Vermont Agency of Transportation

Research Advisory Committee

Project Quarterly Progress Reports

2015 – Q3

(04-01-2015 to 06-30-2015)

Improvement and Operation of the Vermont Travel Model

FINAL QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE: 0001052
SPR: 302

B. PRINCIPLE INVESTIGATOR(s): Jim Sullivan

C. START AND END DATE (per grant assignment): October 1, 2014 – September 30, 2015

D. ANTICIPATED COMPLETION DATE: September 30, 2015

E. PROJECT OBJECTIVES: The overall objectives of this project are to:

1. Maintain the Vermont Travel Model as a comprehensive predictor of travel behaviors of Vermonters
2. Respond to requests from VTrans staff and its contractors to query or run the model for specific applications

F. REPORT PERIOD: April 1st through June 30th, 2015

G. ACCOMPLISHMENTS THIS PERIOD:

- Improvement of the Model:
  - Completed the "halo" analysis recommended by the TMIP peer review panel by incorporating demographic characteristics of external northeastern U.S. Census urban areas (UAs) into the Model's external TAZs, and recommending internalizing one or more of those UAs in the Model
  - Began internalizing the Lebanon-Hanover NH-VT and the North Adams, MA-VT UAs in the Vermont Travel Model, and adding Route 3 in NH and Route 2 in MA into the Model road network
  - Began gathering data on New England UAs that are likely destinations for highway travel to/from Vermont
- Operation of the Model:
  - Assessed the impacts of construction closures of Culvert 20, spanning Route 9 over an ephemeral drainage in Searsburg
  - Documented the findings of the assessment in a technical memorandum

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. PERCENT COMPLETION OF TOTAL PROJECT: 65%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Improvement of the Model:
  - Complete internalizing the Lebanon-Hanover NH-VT and the North Adams, MA-VT UAs in the Vermont Travel Model, and adding Route 3 in NH and Route 2 in MA into the Model road network
  - Finish gathering data on New England UAs that are likely destinations for highway travel to/from Vermont
  - Begin developing an external travel sub-model to reflect the influence of the "halo" region incorporated into the Model
  - Document all Year 7 activities in a final Year 7 Report

Progress report prepared by: Jim Sullivan **Date Prepared:** August 7, 2015

Evaluation of Experimental Features
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 352 Evaluation of Experimental Features

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
Ongoing

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: To evaluate experimental features and products on VTrans projects and installations. This includes installation or application, field monitoring and data collection, testing, photographic analysis and preparation of interim and final reports on the methods chosen. Publication or transmittal of experimental results will be sent to interested Agency units.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:

- Annual and seasonal visits to the following projects:
  - WP 2005-R-2: 50 Gyration Superpave Mix
    - Conducted Annual Visit – took photos, measured rutting and cracking.
  - WP 2011-R-4: 9.5 mm Highly Polymer Modified Thin Hot Mix Asphalt
    - Conducted Annual Visit – took photos, measured rutting and cracking.
  - WP 2012-R-1: Bridge Preservation Inc. Bridge Deck Waterproofing Membrane System
    - Conducted Annual Visit – took photos and made observations.
  - WP 2013-S-1: Fiber Reinforced Polymer (FRP) Strips for Bridge Rehabilitation

        - Took photos, observed performance, noted cracks at midspan points of each horizontal member of each pier and took torque measurements of a sample of nuts holding strips in place.
    - WP 2013-PIF-1: Bridge in a Backpack Arched Bridge System
        - Conducted annual visit – took pictures, measured four arches, took observations. Noted that the headwalls are beginning to bow outward.
- Report Published:
    - WP 2011-R-5: Jahn Permeable Mortar System In a Historic Bridge Abutment Application (Report 2015-10)

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: Email notifications. Reports and updates are available electronically through the following link: http://vtransplanning.vermont.gov/research/research/projects/completed

J. PERCENT COMPLETION OF TOTAL PROJECT: N/A

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Annual and seasonal visits to the following projects:
    - WP 2013-R-3: Pavement Marking Comparison, Brookfield-Montpelier, Interstate 89 Painted Markings:
        - Initial update/report will be drafted and published.
        - Spring retroreflectivity readings both wet and dry will attempted to be collected in April/May 2015.

- Final updates and reports for the following will be completed and published:
    - WP 2008-R-2 - Assessment of TechCrete, a Concrete Repair Material and Joint Sealant (Final)
    - WP 2011-R-1 - Assessment of Super-Slab, a Precast Concrete Slab in a Bridge Approach Application (Initial)
    - WP 2011-R-4: 9.5 mm Highly Polymer Modified Thin Hot Mix Asphalt (HMA) Overlay (Update)
    - WP 2011-R-6: Assessment of the Sterling Lloyd Eliminator Waterproofing Membrane System (Initial)
    - WP 2012-R-2: Poly-Carb Flexogrid Bridge Deck Overlay System (Update)
    - WP 2012-R-3: Assessment of 40” Wide Paving Skid Box
    - WP 2012-R-4: Assessment of Uretek Deep Injection Process (Initial)

- WP 2013-R-3: Pavement Marking Comparison, Brookfield-Montpelier, Interstate 89 Painted Markings (Initial)

Progress report prepared by: George W. Colgrove III
Date Prepared: August 10, 2015

Porous Pavement Performance Evaluation in a Cold Weather Climate – Randolph Park and Ride

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 705 Porous Pavement Performance Evaluation in a Cold Weather Climate – Randolph Park and Ride

B. PRINCIPLE INVESTIGATOR(s):
Jason P. Tremblay, P.E.
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One National Life Drive
Montpelier, VT 05633
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C. START AND END DATE (per grant assignment):
2008-2013

D. ANTICIPATED COMPLETION DATE: *December 31, 2015 due to project being put on hold.*

E. PROJECT OBJECTIVES: The objective of this research initiative is to examine the overall performance and pollutant removal efficiency of an experimental pervious Park and Ride located in the town of Randolph. This will be accomplished by documenting site characteristics such as soil permeability and frost susceptibility with reference to the water table, construction practices with special emphasis placed on grading, compaction and concrete placement, and the occurrence of any surface distresses including cracking and spalling. Infiltration efficiency will be monitored over time with respect to the pervious wearing course and underlying soils with consideration to winter maintenance practices and pressure washing activities. Pollutant removal will be assessed at varying depths within the basin as well as the incidence of bacterial growth at the interface of the basin and underlying soils.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD: This project has been put on hold.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 90%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: Final chain drag and overall assessment will be conducted, all prior to any construction with regards to the re-design. Final report writing will begin and once all final data is collected and compiled, final data analysis will commence.

Progress report prepared by: George W. Colgrove III
Date Prepared: August 10, 2015

Evaluation of Concrete Bridge Mix Designs for Control of Cracking

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 710 Evaluation of Concrete Bridge Mix Designs for Control of Cracking

B. PRINCIPLE INVESTIGATOR(s):
Jason Tremblay, M.S., P.E.
Research Engineer
Vermont Agency of Transportation
One National Life Drive
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Telephone: (802) 828-6945

C. START AND END DATE (per grant assignment):
2009 - 2015

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: Phase I: The objective of this research initiative is to examine a series of differing concrete mix designs in order to begin the process of selecting an optimum design for VTrans bare concrete bridge deck projects as well as other bridge projects. The desire is to lower the amount of cracking that is present on the bridge decks, possibly by using shrinkage control agents and/or by reducing the amount of cementitious material which would result in a reduction of needed mix water, based on the current water/cementious ratios. Laboratory testing of this type is needed in order to provide a basis for support for using shrinkage reducing admixtures and/or adjusting current mix designs.

Mixes will fall within three groups. The first group will be the control group, consisting of batches of normal high performance concrete (HPC), classes A and B. The second group will make use of two different methods of shrinkage control within the control mixes, a shrinkage reducing admixture and a shrinkage compensating cementitious admixture. The third group will make use of an optimized gradation of aggregate and other various alterations.

Phase II: The objective of this second phase of the research initiative is to examine a select few of the top performing mixes tested in the previous study, alter a few key variables in their design, and zero in on the ideal design for the Agency's needs. The first component to evaluate will be the amount of cement required. One mix will be chosen from the initial study and the cement content varied at four different values, 400, 475, 550, and 610 per cubic yard. Four batches of each of these will be produced and tested.

As part of the process it is desired to mix the concrete in larger test batches than during the first study, where mixes were batched in house in approximately 1.5 cubic foot quantities. As part of this phase, mixes will be batched in a three cubic yard quantity; a standard quantity known to replicate the consistency of full scale pours well, and be done by a local concrete producer.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD: This project has been put on hold.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES: The final report for Phase I was distributed to stakeholders throughout the Agency.

J. PERCENT COMPLETION OF TOTAL PROJECT: 100% (phase I), all production, testing, data compilations, and basic analysis has been completed, along with a final report published and distributed. 10% (phase II), concrete mixer received and base mixes decided upon.

K. ACTIVITIES PLANNED FOR NEXT QUARTER: No work is anticipated for Q4 with project on hold. In the next fiscal year, supplies will be purchased for phase II and test batch preparation began.

Progress report prepared by: George W. Colgrove III
Date Prepared: August 10, 2015

Correlating M-E PDG with Vermont Conditions – Phase II

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 711 Correlating M-E PDG with Vermont Conditions – Phase II

B. PRINCIPLE INVESTIGATOR(s):

Chris Benda
Geotechnical Engineering Manager
Construction and Materials Bureau
Vermont Agency of Transportation
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C. START AND END DATE (per grant assignment):
2010-2016

D. ANTICIPATED COMPLETION DATE: The funding has been extended into FFY '14, and it is anticipated the project will be complete by December 31, 2014 – Would like to extend completion date to July 2016.

E. PROJECT OBJECTIVES: Using the information gathered and work completed in Phase I, the first objective of this Phase is to determine the necessary beta-factors for calibration of the M-E PDG software by comparing in-situ pavement distresses with the software output. Both rutting and IRI will be compared at their present day values, along with their quantities over time. Using statistical methods along with NCHRP Report 1-40B *Local Calibration Guide,* a calibration and validation process will be developed and carried out to ascertain the adjustment factors to be used for pavement design in Vermont.

Continuing with the progress of the overall project, the second objective of this phase will be verification of the model. Using additional sites from the 2004 Layer Coefficient Study, in-situ values will be compared with predicted to insure the model is working correctly.

F. REPORT PERIOD: April 1, 2015-June 30, 2015

G. ACCOMPLISHMENTS THIS PERIOD:
We found a couple of "holes" within our traffic data that we are planning on correcting. Some of the traffic data we were using was not as accurate as it could be for each site, so we're now working with Traffic Research to update that information. Because truck traffic is one of the more sensitive parameters to the

program, we've decided to put more time into accurately representing real-world values for the five sites.

We also just received updated pavement inspection dates that we will use to verify the model prediction values. Having the dates down to the month (vs. the year prior dates were given) will help us more closely compare the model results to the real-world results.

H. PROBLEMS ENCOUNTERED (If any): Gathering all of the updated data has proven to be a little more time consuming than anticipated. Traffic Research has just implemented a new software system that will take some time to fully understand. Not necessarily a problem, just setting back the schedule.

I. TECHNOLOGY TRANSFER ACTIVITIES: N/A

J. PERCENT COMPLETION OF TOTAL PROJECT:

80%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: Traffic Research is planning on providing us with the traffic information we've requested by October 2015. We will then incorporate that updated information into our models and see how the predicted values are affected.

Progress report prepared by: Marcy Meyers **Date Prepared:** 8-12-2015

Life-Cycle Determination of Preventative Maintenance Treatments

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 713 Life-Cycle Determination of Preventative Maintenance Treatments

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
2009-2017

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: Preventative maintenance treatments, intended to arrest minor deterioration, retard progressive failures, and reduce the need for corrective maintenance, has the potential to both improve quality and reduce expenditures. The life cycle and associated cost-effectiveness of these treatments may vary significantly based upon the selected treatment, functional classification, traffic demand, condition of the roadway prior to application, constructability, and environmental conditions.

The primary intent of this research initiative is to determine the life expectancy and associated costs of preventative maintenance treatments currently used in the State of Vermont. This will be completed by evaluating the constructability, performance and cost effectiveness of all treatments encompassed within the study. The treatments will include paver placed surface treatments, micro-surfacing (Type I and II), chip seal, hot-in-place recycling, and standard mill and fill treatments.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:

- Collected rutting and cracking data on the following:
  - Colchester IM SURF (12)
  - Brookfield-Williamstown-Berlin IM SURF (11)
  - Barre Town-Orange STP SURF (15)
  - Groton-Ryegate STP SURF (16)
  - Ryegate-Newbury STP SURF (17)

- Berlin-Waterbury IM SURF (20) SB
- Norwich-Fairlee IM SURF (19)
- Dorset-Danby NH SURF (24)

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: None.

J. PERCENT COMPLETION OF TOTAL PROJECT: 70%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Initial report will be reviewed and published.
- Continue with remaining annual site visits.

Progress report prepared by: George W. Colgrove III
Date Prepared: August 10, 2015

Evaluation of Skid Resistance of Bare Concrete Bridge Decks
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 715 Evaluation of Skid Resistance of Bare Concrete Bridge Decks

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
2010-2012

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: The objective of this research initiative is to examine different concrete surface finishing techniques currently in place on bare bridge decks in order to determine which methodologies lead to the greatest skid resistance. Two differing methods of skid resistance testing will be performed, including the use of a British Pendulum Tester as well as a locked wheel skid test. The Structures Section has comprised a list of fifteen bridges that will be tested around the state, 32 years or younger, with five or more different surface finishing techniques used among them. Analysis of the skid resistance data will help lead to the selection of an optimal concrete surface finish thereby increasing the overall safety of the traveling public.

The analysis of these finishing techniques will also include other factors, such as cost, long term durability, quality assurance, construction feasibility and probability of success.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD: None; draft report has been reviewed in house and sent to Wayne Symonds for Structures review, as they were the originators of the solicitation. Awaiting comments for finalization. It has been decided that further review will take place within Research and the project finalized.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 95%, all data collected; data analysis and draft report finished.

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:** Upon completion of reviews, the final report will be finalized and published.

Progress report prepared by: George W. Colgrove III
Date Prepared: August 10, 2015

Use of Piles in Slope Stabilization
QUARTERLY REPORT

A. **PROJECT NUMBER AND TITLE:** Use of Piles in Slope Stabilization
SPR: 719

B. **PRINCIPAL INVESTIGATOR(s):** Callie Ewald, Chris Benda and Mandar Dewoolkar

C. **START AND END DATE (per grant assignment):** February 1, 2011 through March 31, 2012. Extended through August (September) 2015

D. **ANTICIPATED COMPLETION DATE:** August (September) 2015

E. **PROJECT OBJECTIVES:** The primary objective of this research is to provide the Agency with design guidance for reinforcing unstable slopes with steel H-Piles and to gap design software omissions. The primary design tool used by the Agency does not consider every aspect of failure in the piles and does not account for soil stiffness. A second objective of the research is to evaluate the suitability of using the Borehole shear Test (BST) apparatus as an aid in establishing soil parameters for analysis. The BST is a test that is performed in the field which determines effective shear strength parameters of the in-situ soil. Due to the high expense and length of time required for laboratory testing, this device could be of significant benefit in slide mitigation activity. A site in Cornwall, VT has been identified to conduct a field investigation and testing program.

