Quarterly Progress and Performance Indicators Report:
Project Number and Title: 1.17 – Determining Layer Thickness and Understanding Moisture Related Damage of State-Owned Roads Using GPR and Capturing Such in a GIS-Based Inventory
Research Area: 1: Transportation infrastructure monitoring and assessment for enhanced life
PI: *Christopher D.P. Baxter, University of Rhode Island*
Co-PI(s): *N/A*
Reporting Period: *10/1/2021-12/31/2021*
Submission Date: *12/27/2021*

Overview:

- A meeting with the project team and RIDOT personnel was held on October 6, 2021 to identify rural road sites for testing. Eight sites were identified throughout the State with road conditions ranging from poor to excellent.
- Ground Penetrating Radar (GPR) surveys have been performed at five sites by RIDOT personnel and graduate students from URI during the reporting period.
- The GPR data at these sites is currently being analyzed to distinguish between different pavement sections and subbase materials, assess pavement layer thickness, and attempt to assess damage.
- Coring of pavement sections was performed at four of the GPR sites during the reporting period by RIDOT personnel to provide ground truth for the analysis of the GPR data.

Meeting the Overarching Goals of the Project:

How did the previous items help you achieve the project goals and objects? Please give one bullet point for each bullet point listed above.

- Identification of the eight sites for GPR surveying completes Task 4.
- Evaluation of RIDOT's GPR capabilities during the field work completes Task 3 and constitutes progress towards Task 5.
- On-going analysis of the GPR data constitutes progress towards Task 6.
- Analysis of the cores collected at four of the GPR sites will be used to complete Task 6.

Accomplishments:

List any accomplishments achieved under the project goals in bullet point form…

- A significant amount of the field work proposed in this study was completed during the reporting period.

Task Progress and Budget:

Complete the following tables to document the work toward each task and budget (add rows/remove rows as needed, make sure you complete the Overall Project progress row and include all tasks even if they have ended or have not been started)…

Table 1: Task Progress

Task Number: Title	Start Date	End Date	% Complete
Task 1: Kickoff meeting(s) with URI RWU researchers, graduate students, and RIDOT personnel	9/23/2021	9/23/2021	100

Task 2: Review of the relevant literature	9/1/2021	12/31/2021	70
Task 3: Evaluation of RIDOT's GPR capabilities	9/1/2021	12/31/2021	100
Task 4: Identify state-owned roads applicable for field testing	10/1/2021	12/31/2021	100
Task 5: Perform field testing using RIDOT's multi-channel GPR at road speeds	11/1/2021	5/1/2022	70
Task 6: Assess pavement layer thickness using GPR and compare with existing RIDOT information	12/1/2021	5/31/2022	20
Task 7: Incorporate the newly acquired data into RIDOT's GIS-based inventory of roads	5/1/2022	8/31/2022	0
Task 8: Preparation of Final Report and workshop with RIDOT stakeholders on use of the results	7/1/2022	8/31/2022	0
Phase 1 Overall	9/1/2021	8/31/2021	30
Phase 2 Overall	N/A	N/A	N/A
Phase 3 Overall	N/A	N/A	N/A

Table 2: Budget Progress

Project Budget	Spend – Project to Date	% Project to Date (include the date)
Enter Phase 1 Full Budget: $261,428 (Federal + Cost Share)	$44,031 (Federal) ~$40,000 (Cost Share)	32%
Enter Phase 2 Full Budget: $0	N/A	N/A
Enter Phase 3 Full Budget: $0	N/A	N/A

Is your Research Project Applied or Advanced?

☒ **Applied** (*The systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met.)*

☐ **Advanced** *(An intermediate research effort between basic research and applied research. This study bridges basic (study to understand fundamental aspects of phenomena without specific applications in mind) and applied research and includes transformative change rather than incremental advances. The investigation into the use of basic research results to an area of application without a specific problem to resolve.)*

Professional Development/Training Opportunities:

Describe any opportunities for training/professional development that have been provided. Did you provide a training to a State DOT/AOT or industry organization? What was the training? When was it offered? How many people attended? Did you meet with a State DOT/AOT or industry organization to inform them of your findings and how these findings could help their organization? When? How many attended the meeting?

