

Benefit-Cost Analysis Memorandum

Mobility for Everyone, Everywhere in North Carolina (MEE NC)

2022 Rural Grant Application

Prepared for NCDOT

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Executive Summary

A benefit-cost analysis (BCA) was conducted for the Mobility for Everyone, Everywhere in North Carolina (MEE NC) Project (hereafter called the Project) to support the North Carolina Department of Transportation's (NCDOT's) grant application for the USDOT 2022 Rural program. This analysis was conducted in accordance with the 2022 *Benefit-Cost Analysis Guidance for Discretionary Grant Programs* (Guidance).¹ Capital outlays are scheduled to begin 2024 and end in 2026. All values are in 2020 dollars discounted at a 7% discount rate to 2020 and cover a three (3) year operations period.

Exhibit 1 presents the Impact Matrix, which describes the baseline or No Build, the Project as a whole, and the estimated results.

¹ USDOT Benefit Cost Analysis Guidance 2022, <https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf>

Exhibit 1 – Impact Matrix

Current Status/Baseline & Problem to be Addressed	Change to Baseline or Alternatives	Types of Impacts	Affected Population	Economic Benefit (Net Present Values, \$2020 M) Discounted at 7%	Page Reference in BCA	
<p>North Carolina serves rural populations through demand response or paratransit services. Riders would be more effectively served by on-demand mobility services. Without such a service, would-be riders currently rely on family or friends for trips, walk to destinations, or do not make the trips at all.</p>	<p>Eleven (11) rural transit operators would purchase software and/or transportation services to operate on-demand mobility services. Ridership would increase, resulting in travel time savings and avoided waiting time for existing and new riders, saving productive time for caregivers who no longer need to arrange or provide transport, offering convenience and reduced time for scheduling. Reducing auto trips also results in emissions, safety, and vehicle operating cost savings, while increased on-demand service results in new emissions and safety costs.</p>	<p>Safety</p>	<p>Safety from Modal Diversion</p>	<p>Drivers who reduce auto VMT</p>	<p>-\$0.1</p>	<p>10</p>
		<p>State of Good Repair</p>	<p>Vehicle Operating Cost Savings</p>	<p>Drivers who reduce auto VMT</p>	<p>\$1.3</p>	<p>11</p>
		<p>Economic Impacts, Freight Movement, and Job Creation</p>	<p>Travel Time Savings</p>	<p>All riders</p>	<p>\$22.3</p>	<p>11</p>
		<p>Productivity Savings</p>	<p>Caregivers of riders</p>	<p>\$20.0</p>	<p>11</p>	
		<p>Scheduling Time Savings</p>	<p>All riders</p>	<p>\$5.4</p>	<p>11</p>	
		<p>Climate Change, Resiliency, and the Environment</p>	<p>Emissions Savings</p>	<p>General public</p>	<p>-\$0.1</p>	<p>12</p>
		<p>Equity, Multimodal Options, and Quality of Life</p>	<p>Availability of Real-Time Information</p>	<p>All riders</p>	<p>\$1.2</p>	<p>12</p>
		<p>Foregone Trips (Medical and Work)</p>	<p>A portion of new riders who would not have taken the trip otherwise</p>	<p>\$4.7</p>	<p>12</p>	

Exhibit 2 summarizes long-term outcomes of the Project. Taken in total for the 11 participating communities, the Project provides \$54.8 million in net benefits over the analysis period, using a 7% discount rate. Compared to a similarly discounted cost estimate, the Benefit-Cost Ratio for the Project is 2.5, a solid return on this critical investment for the state.