F. **REPORT PERIOD:** April 1, 2015 through July 15, 2015

G. **ACCOMPLISHMENTS THIS PERIOD:** Remediation alternatives were considered in the computer monitoring program Slide. Several technologies were considered and designed to increase the slope factor of safety. Inclinometer and well readings were taken and data added to the current representative graphs.

H. **PROBLEMS ENCOUNTERED (If any):** The movement in the inclinometer is reading much deeper than originally anticipated. This adds an additional level of complexity to the modeling and will require additional survey and modeling.

I. **TECHNOLOGY TRANSFER ACTIVITIES**: None

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 85%

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:** Develop a remediation that increases the factor of safety of the slope and provide recommendations to the District. Finish report with aid from Dr. Dewoolkar for editing and finalize by the end of September.

Progress report prepared by: Callie Ewald
Date Prepared: August 12, 2015

Designing Porous Concrete to Resist Damage from Deicing Salts and Freeze-Thaw
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 730 Designing Porous Concrete to Resist Damage from Deicing Salts and Freeze-Thaw

B. PRINCIPAL INVESTIGATOR(s):

Dr. Mandar Dewoolkar
Associate Professor
School of Engineering - University of Vermont
(802)656-1942

Dr. Edwin R. Schmeckpeper, Associate Professor
Dr. Adam F. Sevi, Assistant Professor
Civil and Enviornmental Engineering
Norwich University

C. START AND END DATE (per grant assignment): June 1, 2012 – December 31, 2014.

D. ANTICIPATED COMPLETION DATE: August 31, 2015

E. PROJECT OBJECTIVES: The scope of this research is to: (1) evaluate in the laboratory porous concrete mixes for their resistance to deicing chemicals; (2) quantify the effects of sand addition on the resistance to deicing salts; (3) quantify the effects of fly ash replacement on resistance to deicing salts; (4) evaluate various chemical admixtures to determine if they improve resistance of porous concrete to deicing salts; and (5) determine how curing time affects resistance to deicing salts.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:

(a) 1st Month: The testing program is progressing. The samples are continued to be tested for freeze-thaw cycles at Norwich.
(b) 2nd Month: The testing program is progressing. The samples are continued to be tested for freeze-thaw cycles at Norwich.
(c) 3rd Month: The testing program is progressing. The samples are continued to be tested for freeze-thaw cycles at Norwich. A report to UVM TRC was prepared and submitted, which is available online at: http://ntl.bts.gov/lib/55000/55100/55142/UVM-TRC-15-006.pdf

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES: N/A

J. PERCENT COMPLETION OF TOTAL PROJECT: 97%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: Freeze-Thaw testing at Norwich will continue. Analysis is expected to progress significantly. A final report will be prepared.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER: None

Progress report prepared by: Mandar Dewoolkar

Date Prepared: July 15, 2015

Prediction and Mitigation of Scour for Vermont Bridges
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 731 Prediction and Mitigation of Scour for Vermont Bridges

B. PRINCIPAL INVESTIGATOR(s):

Mandar Dewoolkar, Ph.D., P.E.
Associate Professor
School of Engineering - University of Vermont
1942.

C. START AND END DATE (per grant assignment): June 1, 2012 – May 31, 2015.

D. ANTICIPATED COMPLETION DATE: August 31, 2015

E. PROJECT OBJECTIVES: Successfully mitigating scour related problems associated with bridges is dependent on engineers' ability to reliably estimate scour potential, design effective scour prevention and countermeasures, design safe and economical foundation elements accounting for scour potential, and design reliable and economically feasible monitoring systems. The specific objectives of this research are to: (1) conduct an extensive literature review on methods to estimate scour potential, methods of monitoring, design methodologies, and countermeasures, and summarize the results in a summary document and make recommendations on specific methodologies that would be adaptable for Vermont; (2) develop a methodology for semi-empirically linking rapid geomorphic assessments (RGA) to observed bridge scour as a predictive tool; and (3) instrument select test sites with relatively low-cost passive sensors that will actively yet remotely communicate excessive scour.

F. REPORT PERIOD: 2015 Q3: April 2015 to June 2015

G. ACCOMPLISHMENTS THIS PERIOD:

a. 1st Month (April 2015): Continued refining and analyzing the comprehensive bridge database. Continued to work on the specific stream power measurements. Continued working on report on the bridge scour damage and vulnerability from Irene. Second version of the scour sensor design is underway.
b. 2nd Month (May 2015): Continued to work on report. Began analysis of feature selection for bridge scour vulnerability. Began reach based scour analysis, including the use of RGA and Stream Power.

c. 3rd Month (June 2014): Completed report on the bridge scour damage and vulnerability from Irene, for the UVM TRC, which is available online at: http://www.uvm.edu/~transctr/research/trc_reports/UVM-TRC-15-002.pdf. Began writing manuscript on feature selection for a bridge scour vulnerability.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES: N/A

J. PERCENT COMPLETION OF TOTAL PROJECT: 75%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: The review of countermeasure and bridge design alternatives will continue. Work on the stream power/geomorphic tool for characterizing stream vulnerability will continue. Report writing is underway, and will continue to expand.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER: $10,000

Progress report prepared by: Mandar Dewoolkar
Date Prepared: July 15, 2015

Pavement Marking Comparison Study

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 732 Pavement Marking Comparison Study

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment): January 1, 2013 – September 30, 2018

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: The objectives of this research initiative include examining and evaluating the reflective and durable characteristics of recessed and surface applied pavement markings in both wet and dry conditions and to classify durable tapes into performance categories based on their durability and adhesion capabilities.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:

- WP 2013-R-3: Pavement Marking Comparison, Brookfield-Montpelier, Interstate 89 Painted Markings:
  - Completed the spring site visits to take readings and photographs and notes regarding the present condition.
- WP 2013-R-4: Pavement Marking Comparison Study – Berlin, VT - US Route 302 Inlaid Pavement Marking Tape, Preformed Thermoplastic, and Bike Lane Markings:
  - None.

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 35%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Initial draft update/report will be completed and published.
- Summer retroreflectivity readings both wet and dry will be collected
- Meet with project managers to discuss WP 2013-R-4 and attend preconstruction meeting for this project if occurs during this quarter.

Progress report prepared by: George W. Colgrove III
Date Prepared: August 10, 2015

Long-Term & Short-Term Measures of Roadway Snow & Ice Control Performance

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE: RSCH016
SPR: 733

B. PRINCIPLE INVESTIGATOR(s): Jim Sullivan

C. START AND END DATE (per grant assignment): April 1, 2013 – March 31, 2015

D. ANTICIPATED COMPLETION DATE: March 31, 2016

E. PROJECT OBJECTIVES: The objectives of this project are to improve the performance of RSIC activities by the VTrans fleet by developing a plan for implementation of new performance measures. Long-term, seasonal measures will be developed which implement a time-to-normal approach. A short-term measure will be pilot-tested, utilizing real-time thermal image processing.

F. REPORT PERIOD: April 1st through June 30th, 2015

G. ACCOMPLISHMENTS THIS PERIOD:

- None

H. PROBLEMS ENCOUNTERED:

- Speed data collection at RWIS stations was not possible due to malfunctioning field equipment and malfunctioning data-servers
- Testing, troubleshooting and field inspection for installation of thermal infrared camera equipment was not completed in time to collect thermal video imagery in a winter storm during 2014. A new end date of 3/31/2015 for the project was established at no additional cost. No effort was incurred from April 1, 2014 to October 1, 2014. The remaining budget was to be used between October 1, 2014 and March 31, 2015 to accomplish the originally defined scope.
- Excessive field modification of the thermal infrared camera equipment was required to affix the camera equipment to the plow truck, and final modifications were completed in late February 2015. Between that time and March 31st, there were no significant winter storms in the Colchester district, so the collection of imagery for 5-6 storms was not possible. A new end date of 3/31/2016 for the project is established at no additional cost, to allow the team one more winter to complete the collection of thermal video imagery. No effort will be incurred from April 1, 2015 to December 31st, 2015. The

remaining budget will be used between January 1, 2016 and March 31, 2016 to accomplish the originally defined scope.

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. PERCENT COMPLETION OF TOTAL PROJECT: 90%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- None

Progress report prepared by: Jim Sullivan **Date Prepared:** August 7, 2015

Statewide Analysis of Guardrails, Curves and Crashes

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 736

B. PRINCIPLE INVESTIGATOR(s): Brian H. Y. Lee

C. START AND END DATE (per grant assignment): 1 Mar 2013 – 30 Dec 2014

D. ANTICIPATED COMPLETION DATE: 31 Dec 2014

E. PROJECT OBJECTIVES:

This research project focuses on the placement of guardrails and the location of curves, both with respect to crash incidents. Since guardrails and curves are often co-located (i.e., many guardrails are placed along curves and many curves have guardrails), it is highly likely that these two road features are correlated in space and confound each other's relationship with crashes. Both guardrails and curves may vary in their attributes by location (e.g., guardrails in size, material, offset; curves in radii, length, pavement material) and can relate to crashes in positive and negative ways. In this project, both guardrails and curves are considered together in a single, holistic statewide study, while maintaining the ability to discuss each of these issues separately.

There are two project objectives:

Objective 1: Develop guidelines that will inform road engineers about contexts in which the use of guardrails to help prevent crashes is appropriate. This would include taking into account of the site conditions, the users, and the types of facilities and guardrails.

Objective 2: Determine curve characteristics that are highly correlated with crashes to help identify locations where safety interventions may be warranted. Similar to Objective 1, this would include taking into account of the site conditions, the users, the types of facilities, and the presence of different interventions.

F. REPORT PERIOD: 1 April 2015 through 30 June 2015

G. ACCOMPLISHMENTS THIS PERIOD:

- Made revisions to final report

H. PROBLEMS ENCOUNTERED (If any):

N/A

I. TECHNOLOGY TRANSFER ACTIVITIES:

N/A

J. PERCENT COMPLETION OF TOTAL PROJECT: 98%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Receive comments & edit report as needed

Progress report prepared by: Brian H. Y. Lee **Date Prepared:** 10 August 2015

Quantifying the Vulnerability of Vermont Bridges to Seismic Loading
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 737 Quantifying the Vulnerability of Vermont Bridges to Seismic Loading

B. PRINCIPAL INVESTIGATOR(s):

Mandar Dewoolkar, Ph.D., P.E.
Associate Professor
School of Engineering - University of Vermont
(802) 656 1942

Eric Hernandez, Ph.D.
Assistant Professor
School of Engineering - University of Vermont
(802) 656-3331

C. START AND END DATE (per grant assignment): May 15, 2013 – May 31, 2016.

D. ANTICIPATED COMPLETION DATE: May 31, 2016

E. PROJECT OBJECTIVES: The overarching objective of this research is to assist the Agency in establishing a methodology for the seismic assessment of their inventory of bridges; that is, to provide a rational basis for ranking their bridges according to their seismic vulnerability in consideration of variations in seismicity, foundation, terrain, and geologic conditions, and structure type, age and importance. The specific objectives are to: (1) review and update Agency's bridge inventory; (2) conduct a thorough literature review on seismic vulnerability ranking of bridges; (3) develop an appropriate seismic vulnerability ranking system for Vermont bridges and slopes associated with bridges; (4) assign and validate the rankings by conducting thorough seismic analysis of select bridge sites; and (5) prepare training materials and final report to assist Agency personnel in the upkeep of the inventory and rating system for retrofitted and new bridges.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:

a. 1st Month (April 2015) – Continued structural modeling of the steel girder type multiple span bridges. Extracted records of additional bridges from the Vermont NBI database and as-built records.
b. 2nd Month (May 2015) – Continued structural modeling of the steel girder type multiple span bridges. Searched and compiled recorded ground motions

from published database to match representative design spectrum for Site Class B and E conditions in southeastern Vermont.

c. 3rd Month (June 2015) – Continued structural modeling of the steel girder type multiple span bridges using non-linear structural analysis. Investigated seismic vulnerability of six bridges of this type with varied span lengths representative of the Vermont inventory in terms of structural damage indices.

H. PROBLEMS ENCOUNTERED (If any): None to date.

I. TECHNOLOGY TRANSFER ACTIVITIES: None in this quarter.

J. PERCENT COMPLETION OF TOTAL PROJECT: 69%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: Search and extract additional recorded ground motion records and additional representative bridge type as-built records for further detailed analyses. Continue detailed seismic analysis of the multiple span steel girder bridge type and computing seismic damage to these bridges subjected to recorded ground motions which are consistent with the AASHTO 2014 LRFD design earthquakes at two representative locations within Vermont, at two soil seismic site class profiles. Apply these analysis results to create a statistical model of probability of various damage levels versus location and soil profile for this bridge type. Prepare for and attend a project TAC meeting, preferably to be held in this quarter.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER (Q4, July-August)

a. July 2015 ~$29,000
b. August 2015 ~$3,180
c. September 2015 ~$3,180

Progress report prepared by: Mandar Dewoolkar
Date Prepared: July 15, 2015

High Speed Ground Penetrating Radar (GPR) for Road Pavement and Bridge Structural Inspection and Maintenance

Quarterly Report

A. PROJECT NUMBER AND TITLE:

SPR: RSCH017-738
High Speed Ground Penetrating Radar (GPR) for Road Pavement and Bridge Structural Inspection and Maintenance

B. PRINCIPLE INVESTIGATOR(s):

Tian Xia
Associate Professor
School of Engineering
University of Vermont

C. START AND END DATE (per grant assignment):

05/01/2014-06/30/2016

D. ANTICIPATED COMPLETION DATE:

06/30/2016

E. PROJECT OBJECTIVES:

The overarching objective of this research is the development of a systematic methodology of employing GPR, including instruments, subsequent data processing and interpretation that can be used regularly as part of a roadway pavement and bridge evaluation program. Test methodologies and procedures that are suitable for Vermont environmental and infrastructural conditions will be explored and evaluated. Moreover we will implement and improve a high speed GPR system that allows driving speed roadway and bridge deck inspection with leveraged inspection resolution. We will investigate the strengths and limitations of GPR to determination the correct implementation both in terms of operation and data assessment, and the range of road conditions for which usage is worthwhile. We will work with VTrans closely to make GPR a suitable tool to facilitate transportation infrastructure survey, maintenance, repair and rehabilitation in Vermont and beyond. To ensure the successful accomplishment of the project, we will fulfill the following research objectives in two phases.