- GPR training was provided to two graduate students by RIDOT personnel.

Technology Transfer:

Complete all of the tables below and provide additional information where requested. Please provide ALL requested information as this is one of the most important sections for reporting to the USDOT. ***ONLY provide information relevant to this reporting period.***

Use the table below to complete information about conference sessions, workshops, webinars, seminars, or other events you led/attended where you shared findings as a result of the work you conducted on this project:

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events					
Type	**Title**	**Citation**	**Event**	**Location**	**Date(s)**
i.e. Conference, Symposium, DOT/AOT presentation, Seminar, etc.	Presentation Title	Full Citation	Name of event (i.e. TIDC 1st Annual Conference) or who was the presentation given to?		
N/A	N/A	N/A	N/A	N/A	N/A

Use the table below to report any publications, technical reports, peer-reviewed articles, newspaper articles referencing your work, graduate papers, dissertations, etc. written as a result of the work you conducted on this project. Please list only completed items and exclude work in progress.

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
i.e. Peer-reviewed journal, conference paper, book, policy paper, magazine/newspaper article	Publication title	Full citation		i.e. Submitted, accepted, under review
N/A	N/A	N/A	N/A	N/A

Answer the following questions (N/A if there is nothing to report):

1. Did you deploy any technology during the reporting period through pilot or demonstration studies as a result of this work? If so, what was the technology? When was it deployed? N/A

2. Was any technology adopted by industry or transportation agencies as a result of this work? If so, what was the technology? When was is adopted? Who adopted the technology? N/A

3. Did findings from this research project result in changing industry or transportation agency practices, decision making, or policies? If so, what was the change? When was the change implemented? Who adopted the change? N/A

4. Were any licenses granted to industry as a result of findings from this work? If so, when? To whom was the license granted? N/A

5. Were any patent applications submitted as a result of findings from this research? If so, please provide a copy of the patent application with your report. N/A

6. Were any industrial contracts awarded base on furthering planned research and development activities as a result of findings from this work? If so, when? How much was awarded? Who awarded the contract? N/A

Please add figures/images that can be included on the website and/or in marketing/social media materials to further clarify your research to the general public.