Exhibit 2 – Costs and Benefits Delivered by the Total Project in Discounted Millions of 2020 Dollars

Costs	
Software (SaaS)	\$1.7
Turnkey (TaaS)	\$20.4
Total Costs	\$22.1

Benefits	
Safety	
Safety from Modal Diversion	-\$0.1
State of Good Repair	
Vehicle Operating Cost Savings	\$1.3
Economic Impacts, Freight Movement, and Job Creation	
Travel Time Savings	\$22.3
Productivity Savings	\$20.0
Scheduling Time Savings	\$5.4
Climate Change, Resiliency, and the Environment	
Emissions Savings	-\$0.1
Equity, Multimodal Options, and Quality of Life	
Availability of Real-Time Information	\$1.2
Foregone Trips (Medical and Work)	\$4.7

Total Net Benefits	\$54.8
Benefit Cost Ratio	2.5
Net Present Value	\$32.7

By applying 2012-2020 North Carolina Statewide RIMS II Multipliers, as purchased from the Bureau of Economic Analysis, to the appropriate costs, the project is expected to generate 1,001 total job-years, of which 816 are directly from the software and on-demand transit operations. These jobs are for the duration of the three-year analysis period and are expected to generate earnings of \$19.3 million.

1. Introduction

Mobility for Everyone, Everywhere in North Carolina (MEE NC) advances the North Carolina Department of Transportation (NCDOT) Integrated Mobility Division (IMD)'s vision and strategy to partner with the state's rural transit systems to launch on-demand transit throughout the state. Expanding on-demand mobility options will respond to unmet transit needs, provide a more equitable transportation system, and improve access to opportunities, services, and resources for transportation disadvantaged populations. To deliver MEE NC, NCDOT IMD will partner with 11 participating communities to modernize transit service, serving a total of approximately 810,000 individuals.² MEE NC will address the state's rural-urban disparities and expand opportunities by providing equitable access to education, healthcare, and employment through on-demand mobility services. By expanding transit accessibility in rural areas through innovative, dynamic, and responsive services, MEE NC will tangibly and meaningfully improve residents' quality of life and enhance local economies.

On-demand mobility services can be defined as a technology-enabled transit service that usually shuttles or vans to provide pooled, on-demand transportation with dynamic routing. There are two models for on-demand services that the MEE NC project will employ: Software as a Service (SaaS) and turnkey services, also called Transportation as a Service (TaaS). SaaS provides the software for a transit agency to use and the agency provides drivers, vehicles, and operations management. The turnkey model encompasses the provision of drivers, vehicles, software, and operations management as a turnkey solution on behalf of a transit agency.

The MEE NC project requires coordination with transit agencies and communities across the state. As such, interested communities were categorized into different tiers. In Tier 1, MEE NC will implement SaaS, which incurs a lower cost, and in Tier 2, MEE NC will implement turnkey services in communities where NCDOT has already made significant investment in on-demand transit services. Tier 3 communities demonstrate a high level of demographic need and where turnkey services are proposed.

Recognizing that each transit system is unique, MEE NC will fund on-demand services tailored to each community's needs and vision. Five Tier 1 agencies have requested SaaS, while six Tier 2 and 3 agencies have requested turnkey services:

SaaS:

- Kerr Area (KARTS)
- McDowell County Transportation
- Randolph County (RCATS)
- Alamance County Transportation Authority (ACTA)
- Johnston County Area Transit (JCATS)

Turnkey:

- Wave Transit (RideMICRO)
- City of Wilson (RIDE)
- Rockingham (ADTS)
- City of Sanford
- Salisbury Transit System (STS)
- Tar River Transit

The Project will consist of a combination of technological and operational improvements to address transportation challenges across the state and create the opportunity for additional riders to benefit from the services. The Project provides benefits under all of the Rural merit criteria.

² MEE NC includes 10 existing transit agencies and the City of Sanford which is currently working closely with NCDOT IMD to plan on-demand service and would become an NCDOT subrecipient and transit provider.

2. Analysis Framework

The parameters of the benefits analysis follow the protocols set by the Office of Management and Budget (OMB) Circular A-94 as well as the recommended benefit quantification methods by the USDOT. Generally, standard factors and values accepted by Federal agencies were used for the benefits calculation except in cases where more Project-specific values or prices were available. In such cases, modifications are noted and references are provided for data sources. The analysis follows a conservative estimation of the benefits. By adhering to a strict standard of what could be included in the benefits analysis, actual total benefits may be greater than depicted in the results.

This project is scalable; each individual agency has independent utility. As such, 12 BCAs were estimated – one for each of the 11 participating communities and another in total. The results of each BCA are found in Section 6 of this document and in the accompanying BCA workbook.