Phase 1 (Year 1):

- **Objective 1:** Review and evaluate current roadway pavement and bridge deck inspection methods employed by VTrans, and gather the available structural as-built plans. Also available GPRs systems and their functionalities will be reviewed.
- **Objective 2:** Develop and improve a high performance high resolution GPR that allows surveying at highway speeds.
- **Objective 3:** Apply GPR for roadway pavement profile inspections.
- **Objective 4:** Apply GPR for bridge deck inspections.

Phase 2 (Year 2):

- **Objective 5:** To inspect seasonal changes and deicing salt effects on pavement and bridge deck condition.
- **Objective 6:** Data registration method will be implemented to facilitate database development and data management. Integration with VTrans Automatic Road Analyzer (ARAN).
- **Objective 7:** Develop systematic GPR inspection flow and procedures applicable for maintenance and rehabilitation decision making.
- **Objective 8:** Identify and recommend areas for further study to improve inspection accuracy and effectiveness.

F. REPORT PERIOD:

04/16/2015 – 07/15/2015

G. ACCOMPLISHMENTS THIS PERIOD:

In this project quarter, two accomplishments have been made: (1) GPR bicycle trail inspection had been conducted with antennas of three different frequencies; (2) GPR database had been set up and developed.

1. GPR Bicycle Trail Inspection

1.1 GPR system configuration and bicycle trail test site

In this project quarter, GPR bicycle trail inspection test had been conducted. Three sets of antennas with different center frequency are used in this test, whose specifications are shown in Table 1. The center frequency of the low frequency antenna set is 400 MHz, the center frequency of the medium frequency antenna set is 1.6 GHz, and the center frequency of the high frequency antenna set is 2.3 GHz. The GPR system test setup is shown in Figure 1.

Table 1 Specifications of Three Sets of Antennas

Antenna Set	Center Frequency
Low Frequency	400 MHz
Medium Frequency	1.6 GHz
High Frequency	2.3 GHz

In theory, if the GPR transmission signal's frequency is high, the range resolution of the inspection is high, while the penetrating depth is low. On the contrary, if the GPR transmission signal's frequency is low, the range resolution is low, while the penetrating depth is deep. Based on this principle, the high frequency antenna set leads to the higher resolution with the lower penetrating capability; the low frequency antenna set has the higher penetrating capability with the lower image resolution.

Figure 1 GPR System Configuration

In this test, the bicycle trail of South Burlington Recreation Path is chosen as the test site for GPR inspection. The bicycle trail picture is shown in Figure 2, and the whole test route displayed on Google Map is shown in Figure 3. The 400 MHz antenna set aims at detecting the deep (> 3ft) objects, such as the drainage pipe, sewer, etc. The 1.6 GHz antenna set and 2.3 GHz antenna set aims at detecting small subsurface features at shallow depth, such as pavement crack, pavement bottom surface, asphalt patch and depression, etc. Several test spots with specific subsurface objects or defects are demonstrated in this report.

Figure 2 Bicycle Trail Test Site

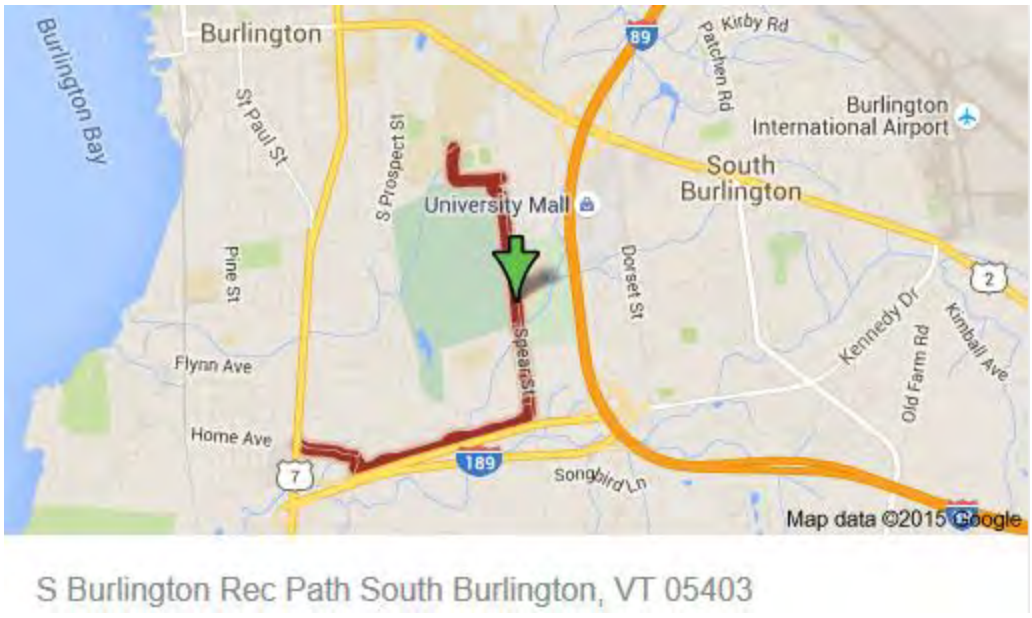


Figure 3 S Burlington Rec Path as Test Site

1.2 Data Processing Approaches

The following signal processing steps are utilized for GPR B-Scan images processing:

Step 1: Zero-offset;

Step 2: Stack every 5 A-scan traces to calculate the average so as to increase the signal-to-noise ratio (SNR);

Step 3: Band pass filter to remove low frequency and high frequency noise;

Step 4: Signal loss compensation by amplitude rescaling along the depth axis.

1.3 Test Spots and Corresponding Results Demonstration

(1) Test Site 1

The GPR inspection on a test spot with an underground sewer is performed. The location of this test spot is displayed on Google Earth, which is marked on the upper left corner in Figure 4. The physical test site picture is shown in Figure 5. The direction of the GPR movement in Figure 5 is from right to left.

Figure 4 Test Site on Google Earth

Figure 5 Test Spot with Underground Sewer

The B-Scan images obtained with the 400 MHz and 1.6 GHz antenna sets are displayed in Figure 6. The 400 MHz B-Scan image shows the underground object at a deep depth (> 3 feet or 36 inches). In the B-Scan image, a cylinder object shows hyperbolic signature. The hyperbola

representing the sewer can be observed at 70 inches depth in the 400 MHz B-Scan image. Also, the subsurface concrete-soil interface is observed at 37 inches depth.

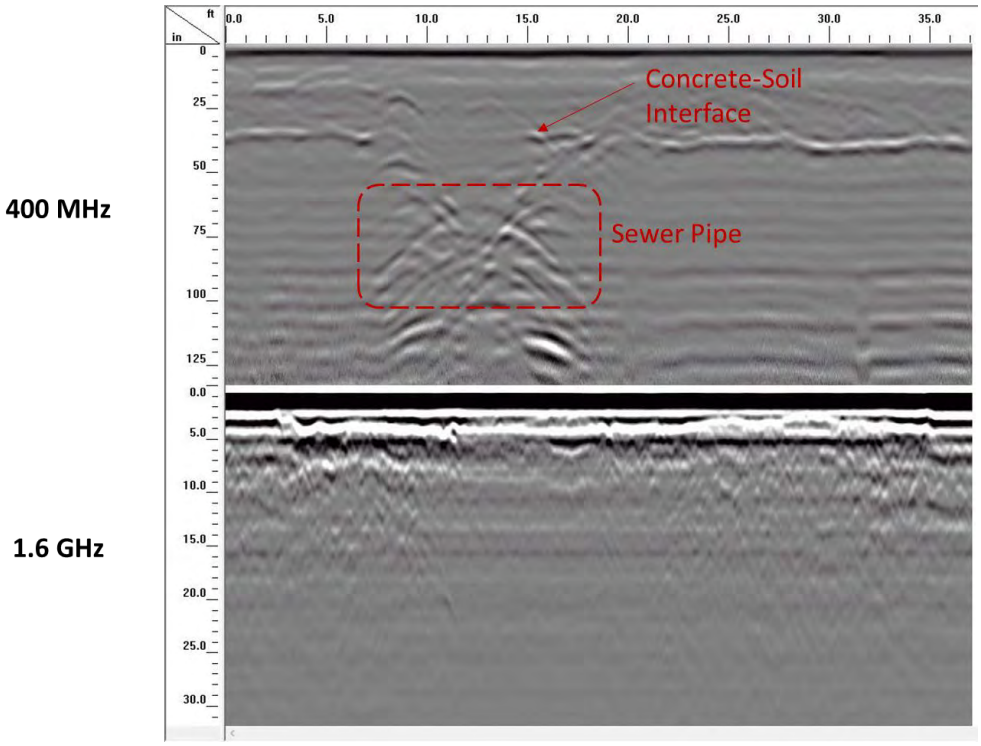


Figure 6 B-Scan Image of Sewer from 400 MHz and 1.6 GHz Antenna Sets

Figure 7 displays the B-Scan image obtained using the 2.3 GHz antenna set. The B-Scan image derived from a high frequency antenna set shows small objects or features at a shallow depth (< 3 feet or 36 inches). In this B-Scan image, the curve representing the asphalt pavement's bottom surface is detected.

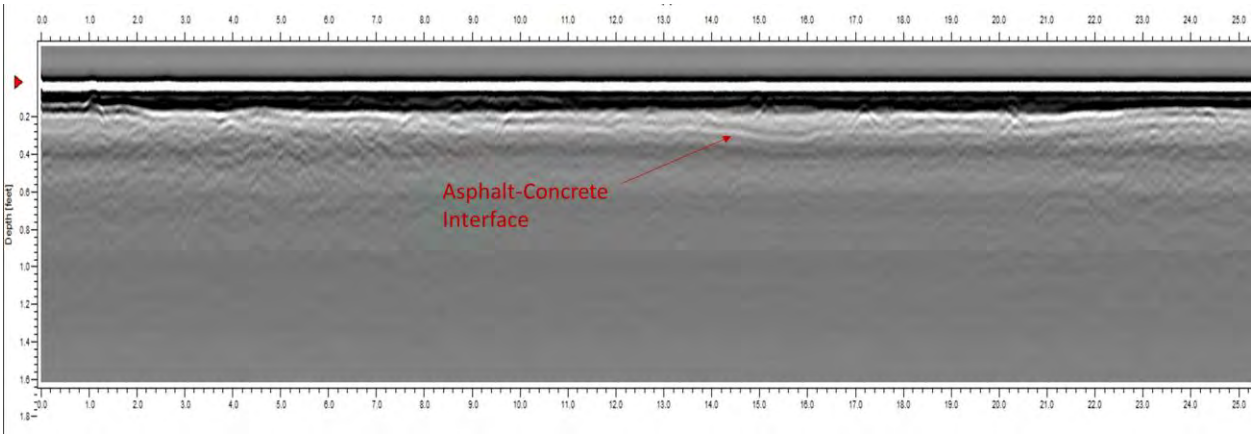


Figure 7 B-Scan Image of Sewer from 2.3 GHz Antenna Set

(2) Test Site 2

The GPR inspection on a test spot with a medium size asphalt patch on the surface is performed. The location of this test spot is displayed on Google Earth, which is marked on the bottom-left corner in Figure 4. The physical test site picture is shown as Figure 8. The medium asphalt patch is marked with a yellow circle in Figure 8.

Figure 8 Test Spot with Medium Asphalt Patch and Small Asphalt Depression

The B-Scan images from the 400 MHz and 1.6 GHz antenna sets are displayed in Figure 9. In 400 MHz B-Scan image, the subsurface concrete-soil interface is detected at 26 inches depth. In the 1.6 GHz B-Scan image, the medium asphalt patch is detected and is marked by a red rectangle in Figure 9.

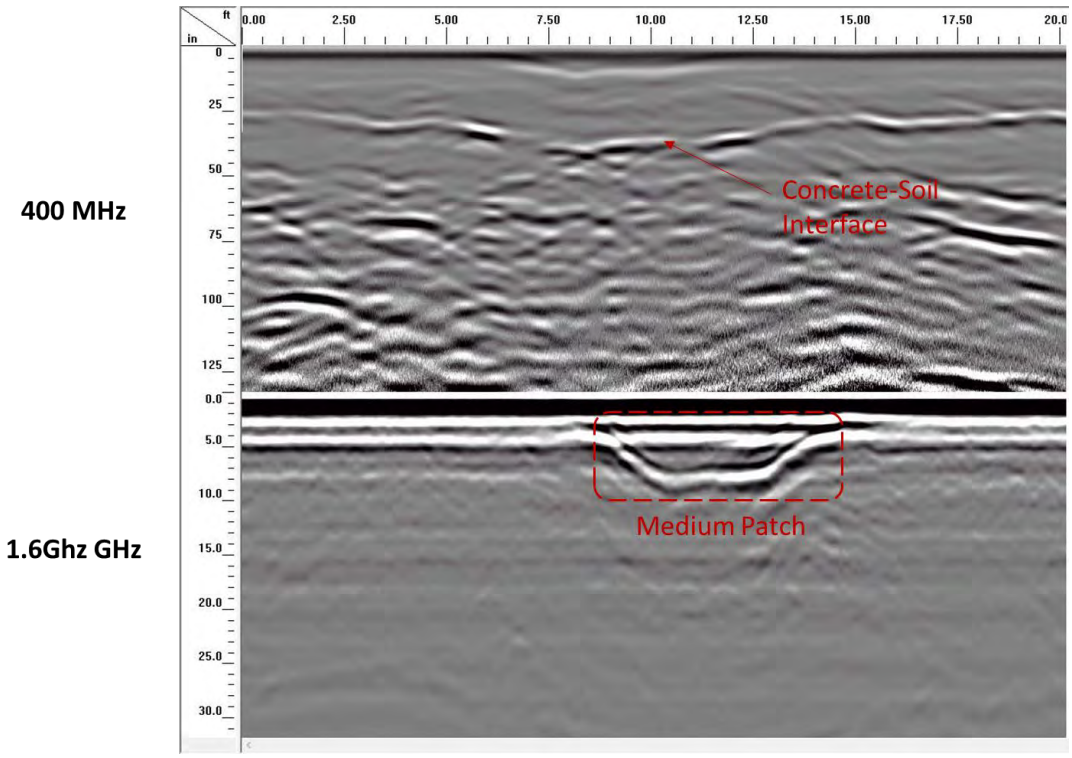


Figure 9 B-Scan Image of Medium Asphalt Patch from 400 MHz and 1.6 GHz Antenna Sets

Figure 10 displays the B-Scan image obtained with the 2.3 GHz antenna set. In this B-Scan image, the medium asphalt patch can be detected, which is marked by a red rectangle in Figure 10.

