

LIST OF RESEARCH NEED STATEMENTS FY-2016

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<u>Planning and Environment</u>			
6101	Develop and Certify EMD 710 Dual Fuel Locomotive Engine	L. Harris	Rail Division
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6103	Evaluation of Performance of Dry Detention Basins in the Highway Right-of-Way	A. McDaniel	Hydraulics
6104	Fish Passage in Culverts	C. Dagnino	PDEA
6105	Economic Analysis of Vegetation Management Practices	D. Harris	Roadside Envi.
6106	Improvements to NCDOT's Wetland Prediction Model	M. Weatherford	PDEA
6107	NCDOT Wetland Modeling Program: Development of Tidal Wetland Models using QL2 Lidar	M. Weatherford	PDEA
6108	Road Kill Composting Pilot and Cost Analysis	R. Maycock	PDEA
6201	The Benefits and Challenges of Performance Based Specifications in Fostering Innovation While Maintaining Safety and Quality versus Method Based Specification	T. Gabriel, R. Hayes	Value Management
6202	Development of Automated Train Counting Tool	N. Perry	Rail Division
6203	Railway Peak Times	F. Burton	Division 10 Planning
6204	Evaluation of the Effectiveness of Shared Lane Markings on High Volume Roads and Multi-Lane Facilities	L. Blackburn	Bike & Ped
6205	Coordinating Road Safety Reviews with Bicycle and Pedestrian Project Prioritization	L. Blackburn	Bike & Ped
6206	Evaluation of School Walk Zones	L. Blackburn	Bike & Ped
6207	Analysis and Validation of Historical Transportation Investment	A. Patel	Program Developm't
6208	Improve the Predictability of Payout Curves and Durations for Mega Projects (excess of ***\$Million): Statistical Analysis and Validation Approach	Al-Ghandour, F. Bowen	Program Developm't Financial Mgmt
6209	MAP-21 Performance Measures (PM) into Action: Management Strategy & Implementations	Al-Ghandour	Program Developm't
<u>Pavement and Maintenance</u>			
6301	Development of a Maintenance Cost Index	J. Corley-Lay	Pavement Mgmt
6302	Use of Ground Tire Rubber (GTR) in NCDOT Construction and Maintenance Projects	Gabriel, Hayes	Value Management
6303	Development of Performance Curves for Composite Pavements in PMS	J. Corley-Lay	Pavement Mgmt
6304	Setting Appropriate Benefit/Condition Jumps for Pavement Treatments in PMS	J. Corley-Lay	Pavement Mgmt
6305	Accelerated Permeability Measurement of Portland Cement and Asphalt Concrete	Surti, Cowsert	Construction, M&T
6306	Re-appraisal of the Specification for Aggregate Base Course (ABC)	Cowsert, Su, Surti	M&T, Construction
6307	Practical Testing Procedures for Obtaining Design Parameters of Unsaturated Soils	C. K. Su	Materials & Tests
<u>Structures and Construction</u>			
6401	Approach Slab Settlement	L. Gilchrist	Division 5 Bridge
6402	Guidelines for Prioritization of Bridge Replacement, Rehabilitation & Preservation Projects	D. Muller	Structures Mgmt
6403	Use of Fiber Reinforcement in Latex Modified Concrete Overlays	R. Pace	Materials & Tests
6404	Reducing Erosion Susceptibility of Coastal Highways using Biologically-mediated Methods	K. J. Kim	Geotechnical
6405	Bridge Joint Alternative	K. Seitz	Div. 9 Resi. Engg.
6406	Internal Curing of Concrete Using Lightweight Aggregate	J. Cowsert	Materials & Tests
<u>Traffic and Safety</u>			
6501	Updated & Regional Calibration Factors for Hwy Safety Manual Crash Prediction Models	B. Murphy	Traffic Safety
6502	Geometric Elements and Traffic Control Devices to Reduce Wrong Way Movements	B. Mayhew	Traffic Safety
6503	Increasing the Utilization of Weather Data for Safety Applications and Traveler Information	B. Mayhew	Traffic Safety
6504	Compatibility Testing of Supplemental Fall Protection Devices on NCDOT Bridges	J. Sprankle	Safety & Risk Mgmt
6505	Potential Applications of Unmanned Aerial Vehicles for Highway Operations (Real Time Event Management/Surveillance), Safety, Maintenance, Construction Inspection, and Storm and Other Damage Assessment and Documentation	A. Wyatt, B. Stevens	Traffic Safety
6506	High Definition Scans to Enhance Pavement Resurfacing Quality Control	Wyatt, Button	Traffic Safety
6507	Continuing Toward ZERO Fatalities in NC	A. Wyatt	Traffic Safety

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Lynn Harris

DATE: 08/8/2014

Branch / Unit: NCDOT Rail Division, Operations Branch

TITLE of your Research Idea: Develop and Certify EMD 710 Dual Fuel Locomotive Engine**Background:**

Engines that operate on a combination of diesel fuel and natural gas, known as dual fuel engines, are an emerging technology in the transportation industry, driven largely by the lower cost of natural gas compared to diesel fuel and the relatively lower environmental pollution levels that natural gas affords. Application of these dual fuel engines includes implementation as the prime mover for railroad locomotives, which are currently standard diesel engines. The NCDOT Rail Division, as part of its continuous drive to be an industry leader with regards to new technology, seeks to implement dual fuel engines on its passenger locomotives as a means to reduce its long-term overall fuel costs and lessen the environmental impact of its locomotives due to engine emissions.

A dual fuel engine is normally created via the implementation of a natural gas delivery kit onto an existing diesel engine. This natural gas delivery kit consists of natural gas storage tanks (housed either within the locomotive engine room or underneath the locomotive), piping to connect the storage tanks to the engine, typically through the injectors, and auxiliary equipment – regulators, safety devices, etc.

What is the Specific Problem or Issue?

NCDOT's current fleet of locomotives uses Electro-Motive Diesel (EMD) 710 prime movers. Where there are certain locomotive dual fuel engines in operational use, these are based on other diesel engine designs– specifically Cummins Genset engines and EMD 645cc engines. There are currently no EMD 710 dual fuel engines in operational use.

Energy Conversions, Inc. (ECI) in Tacoma, WA has a working prototype EMD 710 dual fuel engine, but has historically been unable to find a rail service with locomotives that are equipped with EMD 710 engines and has the overall willingness to allow testing of this dual fuel engine in a working environment. NCDOT is willing to provide ECI with this opportunity for testing.

With all new engine technologies, particularly those that have a direct impact on engine functionality and emissions levels, appropriate Federal Railroad Administration (FRA) operational and US Environmental Protection Agency (EPA) environmental certifications are required. Real-time testing in an operational environment is required in order to demonstrate and ultimately achieve these federal certifications. The NCDOT Rail Division, in connection with the North Carolina State University Environmental Engineering (NCSU EE) department, can provide ECI with the venue, equipment, and logistics required to perform the testing indicate above.

In order to quantitatively demonstrate the reduced environmental impact of the dual fuel engine vs. a standard diesel engine, the NCDOT Rail Division plans to work with the NCSU EE Department to perform emissions testing on the finalized EMD 710 dual fuel engine using Particulate Emissions Measurement System (PEMS) technology. The NCDOT Rail Division and NCSU EE department have extensive experience with past PEMS testing of NCDOT's locomotive prime movers, and can readily implement this testing methodology on the EMD 710 dual fuel engine in a manner that will ensure EPA compliance.

The NCDOT Rail Division currently owns four F59PH locomotives that are rated as EPA Tier Zero Plus, and two F59PHI locomotives that are rated as EPA Tier One. Two additional F59PH locomotive rebuilds have been funded by the FRA for FFY 2015. The Rail Division's goal with the use of CNG as its primary locomotive fuel is to improve their emissions ratings to the EPA Tier Four rating.

List Research Objectives and Tasks:

- Energy Conversions, Inc. (ECI) to review data from NCDOT regarding percentage of operational time spent in each engine throttle position to confirm good candidacy for dual fuel engine implementation
- Site visit to ECI facility in Tacoma, WA to understand the setup of their EMD 710 dual fuel test cell. May also observe working dual fuel EMD 645 engine in Napa, CA, and gather ideas for how to implement on EMD 710 engine; functional concept expected to be very similar
- ECI and NCDOT Engineering and mechanical personnel work together to retrofit NCDOT's locomotives with natural gas delivery systems to create dual fuel EMD 710 engines
- Perform operational and emissions certification testing of dual fuel engine using PEMS methodology and any other testing requirements deemed appropriate by NCSU, NCDOT, and ECI personnel – specific testing requirements and methodologies to be determined collaboratively by all parties in accordance with EPA requirements
- Work with EPA personnel as needed to obtain formal certification of EMD 710 dual fuel engines

What Would be the Product[s] of the Research?

The final product of the research would be a functional, commercially viable, properly certified EMD 710 dual fuel engine that achieves EPA Tier Four compliance. As described earlier, after certification is achieved NCDOT would seek to implement dual fuel technology on all locomotives in its fleet.

How Will You or Others Use the Product[s]?

As described earlier, after certification is achieved NCDOT would seek to implement dual fuel technology on all locomotives in its fleet. The EMD 710 dual fuel engine would ultimately also be available as a commercially available product throughout the rail industry.

How Will the Product Benefit the Department?

Implementation of dual fuel EMD 710 engines onto the NCDOT fleet will allow operation through the high population density Piedmont corridor at reduced fuel cost and lower environmental impact due to reduced engine emissions. The fuel savings to NCDOT could amount to \$250,000+/- per year. The reduced engine emissions would make it easier for NCDOT to qualify for Congestion Mitigation Air Quality (CMAQ) funding from the federal government to pay for operation of the NCDOT passenger trains thus reducing the need for state funding.

Furthermore, NCDOT would be the first locomotive owner in the country to implement a dual fuel EMD 710 engine and thus be recognized as an industry leader in implementing this state-of-the-art technology, and should serve as a model for other DOTs and railroads to follow in the future.

Approval (Division official or Unit Head)

Allan Paul

Deputy Director & Manager

Print Name

Signature

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Andy McDaniel, PE

DATE: July 24, 2014

Branch / Unit: Hydraulics Unit

TITLE of your Research Idea: Swale Design Optimization for Enhanced Application and Pollutant Removal

Background:

NCDOT's NPDES permit, project-specific 401 certifications, and various state and federal regulations require the Department to treat stormwater runoff from new and existing projects. The most cost-effective approach to achieve compliance with these requirements is often through the use of vegetated swales. While the NCDOT *Stormwater Best Management Practices Toolbox* outlines design guidelines for swales, there is a need for greater research into optimized swale design.

What is the Specific Problem or Issue?

NCDOT's BMP Toolbox provides design criteria recommendations for swales which have largely been adopted from various state and national sources of design guidance. These swale design criteria are believed to be generally applicable for "typical" linear applications. However, NCDOT has never independently verified through research that these design criteria are the most appropriate and optimal for the highway environment. More specifically the upper and lower bounds of the design criteria need testing by NCDOT to determine if swales can be a viable stormwater control in a broader range of conditions. Furthermore, there may be additional design criteria, not currently specified in the BMP Toolbox e.g. swale end treatments or vegetation related criteria, which need to be developed in order to allow for the broader application of swales. Finally, NCDOT does not have any swale design criteria which specifically optimize this BMP type for nutrient removal. The lack of optimized swale design criteria hinders the Department's ability to cost-effectively comply with various water supply and environmental protection regulations across the state.

List Research Objectives and Tasks:

The research study should focus on specific practices that would be cost-effective to improve swale performance. Factors assessed (assessment variable) could include traditional design parameters such as length, slope, cross section geometry, vegetation type, vegetation height or other liner types; or enhancements to existing swale design such as soil amendments, end-of-swale treatment systems (e.g., media near swale outlet), etc. The research should delineate a research approach to systematically test performance under a variety of changes in the level of the assessment variable in a controlled field environment using engineered rainfall. The project should then validate the results from the controlled experiments by monitoring full scale swale designs located within NCDOT right-of-way. Researchers should propose a list of parameters of interest, which should, at a minimum include Total Suspended Solids (TSS), TN, TP, and flow volume. The research report should provide guidance on recommended design criteria based on the study results. The project should include an educational component to train design engineers and other practitioners based on the results of this study.

What Would be the Product[s] of the Research?

A report(s) detailing the performance data for the effect of the assessment variable on pollutant loads from swales; recommended design criteria; training materials and delivery.

How Will You or Others Use the Product[s]?

The results will be used to update swale design criteria in the NCDOT *Stormwater Best Management Practices Toolbox*. This manual is used by all engineers preparing drainage designs for NCDOT projects. Additionally SL 2014-1 now authorizes the use of the Department's BMP Toolbox for non-NCDOT roadway projects if such projects will be turned over for state maintenance upon completion.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

This research would allow NCDOT to optimize swale design to maximize regulatory credit and broaden the range of conditions for which swales are recognized as a viable stormwater treatment and conveyance device. This could provide a more cost-effective compliance solution as compared to the implementation of larger, more expensive treatment practices in certain situations.

