and job centers.

Table 4: Commutes by Public Transportation

Location	Percentage of Residents Commuting by Transit
United States	5.1%
Brookpark (west side termini)	1.3%
Cleveland	10.1%
Solon (east side termini)	0.3%

Source: American Communities Survey 5-Year Estimates 2013-2017. United States Census Bureau.

Table 5: Commutes by Public Transportation by Color

Location	White Residents	Black Residents
United States	3.4%	10.7%
Brookpark (west side termini)	1.4%	0.5%
Cleveland	4.5%	17.1%
Solon (east side termini)	0.3%	0.8%

Source: American Communities Survey 5-Year Estimates 2013-2017. United States Census Bureau.

We therefore see a continuous cycle where a lack of reliable transportation, particularly a personal vehicle, leads to an inability to find and maintain employment, which leads to poverty, which leads to an inability to afford reliable transportation. This is one reason poverty is much higher in the central city than the suburbs where the new job hubs have grown.

Table 6: Poverty

<b>Location</b>	<b>Residents Experiencing Poverty</b>
United States	14.6%
Brookpark (west side termini)	11.2%
Cleveland	35.2%
Solon (east side termini)	4.5%

Source: American Communities Survey 5-Year Estimates 2013-2017. United States Census Bureau.

Poverty is over three times higher in Cleveland than at the western termini of our proposed shuttle, and an astonishing eight times higher than at the eastern termini. By designing our automated shuttle route to connect fixed rail service, which predominantly serves Cleveland residents, with suburban job hubs, we can help break the cycle described in the previous paragraph. Workers, and potential workers, will have reliable transportation nearly door to door. This will help them find and keep jobs and rise out of poverty.

The automation of manufacturing over the past decades has allowed the industry to be increasingly productive despite employing fewer workers. Cleveland is unlikely to again have as many workers employed in manufacturing as it did in the aftermath of World War II, at least as a percentage of the total population. This is not necessarily a bad thing though, as diversifying job opportunities will help increase resilience to economic shocks in any particular sector. So as we look to the future, we anticipate the very automation that led to the decline of some jobs being a catalyst to increase employment in others. Automated shuttles creating last mile connections between fixed transit routes and job centers can play a key role in making these jobs accessible for all area residents. Our project will facilitate this job access while also providing USDOT with data to help advance this cause and reduce spatial mismatch between workers and jobs in both urban and rural regions across the country.

### Complexity of Technology

The Complexity of Technology Focus Area encourages projects that propose L3 or greater automated driving systems (ADS) technologies to solve transportation problems. The primary goal of this project is to use L3 technology to better understand challenges of ADS to solve transportation and mobility issues in the future. Although this technology is relatively new, there has been significant ground gained through research and current demonstration implementation projects across the country.

This proposal will further those efforts, gaining a better understanding of the implications of ADS technology to:

- Personal Mobility and Job Access – Understanding how automated vehicles can better connect people to jobs and enhance quality of life
- System Safety – Evaluating the safety risks to all users, including the development of systems-engineering approaches to account for roadway and cyber safety risks. The USDOT estimates that 39,141 people lost their lives travelling the nation’s

transportation system in 2017.<sup>11</sup> Furthermore, they state that of all serious motor vehicle crashes, 94 percent involve driver-related factors, such as impaired driving, distraction, and speeding or illegal maneuvers.

- Human Factors – As identified as a unique challenge by USDOT in its Automated Vehicles guidance<sup>12</sup>, consideration of human factors in the design of buses for all levels of automation—for all participants in the system (transit operators, passengers, and other road users). The interaction between human and machine, ease of use, and comprehensibility of human-machine interfaces (HMI) should be explored thoroughly, particularly with respect to maintaining safety under all operating conditions. Where possible, technology companies should partner with transit agencies and passenger organizations to test various user interface technologies and designs.
- Regulatory Framework - This project will help federal, state, local, and regional transportation providers better understand the challenges of ADS implementation and what regulations and oversight need to be in place to guide future implementation. This is particularly important to ADS implementation on the local transportation system that may not be well understood by state and federal agencies.