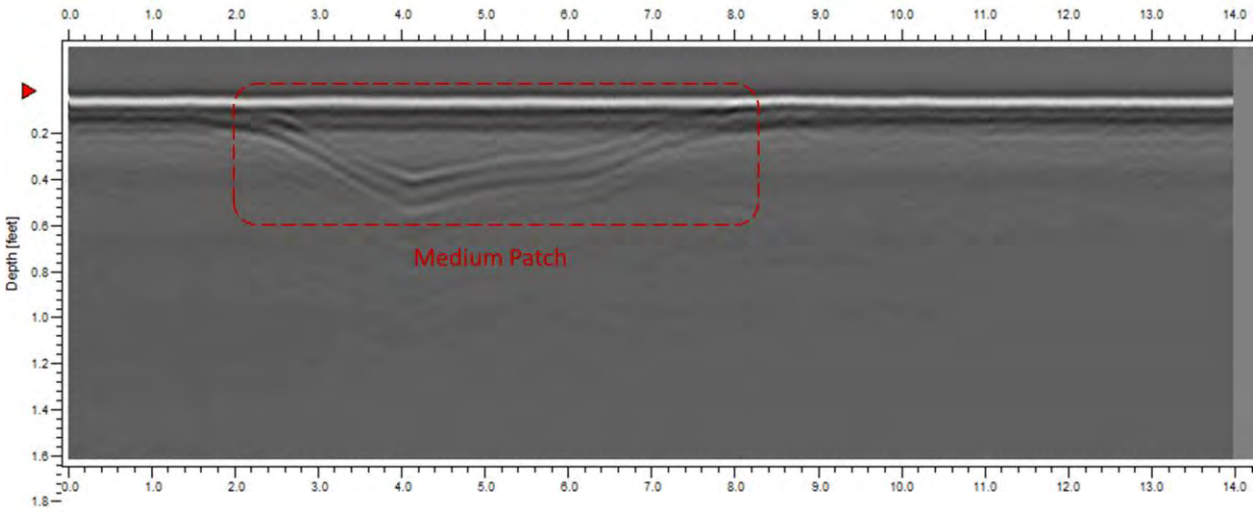


Figure 10 B-Scan Image of Medium Asphalt Patch from 2.3 GHz Antenna Set

(3) Test Site 3

The GPR inspection of a test spot with small asphalt depression on the surface is performed. The location of this test spot is displayed on Google Earth and is marked on the bottom-left corner

in Figure 4. The physical test site picture is shown in Figure 8. The small asphalt depression is circled out in red in Figure 8.

The B-Scan images obtained using the 400 MHz and 1.6 GHz antenna sets are displayed in Figure 11. In 400 MHz B-Scan image, the subsurface concrete-soil interface is detected at 26 inches depth. In the 1.6 GHz B-Scan image, the small asphalt depression is detected and marked by a red rectangle in Figure 11.

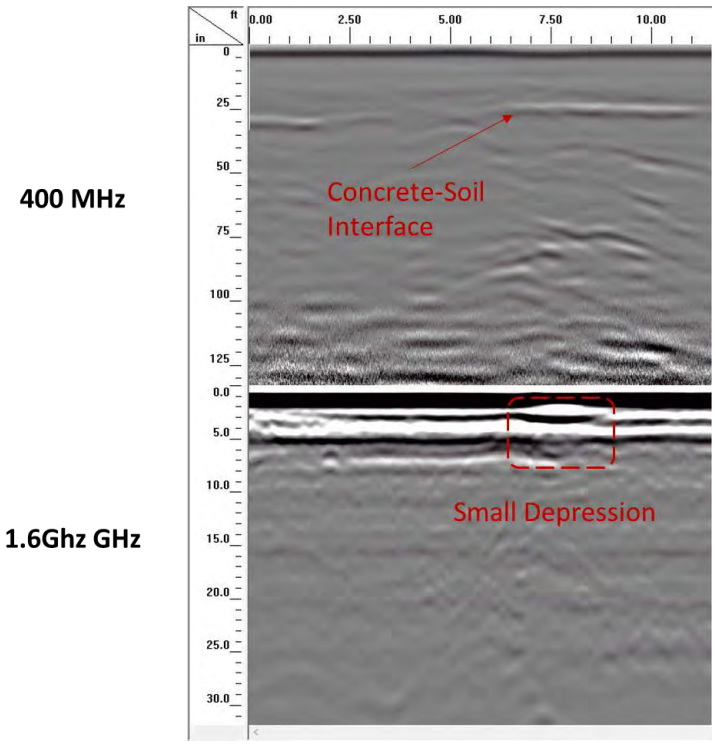


Figure 11 B-Scan Image of Small Asphalt Depression from 400 MHz and 1.6 GHz Antenna Sets

Figure 12 displays the B-Scan image using the 2.3 GHz antenna set. In this B-Scan image, the small asphalt depression can be detected, which is marked by a red rectangle in Figure 12.

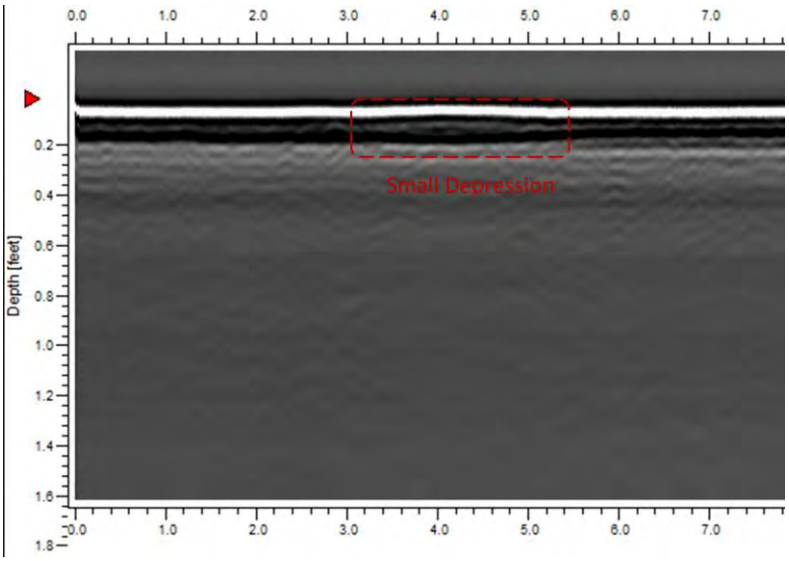


Figure 12 B-Scan Image of Small Asphalt Depression from 2.3 GHz Antenna Set

(4) Test Site 4

The GPR inspection of a test spot with a large asphalt patch is performed. The location of this test spot is displayed on Google Earth, which is marked on the bottom-left corner of Figure 4. The physical test site picture is shown in Figure 13. The large asphalt patch is marked with a red curve in Figure 13.

Figure 13 Test Spot with Large Asphalt Patch

The B-Scan images are displayed in Figure 14. In 400 MHz B-Scan image, the subsurface concrete-soil interface is detected at 26 inches depth. In the 1.6 GHz B-Scan image, the large asphalt patch can be detected, which is marked by a red rectangle in Figure 14.

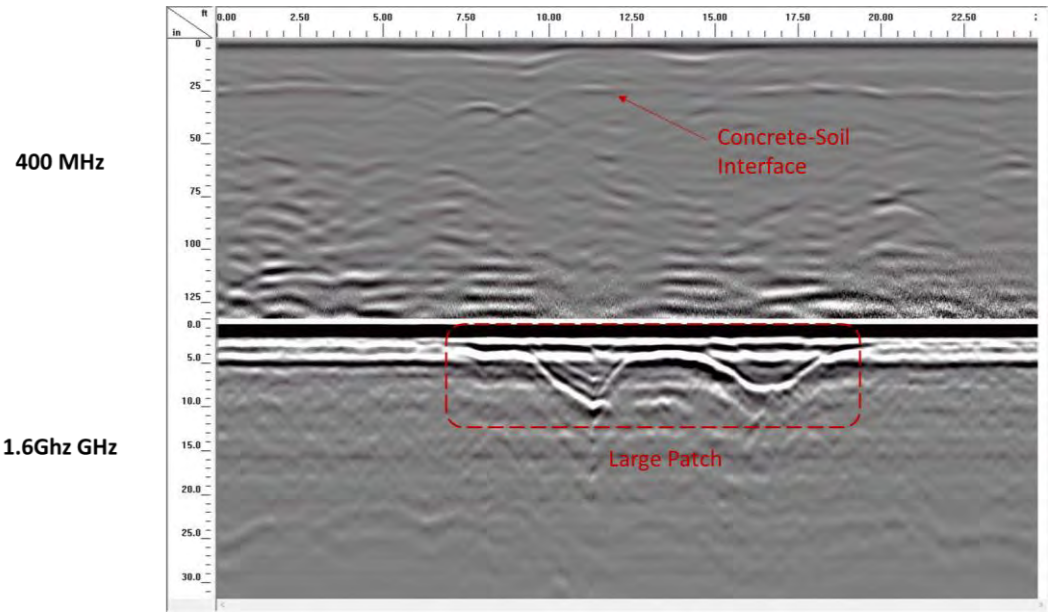


Figure 14 B-Scan Image of Large Asphalt Patch from 400 MHz and 1.6 GHz Antenna Sets

Figure 15 displays the B-Scan image derived from the 2.3 GHz antenna set. In this B-Scan image, the large asphalt patch can be detected, which is marked by a red rectangle in Figure 15.

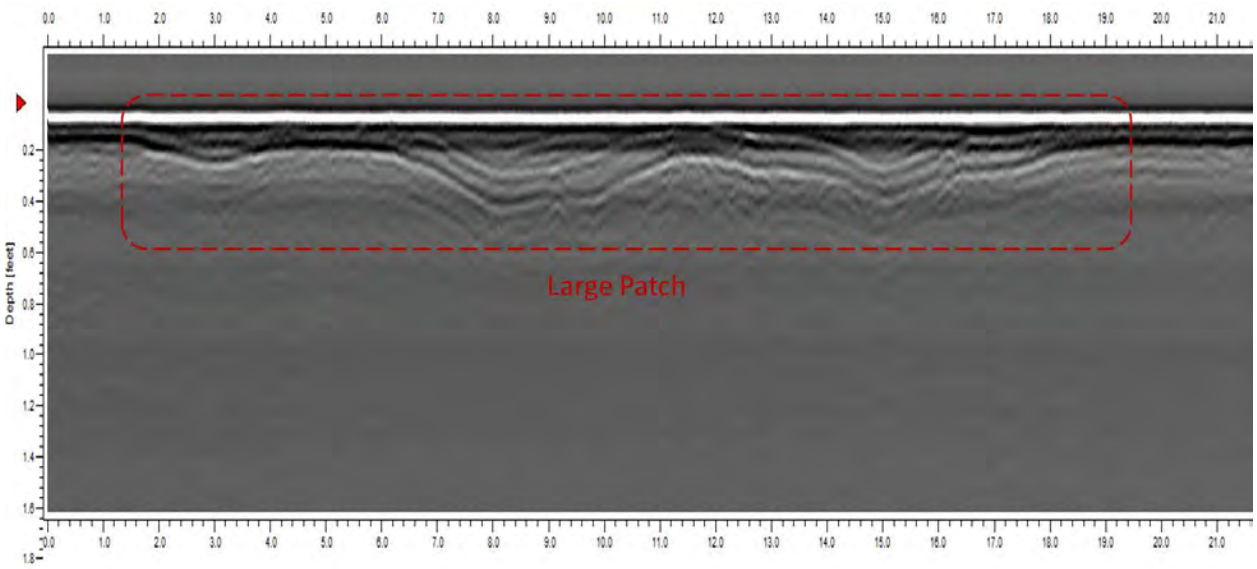


Figure 15 B-Scan Image of Large Asphalt Patch from 2.3 GHz Antenna Set

(5) Test Site 5

The GPR inspection of a test spot plugged with a concrete drain pipe is performed. The location of this test spot is marked in red in Figure 16. The physical test site picture is shown in Figure 17. The asphalt pavement also has small cracks on the surface and can be observed in Figure 17(b).

Figure 16 Test Site on Google Earth

Figure 17 (a) Test Spot Plugged with Concrete Drain Pipe; (b) Asphalt Pavement Crack on the Surface

The B-Scan images are displayed in Figure 18. The hyperbola representing the underground concrete drain pipe can be detected at 26 inches depth in the 400 MHz B-Scan image. Also, the subsurface concrete-soil interface can be detected at 40 inches depth. In the 1.6 GHz B-Scan image, the cracks on the asphalt pavement surface can be detected and is marked by a red rectangle in Figure 18.

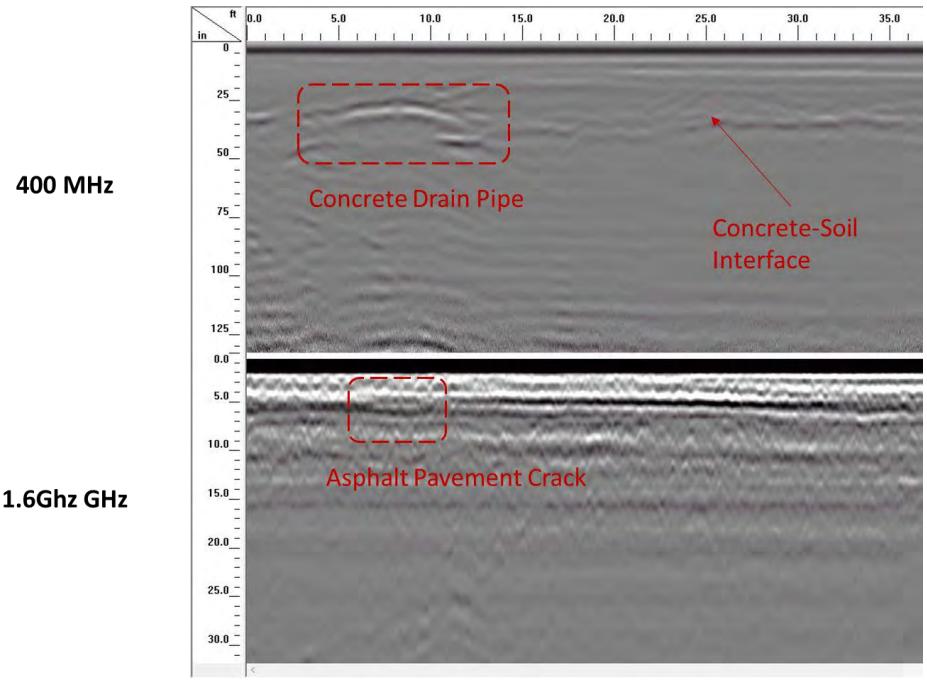


Figure 18 B-Scan Image of Underground Concrete Pipe and Surface Asphalt Crack from 400 MHz and 1.6 GHz Antenna Sets

Figure 19 displays the B-Scan image from the 2.3 GHz antenna set. In this B-Scan image, the cracks on the asphalt pavement surface can be detected, which is marked by a red rectangle in Figure 19.

