

US 321 Calibrating Our National Network to Encourage Commerce and Tourism – 321 CONNECT

BENEFIT COST NARRATIVE

This Benefit-Cost Analysis (BCA) technical memorandum evaluates the long-term benefits and potential disbenefits associated with the US 321 Calibrating Our National Network to Encourage Commerce and Tourism (321 CONNECT) Project (Project). The structure of this document parallels the Project Outcome Criteria document as described in the Notice of Funding Opportunity (NOFO). The document divides benefits and disbenefits into qualitative and quantitative. For quantitative items, estimates were prepared in accordance with the U.S. Department of Transportation (USDOT) BCA Guidance for Discretionary Grant Programs (2026 Update) using total quantifiable project costs and benefits that are adjusted for inflation and then discounted to reflect the time value of money. Where ancillary data sources are used, there are detailed as appropriate in the relevant section(s).

The long-term quantifiable benefits are presented for the Project Outcome Criteria including: safety benefits, economic benefits (travel time savings), and state of good repair. Qualitative benefits are included in each section as appropriate, and described in the Project Outcome Criterion of Innovation.

The final section summarizes the anticipated benefits and costs of the 321 CONNECT project and calculates the overall Benefit-Cost Ratio.

YEARS OF ANALYSIS

The analysis is based on an estimated construction timeline from late 2028 through 2031, with 2032 acting as the first full year post-construction. A benefits period of 2031-2061 was used. This 30-year benefits period is consistent with the BCA Guidance for projects involving widening and other improvements of highways or similar facilities.

METHODOLOGY

Benefits are estimated in accordance with the BCA Guidance. Where no specific approach was provided in the Guidance, NCDOT used best practices and research data as specified in the assumptions and methodology for each measure. The benefits quantified in the BCA use 2024 dollars (as advised by USDOT). Benefits for each project element are described within the benefit categories. In summary, the BCA was created by:

1. Identifying the Project's benefits and costs in terms of proposed improvements versus a no-build scenario;
2. Deriving current and forecasted use levels for the baseline and the "build case";
3. Denominating all benefits and costs in constant 2024 dollars;
4. Assuming inflation based on the Implicit Price Deflators for Gross Domestic Product;
5. Discounting dollar amounts by 7.0% to reflect the time value of money; and

6. Setting an appropriate analysis period of 30 years for the Project's development, construction, and subsequent operational service.

ANALYSIS ASSUMPTIONS

A list of assumptions for the project is provided in the Benefit-Cost Analysis (BCA) workbook and are summarized in Table 1, which displays the generalized BCA input values provided by the USDOT for a variety of categories that include auto occupancy rates, vehicle values of time, and pedestrian and bicycle values. Table 2 shows bicycle/pedestrian assumptions. Table 3 shows project-specific calculated benefits. Most of these project-specific assumptions come from the Greater Hickory Travel Demand Model and the 2023 Crash Strip Analysis. Other sources are noted as appropriate.

Table 1. Input Values from BCA Guidance

Input	Value
General Assumptions	
Analysis Period (Years) - Projects Involving Full Reconstruction of Highways	30
Discount Rate	7%
Dollar Year	2024
Auto Occupancy (Passenger Vehicles, All Travel)	1.52
Auto Occupancy (Trucks)	1.00
Truck Value of Time (Hourly Value)	\$37.20
Passenger Vehicle Value of Time (Hourly Value)	\$20.10
Operating Costs per Mile (Light Duty Vehicles)	\$0.56
Operating Costs per Mile (Commercial Trucks)	\$1.23
Safety - Crash Data Assumptions	
O - No Injury	\$5,500
C - Possible Injury	\$122,400
B - Non-incapacitating	\$256,300
A - Incapacitating	\$1,302,300
K - Killed	\$13,700,000

Table 2. Pedestrian and Bicycling Benefits Assumptions

Assumption	Value	Note
Expanded Sidewalk (per foot of added width)	\$0.13	
Dedicated Cycling Lane (per cycling mile)	\$2.09	
Value per Induced Walking Trip (Ages 20 - 74)	\$8.36	Assumed 68% of trips within age range
Value per Induced Cycling Trip (Ages 20 - 64)	\$7.45	Assumed 59% of trips within age range
Share of trips induced from non-active mode	89%	

Note: Dollar Values are in 2024 - dollar values. 1 Value from https://www.fhwa.dot.gov/tpm/guidance/avo_factors.pdf 2 Value from <https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis>