#### Diversity of Projects

Our proposed shuttles will take place predominantly in outer-ring suburbs, although some corridors will be inner-ring suburban and urban, depending on exact routes. This will allow USDOT to collect data on automated vehicle operation with a wide variety of roadway characteristics. The tables below include potential routes at each job hub location with all roadways, distance covered, speed limit, number of lanes, number of traffic signals, average daily traffic, morning peak period traffic (6:00-9:00a.m.), and afternoon peak period traffic (3:00-7:00p.m.).

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<sup>11</sup> U.S. Department of Transportation, Bureau of Transportation Statistics, special tabulation, September 8, 2018; NHTSA 2017 Fatal Motor Vehicle Crashes: Overview (DOT HS 812 603)

<sup>12</sup> USDOT Automated Vehicles 3.0, Preparing for the Future of Transportation, guidance, <https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/320711/preparing-future-transportation-automated-vehicle-30.pdf>

Table 7 – Roadway Characteristics - Chagrin Highlands / Solon Routes

Street Name	Direction	Miles	Speed Limit	# of Lanes	# of Signals	Estimated 24-HR Total Volume	Estimated AM Peak Period Total Volume	Estimated PM Peak Period Total Volume
CHAGRIN BLVD	EB	3.8	25-35	1-3	15	9000	2100	2300
CHAGRIN BLVD	WB	3.8	25-35	1-2	15	8000	1300	2400
RICHMOND RD	NB	4.2	35-40	1-2	11	3900	700	1400
RICHMOND RD	SB	4.2	35-40	1-2	10	4000	900	1500
CANNON RD	EB	0.9	35	1	1	3500	500	1200
CANNON RD	WB	0.9	35	1	0	2300	600	600
COCHRAN RD	NB	3.5	35	1-2	6	7000	1100	2400
COCHRAN RD	SB	3.5	35	1-2	5	6900	1800	1800
WARRENSVILLE CENTER RD	NB	0.6	25	2-3	4	8300	1500	2600
WARRENSVILLE CENTER RD	SB	0.6	25	2	4	7300	1500	2100
NORTHFIELD RD	NB	3.9	25-40	1-3	14	6900	1400	2200
NORTHFIELD RD	SB	3.9	25-40	1-3	14	5700	1000	2100
SOUTHGATE PARK BLVD	EB	0.5	25	2	2	9	1	3
SOUTHGATE PARK BLVD	WB	0.5	25	2	2	100	5	30
LIBBY RD	EB	1.0	35	2	3	2100	600	600
LIBBY RD	WB	1.0	35	2	3	2300	300	800
BARTLETT RD	NB	0.1	35	1-2	1	2900	1000	700
BARTLETT RD	SB	0.1	35	2	1	1800	200	600
AURORA RD	EB	4.8	25-35	1-2	8	4500	1000	1500
AURORA RD	WB	4.8	25-35	1-2	8	5800	1300	2100

Table 8 – Roadway Characteristics - Cleveland Hopkins International Airport Routes