A custom model was developed to estimate the costs and benefits for the Project over the three years of analysis (2024-2026). The benefits are expressed in constant 2020 dollars, which avoids forecasting future inflation and escalating future values for benefits and costs accordingly. The BCA Guidance deflator and gross domestic product chained price index from the OMB were used to adjust past or future cost estimates or price values into 2020 dollar terms. The use of constant dollar values requires the use of a real discount rate for discounting to the present value. Projects expecting to use Federal funding are required to use a 7% discount rate.

No Build and Build

No Build or Baseline

Without the Project, also referred to as the No Build or baseline, North Carolina rural populations would continue to be served through, demand response, fixed-route, or paratransit services. Riders would prefer to use a more flexible service such as on-demand mobility services. Without such a service, would-be riders currently rely on family or friends for trips, walk to destinations, or do not make the trips at all. Riders who do utilize existing demand response services are often required to schedule trips 24-48 hours in advance and may wait up to 1 hour for their pickup. Ridership in the No Build would grow by 1 percent per year and riders would experience the same service as today.

The baseline assumes that the Project would not move forward, and current conditions and operations would continue. Under the baseline, the purpose of and need for the Project would not be met and would generally be limited to the operation and maintenance of existing services. The Project was compared to the baseline to identify benefits and costs.

Build

Alternately, in the Build, 11 rural transit operators would purchase software and/or transportation services to operate on-demand mobility services. Ridership would increase by 1 percent compared to the No Build for Tier 1 agencies, while ridership for Tier 2 and 3 agencies would have a greater increase in ridership as estimated by the software program Remix. The increases to ridership result in travel time savings and avoided waiting time for existing and new riders, saving productive time for caregivers who no longer need to arrange or provide transport, offering convenience and reduced time for scheduling. Wait times for the service would decrease in the Build as on-demand scheduling software can effectively and efficiently schedule spontaneous trip requests. Reducing auto trips results in emissions, safety, and vehicle operating cost savings, while increased operations for the on-demand transit vehicles results in a negligible net negative impact on emissions and safety.

Analysis Assumptions

A list of assumptions for the Project is provided in the BCA workbook (see Inputs tab in the file BCA.xlsx) as well as in Exhibit 3.

Exhibit 3 – BCA Calculation Inputs

Input	Value	Source
General		
Discount Year	2020	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs
Dollar Year	2020	
Discount Rate - CO2 Emissions	3%	
Discount Rate	7%	
Deflator	See "Deflator" Sheet	
Start Year	2024	NCDOT
Weeks per year	51	Operates nearly year-round
Auto occupancy	1.67	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs
On-Demand Avg Vehicle Occupancy	2.00	NCDOT (driver + 2 passengers; drivers are not considered in benefits)
Operating cost increase YOY, 2017-2018 DR Orange County Transit Authority (OCTA); applied to turnkey services	4%	NTD 2012-2018
Electronic Real-Time Information Displays (per trip)	\$0.29	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs
Share of riders who use a smartphone app for booking trips	82%	Wilson survey
Time Savings		
Value of Time Personal, 2020\$ per person-hour	\$16.20	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs
Value of Time All Purposes, 2020\$ per person-hour	\$17.80	
Value of Time Waiting, 2020\$ per person-hour	\$32.40	
<i>Scheduling:</i>		
Share of hourly VOT attributed to scheduling benefit	7%	Average time 5 minutes per trip for scheduling via operator in No Build; app takes 1 minute. Source: City of Wilson
Value of Time, scheduling per trip	\$1.19	Calculated
<i>Travel Time:</i>		
In Vehicle Travel Time No Build, average per trip (mins)	30	NCDOT
In Vehicle Travel Time Build, average per trip (mins)	28	NCDOT
Wait Time No Build, average per trip (mins)	60	policy requirement
Wait Time Build, average per trip (mins)	20	maximum per policy
Typical hours per week spent arranging or providing transportation.	5	About 40 percent of caregivers spend at least five hours a week providing or arranging transport, according to a 2018 survey from the National Aging and Disability Transportation Center (NADTC), a program administered by n4a and Easterseals that promotes accessible transit https://www.aarp.org/caregiving/home-care/info-2020/transportation-services.html
Share of caregivers spending time	40%	
Weeks per year spent arranging or providing transportation per year. Conservatively less than 52 weeks per year.	6	NCDOT
Share who would not have made the trip	18.2%	Wave Transit on-board survey

