

## LIST OF NCDOT RESEARCH NEED STATEMENTS FY-2017

<b>Environment &amp; Hydraulics</b>			
RNS #	Research Needs Statement (RNS) Title	Submitted by:	Affiliation
7101	Continuing Intensive Monitoring of Nutrient and Material Load in Claridge Nursery Stream "The Canal": assessing the water quality impacts & benefits of a stream restoration in the coastal plain	M. Cox	Project Development & Environmental Analysis
7102	Reef Link Wave Attenuation for SAV Mitigation	K. Herring	PDEA
7103	Creation of Roadside Asset Management Plan – Roadside Vegetation Management	D. Smith	Roadside Environmental
7104	Storm Water Infiltration Zones Along Highways	D. Harris	Roadside Environmental
7105	Assessment of Roadkill Disposal Options	R. Maycock	Roadside Environmental
7106	Assessment, Prioritization and Optimization of Maintenance and Retrofit Water Quality Strategies in Water Supply Watersheds and Other Priority Waters.	M. Lauffer	Hydraulics Unit
<b>Planning, Program, Policy &amp; Transit</b>			
RNS #	Research Needs Statement (RNS) Title	Submitted by:	Affiliation
7201	Powell Bill Program Performance: How we can develop Performance Measures to the Powell Bill Program?	M. Al-Ghandour	Program Development
7202	State Improvement Program (STIP) New Vision: Collaboration Between Budget Programming and Visualization of Transportation Projects	M. Al-Ghandour	Program Development
7203	Preventative Maintenance Criteria Validation	N. Brooks	Fleet Management
7204	Rail Corridor Trespass Severity Assessment	J. Pullen	Rail Division
7205	WaveTrain Level Crossing Warning System	R. Mullinax	Rail Division
7206	Improving Customer Service inside LPA Offices	C. Wilson	DMV
7207	2015 Level of Service	J. Bailey	Transportation Planning
7208	Capturing and Communicating the Value of NCDOT Research	J. Kirby, N. Mastin	R&D
<b>Pavements &amp; Maintenance</b>			
RNS #	Research Needs Statement (RNS) Title	Submitted by:	Affiliation
7301	Quantifying Oxidation Drying of Asphalt Pavements Using Colorimeter	J. Corley-Lay	Pavement Management
7302	Backcalculation of Dynamic Modulus from Falling Weight Deflectometer Data	J. Corley-Lay	Pavement Management
7303	Quantifying the Impact of Crack Sealant on Pavement Surface Friction	J. Corley-Lay	Pavement Management
7304	Use of PUC for Performance Characterization of Aggregate in Bituminous Surface Treatments	J. Corley-Lay	Pavement Management
7305	Use of Rejuvenator Prior to Chip Seal on Aged Flexible Pavement	J. Corley-Lay	Pavement Management
7306	Using Recycled Concrete Aggregate in Non-Structural Concrete on NCDOT Projects in Eastern NC	R. Hayes, J. Kuse	Value Management
7307/ 7502	Evaluation of Methods for Pavement Surface Friction Testing on Non-Tangent Roadways and Segments	A. Wyatt, C. Morrison	Traffic Safety
7308	Regional Peer Exchange on Asset Management and MAP21 Topics	Brandenburg	Asset Management
7309	Use of Laboratory Measured Resilient Moduli in Pavement Design	C. Morrison, C. Su	Pavement Management

**LIST OF NCDOT RESEARCH NEED STATEMENTS FY-2017**

<b>Structures &amp; Construction</b>			
<b>RNS #</b>	<b>Research Needs Statement (RNS) Title</b>	<b>Submitted by:</b>	<b>Affiliation</b>
7401	Improving Replacement Cost Data for NCDOT Highway Bridges	T. Koch	Structures Management
7402	Evaluating the Fatigue and Capacity of Welded and Bolted Repairs of Steel Girders	B. Hanks	Structures Management
7403	Load Rating for NC Legal Vehicles	B. Hanks, G. Muchane	Structures Management
7404	Geosynthetics Laboratory Testing for Reinforced Soil Subgrades	S. Hidden	Geotechnical
7405	Driven Pipe Pile Design and Installation for Strain and Cantilever Traffic Signal Structures	C. Cogdell	ITS & Signals Unit
7406	The effects of contaminated soil and groundwater on subsurface utilities, surface water and drainage	C. Parker, R. Wilkins, M. Lauffer	Geotechnical Engineering
<b>Traffic &amp; Safety</b>			
<b>RNS #</b>	<b>Research Needs Statement (RNS) Title</b>	<b>Submitted by:</b>	<b>Affiliation</b>
7501	What is the Impact of Accessibility in the Vicinity of a Conventional Interchange (CI), a Diverging Diamond Interchange (DDI), and a Diverging Double Roundabout Interchange (DDR) Projects?	M. Al-Ghandour	Program Development Branch
7502/ 7307	Evaluation of Methods for Pavement Surface Friction Testing on Non-Tangent Roadways and Segments	T. Wyatt & C. Morrison	Traffic Safety
7503	Effectiveness of High-Visibility Markings and RRFBs in North Carolina	A. Wyatt	Mobility & Safety
7504	Developing Guidelines and Documentation of Engineering Studies for Establishing NC Speed Limits	T. Wyatt	Mobility & Safety
7505	Development of Planning Level Warrant for Signalization of Synchronized (Super) Streets, Non-Traditional At Grade and One Way Intersections	T. Wyatt	Mobility & Safety Division
7506	Innovative Approaches to Measure Truck Parking Utilization at North Carolina Rest Areas	T. Wyatt & D. Lee	Traffic Safety
7507	Video Collection of Traffic Violations for Public Education and Regulatory Changes	E. Morrison	Research
7508	Economic Impact of Utilizing Access Management	R. Stone	Division 8
7509	Impact of development density on K-factors	B. Wert	Strategic Planning (TPB)

## Environment & Hydraulics



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 15, 2015	<b>RNS#:</b>	7101
<b>Submitter Name:</b>	Marissa Cox	<b>Phone:</b>	919-707-6153
<b>Division / Unit:</b>	PDEA – NES – ICI/On-site Mitigation	<b>Email:</b>	mrcox@ncdot.gov
<b>Research Idea Title:</b>	Continuing Intensive Monitoring of Nutrient and Material Load in Claridge Nursery Stream “The Canal”: assessing the water quality impacts & benefits of a stream restoration in the coastal plain		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

There is a lack of research and understanding on the immediate, mid-, and long term effects of stream restoration projects on water quality. NCDOT partnered with NCFS and NCSU to perform in-stream monitoring of water quality both pre- and during TIP and stream construction under RNS 4105. However, additional data collection & analysis is needed to get an overall, clear picture of the effects on water quality that occur throughout the various stages of a stream restoration project by continuing this effort through the post-construction and stream restoration monitoring phases.

**Background: Provide supporting information about the business unit, processes and tools**

NCDOT is performing on-site mitigation on the NC Forest Service’s Claridge Nursery to offset jurisdictional stream impacts associated with TIP R-2554. As part of the project, NCDOT partnered with NCFS and NCSU to perform in-stream monitoring of water quality both pre- and during TIP and stream construction under RNS 4105 which is set to be completed in June 2016. The construction phase of the Claridge Nursery stream restoration project is set to begin in August 2015 with a completion date in the spring of 2016. To complete the project and to obtain the information on the water quality impacts and benefits of a stream restoration, post-construction/restoration monitoring is essential. This second RNS thus comes as the natural second phase of the project where the overall water quality effects of a stream restoration can be quantified and compared with the data acquired during RNS 4105.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

The tasks of this research will be to continue the intensive continuous monitoring of flow and water quality at the locations of the original stations to allow detection of changes of the water quality signature during the event and at the seasonal scales. In-stream nitrogen removal measurements using the techniques developed during RNS 4105 will be used to assess changes in in-stream removal capacities. Water quality benefits of the restored stream floodplain to intercept upward and lateral groundwater will also be assessed.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

The products of the research will include an overall picture of the hydrology and water quality impacts, detrimental and beneficial, of a stream restoration in the coastal plain. The project will highlight the features and practices responsible for the impacts, deciphering those associated with local conditions from those corresponding to the practices themselves. These observations and findings, supported by data, could help shape new/additional/future guidelines for stream restoration practices to maximize the water quality benefits of this very important practice. This information will also potentially assist the Department in determining when to construct on-site mitigation projects as well assist in making credit ratio determination especially in scenarios where the hypothesized stream improvement via stream mitigation activities will be water quality related.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)



**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

The anticipated benefits include: 1) potential cost savings through proper mitigation construction phasing as well as improved mitigation credit ratios which ultimately result in cost savings as well and 2) new/additional/future guidelines pointing out the features and practices which would be desirable to foster/improve or rather change to maximize the environmental benefits of this mitigation practice. This will provide greater credibility for NCDOT to stakeholders and regulatory agencies on its ability to provide science-informed guidelines.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

The results of this project will potentially assist in future decision making regarding 1) the requirements for stream restoration monitoring and success criteria, 2) mitigation site selection and credit ratio proposals 3) standard protocols for stream restoration construction phasing.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Project Development & Environmental Analysis

**Title:** Environmental Supervisor

**Name:** MARRISA COX

**Approval (Division Official or Unit Head)**

Phillip Harris

Print Name

Signature

Section Head

Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	7/17/15	<b>RNS#:</b>	7102
<b>Submitter Name:</b>	Kathy Herring	<b>Phone:</b>	919-707-6128
<b>Division / Unit:</b>	PDEA/NES	<b>Email:</b>	mkherring@ncdot.gov
<b>Research Idea Title:</b> Reef Link Wave Attenuation for SAV Mitigation			

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

NCDOT needs a diversity of proven effective, and cost effective methods to effectively mitigate for impacts to submerged aquatic vegetation (SAV) associated with coastal bridge projects. Presently there are a limited range of techniques available; some of which are cost prohibitive and do not support diverse biohabitat development, all of which increases NCDOT's risk and costs.

**Background: Provide supporting information about the business unit, processes and tools**

The NCDOT has two bridge projects planned for NC 12 in Dare County, The replacement for the Herbert C. Bonner Bridge and a bridge in the Rodanthe area that will extend out into the Pamlico Sound. As required by law the NCDOT must mitigate for any adverse effects to submerged aquatic vegetation (SAV) within the project corridors. The proposed Rodanthe bridge spans 10 acres of SAV habitat. In addition to these two projects the NCDOT has agreed to study an alternative that would connect the Rodanthe bridge to the Pea Island area that was breached by Hurricane Irene in 2011. This could result in a 7 mile span over the Sound.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Wave modeling, structure construction, seagrass monitoring, wave /wind data collection, biohabitat colonization monitoring

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

There is no one proven method that works for SAV coalescence. This could result in a proven method for SAV mitigation that would be cost effective.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input checked="" type="checkbox"/> Other (Specify)Risk and cost reduction

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

This will provide the data to support a reliable method to encourage the growth of SAV. When combined with other methods, this could result in more diverse ecosystem benefits which would improve compliance with NCDOT's mitigation permit requirements, resulting in potential reduction of mitigation costs.

**Implementation: Describe how the results of research will be put into practice at NCDOT.**

The results of this research would put into practice in creation of more ecologically diverse wave breaks in support of currently pending NCDOT SAV mitigation permit requirements.

**Who will lead the implementation?**

Provide Unit, Position Title and Name.

**Unit:** NES/Biological Surveys

**Title:** Environmental Program Supervisor II

**Name:** Kathy Herring

**Approval (Division Official or Unit Head)**

Phillip Harris		Section Head
Print Name	Signature	Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 17, 2015	<b>RNS#:</b>	7103
<b>Submitter Name:</b>	Derek Smith	<b>Phone:</b>	919-707-2939
<b>Division / Unit:</b>	Roadside Environmental Unit	<b>Email:</b>	dcsmith@ncdot.org
<b>Research Idea Title:</b>	Creation of Roadside Asset Management Plan – Roadside Vegetation Management		

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

To effectively manage vegetation and remain fiscally responsible, it is important to understand the composition of rights of way vegetation particularly in the transition / recovery zones. New herbicides are not being released by the industry to combat herbicide-resistant weeds and despite best management practices; the progeny of these weeds will carry the resistance-gene and will not be controlled by certain families of herbicides. Eventually, large expanses of rights of way will contain weeds we cannot control unless vegetation management plans include appropriate herbicidal modes of action recognized to combat these problematic weeds.

**Background:** *Provide supporting information about the business unit, processes and tools*

The last official survey of roadside turfgrass was conducted in 1999 by NCD&CS in cooperation with the Turfgrass Council of North Carolina. Since that time, the composition of our rights of way has changed considerably. The General Assembly repealed its ban on the installation of bermudagrass and bahia grass, once the primary warm-season turfgrass selection along rights of way, has become less desirable due to its prolific seed head production. In addition, weeds, in certain regions, are becoming genetically more herbicide-resistant making their control problematic. New zoysia grass varieties, introduced by the green industry since 1999, have the potential to significantly decrease routine maintenance specifically by reducing mowing under guardrails and guiderails.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

- 1) Conduct a resistance survey along NC roadsides to identify herbicide-resistant weed species and effective modes of action for their control.
- 2) Determine turfgrass species composition along NC roadsides.
- 3) Develop herbicide and plant growth regulator programs to transition appropriate areas to lower maintenance requiring turf species like zoysia grass.
- 4) Evaluate various programs to establish zoysia and bermuda grass via alternative techniques including vegetative establishment like sprigging.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

A 'next generation' vegetation management program that remains fiscally responsible.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

This research will produce a fiscally responsible 'next generation' vegetation management program that remains fiscally responsible, aids the Divisions through better asset inventory management, and defines specific areas known to possess herbicide-resistant weeds with targeted chemistry and BMP's to manage these resistant weeds.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

The implementation of daily maintenance operations including vegetation selection for erosion control, reduced mowing under stationary objects and improved vegetation management herbicide programs will be positively impacted by the results of this research.

**Who will lead the implementation?**  
*Provide Unit, Position Title and Name.*

**Unit:** Roadside Environmental Unit  
**Title:** State Roadside Erosion Control and Vegetation Management Eng.  
**Name:** David B Harris

**Approval (Division Official or Unit Head)**

Don G Lee	_____	State Roadside Environmental Engineer
Print Name	Signature	Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 10, 2015	<b>RNS#:</b>	7104
<b>Submitter Name:</b>	David Harris	<b>Phone:</b>	919-707-2925
<b>Division / Unit:</b>	Roadside Environmental Unit	<b>Email:</b>	<a href="mailto:davidharris@ncdot.gov">davidharris@ncdot.gov</a>

**Research Idea Title:** Storm Water Infiltration Zones Along Highways

*Note: All fields will expand as you type. Use as much space as needed.*

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

Research is identified benefits to storm water infiltration through the use of deep rooted vegetation. NCDOT needs to identify what species are best suited for this environment and what additional benefits these species have for pollinators.

**Background:** *Provide supporting information about the business unit, processes and tools*

Rich McLaughlin is currently researching for the Hydraulics Unit the benefits of deep tillage for storm water infiltration. Once deep tillage has occurred, what sustainable activity can occur at this site to maintain the infiltration>

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

Identify the benefits deep rooted vegetation has for storm water infiltration while also studying the benefit of these species for pollinators.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

Create long sustainable infiltration zones along the highway for storm while providing a aesthetically pleasing roadside that benefits pollinators.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

Utilizing sustainable methods to minimize storm water runoff will reduce the Departments annual expenditures to build and maintain storm water detention devices.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

The Roadside Environmental Unit can coordinate with the Hydraulics Unit to combine the benefits of aesthetically enhanced landscapes while increasing the storm water infiltration along the roadsides. Plus, create a pollinator habitat.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Roadside Environmental Unit

**Title:** State Roadside Erosion Control and Vegetation Management Eng.

**Name:** David B Harris

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units.*

**Approval (Division Official or Unit Head)**

Don G Lee	State Roadside Environmental Engineer
Print Name	Signature Title





RESEARCH NEED STATEMENT

<b>Submission Date:</b>	<u>7/24/2015</u>	<b>RNS#:</b> (R&D Use)	<u>7105</u>
<b>Submitter Name:</b>	<u>Robin L. Maycock</u>	<b>Phone:</b>	<u>(919) 861-3780</u>
<b>Division / Unit:</b>	<u>Roadside Environmental Unit</u>	<b>Email:</b>	<u>rmaycock@ncdot.gov</u>

**Research Idea Title:** Assessment of Roadkill Disposal Options

*Note: All fields will expand as you type. Use as much space as needed.*

**What is the problem or issue needing investigation? Be specific and detailed. ([Click Here for Form Instructions](#))**

NC General Statutes require State agencies to minimize waste sent landfills to maximum extent practicable. NCDOT has the responsibility to clean up roadkill carcasses and typically disposes of them at local landfills. In 2012, NCDOT was cited for a violation for improperly burying roadkill on state property in Cabarrus County. While there is not currently a ban on roadkill carcasses in landfills in NC, other states have banned the disposal of roadkill in their landfills. The cost of disposal by burial in a landfill in NC ranges from \$10 - \$25 a carcass. NCDOT has invested in incinerators and has been asked to also investigate aerobic composting and anaerobic liquefaction of roadkill carcasses. A statewide research project investigating the relative costs and benefits of roadkill disposal options is needed to determine the most cost-effective, environmentally sustainable and efficient way to dispose of or recycle roadkill.