Other Comments:**Approval (Division official or Unit Head)**

David S. Chang, Ph.D., PE

Print Name

State Hydraulics Engineer

Title

Signature

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Andy McDaniel, PE

DATE: July 24, 2014

Branch / Unit: Hydraulics Unit

TITLE of your Research Idea: Evaluation of Performance of Dry Detention Basins in the Highway Right-of-Way

Background:

NCDOT's NPDES permit requires NCDOT to characterize the quality of runoff from the NCDOT highways and evaluate the performance of various best management practices (BMPs). These performance data are also used to support compliance calculations tools, such as the Stormwater Load Accounting Tool approved by the NC Environmental Management Commission for use on NCDOT projects in the Falls and Jordan Lake watersheds.

What is the Specific Problem or Issue?

NCDOT research data have been used to support the effluent TN and TP concentrations for various BMPs in the Stormwater Load Accounting Tool. However, during the process of developing the NCDOT-specific load accounting tool, it was discovered that the research data for dry detention basins (DDBs) were based on a single research study (Line et al., 2006). The effluent concentrations based on this study (1.58 mg/L TN; 0.22 mg/L TP) were substantially higher than edge-of-pavement concentrations for secondary roads (0.54 mg/L TN; 0.10 mg/L TP) and modestly higher than those for primary roads (1.46 mg/L TN; 0.08 mg/L TP). While vegetated BMPs can increase TP and TN concentrations, there is no known mechanism that would be expected to result in higher effluent concentrations in DDBs. The practical implication of existing concentration assumptions in the load accounting tool is to restrict the use of DDBs for compliance with the Falls and Jordan Lake rules thereby forcing NCDOT to implement more expensive BMPs in certain situations.

List Research Objectives and Tasks:

Evaluate the performance of multiple DDBs across ecoregions, land use types, and loading rates, and evaluate typical influent and effluent concentrations of TSS and N and P species at study sites across a range of precipitation events. The goal of this research would be to identify the factors that influence performance of the DDBs; identify maintenance activities that may have a substantial impact on performance; and provide design enhancements that can improve performance.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are NOT considered a "product," but "deliverables.")

- Performance data for DDBs by ecoregion, land use, loading rate
• Design recommendations for enhanced performance compared to the design standards per the NCDOT Stormwater BMP Toolbox

How Will You or Others Use the Product[s]?

The product will be used to update effluent concentrations in the Stormwater Load Accounting Tool for demonstrating compliance with the Falls and Jordan Lake nutrient load reduction regulations. The information will also be used in future versions of NCDOT's BMP Toolbox to update the chapters on DDBs, if appropriate.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

DDBs are a valuable low-maintenance and relatively low-cost BMP for NCDOT projects. More reliable performance data will support greater use of this BMP. It will also serve to correct, if appropriate, incorrect assumptions in NCDOT-specific load accounting tools for impaired watersheds.

Other Comments:

Approval (Division official or Unit Head)

David S. Chang, Ph.D., PE

Print Name

Signature

State Hydraulics Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Carla Dagnino

DATE: 7/25/14

Branch / Unit: Preconstruction/ PDEA

TITLE of your Research Idea: Fish Passage in Culverts**Background:**

NCDOT has multiple road projects crossing mountain streams that contain trout. Many of these projects will be designed with a culvert structure instead of a bridge due to safety, maintenance, constructability, and cost factors. Natural resource Agencies advocate for bridges arguing that culverts deter fish passage. Even the NCDOT's use of bottomless culverts (known to help facilitate fish passage) has been challenged where culvert lengths are deemed "too long". However, some anecdotal and preliminary research indicates that fish (including trout) will migrate through long culverts (Stantec, 2003; Levine et al, 2006*)

What is the Specific Problem or Issue?

Bridges, even over narrow mountain streams, are expensive. Mountain topography often also makes construction difficult. Mountain bridges are prone to icing. Mountain topography however, also means that culvert lengths often need to be increased to accommodate higher roadways and their associated fill slopes.

List Research Objectives and Tasks:

Tasks: Locate existing, completed project sites where long culverts (≥ 200 feet) are in place. Sampling should take place in box culverts with baffles and without; pipe culverts – smooth and corrugated; and culverts with varying slopes/discharge velocities. Fish populations upstream and downstream will be sampled to determine travel through the culverts. Fish will be tagged to record upstream migration through culverts to breeding areas. Determine what species of fish will travel through culverts and maybe what type of culvert. Biological parameters such as light levels, water temperature, and dissolved oxygen should also be recorded upstream, downstream, and at regular intervals along the culvert.

Objectives: Determine the extent of fish passage through culverts of different types and lengths.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")

The product of the research will be scientific evidence providing verification of the type and length of culvert that can be used and still facilitate fish passage. The research will also provide information as to what fish species will or will not travel through a culvert and what biological factors are affecting fish passage.

How Will You or Others Use the Product[s]?

The research results will be used to help Roadway and Hydraulic engineers validate culvert vs. bridge decisions on mountain projects. It will also help Natural Environment Section staff validate these decisions and obtain Agency concurrence which will in turn aid approval of NCDOT permit applications. This data will also be of use to other state DOT's for similar reasons.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

The department will benefit by having the data needed to design a project using the safest and most cost effective type of structure while knowing our natural resources are protected. Agency concurrence will more easily be obtained if there are data to support the evidence of fish passage through a culvert.

Other Comments:**Approval (Division official or Unit Head)**

Bruce Ellis

Print Name

Signature

Environmental Program Supervisor IV

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: David Harris

DATE: June 30, 2014

Branch / Unit: Roadside Environmental Unit

TITLE of your Research Idea: Economic Analysis of Vegetation Management Practices

Background:

NCDOT utilizes an Integrated Roadside Vegetation Management Program (IRVMP) to manage the states' rights of way. The plan is dependent on using low growing turf species, selective herbicides, and other innovative techniques to maintain a safe and attractive roadside environment for the least amount of cost.

What is the Specific Problem or Issue?

The Department needs to evaluate its current practices from an economic viewpoint and determine the cost benefit of the Department's IRVMP.

List Research Objectives and Tasks:

Identify representative segments of interstate and primary routes across the state to evaluate the Department's current IRVMP practices to determine the optimal combination of available options to minimize the cost to maintain the vegetation within the Department's right of way for its interstate and primary routes. (Example of representative segments: I-40 in Division 3, I-95 in Division 4, I-77 in Division 11, US 421 in Division 9, etc.)

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

A report that would document those practices that were identified as beneficial to the Department. Develop a model projecting cost savings that would be realized if beneficial practices were implemented across the State for all Interstate and Primary routes. Develop an Excel spreadsheet that will aid the Department in projecting and modeling annual maintenance cost to perform the IRVMP.

How Will You or Others Use the Product[s]?

The Department will be able to model their vegetation management operations more accurately and justify future budget allocations.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Reduce maintenance cost for vegetation management operations and improve efficiency

Other Comments:**Approval (Division official or Unit Head)**

Don G Lee, CPESC

Print Name

Signature

State Roadside Environmental Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Morgan Weatherford

DATE: 8/6/14

Branch / Unit: DOH/Preconstruction/PDEA

TITLE of your Research Idea: Improvements to NCDOT's Wetland Prediction Model

Background:

NCDOT began researching/implementing a Lidar-based wetland/stream prediction model to supplant the majority of field-based wetland delineations as part of a major streamlining initiative during the NEPA process. The model utilizes digital elevation models and subsequent terrain derivatives originated from bare-earth Lidar data. SAS software is used for data exploration, analysis and model development. The models are then run and layers are created and analyzed in ArcGIS. Recent research sponsored by NCDOT has led to the automation of much of this process. The results of the model give NCDOT the ability to compare alternatives of road projects while greatly decreasing the need for field delineated wetlands.

What is the Specific Problem or Issue?

Prior to NCDOT Wetland Prediction Model, as wetlands were delineated in the field, additional information regarding the wetland could also be captured. Resource agencies typically require some form of wetland condition and/or wetland type to be provided prior to making decisions on alternatives. NCDOT would like to develop GIS-based methods for determining this information for the wetlands that are predicted.

List Research Objectives and Tasks:

1. Create an automated method capable of assigning NCWAM wetland types to the results of NCDOT-predicted wetlands
2. Develop method to assess the functional potential and condition of NCDOT-predicted wetlands

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

Software capable of performing automated tasks listed in the above section.

How Will You or Others Use the Product[s]?

The product would be used to predict wetlands locations, type and perform a qualitative assessment of the wetland. This data along with other information would then be used to compare potential environmental impacts of road project alternatives which is generally a field-work intensive process. This information could also be used to predict future mitigation needs.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Both short term and long term benefits include decreasing project delivery time and costs spent on field-work while also improving the protection of the state's natural resources.

Other Comments:**Approval (Division official or Unit Head)**

Philip S. Harris, III, PE

Print Name

Signature

Section Head

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Morgan Weatherford

DATE: 8/6/14

Branch / Unit: Highways/Preconstruction/PDEA

TITLE of your Research Idea: NCDOT Wetland Modeling Program: Development of Tidal Wetland Models using QL2 Lidar

Background:

NCDOT began researching/implementing a Lidar-based wetland/stream prediction model to supplant the majority of field-based wetland delineations as part of a major streamlining initiative during the NEPA process. The model utilizes digital elevation models and subsequent terrain derivatives originated from bare-earth Lidar data. The results of the model give NCDOT the ability to compare alternatives of road projects while greatly decreasing the need for field delineated wetlands. However much of this research has been focused on palustrine wetlands on the interior of NC. Additionally, NCDOT is making a significant investment to partially fund an updated of the statewide Lidar dataset collected at the QL2 standard.

What is the Specific Problem or Issue?

Sufficient datasets depicting tidal wetlands are outdated and/or not accurate enough to use in the NEPA/Ledpa selection process. NCDOT has used prediction models other areas for mainly palustrine wetlands but it is expected that different models will need to be developed for tidal wetlands. With the arrival of the new QL2 Lidar, additional research will be needed to determine how to utilize and optimize the voluminous dataset.

List Research Objectives and Tasks:

1. Determine the optimal resolution of DEM and subsequent terrain derivatives and any other variable to predict wetlands
2. Determine the appropriate method to model tidal wetland locations
3. Develop software to automate the process of interpolation, variable creation, model development and application where it is appropriate and feasible to do so.

What Would be the Product[s] of the Research?

Software (tools, models, scripts, etc.) capable of performing predictive modeling of tidal wetlands.

How Will You or Others Use the Product[s]?

The product would be used to predict wetlands locations in the coastal area of the state. This data along with other information would then be used to compare potential environmental impacts of road project alternatives which is generally a field-work intensive process. This information could also be used to predict future mitigation needs.

How Will the Product Benefit the Department?

Both short term and long term benefits include decreasing project delivery time and costs spent on field-work while also improving the protection of the state's natural resources.

Other Comments:**Approval (Division official or Unit Head)**

Philip S. Harris, III, PE

Print Name

Signature

Section Head

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Robin L. Maycock

DATE: 8/5/2014

Branch / Unit: Highway Division/Roadside Environmental Unit/Environmental Compliance Section

TITLE of your Research Idea: Road Kill Composting Pilot and Cost Analysis

Background:

VDOT has confirmed the feasibility of the Advanced Composting Technologies (ACT) aerobic composting method through research. NCDOT needs to assess the financial feasibility of the ACT systems. In Virginia, landfills have banned road kill and livestock carcasses, and in North Carolina, landfills charge \$15-25 per carcass, and some landfills do not accept mortalities. The ACT systems have been used with success in agricultural settings for composting livestock mortality as well as for food processing waste. NCDOT currently buries or landfills road kill and in 2012, received a notice of violation for improper burial on State property.

What is the Specific Problem or Issue?

NCDOT currently does not track costs associated with road kill collection and disposal. With reduced maintenance budgets and increasing fuel and disposal costs, it would be cost-effective to evaluate the current costs, and contrast them with a pilot ACT composting facility, strategically located where road kill disposal costs are highest.

List Research Objectives and Tasks:

Establish a location for a pilot ACT installation where road kill rates are high.
Contrast and compare current costs with costs of establishing, maintaining and operating an ACT composting system.
Determine the return on investment, cost-savings, and effectiveness of NCDOT providing compost facility versus the private sector.

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

A permanent installation of an ACT composting system, in a strategic location where road kill volumes are high, with financial analysis of usage, operation and maintenance of pilot system, in order to determine whether NCDOT should install more systems statewide.

How Will You or Others Use the Product[s]?

The cost analysis will show cost savings or not, which will help determine whether to provide ACT systems within each NCDOT Division. Training on operation and maintenance and an in depth look at the current costs will also be included.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Evaluate potential for decreased disposal costs, increased environmental sustainability, increased resource conservation by reducing waste sent to landfills, and research savings by using previous research efforts by VDOT.

Other Comments:

Regulatory approval already received from NCDENR and NC State Veterinarian for ACT systems in North Carolina.