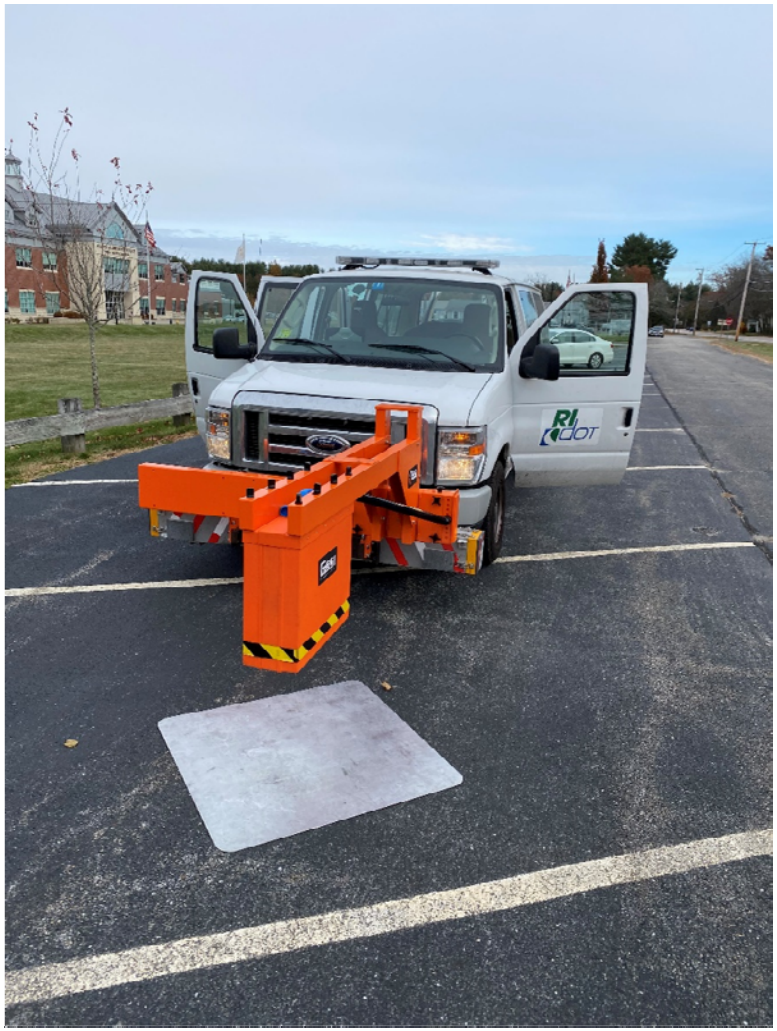

Figure 1. Calibration of the single-antenna GPR system used for the field work during the reporting period.

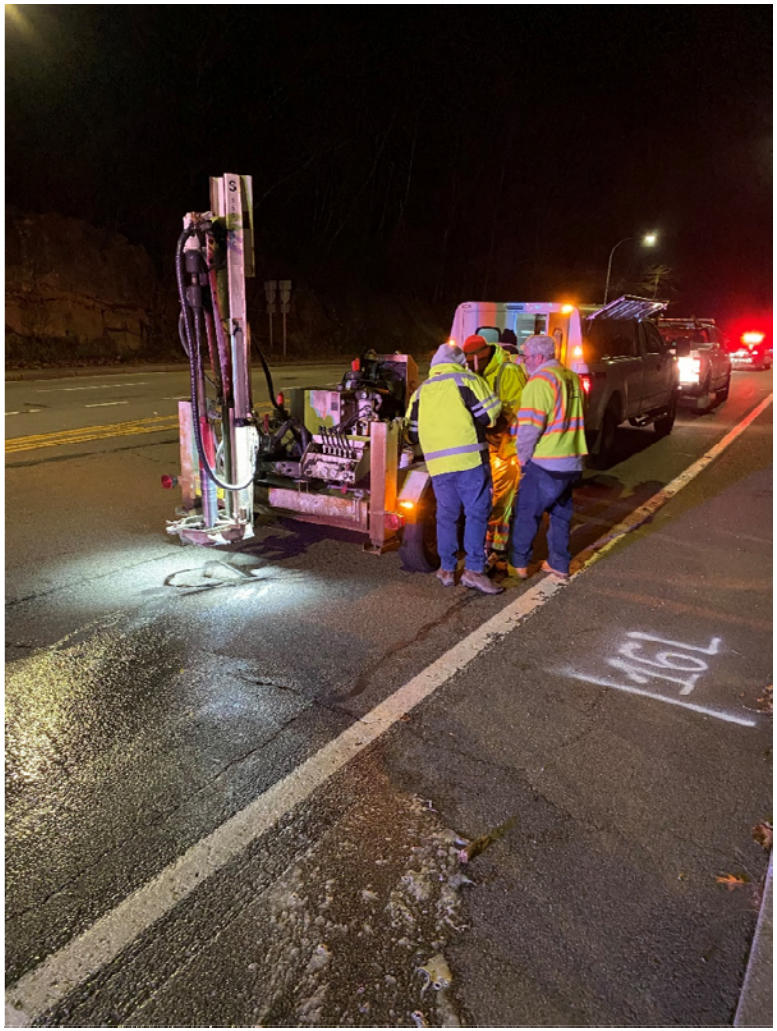

Figure 2. RIDOT's coring crew obtaining cores during the project period at one of the sites where GPR testing was performed for this project.