**Background:** *Provide supporting information about the business unit, processes and tools*

The costs for roadkill disposal fall on the Division maintenance budgets, which have been reduced in recent years. VDOT has already done a significant amount of research on the feasibility of aerobic composting, and is willing to combine efforts with NCDOT to look at mobile composting units that will provide roadkill composting where and when needed. A comprehensive research project to look at cost-effectiveness of various options could result in cost-savings and build on previous research with VDOT as a potential partner.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

Collect cost comparison on data from existing disposal methods and collection contracts, collect cost data on proposed new methods, and evaluate compliance, sustainability and training needs.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

Cost comparison of existing and proposed different disposal options by region, as well as recommendations and guidance on implementation.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input checked="" type="checkbox"/> Other (Sustainability)

**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

Cost savings and environmentally sustainable practices.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

Depending on the results, select optimal roadkill disposal methods by region for NCDOT.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Roadside Environmental Unit

**Title:** Environmental Operations Engineer

**Name:** Robin L. Maycock

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units.*



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 24, 2015	<b>RNS#: (R&amp;D Use)</b>	7106
<b>Submitter Name:</b>	Matt Lauffer, P.E.	<b>Phone:</b>	919-707-6703
<b>Division / Unit:</b>	Hydraulics Unit	<b>Email:</b>	mslauffer@ncdot.gov

**Research Idea Title:** Assessment, Prioritization and Optimization of Maintenance and Retrofit Water Quality Strategies in Water Supply Watersheds and Other Priority Waters.

*Note: All fields will expand as you type. Use as much space as needed.*

**What is the problem or issue needing investigation? Be specific and detailed. ([Click Here for Form Instructions](#))**

NCDOT manages over 80,000 miles of highway system that discharge stormwater runoff to water bodies across the state. While the Department’s NPDES Permit identifies requirements to manage pollutants, an assessment, prioritization and optimization strategy for maintenance and retrofit opportunities has not been developed to facilitate the best use of limited resources to achieve maximum water quality benefit in priority water bodies. In addition, watershed associations are taking an increased role in identifying transportation related impacts to the watersheds and are interested in how NCDOT is addressing pollutant sources

**Background: Provide supporting information about the business unit, processes and tools**

NCDOT has limited resources to manage stormwater runoff from highway facilities discharging stormwater runoff to waters of the State. While significant effort has been placed on construction and post-construction activities, an assessment, prioritization and optimization strategy for the existing roadways and facilities has not been developed. With the existing roadways comprising the majority of impervious surface generating stormwater runoff and maintenance resources being extremely limited, and the need to protect the priority waters in the State such as water supply watersheds, a maintenance and retrofit water quality strategy would provide direction to implementing limited resources to maximize water quality benefit.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

The objectives of this applied research would be the development of a template process on a selected water supply watershed like High Rock Lake that can be used on water supply watersheds across the State to optimize maintenance and retrofit resources. The tasks associated with this objective would include an assessment and prioritization phase. This phase would include both interview and observations of maintenance crews and practices, and a GIS and ground-truthing assessment of geographic features, soils and transportation facilities to determine practices that were having the greatest impact on water quality. Following the assessment and prioritization tasks, an optimization model would be developed that identifies maintenance and retrofit opportunities that deliver the most benefit for the investment.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

- Assessment, Prioritization and Optimization Plan for Maintenance and Retrofit Practices in Priority Watersheds template.
- A plan for the selected watershed studied ( suggest High Rock Lake)
- A list of implementable maintenance and retrofit opportunities in studied watershed that will maximize the reduction of roadway generated pollutants with dollar spent.

Education material that can be used for future plans and implementing identified practices.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

The plan and developed process will be used to support NPDES permit compliance activities as well as other State stormwater rules. The use of the product will help optimize the use of the funds to achieve maximum water quality benefit. The products will serve as a template for other water bodies.



RESEARCH NEED STATEMENT

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

Implementation will benefit the Department by identifying practices that will achieve the most water quality benefit for the dollar spent. The products will also help with providing information to environmental protection advocates on DOTs approach to protecting priority watersheds.

**Who will lead the implementation?**

Provide Unit, Position Title and Name.

**Unit:** Hydraulics Unit

**Title:** Assistant Unit Head

**Name:** Matt Lauffer, P.E.

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

**Approval (Division Official or Unit Head)**

David Chang, Ph.D., P.E.

Print Name

Signature

Hydraulics Unit Head

Title

Planning, Program, Policy & Transit



RESEARCH NEED STATEMENT

**Submission Date:** 7/2/2015 **RNS#:** 7201  
**Submitter Name:** Dr. Majed Al-Ghandour, PE,CPM **Phone:** 919-707-4621  
**Division / Unit:** Program Development Branch **Email:** malghandour@ncdot.gov

**Research Idea Title:** **Powell Bill Program Performance: How we can develop Performance Measures to the Powell Bill Program? Do the Powell Bill Programs Allocations work with the new STI Bill? How these allocations impact on a Municipality or a Town? Is it more or less to a City?**

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Try to reach out the 507 recipients of the Powell Bill Program (PBP) to study how these allocations impact their business and how they use it "SPENDING" and what are options they like to see in streamlining the PBP process. Does it work! Do we need to address some recommendations to the Department to share it with the Legislators to adopt new GS. How the new (STI) Strategic Transportation Investments (statewide, regional, and Division) categories and their funds impact on the PBP? How we can develop Performance Measures to the Powell Bill Program? How these allocations impact on a Municipality or a Town? Is it more or less to a City? Do we have a standardize system to evaluate effectiveness and economic impacts of PBP!

**Background: Provide supporting information about the business unit, processes and tools**

General Statutes 136-41.1 through General Statutes 136-41.4 require the N.C. Department of Transportation to annually appropriate from the Highway Fund, two allocations each fiscal year to all active and qualifying municipalities, a sum equal to ten and four-tenths percent (10.4%) of the net amount after refunds that was produced during the fiscal year by the tax imposed be disbursed to the qualifying municipalities. The appropriated amount shall be allocated on or before October 1 and January 1 each year. The total amount allocated is seventy-five percent (75%) on the basis of relative population and twenty-five percent (25%) on the basis of relative non-State System local street mileage. Each municipality is required to furnish its own certification of street mileage as of July 1 each year. The most recent annual estimate of population is furnished to the Department of Transportation by the State Planning Officer each September.

These "Powell Bill" funds shall be expended only for the purpose of maintaining, repairing, constructing, reconstructing or widening of any street or public thoroughfare including bridges, drainage, curb and gutter, and other necessary appurtenances within the corporate limits of the municipality, or for the planning, construction, and maintenance of bikeways, greenways, and sidewalks. The North Carolina Department of Transportation is pleased to notify 507 municipalities in North Carolina that qualifies for a portion of the 2014 Powell Bill Fund of \$147,310,111.15.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

- 1- Literature review of same kind of PBP programs for other DOTs/States.
- 2- Reach out the Municipalities/ Town/ Cities/Mayors by conducting survey, interviews, etc.
- 3- Identify the strength and the weakness of the PBP.
- 4- Summarize the use of the PBP funds "POWELL BILL SPENDING". Find the common expense type for utilizing the PBP funds!
- 5- Assess and evaluate the PBP impacts on the recipients (Three Ws: When, Where and Why).
- 6- Conduct a PBP Agency-Statewide Analysis.
- 7- Execute What if Model since there are several independents factors, Revenue, population, length
- 8- Evaluate the risk of the PBP on three levels: Municipalities/ Town/ Cities.
- 9- Analyze the PBP and test for standardize Performance Measures between 507 recipients.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

- 1- List of recommendations of how to streamline the process of PBP.
- 2- List of recommendations of what Municipalities/ Town/ Cities/Mayors wish to use PBP for outside the expenses types to comply with the GS!
- 3- List of recommendations when the Municipalities/ Town/ Cities/Mayors wish to get the PBP funds!
- 4- Recommend a new Formula for allocation PBP funds in relation to the STI?
- 5- As STI establishes the Strategic Mobility Formula, a new way of allocating available revenues based on data-driven scoring and local input, can we have same for Strategic Mobility Formula for the PBP.
- 6- Not limited to reports, charts, model, tools, etc.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

Improve customer services of PBP and streamline the process and raise some recommendations.



RESEARCH NEED STATEMENT

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

1. Evaluate the PBP program and set some recommendations to the Legislators.
2. Improve and stream PBP to serve our eligible towns, cities, and municipalities fast and quick based on their needs! Listen to them (flexibility and customer services)!
3. Predict Strategic Mobility Formula for the PBP.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Powell Bill Program Unit/Program Development Branch

**Title:** Manager

**Name:** Majed Al-Ghandour/ Stephanie Benson

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

NCDOT Office of Inspector General  
 Single Audit Compliance Unit (SACU)  
 Agreements Unit  
 Grants System  
 Legislators and our NCDOT Liaisons.

**Approval (Division Official or Unit Head)**

Calvin Leggett, PE

Print Name

Signature

Director of Program Development

Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	7/2/2015	<b>RNS#:</b>	7202
<b>Submitter Name:</b>	Dr. Majed Al-Ghandour, PE,CPM	<b>Phone:</b>	919-707-4621
<b>Division / Unit:</b>	Program Development Branch	<b>Email:</b>	malghandour@ncdot.gov
<b>Research Idea Title:</b>	<b>STATE IMPROVEMENT PROGRAM (STIP) NEW VISION: COLLABORATION BETWEEN BUDGET PROGRAMMING AND VISUALIZATION OF TRANSPORTATION PROJECTS</b>		

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

Simulation and Visualizing support developers, engineers, and planners to enable focus on project scope and accessibility to help users (vehicles, bicycles, pedestrians) gain access to their destination at a low cost per trip in terms of operational and safety. There is a lack of visualization of accessibility tools for project programming in STIP (Budget programming based on access and mobility) are found. This may increase the project costs after built if there are misunderstandings in project scope. For example, no practical method has emerged to include accessibility visualization outcomes within the project alternatives or corridor selection process and to estimate the values of mobility and access for the projects. STIP Budget programming with several funding sources is not collaborated with the project Visualization or Simulation tools when the project on planning stages and is ready for construction. Adding this new vision may help the accuracy of the cost estimate before construction. A lot of projects were revised on their scope and cause their costs increase that were not be addressed on their initial STIP Budget development. It is new arena of integrating simulation, visualization to the STIP programming as a great enhancement to reduce project high costs.

**Background:** *Provide supporting information about the business unit, processes and tools*

Simulation and Visualization of transportation projects have been shown to be a very effective way of communicating information between interested project parties, citizens, policy makers, and stakeholders. Visualization has been used largely for communicating information on the preliminary geometric design, or as photorealistic representations that place transportation projects within their existing or envisioned built or natural context. Visualizing assesses the project before implementation or constructing the project, for example, how roadway, toll, and bridge will look and options (i.e. see it before built it). NCHRP Synthesis 361 (2006). Visualization for Project Development summarizes the growth of visualization in transportation as well as outlining related issues and research needs. With access management concepts using simulation and Visualization tools and coordinate it with STIP Development stages will provide safety, mobility for users (vehicles, bicycles, pedestrians) and accurate cost for the project before construction.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

- 1- Review current literature relevant to project visualization of access management and STIP Development, best practices, and quality tools.
- 2- Evaluate current standards and determine measurement of accessibility analysis and cost estimate.
- 3- Evaluate current standards in STIP development and cost estimate.
- 4- Communicate the methods of Access Management to STIP budget development such as "The systematic control of the location, space, design, and operation of driveways and street connections, medians, median openings, turn lanes, traffic signals, interchange, and roundabout" to the COST and BUDGET!.
- 5- Develop a conceptual framework, methodology, and tools for estimating accessibility of a highway projects and their budget estimates.
- 6- Investigate visualization as a tool for in terms of accessibility and ease of use for the advice seeker (access management).
- 7- Provide new knowledge on which NCDOT STIP engineers and practitioners can base their budget programming, decisions, incorporate, and better utilize these tools for their STIP Developments before constructions.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

- 1- List of recommendations of how to start this new vision between STIP Budget programming and simulation with visualization tools for transportation projects before construction.
- 2- Visualization tools and innovative practices for budget programming.
- 3- Real-time interactive models.
- 4- Graphs, tools, manuals, and guidelines.
- 5- Document analysis and report recommendations. Not limited to reports, charts, model, tools, etc.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)



RESEARCH NEED STATEMENT

Explain Anticipated Benefits: Provide details for the benefits checked above.

- Bring the organization to state-of-the art standard of visualization in transportation and STIP Budget Programming Development.
Accurate cost and programs.
Visualization will be more attractive, detailed, and accurate for decisions to make projects look more selective and desirable.

Implementation: Describe how the results of research will be put into practice at NCDOT.

- Evaluate the STIP program and set some recommendations to utilize Simulation and Visualization tools.
STIP Engineers and others will use tools for producing, manipulating, and presenting accessibility within their projects to get accurate estimate and budget their programs.
Visualization's getting more engaging and interactive for the public and decision makers.

Who will lead the implementation?

Provide Unit, Position Title and Name.

Unit: Program Development Branch

Title: Manager

Name: Majed Al-Ghandour

Additional Comments and Information: See guide. Recommend including info on involvement from other units.

PEDA
ROW
CONSTRUCTION
DIVISION

Approval (Division Official or Unit Head)

Calvin Leggett, PE

Print Name

Signature

Director of Program Development

Title





**RESEARCH NEED STATEMENT**

<b>Submission Date:</b>	<u>07/13/2015</u>	<b>RNS#:</b>	<u>7203</u>
<b>Submitter Name:</b>	<u>Newell Brooks</u>	<b>Phone:</b>	<u>919 835-8004</u>
<b>Division / Unit:</b>	<u>Fleet and Material Management</u>	<b>Email:</b>	<u>nbrooks@ncdot.gov</u>
<b>Research Idea Title:</b>	<u>Preventative Maintenance Criteria Validation</u>		

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

We seek to determine the correct interval and cost/benefit for an effective PM program and is it to have geographic constraints. We presently only use time/mileage as decision based for statewide application. Do we need to take from “or” statements in program to possibly “and/or” statements or perform real time sampling.

**Background:** *Provide supporting information about the business unit, processes and tools*

FMMU is responsible for proper operation associated with NCDOT equipment. We have a canned PM schedule that is based off petroleum based applications and consider all applications of use are the same. We have analyzed initial data from the Piedmont area, in Charlotte. We are seeking to find out if we can derive definable results in the coastal area of the state based on products, usage and environment. We plan to use data to establish optimum delivery time to application of a PM program based on other contributing factors.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

Need to evaluate various vehicle PM parameters to meet optimum cost to benefit for a proactive repair program. We are finding unexpected results in Charlotte area test related to lubrication, engine life and fluid breakdown. We wish to investigate the coastal region for issues related to application and use of equipment.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

A defined structure of PM application based upon equipment, application and environment to determine proper PM performance based on real world test for various functional types of equipment

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

Would maximize the expenditure of time and dollars as corrects the intervals associated with proactive maintenance. This is purchase of new material as well as disposal of used material. This involves purchase of goods, time to perform task and cost of hazardous material disposal. The on time fluid and product replacement should serve to extend life of components and project replacement criteria.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

Establish equipment proactive program for setting up preventative maintenance calls and adequate plans based on analyzed and mathematical induced factors in lieu of a regimentation time/mileage criteria across all classes and applications.

<b>Who will lead the implementation?</b>	<b>Unit:</b> <u>Fleet and Material Management Unit</u>
<i>Provide Unit, Position Title and Name.</i>	<b>Title:</b> <u>State Fleet Maintenance Superintendent</u>
	<b>Name:</b> <u>Newell Brooks</u>

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units.*

**Approval (Division Official or Unit Head)**

<u>Jennifer Brandenburg</u>	<u>State Asset Manag. Engineer</u>
Print Name	Title
Signature	



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 2, 2015	<b>RNS#:</b>	7204
<b>Submitter Name:</b>	Jahmal Pullen	<b>Phone:</b>	919-715-8748
<b>Division / Unit:</b>	Rail Division/Eng. Coordination&Safety	<b>Email:</b>	jmpullen@ncdot.gov
<b>Research Idea Title:</b>	<b>Rail Corridor Trespass Severity Assessment</b>		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Despite having data on actual trespass incidents involving fatalities and injuries as reported by the railroads and the FRA, the Rail Division has no base data on the universe of trespassing in North Carolina, and is therefore unable to evaluate the effectiveness of its on-going BeRailSafe campaign to reduce trespassing acts.