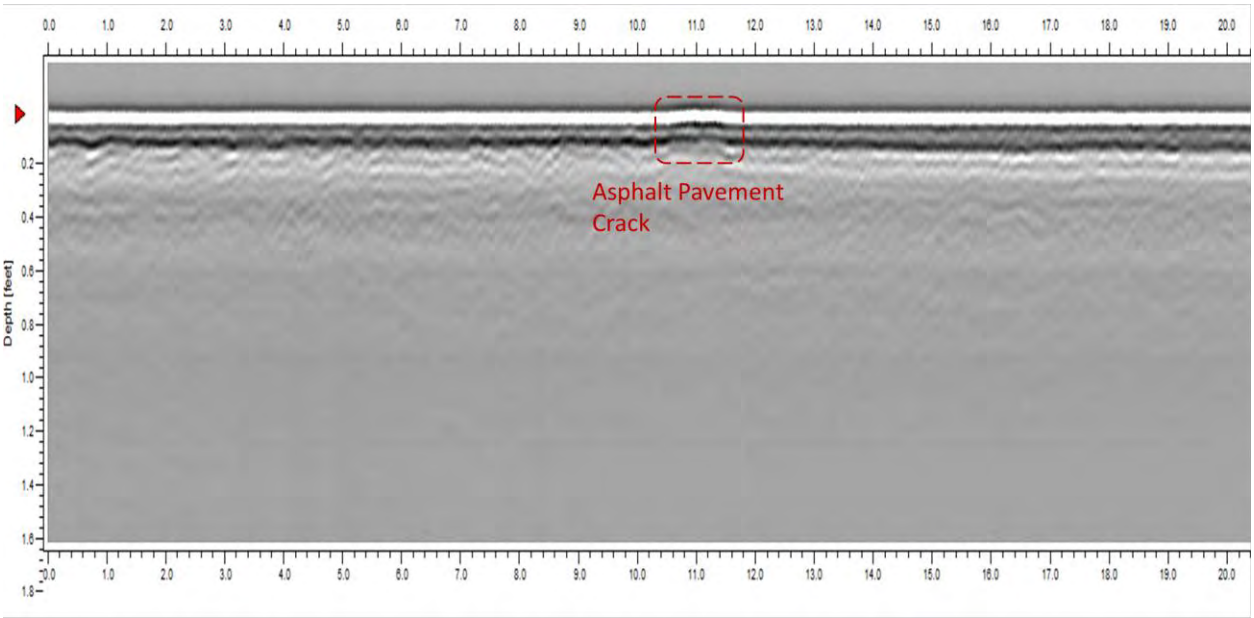


Figure 19 B-Scan Image of Underground Concrete Pipe and Surface Asphalt Crack from 2.3 GHz Antenna Set

(6) Test Site 6

The GPR inspection of a test spot with underground golf course drainage is performed. The location of this test spot is marked by red curve in Figure 20. The physical test site picture is shown in Figure 21.

Figure 20 Test Site on Google Earth

Figure 21 Test Spot with Underground Golf Course Drainage

The B-Scan images are displayed in Figure 22. The hyperbola curve representing the golf course drainage can be detected at 45 inches depth in the 400 MHz B-Scan image. Also, the subsurface concrete-soil interface can be detected at 42 inches depth in the 400 MHz B-Scan image.

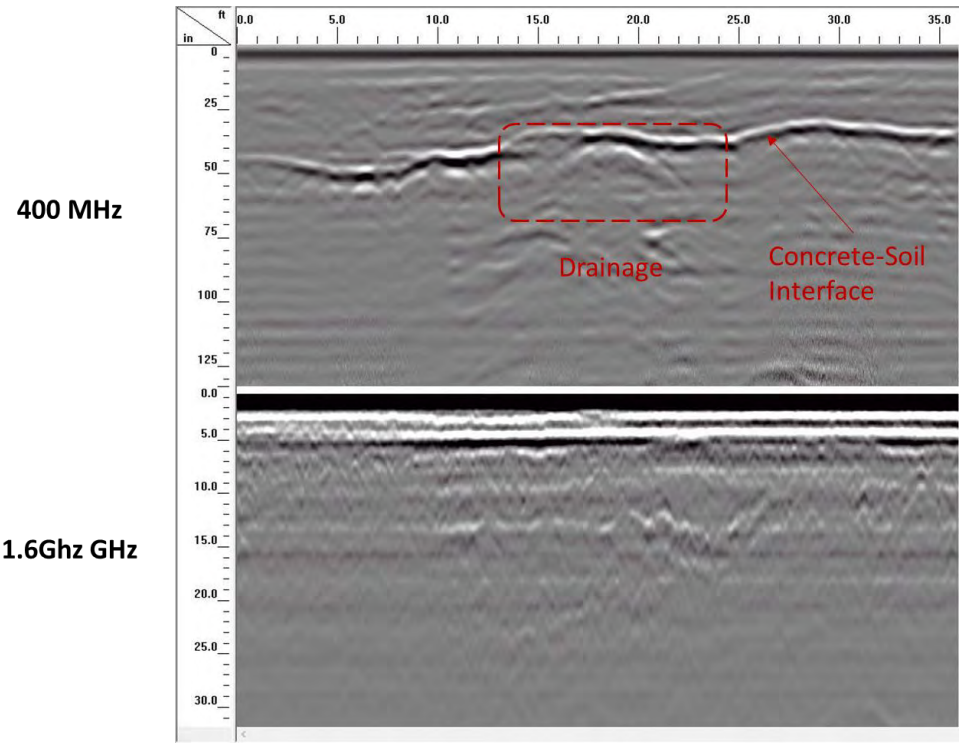


Figure 22 B-Scan Image of Underground Golf Course Drainage from 400 MHz and 1.6 GHz Antenna Sets

Figure 23 displays the B-Scan image from the 2.3 GHz antenna set. In this B-Scan image, the curve representing the asphalt pavement's bottom surface can be detected.

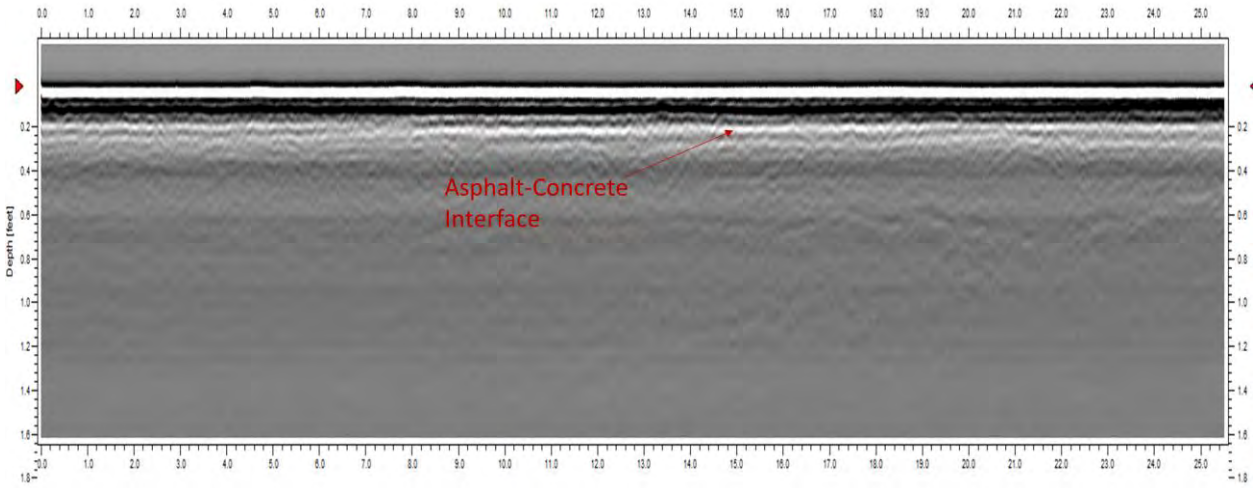


Figure 23 B-Scan Image of Underground Golf Course Drainage from 2.3 GHz Antenna Set

2. GPR Database Development

To better manage the large volume GPR inspection data volume, GPR profile database is developed in this project quarter.

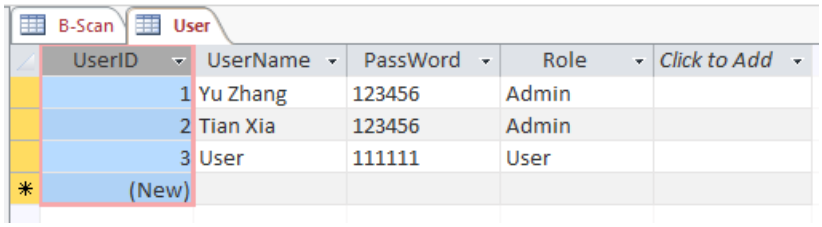
The ‘GPRScan’ database is created using Microsoft Access. The ‘GPRScan’ database has two tables. The first table is entitled ‘User’, which is shown as Figure 24. In the table ‘User’, there are four keys:

(1) UserID: The major key for this table, and the index for each user record;

(2) UserName: The user name for each user record;

(3) PassWord: The password for each user record;

(4) Role: It defines the role of each user. There are two types of users. One is ‘Admin’, and the other is ‘User’. The ‘Admin’ can add, delete, modify and view the records in the GPRScan database (Write & Read authority). While the ‘User’ can only view the records in the GPRScan database (Read Only authority).



B-Scan | User

UserID	UserName	PassWord	Role	Click to Add
1	Yu Zhang	123456	Admin	
2	Tian Xia	123456	Admin	
3	User	111111	User	
(New)				

Figure 24 Table 'User' in the GPRScan Database

The second table is entitled ‘B-Scan’ that is shown as Figure 25. In the table ‘B-Scan’, there are currently five keys (More keys can be added if needed):

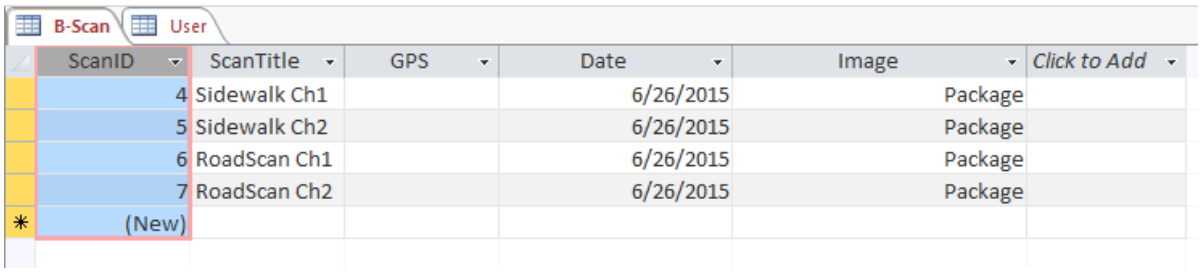
(1) ScanID: The major key of this table, and the index for each B-Scan record;

(2) ScanTitle: The filename for this B-Scan image record;

(3) GPS: The GPS coordinate for each B-Scan image record (currently unavailable for lab and on-campus GPR tests);

(4) Date: The date when this B-Scan data is collected;

(5) Image: The B-Scan image for each record. Figure 26 shows the B-Scan image stored for the 2nd record whose ‘ScanTitle’ is Sidewalk Ch2.



B-Scan | User

ScanID	ScanTitle	GPS	Date	Image	Click to Add
4	Sidewalk Ch1		6/26/2015	Package	
5	Sidewalk Ch2		6/26/2015	Package	
6	RoadScan Ch1		6/26/2015	Package	
7	RoadScan Ch2		6/26/2015	Package	
(New)					

Figure 25 Table 'B-Scan' in the GPRScan Database

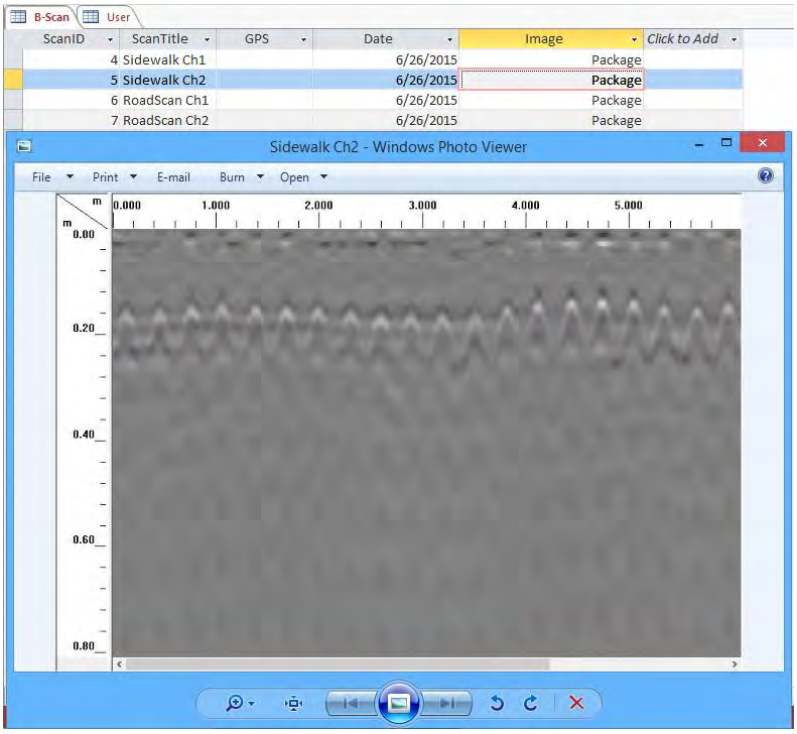


Figure 26 B-Scan Image Stored in Each Record

Database connection and operation is implemented by MATLAB Database Toolbox. MATLAB can use the SQL to communicate with the database. An initial database user interface is developed using MATLAB. Based on project requirement, more sophisticated and specific user interface can be developed and implemented. Figure 27 shows current user interface that connects to GPRScan database via MATLAB Database Toolbox. After connecting to the database, users can access the GPR B-Scan data in the 'B-Scan' table, which is shown as Figure 28.