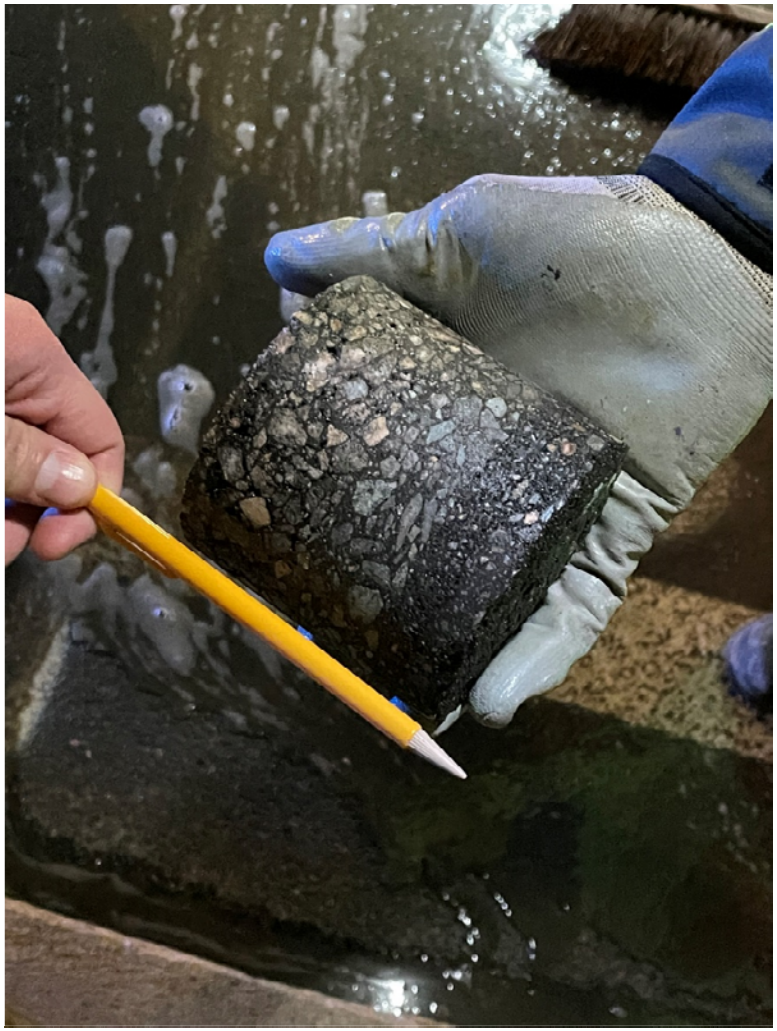

Figure 3. One of the cores collected as part of this project.

Describe any additional activities involving the dissemination of research results not listed above under the following headings:

Outputs:

Definition: Any new or improved process, practice, technology, software, training aid, or other tangible product resulting from research and development activities. They are used to improve the efficiency, effectiveness, and safety of transportation systems. List any outputs accomplished during this reporting period:

- N/A

Outcomes:

Definition: The application of outputs; any changes made to the transportation system, or its regulatory, legislative, or policy framework resulting from research and development activities. List any outcomes accomplished during this reporting period:

- N/A

Impacts:

Definition: The effects of the outcomes on the transportation system such as reduced fatalities, decreased capital or operating costs, community impacts, or environmental benefits. The reported impacts from UTCs are used for the assessment of each UTC and to make a case for Federal funding of research and education by demonstrating the impacts that UTC funding has had on technology and education. NOTE: The U.S. DOT uses this information to assess how the research and education programs (a) improve the operation and safety of the transportation system; (b) increase the body of knowledge and technologies; (c) enlarge the pool of people trained to develop knowledge and utilize technologies; and (d) improves the physical, institutional, and information resources that enable people to have access to training and new technologies. List any outcomes accomplished during this reporting period:

- N/A

Participants and Collaborators:

*Use the table below to list **all** individuals (compensated or not) who have worked on the project.*