**Background:** Provide supporting information about the business unit, processes and tools

In calendar year 2014, there were 20 fatalities and 18 injuries from 37 trespass-related incidents. The 8 incidents that involved Amtrak trains resulted in 7 fatalities and 1 injury. All incidents occurred in the Piedmont corridor between Raleigh and Charlotte. The Rail Division’s BeRailSafe program develops and implements educational programs for first responders, school students and the general public on the dangers of trespassing, yet the number of incidents, fatalities and injuries are so few (although completely avoidable) that a decrease from one year to the next may be just a random result rather than a result of the Division’s safety efforts. Consequently, a better understanding of trespassing locations, frequencies not involving fatalities or injuries is needed.

**Research Tasks:** Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)

Focusing on the Piedmont passenger corridor, video record the engineer’s view for each trip of Piedmont trains 73, 74, 75 and 76 for one full month in each of the four seasons (e.g., February, May, August and November) using a camera mounted in keeping with best industry practices; review files to observe human movements across and close to the tracks, noting time, location, and activity type; summarize and average data by time of day and location, and compare by season.

**Products of the Research:** Examples of products could include models, specifications, policies, general guidance...etc.

A more complete (but still limited) understanding of the extent of trespassing within the Piedmont corridor; the identification of trespass hotspots to focus BeRailSafe education and training efforts for first responders, etc.; a model to extrapolate the data to estimate total trespassing occurrences during survey periods; and a model to forecast average daily trespassing by location.

**Benefit / Knowledge Gain for NCDOT:** Check all that apply.

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** Provide details for the benefits checked above.

**Savings:** better direction of resources to training/education; cost-sharing with local communities; fewer costly delays to passenger and freight trains. **Models:** ability to understand extent of trespassing. **Public safety:** Fact-based education, trespass enforcement in rail-served communities.

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

The results of this research will be a model to forecast trespass incidents by location for the Piedmont corridor and other freight-only rail corridors in North Carolina; and a means to evaluate the effectiveness of the BeRailSafe program

**Who will lead the implementation?** **Unit:** Rail Division  
Provide Unit, Position Title and Name. **Title:** Manager of Engineering Coordination & Safety  
**Name:** Jahmal Pullen, PE

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

This research activity will not impact in any way the scheduling or performance of Piedmont trains 73, 74, 75, or 76.

**Approval (Division Official or Unit Head)**

Paul Worley	Signature	Director	Title
Print Name			



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 23, 2015	<b>RNS#:</b>	7205
<b>Submitter Name:</b>	Richard E. Mullinax, PE, PTOE, CPM	<b>Phone:</b>	(919)733-8015
<b>Division / Unit:</b>	Rail / Crossing Signals	<b>Email:</b>	remullinax@ncdot.gov
<b>Research Idea Title:</b>	WaveTrain Level Crossing Warning System		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Construction and maintenance costs are escalating for current technologies used in the detection of trains approaching level crossings for the purpose of activating warning devices alerting pedestrians and vehicles of the approaching train. These warning devices generally consist of a combination of flashing lights, bells, and gates. The proposed research would investigate a newly developed system for detecting trains as they approach highway-rail at-grade crossings (also referred to as level crossings) that has the potential to substantially reduce lifecycle costs while maintaining safety.

**Background: Provide supporting information about the business unit, processes and tools**

This research would investigate a newly developed technology for detecting trains, the WaveTrain Level Crossing Warning System. Current technology in the United States for train detection to activate warning devices at level crossings is through an electrical circuit using a low voltage current transmitted along the rails. These warning devices are activated by the disruption of this electrical circuit by a train as it enters the circuit.

The WaveTrain Level Crossing Warning System replaces track circuits with technology that detects signals generated naturally in the rails by approaching trains, using the specific sound wave profile associated with trains for detection. The system uses state-of-the-art technology based on sound wave signals integrated with multi-sensors concentrated at the level crossing itself. An advantage of the WaveTrain Level Crossing Warning System is that all components are installed in the vicinity of the level crossing, normally within 50 feet. The WaveTrain Systems does not require long distance cabling or transmittal of an electrical current between the highway-rail grade crossing and the required train detection distance, as conventional methods do. Along higher speed rail lines, the required train detection distance may often exceed one mile in length. In addition, all components are either underground or inside fixed enclosures, unlike current technologies which have some components exposed to environmental elements and potential vandalism.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Proposed major tasks will include: 1.) Perform research of literature and available information on implementation and performance of the WaveTrain Level Crossing Warning System including conducting telephone or weblink interviews with railroad operators in Europe who are currently using the system to ascertain their experiences with the system’s reliability, functionality, flexibility, accuracy, and long-term durability as well as lessons-learned. 2.) Procure construction services, system components, products, and manufacturer support for furnishing and installing one fully-functional WaveTrain Level Crossing Warning System at a location along the Department-owned Piedmont & Northern rail line, in coordination with the current lessee of the rail line, Iowa Pacific Holdings. 3.) Test the system for a period as an overlay to existing track circuit warning activation technology for a sufficient time period or frequency of trains to test the technology and verify safety and reliability. 4.) Provide an interim report of the system performance for the test phase while it was operating in overlay. Subject to successful performance and concurrence of all parties, transfer activation of the warning devices purely to the WaveTrain technology. 5.) For a period of one year, collect data, monitor system performance, and interview current lessee regarding system performance and reliability. 6.) Provide draft and final technical reports of findings and as well as a recommendations for future deployment in the rail industry, if warranted.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

Introduction of a new cost-effective, reliable train detection technology for use at level crossings. Installation of the system along the Department-owned Piedmont & Northern rail line could serve as a potential in-field model of the system for demonstration to other railroads and rail experts. Technical report would provide documentation of system performance to enhance acceptance and consideration of the system for use by these railroads.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)



**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

**Increased Operational Efficiency/Time Savings/Cost Savings:** Without the extensive cabling and electrical components necessary for traditional train detection systems, the WaveTrain Level Crossing Warning System should result in construction manpower time savings. With all components being underground or in enclosed containers to protect them from the environment and vandalism, time savings should also be achieved through reduced maintenance and repair. With all components being housed at the level crossing, further time-savings should be achieved during regularly mandated FRA inspections by the railroad, as personnel will not need to regularly inspect a lengthy track circuit. Construction and maintenance costs are escalating for current technologies used in the detection of trains. These cost escalations impact NCDOT through the allocation of funding for crossing safety improvements and NC general statutes which require the highway authority to pay for 1/2 of the railroads' maintenance costs. The increased operational efficiency / time savings as detailed above would result in a cost savings for NCDOT.

**Improved Worker or Public Safety:** Time spent on or adjacent to railroad track by construction, inspection and maintenance personnel will be reduced, increasing safety for workers.

Successful operation and evaluation of the WaveTrain Level Crossing Warning System could lead to the development of new AREMA (American Railway Engineering and Maintenance-of-Way Association) recommended practices as well as adoption of a new technology into use along the rail infrastructure.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

NCDOT-Rail Division, through membership on national and state-level committees, would promulgate its experience and research on the evaluation of the WaveTrain Level Crossing Warning System. The Rail Division currently has personnel who are active in AASHTO, NCUTCD, AREMA, SCORT, and the Railway Association of North Carolina.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** NCDOT – Rail Division

**Title:** Rail Signals Manager

**Name:** Richard E. Mullinax, PE, PTOE, CPM

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units.*

Successful implementation of the research project will be contingent on a railroad, in conjunction with the vendor, filing and obtaining all necessary FRA approvals per CFRs including Information Filings and PSPs when applicable (Ref.: CFR 49 Part 236, et al.).

**Approval (Division Official or Unit Head)**

Paul Worley	Signature	Director
Print Name	Signature	Title



RESEARCH NEED STATEMENT

Submission Date: 07/02/2015 RNS#: 7206  
 (R&D Use)  
 Submitter Name: Christopher Wilson Phone: 9192808884  
 Division / Unit: LPA Contractor Branch 179 Email: cawilson2@ncdot.gov

Research Idea Title: Improving Customer Service inside LPA Offices

Note: All fields will expand as you type. Use as much space as needed.

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

DMV commissioned a study in 2013 (ITRE Study) to learn what challenges the DMV License Plate Agencies (LPA's) faced as it relates to improving the customer experience. The study shows that 28.5 percent of customers using the 120 LPA's around the state are walking out without completing their transactions. The rate is higher in military towns and cities. The result is reduced productivity in the office and a more frustrated customer due to multiple trips and wait times.

**Background: Provide supporting information about the business unit, processes and tools**

LPA contractor at Branch 179 has developed a web-based application to help remedy the above mentioned problem set. The application allows customers to interact with it while standing in line, or prior to arriving at the office to complete title transfers. WWW.TRANSFERMYAUTO.COM is the application designed to increase office productivity and reduce customer wait times by educating the customer before their visit, and eliminating the need for customers to revisit the office on multiple occurrences to complete one transaction. Customers relocating to or within NC can use the site to determine the following:

- What to bring
- What forms will be encountered
- What payments or fees are due to both state and county
- What property taxes to expect via use of the local county tax calculator
- Special cases such as military, estate, parent/child transfers are explained in detail

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Exploring multiple way of driving internet traffic to transfermyauto.com to help educate customers before they arrive at a DMV LPA office (via digital marketing strategies, or independent contracting/word of mouth marketing).

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

Improving customer service and reducing the wait-time inside the 120 DMV LPA offices across the state.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

The more customers there are with the knowledge they need to register their vehicles, the more prepared they will be to complete their transaction the 1<sup>st</sup> time, thus making it easier for DMV staff to process work.

**Implementation: Describe how the results of research will be put into practice at NCDOT.**

The outcome would be a better understanding of how to drive traffic to a website that educates users on how to register their vehicles in a new state. By driving a large steady flow of traffic into the transfermyauto database, the DMV will start to see an increase in productivity in their LPA offices, as customers become more and more educated on what to bring to their visit to a DMV LPA office.

Who will lead the implementation? Unit: DMV  
 Provide Unit, Position Title and Name. Title: LPA 179  
Name: Christopher Wilson

Additional Comments and Information: See guide. Recommend including info on involvement from other units.



Chris Wilson	<i>Chris Wilson</i>	LPA Contractor	Branch 179
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**Approval (Division Official or Unit Head)**

Print Name	Signature	Title
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Please email a PDF of the signed document **AND** an editable MS Word copy to Ms. Melvena Sams - [msams@ncdot.gov](mailto:msams@ncdot.gov);  
 Questions can be directed to Ms. Sams via email, by phone (919-508-1790) or to the appropriate Research Engineer.  
 For additional guidance, see the [Research Need Statement instructions](#).





RESEARCH NEED STATEMENT

<b>Submission Date:</b>	07/27/15	<b>RNS#: (R&amp;D Use)</b>	7208
<b>Submitter Name:</b>	John Kirby/Neil Mastin	<b>Phone:</b>	919-508-1795
<b>Division / Unit:</b>	Research & Development Unit	<b>Email:</b>	jkirby@ncdot.gov

**Research Idea Title:** Capturing and Communicating the Value of NCDOT Research

*Note: All fields will expand as you type. Use as much space as needed.*

**What is the problem or issue needing investigation? Be specific and detailed. ([Click Here for Form Instructions](#))**

The NCDOT Research & Development Unit (R&D) wishes to improve the tracking of implementation of research projects and the resulting value to the Department as a whole. Value can be measured in many ways and it would be helpful to have a standardized method to capture different forms of benefit and establish the best means to communicate those results.

Topics of interest include: Capturing and measuring implementation. Metrics that need to be established or refined. Optimal time to capture value and measure implementation success. Dealing with and summarizing multiple indicators such as infrastructure life extensions, cost-savings, time-savings, efficiency improvements, safety improvements etc. Identifying potential high value candidates early in the development cycle.

**Background:** *Provide supporting information about the business unit, processes and tools*

The R&D Unit coordinates the development, prioritization, and funding of NCDOT’s Research Program. The unit manages the program on a day to day basis. After research projects are completed, the Unit tracks implementation and seeks to capture the value of the research program. State DOTs must actively work to implement appropriate research findings and should document benefits as stated in Title 23 CFR Chapter 1 Subchapter E Part 420 Subpart B 420.209(6). It is important to measure the benefits of the Department’s research program on a regular basis to determine if research budgets have been used effectively.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

- Literature search – National and state DOT value of research projects/examples.
  - NCHRP 610 and the TRB Research Pays off sites are good examples of starting points.  
http://www.trb.org/publications/pubsresearchpaysoff.aspx
- Select several completed research projects to estimate the benefit of research projects and compare them with costs to conduct the studies.
- Interview Department personnel involved in research projects to obtain subjective and objective information on the success of projects on which they have participated.
- Develop methodologies to convert project benefits into a dollar value where possible.
- Evaluate which projects produce cost benefit and which projects are marginal or unsuccessful by using applicable methodologies.
- Meet with the key champions and others familiar with the research products, and outline a plan to obtain a good estimation of the study benefits and total costs.
- Develop indicators that define a successful project and that could be helpful in the project selection process. Explore methodologies and/or develop a computer model that could facilitate the project evaluation and selection process. In essence, try to identify high values projects early in the process

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

Case studies, Benefit-Cost analysis, Return on Investment estimates, guidance/policy documents on determining and reporting the value of research projects, and computer simulation/model that could facilitate evaluation and selection of research projects





RESEARCH NEED STATEMENT

Benefit / Knowledge Gain for NCDOT: Check all that apply.

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input checked="" type="checkbox"/> Other (Specify)

Explain Anticipated Benefits: Provide details for the benefits checked above.

Provides the R&D Unit better means to actively monitor, support, and encourage methods and practices designed to demonstrate the value of transportation research; facilitate dissemination and exchange of information and experiences among Departmental personnel and outside agencies; and serve as advocates of methods and practices that identify, market, maximize and convey the value of research to others including but not limited to performance measures for the research program and projects.

Implementation: Describe how the results of research will be put into practice at NCDOT.

A computer simulation/model along with compact and succinct guiding document enabling the R&D unit to routinely establish research benefits. Documenting the implementation of the research results will lead to defined benefits (quantified or qualified) for NCDOT that outweighs the cost of the research and implementation. Documented implementation results that have led to significant changes in the Department, positively impacting the conduct of business. Documented results informing the Department that research projects are making demonstrated progress in implementing the results of the research or otherwise following the project recommendations.

**Who will lead the implementation?**  
Provide Unit, Position Title and Name.

**Unit:** Research and Development

**Title:** Research and Development Manager

**Name:** Neil Mastin

Additional Comments and Information: See guide. Recommend including info on involvement from other units.

Period of Performance not to exceed 12 months.

Approval (Division Official or Unit Head)

Neil Mastin		R&D Manager
Print Name	Signature	Title

# Pavements & Materials



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	May 15, 2015	<b>RNS#:</b>	7301
<b>Submitter Name:</b>	Judith Corley-Lay	<b>Phone:</b>	919-835-8201
<b>Division / Unit:</b>	Highways/Pavement Management	<b>Email:</b>	jlay@ncdot.gov
<b>Research Idea Title:</b>	Quantifying Oxidation Drying of Asphalt Pavements Using Colorimeter		

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

Asphalt surfaced pavements in NC experience significant oxidation drying that results in top down cracking. Our current pavement condition survey regarding oxidation is very subjective. Having a method of measuring and quantifying the oxidation drying would allow us to time maintenance or preservation treatments just prior to crack propagation.

**Background:** *Provide supporting information about the business unit, processes and tools*

During a recent research meeting on warm mix asphalt, the researcher demonstrated the use of a colorimeter. That demonstration made me wonder if this device could be used to measure the rate of oxidation of the asphalt surface. This project is to determine the feasibility of using the colorimeter to quantify oxidation for 3 asphalt surface mixes. Among the questions that the research should address: Does oxidation drying occur at a constant rate for all three mixes for the same amount of environmental exposure? How does the rate of oxidation change over time following paving? Do thin lifts oxidize more rapidly than do thick lifts? Can the colorimeter results identify the point where top down cracking begins?

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

The research is expected to include the following tasks, although other approaches can be proposed:

1. Literature review of factors affecting oxidation and the rate of cracking from oxidation drying
2. Identify test mixes for study.
3. Develop a test plan to control exposure for all mixes to similar environmental conditions
4. Place mixtures and obtain initial results including air voids, density, colorimeter
5. Monitor and take colorimeter readings over time.
6. Analyze results and make recommendations regarding use of this test method to quantify oxidation.
7. Recommend next steps if method proves to be feasible.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

Products will include a determination of feasibility, a plan to expand this work to more mixes and different environments, a recommended test procedure.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details of the benefits checked above.*

If this method is feasible, we can begin to program use of fog seals or rejuvenators as the pavement surface dries, resulting in less cracking and improved pavement performance.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

It is anticipated that this project (a feasibility study) will lead to a broader study. Once that is complete, we will be able to model oxidation drying in the pavement management system.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Pavement Management Unit  
**Title:** State Pavement management engineer  
**Name:** Judith Corley-Lay

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units here*

Both the construction unit and materials and tests will be critical partners in this project.