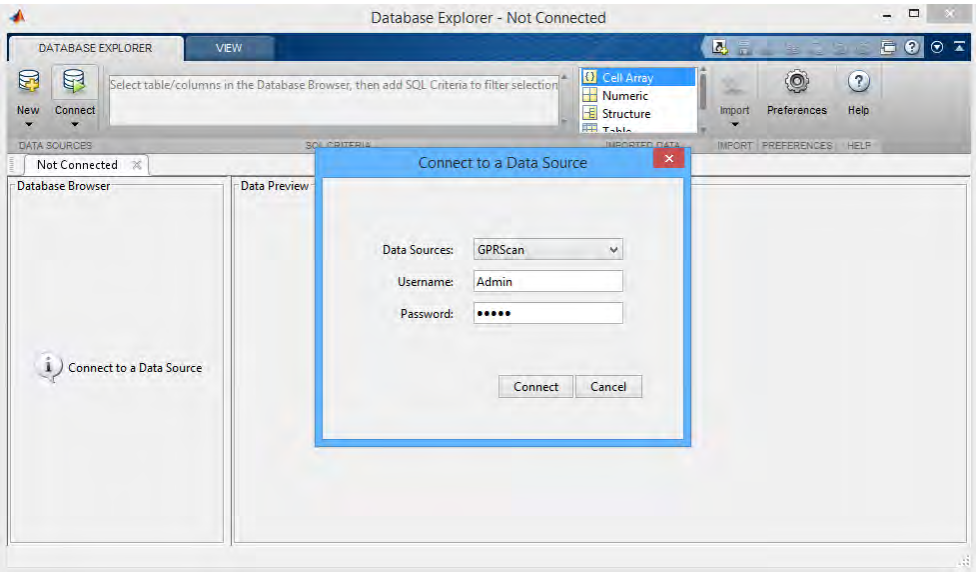


Figure 27 Connect GPRScan Database via MATLAB Database Toolbox

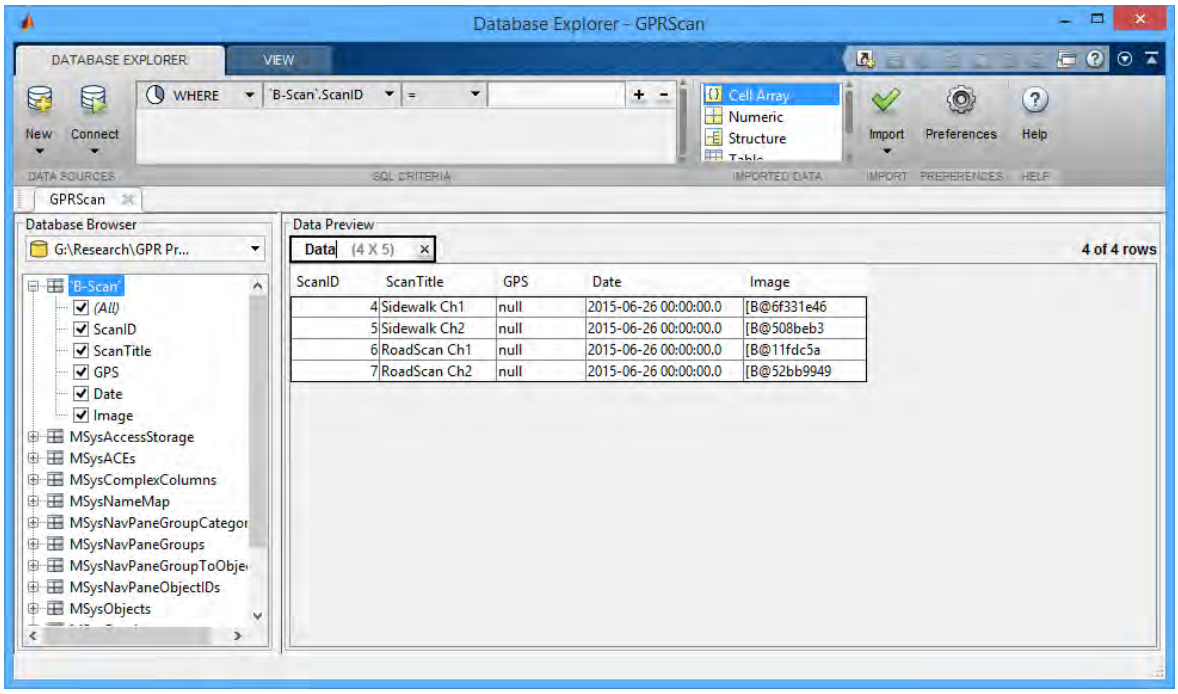


Figure 28 Table 'B-Scan' Accessed in MATLAB

To enable GPR engineers to add new database operation functions in the GPRScan database, a MATLAB code frame is built as shown in Figure 29. GPR engineers can insert new SQL code into this frame to enable further data display operation, as well as insert new signal processing code into to enable further GPR data interpretation operation.

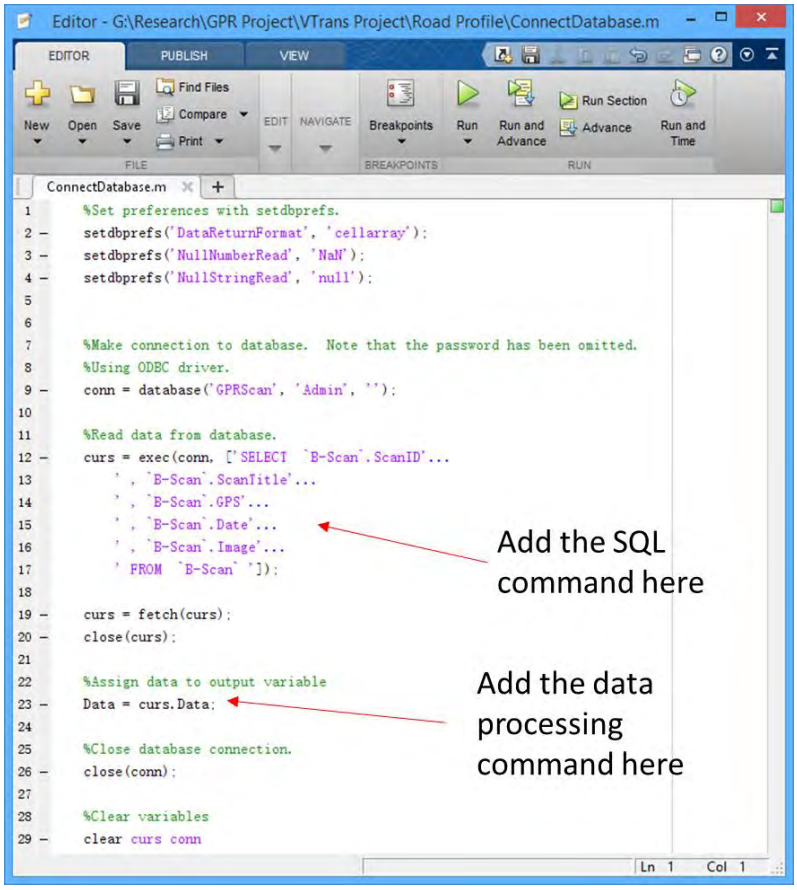


Figure 29 MATLAB Code Frame for Further GPRScan Database Operations

I. TECHNOLOGY TRANSFER ACTIVITIES:

N/A.

J. PERCENT COMPLETION OF TOTAL PROJECT:

Percent completion of total project is estimated to be around 70%. We expect much more accomplishments in the following quarters.

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- More field tests will be conducted either on UVM campus or on spots recommended by VTrans.
- More advanced data processing algorithms will be implemented for result analysis.
- Contact VTrans to identify a road segment or a bridge segment to perform field test. Some traffic control might needed from Vtrans.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER (July 2015 – Oct. 2015, beak down into monthly estimates):

- $3,500 will be paid to Dryver Huston for his summer time.
- $2,400 will be paid to a graduate student for the summer research assistantship

Progress report prepared by: **Tian Xia**

Date Prepared: **07/15/2015**

Cost-Effective and Rapid Concrete Repair Techniques

Quarterly Report FFY2015 Q3

A. PROJECT NUMBER AND TITLE:
RSCH017-739
Cost-Effective and Rapid Concrete Repair Techniques

B. PRINCIPAL INVESTIGATOR(s):
Dryver Huston
Professor
School of Engineering
University of Vermont

C. START AND END DATE (per grant assignment):
05/01/2014-08/31/2015

D. ANTICIPATED COMPLETION DATE:
08/31/2015 (No cost extension approved from original 04/30/2015 end date)

E. PROJECT OBJECTIVES:
The intent of this project is to identify concrete repair practices that work best for the climate and infrastructure conditions in Vermont. Concrete is a principal component of many transportation structures. While highly durable, a variety of processes degrade and damage concrete. Replacement is expensive. Many cases warrant repair instead of replacement. Since many damage processes are progressive, early and properly timed repairs can reduce costs. Overall lifetime cost of ownership approach to selection and design of repairs has merit, but requires good information about costs and outcomes. There is a possibility that proper timing and application of repairs can be of great benefit to maintenance activities – including lifetime costs and rapid techniques that allow for expedited designs of repairs and minimizing repair times. Realizing the advantages of concrete repair requires effective execution of damage identification, damage assessment, repair design, repair, and post-repair assessment.

Phase 1:
This is a proposed one-year single-phase effort. Included in this Phase is Objective 5 which will be to develop a Phase II effort aimed at bringing the best practices into field evaluations.

- **Objective 1:** Assess present practices of concrete repair – The objective is to identify repair practices for concrete transportation infrastructure in Vermont and neighboring states. This will include the processes damage identification, damage assessment, repair design, repair, and post-repair assessment.
- **Objective 2:** Develop flow chart of decision-making and options for repair practice and evaluation – This will create a guide with recommendations for maintenance personnel and engineers, with an emphasis on cost-effective procedures that minimize imposing additional burdens on inspection and maintenance personnel.

- **Objective 3:** Develop procedures for integrating repair options and decisions into asset management – This will aid in reducing lifetime costs of ownership and assist in statewide maintenance planning.
- **Objective 4:** Recommend areas for further study and tech transfer to make cost effective repairs –This will be an effort to identify topics of importance to Vermont and achievable within present resource constraints.
- **Objective 5:** Describe a future Phase II effort that would take the procedures that seem to work the best and apply them in the field – This will result in a test plan for a Phase II effort.

F. REPORT PERIOD:
4/16/2015 – 7/15/2015

G. ACCOMPLISHMENTS THIS PERIOD (broken down by month):

a. 1st Month (April 16 – May 15, 2015)
The main activity this month involved improving and upgrading the computer-based concrete repair decision flow chart and algorithm. Data from various technical reports were loaded into the database and made accessible through hot-links. The bulk of the reports are ACI documents and state of the art reports from State Agencies of Transportation. This also included supplements to the computerized bridge inspection data entry form and the overarching Bridge Repair Decision tree algorithm.

b. 2nd Month (May 16 – June 15, 2015)
The activity this month continued with upgrades and improvements to the decision-making flow chart. GUI-based data import and export options improved the utility of the software. Also included in this activity was an examination of a decision-making flow chart developed by FHWA for Accelerated Bridge Construction. While the problems addressed in the FHWA ABC algorithm are somewhat different than concrete repair, they nonetheless provided insight into the development of a decision-making flow chart.

c. 3rd Month (June 16, 2015 – July 15, 2015)
The activity this month included wring a User's Manual for Concrete Repair GUI. This document describes the underlying structure, motivation and how to use the three main concrete repair algorithms. This includes the paper-based Concrete Repair Decision Tree and Sub-Branches for Deck Repair, Expansion Joints, and Fascias. Next is the computer-based Bridge Inspection Form GUI followed by a description of the Decision Tree GUI, and Flow Chart GUI. Branches. This manual is a living document and will likely be upgraded before the end of the project.

H. PROBLEMS ENCOUNTERED (If any):
No major problems were encountered. A no-cost extension of the end date of the project from 04/30/2015 to 08/31/2015 was requested, approved and processed. The post doctoral researcher (D. Burns) and MS graduate student (J. Razinger) left the project. An undergraduate senior UVM engineering student is joining the project will take up some of their work.

I. TECHNOLOGY TRANSFER ACTIVITIES:
D. Huston presented a paper at the 7th International Structural Health Monitoring and Intelligent Infrastructure Conference in Torino, Italy with the title "Structural Assessment and Repair Information Modeling and Decision Making Tools."

J. PERCENT COMPLETION OF TOTAL PROJECT:
Percent completion of total project is estimated to be around 85%.

K. ACTIVITIES PLANNED FOR NEXT QUARTER:
- Visit additional damaged bridge sites with Vtrans maintenance personnel. This may included the use of nondestructive test equipment, such as ground penetrating radar.
- Continue with decision-making flow chart development.
- Present draft flow chart to Vtrans personnel for comment and feedback.
- Conduct technology transfer activities related to concrete repair with the State of New York and possibly Maine and New Hampshire Departments of transportation.
- Introduce triage decision-making, and the framework for cost estimation into the algorithm.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER (July 16, 2015 – August 31, 2015):
- $4,000 combined salary, fringe benefits, and F&A for student on wages, and possibly a nominal amount for D. Huston
- $150 for travel to bridge sites
- $150 for supplies

Progress report prepared by: **Dryver Huston**

Date Prepared: **7/15/2015**

Using Remote Data Collection to Identify Bridges and Culverts Susceptible to Blockage During Flooding Events

QUARTERLY REPORT

A. PROJECT NUMBER: RSCH017
SPR: 740

B. PRINCIPLE INVESTIGATOR(s): Jim Sullivan

C. START AND END DATE (per grant assignment): July 1, 2014 - June 30, 2016

D. ANTICIPATED COMPLETION DATE: June 30, 2016

E. PROJECT OBJECTIVES: This project will consist of three phases and has nine objectives:

- Phase I: Project kick-off
  - Objective 1: Assemble the team
  - Objective 2: Select stream field sites
  - Objective 3: Finalize the project work plan
- Phase II: Flight operations and data collection
  - Objective 3: Collect stereo imagery for field sites under a variety of conditions
  - Objective 4: Process imagery to extract 2D orthophoto mosaics and 3D surface models
  - Objective 5: Develop, test, and assess feature-extraction capabilities
  - Objective 6: Integrate the data with Geographic Information System (GIS) software
  - Objective 7: Test field-based data transmission approaches
- Phase III: Reporting
  - Objective 8: Summarize the methodology and findings
  - Objective 9: Present the results

F. REPORT PERIOD: April 1st through June 30th, 2015

G. ACCOMPLISHMENTS THIS PERIOD:

- A final set of stereo imagery was collected at Great Brook in Plainfield for time-series imagery analysis
- The imagery from this data collection effort was processed into a 3D surface model
- Time-series imagery was used to monitor the potential for ice jams, and changes in the debris load during a 3-month period in late winter and early spring.