Table 3 - BCA Calculation Inputs - Project-Specific

Input	Value	Source
Annual Average Daily Traffic Volumes (AADT)	Varies by Scenario	NCDOT Traffic Count Database System; Greater Hickory Travel Demand Model
Compound Annual Growth Rate (Weighted average rate of all forecast roadway segments)	1.56%	Greater Hickory Travel Demand Model
VHT/VMT values in vicinity of US 321 CONNECT Project	Varies by Scenario	Greater Hickory Travel Demand Model
Crashes (categorized by type) from 2/1/2014 to 1/31/2024	Varies by Crash Type	NCDOT Traffic Engineering Accident Analysis System Strip Analysis Report
Crash Reduction Factor (CRF) ID 2.3.1 and 2.4.1	0.64	NCDOT Traffic Safety Group

BENEFITS

Criterion #1: Safety

Crash Cost Savings

An in-depth crash strip analysis report was completed for the project based on the 10-year period from February 1, 2014 to May 31, 2024. The 10-year period was selected to minimize effects of Covid 19 traffic reductions in 2020. The crash analysis assessed all 3,961 crashes that occurred during this time, including a breakdown by crash type – fatal, non-fatal injuries and property

damage only crashes (types A, B, and C). A summary of the crash analysis is summarized in the Safety Data tab in the provided BCA workbook.

The crash analysis detailed 5 fatal crashes, 993 injury crashes, and 2,969 property damage crashes. Of the crashes detailed, 2,341 were either rear-end/slow stop crashes. These crash types are often indicative of congested traffic condition. An additional 151 incidents were left-turn same-lane or different lane crashes. These crash types can be expected to decrease with the improved traffic flow associated with RCI interchanges and removal of left turns. Of the listed crashes, 124 indicated that at least one vehicle was traveling in excess of 55 mph. Signalized interchanges have been shown to both improve traffic flow as well as to reduce overall speed. Some extreme speeding events may not be fully addressed by signal progression alone; however, coordinated signal timing and access management are expected to reduce speed variability, conflict points, and stop-and-go conditions across the corridor.

The analysis found that U-4700A Project exceeded the statewide urban arterial average crash rates for total crashes, non-fatal injury crashes, night crashes, and wet weather crashes. Future Year No-Build and Build crash estimates were projected by applying study-specific crash ratios to forecasted vehicle miles traveled (VMT) to produce estimates of different crash types in the future. Benefit values were estimated by using a combination of monetized values per injury level.

It has been shown that an increase in shoulder width, as provided by the Project, will greatly enhance the safety of drivers on the facility. After a review of multiple Crash Reduction Factors (CRFs) from the NCDOT Traffic Safety Group (refer to Table 4), it was determined that a 19% reduction in crashes for the Project facility is a reasonable estimate based on CRF ID 4.15.6 for widening shoulder widths to meet current standards. **Using the factors previously listed, the total safety benefit savings associated with crash reductions were estimated to be \$94.6 million.**

Table 4 - Project Crash Reduction Factor

ID	Counter Measure Description	CMF	Expected Crash Reduction	Application
2.3.1	Signalized to Signalized RCI	0.5		
2.4.1	Two-Way Stop at Unsignalized RCI	0.78		
	Used in BCA	0.64	36%	CRF applied to Build Scenario

Source: [North Carolina Project Development CRF Information](#)

In 2023, [NCDOT's Traffic Safety Unit](#) completed a safety study of 31 RCIs that were constructed without traffic signals in North Carolina between 2009 and 2017. The study found that this intersection type:

- Reduced total crashes by 50%
- Reduced frontal impact crashes (head-on or T-bone crashes) by 80%. These crash types are associated with serious injuries.

A [2010 study by NCDOT](#) found that RCIs also increased traffic throughput, with an average reduction in travel times of 20% when traveling through a signalized RCI. There was a minor increase for drivers on minor arterials adjacent to signalized RCIs, but that average was only 20 seconds more. NCDOT has published [crash reduction factors](#) associated with various improvements, including RCIs.

RCIs not only provide safer crossings for bicyclists and pedestrians; they also allow cities to synchronize traffic signals to control vehicular speed. If a traveler drives at the posted speed, they will encounter green traffic signals throughout the signal-controlled corridor. If they exceed the speed limit, they will encounter a red traffic signal at the next controlled intersection. Over time, drivers adjust to this and are more likely to maintain the posted speed. This can also reduce the number and intensity of vehicular crashes. In the past 10 years, NCDOT reports that in addition to bicycle and pedestrian crashes on US 321, there have been [19 other types of fatal or serious crashes reported](#). Of those crashes, four resulted in fatalities.