Street Name	Direction	Miles	Speed Limit	# of Lanes	# of Signals	Estimated 24-HR Total Volume	Estimated AM Peak Period Total Volume	Estimated PM Peak Period Total Volume
AEROSPACE PKWY	NB	0.3	35	2	1	700	200	300
AEROSPACE PKWY	SB	0.3	35	2	0	200	20	100
CEDAR POINT RD	EB	0.4	25	1	0	1600	600	300
CEDAR POINT RD	WB	0.4	25	1	1	1000	50	500
WALCOTT RD	NB	0.9	25	1	1	1500	400	400
WALCOTT RD	SB	0.9	25	1	0	700	100	200
TAYLOR RD / NASA PKWY	NB	0.9	25	1	1	1200	100	500
TAYLOR RD / NASA PKWY	SB	0.9	25	1	0	2500	600	600
BROOKPARK RD	EB	6.3	35-40	2-3	26	6500	1400	2000
BROOKPARK RD	WB	6.3	35-40	2-3	26	5000	900	1700
TIEDEMAN RD	NB	1.6	35	2-3	9	9700	1700	3200
TIEDEMAN RD	SB	1.6	35	2-3	9	9900	2000	2900
RIDGE RD	NB	0.4	25	2	2	13700	3500	3400
RIDGE RD	SB	0.4	25	2	2	13900	2100	4200
PEARL RD	NB	0.8	25	2	1	6800	1900	1700
PEARL RD	SB	0.8	25	2	1	6900	900	2500
SNOW RD	EB	3.1	35	2	12	3600	600	1300
SNOW RD	WB	3.1	35	2	12	3800	900	1100
W 150TH ST / SMITH RD	NB	1.8	35	1-2	8	8600	1900	2300
W 150TH ST / SMITH RD	SB	1.8	35	1-2	8	10400	1900	3400
W 160TH ST / INDUSTRIAL PKWY	NB	1.3	35	1	1	1400	200	500
W 160TH ST / INDUSTRIAL PKWY	SB	1.3	35	1	1	1000	200	300
PURITAS AVE	EB	1.1	35	2	4	3500	900	900
PURITAS AVE	WB	1.1	35	2	4	4900	700	1800
EMERY AVE	EB	0.6	35	1	1	1500	200	500
EMERY AVE	WB	0.6	35	1	1	1600	300	400
W 140TH ST	NB	0.8	25	1	3	1100	200	400
W 140TH ST	SB	0.8	25	1	3	1000	200	400
LORAIN RD	EB	1.7	25	2	13	4400	800	1500
LORAIN RD	WB	1.7	25	2	13	4400	900	1400
ROCKY RIVER DR	NB	1.2	35	2	4	7400	1100	2700
ROCKY RIVER DR	SB	1.2	35	2	4	7400	1800	2200
GRAYTON RD	NB	1.1	35	1-2	3	6400	1000	1800
GRAYTON RD	SB	1.1	35	1-2	3	6100	1200	1800

## Transportation-Challenged Populations

Access to and from jobs is inextricably linked to greater economic mobility, especially for the 18% of US households who do not own personal vehicles and make less than \$35,000 per year.<sup>13</sup> For seniors, individuals with disabilities, and people with low-incomes (and workers identifying as two or more of these populations), owning and/or safely operating a vehicle is often out of the question.

According to an article from the American Association of Retired Persons (AARP), men and women are working past traditional retirement age into their 70s and 80s. AARP reported that the US Bureau of Labor Statistics expects workers 65 and over to be the fastest-growing segment of the workforce in the coming decade.<sup>14</sup> Some are working because they choose to, while many others work due to financial necessity.

Along those lines, individuals with disabilities are also navigating the workforce in greater numbers. Since the early 1970s and the adoption of person-centered legislation aimed at greater inclusion, individuals with disabilities have more autonomy when choosing where to live, go to school and access healthcare. However, according to the National Council on Disability, economic inclusion is still a barrier to individuals with disabilities: “Many of these same people can and want to work and contribute as taxpayers and consumers but are restricted from doing so by considerable structural barriers to employment.” And when job-seekers are able to find jobs many “continue to earn subminimum wages for their labor.”<sup>15</sup> With a shift away from sheltered workshop environments to employment in the community, transportation is a vital piece towards full inclusion for individuals with disabilities.