**Approval (Division Official or Unit Head)**

Judith Corley-Lay	State Pavement Management Engineer
Print Name	Title
Signature	



RESEARCH NEED STATEMENT

**Submission Date:** June 3, 2015 **RNS#:** 7302  
**Submitter Name:** Judith Corley-Lay **Phone:** 919-835-8201  
**Division / Unit:** Highways/Pavement Management **Email:** jlay@ncdot.gov  
**Research Idea Title:** Backcalculation of Dynamic Modulus from Falling Weight Deflectometer Data

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

Dynamic Modulus is the main parameter used in modeling pavement response in Pavement ME-Design. While the test can be run in the laboratory for new location projects, many of our projects consist of widening or rehabilitating existing pavements. The structural adequacy of these projects is determined using Falling Weight Deflectometer (FWD) and coring. It is difficult to obtain an adequate sample of material from the existing pavement without causing significant damage. This project will explore use of backcalculation using two different software types to obtain the dynamic moduli from FWD data sets.

**Background:** *Provide supporting information about the business unit, processes and tools*

NCDOT tests existing pavements using FWD to determine overlay requirements for pavements scheduled for rehabilitation. In earlier research efforts, Dr. Richard Kim at NCSU developed code which includes backcalculation of dynamic moduli. A separate software code developed by Michigan State University also backcalculates dynamic moduli from FWD deflection tests and has been provided to Dr. Richard Kim. This research will test a low thickness, moderate thickness and thick pavement section with FWD and coring. Samples will be removed for dynamic modulus testing.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

- The research is expected to include the following tasks, although other approaches can be proposed:
1. Literature review on backcalculation of dynamic modulus from FWD data sets and comparison of backcalculated dynamic modulus to laboratory dynamic modulus
  2. Identify pavement sections for testing and coring.
  3. Conduct FWD testing and coring. Note that 6" Diameter cores will be required for the laboratory testing. Deliver samples to laboratory for testing
  4. Backcalculate Dynamic Moduli of pavement layers using both NC State and Michigan State software
  5. Compare the two software results as well as the laboratory results.
  6. Recommend best approach to obtain dynamic modulus for existing pavement layers. Include specific guidance on initial inputs, etc. to improve software performance.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

Recommended software and user guidance to determine dynamic modulus of pavement layers for existing pavements.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details of the benefits checked above.*

If we can use FWD data to obtain not only overlay thickness but also dynamic modulus of existing pavement, it will reduce the number of dynamic modulus tests required for pavement design. These tests are complex and very time consuming, so there will be cost savings as well as a more efficient use of our testing data.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

The results will be implemented by Pavement Management Unit in our design/analysis of existing pavements.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Pavement Management Unit  
**Title:** State Pavement management engineer  
**Name:** Judith Corley-Lay

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units here*

Materials and Tests should be part of this research as they will provide dynamic modulus testing of subgrade materials.



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	June 3, 2015	<b>RNS#:</b>	7303
<b>Submitter Name:</b>	Judith Corley-Lay	<b>Phone:</b>	919-835-8201
<b>Division / Unit:</b>	Highways/Pavement Management	<b>Email:</b>	jlay@ncdot.gov
<b>Research Idea Title:</b>	Quantifying the Impact of Crack Sealant on Pavement Surface Friction		

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

Application of crack sealant is a preservation technique for flexible pavements that prevents water from entering the pavement surface and damaging underlying layers. When applied in excess, or to a road with too much cracking, the sealant may adversely affect friction. This project will identify the density of sealant (perhaps as a percent of the surface area covered with sealant) at which frictional properties drop.

**Background:** *Provide supporting information about the business unit, processes and tools*

NCDOT has a program of actively collecting pavement friction data on a cyclical basis. NCDOT also supports active crack sealing efforts by maintenance forces. In some cases, excessive quantities are applied either through overbanding of the sealant or through use of sealant on pavement with too many cracks. There is concern that the friction on the road surface will drop due to the excessive sealant and increase the risk of wet weather accidents.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

- The research is expected to include the following tasks, although other approaches can be proposed:
1. Literature review of factors affecting pavement surface friction, especially those caused by maintenance activities
  2. Identify method of quantifying crack sealant density at a particular roadway
  3. Identify pavement sections having a wide variety of crack sealant density. When possible identify sections of similar surface mixes with little or no cracking.
  4. NCDOT will test the pavement sections with our locked wheel skid testers with at least three repeats at each site
  5. Analyze results and make recommendations regarding the limit of crack sealant when pavement friction is reduced.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

Guidelines for limiting crack sealant as a percentage of surface area with regard to friction impacts.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details of the benefits checked above.*

The benefit will be improved frictional performance (improved safety). Also may set a threshold where the pavement should be resurfaced rather than crack sealed.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

If high percentages of crack sealing reduce pavement surface friction, guidelines limiting the percentage of crack sealing will be shared with division maintenance personnel.

**Who will lead the implementation?** **Unit:** Pavement Management Unit  
*Provide Unit, Position Title and Name.* **Title:** State Pavement management engineer  
**Name:** Judith Corley-Lay

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units here*

State Maintenance and Operations should be part of this research as well as 2 Division Maintenance Engineers.

**Approval (Division Official or Unit Head)**

Judith Corley-Lay	State Pavement Management Engineer
Print Name	Title
Signature	



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	June 3, 2015	<b>RNS#:</b>	7304
<b>Submitter Name:</b>	Judith Corley-Lay	<b>Phone:</b>	919-835-8201
<b>Division / Unit:</b>	Highways/Pavement Management	<b>Email:</b>	jlay@ncdot.gov
<b>Research Idea Title:</b>	Use of PUC for Performance Characterization of Aggregate in Bituminous Surface Treatments		

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

While earlier research identified the percent uniformity coefficient as an important component of surface treatment performance, no threshold values or range of values was identified.

**Background:** *Provide supporting information about the business unit, processes and tools*

NCDOT has conducted a series of research projects over the last 12 years to improve performance of surface treatments which are the dominant treatments for our SR routes. These research projects have identified 4 components to performance: PUC, fine's content, emulsion application rate and embedment. Identifying the threshold values for PUC will, along with fine's content, allow us to improve our materials specification for aggregate in BST to improve seal performance.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

- The research is expected to include the following tasks, although other approaches can be proposed:
1. Literature review on aggregate characteristics contributing to good performance of surface treatments, as well as work on uniformity coefficients for aggregate in surface treatments.
  2. Develop aggregate mixes with a range of PUCs by gradation fractionating and then re-blending to specific PUC values.
  3. Laboratory test the surface treatments using tests already developed.
  4. Analyze results to determine threshold PUC to assure good performance..

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

Threshold values of PUC to use in specification for aggregates used in bituminous surface treatments. Recommended specification.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details of the benefits checked above.*

If successful, we will be able to improve BST performance by controlling the uniformity of the aggregate. Even a small improvement in performance will have significant impact because of the 40,000 miles of surface treated roads on the NCDOT system.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

The results will be implemented as an improved specification and testing procedure for aggregates used in surface treatments.

**Who will lead the implementation?**  
*Provide Unit, Position Title and Name.*

**Unit:** State Maintenance Operations Unit  
**Title:** State Maintenance Operations Engineer  
**Name:** Emily McGraw

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units here*

Materials and Tests and State Maintenance Operations should be part of this research.

**Approval (Division Official or Unit Head)**

Judith Corley-Lay	_____	State Pavement Management Engineer
Print Name	Signature	Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	June 15, 2015	<b>RNS#:</b>	7305
<b>Submitter Name:</b>	Judith Corley-Lay	<b>Phone:</b>	919-835-8201
<b>Division / Unit:</b>	Highways/Pavement Management	<b>Email:</b>	jlay@ncdot.gov
<b>Research Idea Title:</b>	Use of Rejuvenator Prior to Chip Seal on Aged Flexible Pavement		

**What is the problem or issue needing investigation?** *Be specific and detailed. (Click Here for Form Instructions)*

Many roadways in North Carolina are aged when treated with a chip seal. The aged pavement is drier and more porous than it would be if treated earlier. Would a rejuvenator make the chip seal perform better and would the life extension be sufficient to overcome the cost?

**Background:** *Provide supporting information about the business unit, processes and tools*

Oxidation drying is a significant factor in top down cracking of flexible pavements in NC. Since this occurs from the surface, it results in stiff, dry asphalt at the surface and a drying gradient through the depth of asphalt. The dry surface will absorb liquid from the chip seal, reducing the amount of asphalt available to bind the aggregate in the chip seal. This project will address use of a rejuvenator prior to the chip seal to see if performance is improved.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

It is anticipated that this research will consist of at least the following tasks (although alternate approaches will be considered):

1. Literature review of impacts of oxidation or aging on chip seal performance, impact of rejuvenator on existing pavement surface and subsequent treatment and other directly related topics
2. Develop test plan including laboratory and field trials.
3. Laboratory tests to test the concept (it is anticipated that this will consider a variety of "existing pavement ages" with and without rejuvenator)
4. Field trials may be considered, but will depend on identifying desirable sites and willing contractors.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

Guidelines for when use of rejuvenator will result in improved chip seal performance.  
Benefit in terms of life extension as a function of degree of aging.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details of the benefits checked above.*

If a fairly low cost treatment can improve the performance of a chip seal on an aged pavement, it will assist maintenance forces in using their funds optimally.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

Results will be shared with the Division Maintenance Engineers and the Division Bituminous Supervisors with guidelines for when and how to use rejuvenators.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** State Maintenance and Operations

**Title:** State Pavement Preservation Engineer

**Name:** Emily McGraw

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units here*

**Approval (Division Official or Unit Head)**

Judith Corley-Lay		State Pavement Management Engineer
Print Name	Signature	Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	7/27/2015	<b>RNS#:</b>	7306
<b>Submitter Name:</b>	Robert R. Hayes	<b>Phone:</b>	919-7074812
<b>Division / Unit:</b>	Highways/Transportation Management Program/Value Management	<b>Email:</b>	rrhayes@ncdot.gov
<b>Research Idea Title:</b>	<b>Using Recycled Concrete Aggregate in Non-Structural Concrete on NCDOT Projects in Eastern NC</b>		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Determine the efficacy of using recycled concrete aggregate (RCA) in non-structural concrete on NCDOT projects in Eastern North Carolina to meet the requirements of Class B concrete according to Section 1000-4 of NCDOT 2012 Standard Specifications.

**Background: Provide supporting information about the business unit, processes and tools**

While at a Value Engineering (VE) Study of a project in eastern North Carolina, a Resident Engineer from eastern North Carolina mentioned that contractors are using recycled concrete on their projects, but not on NCDOT projects. The Resident Engineer said that contractors from eastern North Carolina have to go to Rocky Mount to get aggregate which is a long haul distance for aggregate. Eastern North Carolina, i.e., North Carolina east of I-95, has limited access to high quality aggregate. An efficient haul distance for aggregate is less than 50 miles. West of I-95 there is ready access to high quality aggregate. There are going to be many NCDOT projects in eastern North Carolina, such as bridge replacements, over 100 (2016-2025 STIP), that will result in 100s-of-tons of concrete debris. There will also be road construction projects that could benefit from the use of Recycled Concrete Aggregate (RCA). NCDOT 2012 Standard Specifications Section 545-2 allows recycled concrete to be used as road base. But, no where else in the Standard Specifications does it state whether RCA is allowed. A 2004 FHWA study found that 11 states use RCA in new Portland cement concrete.<sup>10</sup> The states and countries that allow the use of RCA in new concrete usually allow 20%-30% RCA, but no more than 50% and is usually for non-structural elements such as curb-and-gutter, valley gutters, sidewalks, concrete traffic islands, barriers and sound walls.<sup>2</sup> Section 846 and Section 1000-4 of NCDOT's 2012 Standard Specifications, describes the use of Class B concrete for the construction of curb, curb-and-gutter, expressway gutter, valley gutter, etc. Using RCA as replacement for some of the coarse natural aggregate (NA) would reduce haul distances and could be less expensive than virgin stone resulting in NCDOT projects faster to complete and less expensive. Also, using RCA in concrete instead of disposing of it conserves a valuable resource, reduces air pollution from the production and transportation of the aggregate, and preserves valuable landfill space.<sup>4</sup>

The most important factor in using RCA is know the source of the RCA – only use recycled concrete from highways or bridge demolition from eastern North Carolina: The highways and bridges of eastern North Carolina were originally constructed with quality aggregate<sup>4</sup>; The highways and bridges of eastern North Carolina are not subjected to de-icing salts and chemicals that can affect the quality of the RCA as in piedmont and western North Carolina; if the pavement is stressed with D-cracking or alkali-silica reactivity, those conditions can be mitigated in the mix design. Another factor in using RCA is to minimize deleterious materials such as soil, wood, asphalt or metal from reinforcing steel. Use magnets during crushing and separation of the concrete to remove any metal. To use RCA in non-structural concrete, fines, that portion of the RCA that passes No. 4 sieve, are not used because they affect the workability and quality of the concrete. To accomplish this, the RCA needs to be washed which increases the cost of its use. Because of RCA's higher water demand, it is recommended that while being stockpiled, RCA is kept in a saturated state. This is another reason to wash the cement fines from the RCA, otherwise, the fines would re-cement the RCA. The cement portion of the RCA that adheres to the aggregate affects the results of the specific gravity and abrasion aggregate tests, they are both lower<sup>4</sup>, and increases air voids, but that does not mean the aggregate is of poor quality. There can be advantages to a lighter concrete. The angularity of the crushed RCA and the porosity of the cement portion, it absorbs more water, can affect the workability of the concrete therefore, more water is needed or additives (such as fly ash) are used which would increase the cost of using RCA in concrete mix.<sup>4</sup> The water absorption of RCA in concrete affects slump, and can affect the freeze-thaw durability of RCA concrete, creep and shrinkage.<sup>4</sup> Alkali-silica reactivity (ASR) may be more of a problem with RCA due to the increased surface area, but that is dependent on the original aggregate. Fly ash is used to mitigate ASR.<sup>4</sup> The addition of fly ash also seems to increase the workability of RCA concrete.<sup>4</sup> According to a Washington State Department of Transportation (WSDOT) study of the inclusion of RCA in concrete for pavement found, that, the inclusion of RCA in concrete increases drying shrinkage and creep, and decreases the modulus of elasticity and tensile strength, but does not seem to affect the compressive strength and freeze-thaw durability.<sup>4</sup> By testing the inclusion of RCA in concrete at different rates, the optimal mix can be determined.





States that allow RCA in concrete on DOT projects.

In IR-19 (Interpretation of Regulation), California allows the use of RCA in "...sidewalk, curb, gutter, parking strip, and pavement provided all the following requirements are met:

- Source of recycled aggregates are identified,
- Use of recycled fine aggregates in concrete is prohibited,
- Use of recycled coarse aggregates from salt contaminated concrete pavements is prohibited,
- Thoroughly cleaned and washed before use,
- Contain no deleterious materials,
- Meet the requirements of the California Building Code and its referenced standards, i.e. ASTM C33,
- Satisfy specific project requirements, and
- When used in minor concrete, the amount shall be limited to no more than 50% of the total dry aggregate mass."

The IR-19 continues with a comment on mix design,

"3. SPECIAL CONSIDERATIONS: Concrete mix designs must account for the physical properties and characteristics of recycled aggregates, such as:

3.1 Recycled Concrete Aggregates (RCA):

- Angular with rough surfaces
- Higher water absorption
- Lower density
- Higher abrasion loss
- May fail sulfate soundness test
- May contain higher level of sodium chloride."

Washington State Department of Transportation (WSDOT) did a study of using RCA in new pavement and found that, "...up to a 45% replacement of coarse natural aggregate with RCA had no significant effect on any of the hardened concrete properties".<sup>4</sup>

Michigan Department of Transportation (MDOT) 2012 Standard Specifications allows "crushed concrete coarse aggregate...in concrete used for lower priority applications such as curb and gutter, valley gutter, sidewalks, concrete barriers, driveways..."<sup>5</sup>

Texas Department of Transportation (TxDOT) allows the use of RCA in pavement, but not in structures.<sup>6</sup>

Other countries such as Germany, UK, Spain, Australia, The Netherlands, and China, allows the use of RCA in concrete.<sup>3</sup>

#### References:

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9. 2016-2025 STIP
10. Transportation Applications of Recycled Concrete Aggregate; U.S. Department of Transportation, Federal Highway Administration; September 2004. <http://www.fhwa.dot.gov/pavement/recycling/applications.pdf>



**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

1. Literature review of using RCA in concrete for non-structural items such as curb-and-gutter, valley gutter, barriers, islands, sound walls, etc.
2. How far do concrete producers in Divisions 1, 2, and 3 in Eastern North Carolina have to go to get aggregate.
3. Obtain samples of RCA from the demolition of concrete pavement or bridge in Divisions 1,2, and 3 with the minimum of deleterious material such as asphalt, soil, or metal. Separate and remove the fines, that portion of the RCA that passes no. 4 sieve. Follow the guidelines for coarse aggregate in Section 1014-2 of NCDOT 2012 Standard Specifications. Perform standard aggregate tests on the processed RCA to determine specific gravity, absorption capacity, abrasion loss, aggregate gradation and alkali-silica reactivity (ASR).
4. Follow the guidelines in NCDOT 2012 Standard Specifications, Section 846 for the construction of concrete curb, etc. and Section 1000 and 1000-4, for Class B Portland concrete as would apply to the construction of curb-and-gutter, concrete island, etc. Using two standard, local, NCDOT approved concrete mix design containing type F fly ash. One mix design containing 120 lbs./cu. yd. fly ash and another mix design containing 131 lbs./cu.yd. fly ash (or as the researcher sees fit not to exceed the maximum water-cement ratio). Replace the natural coarse aggregate with RCA coarse aggregate, by volume, at 0%(control), 15%, 30% and 50% (I determined these percent replacement from the work done by Washington State DOT. See reference #4), mixed with the natural aggregate. Test the fresh concrete for slump, air content and density. For the desired workability, slump, air content, additives, including fly ash (there is a maximum allowed Section 10004(I), Table 1000-3), may need to be added. Use standard procedures for making, curing and breaking concrete cylinders with 7 and 28 day curing times. There shall be 3-cylinders for each fraction (0%, 15%, 30%, 50%) for each of the 3 samples from the 3 Divisions for each of the 2 test mixes, therefore, a total of 72 cylinders.
5. Report on the results of the cylinder breaking tests, compressive strength, for each fraction of RCA replacement for each sample.
6. Report on where the samples were obtained (ex: Bridge over X Creek on highway 12, Division 1) and how the samples were processed, type of equipment used to crush the debris (jaw, or cone, etc.) and was there reinforcing steel and how was it removed.
7. There may be additives, including fly ash required to aid in workability and to obtain the proper slump. What is the cost of using the additives due to using RCA vs. natural aggregate.
8. Analyze results and make recommendations for mix designs with RCA which may include additives.
9. Determine the efficacy of using Recycled Concrete Aggregate in Eastern North Carolina in concrete: The cost of crushing concrete, separating reinforcing steel, separating the fines and washing the RCA and the resulting quality of the RCA concrete vs. the cost of disposal of concrete demolish debris (or are other uses found for it) and the cost of using natural aggregate.
10. Does Eastern North Carolina have the available resources, i.e., are there businesses that have the equipment to crush and process the concrete to be available in enough quantity for NCDOT road projects.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

New specifications and guidance for the use of RCA in new concrete for non-structural concrete roadway elements in eastern NC.