Research cited by FHWA shows that a 10% reduction in vehicle speed is associated with a 15% reduction in crash likelihood (Cambell, et. al., 2012). Based on the proposed RCI, improvements to US 321, a reduction of crashes on the US 321 corridor of 20%, in addition to that cited above, is considered to be a reasonable decrease in crash reductions across crash types. The RCI benefits will provide qualitative benefits beyond the projected 30-year analysis period.

In addition to the quantitative benefits detailed above, the replacement of the at-grade Caldwell County Railroad with a grade-separated crossing eliminates the possibility of rail/vehicle collisions on US 321.

Health and Amenity Benefits

There are current safety issues specific to bicyclists and pedestrians along US 321 and intersecting routes. Since 2007, NCDOT records document six bicycle and 19 pedestrian crashes on or approaching the facility. This has resulted in four fatalities and 17 crashes resulted in injuries (from possible injuries to serious injuries). The RCI design of the U-4700A improvements has been shown to reduce bicycle and pedestrian crashes.

The U-4700A Project will include new active transportation infrastructure. This includes the following improvements:

- Pedestrian accommodations at the proposed 2nd Avenue SW interchange and other intersections by converting facility to an RCI (included as qualitative).

- Converting the existing northbound Catawba River Bridge to a bicycle/pedestrian only facility. The bridge has a roadway width curb to curb of 28 feet and is 825 feet long, for a total area of 23,100 square feet when considering just the structure. Including the logical tie-in points to the City of Hickory's Riverwalk Greenway (currently open) on the south side of the Catawba River and Limbaugh Lane on the north side, the total distance that will be opened to cyclists and pedestrians is approximately 1,200 feet. This would provide 0.23 mile of cycling lanes at \$1.86 per cycling mile and 1,200 feet of at least 20 feet of sidewalk at \$11 per foot.

These new pedestrian and bicycle facilities will provide improved connections and may begin to restore communities that were divided by the construction of US 321. There are 11 census tracts immediately adjacent to the U-4700A corridor that include 14,930 occupied housing units (per the 2020 Census). It is assumed that 75% of these housing units are within the project study area and that each household will make 5.5 trips/day/ household (Source: Bureau of Transportation Statistics).

It is assumed that reconnecting these communities will lead to a travel mode shift of 3% of all trips to be pedestrian trips and 2% of all trips to be bicycle trips. Additionally, there will be mortality reduction benefits for the new bicycle and pedestrian trips. Exhibit 1 details the specifics of these assumptions.

Altogether, the addition of a pedestrian bridge would bring a total benefit of \$2.1 million in non-motorized vehicle activity, as calculated from the addition of the bridge beginning in the first year of project completion (2023).

Criterion #2: Economic Competitiveness and Opportunity

The proposed widening of US 321, combined with replacement of the deficient bridges over the Catawba River, is therefore an economic competitiveness project as much as a transportation project. Official NCDOT materials state that segments of US 321 between Hickory and Lenoir already experience congestion and that many intersections operate at LOS E and F, conditions projected to worsen without improvement.

The U-4700 project will widen the facility to six lanes and eliminate the current at-grade crossing of the Caldwell County Railroad. It will also replace and double track the Norfolk Southern AS line bridge of US 321. More reliable truck trips improve scheduling, reduce buffer time in deliveries, strengthen warehouse and distribution performance, and improve the corridor's attractiveness for future industrial investment.

Travel Time Savings from Project Benefit

The 321 CONNECT project will result in travel time savings for cars and freight vehicles in the Hickory area. US 321 is a part of the National Highway System and is classified as a North Carolina Strategic Transportation Corridor (Corridor D). Corridor D connects I-85 and I-40 to northwestern North Carolina (the Boone area and points north and west), providing vital linkages for freight and tourism. Truck traffic accounts for 8% of vehicle travel along the U-4700A corridor.

Vehicle hours of travel (VHT) – defined as total travel time in hours for passenger cars and trucks – was estimated for the No-Build and Build scenarios in the future year (2050). The difference between these two scenarios provides the foundation to quantify the hours saved for passenger cars and trucks. Travel time savings benefits were estimated using total travel time saved by autos and trucks at a value of \$20.10 per hour for passenger vehicles and \$37.20 per hour for trucks. **The combination of passenger and freight vehicle time-savings provides an estimated savings of \$102.5 million due to the reduction in VHT.**

Avoided Detour Freight Disruption Savings

The avoided freight disruption savings were estimated by the amount of tonnage on the future year no-build volume percentage of trucks estimated per year. This was used to calculate avoided shipper's costs and freight reliability costs associated with an avoided detour. For the purpose of the benefit-cost analysis, a bridge failure rate of 2%/year was used. **The total estimated benefits from the avoidance of offsite detours were \$109.6 million.**

Criterion #3: State of Good Repair

Operations and Maintenance Cost Savings

Due to the limited nature of federal and state transportation funds, it is critical that grant funding results in facilities that require minimal maintenance after construction. In the case of U-4700A, a no-build or “do-nothing” alternative would result in substantial ongoing maintenance operations to keep the US 321 corridor in good operating condition. For this reason, INFRA funding is critical to maintain the construction schedule of U-4700A.

This is exemplified by the maintenance requirements of the bridges crossing the Catawba River. The bridge inspection report in 2022 classified the substructure as 4 (poor condition) with the deck rated as 5 (fair condition) and the superstructure rated as 6 (fair condition). The facility, which was constructed in 1962, is considered structurally deficient. The inspection noted metal deterioration in one location, which is considered a critical find, as well as ten additional items that were assigned as priority maintenance. Cracking was noted in the surface asphalt of the structure, which required additional maintenance activities. NCDOT recently completed a rehabilitation project of the Catawba River southbound bridge on US 321. The total cost of the project was \$2,674,024. This extensive work does not solve all of the issues with the structure. Based on the April 26th NCDOT Bridge Inspection Report, the superstructure of the facility had declined to a 5 (Fair condition), while the deck and substructure are classified as 7. Spalling and cracks are still noted on the bridge deck and corrosion is noted on several plate girders. Exposed REBAR was also documented.

The northbound bridge (0366) was also inspected in June 2022. The deck and superstructure were rated as 4 and the substructure was rated as 5. The bridge is also considered to be structurally deficient. The structure, which was built in 1983, has corrosion and cracking, with some exposed rebar noted. A total of nine items were assigned as priority maintenance activities. Repairs raised the 2026 rating of the facility of the deck and superstructure to 5 and 6, respectively, while the substructure declined to a rating of 4.

In the draft North Carolina Statewide Resilience Improvement Plan currently being reviewed by FHWA, US 321 is listed as a “High Criticality Corridor.” The 321 CONNECT project is designed to ensure the improved resilience of this critical facility. 321 CONNECT crosses the Catawba River, a vital resource as well as a noted recreational site. As part of the safety improvements for the project, US 321 will be grade-separated from the railroad just south of the river. This will necessitate raising the new bridges over the Catawba River by 25 feet. This height increase ensures more resilient structures that will retain connectivity even under more extreme precipitation events. A tributary of the Catawba River, Frye Creek has a floodplain that crosses US 321. As shown in Figure 4, the stream banks are overgrown, which contributes to flooding concerns. Recent years have seen an increase in intensified precipitation events in North Carolina. This trend is expected to continue. This project will allow NCDOT to update the roadway drainage system along US 321. 321 CONNECT will update undersized and overgrown drainage structures, providing increased storage capacity for stormwater and reducing flooding concerns along Frye Creek and other streams along US 321. These improvements are consistent with Objective 2 of the National Climate Resilience Framework – Increase resilience of the built environment to both acute climate shocks and climate stressors.

Operating cost savings were estimated based on the cost of the Build scenario future operating and maintenance costs in comparison with the current state of structures and that associated cost. The total cost savings are \$49.9 million.

Avoided Detour Travel Time Savings

Travel time savings are calculated from the assumption of a detour being necessary in the event of a bridge failure. For the purpose of the benefit-cost analysis, a bridge failure rate of 2%/year was used as a conservative estimate based on the bridge’s current and expected future year ratings. The current route is 4.8 miles with a drive time of 9 minutes as shown in Figure 1. The detour for passenger vehicles would divert 50% of those on a 18.6-mile route with a drive time of 40 minutes as shown in Figure 2. 100% of heavy vehicle traffic would be diverted on a 58.2-mile route with a drive time of 80 minutes as shown in Figure 3. The savings are the difference of additional VHT in event of detour compared to existing route and total to \$17.0 million.

Figure 1: Current U-4700A

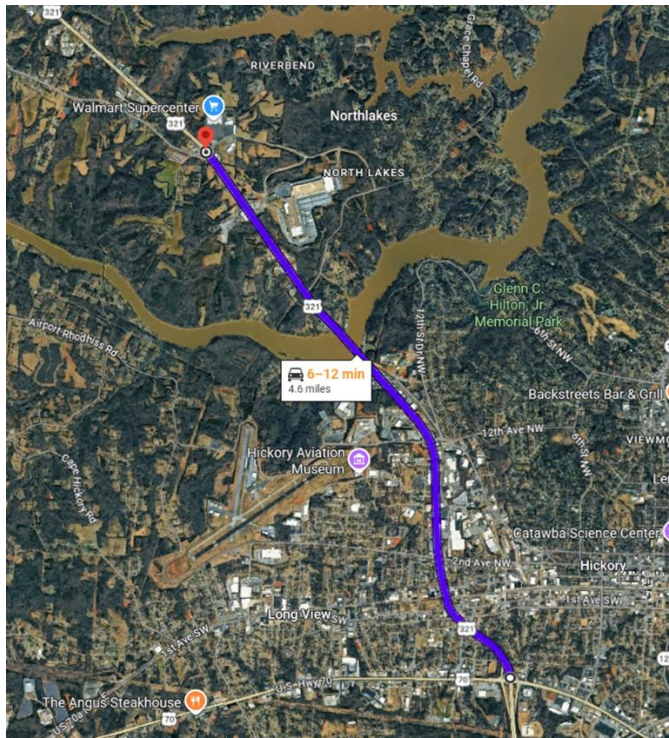


Figure 2: Passenger Vehicle Detour Route

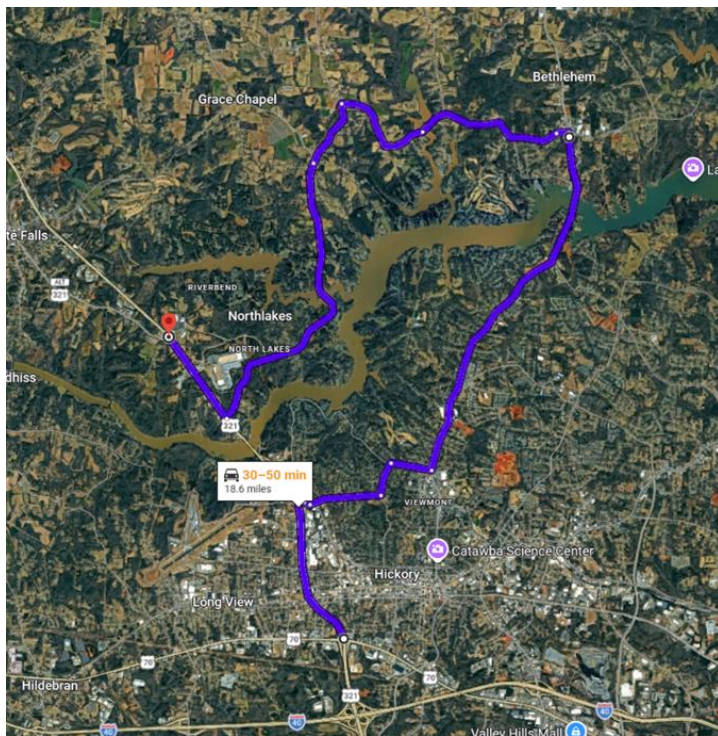
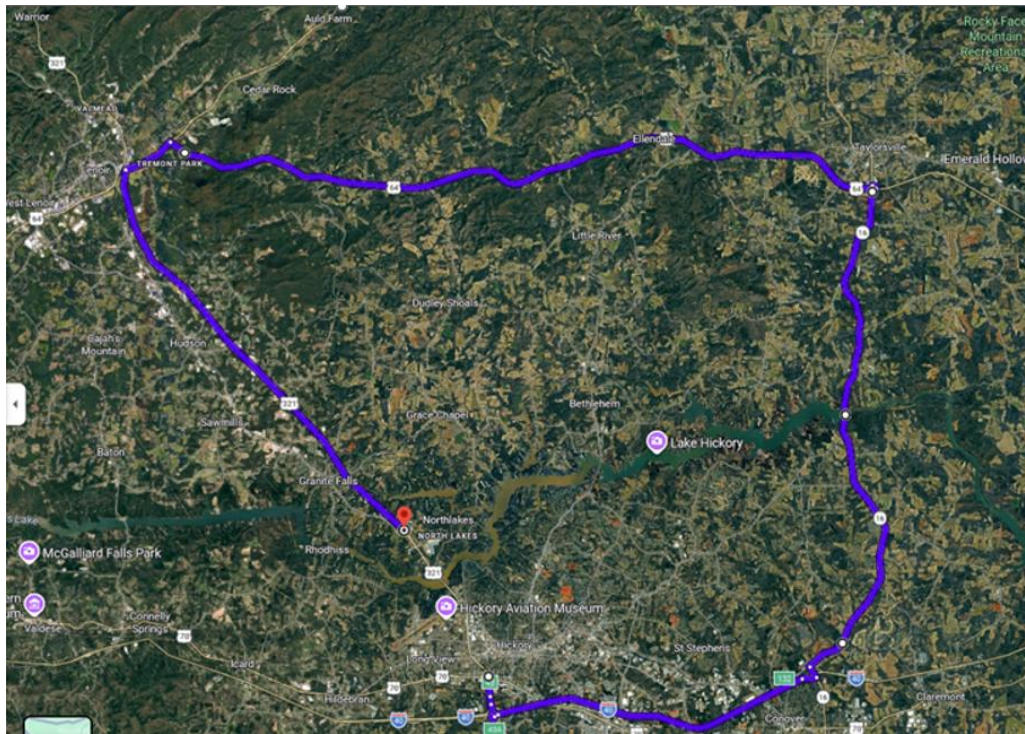


Figure 3: Heavy Vehicle Detour Route

Given the time savings as estimated using total travel time saved by autos and trucks at a value of \$20.10 per hour for passenger vehicles and \$37.20 per hour for trucks, the total benefits anticipated from avoided detours are \$102.4 million.

Avoided Detour Operating Cost Savings

Operating cost savings are calculated from the assumption of a detour being necessary in the event of a bridge failure. For the purpose of the benefit-cost analysis, a bridge failure rate of 2%/year was used as a conservative estimate based on the bridge's current and expected future year ratings. The current route is 4.8 miles with a drive time of 9 minutes. The detour for passenger vehicles would divert 50% of those on a 18.6 mile route with a drive time of 40 minutes. 100% of heavy vehicle traffic would be diverted on a 58.2 mile route with a drive time of 80 minutes. The savings are the difference of additional VHT in event of detour compared to existing route. **In total there is an estimated \$9.4 million in savings associated with reduced operating costs from avoiding an offsite detour in the future.**

The structures over the Catawba River are designed to last for 75 years, far beyond the 30- year period of the BCA analysis. **This provides an estimated residual value of \$12 million.**

In addition to the quantified state of good repair elements discussed above, there are qualitative benefits associated with the 321 CONNECT project.

Criterion #4: Innovation

Highway widening projects generally induce travel, as detailed in Criterion 3. However, it is often the case that much of the increased traffic is the result of traffic from other parts of the network moving to the faster, more efficient system.

However, the project was designed to provide specific environmental improvements. The replacement bridges over the Catawba River are higher, replacing the at-grade Caldwell County Railroad with a grade-separated crossing, eliminating idling emissions when US 321 is closed for train crossings. In addition, the higher bridge provides greater resiliency in the case of flooding events. Care was taken during project design to ensure the new structures would mimic the pier spacing of the current northbound bridge on US 321. This measure was suggested by resource agencies and allows for safer boating on the Catawba River as well as a more consistent channel for aquatic life. In addition, NCDOT Divisions 11 and 12 encourage the use of recycled asphalt and concrete during construction, as well as the use of warm mix asphalt, as appropriate.

Innovative Solutions for Resiliency and the Environment

In the North Carolina Statewide Resilience Improvement Plan approved by FHWA (April 2024), US 321 is listed as a “High Criticality Corridor.” If the 321 CONNECT project is funded, NCDOT will install a flood gauge at Frye Creek, which will be connected to North Carolina’s Flood Inundation Mapping and Alert Network for Transportation (FIMAN-T). FIMAN-T was developed as a partnership between NCDOT and NC Emergency Management (NCEM) to provide NCDOT officials and emergency management stakeholders with real time and forecasted flood inundation depths along roads, bridges and other NCDOT assets in support of risk-based decision-making during flooding events. The tool provides visualization and metrics for roadway inundation, bridge hydraulic performance, and identification of potentially impacted NCDOT assets. The system reports critical emergency response information, such as bridge freeboard (the distance between the water surface and the bridge’s low chord elevation), allowing for a more informed response by NCDOT, NCEM and other stakeholders.

BridgeWatch is also an online application service that allows NCDOT to proactively monitor floor levels and rainfall conditions conducive to flooding at valuable bridges and culverts. These internal tools, in combination with DriveNC.gov, allow DOT staff to send customized electronic alerts via cell phones, emails, application dashboards, etc. when roadways and bridges are experiencing dangerous or critical conditions.

The 321 CONNECT project is designed to ensure the improved resilience of this critical facility. These benefits qualify as qualitative.

The 321 CONNECT project will provide increased ability to adapt to climate change. Drainage along the entire Project will be upgraded, allowing for greater storage during flood events. Recent years have seen an increase in heavy rainfall events in North Carolina and this trend is expected to continue.

Innovative Financing Solutions

While all states struggle to finance needed transportation projects, the needs of North Carolina are particularly complex. In addition to managing the second largest roadway system in the United States, the state is still working to restore western North Carolina’s transportation

network following the devastation of Hurricane Helene. The state has pursued several innovative financing tools to meet project needs. To finance the purchase of right of way for the U-4700 project, NCDOT utilized Grant Anticipation Revenue Vehicle (GARVEE) bond financing. GARVEE bonds are an FHWA-recognized transportation finance tool that used future Federal-aid reimbursements to generate upfront capital and accelerate delivery of eligible highway projects.

Innovative Construction Techniques

NCDOT will explore the use of recycled concrete and innovative bridge materials to reduce materials costs and potentially extend the effective lifetime of the bridge. As part of an Accelerated Innovation Deployment Demonstration (AID) grant, NCDOT recently utilized glass fiber reinforced polymer bridge deck technology on the [Harkers Island Bridge](#). Such materials are corrosion resistant and can allow for structural health monitoring of the bridge by embedding fiber optic sensors in the bridge deck.

Innovative Agency Coordination

U-4700 participated in NCDOT's NEPA/Section 404 Merger Process. Under this process, NCDOT meets with resource agency representatives at key points during project development to reach concurrence on:

- Purpose and Need and Study Area Defined
- Detailed Study Alternatives Carried Forward
- Bridging Decisions and Alignment Review
- Least Environmentally Damaging Practicable Alternative
- Avoidance and Minimization Measures
- Hydraulic Design Review
- Permit Drawing Review

The Merger Process is designed to provide increased coordination with the goal of expediting permitting. No outstanding concerns have been identified that could impact project permitting. NCDOT has developed a project commitments dashboard which ensures that commitments made during project development are tracked and followed during and after construction. As discussed in the Requirements document, NCDOT has developed a comprehensive schedule for 321 CONNECT. The Department is confident not only of initiating construction activities within 18 months of funding obligation, but also of delivering this complex project completely in FY 2030.

BCA SUMMARY

The analysis resulted in a 2.21 BCR and a positive Net Present Value of \$217.3 million (refer to Table 5) over 30 years. This is considered a “High” economic analysis rating (the project's benefits will exceed its costs with a BCR of at least 2.0). NCDOT has concluded that these benefits reasonably justify the costs of US 321 CONNECT.

Table 5 - Total Project Benefit-Cost Analysis

Item	Value
Project	US 321 CONNECT
Capital Costs (2026\$) (includes previously realized costs)	\$357,450,000
Project Costs (NPV \$2024)	\$179,771,137
Total Net Benefit	\$397,109,875
Total Net Benefit (NPV \$2024)	\$217,338,738
Benefit-Cost Ratio	2.21

Table 6: Project Benefits Summary (in NPV)

Benefit Category	Value
Operations and Maintenance Cost Savings	\$49,886,921
Crash Cost Savings	\$94,594,875
Travel Time Savings from Project	\$102,457,193
Avoided Detour Travel Time Savings	\$16,989,864
Avoided Detour Operating Costs Savings	\$9,446,271
Non-Motorized Traveler Amenity & Mortality Savings	\$2,114,352
Avoided Detour Freight Disruption Savings	\$109,628,560
Residual Value	\$11,991,838
Total Benefits	\$397,109,875