Share who would get a ride from someone else	15.0%	Wave Transit on-board survey
On-demand mobility services annual growth	1.0%	NTD: OCTA, 2017-2018; held constant
Share of adults with disabilities relying on family/friends for ride	75%	NADTC, KRC Research, "Transportation Needs and Assessment; Survey of Older Adults, People with Disabilities, and Caregivers," December 2018
Cost of foregone medical trips	\$357.00	Page 25, https://www.ugpti.org/resources/reports/downloads/2014-07-cost-benefit-analysis.pdf
Cost of foregone medical trips (2020\$)	\$392.70	Adjusted with GDP deflator
Cost of foregone work trips	\$49.00	Page 26, https://www.ugpti.org/resources/reports/downloads/2014-07-cost-benefit-analysis.pdf
Cost of foregone work trips (2020\$)	\$53.90	Adjusted with GDP deflator
<i>Trip Purpose</i>		
Medical	7.00%	Wave Transit on-board survey
Work	19.10%	Wave Transit on-board survey
Average auto trip length, all purposes (miles)	10.50	Table 5b, NHTS 2017 https://nhts.ornl.gov/assets/2017_nhts_summary_t_ravel_trends.pdf
Average walking speed (mph)	3.2	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs
Average vehicle speed (mph)	35	NCDOT
Average trip length, walking	0.86	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs
Travel Time saving, walking avoided (hrs per trip)	0.24	Calculated
Average new on-demand trip (miles)	11.8	NCDOT
Vehicle Operating Cost per mile (2020\$), auto	\$0.45	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs
Safety		
O- No injury (2020\$)	\$3,900	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs
C - possible injury (2020\$)	\$77,200	
B - non-incapacitating injury (2020\$)	\$151,100	
A - incapacitating (2020\$)	\$554,800	
K - killed (2020\$)	\$11,600,000	
U - Injured (severity unknown) (2020\$)	\$210,300	
# Accidents Reported (unknown if injured) (2020\$)	\$159,800	
Injury Crash (2020\$)	\$302,600	
Fatal Crash (2020\$)	\$12,837,400	
PDO per vehicle (2020\$)	\$4,600	
Modal Diversion External Benefits	10%	
Environmental		
Grams per metric ton	1,000,000	
Damage Costs for Emissions per metric ton (2020\$)	See Workbook	2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs

3. Benefit Analysis

The method, analysis, and results for each Project benefit category are described in the following sections.

The majority of the benefits analysis come from the agencies' ability to serve additional passengers with the new software. As a result, ridership is expected to increase from the No Build based on preliminary estimations provided by the software for each agency in the first year of operations. Ridership in the No Build comes from each agency's ridership in 2021, escalated by 1% per year based on Orange County Transportation Authority NTD data from similar experience of switching from traditional demand response transit to on-demand services. The Build ridership is based on output of the software; similar software would be purchased and utilized to schedule service in the Build. In general, each operator can serve multiple times more riders in the Build than the No Build. See the Ridership tab of the accompanying workbook for more information.

The difference between the ridership in the Build and No Build is the population of riders not served; these riders presumably would have taken the service but for its inconvenient scheduling, pickup or drop off locations, long wait times, and other difficulties. As a result, these riders not served either did not take the trip, walked, or relied on a caregiver to provide the ride. Surveys were used to estimate the shares of each type of activity as well as other inputs including trip purpose, share who would use a smartphone app (or web portal) to schedule rides, time to schedule service, and more.

The benefits analysis in the following sections report the total benefits of all 11 operators.

Safety

The Project would result in safety benefits by diverting auto trips to on-demand transit; new on-demand bus miles are considered as an offset to the safety benefit.