First and last mile connections to transit have consistently been identified as barriers to mobility in transportation-challenged populations, particularly for seniors and individuals with disabilities. During public outreach for the Coordinated Human Service-Public Transit Transportation Plan for Northeast Ohio update, a commonly addressed concern of job seekers and vocational training programs is that employment opportunities are contingent upon transportation. Qualified and willing candidates often turn down jobs because they cannot secure safe and reliable transportation to and from work. Specialized providers and paratransit service can fill these needs, but due to unreliable scheduling, individuals report that they have lost jobs for being late to work. Participants in public meetings also pointed out that shift work with varying schedules makes transportation extremely difficult for all but those who own their own vehicles. Reliable and safe transportation to and from job hubs would create much-needed access for individuals who need employment opportunities the most.

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<sup>13</sup> Center for Transit-Oriented Development. (2014) “Creating Connected Communities: A Guidebook for Improving Transportation Connections for Low and Moderate-Income Households in Small and Mid-Sized Cities.” U.S. Department of Housing and Urban Development, Washington, DC.

<sup>14</sup> Miller, Mark. 2015. “Take This Job and Love It!” *AARP The Magazine*. February/March 2015

<sup>15</sup> National Council on Disability (NCD). (2018). “From the New Deal to the Real Deal: Joining the Industries of the Future.” Washington, DC.

## Prototypes

This project seeks to secure the services of existing companies that are already equipped and ready to provide fully operable automated shuttle service solutions. These solutions have been implemented at many locations worldwide and are actively supporting safe demonstrations. In fact, several of them are already providing safety and other data required under this opportunity directly to USDOT.

## Requirements

The proposed four-year project will have a physical demonstration at least throughout years two through four. The first year will culminate in the release a Request for Proposals (RFP) for an automated shuttle provider. Selection will require that the provider is able to meet the terms and requirements as set forth by USDOT in the Notice of Funding.

As described previously, our demonstration project will take place on a variety of road types in a variety of climates. As a government agency, NOACA is well-versed in communicating with other government agencies and the public at-large. Essentially all of our work requires extensive public interaction both on the front-end to gather stakeholder input as well as throughout the life of a project and upon its completion to share progress and data and collect feedback.

All relevant and required data would be publicly accessible except data that contain personally identifiable information, confidential business information or classified information, in near real-time. NOACA anticipates contracting with an existing autonomous vehicle manufacturer that is already collecting and transmitting data to USDOT. We will require that input/output user interfaces are provided on the ADS which allow users with varied abilities to input a new destination or communicate route information. The input/output interface and all related applications must be accessible and must allow access to information generated by the ADS.

## Approach

### Technical Approach

We will work with USDOT to finalize our technical approach, including the data management plan. We anticipate procuring a consultant in the first six months of the project to assist with this work. We will subsequently select an autonomous vehicle provider capable of providing real-time data to NOACA and USDOT. This contract will be all-encompassing, so the vehicle provider will also provide a driver for emergencies and conduct all operations and maintenance of the vehicles. Cleveland does have some electric charging stations, and more are regularly being brought on-line. The shuttle will either have a programmed route to the nearest charging station, or the driver can take over to steer the shuttle in the right direction. It is possible charging stations may be developed at the transit stations during the demonstration period as well – these are obvious places where people store vehicles for several hours, so it makes sense for the private sector (or even the transit agency) to monetize this vehicle storage through electric charging.



For project evaluation, NOACA has a Safety and Operations team that regularly collects, analyzes, and updates safety data for the region. The team will use data from the shuttles to evaluate safety in relation to human-driven vehicles. Because connecting workers with jobs is a key goal, we will also conduct surveys of both businesses and workers during and after the demonstration project to evaluate the effectiveness of the shuttle systems in providing services that help people find and keep jobs.

#### Legal, Regulatory, and Environmental Obstacles

The demonstration proposed under this project will not require exemption from Federal Motor Vehicle Safety Standards (FMVSS), Federal Motor Carrier Safety Regulations (FMCSR), or any other regulation, to the best of NOACA's knowledge.