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

1. Time savings – reduce haul distance and therefore time saving
2. Cost saving – Using an available resource (RCA) vs. buying virgin aggregate, plus the time saving of not hauling long distances and the less time a project takes the less expensive it is.
3. New specifications
4. Not having large dump trucks on the highways hauling long distances improves public safety.
5. Good stewardship of the environment – RCA used instead of going into a landfill.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

Materials and Testing will have new specifications and guidelines to use RCA in non-structural concrete in eastern North Carolina for Resident Engineers, contractors and concrete producers.

**Who will lead the implementation?**  
*Provide Unit, Position Title and Name.*

**Unit:** Materials and Tests

**Title:** State Materials Engineer

**Name:** Chris Peoples



RESEARCH NEED STATEMENT

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units.*

The below units will need to be consulted for implementation:  
Materials and Tests,  
Division Engineers of Divisions 1, 2 & 3,  
Sherry Yarkosky, DENR, Recycling Business Assistance Center 919.707.8133

**Approval (Division Official or Unit Head)**

Jessica Kuse, PE, CPM

State Value Management Engineer

Print Name

Signature

Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 1, 2015	<b>RNS#: (R&amp;D Use)</b>	7307 / 7502
<b>Submitter Name:</b>	Tony Wyatt & Clark Morrison	<b>Phone:</b>	T. Wyatt: 919-773-2887 C. Morrison: 919 835-8202
<b>Division / Unit:</b>	Traffic Safety & Pavement Management	<b>Email:</b>	<a href="mailto:adwyatt@ncdot.gov">adwyatt@ncdot.gov</a> & <a href="mailto:cmorrison@ncdot.gov">cmorrison@ncdot.gov</a>
<b>Research Idea Title:</b>	Evaluation of Methods for Pavement Surface Friction Testing on Non-Tangent Roadways and Segments		

Note: All fields will expand as you type. Use as much space as needed.

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Current methods of measuring pavement friction have limitations with regard to horizontal curves, ramps, intersections, and elevated surfaces. As a fundamental feature in highway performance and road safety, pavement friction values can provide important information that can enable better identification of locations for friction improvement treatments and the limits of the treatments.

**Background: Provide supporting information about the business unit, processes and tools**

North Carolina is recognized for good roads, good aggregates and almost model system friction values. North Carolina's Pavement Management System includes traditional locked wheel friction values regularly measured on primary routes and available on other road sections as requested. Pavement friction is important for the safe traversal of highways, particularly on horizontal curves, ramps, intersections, and elevated surfaces. While NC has both a strong Pavement Management Program and a strong Safety Improvement Program there has been little alignment between road sections with concentrations of wet crashes and road sections with friction values lower than the actual friction demand. The traditional test has limitations, including testing on curves, and short roadway segments. New tools and processes are emerging that can supplement traditional locked wheel tangential friction measuring tools and can provide detailed continuously measured friction values which can provide critical details to better understand road departures, wet crashes, and overall traffic performance and safety along ramps, loops, curves, and super-elevated sections that have traditionally been difficult to assess friction on. This improved knowledge could help better identify the most appropriate / effective treatments and better define the limits of the needed treatment.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Tasks for this project should include an evaluation of the effectiveness of continuous friction testing methods and their potential usefulness on a variety of North Carolina roadways and surfaces, providing comparisons of obtained average friction values on various road segments – including curves, ramps, loops, intersections, steep grades of approaches, and super-elevated pavements – as a supplement to current friction testing practices. Testing methods may include the locked wheel test currently used by NCDOT, along with the Aerogroup GripTester, and other available methods. In addition to traditional surfaces and road features – this research effort would also be tasked to include common pavement types, various overlays, sealants, high friction surface treatments (both treatment and comparison sites), roadway conditions, and future implementation guidance.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

Research products should include a comparison of friction obtained from various different equipment and methodologies, and average friction values by pavement condition and type, feature (curve/ramp/loop/super elevated section/section on grade), critical friction limits, as well as, potential implementation guidance for continuous friction testing technology.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)



RESEARCH NEED STATEMENT

**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

The testing methods and equipment can directly lead to increased curve, ramp, and loop pavement performance as more information about critical friction and limits will improve NCDOT's ability to improve safety investments and performance. The testing could lead to the development of models to estimate pavement friction which could influence pavement specifications in areas which would benefit from higher friction. These improvements could lead to the overall improvement of public safety on NCDOT roadways.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

The research results could include enhanced information about non-tangent roadway segments and the use of new testing equipment and methods for pavement evaluation that would complement and extend NC's already strong pavement management efforts..

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Pavement Management

**Title:** State Pavement Design Engineer

**Name:** Clark Morrison, PhD, PE

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units.*

The Traffic Safety Unit, the Construction Unit and the Pavement Management Unit should collaborate on this research project.

**Approval (Division Official or Unit Head)**

Judith Corley-Lay

Print Name

Signature

State Pavement Engineer

Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	<u>7/20/2015</u>	<b>RNS#:</b> (R&D Use)	<b>7308</b>
<b>Submitter Name:</b>	<u>Jennifer Brandenburg</u>	<b>Phone:</b>	<u>919-733-3725</u>
<b>Division / Unit:</b>	<u>Asset Management</u>	<b>Email:</b>	<u><a href="mailto:jbrandenburg@ncdot.gov">jbrandenburg@ncdot.gov</a></u>

**Research Idea Title:** Regional Peer Exchange on Asset Management and MAP21 Topics

*Note: All fields will expand as you type. Use as much space as needed.*

**What is the problem or issue needing investigation? Be specific and detailed. ([Click Here for Form Instructions](#))**

All states have developed processes, guidelines, and/or computer systems to manage current issues. Rather than always working alone, Asset Management seeks to break down the silos or state lines and learn from neighboring states in a variety of topics. Topics include but are not limited to:

- Budgeting and Allocations
- Work force development
- Technological advances in condition assessments
- Management systems
- Equipment management
- Transportation Assessment Management Plans

**Background:** *Provide supporting information about the business unit, processes and tools*

Federal and state law requires increasing levels of Asset Management cooperation across the entire North Carolina Department of Transportation. MAP21 includes several requirements for Transportation Asset Management Plans and high levels of federal and state reporting. The impacts of funding must also be considered when creating the STIP.

**Research Tasks:** *Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)*

Tasks included, but may not be limited to:

1. Conduct a literature review and investigation on the progress in the topics above in the surrounding states
2. Identify up to 4 regional states with high levels of implementation in several topics.
3. In coordination with NCDOT Asset Management Staff, design a peer exchange program to answer the most pressing questions facing NCDOT.
4. Coordinate travel plans to bring peer states to NC for meetings and discussions.
5. Facilitate the meetings.
6. Compile the results of each peer exchange into a cohesive guidance document with interim documents produced for each meeting that outline best practices.

**Products of the Research:** *Examples of products could include models, specifications, policies, general guidance...etc.*

The most important product is the series of meetings. Face to face meetings with experts and peers in other states will provide immediate impact to NCDOT activities.

The final product should be a report that provides best practice guidance to NCDOT business units and identifies areas in which NCDOT is leading or doing well. Interim reports will be needed to assist business units as the project progresses.

**It is desired that this project be completed in a 1 year time frame.**

**Benefit / Knowledge Gain for NCDOT:** *Check all that apply.*

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*



RESEARCH NEED STATEMENT

The principle benefit is acquiring direct knowledge of best practices from other states and identifying strengths and weaknesses in NCDOTs efforts. This project could create some cost savings by reducing development timeframes.

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

Direct discussions during the peer exchanges will carry over into immediate work processes. The final report will help NCDOT to identify best practices that will make it into NCDOT business processes.

**Who will lead the implementation?** **Unit:** Asset Management  
*Provide Unit, Position Title and Name.* **Title:** State Asset Management Engineer  
**Name:** Jennifer Brandenburg

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

The subunits of Asset Management will be heavily involved. Additional NCDOT units that must be involved in the TAMP and MAP21 aspects can be identified.

**Approval (Division Official or Unit Head)**

Jennifer Brandenburg	_____	State Asset Management Engineer
Print Name	Signature	Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 22, 2015	<b>RNS#:</b>	7309
<b>Submitter Name:</b>	Clark S. Morrison C. K. Su	<b>(R&amp;D Use)</b>	919-835-8202
<b>Division / Unit:</b>	Pavement Management Materials & Tests	<b>Phone:</b>	919-329-4150
		<b>Email:</b>	<a href="mailto:cmorrison@ncdot.gov">cmorrison@ncdot.gov</a> <a href="mailto:cksu@ncdot.gov">cksu@ncdot.gov</a>
<b>Research Idea Title:</b>	Use of Laboratory Measured Resilient Moduli in Pavement Design		

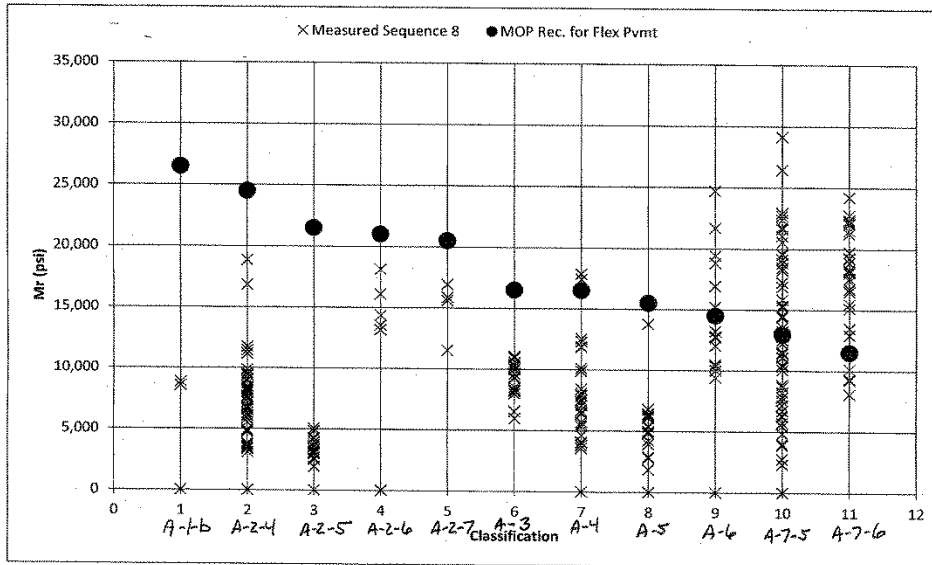
Note: All fields will expand as you type. Use as much space as needed.

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Resilient moduli for both subgrade soils and aggregate base courses are import inputs in the Mechanistic-Empirical Pavement Design Guide. Use of laboratory-measured resilient moduli has been difficult. The attached figure shows a comparison of a sampling of laboratory measured resilient moduli, by AASHTO soil classification, along with the default values used by the MEPDG software, and presented in the MEPDG Manual of Practice (MOP). A number of issues are apparent:

- Measured values for the sandy soil are lower than those for clayey soils, contrary to experience and the default values.
- The scatter for clayey soils is especially large.
- Measured values for sandy soil are significantly lower than the default values.

These factors make use of the laboratory resilient moduli for pavement design purposes difficult, as they can lead to thinner pavement over clayey soils than over sandy soils.



**Background:** Provide supporting information about the business unit, processes and tools





RESEARCH NEED STATEMENT

At least two factors may contribute to uncertainty in laboratory resilient moduli: the moisture content and the method of compaction.

Recent research from Virginia ("Resilient Modulus Values for Base Aggregate from Virginia", Hossain and Lane, 2015 TRB Annual Meeting) indicates that a change in moisture content from optimum to ~1% above optimum results in changes in resilient modulus, for aggregate base course, ranging from 2% to 74% with a median change of 23%. Changes can be expected to be larger for clayey soils, and for moisture changes wet of optimum.

Resilient modulus tests are run at optimum moisture content. Optimum moisture content is determined from a Proctor density test. The uncertainty in this moisture content may be as much as 1%. In addition, there is some variability in the moisture content in the sample preparation process (0.5 to 1.0% per AASHTO T-307). The resilient modulus input parameter required by the MEPDG software is that at the construction moisture content. This may be different from the optimum moisture content. All these factors make it difficult to determine the MEPDG input resilient modulus from the laboratory resilient modulus.

In addition, the NCDOT laboratory uses static compaction to prepare resilient modulus samples of sandy soils or aggregate base. The AASHTO Standard (T-307) for resilient modulus testing recommends vibratory compaction. This may also contribute to uncertainty in the results.

**Research Tasks:** Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)

For a variety of soil types and aggregate bases:

- Determine the uncertainty in the optimum moisture content determined by the Proctor density test.
- Determine the uncertainty in moisture content in the sample preparation process.
- Determine the impact of the uncertainties in moisture on the measured resilient moduli.
- Provide recommendations on how to account for these uncertainties when determining the design resilient moduli values to be used in the MEPDG software.

For a variety of sandy soils and aggregate bases:

- Determine the impact of using static compaction vs. vibratory compaction on the measured resilient modulus.
- If appropriate, provide recommendations on sample preparation and/or interpretation of resilient modulus results based on the compaction method.

As possible, provide guidance on determining resilient modulus input parameters from laboratory test results.

**Products of the Research:** Examples of products could include models, specifications, policies, general guidance...etc.

Guidance on interpreting the laboratory results and determining resilient modulus inputs for the MEPDG software.

**Benefit / Knowledge Gain for NCDOT:** Check all that apply.

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** Provide details for the benefits checked above.

Better laboratory testing for resilient moduli, and better use of laboratory results in the software used for pavement design will result in more cost effective pavement designs that will prevent premature pavement distresses and unnecessarily conservative designs that will use up scarce funding.

**Implementation:** Describe how the results of research will be put into practice at NCDOT.



RESEARCH NEED STATEMENT

Pavement Management would use the guidance to interpret resilient modulus laboratory results, and develop inputs for the MEPDG software. Depending on the results of the research, the Materials and Tests Lab might use the guidance provided to improve laboratory testing procedures.

Who will lead the implementation?

Provide Unit, Position Title and Name.

<b>Unit:</b>	Pavement Management	Materials & Tests
<b>Title:</b>	State Pavement Design Engineer	Assistant Soils Engineer
<b>Name:</b>	Clark S. Morrison	C. K. Su

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

Pavement Management, M&T, and Geotechnical should be represented on the implementation committee.

Approval (Division Official or Unit Head)

Judith Corley-Lay		State Pavement Management Engineer
Print Name	Signature	Title

# Structures & Construction



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 20, 2015	<b>RNS#:</b>	7401
<b>Submitter Name:</b>	Thomas K. Koch	<b>Phone:</b>	919-707-6402
<b>Division / Unit:</b>	Structures Management	<b>Email:</b>	tkoch@ncdot.gov
<b>Research Idea Title:</b>	Improving Replacement Cost Data for NCDOT Highway Bridges		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

A sound asset management plan relies upon the best possible data about existing assets when making engineering decisions on preservation, rehabilitation and replacement of bridge assets. While it seems easy to estimate a replacement cost for existing bridges, experience has shown that these estimates are often inaccurate, especially for bridges at the high- and low-end of the cost scales. It is thought that recent construction trends, the effects of economies of scale, variations in competitive labor rates are among the many factors that contribute to this inaccuracy. It is hoped that this study will identify these reasons for inaccuracy with the ultimate goal of providing accurate and realistic replacement cost data.