Safety from Modal Diversion

The Project improves rural transportation through on-demand mobility services; as a result, an increase in ridership is expected. A portion of the riders not served in the No Build would rely on caregivers for transportation. The share who would get a ride from caregivers, average trip length, and auto occupancy are shown in Exhibit 3.

North Carolina crash rates for fatalities,³ Bureau of Transportation Statistics (BTS) crash rates for injured persons, property damage only (PDO)⁴, and the values of the crashes were applied to values of crashes avoided as found in Exhibit 3. As an offset to modal diversion benefits, the new miles incurred by the on-demand systems, estimated at 11.8 miles per trip and auto occupancy of 2 passengers, the VMT were applied to crash rates as found from BTS. Guidance states that only 10% of safety costs are external; as a result, safety benefits of modal diversion were factored down to only consider the external damages.

Safety benefits from modal diversion total - \$0.1 million when discounted at 7%.

State of Good Repair

Vehicle operating costs would be avoided by the caregivers who save VMT when the on-demand service is operating.

³ NCDOT 2020 Traffic Crash Facts, <https://connect.ncdot.gov/business/DMV/CrashFactsDocuments/2020%20Crash%20Facts.pdf>

⁴ BTS Motor Vehicle Safety Data Table 2-17, <https://www.bts.gov/content/motor-vehicle-safety-data>

Vehicle Operating Costs Avoided

The auto trips diverted to transit saves auto VMT. Auto operating cost savings were estimated using a cost savings of \$0.45 per reduced auto VMT as recommended by Guidance and presented in Exhibit 3.

Vehicle operating cost savings totals \$1.3 million, discounted at 7 percent.

Economic Impacts, Freight Movement, and Job Creation

There are three types of time savings that result from the Project: travel time savings for users during the trips, productive time savings for caregivers, and scheduling time savings.

Travel Time Savings

The travel time savings for the Project result from improved mobility and operations that result from the use of the software. It is estimated that on average, riders save two minutes of in-vehicle travel time per trip, and Tier 2 riders also save 80 minutes of wait time. This is due to established policies stating that riders must be ready for one hour on either side of the trip, as the pickup time has a 60 minute window. In the Build, the on-demand software technology would reduce the wait time to 20 minutes. Tier 1 riders save 40 minutes of wait time per trip. For systems with all induced ridership, the rule of half is applied to the incremental travel time savings between the Build and No Build.

The total travel time savings for the Project is \$22.3 million, discounted at 7%.

Productivity Savings

Some potential riders, particularly the elderly and disabled, rely on family, friends, and other caretakers to transport them to doctor appointments, social events, and to do necessary errands. A continued need rather than a one-time commitment, these trips can be burdensome on caregivers who have to spend business and personal time coordinating transportation or providing the transportation for the transportation-dependent family or friend. As found in the Wave Transit survey, 15% of riders would get a ride from someone else in the absence of the service.

The literature also estimated the amount of time spent by caregivers providing or arranging transportation. Not all of these trips come at the expense of work, so the benefit applies the value of time for all purposes. Based on the literature, "About 40 percent of caregivers spend at least five hours a week providing or arranging transport, according to a 2018 survey from the National Aging and Disability Transportation Center (NADTC)."⁵ The analysis assumes 30 hours per year⁶ are saved for the caregivers of new riders.

The productive time savings for caregivers totals \$20.0 million when discounted at 7%.

Scheduling Time Savings

The on-demand transit users will be able to schedule a ride using a smartphone app or web portal instead of calling an operator to arrange the pickup and drop off at least 24 hours in advance. The ride may be scheduled on the app within 20 minutes, providing flexibility for users. This scheduling benefit is measured as a change in the time needed to schedule by phone and by app. Survey data shows the average call to schedule a trip in the No Build is five minutes, while the app takes one minute. The survey shows 80% of users would use the app, resulting in a benefit of \$1.19 per trip. This benefit is in addition to

⁵ AARP, "Transportation: What Caregivers Need to Know," January 17, 2020, <https://www.aarp.org/caregiving/home-care/info-2020/transportation-services.html>

⁶ Caregivers spend about 5 hours every week; this analysis applies a conservative 6 weeks of savings per year.

the Productivity Savings because Scheduling Time Savings is a benefit for existing riders in the No Build while Productivity Savings is a disbenefit avoided for caregivers of new riders.