Approval (Division official or Unit Head)

Don G. Lee, CPESC

Print Name

State Roadside Environmental Engineer

Signature

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Tami Gabriel and Robert Hayes

DATE: June 24, 2014

Branch / Unit: Technical Services-Value Management

TITLE of your Research Idea: The Benefits and Challenges of Performance Based Specifications in Fostering Innovation While Maintaining Safety and Quality versus Method Based Specification

Background:

The North Carolina Department of Transportation is predominately Method Based Specification (MBS) driven in the delivery and acceptance of highway construction projects. In a MBS culture the department may be missing out on advances in innovation and technology that could increase efficiency and add value. Certain projects may not lend themselves to a PBS approach but may still require a MBS. According to a report "*Legal Problems Arising Out of Highway Programs*" prepared by Michael C. Loulakis, Esp., Capital Project Strategies, LLC and James B. McDaniel, TRB Counsel for Legal Research Projects and coordinated by the National Cooperative Highway Research Program, complex construction projects and projects located on congested, high speed interstates may yield the best results utilizing the PBS guidelines. The department's Design Build program specifications more closely resemble a blend of PBS and MBS unlike the central and division let projects.

What is the Specific Problem or Issue?

What is the "optimal" blend of PBS and MBS for the department to capitalize from innovation and technology to gain a superior product while not compromising quality or safety?

List Research Objectives and Tasks:

Identify types of projects that would benefit from a PBS approach or a blend of PBS and MBS. Identify project types that would not benefit from a PBS approach.

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

The product of the research would be to have developed a method for rating projects as beneficial for a PBS approach or PBS/MBS and ultimately lead to issuance of project specific special provisions that could one day be incorporated as a Standard Specification.

How Will You or Others Use the Product[s]?

The Construction, Contract and Roadway units could use this product in the selection of projects for a PBS or PBS/MBS method.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

The ability to identify projects that could capitalize from the latest innovation and technology, if chosen properly, could reduce costs, reduce construction time, increase safety and quality.

Other Comments:

The idea of strictly a PBS method of construction is fallible and certain narrowly scoped projects would not render a greater efficiency, however there may be an optimal balance between PBS/MBS to yield a greater value through the application of innovative technologies.

Approval (Division official or Unit Head)

Jessica Kuse, PE, CPM

Print Name

Signature

State Value Management Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Neil L. Perry

DATE: 7/2/14

Branch / Unit: Rail Division, Planning and Development

TITLE of your Research Idea: Development of Automated Train Counting Tool

Background:

Currently, without human field observation, we have no way of counting trains or train cars. Cars and trucks on our roads and highways are counted by tubes, inductive loops, microwave, and video detection located within NCDOT right-of-way.

What is the Specific Problem or Issue?

We desire the ability to count trains and number of train cars autonomously without encroaching on to railroad right-of-way.

List Research Objectives and Tasks:

1. Identify technology, capability, and feasibility of utilizing an "off-the-shelf" device or system of devices capable of recording video upon detection of movement (perhaps a "deer camera").
 - a. Can such a device detect and record trains crossing in front of its detection zone and turn off once the train has passed, while the camera is located 100' or so away from the track (outside of railroad right-of-way)?
 - b. Requirements:
 - I. Weatherproof
 - II. Attachable to another surface (utility pole, free-standing or otherwise)
 - III. Tamper-proof
 - IV. Long power life, – able to be left for at least one week on site
 - V. Motion detect power on, – detect a train visually and begin and end recording
 - VI. Record video of entire train
 - VII. Resolve detail on side of rail car sufficient to see reporting marks (letters and numbers identifying car owner)
 - VIII. Sufficient storage capacity to record every train that passes a crossing for a significant amount of time (1 week or more)
 - IX. Camouflage, black, or some other color as to be as inconspicuous as possible.
2. Can the recorded video be scanned by a computer that counts the number of trains, # of train cars, and generate a report?
 - a. Identify an expert in video/image recognition technology
 - b. Scope proposed development of a program to recognize each train beginning and ending, time and date stamp, etc.
 - c. Develop to 'beta' form where results are reliable across multiple trials at multiple crossings, taking into account variable train speed, length, and potential for stopping near the crossing.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")

Assess current market and feature set for easily available deer cameras. If no deer camera offers the feature set required (lens design, auto-motion detect, video format), then Identify a software package or methodology to extract data or "counts" from the video and generate a report. Time, date, # trains/train cars, speed, possibly even identifying markings on the train cars themselves.

How Will You or Others Use the Product[s]?

Ability to count trains and train cars over a period of time allows us to calculate volume to capacity ratio/train density/track congestion, as well as measure train speed, and possibly identify train cargo by train car markings.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Short-term – Ability to identify congested rail corridors. Look for potential safety problems (cars driving around gates, etc.)

Long-term – Save money and time by pinpointing tracks that need improvements and tailoring those improvements based on the video and data collected by these "deer cameras."

Approval (Division official or Unit Head)

Shirley R. Williams

Print Name

Signature

Manager

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Frederick E. Burton III, PE

DATE: 7/21/2014

Branch / Unit: NCDOT Div of Highways, Division 10, District 2

TITLE of your Research Idea: Railway Peak Times

Background:

NCDOT TIP#P-5208 can suffer delays due to contractors not being able to have sufficient 'track time', railroad-authorized time spans between passing trains, to efficiently perform their work. In this specific instance, a large number of freight trains depart Northern Virginia, Columbia SC and Atlanta in the wee hours of the morning and reach the project from both directions in the middle of the day. Five of the eight daily passenger trains also operate through the project during those hours.

What is the Specific Problem or Issue?

Contractors perform their work on railroad projects during times and days which have traditionally been used for highway construction operations, i.e., daylight, Monday through Friday. Due to the week-long cyclical nature of long-distance freight movement, lulls in traffic may occur at very different days and times.

List Research Objectives and Tasks:

Determine how traffic patterns of busy rail lines may be studied: on-site observations, operating records, internal railroad schedules, interviewing officials. Identify the least busy times of both the week and each day. Identify seasonal fluctuations in traffic which might skew or otherwise alter normal lulls in train movements. Identify means of determining periodic major railway company maintenance projects on the route which will close the line to daylight train movements for a series of entire dates.

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

A methodology to determine site-specific periods of intense and reduced levels of rail movements according to times of day and days of the week with seasonal adjustments and additional predetermined 'targets of opportunity'.

How Will You or Others Use the Product[s]?

The determination of consistent periods of reduced train movements will correspond to increased 'track time' for the contractors. This can be used to specify the days and times which will be available for work on the project and these parameters can be written into the terms of the contract.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Short-term: increase the contractors' efficiency; enable the contractors to bid on projects with a more accurate knowledge of the time available to perform the work, increase safety by minimizing interaction between construction forces and passing trains.

Long-term: Avoid contract time overruns, reduce overtime costs, achieve railroad and Federally imposed deadlines for project completion and acceptance

Other Comments:

As the NCDOT becomes more involved with other modes of transportation, this will enable them to execute projects on busy railway lines with the same level of efficiency as has been normal for highway projects.

Approval (Division official or Unit Head)

Brett Canipe, PE

Print Name

Signature

District Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Lauren Blackburn

DATE: 7/24/2014

Branch / Unit: Bicycle and Pedestrian Division

TITLE of your Research Idea: Evaluation of the Effectiveness of Shared Lane Markings on High Volume Roads and Multi-Lane Facilities

Background:

Shared Lane Markings, or sharrows, are being used on North Carolina's roadways to assist bicycles with lateral positioning, reduce the chance of a bicyclist impacting the door of a parked vehicle, alert road users that bicyclists may occupy the traveled way, encourage safe passing by motorists, and reduce the incidence of wrong way riding by bicyclists.

What is the Specific Problem or Issue?

Shared Lane Markings were introduced to the MUTCD in 2009, limiting the application to roadways that have a speed limit of 35 mph or below. No additional guidance is given to other roadway characteristics for the application of Shared Lane Markings. Based on the small body of research on sharrows indicating their positive impact on bicyclist and motorist behavior when installed near parked cars, some states have further constrained the use of these markings only to urban applications where on-street parking exists. While an upper limit for posted speed has been identified in the guidance, there are other road characteristics that may influence the intended positive safety effects of Shared Lane Markings. To-date there is no clear research that considers how vehicle volumes, number of lanes, lane widths, or actual speed differentials between bicyclists and motor vehicles affect the performance of a Shared Lane Marking. Previous studies of the Shared Lane Marking have primarily shown the benefit in the reduction of "dooring" related crashes in urban areas, but there have been no significant studies to date showing benefit from the placement on roadways where parking does not exist. Results are mixed on their effectiveness on multi-lane facilities with parking, and anecdotes in the research show potential for safety concerns in regards to the passing distance between vehicles and bicyclists, which begs the question for further evaluation. NCDOT Complete Streets Planning and Design Guidelines currently give flexibility in application of Shared Lane Markings on several street cross sections which allows for engineering judgment to determine their appropriateness at a given location. The research aims to further the volume of knowledge on the benefits of Shared Lane Markings and better define if limitations exist for the application of Shared Lane Markings on higher-volume and/or multi-lane facilities.

List Research Objectives and Tasks:

Study motorist and bicyclist behaviors on existing facilities with Shared Lane Markings to evaluate the effectiveness of the markings on safe sharing of the roadway. Roadway characteristics targeted will include traffic volumes, number of lanes, lane width for the shared lane where the marking is installed, presence or absence of on-street parallel parking and parking utilization.

What Would be the Product[s] of the Research?

Expanded guidance on other road characteristics beyond posted speeds under which the use of Shared Lane Markings may be appropriate and additional considerations regarding their application on higher-volume and multi-lane facilities.

How Will You or Others Use the Product[s]?

The product would be of use to all divisions planning for and implementing bicycle markings on state maintained roadways, and aid in decision-making processes when determining what type of facility or treatment may best accommodate bicyclists on roadways with higher volumes and multiple lanes.

How Will the Product Benefit the Department?

Results of this research will provide more comprehensive information to planners and engineers attempting to comply with NCDOT's Complete Streets guidance when considering the installation of future Shared Lane Marking applications on roadways within North Carolina. The findings will improve bicyclist safety by ensuring that sharrows are not placed on roads where they are not appropriate.

Other Comments:**Approval (Division official or Unit Head)**

Lauren Blackburn

Print Name

Signature

Bicycle and Pedestrian Division Director

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Lauren Blackburn

DATE: 7/24/2014

Branch / Unit: Bicycle and Pedestrian Division

TITLE of your Research Idea: Coordinating Road Safety Reviews with Bicycle and Pedestrian Project Prioritization

Background:

Pedestrian and bicycle projects are considered for funding through the State Transportation Improvement Program (STIP) as well as through MPOs separate TIP processes. Safety is a primary criterion to be used by the Division of Bicycle and Pedestrian Transportation to rank pedestrian and bicycle projects for potential funding allocation from various sources (STIP, TAP funds, etc.).

What is the Specific Problem or Issue?

Local agencies, including MPOs and RPOs, in cooperation with NCDOT, need assistance in developing methodologies for identifying safety needs and prioritizing projects to submit for funding through the STIP that help to meet the State's safety and other goals. The State also requires that projects submitted be incorporated into local plans. So, while needs may have been broadly identified using criteria similar to those above, the types of safety issues and most appropriate remedies may not be known until further diagnosis is performed. These details may be lacking in comprehensive transportation plans or other types of local plans that have identified corridors for pedestrian and bicycle safety improvements. Local organizations need assistance in screening and prioritizing problem corridors for safety improvements, and in identifying and the types of improvements needed to maximize benefits to transportation stakeholders.

List Research Objectives and Tasks:

The State has an excellent data source - six years of geo-coded pedestrian and bicycle crash data - as well as roadway inventory data to help develop a safety screening process. Once initial lists are generated and ranked, further diagnosis is needed to determine the nature of problems and appropriate remedies for the road and area type. Roadway safety reviews or audits (RSAs) are a useful tool to diagnose specific problems and identify appropriate treatments. The information developed through RSAs would also provide inputs into feasibility/constructability assessments used in project ranking. Finally, the land use and density data elements needed for the other scoring factors may be added to the safety information to develop the ranking criteria and generate an overall project "score" before submittal.

The proposed tasks include:

- Develop an easy-to-use problem screening/ranking methodology to prioritize corridors for potential pedestrian or bicycle safety improvements and further diagnosis. (Use one MPO and one RPO as a demonstration. Methods may be tailored for urban versus rural areas.)
- Conduct Roadway Safety Audits, in collaboration with NCDOT on up to five corridors for each type of jurisdiction (metropolitan and rural) and draft RSA reports characterizing the problems and solutions recommended. The list may include "intersection-only" or "corridor" projects that meet eligibility requirements for funding.
- Describe the methodologies used so they can be replicated, and discuss any issues or potential improvements to the screening and ranking process developed as identified through the screening and RSA process. Include highlights and examples from the research.
- Optional task: Conduct outreach/training webinars with MPO and RPO personnel statewide to disseminate these practices.

What Would be the Product[s] of the Research?

A model problem identification and prioritization process for MPOs and RPOs to use or adapt in collaboration with NCDOT to identify corridors or intersections with top safety concerns, identify solutions, and prioritize project proposals for the STIP using the relevant criteria.

How Will You or Others Use the Product[s]?

NCDOT would disseminate these procedures to MPOs/RPOs and NCDOT partners. The model procedures would be used to help develop and prioritize the project proposals to be submitted by each MPO/RPO to the STIP, using the identified criteria. The projects submitted would contain more and better information about the proposed projects and expected benefits and costs to help NCDOT in selecting projects that meet the State's goals and objectives. The rankings could also be used in the STIP bicycle and pedestrian prioritization process.