**Background: Provide supporting information about the business unit, processes and tools**

Current bridge replacement cost estimates are not always accurate; this leads to poor decision making and ultimately higher costs.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

1. Examine historical data and review how current bridge replacement costs are tabulated by BMS.
2. Identify gaps between current estimates and actual costs.
3. Develop improved cost estimate algorithm that incorporates newest costs trends and other information found in the study.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

Improved cost estimating for determining replacement costs for both High Value Bridges (HVB) and small bridges. Ultimately the new information will be imported into BMS to improve spending decisions.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

Better financial decision making; improved management of bridge assets

**Implementation: Describe how the results of research will be put into practice at NCDOT.**

This information will be added to the BMS with the help of Agile Assets Inc. This will lead to better decisions regarding preservation, replacement and rehabilitation.

**Who will lead the implementation?**

Provide Unit, Position Title and Name.

**Unit:** Structures Management Unit

**Title:** Squad Leader/Project Engineer

**Name:** Cary Clemmons or Danny Muller, PE

**Additional Comments and Information: See guide. Recommend including info on involvement from other units.**

**Approval**

Tom Koch	_____	State Structures Engineer
Print Name	Signature	Title

<b>Submission Date:</b> 7/23/2015	<b>RNS#:</b> 7402
<b>Submitter Name:</b> Brian C. Hanks	<b>Phone:</b> 919-707-6419
<b>Division / Unit:</b> Structures Management Unit	<b>Email:</b> bhanks@ncdot.gov
<b>Research Idea Title:</b> Evaluating the Fatigue and Capacity of Welded and Bolted Repairs of Steel Girders	

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

The load carrying capacity of steel girder bridges is reduced when the girders are damaged or experience section loss from corrosion. When capacity reduction is limited to a small portion of the girder, restoring capacity is achieved by removing damaged/corroded steel then welding new steel or bolting additional steel to the existing steel. When an engineer is choosing the proper repair to detail, limited technical information exists on the performance of welded and bolted repairs. Without guidelines the engineer tends to select a repair detail based on historic preference. Establishing guidelines which compare fatigue, capacity and durability of welded and bolted repairs will provide designers a valuable tool when selecting a cost effective repair.

**Background:** Provide supporting information about the business unit, processes and tools

Lack of technical information comparing performance of welded and bolted repairs leads designers to provide repair details based on historic preference.

**Research Tasks:** Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)

- 1) Literature Review
- 2) Develop prototypes of a welded repair, a bolted repair and an undamaged girder for testing
- 3) Compare and contrast the fatigue of the welded and bolted repairs
- 4) Compare the capacity of the welded and bolted repairs to the undamaged girder

**Products of the Research:** Examples of products could include models, specifications, policies, general guidance...etc.

Design guidelines depicting when a welded repair or a bolted repair should be detailed.

**Benefit / Knowledge Gain for NCDOT:** Check all that apply.

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** Provide details for the benefits checked above.

Properly detailed repair material will increase structural performance/capacity. Repairs can be considered engineered repairs and potentially increase the load rating of the bridge. Utilizing the proper repair material reduces waste resulting in cost savings.

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

The design guidelines will be incorporated into Structures Management's Preservation and Repair Manual. This manual covers the policies designers must follow when designing and detailing preservation and repair projects for NCDOT.

**Who will lead the implementation?**

Provide Unit, Position Title and Name.

**Unit:** Structures Management Unit

**Title:** Squad Leader

**Name:** David Snoke

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

**Approval (Division Official or Unit Head)**

Brian Hanks for Tom Koch	Assistant Unit Head
Print Name	Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 24 <sup>th</sup> , 2015	<b>RNS#:</b>	7403
<b>Submitter Name:</b>	Brian Hanks / Gichuru Muchane	<b>Phone:</b>	(919) 707-6424
<b>Division / Unit:</b>	Structures Management Unit	<b>Email:</b>	gmuchane@ncdot.gov
<b>Research Idea Title:</b>	Load Rating for NC Legal Vehicles		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

NCDOT load rates bridges for 13 vehicles that can legally travel on interstate highways and 16 vehicles that can legally travel on non-interstate highways. The Analysis Group load rates bridges for the applicable set of vehicles and determines the vehicle that controls the load posting. Each set of vehicles is grouped into single vehicles (SV) and truck tractor semi-trailers (TTST). Bridges are load posted for the controlling SV and TTST. On multi-span bridges, the effort required to load rate each span for all vehicles with the applicable set of vehicles is arduous and time consuming. Structures Management Unit would like to streamline the load rating process by developing a smaller set of vehicles that will be used for load rating short, medium and long-span bridges.

**Background:** Provide supporting information about the business unit, processes and tools

- The legal vehicles are broadly described and outlined in the NC General Statutes (GS §20-118).
- Representative legal vehicles, which produce the most severe force effects, have been derived from the guidance provided in the General Statutes.
- The vehicles can be readily updated when changes are made to the General Statutes.
- The representative vehicles are described and coded into the in-house bridge analysis and load rating software that is used to rate routine bridges.

**Research Tasks:** Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)

1. Review the lists of representative legal vehicles.
2. Determine if the existing lists of vehicles can each be reduced to shorter list of vehicles that envelope the force effects of the existing list of vehicles.
3. Establish a methodology for developing the shorter list of load rating vehicles.
4. Provide the shorter lists of non-interstate and interstate vehicles.
5. Provide a methodology for updating the list of vehicles when changes to the General Statutes are made.
6. Provide a software tool which performs the calculations or executes the algorithm & implements the methodology.

**Products of the Research:** Examples of products could include models, specifications, policies, general guidance...etc.

1. Reduced list of legal vehicles, which will be used for load rating.
2. Methodology for updating the load rating vehicles when changes are made to the General Statutes.

**Benefit / Knowledge Gain for NCDOT:** Check all that apply.

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** Provide details for the benefits checked above.

- Streamline the effort required to load rate multi-span multi-beam bridges.
- Fewer vehicles will require less time to load rate, hence reduce engineering expenses.
- Time savings when all bridges need to be re-rated due to changes in the General Statutes.

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

The new load rating vehicles will be immediately incorporated into the existing analysis and load rating software used by the Structures Management Unit. Consulting engineers will also be required to use the new vehicles when load rating newly designed structures and existing municipal structures.

**Who will lead the implementation?** **Unit:** Structures Management Unit  
**Title:** Project Engineer (Engineering Supervisor – Adv.)  
**Name:** James Bolden

**Approval (Division Official or Unit Head)**

Gichuru Muchane for Tom Koch	Asst. Unit Head
Print Name	Title
Signature	



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 17, 2015	<b>RNS#:</b>	7404
<b>Submitter Name:</b>	Scott Hidden	<b>Phone:</b>	919-707-6856
<b>Division / Unit:</b>	Geotechnical Engineering Unit	<b>Email:</b>	shidden@ncdot.gov
<b>Research Idea Title:</b>	Geosynthetics Laboratory Testing for Reinforced Soil Subgrades		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

NCDOT currently addresses subgrade problems with either undercut and replace or chemical stabilization. Another option that is common in other states is to reinforce subgrades with geosynthetics, typically geogrid. In general, NCDOT does not do this for several reasons but one of the main reasons is that there is no protocol for geosynthetic subgrade reinforcement that is economical and both laboratory and performance based. As a result, it is difficult for the Department to specify reinforced subgrades because there is not an accepted standard that all geosynthetic products must meet.

**Background: Provide supporting information about the business unit, processes and tools**

For many years, NCDOT primarily used chemical stabilization and undercut and replace for subgrade improvement. Other options were historically more expensive, less reliable or had a higher risk. Recently, NCDOT and industry have been pursuing other alternatives for subgrade improvement to potentially save costs and/or time and provide Contractors with options. NCDOT began including the option for replacing chemical stabilization with ABC and a geotextile in June.

The most common research cited for reinforced soil subgrades is an ASCE Journal Article from 2004 by Giroud and Han entitled *Design Method for Geogrid-Reinforced Unpaved Roads*. This full-scale research is based on a Tensar HDPE "punched and drawn" biaxial geogrid that was patented in the US. Since this patent expired on June 1, 2012, the cost of HDPE geogrid has been reduced dramatically making geosynthetic reinforced subgrades potentially economical.

There is also an effort to develop a NTPEP Work Plan for geosynthetic subgrade reinforcement that has been going on for several years. However, this effort has not yet resulted in a laboratory testing program and a delivery date is unknown. To date, the most comprehensive research in this area is a TRB Pooled Fund study completed in 2014 by Montana State University entitled *Relative Operational Performance of Geosynthetics Used as Subgrade Stabilization*. In the conclusions of this research, it states the following which does not allow NCDOT to specify geosynthetics for subgrade reinforcement based on material properties.

Further work is necessary to more confidently specify minimum values for geosynthetic material properties associated with good rut performance. The specified properties are mutually important, and products having only one of the specified properties may not perform well. Further research is necessary to determine the combined effect of these properties as they relate to subgrade stabilization of a greater variety of base thicknesses and subgrade strengths. Information from that research could be used to augment or determine specific design parameters for a wider range of subgrade stabilization applications. Despite the fact that the woven and non-woven geotextiles performed well in the field study, it is unknown which material properties are directly responsible for their performance. Intuitively, surface friction properties and tensile strength of the materials plays an important role however, additional work is needed to evaluate the effect individual geotextile properties have on their performance in subgrade stabilization applications.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

It is expected that a variety of geosynthetics would be laboratory tested under different conditions with different NCDOT materials to simulate actual field conditions. Researchers would need to gather information about current NCDOT pavement and subgrade design practices to integrate the results into design procedures. Results will need to be correlated with and compared to other research and actual field testing to verify results.



RESEARCH NEED STATEMENT

Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.

The testing protocol is expected to be economical, repeatable and performance based and must yield results that can be incorporated into existing design procedures and are representative of actual field conditions. The protocol would basically be similar to what NTPEP is trying to develop. The protocol should be defensible such that NCDOT can require the testing in specifications and economical so it does not cost too much for manufacturers to get their products tested.

Benefit / Knowledge Gain for NCDOT: Check all that apply.

- Checkboxes for: Increase Operational Efficiency / Time Savings, Cost Savings, Improved Material, Structure, Pavement Performance, Improved Models (Performance/Traffic/Financial etc.), New or Improved Specifications, Improved Worker or Public Safety, Permitting / Regulatory Compliance, Other (Specify)

Explain Anticipated Benefits: Provide details for the benefits checked above.

Based on the anticipated testing protocol, NCDOT will be able to write a generic specification for geosynthetic subgrade reinforcement to provide another option for subgrade improvement while maintaining quality. Additional options will create competition and therefore lower costs. Not only will there be competition with other subgrade improvement alternatives, there will also be competition between different geosynthetic products.

Implementation: Describe how the results of research will be put into practice at NCDOT.

The testing program would become self-funded as manufacturers would pay the costs for future testing of their products. NCDOT would develop an approved product list (APL) of geosynthetic products for subgrade reinforcement and products without testing would not be placed on the list. A generic specification would be developed for geosynthetic subgrade reinforcement requiring Contractors to select a product from the APL.

Who will lead the implementation?

Provide Unit, Position Title and Name.

Unit: Geotechnical Engineering Unit

Title: Support Services Supervisor

Name: Scott Hidden

Additional Comments and Information: See guide. Recommend including info on involvement from other units.

Other units to be involved would include Pavement Management Unit, Construction and Materials & Tests Unit.

Approval (Division Official or Unit Head)

Table with 3 columns: Print Name, Signature, Title. Row 1: John Philichuck, [Signature], State Geotech Engineer





RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 2 2015	<b>RNS#:</b>	7405
<b>Submitter Name:</b>	Conzuela Cogdell	<b>Phone:</b>	919-661-5995
<b>Division / Unit:</b>	ITS & Signals	<b>Email:</b>	cbcogdell@ncdot.gov
<b>Research Idea Title:</b>	Driven Pipe Pile Design and Installation for Strain and Cantilever Traffic Signal Structures		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

After years of performing structural reviews for structural signal supports and foundations (Based on site specific boring reports) we discovered that the soil characteristics found on the coast made the installation of traditional drilled shafts (caissons) economically and structurally unrealistic. The steel structure designs were either replaced by wooden pole installation, the drilled shafts increased in size equal to that of a bridge pier (due to poor soil conditions), and shallow foundations or grade beams were employed. Wooden Pole installation has a low service life and limiting span lengths, yet large drilled shafts, foundations and other reinforced concrete foundations requires large amounts of excavation and right-of-way which may not be readily available under all projects. We need a means to provide foundations that have a small footprint, economical, and have the ability to maximize the soil properties found in saturated sandy silts and alluvial soils often found on the coast of North Carolina to resist torsion as well as moment loading.

**Background: Provide supporting information about the business unit, processes and tools**

In 2001, ITS and Signals was given the responsibility of designing, reviewing and troubleshooting traffic structures and their corresponding foundations across all 14 Divisions within NCDOT. Over the years the efforts of the Structural Review Group has led to the creation of Standard Strain Poles for five separate wind zones, standard drilled shaft foundations, multiple in-house programs that has propelled the section from hand calculations to time and economically efficient reviews performed by Excel Spreadsheets, developed a database to track our Signal Structure Inventory, and administers routine inspections on our existing intersections. We also have the capacity to design Traffic Structures using the most current codes, foundations, and resolve construction related problems that may arise. The tools we have available are: in-house programs, LPILE, APILE, FB Pier, STAAD.Foundation, STAAD.PRO, Microstation, LT Base, Brass Pole and HILTI Profis Anchor.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

We anticipate the need for finite element modeling (STAAD or ANSYS-LSDYNA), utilization of test pile (see static load testing (ASTM D1143-07e1), rapid load testing (ASTM D7383-08), or high-strain dynamic testing with (or without) signal-matching analysis (ASTM D4985-08) to develop driving criteria, interaction with NCDOT Materials and Tests for welding procedures and possible certification (welding and nondestructive testing), including research of FHWA, AASHTO, AISC and the US Army Corps of Engineers to verify the most relevant and current code provisions are followed. Determining the effects of Vibratory versus Impact Hammer installation on the overall capacity of the pipe pile and surrounding buildings/soils is instrumental in determining the viability of a chosen pile driving method within an urban area.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

We seek a standard design for a Steel Pipe Pile Cap Assembly and Fin (for Torsional Resistance) that will meet the design capacity constraints of our Standard Strain Poles and Cantilever Structures with an arm length of 50ft-75ft. Along with the standard design (encompassing welding, erection process, and leveling procedure) we also seek a pile driving criteria and a Excel spreadsheet/Program to aid in structural reviews.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

There are a number of anticipated benefits. One benefit is reduction in construction time. This reduction in time is due to the removal of concrete curing time before the traffic structure can be erected. Regarding cost savings, the pipe pile will have a smaller footprint, so the need to purchase additional right-of-way or the need to build large substructures is removed. In the event the boring report indicates a high water table and a wet concrete pour is required, the installation of a steel pipe pile will remove the need of using and the disposal of slurry thus reducing the cost of installation.



RESEARCH NEED STATEMENT

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

We will use the pipe pile installation in lieu of wooden piles, excessively large drilled shafts and shallow foundations when boring reports indicate poor soils, the right-of-way is not available and the Division, Municipality, or Developer requires Steel Traffic Structures.

**Who will lead the implementation?**

Provide Unit, Position Title and Name.

**Unit:** ITS and Signals

**Title:** Structural Engineer -Journey

**Name:** Conzuela B. Cogdell

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

We have spoken to the Geotechnical Unit, Materials and Tests, and NC A&T State University for guidance regarding the concept of Steel Pipe Installation. We also recommend involving Steel Fabricators who currently provide poles for NCDOT projects. ATS-Sales, Valmont, and Millerbernd Manufacturing have all expressed willingness to share technical expertise by answering questions that may arise.

**Approval (Division Official or Unit Head)**

Print Name

Signature

Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	August 6, 2015	<b>RNS#:</b>	7406
<b>Submitter Name:</b>	Cyrus Parker / Ron Wilkins / Matthew Lauffer	<b>Phone:</b>	919-707-6866
<b>Division / Unit:</b>	Technical Services / Geotechnical Engineering Unit, Utilities Unit, Hydraulics Unit	<b>Email:</b>	Cfparker1@ncdot.gov rbwilkins@ncdot.gov mslauffer@ncdot.gov
<b>Research Idea Title:</b>	<b>The Effects of Contaminated Soil and Groundwater on Subsurface Utilities, Surface Water and Drainage</b>		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Subsurface utilities and drainage are routinely installed by the Department and others in areas of soil and groundwater contamination. The GeoEnvironmental Section recommends protecting utilities and sealing drainage in these areas as a precautionary measure due to the lack of research on the following questions. If these structures are not hardened against contaminants how will the following be impacted?