- A GIS database was built and outreach materials were developed for effective visualization of debris-load changes

H. PROBLEMS ENCOUNTERED (if any):

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. PERCENT COMPLETION OF TOTAL PROJECT: 20%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Deliver the initial work plan, including the SOP for imagery collection, and the complete map of test sites
- Continue to capitalize on synergies between this project and other projects funded by the U.S. DOT to allow collect more imagery throughout the next quarter in consultation with the project advisors from VTrans and ANR

Progress report prepared by: Jim Sullivan **Date Prepared:** August 7, 2015

Personal Transportation Plan Pilot Program (PTP3), Phase 1

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
RSCH017-741: Personal Transportation Plan Pilot Program (PTP3), Phase 1

B. PRINCIPLE INVESTIGATOR(s): Brian H. Y. Lee

C. START AND END DATE (per grant assignment): 1 Jun 2014 – 30 Sep 2015

D. ANTICIPATED COMPLETION DATE: 30 Sep 2015

E. PROJECT OBJECTIVES:

The Personal Transportation Plan Pilot Program (PTP3) is a collaboration between VAOT, the University of Vermont (UVM), and the Vermont Statewide Independent Living Council (SILC, www.vtsilc.org). The **primary objective** of the entire project is to:

> Improve the mobility of Vermonters with disabilities by creating a personal transportation planning tool that would be used by the target population as well as their families, friends, and other caretakers to match existing transportation resources with their travel needs.

The long-term objective of this effort is to create a planning tool that would be used by transportation-disadvantaged Vermonters from across the entire state. There will be online and paper/telephone versions of this tool where users can answer a list of questions concerning the schedules and locations of various activities in their lives and be interactively guided to information about existing transportation resources that could help meet their travel needs.

The PTP3 project will include at least four phases: I) Pre-Program Assessment, II) Pilot Program Development, III) Pilot Program Implementation, and IV) Post-Program Evaluation. The research work in this current project only concerns Phase I of this pilot program. The following are the **Phase I objectives**. Other phases of this pilot program are outside of this proposed scope of work.

1. Phase I: Pre-Program Assessment
   a. Objective 1: Identify mobility needs
   b. Objective 2: Measure abilities to meet mobility needs
   c. Objective 3: Inform the subsequent phases

F. REPORT PERIOD: 1 April 2015 to 30 June 2015

G. ACCOMPLISHMENTS THIS PERIOD:

- Conducted survey in online & paper formats
- Preliminary data analysis

H. PROBLEMS ENCOUNTERED (If any): We supplemented the online survey with a paper version to accommodate some seniors and the visually impaired.

I. TECHNOLOGY TRANSFER ACTIVITIES: N/A

J. PERCENT COMPLETION OF TOTAL PROJECT: 60%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Perform data analysis with survey results
- Complete draft report

Progress report prepared by: Brian H. Y. Lee **Date Prepared:** 10 August 2015

The changing risk of extreme event impacts on Vermont transportation infrastructure

Quarterly Report

A. Project number and title: 742: The changing risk of extreme event impacts on Vermont transportation infrastructure
SPR: RSCH015

B. **Principal Investigator:** Arne Bomblies, UVM School of Engineering

C. **Start and End date**: 1/15/15 – 1/15/17

D. **Anticipated completion date:** 1/15/17

E. Project objectives:

a. The generation of a map of change factors associated with precipitation changes from climate change that can be easily applied to current design methodology.

b. Precipitation time series for model simulations will be generated using a stochastic, data-driven approach.

c. Generate a report on the nature of climate change impacts on extreme flows in Vermont.

F. **Report period:** 4/15/15 – 7/15/15

G. Accomplishments this period:

a. April 2015 – July 2015: This period saw the finalization of the climate-driver portion of the model that will be used for the design analysis. This is the statistical model that simulates the changes in climate that are causing changing magnitudes in floods for a given return period, and has also been referred to as the "Monte Carlo Markov Chain Model". The model greatly outperforms climate model output. Challenges were figuring out how to simulate variations in how much area is covered by rainfall at a given time, ensuring that temperatures in the model are appropriate for the type of weather (precipitation vs. no precipitation) on a particular day (done with conditional probabilities using past observations), and ensuring that the daily temperature range also was representative of reality. All of these challenges were overcome. The hydrology model will determine the fate of the precipitation (rain or snow), and that is the next step that we are getting into now.

The tests of covariates in climate indices that may affect flooding is ongoing.

H. **Problems encountered**: No problems have been encountered.

I. **Technology transfer activities**: None.

J. **Percent completion of total project**: 25%

K. **Activities planned for next quarter**:

a. The major thrust for the next quarter is running the hydrology model using the changing climate input to simulate how the extreme stream flow events are changing and will likely change in the future. It is the basis for the generation of the "change factor" for design usage, a primary goal of this research project. A large number of scenarios will be

run for the Mad River, and the resulting flow statistics will be summarized and a non-stationary flood frequency analysis will be performed. If time permits, we may begin with laying the groundwork for the second hydrology model for which the nonstationary analysis will be performed.

L. **Estimated budget amount spent next quarter**: Total = $20570. (Cam White salary, $6750; Cam White fringe, $479.28; Cam White tuition, $3546; Arne Bomblies summer salary, $6000; F+A, $3795).

Progress report prepared by: Arne Bomblies

Date prepared: August 6, 2015

INTELLIGENT COMPACTION FOR EMBANKMENT, SUBGRADE, AND BASE MATERIALS CONSTRUCTION IN VERMONT

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 744 Intelligent compaction for embankment, subgrade, and base materials construction in Vermont

B. PRINCIPAL INVESTIGATOR(s):

Ehsan Ghazanfari, Ph.D., P.E.
Assistant Professor
School of Engineering - University of Vermont
(802) 656 1770

Mandar Dewoolkar, Ph.D., P.E.
Associate Professor
School of Engineering - University of Vermont
(802) 656 1942

C. START AND END DATE (per grant assignment): April 1, 2015 – March 30, 2016.

D. ANTICIPATED COMPLETION DATE: March 30, 2016

E. PROJECT OBJECTIVES: The project investigates reliable and cost-effective Intelligent Compaction (IC) techniques for comparatively smaller-scale embankment, subgrade, and base material construction typically needed in Vermont. The specific objectives of the project are: (i) perform in-depth literature review to identify most efficient and cost-effective IC techniques suitable for Vermont based on availability of equipment, contractors, required resources, and for project sizes typical for Vermont; (ii) identify the field Quality Assurance (QA) techniques currently available for intelligent compaction, the results of other correlation studies and recommendations for establishing QA parameters; (iii) evaluate the degree of uncertainty associated with ICMVs using available data and laboratory experiments; (iv) identify test sections in collaboration with VTrans to conduct IC techniques in phase II of the project.

F. REPORT PERIOD: 2015 Q1

G. ACCOMPLISHMENTS THIS PERIOD:

a. 1st Month (April 2015) – Researched background literature on different Intelligent Compaction (IC) techniques provided by the Federal Highway Administration based on different projects conducted in the United States to

identify most efficient and cost-effective IC techniques suitable for Vermont based on availability of equipment, contractors, required resources, and for project sizes typical for Vermont.

b. 2nd Month (May 2015) – Started researching background literature on different practices for construction quality assurance including appropriate stiffness parameters and field verification methods used all around the word.

c. 3rd Month (June 2015) – Started researching background literature on the degree of uncertainty associated with Intelligent Compaction Measurement Values (ICMVs). In particular, using the existing data in the literature the work started to investigate how stiffness measurements from ICMVs validate/confirm the in-situ measurements from conventional in-situ methods.

H. PROBLEMS ENCOUNTERED (If any): None to date.

I. TECHNOLOGY TRANSFER ACTIVITIES: None in this quarter.

J. PERCENT COMPLETION OF TOTAL PROJECT: 28%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: Continued researching different IC techniques, different practices for construction quality assurance including appropriate stiffness parameters and field verification methods, and the degree of uncertainty associated with ICMVs. Begin identifying most efficient and cost-effective IC techniques suitable for Vermont and begin preparation for performing laboratory scale experiments to investigate how stiffness values obtained via accelerometers validate/confirm and correlate to the in-situ measurements from conventional methods.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER (Q2, July-September)

a. July 2015 $2,500
b. August 2015 $7,000
c. September15 $4,500

Progress report prepared by: Ehsan Ghazanfari
Date Prepared: July 15, 2015

Demonstration and Purchase of PG Binder Testing Equipment
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 905 Demonstration and Purchase of PG Binder Testing Equipment

B. PRINCIPAL INVESTIGATOR(s):

George W. Colgrove III, Research and Development and
Troy Lawson, Asphalt & Hot Mix Unit, Materials Lab

C. START AND END DATE (per grant assignment): December 15, 2013 – September 30, 2014.

D. ANTICIPATED COMPLETION DATE: August 31, 2015

E. PROJECT OBJECTIVES: Materials and Research initiated an effort to procure the same PG Binder lab equipment that it acquired earlier in a Pooled Fund Project. The Pooled Fund project was a New England wide project where the New England states would use the same testing equipment to unify the testing processes and for comparisons. With the pooled fund project terminating early, this effort was initiated to complete the equipment acquisition.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:
No activity has been completed in this period.

MMA equipment is being updated or augmented with new testing devices. Acquiring wireless equipment for the MMA lab has been suspended.

H. PROBLEMS ENCOUNTERED (If any):
No problems have been encountered in this period.

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 99%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

A Research Update will be produced to summarize the effort in obtaining and installing the new PG Binder.

Progress report prepared by: George Colgrove
Date Prepared: August 10, 2015

Pavement Performance and Annualized Cost Study
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 921 Pavement Performance and Annualized Cost Study

B. PRINCIPLE INVESTIGATOR(s):
Wendy Ellis
Research Technician V
Vermont Agency of Transportation
2178 Airport Rd., Unit B
Berlin, VT 05641
Telephone: (802) 828-6918
Fax: (802) 828-2792

C. START AND END DATE (per grant assignment):
ongoing

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: To collect performance data from a comprehensive array of pavement rehabilitation techniques for the purpose of monitoring effectiveness and costs. The evaluation is centered upon those projects which have rehabilitated existing pavements with reclaimed base stabilization, cold recycled bituminous concrete, milling followed by overlay, and overlays. Projects have been selected from distinct microclimates representing the range of Vermont weather conditions. This project is vital to the ongoing success of our paving program. Findings from this study will be used to determine the most cost effective treatment based upon various factors including daily traffic, underlying soils and pavement profile, and roadway condition prior to any rehabilitation efforts.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:

- Site Visits to:
  - Addison-New Haven STP 9632 (1)S
  - Barton STP9713
  - Barton-Irasburg STP-2107(1)S
  - Bridgewater-Woodstock NH 2211(1)S
  - Brighton-Morgan-Warren Gore STP 2724(1)S
  - Canaan STP SURF (7)
  - Castleton-West Rutland STP 2705 (1), STP 2909 (1), STP 2908 (1)
  - Chelsea-Vershire STP 2331 (1)
  - Dover-Stratton STP2214(1)S

- Elmore-Morristown STP 2937(1)
- Hardwick STP SURF (9)
- Killington-Bridgewater NH 2502(1)S
- Marshfield-Cabot NH 2104(1)S
- Montgomery-Westfield
- Morgan-Brighton STP SURF( )
- Newport-Coventry-Newport STP 2802 (1)
- Putney-Westminster STP 2946(1)
- Randolph STP 2932 (1)
- Rochester-Granville STP-2124(1)S
- Rupert-Pawlet STP 2133 (1)S
- Stockbridge-Rochester STP 2910(1)
- Thetford-Fairlee STP 2710 (1)
- Troy STP 2717 (1)
- Troy-Newport STP 2613 (1)
- Vershire-Thetford
- Wallingford-Clarendon NH 2216(1)S
- Warren Gore-Norton STP 2725 (1)S
- Warren-Waitsfield
- Westfield-Jay-Troy STP 2903(1)
- Whitingham-Cornwall-Middlebury STP 2629 (1)
- Worchester-Elmore STP 2209 (1)S

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: N/A

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Annual site visits will continue for all remaining sites not completed.

Progress report prepared by: George W. Colgrove III
Date Prepared: August 10, 2015

An Assessment of Culvert Replacements Modified for Fish Passage

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 969 An Assessment of Culvert Replacements Modified for Fish Passage

B. PRINCIPLE INVESTIGATOR(s):
Wendy Ellis
Research Technician V
Vermont Agency of Transportation
2178 Airport Rd., Unit B
Berlin, VT 05641
Telephone: (802) 828-6918
Fax: (802) 828-2792

C. START AND END DATE (per grant assignment):
2008-2013

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: With over 50 modified culverts previously installed throughout the State of Vermont, the objective of this research project is to determine the effectiveness of fish passage restoration. An examination of representative fish passage structures will define the character, durability and stability of the constructed habitats and improved connectivity up and downstream of the culvert. In addition, the research project will evaluate the cost-effectiveness of these types of structures, including the timing of the natural bed load accumulation in the structure.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:

- This project has been put on hold.

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 90%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Final report will be drafted and published.

Progress report prepared by: George W. Colgrove III
Date Prepared: August 10, 2015

PERFORMANCE MONITORING OF JOINTLESS BRIDGES – PHASE III
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE: Performance Monitoring of Jointless Bridges – Phase III
SPR: 986

B. PRINCIPLE INVESTIGATOR(s): UMass professors Scott Civjan and Sergio Brena

C. START AND END DATE: **Start:** October 5, 2007 **End:** May 31, 2014

D. ANTICIPATED COMPLETION DATE: May 31, 2015

E. PROJECT OBJECTIVES:

The objectives of this research project are to increase the knowledge base of VTrans' engineers and answer as many design and construction related questions as possible while 1) providing appropriate documentation of the research, 2) outlining current performance issues, and 3) providing recommendations for the design and construction of jointless bridges.

F. REPORT PERIOD: 2015 Q3

G. ACCOMPLISHMENTS THIS PERIOD:

Data was downloaded by VTrans and data subsequently sent to UMass for addition to the records. UMass provided VTrans with plots of the data. The project is being negotiated to continue with data collection at no additional cost for an unspecified amount of time.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. PERCENT COMPLETION OF TOTAL PROJECT:

100% Project is being extended for additional data collection for future analysis.

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

The no-cost extension will be negotiated and if approved, enacted. If the project is extended, VTrans personnel will download data quarterly and send to UMass to compile the data and provide analysis on an as-needed basis.