The total scheduling time savings is \$5.4 million, discounted at 7%.

Climate Change, Resiliency, and the Environment

The Project would result in environmental benefits by saving travel time and avoiding VMT through modal diversion from auto to on-demand mobility services.

Emissions Savings from Modal Diversion

With the improvements to the service, it is expected that residents would shift their transportation preferences from auto or walking to using on-demand transit. The modal shift from auto to transit produces a reduction in VMT and the avoided VMT decreases the amount of annual nitrogen oxides (NO_x), particulate matter (PM_{2.5}), sulfur oxide (SO_x), and carbon dioxide (CO₂) in the atmosphere. Auto and bus emissions rates (g/mile) are estimated based on the California Air Resources Board (CARB) Onroad Emissions Rates model, which was run in order to estimate the emissions rates.⁷ California has some of the nation's strictest emissions standards; as a result, the rates used in this analysis are conservative. The auto emissions avoided were netted with the increased transit VMT. Tier 2 and 3 services will be operated by autos; therefore, transit (bus) emissions rates were used for Tier 1 only.

The tons of reduced emissions were monetized using the recommended values as shown in Exhibit 3. The value of CO₂ avoided was discounted at 3%.

The emissions savings from the Project total -\$0.1 million, discounted at 7%.

Equity, Multimodal Options, and Quality of Life

The Project offers convenience, allowing riders to schedule trips more easily and to make it to appointments and work reliably.

Availability of Real-Time Information

The agencies participating in the Project will have on-demand service, with users able to request trips and view real-time bus location information on their smartphones. This amenity is valued at \$0.29 per trip based on USDOT Guidance. Traveler surveys showed 82% of riders use the app and would benefit from the amenity.

The benefit of availability of real-time information totals \$1.2 million, discounted at 7%.

Foregone Trips

Without the service and its increased reliability and flexibility, riders would miss work and medical appointments, resulting in further public assistance needed as health deteriorates and job security fades. The National Center for Transit Research released a Cost-Benefit Analysis for Rural and Small Urban Transit in July 2014. The analysis estimated that providing 500 trips per year, or two one-way trips for 250 working days per year, could allow an individual to keep a job and not require government assistance. This could reduce government assistance by \$24,400 in state and federal expenditures, or the equivalent to \$49 per trip in costs of foregone work trips. Updating this to 2020 dollars results in \$53.90 per trip in benefits from avoiding foregone work trips.

⁷ Raw Data and Results for LDV WTW emissions. Online. California Air Resources Board. November 2020. https://ww2.arb.ca.gov/sites/default/files/2020-11/LDV_MSS_supporting_materials_ISAS_Nov2020.xlsx

An addition, a tool was developed by Hughes-Cromwick et al. in 2005⁸ to calculate the cost differences between well-managed and poorly-managed care, including improvements in quality of life but minus the costs of medical treatment, trips required, and other factors. The one-way trip net benefit and a range of the share of users would not have taken a trip without transit⁸ results in the number of foregone medical trips per year without on-demand mobility services. Foregone medical trips are valued at \$392.70 in 2020 dollars.

Based on survey data that showed 18% would not have taken the trip without the service, and 7% of trips are for medical purposes and 19.1% for work, **benefits of \$4.7 million total from avoiding foregone medical and work trips**. The analysis conservatively does not include the value of a trip not taken for other trip purposes.

4. Cost Analysis

The Project has two cost components: the initial capital costs of software and ongoing costs to purchase transportation service.

Software as a Service

The SaaS costs for the Project include the cost of the software annually.

The total SaaS costs for the Project discounted at 7% are \$1.7 million.

Turnkey Service

The systems would only be able to utilize the new software and serve riders under an increased operating scenario. As such, the Build costs of turnkey were estimated for Tier 1 agencies based on an incremental increase to the No Build costs as found from NCDOT data; the increase applied is 3.8% based on similar experience for Orange County Transit Authority as found in the National Transit Database. Tier 2 costs were estimated using the software and represent the net new costs of the service. The resulting costs for Tier 1 were compared to the No Build in order to estimate the net new increases.