How Will the Product Benefit the Department?

These procedures could be used both to help improve local project development, and to improve project selection processes to maximize overall safety and other benefits.

Approval (Division official or Unit Head)

Lauren Blackburn

Print Name

Signature

Bicycle and Pedestrian Division Director

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Lauren Blackburn

DATE: 7/24/2014

Branch / Unit: Bicycle and Pedestrian Division

TITLE of your Research Idea: Evaluation of School Walk Zones

Background:

For years, school districts and individual schools in North Carolina have established “walk zones” or “no transport zones.” Financial constraints and school administrator support for walking and bicycling to school are two of the main reasons seen for establishing them. These zones typically involve establishing a walking boundary of approximately one-half or one mile out from an elementary school—sometimes further for middle and high schools—and not providing school bus transportation within that area. In 2001, HSRC and ITRE conducted an NCDOT Division of Bicycle and Pedestrian Transportation initiated study that examined school walk zone policies in North Carolina and around the country. The study promoted a standardized means of establishing walk zones and offered guidance on their implementation.

What is the Specific Problem or Issue?

Considering that many districts and schools have established walk zones in NC, transportation planners, educators and health professionals asking whether and how these zones impact students’ safety, districts’ transportation costs, and families’ school travel mode choices. HSRC has geocoded six years’ worth—and counting—of pedestrian and bicyclist crash data, and anticipates having access to at least 100 schools’ student travel data. Therefore, the research team proposes conducting an impact evaluation of school walk zones in NC. The proposed evaluation would seek to answer such questions as:

- Do walk zones assist in advancing the safety of walking and bicycling to school?
- Do they save school districts money by not having to provide transportation for students living within a specified distance of the school?
- To what extent do walk zones encourage families to walk and bicycle to school rather than drive?

List Research Objectives and Tasks:

Depending on the availability of school- and district-level information, the research team proposes to:

- select 250-300 schools and conduct a cross-sectional study that examines the impact of walk zones on school transportation costs, students’ safety, and families’ school travel mode choices after controlling for schools’ income, urban-rural characterization, geographical location, and racial/ethnic diversity; or
- select 30-50 schools—half with and half without walk zones—matched according to school-level income, urban-rural characterization, geographical location, and racial/ethnic diversity and conduct a before-after study of walk zones’ impacts on school transportation costs, students’ safety, and families’ school travel mode choices.

Potential tasks include:

- Collaborate with NCDOT and the NC Active Routes to School Project in identifying the types and frequencies of policy-related, educational and promotional walking and bicycling to school activities that schools conducted over the study period.
- Analyze associations among the presence of walk zones and outcomes related to school transportation costs, the safety of walking and bicycling to school (i.e., via crash and/or speed data), and families’ school travel mode choices after controlling for confounding variables.
- Develop noteworthy case studies, which clearly link walk zones with cost- safety- and mode shift-related outcomes.
- Develop an illustrative report for NCDOT to reference and inform constituents about the potential consequences of establishing school walk zones.

What Would be the Product[s] of the Research?

Results from the proposed walk zone evaluation would be documented in a well-organized, technically sound, and easily understood report that included case studies on the various potential impacts of school walk zones.

How Will You or Others Use the Product[s]?

NCDOT will have the ability to reference and share report methods and findings with NCDOT divisions and Local Education Agencies across the state to provide information on walk zones’ impacts on school community goals. This information could influence schools in determining whether to establish walk zones, how they proceed to implement the walk zones and the types of outcomes they should anticipate.

How Will the Product Benefit the Department?

The report will provide NCDOT with valuable information on the cost-, safety- and mode shift-related impacts of walk zones. This proposed evaluation could provide a methodology for other states and research groups to evaluate potential effects of implementing walk zones.

Approval (Division official or Unit Head)

Lauren Blackburn

Bicycle and Pedestrian Division Director

Print Name

Signature

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Alpesh Patel

DATE: July 21, 2014

Branch / Unit: Program Development Branch

TITLE of your Research Idea: Analysis and Validation of Historical Transportation Investment

Background:

Since 2011 NCDOT has used TREDIS (Transportation Economic Development Impact System) to determine the economic impact of transportation investment within its Strategic Prioritization process. TREDIS is commercially available tool used by over 45 government agencies around the country and has gained increasing level of acceptance amongst NCDOT's partners. NCDOT uses the change in economic conditions over a 30 year period to quantify the value of the transportation impact to a specified area, which is referred to as the "economic competitiveness" score for a highway project under the new Strategic Transportation Investments (STI) law. Due to only the recent availability however of such tools longer term validation (i.e., predicted results to real world results) are difficult to compare and report.

What is the Specific Problem or Issue?

Need to validate the economic model being used by NCDOT. Determine a methodology to determine and quantify the economic impact of historical transportation investment in North Carolina. Timeframe needed is minimum 25 years (1989) and should focus on highway investment and on the subsequent economic changes in the project's vicinity.

List Research Objectives and Tasks:

Quantify the longer term change in economic productivity (and jobs created) due to the highway investment on analogous Statewide Mobility eligible routes since 1989 relative to predictions made by TREDIS had it been available at that time.

Determine the degree of TREDIS model accuracy based on this historical perspective; outline and consider other drivers of economic activity over the 25 year timeframe which would affect results of this analysis.

Determine what adjustments could augment the accuracy of the TREDIS model for NCDOT's future use.

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

Data driven analysis to determine highway investment impact; quantifiable validation of the use of current NCDOT's economic analysis tool.

How Will You or Others Use the Product[s]?

Validation of current NCDOT economic impact scoring in Strategic Prioritization; Showcase the multi-decades economic growth from prior highway investment decisions.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Use of TREDIS under STI for economic competitiveness scoring influences nearly \$1 billion per year in investment decisions. Validation of those decisions based on reliable economic predictions is essential. This research will also provide a clear historical perspective on the role and link of transportation investment to economic vitality and job creation.

Other Comments:**Approval (Division official or Unit Head)**

Calvin W. Leggett, PE

Print Name

Signature

Manager

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Majed Al-Ghandour, PhD, PE / Frank Bowen

DATE: July 21, 2014

Branch / Unit: Program Development Branch / Financial Management Branch

TITLE of your Research Idea: Improve the Predictability of Payout Curves and Durations for Mega Projects
(excess of ***\$Million): Statistical Analysis and Validation Approach

Background:

The NCDOT – Financial Management process is an important step in efficiently scheduling the highway construction program. Large projects (*** \$Million or greater) account for the majority of total highway construction expenditures. The construction durations and payment schedules for these projects vary significantly based on the type of project, work to be accomplished and unpredicted events. Accurate expenditure forecasts for large projects are critical to NCDOT Cash Management. There are planned and organized efforts underway to insure that NCDOT has the most up to date and reliable cash forecasting tools available.

The Program Development Branch programs, develops, and coordinates these cash flow efforts with the Funds Administration Section to develop an accurate project letting schedules and payment forecasts. A risk analysis management process has been developed that identifies, evaluates, and prioritizes project payout funding risks. Individual project expenditure forecasting tools have been developed or are currently under development. Because large projects have such a high impact on total construction expenditure forecasting, NCDOT requires a detailed and accurate expenditure forecasting tool for these projects.

What is the Specific Problem or Issue?

NCDOT is continuously seeking ways to improve to its financial management and quality tools. The current forecast model is based on the duration on the contracts which is not simple to predict after project is let (underestimates actual construction periods). The current NCDOT system, the Highway Construction and Material System (HiCAMS) has a lack of validation and verified forecasting process that leads to the development of the individual payout curve (monthly construction expenditure). It is essential to forecast the individual payout curve for all projects that are programmed to be let in the future. Another concern is the large Mega projects, (greater than \$*** million) which make up nearly 70- 80% of the total construction expenditures due to their large amount of payout.

List Research Objectives and Tasks:

Objectives:

- We are seeking development of a method to accurately forecast construction expenditure for individual large projects in excess of *** \$Million based on available data. We will need to compare your methods, inputs and outputs for proposed forecasting study to our existing methods.
- As researchers, you need to discuss the best method to forecast large projects, either through contract methods or further refinement of individual project payout curves for projects exceeding *** \$Million. This refinement could assist in forecasting from scheduling up to project let, when the actual contractor's contract curve may be utilized. Current TIP forecasting tools have yielded reasonable annual variance, but this area represents the largest risk, so further reviews for enhancements are always necessary for future performance evaluation.

Tasks:

- Review current literature relevant forecasting cash model payout curves, best practices, and quality tools.
- Identify, collected and analyze available project data from NCDOT Project Management and Funds Administration.
- Evaluate Construction Start Dates vs. Contract Award Date.
- Stratify different categories for project exceeding *** \$Million.
- Develop models, reports, graphs, simulation, and tools for forecasting (individually and aggregate) project expenditures.
- Identify failure modes and determine their effects related to pay out curves.
- Identify effective problem solving in area of project management, cash model, and funding administration.

What Would be the Product[s] of the Research?

Models, framework, graphs, tools, manuals, guidelines, and applications for NCDOT related to Risk Analysis and Forecasting for Cash Model Payout Curves: Financial Management in Construction (HiCAMS).

How Will You or Others Use the Product[s]?

- Cash Model groups
- HiCAMS groups

How Will the Product Benefit the Department?

- Data Driven Model.
- Bringing the organization to state-of-the art standard of quality control and good forecast models.
- Improving funding risk identification and capture in early stages.
- Improving the assessment and understanding of funding forecasting risks and projects forecasts.
- Improving the ability to identify and influence risk while we still have opportunity in the project lifecycle for project *** \$Million.
- Improve NCDOT ability to deliver STIP projects on time and within budgets.

Approval (Division official or Unit Head)

David Tyeryar

Calvin Leggett

Print Name

Signature

Financial Management CFO

Program Development Branch Manager

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Majed Al-Ghandour, PhD, PE
Branch / Unit: Program Development Branch

DATE: July 25, 2014

TITLE of your Research Idea: MAP-21 Performance Measures (PM) into Action: Management Strategy and Implementations

Background:

MAP-21, the Moving Ahead for Progress in the 21st Century Act for funding surface transportation programs for fiscal years (FY) 2013 and 2014. MAP-21 is the first long-term highway authorization enacted since 2005. Moving Ahead for Progress in the 21st Century Act (MAP-21) creates a performance-based and multimodal program to strengthen the U.S. transportation system. By focusing on national goals, increasing accountability, and improving transparency, these changes will improve decision-making through better informed planning and programming.

What is the Specific Problem or Issue?

NCDOT developed a great ORGANIZATIONAL performance measure as shown on their web site. <https://apps.dot.state.nc.us/dot/dashboard>. NCDOT needs to put MAP -21 in actions and determine a methodology to determine and quantify. There is a lack of strategies, tools, and implementations for MAP-21 funded multimodal projects. NCDOT needs to interrelate for Performance Measures (PM) to the five rules USDOT that recommends as an anticipated PM such as: planning, highway safety, highway conditions, congestion/system performance and Transit performance. NCDOT wants to ensure that measures are based on consistent, accurate, and timely data?

List Research Objectives and Tasks:Objectives:

1. To discuss the best methods to put MAP-21 PM into action and develop strategies to accommodate the MAP-21 performance-based and multimodal programs.
2. To review various definitions of MAP-21 PM and proposed implement methods to achieve and focus on the MAP-21 Federal-aid programs on the following Management Strategy areas:
 - Performance Measures
 - Performance Targets
 - Performance Plans
 - Target Achievement
 - Performance Reporting
3. To implement Data Driven applications/tools to achieve NCDOT management strategies for following goals:
 - Safety
 - Infrastructure Condition
 - Congestion Reduction
 - System Reliability
 - Freight Movement And Economic Vitality
 - Environmental Sustainability
 - Reduced Project Delivery Delays
4. To Measure Consistency; Data elements necessary to collect and maintain standardized data.

Tasks:

- Review current literature Review on Transportation System Performance Measures.
- Review current and relevant MAP -21 PM from USDOT rules, requirements, and PM of DOT agencies, best practices, and quality tools.
- Identify, collected and analyze available MAP- 21 project data, performance-based and multimodal programs, from NCDOT Departments and Divisions (**Interview Target Focus Groups**).
- Evaluate goals and data for PM.
- Develop process, procedures, models, all MAP-21 reports, graphs, simulation, and tools for forecasting (individually and aggregate) for what needs for PM.

What Would be the Product[s] of the Research?

- Management Strategy Models, framework, tools, guidelines, and applications for NCDOT related to MAP-21 implementation.

How Will You or Others Use the Product[s]?

- MAP-21 PM Requirements.
- Establish tools for other federal future programs.

How Will the Product Benefit the Department?

- Data Driven Model.
- Bringing the organization to state-of-the art standard of quality control and good PM models.
- Improving the assessment and understanding the targets and plans and data for MAP-21PM.