- service life of the product
- quality of service or performance of the product
- groundwater and surface water as related to human health and environmental quality

**Background:** Provide supporting information about the business unit, processes and tools

Transportation projects are often constructed and maintained in the presence of soil and groundwater contaminated with petroleum, solvents, and other toxic and hazardous substances. Subsurface utilities and drainage structures are often installed in areas where these contaminants were not known to be present until excavation begins.

**Research Tasks:** Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)

The research should

- determine the effect contaminated soil and groundwater have on subsurface utilities and drainage structures for both hardened and unhardened systems
- determine the effect on the environment due to the installation of these systems in contaminated areas
- determine when and how best to harden each system against the most common contaminants found on transportation projects.

**Products of the Research:** Examples of products could include models, specifications, policies, general guidance...etc.

The products:

- a table of contaminants, contaminant concentration, and soil types in which it is recommended to harden utilities and drainage
- material descriptions and techniques to harden various subsurface utilities and drainage structures against various chemical attacks
- list of construction methods to prevent preferential pathways for contaminant migration
- a description of adverse effects on utilities and drainage structures installed with and without hardening based on field and literature studies
- a best management practice guidance document for installing subsurface utilities and drainage in contaminated soil and groundwater.

**Benefit / Knowledge Gain for NCDOT:** Check all that apply.

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** Provide details for the benefits checked above.



RESEARCH NEED STATEMENT

- The GeoEnvironmental Section will be able to issue recommendations based on sound research instead of as a precautionary measure.
- The Utilities Unit and the Hydraulics Unit will benefit by not having to harden utilities and drainage unless the conditions warrant hardening.
- The Department will have more options available in the event hardening is necessary resulting in a cost and time saving on future projects.
- The Department will have a consistent best management practice across all Units and Divisions.

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

The information and tools obtained from this research will be used by GeoEnvironmental, Utilities, and Hydraulics in determining which structures should be protected from soil and groundwater contaminants. This research will also provide a list of options on which techniques and materials should be used in the event protection is needed. The guidance document can also be used as a reference for Division maintenance and construction projects to ensure that best management practices are employed consistently across the state when installing subsurface utilities and drainage in contaminated soil and groundwater.

**Who will lead the implementation?**

Provide Unit, Position Title and Name.

**Unit:** Geotechnical Engineering Unit, GeoEnvironmental Section

**Title:** GeoEnvironmental Supervisor

**Name:** Cyrus Parker

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

As stated above, the Utilities Unit and Hydraulics Unit are also interested in this research.

**Approval (Division Official or Unit Head)**

John Pilipchuk

Print Name

Signature

State Geotechnical Engineer

Title

## Traffic & Safety



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	7/2/2015	<b>RNS#:</b>	7501
<b>Submitter Name:</b>	Dr. Majed Al-Ghandour, PE,CPM	<b>Phone:</b>	919-707-4621
<b>Division / Unit:</b>	Program Development Branch	<b>Email:</b>	malghandour@ncdot.gov
<b>Research Idea Title:</b>	<b>What is the Impact of Accessibility in the Vicinity of a Conventional Interchange (CI), a Diverging Diamond Interchange (DDI), and a Diverging Double Roundabout Interchange (DDR) Projects?</b>		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Which interchanges (CI, DDI, and DDR) is considered as the best solution in some cases for the NCDOT interchanges? Why and where can we design them (rural, urban, and suburban)?

What is the standard access spacing factors should be analyzed for each interchange?

What is the impact on each interchange area to the land use life cycle cost and access management value?

What is the best practice NCDOT is needed compared to nationwide practice to determine access points in the vicinity of interchanges (CI, DDI, and DDR)?

What are the variations of the speed, crossroad facilities, and sight distances, and others to be addressed for crossroads, access points, and fringes?

What is the spillback from any of these vicinity interchanges (CI, DDI, and DDR) onto the nearest road access point?

What are some of the limitations of the DDI in terms of access management compared to CI?

The DDI works best when there is at least one heavy left turn movement and/or unbalanced thru movements. What are other options helps access points?

What are more innovative geometric designs to be considered for DDIs such as DDR? More challenges will be the channelization turns at roundabouts, how can be evaluated?

How we can accommodate Pedestrians and Bicyclists on or in the vicinity area of these interchanges?

Do we have a visualization tools to demonstrate Access Management values and concepts in the vicinity of interchanges (CI, DDI, and DDR) during planning and design?

**Background: Provide supporting information about the business unit, processes and tools**

NCHRP Synthesis 332 and others provided a review on crossroads in the vicinity only of a Freeway Interchange (Conventional) and nothing about other types such as DDI and DDR. FHWA introduces the DDI design to accommodate left-turning movements at signalized, grade-separated interchanges of arterials and limited-access highways while eliminating the need for left-turn phasing (FHWA-HRT-07-048). DDI shows a safety benefits by reducing the conflicts points from 26 (conventional) to 14 (DDI) and where the conflicts points spread out throughout interchange. DDI provides a better sight distance at turns and pedestrian crossings are shorter. DDI also shows operational benefits by supporting a unique phase combinations, simple left and right turns from all directions, only two phases needed with short cycle length and a better signal network synchronization. DDI adds more cost benefits such as existing bridge can be used or less bridge structure and additional right-of-way rarely needed. NCDOT may need some research in this area to translate the results directly into practice and guidance to improve access spacing and access management value.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

- 1- Review current literature relevant to CI, DDI and DDR interchanges, best practices, safety and operational features, cost, and limitations.
- 2- Brief evaluate current practice for the NCDOT standards in designing intersections, interchanges, DDI: the operations, benefits, limitations.
- 3- Develop a conceptual framework, methodology, and guides access management for vicinity interchanges (CI, DDI, and DDR) and selection criteria.
- 4- Determine ways to solve some issues involving DDI & DDR and their impacts on access points.
- 5- Provide new knowledge on which NCDOT engineers and practitioners can base their decisions and incorporate better utilize these tools for optimum DDI & DDR design to have good case studies of access management areas.
- 6- Explore the safety and operational performance of interchanges (CI, DDI, and DDR).
- 7- Perform traffic analysis and trade-off analysis related to the need to use interchanges (CI, DDI, and DDR) with access management concepts.
- 8- Optimize the cost benefits from variations of interchanges (CI, DDI, and DDR) to the land use.
- 9- Accommodation for Pedestrians and Bicyclists on access points in the vicinity of interchanges (CI, DDI, and DDR).
- 10- Establish guidelines and best practices.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

- 1- Develop Access Management Guidelines for spacing from ramps and access points of crossroads, sites, areas, etc.
- 2- Tools, models, and innovative practices Graphs, tools, manuals and guidelines.
- 3- Document analysis and report recommendations. Not limited to reports, charts, model, tools, etc.



RESEARCH NEED STATEMENT

Benefit / Knowledge Gain for NCDOT: Check all that apply.

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

Explain Anticipated Benefits: Provide details for the benefits checked above.

- Bring the organization to state-of-the art standard of designing access management and roads in vicinity of interchanges (CI, DDI, and DDR).
- Improve the practice of designing interchanges (CI, DDI, and DDR) to Pedestrians and Bicyclists on access points in the vicinity of the interchange.

Implementation: Describe how the results of research will be put into practice at NCDOT.

1. Engineers will use supportive criteria, standards, innovations for producing, manipulating, and presenting for delivery project with interchanges (CI, DDI, and DDR) with a good in vicinity access management access points.

Who will lead the implementation?

Provide Unit, Position Title and Name.

Unit: Program Development Branch/Congestion Management Unit

Title: Manager/Regional Engineer

Name: Majed Al-Ghandour/Jim Dunlop

Additional Comments and Information: See guide. Recommend including info on involvement from other units.

TRAFFIC  
PEDA  
ROW  
CONSTRUCTION  
DIVISION

Approval (Division Official or Unit Head)

Calvin Leggett, PE	_____	Director of Program Development
Print Name	Signature	Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 1, 2015	<b>RNS#: (R&amp;D Use)</b>	7502 / 7307
<b>Submitter Name:</b>	Tony Wyatt & Clark Morrison	<b>Phone:</b>	T. Wyatt: 919-773-2887 C. Morrison: 919 835-8202
<b>Division / Unit:</b>	Traffic Safety & Pavement Management	<b>Email:</b>	<a href="mailto:adwyatt@ncdot.gov">adwyatt@ncdot.gov</a> & <a href="mailto:cmorrison@ncdot.gov">cmorrison@ncdot.gov</a>
<b>Research Idea Title:</b>	Evaluation of Methods for Pavement Surface Friction Testing on Non-Tangent Roadways and Segments		

Note: All fields will expand as you type. Use as much space as needed.

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Current methods of measuring pavement friction have limitations with regard to horizontal curves, ramps, intersections, and elevated surfaces. As a fundamental feature in highway performance and road safety, pavement friction values can provide important information that can enable better identification of locations for friction improvement treatments and the limits of the treatments.

**Background: Provide supporting information about the business unit, processes and tools**

North Carolina is recognized for good roads, good aggregates and almost model system friction values. North Carolina's Pavement Management System includes traditional locked wheel friction values regularly measured on primary routes and available on other road sections as requested. Pavement friction is important for the safe traversal of highways, particularly on horizontal curves, ramps, intersections, and elevated surfaces. While NC has both a strong Pavement Management Program and a strong Safety Improvement Program there has been little alignment between road sections with concentrations of wet crashes and road sections with friction values lower than the actual friction demand. The traditional test has limitations, including testing on curves, and short roadway segments. New tools and processes are emerging that can supplement traditional locked wheel tangential friction measuring tools and can provide detailed continuously measured friction values which can provide critical details to better understand road departures, wet crashes, and overall traffic performance and safety along ramps, loops, curves, and super-elevated sections that have traditionally been difficult to assess friction on. This improved knowledge could help better identify the most appropriate / effective treatments and better define the limits of the needed treatment.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Tasks for this project should include an evaluation of the effectiveness of continuous friction testing methods and their potential usefulness on a variety of North Carolina roadways and surfaces, providing comparisons of obtained average friction values on various road segments – including curves, ramps, loops, intersections, steep grades of approaches, and super-elevated pavements – as a supplement to current friction testing practices. Testing methods may include the locked wheel test currently used by NCDOT, along with the Aerogroup GripTester, and other available methods. In addition to traditional surfaces and road features – this research effort would also be tasked to include common pavement types, various overlays, sealants, high friction surface treatments (both treatment and comparison sites), roadway conditions, and future implementation guidance.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

Research products should include a comparison of friction obtained from various different equipment and methodologies, and average friction values by pavement condition and type, feature (curve/ramp/loop/super elevated section/section on grade), critical friction limits, as well as, potential implementation guidance for continuous friction testing technology.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input checked="" type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)





RESEARCH NEED STATEMENT

**Explain Anticipated Benefits:** *Provide details for the benefits checked above.*

The testing methods and equipment can directly lead to increased curve, ramp, and loop pavement performance as more information about critical friction and limits will improve NCDOT's ability to improve safety investments and performance. The testing could lead to the development of models to estimate pavement friction which could influence pavement specifications in areas which would benefit from higher friction. These improvements could lead to the overall improvement of public safety on NCDOT roadways.

**Implementation:** *Describe how the results of research will be put into practice at NCDOT.*

The research results could include enhanced information about non-tangent roadway segments and the use of new testing equipment and methods for pavement evaluation that would complement and extend NC's already strong pavement management efforts..

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Pavement Management

**Title:** State Pavement Design Engineer

**Name:** Clark Morrison, PhD, PE

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units.*

The Traffic Safety Unit, the Construction Unit and the Pavement Management Unit should collaborate on this research project.

**Approval (Division Official or Unit Head)**

Judith Corley-Lay

Print Name

Signature

State Pavement Engineer

Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	June 30, 2015	<b>RNS#:</b>	7503
<b>Submitter Name:</b>	Tony Wyatt	<b>Phone:</b>	919-773-2887
<b>Division / Unit:</b>	Mobility & Safety Division	<b>Email:</b>	adwyatt@ncdot.gov
<b>Research Idea Title:</b>	Effectiveness of High-Visibility Markings and RRFBs in North Carolina		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

This research will conduct field studies in North Carolina evaluating the in-service effectiveness of rectangular rapid flashing beacons (RRFBs) and high-visibility markings at crosswalks. The research may include before and after studies at installation locations, comparison sites, with special consideration on long-terms effects on driver speed, yielding, pedestrian utilization, compliance and activation, and pedestrian safety.

**Background: Provide supporting information about the business unit, processes and tools**

Pedestrian safety and delineation treatments, including high visibility markings and rectangular rapid flashing beacons (RRFB) are increasingly being requested by municipalities and citizens in North Carolina, but no clear research is available on the effectiveness of these treatments. NC-based field studies are needed to document effectiveness of these treatments.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Research tasks include reviewing the literature on treatment effectiveness, identifying existing and planned installations in North Carolina, reaching out to DOT divisions and municipalities about their needs and concerns, lessons learned. developing a data collection plan, collecting data, data analysis and reduction, and developing a final report with practice-ready recommendations and findings for DOT to use.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

Products of this research are data collection and analysis results of treatment evaluation, a final report summarizing findings, development of a training module to implement findings to staff, and specific recommendations for use of RRFBs and High-Visibility Markings in North Carolina

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

The research will result in increased operational knowledge and efficiency in responding to municipal requests about treatment installations, provide improved models for predicting performance of these treatments, and result in improved specifications for when and where these treatments are recommended and allowed for installations (improved consistency and uniformity).

**Implementation: Describe how the results of research will be put into practice at NCDOT.**

This research will be implemented through web based TEPPL-ready guidance on when and where to use these treatments, classroom training for staff, and will better enable facilitating responses and interaction with municipalities and citizen's request for treatment installation.

**Who will lead the implementation?**

Provide Unit, Position Title and Name.

**Unit:** Transportation Mobility & Safety Unit

**Title:** State Traffic Engineer and State Signing and Delineation Engineer

**Name:** Kevin Lacy and Ron King

**Additional Comments and Information: See guide. Recommend including info on involvement from other units.**

Research of interest to various NCDOT groups, including the Division of Bicycle and Pedestrian Transportation, the Mobility & Safety Division, Signing and Delineation and Traffic Safety Units, ITS and Signals Unit, all NCDOT Divisions and Regions, Municipalities and Private Engineering Firms.

**Approval (Division Official or Unit Head)**

Terry Hopkins	_____	State Safety Traffic Engineer
Print Name	Signature	Title



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	June 30, 2015	<b>RNS#:</b>	7504
<b>Submitter Name:</b>	Anthony Wyatt, PE, PTOE, CPM	<b>Phone:</b>	919-773-2887
<b>Division / Unit:</b>	Mobility & Safety / Traffic Safety	<b>Email:</b>	adwyatt@ncdot.gov
<b>Research Idea Title:</b>	Developing Guidelines and Documentation of Engineering Studies for Establishing NC Speed Limits		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

There are not well-established or well documented guidelines that are used uniformly across the Department within the Division and Region Traffic offices. Current guidance is scattered, and in some cases outdated and inconsistent. All documented guidelines are from the mid 1990's or before and may not reflect current engineering research and practice.

**Background: Provide supporting information about the business unit, processes and tools**

There have been significant national, state and local changes (Higher Freeway Speeds, Complete Streets, Vulnerable User Concerns, School Speed Zones, Work and Maintenance Zones, Differential Limits for large Vehicles and Special Vehicles, Context Sensitive conditions, Subdivisionwide Speed Limits, etc.) with regard to speed limits since the NHS Act of 1995 removed the mandatory National 55 MPH speed limit. North Carolina has a wide range of roads, road functions, and emerging communities where there is a need for updated and unified guidance, ongoing training, and improved, more consistent engineering investigations and documentation for speed limit recommendations.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Full assessment of Existing Practices / Survey of Divisions and Municipalities and PEFs – Model Sister States  
Literature Review – State of the Practice  
Regulatory Review – NC General Statutes and MUTCD Requirements/Guidance  
Convene Work Sessions with Research panel and representatives of the 14 Highway Divisions/Charettes to Develop NC Guidelines  
Recommendations for Delivery of Training (findings/Recommendations)  
Improve Organization of Multitude of TEPL Guidelines and Scattered national and Other Guidelines

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

Complete document (printed and web enable smart publication) containing a one stop location for all the different types of speed limit reviews including controlled access freeway requests. The document shall include a typical engineering study example or form to be used for documenting existing conditions and engineering justifications for establishing speed limits and investigating and recommending curve and ramp speed advisories (based on MUTCD criteria).

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input checked="" type="checkbox"/> Other (Specify) Improved Uniformity / Consistency

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

Consistency in application of speed zoning principles. Better adherence to standard/industry practices and federal requirements such as MUTCD as well as NC General Statutes/Administrative Code. A unified and consistent practice on setting speed limits would benefit the department also from the standpoint of evidence driven decision making and potentially even from a tort liability perspective. (May need to expand)

**Implementation: Describe how the results of research will be put into practice at NCDOT.**

Through participation in the research effort and development of the guidance and tool, the NCDOT's Highways Divisions and Traffic Safety Regions will receive training/instruction and materials that will improve the consistency and uniformity of these important safety, operational and regulatory recommendation studies. The support and buy-in from the Division and Regions and their commitment to adhere and defend the practice will be essential for success. A coordinated statewide training and outreach effort will be an instrumental component of a successful implementation as will outreach and training opportunities for local agencies and private engineering firms. .