The total turnkey costs for the Project discounted at 7% are \$20.3 million.

The costs are shown for each participating community in Exhibit 4.

⁸ Godavarthy, R, Mattson, J, and Ndembe, E, National Center for Transit Research, "Cost-Benefit Analysis of Rural and Small Urban Transit," July 2014, Figure 4.2, <https://www.ugpti.org/resources/reports/downloads/2014-07-cost-benefit-analysis.pdf>. Used as a proxy for on-demand mobility services availability.

Exhibit 4 – Total Costs, in Discounted 2020 Dollars

	SaaS	Incremental Operating Costs
Tier 1 - Readily Implementable On-Demand Services (SaaS)		
Kerr Area (KARTS)	\$565,000	\$296,000
McDowell County Transportation	\$155,000	\$45,000
Randolph County (RCATS)	\$478,000	\$131,000
Alamance County Transportation Authority (ACTA)	\$341,000	\$137,000
Johnston County Area Transit (JCATS)	\$93,000	\$181,000
Tier 1 Total	\$1,632,000	\$790,000
	SaaS	Turnkey
Tier 2 - Significant NCDOT IMD investment in on-demand planning and operations (Turnkey)		
Wave Transit (RideMICRO)	\$105,000	\$4,226,000
City of Wilson (RIDE)		\$3,890,000
Rockingham (ADTS)		\$1,592,000
City of Sanford		\$4,820,000
Tier 2 Total	\$105,000	\$14,528,000
Tier 3 – Turnkey service prioritized and funded in order of TDI Rank based on available funding (Turnkey)		
Salisbury Transit System (STS)		\$1,891,000
Tar River Transit		\$3,140,000
Tier 3 Total	\$0	\$5,031,000
Total	\$1,737,000	\$20,349,000

Source: NCDOT

Total costs for the Project, discounted at 7%, are \$21.1 million.

5. BCA Results

The analysis results in a total Project Benefit-Cost Ratio (BCR) of 2.5 when discounted at a rate of 7%. Exhibit 5 displays a summary of the BCA results for the total Project. The individual BCAs for each participating community are shown following Exhibit 5.

Exhibit 5 – BCA Results for the Project

Costs	
Software (SaaS)	\$1.7
Turnkey (TaaS)	\$20.3
Total Costs	\$22.1

Benefits	
Safety	
Safety from Modal Diversion	-\$0.1
State of Good Repair	
Vehicle Operating Cost Savings	\$1.3
Economic Impacts, Freight Movement, and Job Creation	
Travel Time Savings	\$22.3
Productivity Savings	\$20.0
Scheduling Time Savings	\$5.4
Climate Change, Resiliency, and the Environment	
Emissions Savings	-\$0.1
Equity, Multimodal Options, and Quality of Life	
Availability of Real-Time Information	\$1.2
Foregone Trips (Medical and Work)	\$4.7