Approval (Division official or Unit Head)

Calvin Leggett, PE

Print Name

Manager, Program Development Branch

Title

Signature

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Judith Corley-Lay

DATE: July 15, 2014

Branch / Unit: Highways/asset Management/Pavement Management

TITLE of your Research Idea: Development of a Maintenance Cost Index

Background:

NCDOT develops multi-year plans for many activities, including our Transportation Improvement Program, Resurfacing, Interstate Plan. The Legislature is asking for similar plans, with a 3 to 5 year duration for preservation, rehabilitation, maintenance, etc. The Construction Cost Index has existed for many years and allows construction project planners to demonstrate "at a glance" the trends in construction costs. Having a similar type of metric for maintenance activities would assist NCDOT in expressing needs over multiple years using trends in maintenance costs.

What is the Specific Problem or Issue?

There currently is no metric that shows the effect of cost changes over time for maintenance activities. This metric is needed because multi-year plans are being requested and are likely to be part of our business into the future.

List Research Objectives and Tasks:

The objective is a Maintenance Cost Index that can be computed every year and that will show the trends in prices over time.

It is anticipated that at a minimum, the following tasks would be involved:

1. Literature review regarding maintenance cost indices or other similar metrics.
2. Identification of the maintenance tasks that should be included to capture the cost trends.
3. Identification of the materials, labor, transportation, and placement costs associated with each maintenance task from 2.
4. If there are cost differentials based on quantity, identify them.
5. Develop a simple spreadsheet to capture the data.
6. Demonstrate the calculation of the MCI for two years.
7. Provide a final report outlining all aspects of the work.

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

The product would be a Maintenance Cost Index and a spreadsheet to calculate it.

How Will You or Others Use the Product[s]?

It is expected that the MCI will be used to demonstrate cost differences between divisions, and to demonstrate the change in maintenance costs over time to the Legislature and the public.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

It will take several years to demonstrate trends, but if the MCI is calculated and explained clearly, it will help NCDOT present cost issues in a clear, intuitive and consistent manner.

Other Comments:**Approval (Division official or Unit Head)**

Judith Corley-Lay

Print Name

Signature

State Pavement Management Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Tami Gabriel and Robert Hayes

DATE: June 25, 2014

Branch / Unit: Technical Services-Value Management

TITLE of your Research Idea: Use of Ground Tire Rubber (GTR) in NCDOT Construction and Maintenance Projects

Background:

Recycled tires in asphalt have been experimented with since the 1930s, in the 1990s NCDOT experimented with this process and it was found to cost +20% more than the conventional method of asphalt construction. What was reviewed in the '90s may have only been the upfront cost of construction versus the potentially reduced maintenance costs and other benefits such as smoother ride and noise reduction possibly eliminating noise barrier walls in certain areas. With gains in technology and reduced dollars for construction and maintenance, the department is keen on testing GTR's performance properties to that of conventional asphalt construction. Several other states (CA, AZ, LA and FL) are using GTR in asphalt in what appears to be becoming a standard practice.

What is the Specific Problem or Issue?

With limited highway construction and maintenance dollars, the department is challenged with discovering new methods, products or processes that reduce the cost of maintaining the asphalt roadway system within the state. Historically, the initial cost of construction has been the deciding factor in contract award however it may be advantageous to look at the life cycle reduction costs that may be associated with applying GTR in pavement applications to reduce future maintenance costs by extending the life of the asphalt.

List Research Objectives and Tasks:

- Compare the life cycle cost of GTR to Conventional asphalt construction to determine the viability of replacing conventional asphalt mixes with GTR on certain projects.
- Compare the construction cost of each application.
- Compare cost of maintenance of the two processes.

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

Having a formulaic method to compare the life cycle costs of GTR and conventional asphalt construction processes.

How Will You or Others Use the Product[s]?

To make quantifiable determinations on future construction practices if on certain projects GTR would be beneficial over conventional methods or vice versa.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

The potential benefits may be to reduce highway maintenance costs, noise reduction which may eliminate the construction of noise barrier walls on some areas of interstate.

Other Comments:

The department is in the process of identifying a test project for GTR. A specification has recently been written addressing the use of GTE on NCDOT projects.

Approval (Division official or Unit Head)

Jessica Kuse, PE, CPM

Print Name

Signature

State Value Management Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Judith Corley-Lay

DATE: July 16, 2014

Branch / Unit: Highways/Asset Management/Pavement Management

TITLE of your Research Idea: Development of Performance Curves for Composite Pavements in PMS

Background:

Pavement Management has proposed and received research funding in recent years to improve our pavement deterioration models. We have a project beginning now that will look at performance curve adjustments for automated distress data. In our current deterioration models, we have two pavement types: flexible and rigid. In reality we also have composite pavements (which in most cases consists of asphalt overlays of concrete pavements.) Composite pavements have different dominant distresses than a typical asphalt pavement.

This work will use the construction history in PMS to identify composite pavements. The performance of the pavements following treatments will be used to generate deterioration models. The research team will identify various appropriate families of composite pavement models. Note that a placeholder should be provided for concrete overlays of asphalt pavements (white topping) although we do not have data to develop a curve at this time.

What is the Specific Problem or Issue?

Is our current use of generalized asphalt performance curves appropriate for composite pavements? Are the recommended treatments for asphalt roadways the "right" choice for asphalt over concrete composite pavement? Over time, the number of composite pavements tends to increase (Missouri reports that 80% of their interstate pavements are composite pavements) and NCDOT needs to make sure we are modeling these pavements correctly in PMS so they are properly included in our short and long term plans.

List Research Objectives and Tasks:

The objectives are to identify composite pavement sections in the Pavement Management System, model the deterioration of these sections over time, and identify the distresses that lead to the next treatment and the treatment type that is most appropriate. Among the required tasks are at least the following:

1. Conduct a literature review on deterioration curves for composite pavements, dominant distresses in composite pavements, treatments for those distresses, and other related topics.
2. Use the construction history to pull composite pavement sections from PMS. Clean the data.
3. Develop deterioration curves for the composite pavement sections. Use family curves as appropriate.
4. For those composite sections that have had a second treatment, identify the distresses that triggered the treatment.
5. Recommend appropriate treatments for the most common distresses and threshold values.
6. Provide a final report documenting all aspects of the work.

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

This research will result in models for composite pavements along with trigger values and recommended treatments for composite pavement distresses.

How Will You or Others Use the Product[s]?

The products will be implemented into the PMS allowing us to more accurately estimate time to treatment, cost of needed treatments, and overall system condition. These will assist in establishing projects and work plans.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

The department will benefit by having more accurate progression of pavement deterioration for composite pavements. This allows improved short and long term planning of pavement infrastructure activities.

Approval (Division official or Unit Head)

Judith Corley-Lay

Print Name

Signature

State Pavement Management Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Judith Corley-Lay

DATE: July 16, 2014

Branch / Unit: Highways/Asset Management/Pavement Management

TITLE of your Research Idea: Setting Appropriate Benefit/Condition Jumps for Pavement Treatments in PMS

Background:

Pavement Management has proposed and received research funding in recent years to improve our pavement deterioration models. We have a project beginning now that will look at performance curve adjustments for automated distress data. The next component we want to evaluate is the performance jump following a pavement treatment.

When a treatment is applied to a pavement, the condition is improved. The amount of improvement can be called a benefit jump or a condition jump and is a function of the condition of the pavement prior to the treatment as well as the amount of repair done as part of the treatment. For example, a simple overlay over cracked pavement does not provide the same structural benefit as the same overlay constructed along with 20% patching. One of these would be expected to deteriorate faster than the other. A complicating factor is that both of these treatments would result in a Pavement Condition Rating of 100 or nearly 100 in the survey immediately following treatment. Other treatments have more of a timed cycle, like sealing cracks, patching or fog sealing.

What is the Specific Problem or Issue?

What is the appropriate bump in condition associated with our most common treatments? How can we reconcile the pavement condition rating made following treatment to the bump? Do treatments that are currently treated as timed actually perform that way? Do treatments like mill and fill and overlays result in a performance curve that are parallel to the original curve following the bump in condition?

List Research Objectives and Tasks:

The objectives are to identify appropriate condition bumps associated with common pavement treatments. Identify whether the performance following treatment is parallel to the initial curve, rejoins the curve at some point in time, or is independent of the initial curve. Among the required tasks are at least the following:

1. Conduct a literature review
2. Propose methods of calculating the benefit jump from various treatments.
3. Obtain pavement management data and test whether sufficient data is available. It may be that there is sufficient for a subset of treatments.
4. Identify the benefit jumps for treatments having sufficient data.
5. Recommend methods of reconciling the calculated benefit with the pavement condition survey results.
6. Evaluate performance curves following treatments regarding whether they rejoin the earlier curve, parallel the original curve or have some other form.
7. Provide a final report documenting all aspects of the work.

What Would be the Product[s] of the Research?

This research will result in specific inputs for the pavement management system in handling common pavement treatments.

How Will You or Others Use the Product[s]?

The products will be implemented into the PMS which is used to develop pavement programs like pavement preservation, resurfacing, etc.

How Will the Product Benefit the Department?

The department will benefit by having more accurate progression of pavement deterioration. This allows improved short and long term planning of pavement infrastructure activities.

Approval (Division official or Unit Head)

Judith Corley-Lay

Print Name

Signature

State Pavement Management Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Nilesh Surti and Jack Cowser

DATE: July 29, 2014

Branch / Unit: Construction Unit / Materials and Tests Unit

TITLE of your Research Idea: Accelerated Permeability Measurement of Portland Cement and Asphalt Concrete**Background:**

The durability and long-term performance of materials is a main driver in life cycle analysis and quantifying sustainability. One of the main requirements for sustainable materials is durability and superior long-term performance. Durability and long-term performance of transportation infrastructure is directly related to the ability of material to impede the ingress of moisture. Moisture ingress can be measured using different measurement techniques. One of the measurement techniques that can be potentially used as a main indicator of durability for both Portland cement concrete and asphalt concrete materials is permeability. Current water permeability measurement devices mainly function at high pressures that might damage the material during the testing, therefore providing unreliable results. The current measurement methods also require rather lengthy measurement periods during which the properties of the material might change and the results might not be representative of the state and maturity of the material. Furthermore, no method so far has been developed to measure the permeability of both Portland cement concrete and asphalt concrete.

What is the Specific Problem or Issue?

NCDOT is interested in new method(s) and technique(s) of permeability measurement that do not have the shortcomings of the current methods including the use of high pressure and long measurement durations. The proposed method(s) should be applicable to both Portland cement concrete as well as asphalt concrete.

List Research Objectives and Tasks:

The objectives of the proposed project are:

8. To perform an extensive literature review on the existing methods of permeability measurement used in the laboratory and in the field;
9. To develop a new permeability measurement method(s) that can be used for both portland cement and asphalt concrete including calibration method, method of operation, and establish the reliability of the method;
10. To perform tests on specimens prepared in laboratory as well as NCDOT cores collected in the field so that a database for permeability for NCDOT field cores can be developed.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")

1. A comprehensive literature review on existing laboratory and field methods of permeability measurement
2. A new method for measuring permeability that does not have the operational difficulties of existing methods
3. The equipment prototype including calibration method and method of operation
4. Results of testing on NCDOT cores collected in the field as well as the results of measurements performed on the specimens made in the laboratory

How Will You or Others Use the Product[s]?

The products of this research will allow NCDOT to rapidly perform reliable permeability measurements on concrete and asphalt materials. The measurements that will be performed on the cores collected in the field will provide NCDOT with a database that can be correlated with the expected durability of the materials.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

The product of this research will help NCDOT to more rapidly assess the durability and quality of concrete and asphalt materials through rapid permeability testing. This will potentially reduce the duration and cost of testing and quality control for NCDOT and accelerate the progress of projects. This is in line with the recent push for durability, long-term performance (e.g., 100 year) design, and increasing the sustainability of infrastructure.

Approval (Division official or Unit Head)

Ron Hancock, PE
Chris Peoples, PE

Print Name

Signature

State Construction Engineer
State Materials Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Jack Cowsert / Nilesh Surti / C. K. Su

DATE: July 31, 2014

Branch / Unit: Materials and Tests

TITLE of your Research Idea: Re-appraisal of the Specification for Aggregate Base Course (ABC)

Background:

The current specifications for acceptance of ABC materials dated back about half century ago with few minor adjustments through the years. It is a type of "recipe" specifications, which is employed by majority of the DOTs around the country. The specifications dictate the percentages of individual particle that shall be blended in an aggregate product, based on the assumption that the product will achieve the desired engineering performance as long as it meets required gradations and placed and compacted properly in the field. However, the biggest disadvantage of the "recipe" specifications is that it cannot quantify the mechanical behavior of the aggregates under different traffic and weather conditions, which will determine the stress states and moisture variations. With the rising concerns of environmental and sustainable issues more by-products and recycled materials are mixed into the virgin materials. Is the current specification still suitable and sufficient to address the new materials? Additionally, the mechanical properties of pavement materials, which include the unbound aggregates, are critical input for the mechanistic-empirical pavement design method.

What is the Specific Problem or Issue?

With further understanding of stress conditions and material behaviors, the criteria for accepting the material of ABC based on the current gradation specifications seems insufficient and outdated. How the mechanical properties and other relevant factors can be incorporated into the gradation specification? Can the tests be practical enough to be used routinely to determine the variables? Can the new specification be used as an acceptance criterion? Can the new specification be related to design parameters?