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members				
Individual Name & Title	**Dates involved**	**Email Address**	**Department**	**Role in Research**
Chris Baxter	9/1/21-12/31/21	cbaxter@uri.edu	Ocean/Civil Engineering, URI	PI
Nicole Martino	9/1/21-12/31/21	nmartino@rwu.edu	Civil Engineering, RWU	Co-PI
Peter Healey	9/1/21-12/31/21	Peter.healey@dot.ri.gov	Pavement Engineering, RIDOT	Technical Champion from RIDOT
Mike Byrne	9/23/21-12/31/21	michael.byrne@dot.ri.gov	Materials Engineering, RIDOT	Management Team Member
Liz Cornell	9/23/21-12/31/21	elizabeth.cornell@dot.ri.gov	Pavement Engineering, RIDOT	Management Team Member
Christos Xenophontos	9/23/21	christos.xenophontos@dot.ri.gov	Planning, RIDOT	Administrator

*Use the table below to list **all** students who have participated in the project during the reporting period. (This includes all paid, unpaid, intern, independent study, or any other student that participated in this project.) **ALL FIELDS ARE REQUIRED.***

Table 6: Student Participants during the reporting period								
Student Name	**Start Date**	**End Date**	**Advisor**	**Email Address**	**Level**	**Major**	**Funding Source**	**Role in research**

Pamela Franco	9/1/21	9/30/21	Chris Baxter		Master's	Civil Engineering	TIDC	Literature review; field work; data analysis and interpretation
Andrew Pariseault	9/1/21	9/30/21	Chris Baxter		Master's	Civil Engineering	TIDC	Literature review; field work; data analysis and interpretation

Use the table below to list any students who worked on this project and graduated or received a certificate during this reporting period. Include information about the student's accepted employment (i.e. the student is now working at MaineDOT) or if they are continuing their students through an advanced degree (list the degree and where they are attending).

Table 7: Students who Graduated During the Reporting Period

Student Name	Degree/Certificate Earned	Graduation/Certification Date	Did the student enter the transportation field or continue another degree at your university?
N/A			Please list the organization or degree

Use the table below to list any students that participated in Industrial Internships:

Table 8: Industrial Internships

Student Name	Degree/Certificate Earned	Graduation/Certification Date	Did the student enter the transportation field or continue another degree at your university?
Pamela Franco	B.S.C.E	5/20/21	Worked at GZA Geoenvironmental, Inc. (geotech) over the summer and continuing for another degree at URI
Andrew Pariseault	B.S.C.E	5/20/21	Worked at GZA Geoenvironmental, Inc. (geotech) over the summer and continuing for another degree at URI

*Use the table below to list **organizations** that have been involved as partners on this project and their contribution to the project.*

Table 9: Research Project Collaborators during the reporting period

Organization	Location	Contribution to the Project				
		Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges
		List the amount	List the amount	Mark with an "x" where appropriate		
RIDOT	Providence, RI	$0	~$40,000	x		x

*Use the table below to list **individuals** that have been involved as partners on this project and their contribution to the project.*
*(**List your technical champion(s) in this table.** This also includes collaborations within the lead or partner universities who are not already listed as PIs; especially interdepartmental or interdisciplinary collaborations.)*

Table 10: Other Collaborators

Collaborator Name and Title	Contact Information	Organization and Department	Date(s) Involved	Contribution to Research
Peter Healey	Peter.healey@dot.ri.gov	Pavement Engineering, RIDOT	9/1/21-9/30/21	Technical Champion from RIDOT
Christos Xenophontos	christos.xenophontos@dot.ri.gov	Planning, RIDOT	9/23/21	Administrator and Outreach
Liz Cornell	elizabeth.cornell@dot.ri.gov	Pavement Engineering, RIDOT	10/1/21-12/31/21	Performed GPR surveys

Use the following table to list any transportation related course that were taught or led by researchers associated with this research project:

Table 11: Course List

Course Code	Course Title	Level	University	Professor	Semester	# of Students
i.e. CE 123		Grad or undergrad?	Where was the course taught?	Who taught the course?	Enter Spring, Fall, Summer, Winter and the year	How many students were enrolled in the class?
CVE 579	Advanced Soil Mechanics	Grad	URI	Chris Baxter	Fall, 2021	9

Changes:

N/A

Planned Activities:

List the activities planned during the next quarter.

- Finish field testing
- Analyze GPR data
- Begin incorporating results in RIDOT's GIS framework.