**Who will lead the implementation?**  
Provide Unit, Position Title and Name.

**Unit:** Mobility and Safety Division  
**Title:** State Traffic Engineer designee  
**Name:** \_\_\_\_\_

**Additional Comments and Information: See guide. Recommend including info on involvement from other units.**

Brian Mayhew (Traffic Safety Unit); Representative from Division (J.P. Couch) and representative from Governor's Highway Safety Program (Bob Stevens)

**Approval (Division Official or Unit Head)**

Terry Hopkins	State Traffic Safety Engineer
Print Name	Title
Signature	



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 24, 2015	<b>RNS#:</b>	7505
<b>Submitter Name:</b>	Tony Wyatt, Jim Dunlop and Ryan Hough	<b>Phone:</b>	919-773-2887 and 919-661-4832
<b>Division / Unit:</b>	Mobility & Safety Division	<b>Email:</b>	adwyatt@ncdot.gov, jdunlop@ncdot.gov and rwhough@ncdot.gov
<b>Research Idea Title:</b>	Development of Planning Level Warrant for Signalization of Synchronized (Super) Streets, Non-Traditional At Grade and One Way Intersections.		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

While North Carolina is a national leader in the design, construction and operation of SYNCHRONIZED (Super & RCUT) Street Corridors, there is no current warrant adjustments or standard analysis methodology documented for engineers to apply consistently to determine if /when a superstreet should be considered for partial or full signalization.

**Background: Provide supporting information about the business unit, processes and tools**

Synchronized (Super) Streets allow for both high-speed and safe highways by restricting crossing and left turn movements from the minor approaches. In order to determine the best intersection design to reduce user delay, planners need guidance on when signalization of an intersection is warranted. Similar warrants are provided for standard intersections but there is no such guidance for superstreets.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Tasks for this process should include state of the practice literature and model approaches review, gathering traffic volumes at current signalized and unsignalized synchronized and one way (non-traditional) intersections, observation of queuing and delay, crash history, reviewing current "rule of thumb" and surrogate methods/practices for determining the need for signalization, and developing a formal guideline for warrant analysis for signalization of synchronized streets, one way intersections and non-traditional intersection treatments.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

The research product should include a planning level approach for the consistent and defensible performance of signalization warrants for synchronized streets, one way at grade intersections, and non-traditional intersection configurations. Report should include basis, guidelines, worksheets and documentation recommendations. A training module (classroom and webinar format) and one page (print ready pdf) brochure of the methodology would be utilized to train NCDOT staff, Municipal staff and Private Engineering staff.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input checked="" type="checkbox"/> Other (Specify) Improved Consistency/Uniformity

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

The development of a warrant would provide an improved more uniform set of guidelines for clear specification for NCDOT decision makers with proposed and existing synchronized streets, one-way street intersections and non-traditional intersection configurations (half signals, etc). This guideline / tool can improve uniformity and defensibility of critical agency decisions for these corridor intersections and limit the second guessing and redundancy of effort that can be expended due to the lack of a consistent methodology. This is a recognized national Need (not specific to just North Carolina).

**Implementation: Describe how the results of research will be put into practice at NCDOT.**

The improved Guidance and tools would be endorsed/adopted by NCDOT as a supplemental tool for the FHWA *Signalized Intersections: An Information Guide* and the FHWA *Manual on Uniform Traffic Control Devices*. It could potentially be considered by FHWA for future MUTCD editions. Classroom and web based Training would be delivered to NCDOT staff. The materials developed for NCDOT training/implementation of guidance – would/could be utilized for Municipal staff and private engineering firm staff.

**Who will lead the implementation?**  
Provide Unit, Position Title and Name.

<b>Unit:</b>	Transportation Mobility and Safety (Regional Traffic / Traffic Safety Unit)
<b>Title:</b>	Eastern and Western Traffic Operations & Field Safety Engineers
<b>Name:</b>	Haywood Daughtry and Bucky Galloway

**Additional Comments and Information: See guide. Recommend including info on involvement from other units.**

Successful Effort will need to Include Congestion Management and ITS/Signals Expertise, in addition to Traffic Safety Unit, Regional Traffic and Division Traffic experts.

**Approval (Division Official or Unit Head)**

Terry Hopkins	State Traffic Safety Engineer
Print Name	Title
Signature	



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 24, 2015	<b>RNS#:</b>	<b>7506</b>
<b>Submitter Name:</b>	Tony Wyatt and Don Lee	<b>Phone:</b>	919-773-2887 and 919-707-2920
<b>Division / Unit:</b>	Traffic Safety and Roadside Environmental	<b>Email:</b>	adwyatt@ncdot.gov and dlee@ncdot.gov
<b>Research Idea Title:</b>	<b>Innovative Approaches to Measure Truck Parking Utilization at North Carolina Rest Areas</b>		

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

With the growth of North Carolina and the almost global adoption of just-in-time approaches to the shipment and deliver of goods – which basically makes highways industry’s “new warehouse” - the availability of large truck parking spaces at North Carolina rest areas, as a supplement to privately-operated truck stops/oases, is important for providing areas for truck operators to rest (in accordance with federal hours of service standards), access rest room facilities and to be able to safely check equipment (vehicle and loads) Currently, there are North Carolina Interstate Rest Areas that are regularly at capacity during evening peak demand periods which results in facility over flow and pursuit of alternate parking options. North Carolina does not currently have rest area truck volume, truck parking space utilization data or a methodology for sampling and estimating the commercial motor vehicle usage or demand for parking along interstates.

**Background: Provide supporting information about the business unit, processes and tools**

MAP-21 (Section 1401. Jason’s Law) attempts to assess and address the NATIONAL need for adequate long-term parking of commercial motor vehicles to improve the safety of commercial drivers and the general public. This research effort would help provide important utilization metrics and demand information about the availability of publicly-available commercial motor vehicle parking at North Carolina rest areas, as directed by MAP-21 and for asset management purposes.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

The research project would include a literature review regarding state of the practice publications and technologies that can be utilized to sample/monitor and accurately measure and document the large truck parking needs (demand, utilization/turn-over and duration) of select NC Rest Area locations (and adjacent interchanges/ramp shoulders) to better document, and understand truck parking demands and impacts. The research will develop and apply a technology based sampling approach that NCDOT could utilize private traffic data firms to conduct/update in the future.

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

The products of the research should include average parking utilization rates by time of day, day of week, and season, and more importantly a research approach utilizing available technologies for North Carolina to periodically sample, and document demand, utilization and duration for marked rest area parking spaces and overflow use of unmarked spaces and shoulders along off and on ramps within and adjacent to the studied rest area sites.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input checked="" type="checkbox"/> Other: Ability to Provide Requested Data to FHWA/USDOT

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

The use of data driven metric and improved knowledge regarding the magnitude of need and the duration of shortages could allow the Department to employ traffic management approaches to improve distribution of demand, improve sharing of occupancy conditions, and improve information that the drivers and terminal operators can utilize in improving route and time of day trip planning. The knowledge regarding the needs, and deficiencies could also be effectively utilized by Private Parking facility operators and businesses to identify opportunities for expansion or new facilities to better meet the demand for services. Parking demand, utilization and duration rates (models) could be used to improve the allocation of future potential upgrades in the availability of publically provided truck parking. The availability of truck parking can impact public safety if an insufficient amount of parking results in tired drivers choosing to remain on the roadway or parking in a potentially unsafe location (see Sec1401. Jason’s Law of MAP-21).

**Implementation: Describe how the results of research will be put into practice at NCDOT.**

This research could help better identify and document time frames when more CMV parking spaces in public facilities are available and for future investment consideration could help provide a mechanism and data to help prioritize truck parking and facility needs and improvements at both private and public rest areas.

<b>Who will lead the implementation?</b>	<b>Unit:</b> Roadside Environmental
<i>Provide Unit, Position Title and Name.</i>	<b>Title:</b> State Roadside Environmental Engineer
	<b>Name:</b> Don Lee

**Additional Comments and Information: See guide. Recommend including info on involvement from other units.**

The Traffic Safety Unit and Roadside Environmental Unit should collaborate on this research project. Division Operations and Traffic / Incident Management would also be seen as key partners in this effort. It may be beneficial to include a representative from NCSHP Motor Carrier Division and a Representative from the Trucking Industry and/or NC Trucking Association.

Approval (Division Official or Unit Head)



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	7/31/15	<b>RNS#:</b> (R&D Use)	7507
<b>Submitter Name:</b>	Ernest Morrison	<b>Phone:</b>	919-508-1874
<b>Division / Unit:</b>	Research	<b>Email:</b>	eemorrison@ncdot.gov

**Research Idea Title:** Video Collection of Traffic Violations for Public Education and Regulatory Changes

Note: All fields will expand as you type. Use as much space as needed.

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Often driver traffic safety issues are difficult to explain to the general public and to political leaders. Often safety issues cannot be fully addressed by engineering solutions, but require regulatory changes. Also, there is a reluctance to accept automated traffic control measures such as red light cameras and automated speed ticketing systems, which can improve safety for the travelling public. The reluctance to accept automated systems is partially due to the perception that the police adequately handle these safety issues.

**Background:** Provide supporting information about the business unit, processes and tools

Video of actual traffic violations will have more impact than staged video productions.

**Research Tasks:** Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)

The purpose of this research is to obtain video evidence of the type and period of occurrence of traffic safety issues at specific intersections where traffic violations are known to occur. The video data will be collected in Raleigh, NC. Cameras will be setup for one week at each intersection and then the installation rotated to cover other intersections of interest. A database will be developed as part of this research to store and maintain the video clips. The video evidence will be collated and analyzed by experienced research Traffic Engineers. Traffic Engineers will analyze the collected data and perform statistical analysis of the period of occurrence of the traffic violations found and estimate the occurrences on a yearly basis. The collected video data will be cross referenced by type of traffic safety issue and provided in a searchable database for use by the NCDOT Traffic Safety Unit.

**Products of the Research:** Examples of products could include models, specifications, policies, general guidance...etc.

Clear video evidence of driver safety violations at specified intersections in Raleigh, NC. A report detailing the type and estimated extent of the violations. A searchable database of video clips cross referenced by type of traffic violation. This database will be designed to be expandable and to allow easy data entry of additional video clips by NCDOT employees. The database will be developed in MS Access.

**Benefit / Knowledge Gain for NCDOT:** Check all that apply.

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input checked="" type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input checked="" type="checkbox"/> Permitting / Regulatory Compliance
<input checked="" type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** Provide details for the benefits checked above.

Public education concerning Traffic Safety violations. Some video clips could be used in televised public service announcements. The video clips could be rotated into the NCDOT web page. The collected information will be provided to the state legislature concerning Traffic Safety issues on an as needed basis.

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

The video collected will be used to educate elected officials and the public concerning traffic safety issues. The video clip database will be used for future collection and storage of video traffic safety violation data. If this research is successful, it is expected the studies could be extended to other major urban areas of the state, with the data cross referenced and stored in the database created as part of this research.

**Who will lead the implementation?**  
Provide Unit, Position Title and Name.

<b>Unit:</b>	Traffic Safety Unit
<b>Title:</b>	State Traffic Engineer
<b>Name:</b>	Kevin Lacy



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	August 1, 2015	<b>RNS#: (R&amp;D Use)</b>	7508
<b>Submitter Name:</b>	Rob Stone	<b>Phone:</b>	910-944-2344
<b>Division / Unit:</b>	Division 8	<b>Email:</b>	<a href="mailto:robstone@ncdot.gov">robstone@ncdot.gov</a>

**Research Idea Title:** Economic Impact of Utilizing Access Management

*Note: All fields will expand as you type. Use as much space as needed.*

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

Access Management is an important process for improving safety and congestion along developed corridors but business owners feel that the process will hurt their businesses and discourage customers. Because of this, many cities and towns are reluctant to implement Access Management practices. Local data showing the short and long term effects of implementing access management practices are needed to address business owner's and governmental official's concerns.

**Background:** Provide supporting information about the business unit, processes and tools

**Research Tasks:** Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)

Before and after studies are needed to show the economic impact of implementing access management; including cost savings related to increased traffic safety and how business sales and customers were directly affected.

**Products of the Research:** Examples of products could include models, specifications, policies, general guidance...etc.

Data showing how businesses were affected by implementing Access Management Processes.

**Benefit / Knowledge Gain for NCDOT:** Check all that apply.

<input type="checkbox"/> Increase Operational Efficiency / Time Savings	<input type="checkbox"/> New or Improved Specifications
<input type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input checked="" type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits:** Provide details for the benefits checked above.

Developing and constructing safety projects to address safety and congestion issues caused by poor access management practices will be much easier if local data is available showing how access management affects local businesses' bottom dollar.

**Implementation:** Describe how the results of research will be put into practice at NCDOT.

The results would be used to support safety projects.

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** TBD

**Title:** \_\_\_\_\_

**Name:** \_\_\_\_\_

**Additional Comments and Information:** See guide. Recommend including info on involvement from other units.

Convincing municipalities of the safety and congestion benefits of access management processes would be much easier if local data was available showing that these practices do not hurt businesses or discourage customers.



RESEARCH NEED STATEMENT

<b>Submission Date:</b>	July 22, 2015	<b>RNS#: (R&amp;D Use)</b>	7509
<b>Submitter Name:</b>	Brian Wert, PE	<b>Phone:</b>	919-707-0974
<b>Division / Unit:</b>	Strategic Planning (TPB)	<b>Email:</b>	bmwert@ncdot.gov

**Research Idea Title:** Impact of development density on K-factors

*Note: All fields will expand as you type. Use as much space as needed.*

**What is the problem or issue needing investigation? Be specific and detailed. (Click Here for Form Instructions)**

NCHRP 765 is the latest guidance for traffic forecasting. In NCHRP 765 there is a process for estimating the impacts of peak spreading based on capacity constraints. TPB is looking to deploy this tool to help determine how design data may change in the future. In an effort to ground the suggestions that come out of the use of the peak spreading tool TPB needs to understand how K-factor data changes. We are particularly curious as to what levels other large cities, such as Atlanta, Baltimore, and Washington DC experience. Knowing this information will provide us information on what are reasonable levels as to how peak traffic spreads and what are unreasonable levels. Ideally this data would come in relationship to development density, but I assume that such information does not exist. If so, then an urban/rural divide would be helpful with a few different levels of urban area size (Less than 50 k, 50k to 200k, 200k to 1M, 1M to 2M, greater than 2M as an example). It is expected that this information will prove most helpful for both urban areas and for high leisure travel areas as well as provide information for areas in between.

**Background: Provide supporting information about the business unit, processes and tools**

Understanding peak spreading is crucial to the NEPA process and determination of the preferred alternative. For instance, if we assume that current design data stays intact we may select an 8-lane cross-section. If peak spreading were to occur we may project a lower peak hour volume in the future which will require only a 6-lane cross-section. As such, understanding peak spreading allows us to make decisions about how to design a project given limited funds. It also helps to provide a more complete set of information to help inform the NEPA process.

**Research Tasks: Describe specific activities that are anticipated (gathering data, structural testing, traffic analysis, etc.)**

Historic counts in the same location will be gathered to see if any trends can be identified.  
Historic and current data from other larger metropolitan areas to determine reasonable values we may expect in the future in NC.  
Much of this data exists in HPMS data for NC and from FHWA for other states. INRIX can also be used as a secondary source of data

**Products of the Research: Examples of products could include models, specifications, policies, general guidance...etc.**

Products will include specifications and general guidance for the use of peak spreading and reasonable levels that may occur.

**Benefit / Knowledge Gain for NCDOT: Check all that apply.**

<input checked="" type="checkbox"/> Increase Operational Efficiency / Time Savings	<input checked="" type="checkbox"/> New or Improved Specifications
<input checked="" type="checkbox"/> Cost Savings	<input type="checkbox"/> Improved Worker or Public Safety
<input type="checkbox"/> Improved Material, Structure, Pavement Performance	<input type="checkbox"/> Permitting / Regulatory Compliance
<input type="checkbox"/> Improved Models (Performance/Traffic/Financial etc.)	<input type="checkbox"/> Other (Specify)

**Explain Anticipated Benefits: Provide details for the benefits checked above.**

This is expected to improve operation efficiency of the NEPA process by providing more accurate information.  
Cost savings can be expected in the form of right sized designs and a more effective defense against law suits related to forecasts in the NEPA process  
Final product will be new specifications.

**Implementation: Describe how the results of research will be put into practice at NCDOT.**

Results of this operation will be included in the instructions for the peak spreading tool that will be utilized by traffic forecasters internal and external to NCDOT.





RESEARCH NEED STATEMENT

**Who will lead the implementation?**

*Provide Unit, Position Title and Name.*

**Unit:** Transportation Planning Branch

**Title:** State Traffic Forecast Engineer

**Name:** Brian Wert

**Additional Comments and Information:** *See guide. Recommend including info on involvement from other units.*

[Empty box for additional comments and information]

**Approval (Division Official or Unit Head)**

Dan Thomas		Unit Head
Print Name	Signature	Title