List Research Objectives and Tasks:

A new approach to test, evaluates, approve and accept aggregate base course material. The new specification shall consider not only the appropriate ratios of blending, but also the mechanical properties and other factors of material, which will affect the performance of final product throughout its service life.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")

- Aggregate base course acceptance criteria
- List of required tests
- User's manual
- Workshop

How Will You or Others Use the Product[s]?

The product will be included in the future edition of NCDOT Standard Specifications. With the ranges of values in the specification, the design unit could also use it as reference values for primary design and the construction offices and Materials and Tests unit will use it as guidelines to test, evaluate and determine the acceptance of base course materials.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

With the new specifications, the pavement system can be designed more efficiently according to the anticipated traffic loads and other factors and the performance should be correlated and evaluated in a more meaningful way, which means the maintenance cost could be more predictable and manageable. Plus, the new development can also provide a new perspective in evaluating base course materials, which could encourage construction material industry to further innovation in new generation of materials that can meet the engineering functions and satisfy the needs of sustainability.

Approval (Division official or Unit Head)

Ron Hancock, PE
Chris Peoples, PE

Print Name

Signature

State Construction Engineer
State Materials Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: C. K. Su

DATE: July 31, 2014

Branch / Unit: Materials and Tests

TITLE of your Research Idea: Practical Testing Procedures for Obtaining Design Parameters of Unsaturated Soils

Background:

Soils encounter in many earthworks at highway projects in North Carolina are typically unsaturated, such as the compacted soils in a pavement layer or temporary cut or shoring in residual soils. In the current practice the engineering properties of these materials are determined from classic soil mechanics tests under completed saturated condition. Oftentimes it provides analysis parameters for the worst scenarios that the material could possibly experience throughout life of the project. With further understanding and advancement in testing equipment and analysis models, the unsaturated soil mechanics has gained broader recognition among the geotechnical engineering community. However, due to the complexity of testing and analysis, the unsaturated soil mechanics still suffers greatly for acceptance in practical engineering applications.

What is the Specific Problem or Issue?

By considering the mechanical properties of unsaturated soils, there will be a great impact in many geotechnical analyses and designs, especially in the Piedmont residual soils at North Carolina, because construction soils of the projects do not have to be designed as the worst scenario. Unfortunately current available testing equipment for unsaturated soils testing is more suitable for academic research purpose. There is a need for reasonably simplified testing equipment, testing procedures, and data reduction method that can be performed routinely.

List Research Objectives and Tasks:

- Develop a simplified unsaturated soil testing equipment and testing procedure
- Develop a methodology to reduce test data into a useful format
- Develop a training guide for laboratory technicians
- Develop a handbook for potential applications
- Develop a workshop for technology transfer to design engineer

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

Newly designed or modified testing equipment, testing procedure, data reduction method, equipment maintenance manual, training guide, handbook of applications, and workshop

How Will You or Others Use the Product[s]?

The Soils Laboratory will perform the test with the developed testing equipment and procedure. The test data will be used by design engineers at geotechnical engineering unit and potentially for pavement design group.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

The test data generated by traditional tests are conservative under the unsaturated condition. With the unsaturated soil test data, there will be a swiping change in the design and construction practice. The projects do not have to be designed as the worst scenario and the construction steps can be streamlined and accelerated, which can be translated as to have more economical design and higher operational efficacy. The overall construction cost of projects will be minimized.

Other Comments:**Approval (Division official or Unit Head)**

Chris Peoples

State Materials Engineer

Print Name-----
Signature-----
Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Lisa B. Gilchrist, Division 5 Bridge Program Manager **DATE:** 7/14/2014
Branch / Unit: Division 5 – Bridge Program

TITLE of your Research Idea: Approach Slab Settlement

Background:

Settlement of approach slabs is a common and recurring problem. When settlement occurs it is generally not uniform across the slab and often results in uneven or cracked pavement which leads an unsafe driving condition. Continued impact loads from trucks on slabs that have settled could result in damage to the structure. At NCDOT we utilize a Special Provision (SP4 R02) for Reinforced Bridge Approach Fills, however, during routine bridge inspections it has been noted that settlement has occurred even though the fill beneath the slab has been reinforced using geosynthetics and select backfill.

What is the Specific Problem or Issue?

Approach slabs constructed at bridge locations within Division 5 continue to undergo settlement after construction. Once the settlement is identified, Division 5 Bridge Maintenance coordinates with the Geotechnical Engineering Unit to level the slabs using mudjacking. Often slabs must be leveled multiple times. Drilling multiple holes through a slab to perform mudjacking can lead to slab cracking. When the cracking becomes excessive the slab must be removed or paved over using a bituminous overlay to achieve a smooth riding surface.

List Research Objectives and Tasks:

1. Determine conditions that lead to settlement (provide cause & effect, 14 research sites are available)
2. Using innovative techniques (new products including grout mix varieties and/or polymers) determine how approach slabs can be effectively leveled such that repeat leveling is not required.
3. Using data gathered at research sites, evaluate how the settlement can be prevented on future bridge replacements.

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

1. Create a list of repair methods
2. Create a special provision for each repair method
3. Create a list preventive construction methods that can be incorporated on future bridge replacements.

How Will You or Others Use the Product[s]?

The repair methods and special provisions will be used when settlement is encountered under approach slabs on existing structures.

The preventative construction methods will be provided to the Division Construction Engineer for evaluation and future use.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Reduced time and cost spent investigating and repairing approach slabs. Provide safer driving conditions for the traveling public.

Other Comments:

The Division 5 Bridge Program has started a small investigation at two project sites.

Approval (Division official or Unit Head)

Lisa B. Gilchrist

Print Name

Lisa B. Gilchrist

Signature

Bridge Program Manager – Division 5

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Daniel Muller

DATE: 7/17/2014

Branch / Unit: Structures Management Unit

TITLE of your Research Idea: Guidelines for Prioritization of Bridge Replacement, Rehabilitation and Preservation Projects**Background:**

NCDOT has used several different criteria to prioritize bridges for replacement. Priority for replacement has previously been calculated using deficiency points, a Priority Replacement Index (PRI), and various other methods. Given the limited funds that are available for infrastructure maintenance, NCDOT would like to update this index to ensure that we are selecting the most critical bridges for improvement. In addition, beginning with the passing of Strategic Transportation Investment, all State Highway Trust Fund and Federal Aid Funds must be allocated based on data driven scoring. While the new law does not contain prioritization language for bridge replacement, NCDOT wants to be sure that the funds set aside for bridge replacements use a transparent prioritization index that meets the intent of current requirements.

What is the Specific Problem or Issue?

Determining the appropriate index to prioritize the need to replace or improve one structure when compared to other bridges on the State highway system. While weighting of different variables will most likely be required, the Department prefers that variables are not double counted (i.e. combining two different indices that include a common variable).

List Research Objectives and Tasks:

1. Perform a literature review of recent research and survey best practices of States with highway systems of similar size, variety and scope.
2. Research current law, previous NCDOT practices and NCDOT values concerning prioritization of bridge projects.
3. Prepare alternatives of best recommended indices and provide trial results for comparison to the current PRI. Note that past experience has shown that a wide spread in the index is preferred.
4. Make a final recommendation as to the optimum Bridge Replacement, Preservation and Rehabilitation Indices.

What Would be the Product[s] of the Research?

Indices that can assist in prioritizing each bridge in the state in accordance with the need for it to be replaced, rehabilitated or preserved.

How Will You or Others Use the Product[s]?

The products will be used to aid in optimizing highway funds for bridge projects, to select bridges for individual bridge programs and to establish budgetary needs in regards to bridge funding. Products will also be used to weigh municipal bridges against State bridges for prioritization for federal aid funds.

How Will the Product Benefit the Department?

The Department has used various methodologies in the past for prioritizing bridges for replacement. As funds become more limited, decisions on how to use those funds may become more contested. Having independent research selection criteria will provide the department with a transparent rational approach for selecting bridges for replacement or improvement. It will also aid in updating our selection criteria to be with current legislation.

Other Comments:

Project is to be more than one year in length.

The main focus of the work should be to develop the Bridge Replacement Index. Rehabilitation and Preservation Indices should be considered secondary.

Approval (Division official or Unit Head)

Greg Perfetti

Print Name

Signature

State Structures Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Randy Pace

DATE: July 21, 2014

Branch / Unit: Materials and Tests Unit

TITLE of your Research Idea: Use of Fiber Reinforcement in Latex Modified Concrete Overlays

Background:

The Department is using a lot of latex modified concrete overlays to rehabilitate bridge decks. To help expedite the project and minimize traveling delays to the public, the use of rapid set cement is being specified in conjunction with the latex modified concrete to achieve high strength concrete in 4 hours.

What is the Specific Problem or Issue?

The use of rapid set cement is generating an accelerated hydration process within the modified concrete. The high heat of hydration within the concrete mix is contributing to the formation of drying shrinkage cracks on the bridge decks which is counterproductive to having the deck overlaid in the first place.

List Research Objectives and Tasks:

1. Determine the best practice for use of Rapid Set Cement in latex modified concrete.
2. Will the addition of fibers into the latex concrete negate the effects of the drying shrinkage cracks?
3. If so, at what rate (lbs./cy) is sufficient to negate the drying shrinkage cracks?

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")

Acceptable application rates for the use of fibers in latex modified concrete.

How Will You or Others Use the Product[s]?

Specifications governing the use of fibers in latex overlays will be determined and implemented into the Department's specifications.

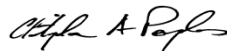
How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Fibers can increase the durability of the latex concrete overlay thus making for successful bridge deck treatments that will last longer. Eliminating the shrinkage cracks in overlays reduces the short term and long term maintenance efforts of the Department.

Other Comments:**Approval (Division official or Unit Head)**

Chris Peoples



State Materials Engineer

Print Name

Signature

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: K J Kim

DATE: July 23, 2014

Branch / Unit: Geotechnical Engineering Unit

TITLE of your Research Idea: Reducing Erosion Susceptibility of Coastal Highways using Biologically-mediated Methods

Background:

Current roadbed supporting coastal highways in North Carolina (e.g., Highway 12) are susceptible to erosion during large storm events. We have experienced over-washing of coastal highways due to coastal storm surges, which led to pavement damage and even highway closure. Direct storm wave action on the seaward side of the highway and weir-flow damage on the landward side of the highway can undermine the roadbed, erode the supporting soil, and lead to pavement failure. Preventing the erosion of the subgrade soils and slopes will reduce the damage to the coastal highways, and help maintain open and connected highways during the recovery period after storm events. Biologically-mediated soil improvement methods can be used to stiffen the soil and reduce its susceptibility to erosion during storm events. Biologically-mediated methods offer an innocuous, natural, and cost-effective way to enhance the performance of the coastal highways.

What is the Specific Problem or Issue?

1. The subgrade and slopes of coastal highways can be eroded during storm events which can lead to pavement failure and road closure.
2. Reducing erosion susceptibility of the subgrade soils and slopes will improve the performance of coastal highways; however, it should be done in a manner that will not disrupt the coastal ecology surrounding the highways.

List Research Objectives and Tasks:

1. Develop a treatment procedure to stiffen the roadbed of coastal highways to prevent or minimize erosion during storm events that will not disrupt the coastal ecology surrounding the highways.
2. Demonstrate the soil's increased resistance to erosion using laboratory experiments.
3. Up-scale treatment procedure for in situ implementation utilizing the Department's current equipment and techniques, and demonstrate its success using large-scale experiments.
4. Demonstrate the improvement in performance of coastal highways during a large storm using numerical modeling.
5. Develop a numerical modeling framework that the department can use to assess likely highway performance during expected storms in order to determine damage-susceptible areas that should be treated.

What Would be the Product[s] of the Research?

The research products will include an in situ treatment procedure that can easily be implemented by the Department and a modeling framework that will allow the department to assess damage-susceptible areas of the highways that should undergo treatment.

How Will You or Others Use the Product[s]?

The products will be used by the Department to allocate available funds towards the most likely regions of the coastal highways to be damaged during large storm events, and to treat those regions to prevent pavement failure or road closure. The Department will also use the products to implement the treatment process to achieve the desired improvement in erosion resistance.

How Will the Product Benefit the Department?

The products will improve the resiliency of coastal highways by preventing damage from storm events. The coastal highways will remain open and connected after a storm event, increasing the ability of the communities to recover quickly after an event. The repair and maintenance costs will also decrease due to improved performance of the coastal highways.

Approval (Division official or Unit Head)

John L. Pilipchuk, LG, PE

Print Name

Signature

State Geotechnical Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Kelly Seitz

DATE: 8-4-14

Branch / Unit: Division 9/ Salisbury Resident Office

TITLE of your Research Idea: Bridge Joint Alternative

Background:

Current bridge expansion joints are prone to failing, especially armor joints with elastomeric concrete and evazote seals. The 2012 armor joint standard has been removed to potential problems.

What is the Specific Problem or Issue?

Failing joint seal and joint failure under traffic.

List Research Objectives and Tasks:

Seek better alternatives to current NCDOT standards.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are NOT considered a "product," but "deliverables.")

- Optimal guidelines for material selection, design and construction techniques to minimize bridge expansion joint failures.
- A monitoring program to track the long term performance of current joint designs and materials versus test designs.
- Training program for NCDOT personnel and contractors on new techniques

How Will You or Others Use the Product[s]?