It is also expected that the project will be categorized as an Exempt project under the National Environmental Policy Act requirements as administered through USDOT. No additional environmental studies and or mitigation is anticipated.

In preparation of the project management plan, NOACA will work closely with state, local and regional jurisdictions to understand and account for any related standards, rules, or ordinances that that may be impacted in the implementation of this project.

#### Commitment to Provide Data and Participate in Safety Outcomes

NOACA commits to provide all necessary data and work with USDOT on evaluating safety and mobility outcomes. One of the key aspects of this proposal is the benefits of connecting workers with jobs, so we especially want to monitor if this is happening and how it can be replicated across the region and country. Our selection of an automated shuttle provider will be contingent upon their willingness to share real-time data and any other necessary information with NOACA, USDOT, and any other regulatory bodies.

#### Risk Identification, Mitigation, and Management

NOACA will work with USDOT and the shuttle operator to identify and mitigate risks. The obvious concern with new automated technology is an error that causes the vehicle to ignore traffic operations or otherwise drive erratically. This risk will be mitigated by requiring a licensed and trained operator to be in the driver's seat at all times and ready to take over in any adverse situation. This person will also be able to help elderly, disabled, or injured passengers get on and off the shuttle, and they will reduce the likelihood of possible negative interactions between passengers.

Before deployment, we will have shuttles operate several test runs of the routes with only the driver on board so that the vehicles can learn the route. This will help identify any deficiencies in lane markings and signage, and we will make improvements if needed so that the shuttle can see these cues. NOACA has a program called Street Supplies that provides paint, cones, temporary bollards, tape, and other materials for demonstration projects like bike lanes. This low-cost method allows us to study and make adjustments before spending significant infrastructure funding on new designs. This strategy can easily be replicated for autonomous shuttles.

Although our diverse weather presents a great opportunity to learn and advance the technology, it also presents a risk for safe shuttle operations in icy conditions, when snow covers lane markings, or when fog or heavy precipitation prevent cameras or sensors from knowing where the shuttle is in relation to other road users. Again, having someone seated at the wheel will mitigate these concerns. It is even possible that at the start of a trip, operators decide weather conditions are too bad and decide to manually operate the shuttle that day.

Automated vehicles have been deployed elsewhere in the country with obvious colors, markings, and/or sounds that let other road users know it is an automated vehicle. This is especially important for pedestrians and cyclists, the most vulnerable road users. We will require our selected shuttle operator to take all of these precautions so that everyone can tell from a distance that an autonomous shuttle is operating.

We hope to be ambitious with our shuttles as the technology advances, with hopes that we can offer service at speeds greater than currently exist. Because our shuttles are operating predominantly on suburban arterials, most of the streets have speed limits of 35 miles per hour, and in some places up to 40mph. If the vehicles are unable to reach these speeds, we may consider alternate routes. Again, shuttles will have obvious markings, so if they are, for example, traveling 20-25 miles per hour where the posted limit is 35mph, it will be obvious to everyone approaching.

We plan to collaborate regularly with local law enforcement, particularly through the NOACA Intelligent Transportation System Architecture, where several law enforcement agencies are already on our Steering Committee. They will know where and when shuttles are operating and may even be able to station officers on these corridors while the shuttle is operating.

Key to all of this is extensive communication with the public. Before any vehicle is deployed, as well as throughout the project duration, we will hold public meetings so that people know where and when shuttles operate and how to recognize them. We will hold meetings at different places and different times of day, giving as many people as possible the opportunity to learn and participate. We will publish exact routes and shuttle operating times in local media and on the NOACA website and social media.

#### [Approach to Non-Federal Resources](#)

NOACA is seeking \$6,300,000 (98%) of the project costs from USDOT. NOACA is contributing \$100,000 (2%) for year 1 planning and development. If successful, this demonstration will be utilized as a model for expansion of autonomous shuttles at additional job centers within Northeast Ohio, leveraged and supported by dollars from public and private partners in the region.