Progress report prepared by: George W. Colgrove III **Date Prepared:** August 10, 2015

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Date: __06/30/2015

Lead Agency (FHWA or State DOT): __Vermont Agency of Transportation_____

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(222)	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☑Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☐Quarter 4 (October 1 – December 31)

Project Title: New England Transportation Consortium (VI)

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Bill Ahearn	802-828-2561	Bill.Ahearn@state.vt.us

Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
CA0306	NETC 06-4	9/16/13
	NETC 07-1	7/1/13
	NETC 09-2	9/1/13
	NETC 09-3	9/1/13
	NETC 10-3	9/16/13
	NETC 13-1	9/1/14
	NETC 13-2	6/1/14
	NETC 13-3	12/1/14
	NETC 14-1	3/1/15
	NETC 14-2	2/1/15

Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
NETC 06-4 9/15/15	9/15/15 (NCE requested 9/15/16)	0 (1 pending NCE for NETC)
NETC 07-1 3/31/16	3/31/16	0
NETC 09-2 2/28/16	2/28/16	0
NETC 09-3 8/31/15	8/31/15, NCE to 12/31/15	1 (NCE approved 6/23/15)
NETC 10-3 9/15/15	9/15/15	0
NETC 13-1 8/31/16	4/2/16 (original proposal 8/31/16)	0 (1 pending NCE for NETC)
NETC 13-2 5/31/16	4/2/16 (original proposal 5/31/16)	0 (1 pending NCE for NETC)
NETC 13-3 11/30/15	3/31/16	1
NETC 14-1 4/2/16	4/2/16 (original proposal 8/31/16)	0 (1 pending NCE for NETC)
NETC 14-2 4/2/16	4/2/16 (original proposal 5/31/16)	0 (1 pending NCE for NETC)

Project schedule status:

☑ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
NETC 06-4 $242,909	$42,304.32	30%
NETC 07-1 $198,154	$116,054.34	75%
NETC 09-2 $80,000	$25,085.65	55%
NETC 09-3 $165,000	$110,168.38	81%
NETC 10-3 $150,158	$38,835.52	40%
NETC 13-1 $174,923	$39,016.86	35%
NETC 13-2 $249,785	$0	10%
NETC 13-3 $100,000	$13,847.91	20%
NETC 14-1 $100,000	$0	0%
NETC 14-2 $205,554	$0	15%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
NETC 06-4 $42,304.32 5%	$15,258.78	89.5% (based on 24 months)
NETC 07-1 $116,054.34 12%	$20,705.35	73% (based on 33 months)
NETC 09-2 $20,415.38 0%	$5802.67	80% (based on 30 months)
NETC 09-3 $110,168.38 2%	$712.10	78% (based on 28 months)
NETC 10-3 $30,835.52 0%	$10,386.24	89.5% (based on 24 months)
NETC 13-1 $39,016.86 13%	$8,585.86	41% (based on 24 months)
NETC 13-2 $0 10%	$0	50% (based on 24 months)
NETC 13-3 $13,847.91 19%	$13,847.91	25% (based on 12 months)
NETC 14-1 $0 0%	$0	22% (based on 18 months)
NETC 14-2 $0 15%	$0	20% (based on 24 months)

Project Description:

06-4 Preventative Maintenance and Timing of Applications
07-1 In-Place Response Mechanisms of Recycled Layers Due to Temperature and Moisture Variations
09-2 Effective Establishment of Native Grasses on Roadsides
09-3 Advanced Composite Materials: Prototype Development and Demonstration
10-3 Low Temperature and Moisture Susceptibility of RAP Mixtures with Warm Mix Technology
13-1 Development of High-Early Strength Concrete for Accelerated Bridge Construction Closure Pour Connections
13-2 HMA Mixtures Containing Recycled Asphalt Shingles (RAS): Low Temperature and Fatigue Performance of Plant-Produced Mixtures
13-3 Improved Regionalization of Quality Assurance (QA) Functions
14-1 Measuring the Effectiveness of Competency Models for Job-Specific Professional Development of Engineers & Engineering Technicians
14-2 Investigation of Northern Long Eared Bat Roosting Sites on Bridges

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

NETC 06-4, Work continued on the literature review for this project (Task 2). The research team recently evaluated each of the projects provided by the participant states and the corresponding data in order to identify two suitable

projects for optimal timing analysis and case study illustration. A memo was prepared and submitted to the project committee for review and comments.

NETC 07-1, This quarter was focused on FWD testing at the NH and ME sites and analysis of the data. Regular FWD testing has been conducted at all four sites through the spring thaw and recovery period. Several additional FWD tests will be conducted to capture full recovery into the summer period. Analysis of the FWD data has focused on the adjusted center deflection (ACD) and various parameters that can be calculated directly from the deflection measurements. The frost – thaw depth plots with the adjusted center deflection measurements during the spring thaw and recovery period show the deflections increase to a maximum value shortly after full thaw occurs for each section. Gradual recovery has been observed in the Auburn and Warren Flats sites with the analysis that has been completed to date. The analysis for the Kancamagus site has not yet been completed.

NETC 09-2, The following activities were implemented during this reporting period:

Survey and Interviews:

- The write-up of the interviews of the 5 New England DOTs is in progress.

Establishment of the new demonstration sites along Rt. 6:

- April 2015: CT DEEP was contacted to assist with the Truax drill and to provide an operator for the establishment of one demonstration site.
- May 7, 2015 and May 15, 2015 – new demonstration sites were sprayed with RoundUp non-selective herbicide
- May 21, 2015 – some demonstration sites were mowed and raked
- May 22, 2015 – a new trial for the establishment of the little bluestem with was planted using topsoil, hydromulch, straw, clayballs and sawdust at the site #1 along Rt.6.
- May 28, 2015 – a site #2 was planted with the Truax seed drill
- May 22, 2015 all sites along Rt. 6 were visited with Rebecca Brown (University of Rhode Island) to consult about the establishment of native grasses.
- By-weekly site inspections were conducted throughout June to observe the germination and establishment rates.

NETC 09-3,

- Two teleconferences were held with the Project Technical Committee on May 20th and June 24th.
- The installation of FRP drains was documented at the Union Street westbound overpass bridge in Bangor, ME on June 3rd. The bridge visit was coordinated with the AASHTO Domestic Scan Team.
- A Dropbox folder was setup to share technical information with the Project Technical Committee.
- Task 4- Product validation: baseline mechanical properties and durability performance based on coupon tests for three vendors were reviewed with the Technical Committee.
- Tasks 5 and 6 - Document installation of FRP drains in bridges. Contacted MaineDOT to coordinate the inspection of FRP drains installation in three bridges: 1) Westbrook Bridge, 2) Howland-Enfield Bridge, and 3) Union Street Eastbound Overpass Bridge. Develop an inspection protocol for FRP bridge drains.

NETC 10-3, UMASS Dartmouth contacted Tilcon CT about reproducing the mixtures produced in October 2014 that did not meet the required volumetric properties. UMASS Dartmouth contacted the other contractor (Palmer Paving) who agreed to produce mixture for this study. This contractor stated that they will produce the mixtures in April or May 2015. An additional contractor was contacted (PJ Keating) to determine if they would help with producing the mixtures for this study in the event one of the selected contractors cannot supply the mixtures.

NETC 13-1, The following activities were performed during this reporting period:

- Task 1: Literature Search: Progressed on written summary of the literature review including main findings of relevant research reports, technical papers and survey responses. Performed additional literature review to obtain research reports and technical papers to assist in further development of mix design trial batches.
- Task 3: Develop Mix Design: Tested 7 concrete mix design trial batches initially based off of a state-of-practice mix design, and compared test results using compressive strength tests on 4 by 8 in. cylinders and workability. The adjustments made to the state-of-practice mix design throughout the 7 trial batches include decreased

maximum coarse aggregate size, elimination of fly ash, modification of admixture quantities and variation of the water-to-cement ratio. Developed new base mix design using proportioning specified in ACI 211.4-R: Guide for Selecting High-Strength Concrete Using Portland Cement and Other Cementious Materials.

- Task 4: Test Mixture: Shrinkage test (AASHTO PP 34-99) setup has been fully designed and fabricated nearly to completion.

NETC 13-2, 1) UMass Dartmouth continued to contact several producers of asphalt mixtures in New England about their availability and willingness to participate in the study. Finally, one contractor stated that his company will help the research team with the study. 2) the literature review for this project is almost complete.

NETC 13-3, During this past quarter good progress was made in this study. The researchers reviewed a number of specifications and QA process documents from various New England State DOTs as well as continued the literature review on the topic. The project kick-off meeting was held at University of New Hampshire on April 30th. The meeting aided in refining the research activities and also aided in making initial contact with the various DOT personnel involved with the study. The meeting also helped refine the interview questionnaire prepared by researchers.

Co-PI of the project is also involved in developing inspector training course for NETTCP for PCE/PSE. The pilot for this course was taught during this quarter and was attended by the student working on the project.

During this quarter the researchers visited three DOTs (NH, ME and RI) as part of the QA process reviews through interview of DOT engineers and QA inspectors. All interviews have already been transcribed and the information is being processed towards developing a common acceptance standard for PCE/PSE.

NETC 14-1, Notice to proceed letter sent to PI on May 22, 2015. No progress reported this quarter.

NETC 14-2

- Kick –off meeting on May 18, 2015
- Literature review completed including searches in databases, web searches and contact with researchers and relevant organizations
- Phone interviews with Fishery and Wildlife, DOT and other organization personnel completed
- Joined and posted inquiries regarding bats in bridges to relevant listserv groups
- Acoustic monitoring equipment ordered and partially received
- Infra-red camera ordered and received
- Miscellaneous supplies purchased for field work
- Advertising, interviewing and hiring of two undergraduate research assistants completed
- Training by Alyssa Bennett completed for Scott Civjan, Angela Berthaume and Helen Yurek
- Initial use of acoustic monitoring equipment at VT bridge site known to have active bat roosting.
- GIS software set up to integrate maps with National Bridge Inventory to determine routes for visual screening and instrumentation
- Rapid visual screening of over 70 bridges in VT, NH, RI and MA to evaluate for signs of roosting to narrow down instrumented structures

Anticipated work next quarter:

NETC 06-4, Continue work on the literature review. Compile and tabulate survey responses for Task 3&4. Commence work on Task 5&6.

NETC 07-1, A few additional FWD tests will be conducted this quarter. The research team will complete the analysis of the FWD results in combination with the measurements from the in-place instrumentation. Pavement evaluation and back calculation of modulus values from the FWD testing will begin this quarter.

NETC 09-2, Complete the interview analyses and write-up. Continue writing a chapter about the establishment of the

demonstration plots along Rt. 6. Evaluate the plots installed last fall. Establish additional experimental plots in May.

NETC 09-3, Submit draft report for Task 4 summarizing test data and discussing compliance with specifications. Generate feedback from manufacturers on minimum allowable baseline and durability values for mechanical properties, and assurance on field performance and durability. Coordinate with DOTs inspection and documentation of bridge drain installations.

NETC 10-3, UMass Dartmouth will attempt to obtain and begin testing the plant produced mixtures.

NETC 13-1, Task 1: Continue work on the written summary of the literature review including main findings of relevant research reports, technical papers and survey responses. Continue literature search as required. Task 2: Adjust existing concrete mix design specifications based on feedback from the NETC Project Technical Committee (pending feedback from committee). Task 3: Adjust the newly proportioned mix design (ACI 211.4R proportions) to obtain required strength and sufficient workability. Test preliminary concrete mixtures that reach compressive strength goal and qualitatively acceptable workability for remaining initial short-term performance criteria (set time, air content and slump). Task 4: complete fabrication of shrinkage test (AASHTO PP 34-99) setup. Execute practice tests using the test setup. Begin design and fabrication of bar pullout test (ASTM A944) setup.

NETC 13-2, Complete Literature Review. The contractor (PJ Keating) will deliver the virgin materials (asphalt binder, aggregates, and shingles) that will be used in producing the mixture to UMass. UMass will start developing mixture designs.

NETC 13-3, Interview with DOT engineers and QA inspectors for CT, MA and VT; Visit of PCE/PSE facility and interview of fabricator(s) as well as New England PCI; Development of draft common acceptance standards

NETC 14-1, Kick-off meeting with project Technical Committee.

NETC 14-2

- Rapid visual screening of bridges in Western MA, ME and Northern NH
- Acoustic monitoring and thermal imaging of at least nine bridges during maternity roosting season
- Acoustic monitoring and thermal imaging of at least nine bridges during post-maternity roosting season
- Initial evaluation of data
- Initial reporting of bridge characteristics including signs of structural causes of staining and signs of possible bat roosting

Significant Results:

None as of this reporting period.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

NETC 06-4, Current End Date for this project is 9/15/15. UMass Dartmouth requested a no-cost time extension (September 2014) in order to include more new pavement preservation projects ongoing in the New England states to this study, investigate and purchase the needed testing devices, and to allow more time for field evaluation of the preservation projects included in the study. The requested time extension was for one year with a new end date of 9/15/2016. New End Date is beyond NETC contract end-date. NCE approval is waiting for NETC contract NCE approval.

NETC 07-1, None during the current period.

NETC 09-2, No problems were encountered during this reporting period.

NETC 09-3, None during the current period.

NETC 10-3, In September 2014, UMass Dartmouth formally requested a no additional cost time extension for this project of twelve month (new end date 9/15/2016). The basis of the request is that the contractors have not produced or provided the mixtures required for this study. The Technical Committee did not approve the NCE request, and decided to hold off on submitting the NCE request until after samples were received from the contractors. NETC 10-2 has 2.5 months remaining of the 24 month project. The percent of work completed is 40%. The End Date is now less than 90 days. The NETC Coordinator contacted the Technical Committee and is awaiting a recommendation for the future of this project.

NETC 13-1, No problems encountered to date. The proposed project period was 24 months. However, the NETC coordinator's contract end date is 4/2/16, and the project cannot be contracted past that end date. The project will require a NCE for end date 8/31/16 as soon as the NETC contract NCE is approved.

NETC 13-2, The project period is 50% complete with only 10% of the project tasks completed, and no expenses have been invoiced to date. The proposed project period was 24 months. However, the NETC coordinator's contract end date is 4/2/16, and the project cannot be contracted past that end date. The project will require a NCE for end date 5/31/16 as soon as the NETC contract NCE is approved

NETC 13-3, None during the current period.

NETC 14-1, Notice to proceed was received three months past the project start date. The proposed project period was 18 months, ending 8/31/16. However, the NETC contract end date is 4/2/16. The project will require a NCE for end date 8/31/16 as soon as the NETC contract NCE is approved.

NETC 14-2

- Notice to proceed was three months past the project start date. The project relies on data collected during summer months, requiring work during summer 2016 to complete the project.
- Project notice to proceed precludes any 2015 data from early season (pre-maternity roosting).
- Interactions with Fish and Wildlife, DOT and other organization personnel did not identify any new bridges with known or likely bat presence (per Tasks 1 and 3). Therefore more effort than anticipated will be involved in rapid visual screening of bridges to identify specific bridges for monitoring program. Currently over 70 bridges have been screened in VT, NH, RI and MA by the project team while awaiting equipment. Based on these initial interviews it is expected that the scope of Task 3 will need to be revised.
- Acoustic monitoring equipment was on backorder, most received in late June.
- External battery cables and Sonobat software are still not received by UMass.
- Personnel on project will differ from proposed. Two undergraduate research assistants have been hired to assist a graduate student (funded by NSF scholarship) working on the project. This will be re-evaluated for the second year.
- The proposed project period was 24 months, ending 5/31/16. However, the NETC contract end date is 4/2/16. The project will require a NCE for end date 8/31/16 as soon as the NETC contract NCE is approved.

Potential Implementation:
The 7 research projects listed above are still in progress. Implementations of the results of those projects are not anticipated in the near future.