Total Net Benefits	\$54.8
Benefit Cost Ratio	2.5
Net Present Value	\$32.78

	Total Discounted 2020 \$M											
	Kerr Area (KARTS)	Johnston County Area Transit (JCATS)	Randolph County (RCATS)	Alamance County Transportation Authority (ACTA)	McDowell County Transportation	City of Wilson	City of Sanford	Rockingham (ADTS)	Cape Fear Public Transportation Authority (Wave)	Salisbury Transit System (STS)	Tar River Transit	Total Project
Costs												
Software (SaaS)	\$0.6	\$0.1	\$0.5	\$0.3	\$0.2	\$0.0	\$0.0	\$0.0	\$0.1	\$0.0	\$0.0	\$1.7
Turnkey (TaaS)	\$0.3	\$0.2	\$0.1	\$0.1	\$0.0	\$3.9	\$4.8	\$1.6	\$4.2	\$1.9	\$3.1	\$20.3
Total Costs	\$0.9	\$0.3	\$0.6	\$0.5	\$0.2	\$3.9	\$4.8	\$1.6	\$4.3	\$1.9	\$3.1	\$22.1
Benefits												
Safety												
Safety from Modal Diversion	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	-\$0.1
State of Good Repair												
Vehicle Operating Cost Savings	\$0.1	\$0.1	\$0.3	\$0.3	\$0.1	\$0.2	\$0.1	\$0.0	\$0.1	\$0.0	\$0.1	\$1.3
Economic Impacts, Freight Movement, and Job Creation												
Travel Time Savings	\$5.6	\$0.0	\$1.4	\$2.5	\$1.0	\$0.0	\$2.9	\$2.4	\$2.4	\$1.9	\$2.2	\$22.3
Productivity Savings	\$0.1	\$0.0	\$0.0	\$0.0	\$0.0	\$4.2	\$3.9	\$3.2	\$3.2	\$2.5	\$2.9	\$20.0
Scheduling Time Savings	\$0.3	\$0.2	\$0.1	\$0.1	\$0.1	\$0.3	\$0.1	\$0.1	\$3.3	\$0.2	\$0.7	\$5.4
Climate Change, Resiliency, and the Environment												
Emissions Savings	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	-\$0.1
Equity, Multimodal Options, and Quality of Life												
Availability of Real-Time Information	\$0.1	\$0.0	\$0.0	\$0.0	\$0.0	\$0.1	\$0.0	\$0.0	\$0.7	\$0.1	\$0.2	\$1.2
Foregone Trips (Medical and Work)	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$1.0	\$0.9	\$0.8	\$0.7	\$0.6	\$0.7	\$4.7
Total Net Benefits	\$6.2	\$0.3	\$1.8	\$3.0	\$1.2	\$5.7	\$7.8	\$6.5	\$10.3	\$5.3	\$6.8	\$54.8
Benefit Cost Ratio	7.2	1.2	2.9	6.2	5.9	1.5	1.6	4.1	2.4	2.8	2.2	2.5
Net Present Value	\$5.3	\$0.0	\$1.2	\$2.5	\$1.0	\$1.8	\$3.0	\$4.9	\$6.0	\$3.4	\$3.6	\$32.7

6. Job Creation

As per USDOT Guidance, the jobs created through the project cannot be quantified as benefits; however, total employment and total earnings impacts are estimated. These are the sum of three categories of impacts:

- Direct effect – Includes the effects on industries that are directly purchased for project, including software.
- Indirect effect – Includes the effects on supporting industries that supply goods and services to the direct effect industries. This includes workers in industries that supply equipment and other materials that are needed.
- Induced effect – Includes the effect of direct and indirect workers spending their income on consumer goods and services such as food, shelter, clothing, recreation, and personal services.

The interpretation of the RIMS II employment multipliers used in the analysis is as follows. The final demand employment multiplier represents the total change in number of jobs that occurs in all industries for each \$1 million of output (in 2020\$) delivered to final demand by the industry in question. In this case, costs are allocated between Operations & Maintenance, Professional Services (for Design) and Construction, based on the capital cost allocation. The employment effects are expressed in job-years, which are defined as one job for one person for one year. For example, three job-years are equal to three people doing a job for one year, or one person doing a job for three years.

By applying 2012-2020 North Carolina Statewide RIMS II Multipliers, as purchased from the Bureau of Economic Analysis, to the appropriate costs, the project is expected to generate 1,001 total job-years, of which 816 are directly from the software and on-demand transit operations. These jobs are for the duration of the three-year analysis period and are expected to generate earnings of \$19.3 million. A summary and breakdown of the employment and earning impacts is shown below.

Exhibit 6– Employment and Earnings Impacts

	Total Employment Impact (Job-Years)	Direct Employment Impact (Job-Years)	Total Earnings (2020\$ M)
Software	20	8	\$1.4
On-Demand Transit Operations	981	808	\$17.9
Total	1,001	816	\$19.3

Appendix A List of Supporting Documents

AECOM, "BCA.xls" excel workbook

USDOT Benefit Cost Analysis Guidance 2022, <https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf>