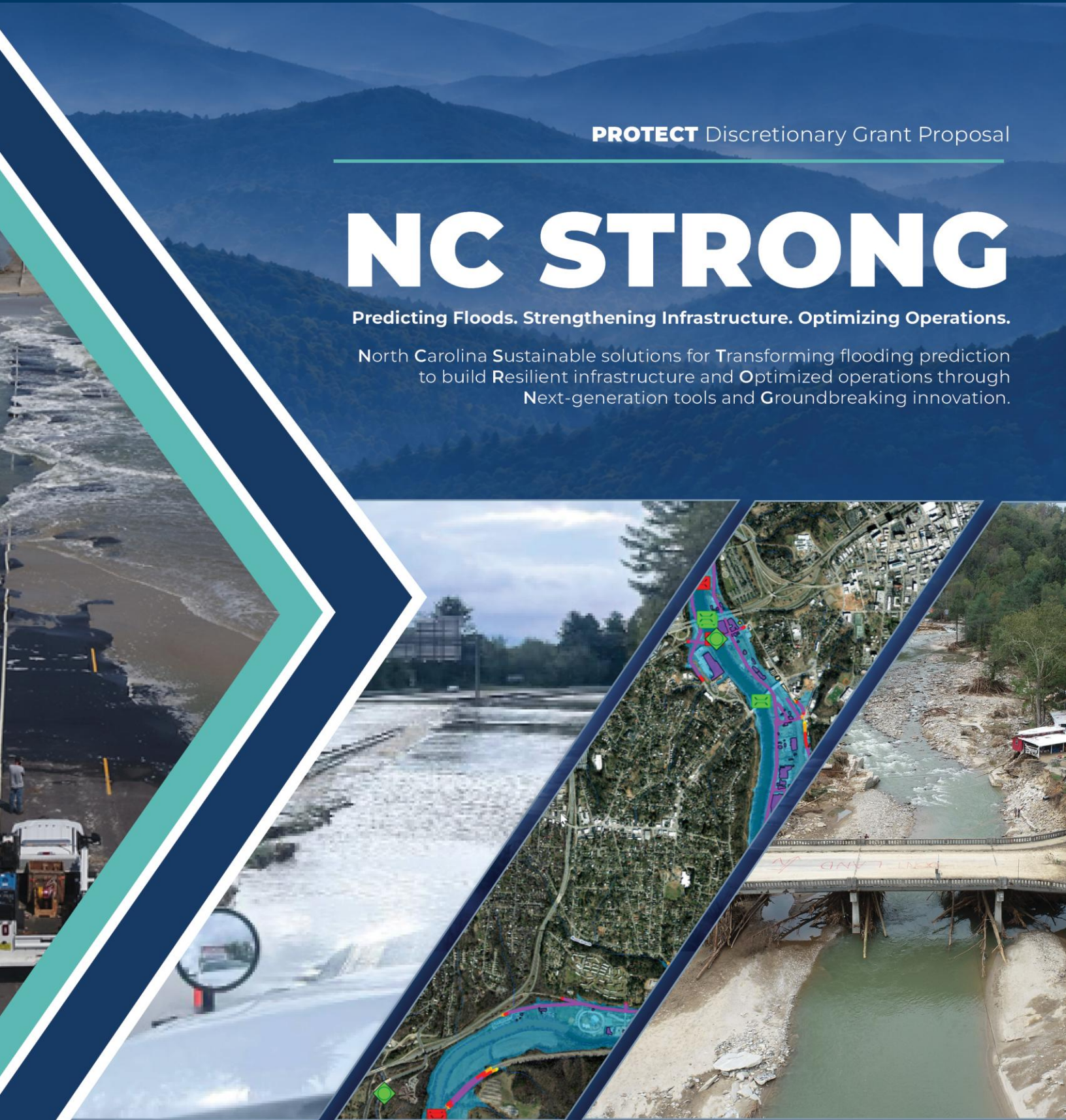


NC STRONG

Predicting Floods. Strengthening Infrastructure. Optimizing Operations.

North Carolina Sustainable solutions for Transforming flooding prediction to build Resilient infrastructure and Optimized operations through Next-generation tools and Groundbreaking innovation.



I. Summary



Project Summary Table

Project Title	NC STRONG: N orth C arolina S ustainable solutions for T ransforming flooding prediction to build R esilient infrastructure and O ptimized operations through N ext-generation tools and G roundbreaking innovation
Lead Applicant Name	North Carolina Department of Transportation (NCDOT)
Lead Applicant Type	☒ A State or political subdivision of a State.
Type of Grant(s)	☒ Planning
Planning Activity Type	☒ Resilience planning, predesign, design, or data tools ☒ Technical capacity building ☒ Evacuation planning and preparation
Project Area	State of North Carolina, all 100 counties and all 14 NCDOT Divisions. FIMAN and BridgeWatch enhancements apply statewide. The T-SAPP surge and compound flooding model extension runs from the Atlantic coastline inland to I-95.
Amount of Funding Requested Under this NOFO	\$4,700,000
Total Project Cost	\$4,700,000
Which type(s) of natural hazards does the project address?	Tropical cyclones; storm surge; coastal flooding; riverine (fluvial) flooding; extreme precipitation and pluvial flooding; compound flooding arising from the coincidence of surge, tides, riverine flow, and rainfall; coastal erosion and wave action; sea level change; earthquakes; future weather events.
Which transportation modes are addressed by the project?	Highway (Title 23 facilities, including the Interstate System, the National Highway System, the National Highway Freight Network, and the State-maintained secondary system); public transportation (NCDOT Ferry Division - 7 routes and 13 ferry ramps); port access and intermodal connectors serving the Ports of Wilmington and Morehead City and the Military Ocean Terminal Sunny Point; Aviation; Rail.



Project Description

The North Carolina Department of Transportation requests \$4.7 million in PROTECT Planning Grant funding to enhance NC STRONG, a statewide transportation resilience initiative that will help North Carolina identify vulnerabilities, anticipate disruptions, protect critical infrastructure, support evacuation planning, guide emergency response, and inform future resilience investments.

North Carolina's transportation system faces recurring threats from coastal storm surge, riverine flooding, extreme rainfall, compound flooding, landslides, and coastal erosion. These threats endanger critical transportation assets including Interstate highways, Strategic Transportation Corridors, freight routes, ferry connections, military access routes, port connectors, bridges, and culverts. Recent events, including Hurricanes Florence and Helene, demonstrated how transportation disruptions can isolate communities, impede evacuations, delay emergency response, and disrupt regional and national supply chains.

NCDOT has already established a strong foundation for transportation resilience through the **Flood Inundation Mapping and Alert Network (FIMAN), the Transportation Surge Analysis Prediction Program (T-SAPP), and BridgeWatch.**

While these tools support transportation preparedness, response, and recovery, important gaps remain in transportation-impact mapping, compound flood forecasting, bridge and culvert vulnerability assessment, and coverage in ungauged or under-modeled areas.

NC STRONG will close these gaps through five integrated improvements:

1. Expanding FIMAN transportation-impact mapping,
2. Doubling T-SAPP's modeling coverage,
3. Enhancing BridgeWatch monitoring capabilities,
4. Introducing probabilistic flood forecasting, and
5. Integrating satellite-based Earth observation data.

Together, these improvements will provide communities, emergency managers, and transportation agencies with earlier, clearer, and more actionable transportation intelligence to improve preparedness, strengthen resilience, and maintain mobility during future disasters.

II. Project Information



Project Location

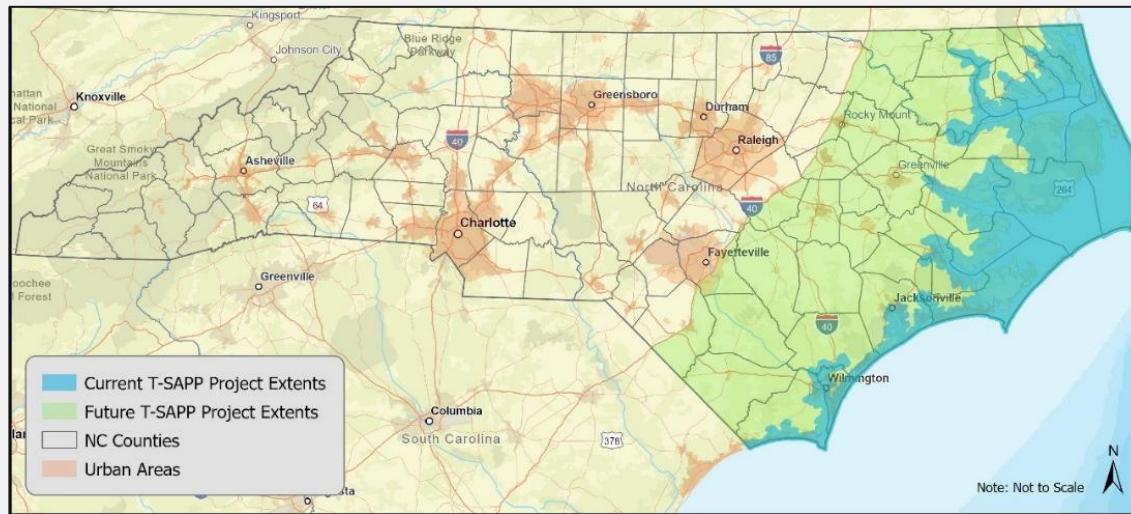


Figure 1: Project Location: T-SAPP Project Extents (Current and Future)

NC STRONG is a statewide resilience initiative serving all 100 counties, 14 NCDOT Divisions, approximately 81,000 miles of roadway, and more than 16,000 bridges and water crossings. The project encompasses transportation assets vulnerable to coastal storm surge, riverine flooding, extreme rainfall, compound flooding, landslides, and coastal erosion. FIMAN and BridgeWatch enhancements will be implemented statewide, while T-SAPP compound-flood modeling enhancements focus on eastern North Carolina between the Atlantic Coast and I-95 (Figures 1-3).

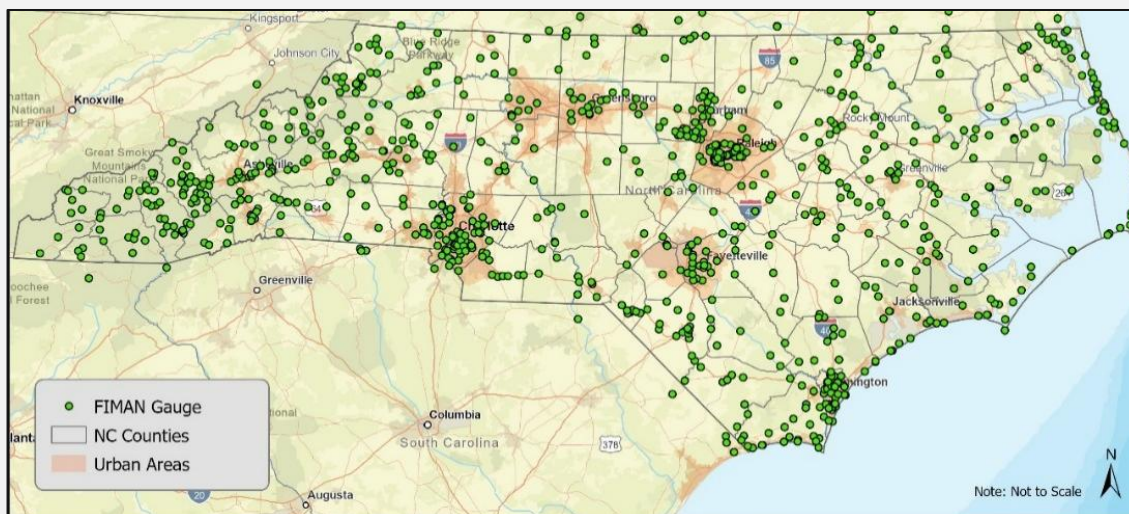


Figure 2: Project Location: FIMAN Gauge Network



Per Section C.3 of the FY24-FY26 PROTECT Notice of Funding Opportunity, "A project located in both an urban and a rural area will be designated as rural if the majority of the project's footprint is in rural areas." The majority of North Carolina is rural; therefore, the project is designated as rural.

As a statewide activity, the project area includes every FEMA-designated Special Flood Hazard Area in North Carolina, as mapped by the North Carolina Floodplain Mapping Program. There are approximately 9,600 square miles of Special Flood Hazard Area in North Carolina, equaling 18.2 percent of the state's land area.

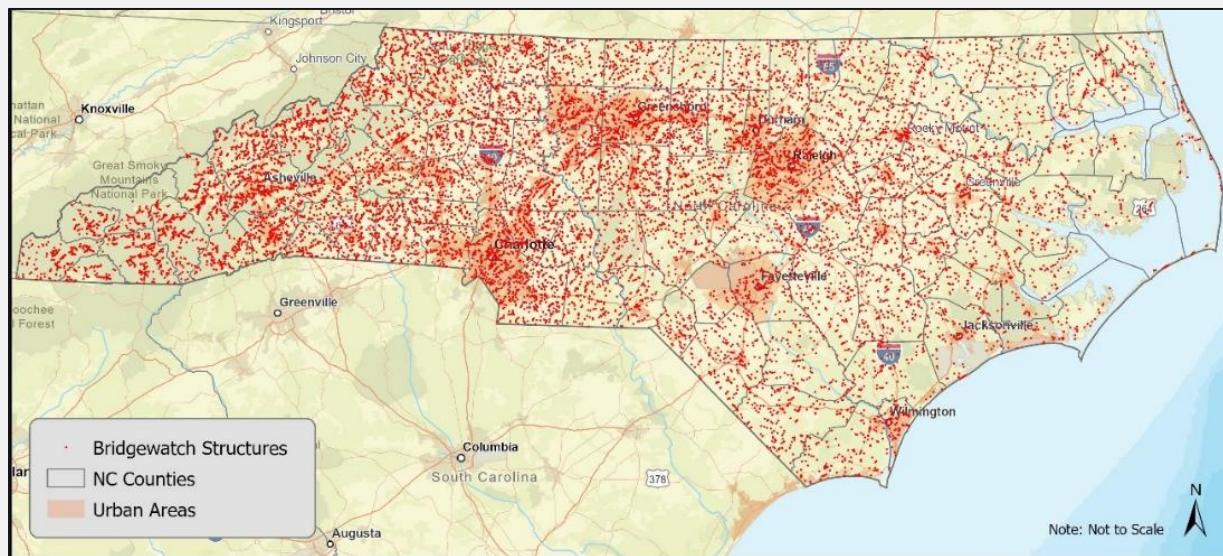


Figure 3: Project Location: BridgeWatch Enhancement Locations

Supporting Parties

NCDOT is the sole applicant and recipient. Supporting parties include:

- **UNC Center for Natural Hazards Resilience and the Renaissance Computing Institute:**
 - Development and calibration of the ADCIRC model for storm surge simulations to capture compound flooding and operate the ADCIRC Predictions System for deterministic forecasts of extratropical and tropical events threatening North Carolina. This model supports NCDOT's T-SAPP application.
- **North Carolina Emergency Management (NCEM):**
 - Owner and operator of the FIMAN gauge network, coordinating data integration and output use at the State Emergency Operations Center.



Eligible Facility Type

- ☒ Highway project eligible for assistance under Title 23;
- ☒ Public transportation facility or service eligible for assistance under chapter 53 of Title 49;
- ☒ Facility or service for intercity rail passenger transportation (as defined in Section 24102 of Title 49); or
- ☒ Port facility, including a facility that:
 - a. Connects a port to other modes of transportation;
 - b. Improves the efficiency of evacuations and disaster relief; or
 - c. Aids transportation. (23 U.S.C. § 176(d)(5) C).

Project Background

NCDOT requests PROTECT Planning Grant funding to advance **NC STRONG**, a statewide resilience-planning and data-tools initiative that will strengthen North Carolina's ability to identify transportation vulnerabilities, anticipate disruptions, support emergency response, improve evacuation planning, and inform future resilience investments. NC STRONG builds upon three existing operational transportation resilience systems: **FIMAN, T-SAPP, and BridgeWatch**.

North Carolina's transportation system is increasingly vulnerable to coastal storm surge, riverine flooding, extreme rainfall, compound flooding, landslides, coastal erosion, and changing environmental conditions. Recent disasters, including Hurricanes Florence and Helene, demonstrated how these hazards can close major transportation corridors, isolate communities, disrupt emergency access, interrupt freight movement, and cause significant economic losses. More than 2,500 roadway closures occurred during Hurricane Florence alone (Figure 4), highlighting the need for improved transportation-specific flood intelligence and resilience planning (Figure 5).



Figure 4: Interstate 40 in Wallace, NC (September 2018) Source: NCDOT



Over the past decade, NCDOT and its partners have invested in the development and operation of FIMAN, T-SAPP, and BridgeWatch to support transportation preparedness, response, and recovery activities. These systems currently provide flood observations, transportation-impact information, coastal flood forecasting, and bridge vulnerability monitoring used by transportation agencies, emergency managers, and local governments statewide. Prior investments exceeding several million dollars have established a strong operational foundation and demonstrated the effectiveness of transportation-focused flood intelligence. The NC STRONG initiative is nationally recognized by awards from ACEC and FHWA.

NC STRONG represents the next phase of this effort. The project will expand transportation-impact mapping, extend compound-flood forecasting inland toward I-95, enhance bridge vulnerability assessments, introduce probabilistic forecasting capabilities, and integrate satellite-based Earth observation technologies into transportation decision-making.

More information about the NC STRONG data-tools initiative, including program videos, one-pagers, support letters, and maps is available at [Connect NCDOT - NC STRONG](#).

No previously incurred costs are included in this request; all requested funds support future planning, modeling, validation, implementation, training, and resilience-planning activities.



Figure 5: US 64 over Broad River – Hurricane Helene – Bat Cave, NC (September 2024)

A blue-tinted landscape photograph showing a multi-span concrete bridge crossing a wide river. The bridge has several large rectangular piers. In the background, there are rolling hills and mountains under a cloudy sky. The foreground is filled with dense trees. The overall mood is serene and natural.

III. Budget & Funding



North Carolina Department of Transportation

NC STRONG Detailed Costs and Budget

FY24–FY26 PROTECT Discretionary Grant (FHWA-PROT-26-001) — Planning Grant

Task costs include a 10 percent contingency to account for cost uncertainty in multi-year cloud computing, data acquisition, and consultant labor rates and 6% for inc

WBS	Task / Subtask	Year 1	Year 2	Year 3	Year 4	Total
Task 1	Project Management, Grant Administration + Reporting					
	Project management, grant administration + reporting — grant agreement and task orders, ongoing project management, FHWA coordination + progress reporting					
1.1		\$41,125	\$41,125	\$41,125	\$41,125	\$164,500
	Task Total	\$41,125	\$41,125	\$41,125	\$41,125	\$164,500
Task 2	T-SAPP — Coastal + Compound Flood Forecasting					
	2.1 Operational Testing / Demonstration					
	Deterministic ADCIRC storm surge / compound forecasts (daily synoptic + tropical) delivered to T-SAPP + BridgeWatch					
2.1.1		\$40,625	\$40,625	\$40,625	\$40,625	\$162,500
	Deterministic (ADCIRC+SFINCS) + probabilistic (~20–30 member ensemble) forecasts with data extraction to T-SAPP + BridgeWatch					
2.1.2		\$36,125	\$36,125	\$36,125	\$36,125	\$144,500
	Cloud computing operations — hosting, compute + storage for operational forecast and AI-enabled workflows + testing					
2.1.3		\$11,225	\$11,225	\$11,225	\$11,225	\$44,900
	2.1 Subtotal	\$87,975	\$87,975	\$87,975	\$87,975	\$351,900
	2.2 Model + Data Enhancements					
	ADCIRC mesh — resolution enhancement, extension east of I-95, calibration + validation					
2.2.1		\$181,440	\$120,960	-	-	\$302,400
	Hindcast archive expansion with significant events from prior year					
2.2.2		\$48,240	\$40,200	\$40,200	\$32,160	\$160,800
	Integration of P-Surge + probabilistic flooding (ensemble, probability layers, visualization for NCDOT/NCM)					
2.2.3		\$136,080	\$90,720	\$45,360	\$30,240	\$302,400
	Compound flooding + inland extension to I-95 — fluvial inputs (NWM, river forecasts), ADCIRC+SFINCS, rain-on-grid / subgrid / mass conservation, validation					
2.2.4		\$177,065	\$177,065	\$101,180	\$50,590	\$505,900
	Cloud computing integration of AI solutions — AI-assisted forecasting, automated data ingestion + delivery to T-SAPP / BridgeWatch					
2.2.5		\$56,640	\$42,480	\$28,320	\$14,160	\$141,600
	2.2 Subtotal	\$599,465	\$471,425	\$215,060	\$127,150	\$1,413,100
	Task Total	\$687,440	\$559,400	\$303,035	\$215,125	\$1,765,000
Task 3	FIMAN — Flood Inundation Mapping + Alert Network					
	3.1 Operational Testing / Demonstration					
	FIMAN gauge network operations + forecast product demonstration					
3.1.1		\$65,875	\$65,875	\$65,875	\$65,875	\$263,500
	3.1 Subtotal	\$65,875	\$65,875	\$65,875	\$65,875	\$263,500
	3.2 Enhancements + Innovations					
	Coverage Expansion — gap analysis to identify potential new gauge locations; horizontal + vertical extension of existing inundation extents for enhanced coverage					
3.2.1		\$102,800	\$77,100	\$51,400	\$25,700	\$257,000
	Transportation Asset Impact Products — impact products for existing gauges without them; structure overtopping levels for consistency with BridgeWatch					
3.2.2		\$61,950	\$82,600	\$41,300	\$20,650	\$206,500
	Foundational Data Upgrades — updates to lidar, roadway alignment + bridge geometry data					
3.2.3		\$85,750	\$51,450	\$34,300	-	\$171,500
	Pilots + Emerging Technologies — SAR-based products; inland probabilistic modeling; gauge-based machine learning and/or physics-enabled AI forecasting + ingestion					
3.2.4		\$61,950	\$61,950	\$51,625	\$30,975	\$206,500
	MPO / RPO + community outreach and training					
3.2.5		\$31,050	\$25,875	\$25,875	\$20,700	\$103,500
	Evacuation scenario products for NCEM + county partners					
3.2.6		-	\$36,150	\$48,200	\$36,150	\$120,500
	Pre-season exercises with NCEM + county partners					
3.2.7		\$8,650	\$17,300	\$25,950	\$34,600	\$86,500
	3.2 Subtotal	\$352,150	\$352,425	\$278,650	\$168,775	\$1,152,000
	Task Total	\$418,025	\$418,300	\$344,525	\$234,650	\$1,415,500
Task 4	BridgeWatch — Bridge Vulnerability + Overtopping Alerting					
	4.1 Operational Testing / Demonstration					
	BridgeWatch platform operations + demonstration, monitoring + alert issuance statewide					
4.1.1		\$36,125	\$36,125	\$36,125	\$36,125	\$144,500
	Ingestion of T-SAPP, FIMAN + probabilistic forecast feeds into BridgeWatch					
4.1.2		\$18,125	\$18,125	\$18,125	\$18,125	\$72,500
	4.1 Subtotal	\$54,250	\$54,250	\$54,250	\$54,250	\$217,000
	4.2 Enhancements + Innovations					
	Statewide BridgeWatch threshold calibration					
4.2.1		\$214,000	\$128,400	\$42,800	\$42,800	\$428,000
	Strengthened ADCIRC-based BridgeWatch alerting					
4.2.2		\$85,200	\$113,600	\$85,200	-	\$284,000
	Probabilistic / SAR data integration into BridgeWatch					
4.2.3		\$85,200	\$63,900	\$42,600	\$21,300	\$213,000
	Machine learning + AI integration testing					
4.2.4		\$42,600	\$42,600	\$35,500	\$21,300	\$142,000
	Training + publications — user training, transferable schemas, tools + templates					
4.2.5		-	\$14,200	\$21,300	\$35,500	\$71,000
	4.2 Subtotal	\$427,000	\$362,700	\$227,400	\$120,900	\$1,138,000
	Task Total	\$481,250	\$416,950	\$281,650	\$175,150	\$1,355,000
PROJECT TOTAL		\$1,627,840	\$1,435,775	\$970,335	\$666,050	\$4,700,000

A blue-tinted landscape photograph. In the foreground, a multi-lane bridge with concrete pillars spans a wide river. The river has some marshy islands. In the background, there are rolling hills and mountains under a cloudy sky. The text "IV. Merit Criteria" is overlaid in white, bold font in the center of the image.

IV. Merit Criteria

Merit Criteria



Criterion 1: Program Alignment

Objective A: Enable Communities to Assess Vulnerabilities in Current and Future Weather Events, Natural Disasters, and Changing Conditions

North Carolina's transportation system is increasingly exposed to coastal storm surge, riverine flooding, extreme rainfall, compound flooding, landslides, and coastal erosion (Figure 6). Hurricane Florence and Hurricane Helene substantially disrupted Interstate highways, isolated rural communities, severed access to hospitals and emergency services, interrupted freight movement, and delayed recovery efforts. Hurricane Florence caused more than 2,500 roadway closures, including disruptions to I-40 and I-95, while Hurricane Helene highlighted the vulnerability of mountain communities served by limited transportation corridors.

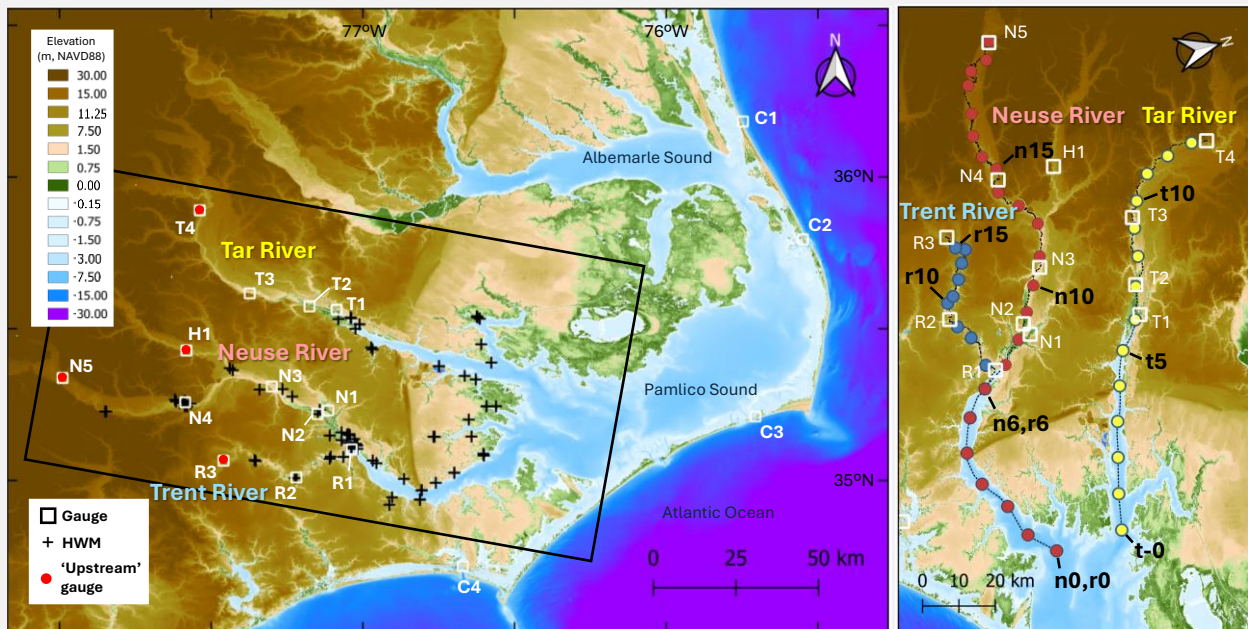


Figure 6: NC STRONG will provide expanded transportation intelligence and improved flood vulnerability awareness with the development of compound-flood modeling up many mainstem river basins including the Tar, Neuse, and Trent. These efforts will link FIMAN gauge readings to T-SAPP mapping and impacts as well as BridgeWatch alerting.

NCDOT has already established a strong foundation for transportation resilience through the FIMAN, the T-SAPP, and BridgeWatch. These operational tools support transportation preparedness, emergency response, asset monitoring, and recovery



activities across the state. However, significant gaps remain where transportation-impact mapping is limited, flood forecasting is constrained, structures lack supporting water-level information, or communities are in ungauged and under-modeled areas. These limitations reduce transportation agencies, emergency managers, and local governments' ability to fully understand transportation vulnerabilities before a disaster strikes.

NC STRONG expands transportation intelligence through five integrated improvements that provide earlier and more complete information regarding roadway inundation, bridge exposure, evacuation-route vulnerability, and transportation disruptions.

The value of these tools has already been demonstrated during real-world events. Prior to Hurricane Helene, NCDOT's flood-warning tools identified potential overtopping along I-40 near Asheville (Figure 7) nearly 48 hours before flooding occurred, allowing staff to monitor conditions and close the roadway before motorists were placed at risk. Enhanced forecasting and transportation-impact datasets also supported flood preparedness efforts within Asheville's River Arts District. Customized FIMAN alert thresholds for 47 businesses in the Arts District were developed which protected irreplaceable inventory and allowed for evacuation of vulnerable facilities before record flooding occurred.



Figure 7: FIMAN alerted NCDOT to the potential overtopping of I-40 outside of Asheville nearly 48 hours in advance, allowing for planned closure of the critical route and mitigating risk to unsuspecting travelers.

Communities will gain improved visibility into vulnerable roads, bridges, culverts, evacuation routes, freight corridors, ferry connections, military access routes, and other critical transportation assets. By building upon established systems already trusted and used by transportation and emergency management professionals like [DriveNC](#): North Carolina's interaction traffic information site, NC STRONG will help communities assess current and future vulnerabilities, understand the consequences of transportation disruptions, and strengthen resilience to natural hazards and changing conditions



Objective B: Enable Communities to Plan Transportation Improvements and Emergency Response Strategies to Address Transportation Vulnerabilities

NC STRONG is designed not only to identify transportation vulnerabilities, but also to increase communities' capabilities to act on that information. North Carolina's communities, particularly rural jurisdictions, Tribal communities, ferry-dependent areas, and mountain communities with limited route redundancy, often lack the specialized technical resources needed to independently assess transportation vulnerabilities and forecast transportation impacts. NC STRONG places advanced transportation resilience capabilities into systems that communities already use, allowing local decision-makers to access actionable transportation intelligence without requiring specialized modeling expertise.

The enhanced FIMAN, T-SAPP, BridgeWatch, probabilistic forecasting, and Earth observation capabilities developed through NC STRONG will directly support emergency preparedness, evacuation planning, continuity of operations planning, incident response, and post-disaster recovery activities. Improved intelligence regarding roadway inundation, bridge exposure, and network disruption will enable transportation agencies to plan detours, prioritize inspections, support closure decisions, improve public information, and coordinate emergency response activities before hazards impact the transportation system.



Figure 8: The Closure of a NCDOT Bridge in Yancey County in August of 2021 due to Tropical Storm Fred cutoff a major route in a rural community. Site-specific thresholds like those proposed under NC STRONG were established to monitor the vulnerable temporary bridge during construction.

The same information also supports longer-term transportation planning and investment prioritization. Repeatedly impacted corridors, vulnerable bridges and culverts, isolated communities, evacuation bottlenecks, and high-consequence transportation assets can be identified and evaluated for future resilience improvements (Figure 8).



NC STRONG builds on proven operational uses of transportation intelligence. In June 2023, a BridgeWatch alert on SR-1128 in Polk County prompted a post-event inspection that identified significant overtopping and scouring damage requiring bridge closure. During Hurricane Debby in 2024, BridgeWatch alerts were prioritized using bridge foundation and scour-critical data, allowing inspection teams to focus first on the structures facing the greatest risk.

By improving existing statewide decision-support systems rather than creating a new standalone platform, NC STRONG will rapidly deliver practical benefits to transportation agencies, emergency managers, local governments, Tribal communities, the military and the traveling public.

Criterion 2: Planning Activity Approach

Objective B: Resilience Planning and Data Tools

NC STRONG is a statewide resilience-planning and data-tools initiative that enhances North Carolina's ability to identify transportation vulnerabilities, anticipate disruptions, support emergency response, and guide resilience investments. Instead of a new platform, it expands three existing systems used by NCDOT and partners, increasing geographic reach, predictive ability, transportation intelligence, and operational value (Figure 9). The project also introduces innovative forecasting and observational tools to address flood-resilience gaps.

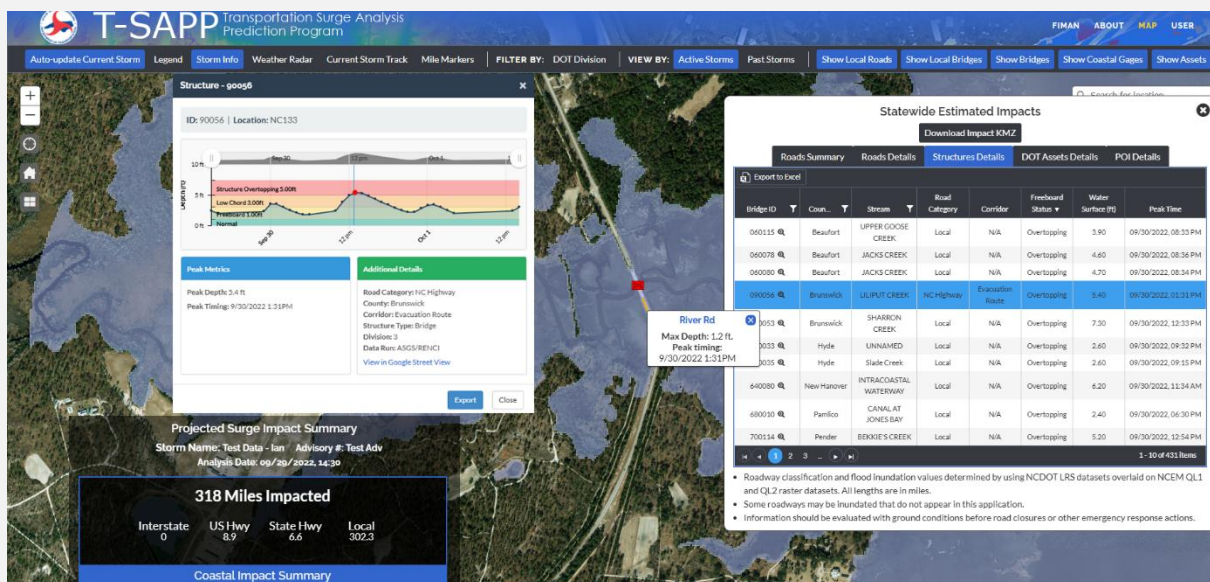


Figure 9: NC STRONG enhancements such as compound flooding, probabilistic modeling, and ADCIRC mesh refinement/expansion will leverage existing T-SAPP functionality to identify transportation network impacts based on new datasets to a larger area.



The project is organized around four coordinated work elements: (1) Project Management and Grant Administration; (2) T-SAPP Coastal and Compound-Flood Forecasting Enhancements; (3) FIMAN Transportation Impact Mapping Enhancements; and (4) BridgeWatch Bridge Vulnerability and Overtopping Alert Enhancements..

NC STRONG will fund the following expansions to NCDOT's suite of tools:

T-SAPP: Expand the modeling footprint inland to I-95, increasing coverage from 235 to 462 census tracts and improving analysis of storm surge, rainfall, and river flooding interactions. Improvements include ADCIRC mesh expansion (Figure 10), calibration, probabilistic flood forecasting, NOAA P-Surge integration, compound-flood simulations, AI forecasting workflows, cloud computing, and transportation-specific probability layers for decision-making.

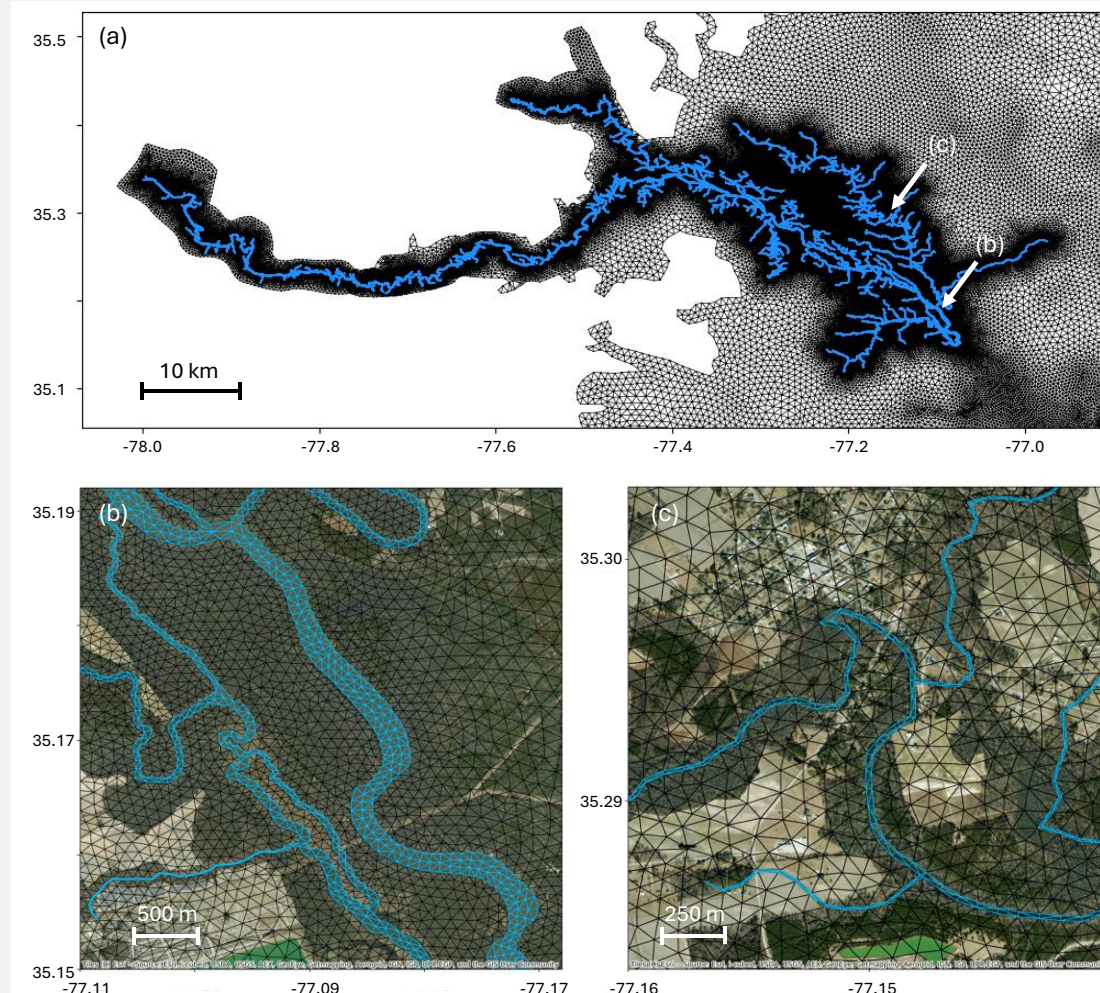
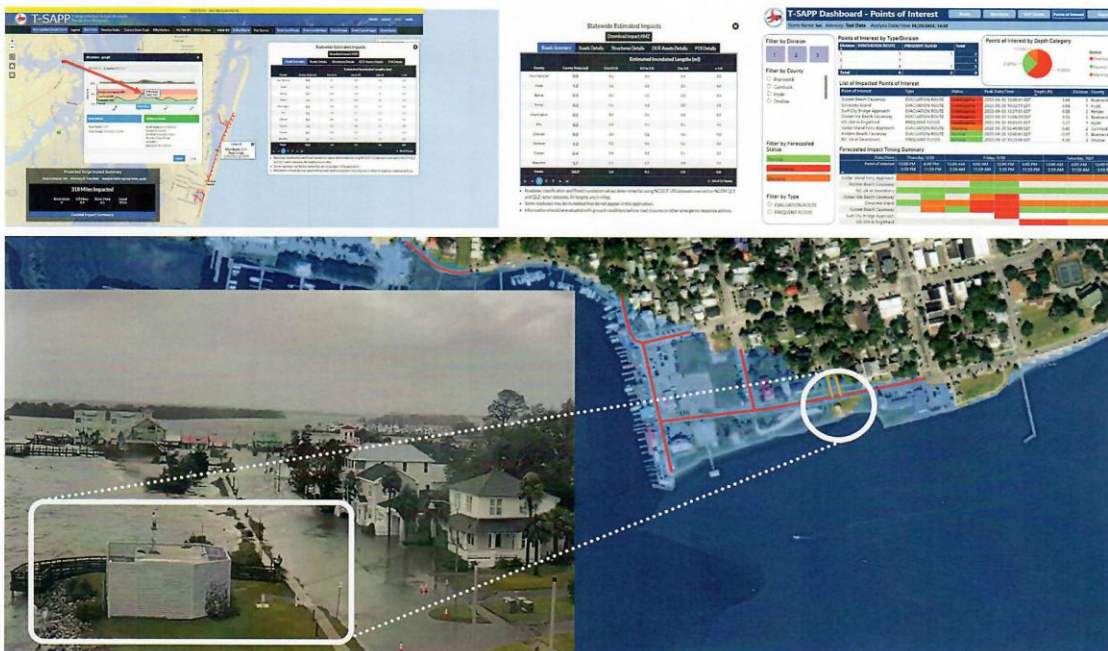


Figure 10: Detailed ADCIRC mesh generation to support compound-flood modeling along inland rivers will link FIMAN gauge readings to ADCIRC modeling and expand T-SAPP's current footprint while also enabling additional alerting capabilities in BridgeWatch.



2027 Engineering Excellence Award Winner



NCDOT Transportation Surge Analysis Prediction Program (T-SAPP)

| Statewide, North Carolina

On October 7, 2026, NCDOT's T-SAPP received a 2027 "Grand" Engineering Excellence Award from the American Council of Engineering Companies of North Carolina (ACEC/NC), recognizing its recent enhancements as an outstanding example of engineering achievement in the state. The award confirms that the foundation this project builds on is already delivering recognized value for North Carolina's transportation network.



FIMAN: Conduct a statewide gap analysis to find opportunities for expanded transportation-impact mapping and new monitoring sites. Enhancements include developing impact products at existing locations, expanding overtopping analyses, updating foundational data, piloting SAR observations, inland probabilistic and AI-supported forecasting, community outreach, MPO and RPO training, evacuation products, and pre-season exercises with emergency partners.

BridgeWatch: Conduct a statewide threshold calibration, strengthen ADCIRC alerting, integrate probabilistic forecasts and SAR data, test machine learning, train users, develop publications, and improve alerting at ungauged structures. Add support for temporary infrastructure, bridge replacements, and transportation asset monitoring.

NC STRONG leverages an extensive network of Federal, State, and local data sources. These include National Weather Service forecasts, NOAA coastal and meteorological information, stream and coastal gauges, National Water Model datasets, NEXRAD radar products, LiDAR-derived terrain, the DriveNC traveler information system, roadway geometry, bridge information, high-water marks, transportation asset inventories, road-closure records, historical flood archives, SAR observations, and existing FIMAN, T-SAPP, and BridgeWatch data resources. Historical events and hindcasts will calibrate, validate, and evaluate improvements. Future-condition planning will use scenario modeling, probabilistic forecasting, compound-flood simulations, and Earth observation tech to extend insight into ungauged and under-modeled areas.

Objective C: Resilience Planning for Surface Transportation Assets

CDOT and local partners with improved information regarding flood exposure, transportation consequences, and asset vulnerability across the State's transportation network.

The project will strengthen the ability to identify transportation assets most vulnerable to flooding and evaluate the frequency, severity, and consequences of disruption. Enhanced FIMAN transportation-impact mapping, expanded T-SAPP compound flooding analyses, improved BridgeWatch structure monitoring, probabilistic forecasting capabilities, and Earth observation datasets will collectively provide transportation agencies with a more comprehensive understanding of vulnerability under both historical (Figure 11) and future flood conditions. These data products will support evaluation of roadway segments, bridges, culverts, ferry facilities, evacuation routes, freight corridors, military access routes, and other critical transportation assets where failure could result in significant community, economic, or mobility impacts.



The resulting information will support development and prioritization of resilience strategies, including roadway elevation projects, bridge and culvert replacements, drainage improvements, monitoring enhancements, route redundancy investments, emergency-access improvements, operational changes, and nature-based solutions.

Within the Wilmington MPO region, the Town of Leland's Resilient Routes initiative demonstrates how transportation-focused flood intelligence can be used to identify vulnerable evacuation corridors, assess critical access routes, and prioritize resilience investments. NC STRONG will expand this capability statewide through enhanced FIMAN, BridgeWatch, and transportation vulnerability assessment tools, enabling communities to identify evacuation constraints, evaluate alternate routes, strengthen emergency preparedness, and make more informed resilience investment decisions before disasters occur.

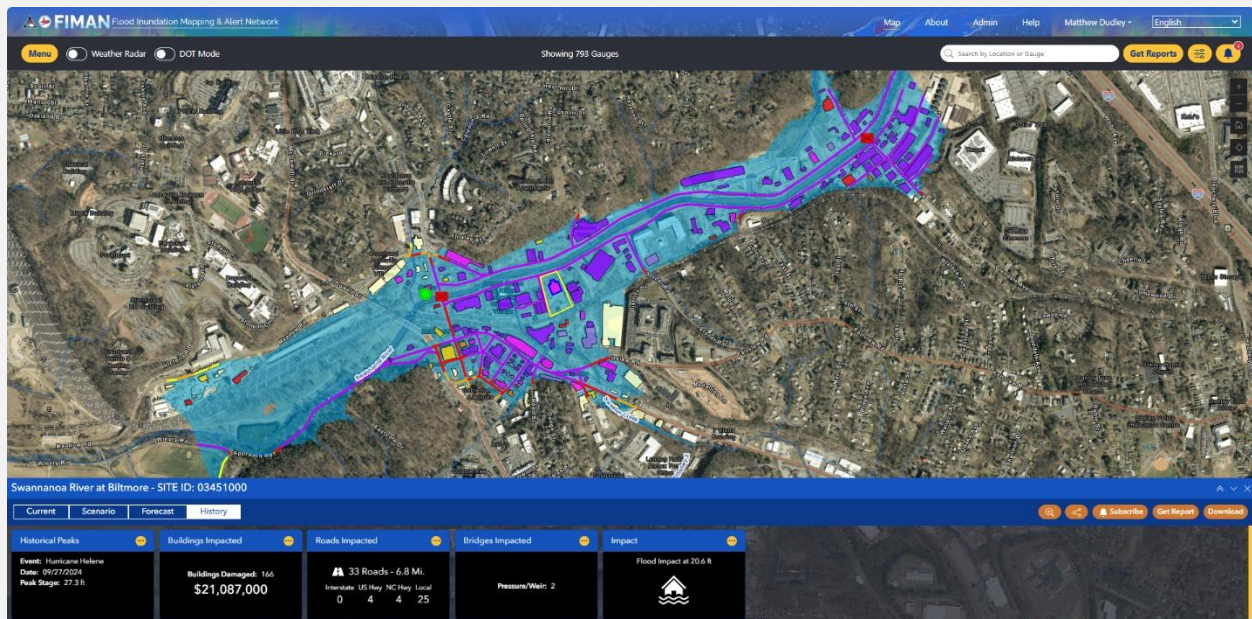


Figure 11: Under NC STRONG, continued archival of historic events in FIMAN, such as Hurricane Helene along the Swannanoa River will provide valuable site-specific planning information to help mitigate repetitive disruptions to transportation assets.



Objective D: Evacuation Planning and Preparation

NC STRONG directly supports evacuation planning by improving information regarding transportation disruptions before and during flood events. Enhanced FIMAN, T-SAPP, and BridgeWatch functionality and data sets will help identify where evacuation routes, emergency access corridors, ferry routes, military access corridors, and freight routes may become compromised.

The project includes development of evacuation-scenario products, pre-season exercises with county and state emergency-management partners, community outreach, and training activities that incorporate enhanced flooding intelligence into preparedness planning. Enhanced forecasting and transportation-impact information will support staging decisions, evacuation timing, detour planning, shelter access, emergency resource deployment, and continuity-of-operations planning.

North Carolina hosts one of the country's largest clusters of military facilities, such as Fort Liberty, Marine Corps Base Camp Lejeune, Marine Corps Air Station New River, Marine Corps Air Station Cherry Point, Seymour Johnson Air Force Base, Coast Guard sites, and the Military Ocean Terminal Sunny Point (MOTSU), the largest military ammunition depot in the U.S. These sites depend on transportation routes that are susceptible to flooding, storm surges, heavy rainfall, and other natural threats. Enhancing the understanding of flood effects on critical transportation routes, including elements within the Strategic Highway Network (STRAHNET), will help NC STRONG improve transportation resilience, supporting military readiness and national defense logistics.

Criterion 3: Innovation

Objective A: Nature-Based Solutions

NC STRONG introduces an innovative approach to resilience planning by combining transportation intelligence, flood forecasting, vulnerability assessment, and decision-support tools into a single framework that can inform both structural and nature-based resilience investments. Rather than relying solely on historical flooding records or localized engineering studies, NC STRONG will provide transportation agencies and local communities with data-driven insights regarding where flooding occurs, which transportation assets are vulnerable, and where resilience strategies can provide the greatest benefit. This capability directly supports planning and prioritization of Nature-Based Solutions by helping identify locations where natural systems can reduce transportation risk, improve resilience, and protect critical transportation infrastructure.



Figure 12: NC STRONG will provide new opportunities for identification of vulnerable locations that can benefit from nature-based solutions like the living shoreline NCDOT constructed along NC 24, a vital coastal route connecting Marine Corps Base Camp Lejeune.

NCDOT has shown the value of resilience planning for nature-based infrastructure. In 2019, they received a Coastal Resilience Grant to build a living shoreline protecting about 2,100 feet of NC 24, a vital coastal route to Marine Corps Base Camp Lejeune (Figure 12). This project showed how natural features can boost transportation resilience and guard assets vulnerable to coastal hazards. The corridor exemplifies how resilience funding can improve transportation reliability, community resilience, and defense mobility.

NC STRONG enhances NCDOT's ability to find and prioritize similar projects statewide. It uses archives, impact mapping, flood modeling, vulnerability analysis, probabilistic forecasts, and Earth data to inform planning. These tools help identify sites where nature-based solutions like living shorelines, wetland restoration, floodplain reconnection, natural storage, and stream restoration can cut transportation risks while offering environmental and community benefits.

By integrating transportation asset data with historical observations and future-condition analyses, NC STRONG allows decision-makers to move beyond reacting to individual disasters and toward proactively identifying locations where resilience investments can reduce long-term risk. This represents an innovative approach because the same transportation intelligence framework used for emergency response and operational decision-making can also guide planning and prioritization of future nature-based resilience projects.



Objective B: Innovative Technologies and Techniques for Analyzing Risk and Risk-Reduction Strategies

NC STRONG's primary innovation is not creating a new flood-warning tool; it is integrating advanced forecasting, transportation-impact analysis, Earth observation technologies, and operational decision-support processes into a single statewide transportation resilience intelligence framework. The project builds upon existing NCDOT investments in FIMAN, T-SAPP, and BridgeWatch, allowing innovation investments to focus on capability expansion rather than foundational system development, including:

- **Advancing compound flooding analysis:** Many major transportation disruptions in North Carolina happen when storm surge, rainfall, and river flooding occur together. Current methods often evaluate these hazards separately. NC STRONG will improve assessment of compound flooding with expanded ADCIRC modeling, inland analysis toward I-95, integration of fluvial inputs, and better transportation-impact evaluation. These upgrades enhance understanding of transportation vulnerabilities where multiple flood factors impact infrastructure.
- **Introducing probabilistic transportation forecasting:** Transportation decisions often rely on a single forecast. NC STRONG uses ensemble forecasting and probability layers to show the likelihood of impacts, offering emergency managers and agencies better insight into uncertainty, risk, and consequences.
- **Integrating physics-enabled artificial intelligence and cloud computing capabilities:** NC STRONG will assess AI-supported forecasting to enhance efficiency, automate data ingestion, and extend to hard-to-reach locations, leveraging scalable, redundant cloud infrastructure.
- **Incorporating Earth observation technologies into transportation resilience planning:** Satellite-based SAR provides near real-time flood data regardless of time or clouds. NC STRONG will assess how these datasets complement gauges and models, offering transportation agencies extra awareness in ungauged and monitored areas (Figure 13).

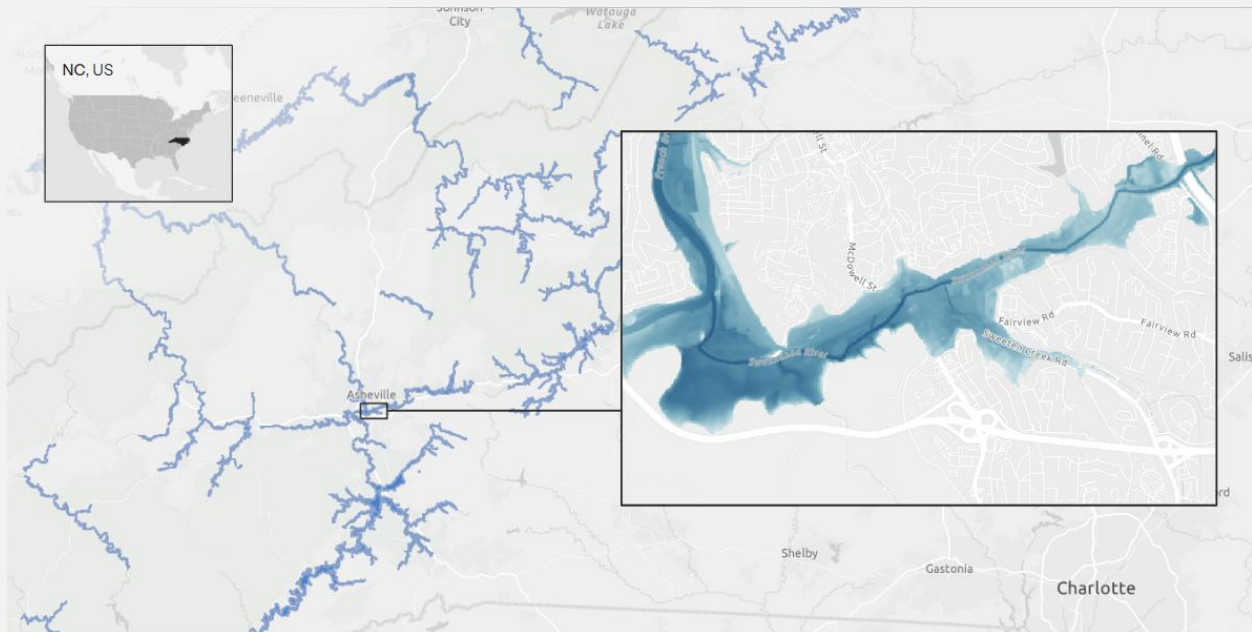


Figure 13: NC STRONG will leverage innovative technologies including SAR-based observation data to fill in gaps between FIMAN monitoring locations such as that shown above during Hurricane Helene.

Collectively, these innovations provide transportation agencies with more complete, geographically extensive, and transportation-specific information regarding flood exposure, roadway inundation, bridge vulnerability, evacuation route performance, and transportation system impacts. The resulting information can support evaluation of future monitoring needs, operational strategies, evacuation planning, infrastructure improvements, resilience investments, and risk-reduction



Objective C: Replicable Innovative Techniques and Best Practices

NC STRONG is designed to create innovations that can be replicated by transportation agencies nationwide. The project builds upon operational systems already in use and documents how forecasting, modeling, Earth observation, transportation asset information, and decision-support processes can be integrated into a unified resilience-planning framework.

Project deliverables will include documented methodologies, transportation-impact assessment approaches, threshold-development procedures, geospatial workflows, forecasting techniques, validation procedures, training materials, publications, and implementation guidance. The project also includes user training, community outreach, MPO and RPO engagement, exercises, and documentation activities that help translate technical innovations into operational practices. The transferable framework developed through NC STRONG may be particularly valuable for states facing similar challenges related to coastal flooding, inland flooding, compound hazards, evacuation planning, military access, freight-mobility resilience, and transportation asset vulnerability. By demonstrating how existing operational systems can be expanded and integrated rather than replaced, NC STRONG provides a cost-effective and scalable model for improving transportation resilience nationwide (Figure 14).

Through its integration of nature-based resilience planning, compound- flood analytics, probabilistic forecasting, artificial intelligence, Earth observation technologies, and transportation-focused decision support, NC STRONG directly

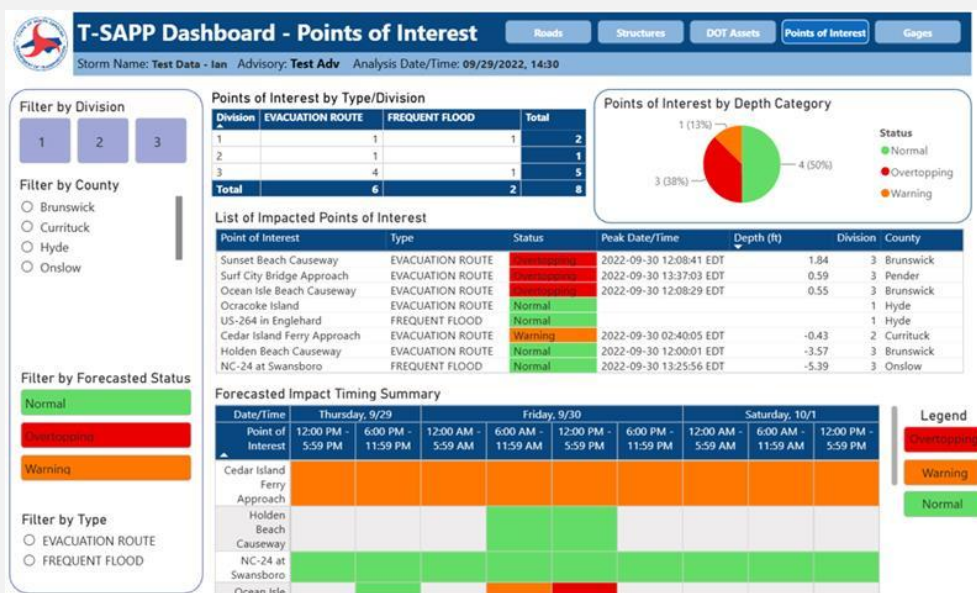


Figure 14: User-friendly interactive Power BI dashboards summarizing transportation impacts during flood events has proven to be an innovative and replicable best practice

advances the PROTECT Program's objective of applying innovative approaches to better understand transportation risk and identify effective resilience strategies.

A blue-tinted landscape photograph showing a multi-span concrete bridge crossing a wide river. The bridge has several large rectangular piers. In the background, there are rolling hills and mountains under a cloudy sky. The foreground is filled with dense trees. The overall mood is serene and natural.

V. Project Readiness

Project Readiness



Technical Assessment

A. Resources and Capacity to Deliver the Project

NCDOT possesses the organizational, technical, financial, and operational capacity necessary to successfully deliver NC STRONG. The NCDOT Hydraulics Unit serves as the lead implementation team and has extensive experience managing statewide flood warning, transportation intelligence, and resilience initiatives. NCDOT coordinates closely with North Carolina Emergency Management (NCEM), the UNC Center for Natural Hazards Resilience, Renaissance Computing Institute (RENCI), MPOs, RPOs, Tribal governments, county emergency managers, and other transportation stakeholders, as demonstrated in over thirty letters of support. These partnerships are already established and actively support existing operational programs, reducing startup risk and accelerating implementation.

NCDOT has a proven track record of successfully administering federally funded infrastructure and resilience projects; NCDOT is currently executing two projects awarded funds through the PROTECT grant program: improvements to US 74 at the Lumber River and a planning grant focused on NC 12 in Dare County.

B. Technical Feasibility

NC STRONG is technically feasible because it focuses on expanding coverage, improving decision-support products, and integrating emerging technologies into established workflows. The proposed activities rely on widely accepted transportation, meteorological, hydrologic, and geospatial methodologies and utilize National Weather Service forecasts, National Water Model inputs, NOAA products, stream and coastal gauges, LiDAR-derived elevation data, transportation asset inventories, historical flood records, and existing NCDOT operational systems. These established datasets reduce uncertainty and provide a strong foundation for project implementation.

The project's technical innovations are similarly grounded in existing operational practices. Probabilistic forecasting builds on the deterministic forecasts currently generated through T-SAPP. Earth observation technologies such as Synthetic Aperture Radar (SAR) supplement, rather than replace existing gauge networks and forecasting systems. Artificial intelligence applications are focused on improving forecasting efficiency, expanding coverage, and automating data integration processes rather than introducing entirely new operational frameworks. These



enhancements reduce implementation risk while increasing transportation intelligence capabilities.

In addition, NC STRONG relies heavily on phased testing, validation, and demonstration activities before enhancements are integrated into operational systems. Historical events, hindcast analyses, high-water mark datasets, observed flood extents, transportation impact records, and existing system outputs will be used to evaluate and validate new forecasting and vulnerability products. This iterative implementation approach minimizes technical risk while ensuring new capabilities produce measurable operational value.

C. Work plan and Deliverability

The NC STRONG project is supported by a structured implementation schedule and budget that ensures effective delivery of the project. NCDOT has conducted a detailed evaluation of existing resources, criticality of projects, and ability to acquire needed materials to create a realistic, action-oriented work plan. The proposed schedule includes activities, milestones, and deliverables that align with the project's scope and objectives. NCDOT has carefully accounted for contingencies, including potential schedule adjustments and evolving data needs, to ensure the feasibility and effectiveness of the proposed work plan. NC STRONG is organized around four clearly defined work elements that build upon one another throughout the period of performance:

- **Task 1: Project Management, Grant Administration, and Reporting**
- **Task 2: T-SAPP Coastal and Compound-Flood Forecasting**
- **Task 3: FIMAN Transportation Impact Mapping**
- **Task 4: BridgeWatch Enhancements**

D. Project Schedule and Readiness for Immediate Implementation

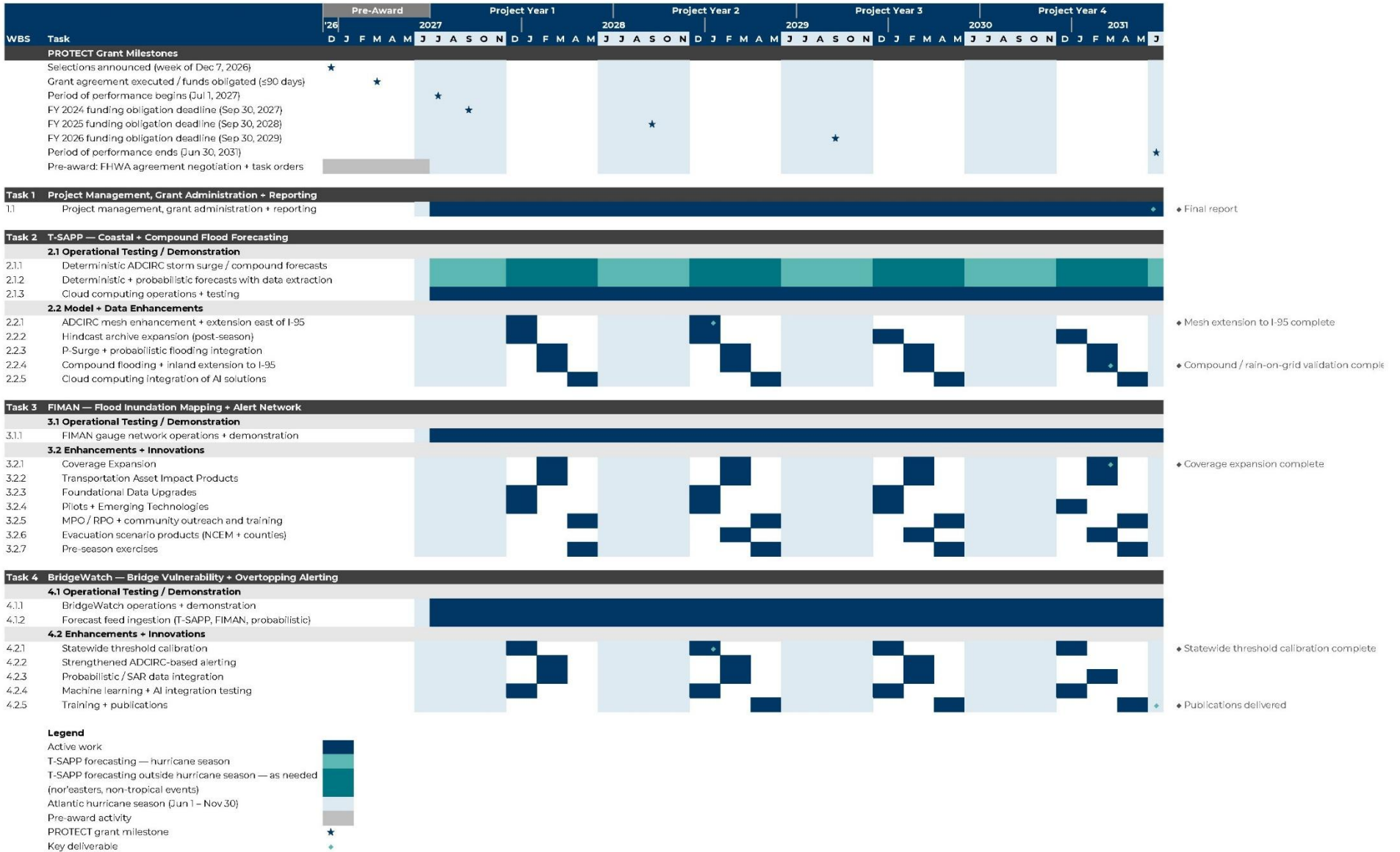
NCDOT is prepared to begin implementation immediately following award and grant agreement execution, with a performance period extending through June 2031.

The work plan was intentionally structured around North Carolina's flood and hurricane seasons to maximize operational value and minimize implementation risk. Development, testing, and innovation activities occur primarily during non-hurricane-season windows, while operational forecasting, monitoring, and demonstration activities continue throughout the project period. This approach allows lessons learned from each flood season to be incorporated into future enhancements and validation activities.



Project Schedule — NC STRONG (FY24–FY26 PROTECT Planning Grant)

Period of performance assumed July 1, 2027 – June 30, 2031. Development work occurs Dec 1 – Jun 1; Atlantic hurricane season (Jun 1 – Nov 30) si



Development tasks are scheduled in Dec 1 – Jun 1 windows only in project years with budgeted cost (see Table 2 – Detailed phasing).
Each development activity runs a two-month block (Dec-Jan, Feb-Mar, or Apr-May); hindcasts follow each season (Dec-Jan) and exercises/training



E. Risk Management and Long-Term Sustainability

NC STRONG presents a low implementation risk because the project emphasizes enhancement rather than replacement. Existing systems will continue operating throughout project implementation, allowing enhancements to be tested and validated before operational deployment. This reduces disruption risk and provides multiple opportunities to verify accuracy and effectiveness prior to adoption.

The project's long-term sustainability is further strengthened because all major deliverables integrate directly into NCDOT's ongoing operational resilience infrastructure rather than existing as standalone planning products

Financial Completeness Assessment

A. Reasonable and Necessary Costs

With NCDOT's experience delivering similar projects, the organization's detailed Project Delivery Network, and history of successfully administering and managing federally funded infrastructure projects, NCDOT has the proficiency necessary to complete all aspects of the NC STRONG Project at a reasonable cost. NCDOT has the expertise and knowledge to know what a reasonable price is for the different components of the project. The NC STRONG budget is reasonable, necessary, and directly aligned with the scope of work.

B. Financial Capacity and Cost Control

NCDOT regularly manages Federal transportation funds and complex programs. It maintains financial systems, procurement procedures, and oversight mechanisms that ensure compliance and responsible use of public funds.

NC STRONG incorporates multiple layers of financial oversight, including project management, schedule monitoring, task-level budgeting, contract management, and periodic progress evaluations. Project tasks are phased over four years and organized around defined milestones and deliverables, allowing expenditures to be tracked against both schedule and performance objectives. This structure provides opportunities to evaluate progress, identify emerging risks, and implement corrective actions before cost or schedule variances become significant.

A 10 percent contingency allowance is incorporated throughout the project budget to address uncertainty associated with multi-year cloud-computing costs, consultant labor rates, and data acquisition requirements. In addition, 6 percent of the total budget is rolled into the total budget for indirect project costs. This approach allows the project to accommodate normal fluctuations in implementation costs while maintaining delivery of approved project objectives



C. Potential Cost Overruns

The risk of cost overruns is low because NC STRONG advances existing operational systems rather than developing entirely new platforms.

Project costs will be controlled through phased implementation, milestone-based work planning, routine budget reviews, and prioritization of activities that directly support project objectives. Development work is intentionally organized in discrete implementation phases, allowing NCDOT to evaluate performance, validate outputs, and confirm budget assumptions before proceeding with subsequent activities. The project schedule also distributes development activities over multiple years, reducing the likelihood of concentrated expenditures and providing flexibility to respond to changing conditions.

Should unforeseen conditions affect individual activities, NCDOT may sequence or reprioritize tasks to maintain delivery of the project's core objectives while remaining within available funding. The phased approach provides sufficient flexibility to manage cost and schedule risks without compromising overall project outcomes.

D. Availability of Funding

NCDOT requests 100 percent Federal funding for NC STRONG as permitted under the PROTECT Planning Grant Program. No non-Federal match is required, and no contingent funding sources are necessary for project completion. The requested PROTECT award fully supports the project budget and does not depend on future appropriations, third-party contributions, or other uncertain funding commitments.

The requested funding is sufficient to complete all proposed activities. Because the project is limited to planning and resilience data-tool activities, the budget fully captures the resources necessary to deliver the proposed scope.

E. Financial Sustainability

NC STRONG invests in long-term transportation resilience, enhancing existing systems managed by NCDOT and partners. Improvements like forecasting, impact assessments, Earth observations, evacuation tools, and decision-support will be integrated into current operational platforms, ensuring sustained value beyond the grant period.

As a result, Federal investment through the PROTECT program will not only produce planning products but will also strengthen statewide transportation resilience systems that support preparedness, emergency response, recovery, asset management, and future resilience planning for years beyond project completion.



Permitting Risk Assessment

A. National Environmental Policy Act (NEPA)

NC STRONG is a planning activity, and as such, NCDOT anticipates a categorical exclusion under 23 CFR 771.117(c) with minimal environmental review requirements and no environmental risks that would affect project delivery.

The project does not involve construction, excavation, work within waters of the United States, impacts to wetlands, floodplain modification, utility relocation, or alterations to transportation infrastructure. Accordingly, no Federal, State, or local construction permits are anticipated.

The project is positioned to meet PROTECT obligation requirements, complete activities within the proposed period of performance, and deliver meaningful transportation resilience benefits statewide.

C. Public and Stakeholder Engagement

The project will align with [NCDOT's Statewide Public Involvement Plan](#). The project schedule includes dedicated outreach, coordination, training, exercises, evacuation planning support, and stakeholder engagement activities to strengthen implementation and encourage adoption of enhanced capabilities. Because the project expands the existing services rather than introducing controversial infrastructure projects, NCDOT does not anticipate public opposition or stakeholder concerns that could delay project delivery. Stakeholder engagement is expected to strengthen project outcomes while reducing implementation risk.

D. Technical, Schedule, and Implementation Risks

The principal risks associated with NC STRONG are technical rather than environmental or permitting related. These risks primarily involve integration of new forecasting, modeling, Earth-observation, and decision-support capabilities into existing systems. However, project risk is substantially reduced because all proposed enhancements build upon mature operational platforms already in statewide use.

The project has a strong evaluation component, as described in the Technical Feasibility section of the grant application.

A blue-tinted landscape photograph. In the foreground, a multi-lane bridge with concrete pillars spans a wide river. The river has some small islands or marshes. In the background, there are rolling hills and mountains under a cloudy sky. The overall tone is serene and somewhat somber due to the monochromatic blue color scheme.

V. DOT Selection Priorities

DOT Selection Priorities



Selection Priorities Checklist

- ☒ The project supports critical infrastructure for industries of national interest.
- ☒ The project would contribute to promoting economic prosperity in communities, including rural areas and Tribal communities.
- ☒ The project prioritizes improvement of the condition and safety of existing transportation infrastructure, particularly infrastructure with high cost of failure, such as bridges with lengthy detours, impacts to critical corridors, or failures that will cause economic disruption.
- ☒ The project demonstrates an ability to meet PROTECT Competitive Grant Program obligation deadlines.
- ☒ The project will reduce roadway traffic congestion.
- ☒ The project improves access to national security and defense facilities or facilitates movement of military cargo or personnel.
- ☐ The project repurposes existing specialized travel lanes for bicycles, buses, or pedestrians for general purpose use by all motor vehicles, including single-occupant motor vehicles and the applicant demonstrates the repurposing will meet the PROTECT program purpose, will reduce congestion on the facility, will utilize 40 percent or less of requested PROTECT funds for adding capacity consistent with 23 U.S.C. 176(d)(5)(G)(i)(I), will address safety consistent with the merit criteria described in Section F of this NOFO, and will comply with applicable federal requirements, including the Clean Air Act and criteria under 23 U.S.C. 217(e).
- ☐ None of the above apply to the project.



1. Supports Critical Infrastructure for Industries of National Interest

North Carolina's transportation network supports several industries of national significance, including agriculture, food processing, pharmaceutical manufacturing, forestry products, military logistics, tourism, and international trade. Major freight corridors, including I-95, I-40, US 70 (future I-42), US 17, and critical connections to the Ports of Wilmington and Morehead City, are highly vulnerable to flooding and storm-related disruptions. Hurricanes Florence and Matthew demonstrated that transportation disruptions on these facilities can affect freight movement across the eastern United States and delay delivery of critical goods and services.

NC STRONG will provide improved transportation intelligence regarding where, when, and how transportation disruptions occur. Enhanced forecasting, transportation-impact mapping, bridge vulnerability assessment, and Earth observation capabilities will allow NCDOT and partner agencies to maintain mobility on corridors that support nationally significant economic activity and supply chains. The project will help identify vulnerabilities before disruptions occur and support long-term resilience investments that strengthen transportation reliability.

2. Promotes Economic Prosperity in Rural and Tribal Communities

Much of North Carolina's transportation system serves rural communities where limited route redundancy means that closure of a single roadway, bridge, ferry route, or culvert can isolate residents from employment centers, health care services, schools, and commercial activity. Agricultural production, food processing, forestry, and tourism industries located throughout eastern and coastal North Carolina are particularly vulnerable to transportation disruptions.

The project will also benefit Tribal communities throughout North Carolina, including the Lumbee Tribe (the largest tribe east of the Mississippi River), Eastern Band of Cherokee Indians, Coharie Tribe, Meherrin Tribe, Waccamaw Siouan Tribe, Haliwa-Saponi Tribe, Sappony Tribe, and Occaneechi Band of the Saponi Nation, many of which are located in areas vulnerable to flooding, landslides, and transportation access challenges. Enhanced transportation-impact mapping, flood forecasting, and decision-support tools will improve emergency preparedness, mobility planning, and long-term resilience planning for Tribal communities and local governments.



3. Improves the Condition and Safety of Existing Transportation Infrastructure

NC STRONG focuses entirely on protecting and improving management of existing transportation assets. The project supports approximately 81,000 miles of State-maintained roadway and more than 16,000 bridges, culverts, and water crossings through enhanced monitoring, forecasting, transportation-impact mapping, and vulnerability assessment.

Improved transportation intelligence will help NCDOT identify high-risk assets, prioritize inspections, support closure decisions, improve traveler safety, and evaluate future resilience investments. The project will also help identify locations where resilience strategies such as bridge improvements, drainage upgrades, route redundancy projects, monitoring enhancements, and nature-based solutions may reduce long-term risk.

4. Demonstrates Ability to Meet Obligation Deadlines

NC STRONG is highly positioned for timely implementation because it builds upon mature operational systems already in statewide use. FIMAN, T-SAPP, and BridgeWatch are currently operational and supported by established technical teams, partner agencies, data-sharing agreements, and implementation procedures.

The project does not require construction, right-of-way acquisition, utility relocation, environmental permits, or land-use approvals. Activities consist primarily of forecasting enhancements, transportation-impact mapping, vulnerability assessments, software improvements, data integration, training, stakeholder engagement, and implementation of decision-support capabilities.

5. Reduces Roadway Traffic Congestion

Flood-related roadway closures are a major source of recurring congestion throughout North Carolina. During major storm events, closures on Interstate highways and regional roadways can force traffic onto limited alternative routes, increasing travel times, delaying emergency response, and disrupting freight movement.

NC STRONG improves congestion management by helping transportation agencies anticipate transportation disruptions before they occur. Improved forecasting and transportation-impact mapping allow detours to be identified earlier, resources to be staged in advance, and closure decisions to be based on more accurate information. Enhanced transportation intelligence can also reduce unnecessary closures by improving understanding of actual transportation impacts and flood risk.



6. Supports National Security and Defense Mobility

North Carolina contains one of the nation's largest concentrations of military installations, including Fort Bragg, Camp Lejeune, MCAS New River, MCAS Cherry Point, Seymour Johnson Air Force Base, Coast Guard facilities, and the MOTSU. Access to and from these facilities depends on transportation corridors vulnerable to flooding, storm surge, extreme rainfall, and other natural hazards.

NC STRONG will strengthen resilience planning for military access routes and STRAHNET facilities by improving understanding of transportation vulnerabilities, evacuation routes, and critical freight movements. Enhanced transportation intelligence will help military installations, emergency managers, and transportation agencies better plan for storm response, installation access, evacuation activities, and post-disaster recovery. The project therefore supports both military readiness and national defense mobility while protecting transportation infrastructure critical to mission continuity.