The results will be incorporated into NCDOT Standard Specifications and future special provisions.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Reduce long term maintenance costs for the Department.

Other Comments:

Currently Portland Cement Concrete Pavement utilizes products such as Dow Corning 888 on expansion joints without bevel saw cut or chamfer strip. See attached sketch. Fibrecrete by Applied Polymerics is currently used for concrete repairs.

Approval (Division official or Unit Head)

Chris T. Corriher, PE

Print Name

Signature

District Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Jack Cowsert

DATE: 07/09/2014

Branch / Unit: Materials and Tests

TITLE of your Research Idea: Internal Curing of Concrete Using Lightweight Aggregate

Background:

Curing of concrete is a critical process in the development of long lasting structures. Traditionally, only external curing is performed, and the duration of the curing is limited by the construction sequencing. An investigation into the costs and benefits of utilizing internally cured concrete (ICC) and development of specifications for its implementation will provide alternatives for utilizing longer lasting concrete mixes where economically feasible.

What is the Specific Problem or Issue?

The hydration process in concrete is critical to strength development and long term durability. By providing additional moisture within the concrete, hydration is extended, and improved properties are obtained. Use of pre-wetted lightweight aggregate in concrete mixtures has been demonstrated to provide extended hydration, and this research will aid in establishing the value of using lightweight aggregates on North Carolina concrete mixtures.

List Research Objectives and Tasks:

- Develop ICC mix designs using lightweight aggregate to provide extended internal curing.
- Cast sections of ICC and standard concrete on a demonstration project.
- Install and monitor instruments and test materials used in the structure to determine effect on properties.
- Determine the cost effectiveness of ICC versus conventional concrete by comparing permeability, strength and durability performance.
- Develop specifications for IC concrete mixtures.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")

A cost/benefit analysis will be documented and a specification will be developed.

How Will You or Others Use the Product[s]?

Mix designs utilizing ICC technology will be implemented where economically feasible.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

Improved performance from concrete mixtures using ICC technology will improve concrete properties and delay required maintenance operations resulting in longer lasting structures.

Other Comments:**Approval (Division official or Unit Head)**

Chris Peoples

Print Name-----
Signature

State Materials Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Brian Murphy

DATE: 7/24/14

Branch / Unit: Transportation Mobility and Safety / Traffic Safety Unit

TITLE of your Research Idea: Updated and Regional Calibration Factors for Highway Safety Manual Crash Prediction Models

Background:

In order to achieve the greatest return on the investment of limited budgets, it is imperative that decisions are made based on the best information regarding the safety implications of various design alternatives and engineering treatments. The Highway Safety Manual (HSM) provides analytical tools and techniques for quantifying the safety effects of decisions made in planning, design, operations, and maintenance. The methods and tools in the HSM can be used to identify sites with the most potential for safety improvement, identify factors contributing to crashes or safety issues and associated potential countermeasures to address these issues, conduct economic appraisals of safety improvements and prioritize projects, calculate the effect that various design alternatives have on safety, and estimate the safety effects of planning, design, operations, and policy decisions.

What is the Specific Problem or Issue?

In order to be able to use the advanced tools in the HSM, it is necessary for each jurisdiction to develop crash prediction models (also called safety performance functions) that relate crash frequency and severity to roadway characteristics for different types of facilities. Two previous NCDOT projects (2009-07 and 2010-09) estimated calibration factors for the prediction models from Part C of the HSM. These calibration factors have been extensively used by NCDOT as part of their decision making process. HSM recommends that these calibration factors be updated every three years. In addition, separate calibration factors are now desired by the NCDOT Traffic Safety Unit for the three different regions in North Carolina (Western, Piedmont, and Coastal) to properly account for the significant differences in terrain, climate, and roadway characteristics. The previous research effort found large differences between these regions in the preliminary calibration factors. The goal of the proposed effort is to estimate the calibration factors for all the facility types in Part C of the HSM based on the latest five years of roadway, traffic, and crash data from North Carolina.

List Research Objectives and Tasks:

The overall objective is to estimate the calibration factors for all the prediction models in Part C of the HSM (that are of interest to NCDOT) based on the latest five years of roadway, traffic, and crash data from North Carolina. Separate calibration factors are desired for the three different regions in North Carolina (Western, Piedmont, and Coastal) to properly account for differences in terrain, climate, and driver population. This will be accomplished through identifying new segments in each region to be added to the previous research effort, collecting data on these segments, obtaining TEAAS crash data, and developing the calibration factors. This research should also give some guidance regarding how often calibration factors should be updated based on how much the calibration factors change from year to year. If there is little change in the calibration factors from year to year, it may not be critical to update them very often.

What Would be the Product[s] of the Research?

The end product would be Statewide calibration factors, regional calibration factors, and the "proportion of related crashes" values for all prediction models in Part C of the Highway Safety Manual based on the latest five years of data. Calibration factors for other models (such as freeways) that are slated to be part of the next Highway Safety Manual should also be considered. North Carolina specific safety performance functions developed as part of NCDOT research project 2010-09 will not be updated as part of this project. Only the safety performance functions found in Part C of the Highway Safety Manual or those proposed for inclusion in the next version of the Highway Safety Manual are being considered for this project.

How Will You or Others Use the Product[s]?

The Traffic Safety Unit is currently using Statewide calibration factors in to compare different proposed project alternatives during the project development process. The demand for this type of analysis is expected to increase as the Department emphasizes the importance of data-driven decisions.

How Will the Product Benefit the Department?

Updated calibration factors and regional calibration factors will allow the Department to more accurately describe how safety performance is affected by design elements. This type of analysis is often performed when comparing different project alternatives during the project development process. Updated and regional calibration factors will allow the Department to make these types of decisions with the best available information.

Approval (Division official or Unit Head)

J. Kevin Lacy, PE, CPM

State Traffic Engineer

Print Name-----
Signature-----
Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Brian Mayhew

DATE: July 10, 2014

Affiliation: Traffic Safety Unit

Contact Information: bmayhew@ncdot.gov, 919-773-2886

TITLE of your RNS: Geometric Elements and Traffic Control Devices to Reduce Wrong Way Movements

Background:

The layout, design, and traffic control devices at an interchange are used to communicate appropriate movements to drivers. However, some of these features are more likely to result in misunderstanding or unintended movements. The application of improvements or countermeasures at particularly difficult locations may improve the safety performance.

What is the Specific Problem or Issue?

Wrong way collisions are a persistent issue on interstates in several counties. These collisions are typically severe and are potentially correctable, if thoroughly understood, through enhancements to interchange geometric features and traffic control elements.

List Research Objectives and Tasks:

The relevant objectives and tasks include:

- An inventory of interchange layouts, design features, and traffic control devices at locations that may be the source of wrong way movements on Freeways in selected counties (Wake, Mecklenburg, Forsyth, Durham, Guilford and Haywood).
- An evaluation of the effects of various interchange elements on the occurrence of wrong way movements.
- A recommendation of best practices for reducing wrong way movements. Recommendations would be developed for each inventoried interchange in the selected pilot counties.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are **NOT** considered "products." They are "deliverables.")

The products of this research should include:

- An assessment of interchanges and factors contributing to wrong way collisions
- A toolbox of best practices for reducing wrong way movements
- A prioritized list of recommendations for the inventoried interchanges in the pilot counties

How Will You or Others Use the Product[s]?

These products will be integrated into current practices to improve the safety performance of interchanges by reducing wrong way movements.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

This research will lead to improved safety performance on our roadways through increased understanding of contributing factors to wrong way collisions.

Other Comments:**Approval (Division official or Unit Head)**

J. Kevin Lacy, PE, CPM

Print Name

State Traffic Engineer

Title

Signature

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Brian Mayhew

DATE: July 10, 2014

Affiliation: Traffic Safety Unit

Contact Information: bmayhew@ncdot.gov, 919-773-2886

TITLE of your RNS: Increasing the Utilization of Weather Data for Safety Applications and Traveler Information

Background:

Weather is an influential factor for highway safety. Extreme weather conditions, such as dense fog and heavy rain, can directly affect the level of safety on a road. Fog presents a challenge to motorists and can result in significant safety concerns due to the reduced visibility. Applying fog prediction models could provide advance warning to motorists.

During collision analyses, accurate weather condition data are essential for establishing contributing factors for collisions. However, rural locations may have to rely on data from weather stations that are distant from the crash location and may have different weather events.

What is the Specific Problem or Issue?

For motorists, the lack of timely data about potentially foggy conditions poses a significant threat. In particular, these conditions can result in severe injuries as some drivers choose much lower speeds than other vehicles. Multiple vehicles (more than two) may collide as a result of these conditions.

Another issue results from the analysis of collision data when weather data is linked to collision reports. As the distance between the location of the crash and the nearest weather station increases, the likelihood of accurate weather data at the crash location decreases, particularly during weather events that are heavily localized.. Therefore, a methodology for better analysis and use of weather data is needed.

List Research Objectives and Tasks:

This research project has the following objectives:

1. Assess the feasibility of utilizing fog prediction models and real time weather data to provide timely street level information.
2. Develop an implementation plan for integrating fog prediction into NCDOT systems for alerting motorists.
3. Develop a methodology for improving the accuracy of weather data for collisions analyses.

What Would be the Product[s] of the Research?

(Note: Progress reports and the Final report are **NOT** considered "products." They are "deliverables.")

Related to the objectives of the project:

1. An implementation plan for integrating fog prediction into NCDOT systems for alerting motorists.
2. Guidance for implementing a methodology for improving the accuracy of weather data for collisions analyses and countermeasure evaluation.

How Will You or Others Use the Product[s]?

These products will be integrated into current practices to improve safety and accuracy of the work NCDOT performs.

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

This research will lead to improved safety performance on our roadways, during inclement conditions, and improve collision analyses with more accurate data.

Approval (Division official or Unit Head)

J. Kevin Lacy, PE, CPM

Print Name

Signature

State Traffic Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Jay Sprankle

DATE: 8/15/2014

Branch / Unit: Safety & Risk Management

TITLE of your Research Idea: Compatibility Testing of Supplemental Fall Protection Devices on NCDOT Bridges

Background:

Road bridges in NC have several types of guardrails designed to protect vehicles. Many types of these guardrails do not provide adequate fall protection for NC DOT workers who work on the bridge. There are a number of supplemental protective devices that can provide adequate protection but not all devices fit all bridge rails.

What is the Specific Problem or Issue?

Non-conforming guard rails on bridges provide inadequate fall protection for DOT workers

List Research Objectives and Tasks:

Select one or more engineered supplemental fall protection devices
 Determine, for each selected device, whether it can be properly attached to any given bridge rail
 Provide written criteria describing whether and how supplemental devices attach to existing bridge rails

What Would be the Product[s] of the Research?

*(Note: Progress reports and the Final report are **NOT** considered a "product," but "deliverables.")*

A comprehensive matrix for selecting supplemental protective devices for bridge rails along with written criteria on using the supplemental protective device. Matrix and criteria should be provided electronically.

How Will You or Others Use the Product[s]?

Users will be able to determine, before leaving the yard, what supplemental protective equipment is compatible with the types of bridge rails to be accessed. The information will allow crews to efficiently plan work

How Will the Product Benefit the Department?

(e.g., increase operational efficiency, decrease costs, enhance safety, etc. Indicate short term and/or long term benefit)

By knowing what equipment will provide adequate fall protection, crews can plan work to maximize work efficiency, minimize set-up and transport times, and provide better fall protection for workers. The result will be lower operating costs and greater employee safety.

Other Comments:**Approval (Division official or Unit Head)**

Robert Andrews

Print Name-----
Signature

Safety & Risk Management

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Anthony D. Wyatt, PE, PTOE, Bob Stevens, NC GHSP **DATE:** August 15, 2014
Branch / Unit: NCDOT / Transportation Mobility & Safety Division / Traffic Safety Unit

TITLE of your Research Idea: Potential Applications of Unmanned Aerial Vehicles for Highway Operations (Real Time Event Management/Surveillance), Safety, Maintenance, Construction Inspection, and Storm and Other Damage Assessment and Documentation

Background:

One of the most rapidly emerging technologies in the United States is the increasing capabilities and utilization of unmanned aerial vehicles (UAV). Due to the almost overnight advances that have been made with regard to performance, range, control, navigation (GPS), real time photography, battery life, reliability and system costs, many individuals and businesses are studying the potential advantages that such remotely controlled devices may provide. Due to concerns with privacy and air space issues in addition to Federal Aviation regulations that have fallen behind many states are also studying and implementing their own legislative controls on the acceptable use of UAVs (non-military “domestic” and “commercial” drones).

The UAV, control and optics industry is poised to continue to make additional major advances and North Carolina could potentially benefit as an ideal State for research, testing, evaluation, application and manufacturing.

What is the Specific Problem or Issue?

There has been a reluctance to venture into the utilization of unmanned aerial vehicles – partly due to privacy concerns (ACLU), lack of clarity with regard to regulatory constraints and forthcoming improved FAA regulations and guidance, and partly due to the initial costs, training and risks of losing a high cost asset due to an interruption in communications. It would be to the Department’s benefit to have at least investigated and studied the potential business applications and advantages of unmanned aerial system vehicles.

Without some degree of formal research and investigation into the potential that UAV systems could offer North Carolina agencies, municipalities, private engineering firms and emergency responders North Carolina could be at a competitive disadvantage with other states that are more progressively supporting this emerging industry and the many applications where UAVs could offer considerable benefits in terms of timeliness, safety (both to the public and to highway workers) and extended capabilities (at a reasonable cost).

List Research Objectives and Tasks:

Current state of the practice literature survey to assemble contemporary information with regard to forthcoming FAA regulations, NC General Assembly perspective (HB 744 Section 7.11 a + b under Vehicle Management), NC State University NEXGEN Air Transportation updates and survey of States active in the development and application of UAV technology (Utah, Colorado, Alaska, others) and specific law enforcement and emergency responders already utilizing UAVs.. In particular the efforts in the areas of real time traffic surveillance, special event traffic management, disaster assessments, high altitude bridge inspections, high altitude high mast lighting and other structural assessments, accelerated crash investigations and scene documentation and crash and major event (rockslide/bridge failure) reconstruction. The research should also determine to what degree technologies such as High Definition scanning could potentially be utilized from an aerial unmanned platform/vehicle to avoid on ground set ups and exposure of workers and equipment to live traffic.

- Determine what business areas NCDOT and partner agencies could potentially reap the most benefit from employment of UAV system technology.
- Determine what Legislative measures would be necessary to ensure agency was provided with necessary capabilities and latitude of operation.
- Identify in detail the risks associated with agency investment in and application of UAV systems and technology.
- Advise on the current state of the available hardware, controls, software, security, reliability, training, and evolution rate of the technology (i.e. how quickly would pilot investments be made obsolete by rapid technological advances).
- Provide a recommendation on the most immediate area of benefit and what is any measure the agency should be taking to pursue investment in the UAV systems and technology or if we would be better served to outsource to specialized providers when the need would arise?

What Would be the Product[s] of the Research?

Literature search and survey.

Business Plan with evidence driven recommendations for a deliberate approach for investment.

Development and delivery of training module to advance decision maker’s knowledge of the potential for UAVs & the limitations & risks.

How Will You or Others Use the Product[s]?

The agency and partners will be able to utilize the products of this research to improve future business approaches to utilize technology to improve the quality of services provided to and for the traveling public. The actual units and NCDOT business functions that may warrant further study and possible pilot implementations of UAV tools will be determined by the research findings and the advisory team.

How Will the Product Benefit the Department?

The groundwork in UAV will enable NC to be competitive with other states in this rapidly emerging and potentially economically significant market sector.

Other Comments:

SB 744 (Budget Bill) <http://www.ncleg.net/Sessions/2013/Bills/Senate/PDF/S744v8.pdf> (see numbered page 25 of PDF)

VEHICLE MANAGEMENT SECTION 7.11.(a) Section 7.16(e) of S.L. 2013-360 reads as rewritten:

"SECTION 7.16.(e) Until July 1, 2015, December 31, 2015, no State or local governmental entity or officer may procure or operate an unmanned aircraft system or disclose personal information about any person acquired through the operation of an unmanned aircraft system unless the State CIO approves an exception specifically granting disclosure, use, or purchase. Any exceptions to the prohibition in this subsection shall be reported immediately to the Joint Legislative Oversight Committee on Information Technology and the Fiscal Research Division.

The following definitions apply in this section:

- (1) "Unmanned aircraft" means an aircraft that is operated without the possibility of human intervention from within or on the aircraft.
- (2) "Unmanned aircraft system" means an unmanned aircraft and associated elements, including communication links and components that control the unmanned aircraft that are required for the pilot in command to operate safely and efficiently in the national airspace system."

SECTION 7.11.(b) If Section 7.16(e) of S.L. 2013-360 is repealed during the 2014 Session of the 2013 General Assembly, then Section 7.16 of S.L. 2013-360 is amended by adding the following new subsection:

"SECTION 7.16.(g) Until December 31, 2015, no State or local governmental entity or officer may procure or operate an unmanned aircraft system or disclose personal information about any person acquired through the operation of an unmanned aircraft system unless the State CIO approves an exception specifically granting disclosure, use, or purchase. Any exceptions to the prohibition in this subsection shall be reported immediately to the Joint Legislative Oversight Committee on Information Technology and the Fiscal Research Division.

The following definitions apply in this section:

- (1) "Unmanned aircraft" means an aircraft that is operated without the possibility of human intervention from within or on the aircraft.
- (2) "Unmanned aircraft system" means an unmanned aircraft and associated elements, including communication links and components that control the unmanned aircraft that are required for the pilot in command to operate safely and efficiently in the national airspace system."

<http://www.itre.ncsu.edu/ngat/> NCSU NEXTGEN Air Transportation

<https://www.youtube.com/watch?v=91pMoDaLr4#t=47>

<https://www.youtube.com/watch?v=v7SvcgLRlWw> Storm Damage Hurricane Sandy

<https://www.youtube.com/watch?v=G0xPdDZ61ul>

<https://www.youtube.com/watch?v=6uyAK0std6o>

http://www.faa.gov/news/press_releases/news_story.cfm?newsid=15576

<http://www.bizjournals.com/triangle/blog/techflash/2014/06/north-carolinas-drone-legislation-is-critical-to.html?page=all>

<http://www.bizjournals.com/triangle/blog/techflash/2014/08/aclu-the-fear-is-police-drones-in-nc-could-surveil.html?page=all>

400 foot ceiling / Not sold for Commercial purposes

Consider: NCSHP Reconstruction Gaskins

Bob Steven NCGHSP

Charlie Brown L&S

Keith Johnston Photogrammetry

Bobby Walston Aviation

Approval (Division official or Unit Head)

J. Kevin Lacy, PE

Print Name

Signature

State Traffic Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Anthony D. Wyatt, PE, PTOE, John Button, PE

DATE: August 15, 2014

Branch / Unit: NCDOT / Transportation Mobility & Safety Division / Traffic Safety Unit

TITLE of your Research Idea: High Definition Scans to Enhance Pavement Resurfacing Quality Control**Background:**

The NCDOT is charged with the management and maintenance of one of the largest and most challenging transportation systems in the United States. With over 80,000 centerline miles of state maintained roads the annual paving and resurfacing elements constitute a significant investment component for NCDOT. While the agency has made great strides with performance based and evaluation driven business practices, we still need to ensure that when significant resurfacing investments are made that we are providing the traveling public with not only the improved ride-ability but also improved safety and performance for all conditions.

What is the Specific Problem or Issue?

If a resurfacing impacts the road super-elevation or the roads surface geometry and transitions to the degree that the road surface is more prone to the accumulation of water, patterns of wet related crashes can develop within a short period of time (even with what are considered "acceptable" surface friction values). To compensate/correct for these situations – once the issue has been diagnosed - the department will consider treatments including wedging and resurfacing (again), resurfacing with an open graded friction course, or other countermeasures/combinations of treatments – depending on the conditions, circumstances and limitations of the location. This type of corrective action for a "just resurfaced" road is expensive and cause the traveling public to endure additional impacts and costs. There is also risk to the department from potential litigation and in terms of public perception and credibility.

List Research Objectives and Tasks:

The objective of this research would be to study and measure the cost effectiveness and safety preventative effectiveness to regularly perform pavement scans (high definition) on controlled access highways with pavement widths of three lanes or greater prior to the highway being resurfaced and after the highway has been resurfaced for the purpose of ensuring proper super elevation and pavement drainage (and transitions) on these wider expanses of pavement. Identify hierarchy of facility features that could be utilized to refine and apply HD scan to most potentially beneficial sites (70 MPH, 3 plus lanes. Existing indication of wet crash concentrations, etc.

What Would be the Product[s] of the Research?

The product of the research would be a better understanding of some of the factors and practices that are involved in resurfacing roads and effectively preserving or improving critical super-elevation and road surface drainage capabilities for high speed wide expanses of pavement. Technical guidelines that indicate when additional QC measures like HD 3D scanning could be cost effectively employed to improve wide pavement performance and road safety.

How Will You or Others Use the Product[s]?

The findings will provide essential information regarding these critical features and how the department is currently identifying and correcting deficiencies in resurfaced roads verses how the department could proactively utilize an emerging technology to improve the long term performance of our pavements with regard to wet performance and safety. The evidence and documentation provided by the additional quality control would have the potential to further indemnify the agency in cases where driver behaviors, equipment issues, and other factors resulted in wet related collisions. Findings could improve specification requirements, inspections, and potentially warranty aspects of high magnitude and cost resurfacing investments.

How Will the Product Benefit the Department?

Improving the service life and safety performance of North Carolina's highways reduces costs to the agency and the traveling public, reduces the need for corrective fixes (immediately following major resurfacings), reduces the agencies risk from wet weather crashes associated with surface deficiencies, and reduces the traveling public and highway worker's exposure to each other. The improved awareness and emphasis on correct super-elevations could potentially benefit all resurfacing work.

Other Comments:

John Button / TRIAD Regional Traffic Safety Engineer Winston Salem
Charlie Brown / High Definition Scanning

Approval (Division official or Unit Head)

J. Kevin Lacy, PE

Print Name

Signature

State Traffic Engineer

Title

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Your Name: Anthony D. Wyatt, PE, PTOE

DATE: August 15, 2014

Branch / Unit: NCDOT / Transportation Mobility & Safety Division / Traffic Safety Unit

TITLE of your Research Idea: Continuing Toward ZERO Fatalities in NC**Background:**

North Carolina has realized significant reductions in traffic related fatalities and severe injuries during the past seven years. These reductions have been sustained with continued population growth in North Carolina and with strong travel demands on our streets and highways. That being said – there are still too many lives lost on our streets and highways. North Carolina has championed 4E (education, engineering, enforcement and emergency response) approaches and we have partnered with a wide range of agency, advocacy and research partners over the years to better understand and improve transportation safety for all system users. Even with the significant and encouraging progress there are still some alarming areas where we are still losing too many lives. This proposal identifies three (3) areas where we continue to have difficulty with understanding and reducing the fatalities and severe injuries associated with these behaviors on North Carolina streets and highways. [Ideally these categories could be vetted by NC's Executive Committee for Highway Safety - and the most important/critical/highest priority research need could be prioritized/accelerated/advanced].

What is the Specific Problem or Issue?

- (1) Alcohol and Impairment Impacts on Pedestrian Safety in North Carolina (including time of day considerations and both driver and pedestrian behaviors and factors)
- (2) Hit and Run Crash Impact on Communities, responders, and families
- (3) Room to Live – The Alarming number of NC Highway fatalities that are still Unbuckled (Drivers & Occupants)

List Research Objectives and Tasks: *Please contact Mr. Anthony D. Wyatt at 919-773-2887 or adwyatt@ncdot.gov for details.*

- To be determined by NC Executive Committee for Highway Safety (or work teams).
- Quantify the problem in terms of fatalities and injuries (and distribution) and study in detail the circumstances and factors involved in the events.

What Would be the Product[s] of the Research?

State of the Issue Literature Research and Detailed white papers (for each topic) and issue briefs (suitable for decision makers/elected officials) with contemporary safety performance data and impact/costs to outline the factual knowledge and magnitude of the issue in terms of North Carolina's overall safety picture. White paper summaries should correlate how the issue aligns with NC's soon to be published 2014 Strategic Highway Safety Plan. Literature research should include contemporary national data on these categories for comparison of NC's performance. Coordination with NC Executive Committee for Highway Safety will be necessary.

Quantify the problem in terms of fatalities and injuries (and distribution) and study in detail the circumstances and factors involved in the events. Utilizing North Carolina data/evidence produce crash costs for each of the three (3) emphasis categories.

Identify candidate proven countermeasures that could be more effectively utilized to combat the problem and any gaps/needs in terms of approaches to effectively reach and impact the involved behaviors/populations. Effort should include any Public Information and Education deficiencies/opportunities, any geographic concentrations that may warrant targeted (4E) efforts, current enforcement and adjudication efforts, effective engineering countermeasures, deficiencies and needs, and any critical legislative/regulatory needs.

How Will You or Others Use the Product[s]?

The department's multi-partner Executive Committee for Highway Safety – and NCDOT's internal and external safety partners can utilize this research to better understand, define, assess, identify and prioritize program level responses to the often difficult categories of injuries and fatalities that defy traditional proven treatments. The identification of behaviors that contribute to these highway fatalities and the degree to which that can realistically be expected to be treated utilizing proven approaches will be critical as goals to approach zero fatalities are evolving. The improved knowledge can be integrated into driver's education, press releases (media knowledge), presentations, training and hearing opportunities and messages that insurers, medical providers, enforcement officers, and the legal communities provide to NC's citizens.

How Will the Product Benefit the Department?

As competitive evidence driven programs rely on best available information and knowledge, it is important that efforts undertaken and investments being made are not simply to appease or satisfy public outcry, but that treatments and interventions have some degree of legitimacy and effectiveness for the conditions/behaviors that contributed to the injury/fatality. The improved knowledge with regard to the nature of these events and the impact to the citizens of North Carolina can help North Carolina continue to improve its efforts to invest in the categories of projects that will offer the greatest effectiveness for the greatest need.

Approval (Division official or Unit Head)

J. Kevin Lacy, PE

Print Name

Signature

State Traffic Engineer

Title