Quarterly Progress Report:
Project Number and Title: Project C19.2020: Damage Modeling, Monitoring, and Assessment of Bridge Scour and Water Borne Debris Effects for Enhanced Structural Life
Research Area: Thrust 1 -Transportation Infrastructure Monitoring & Assessment for Enhanced Life
PI: Wei Zhang, Ph.D., P.E., Associate Professor, Department of Civil & Environmental Engineering, University of Connecticut
Co-PI(s): Ramesh B. Malla, Ph.D., F. ASCE, F. EMI, Professor, Department of Civil & Environmental Engineering, University of Connecticut; and Nalini Ravishanker, Ph.D., Professor, Department of Statistics, University of Connecticut
Reporting Period: July 01, 2021 to September 30, 2021
Submission Date: September 30, 2021

Overview: (Please answer each question individually)
Brief overview and summary of activities performed during the reporting period:
Activities performed during this reporting period were focused primarily on communicating and collecting data from Maine DOT, VTrans, and CTDOT to analyze bridge scour and waterborne debris impacts on bridges, and preparing methodologies for the field testing, data collection and processing.

- Collaboration with VTrans and Maine DOT has been maintained.
- A meeting with project technical champions Messrs. Jeff DeGraff of VTrans and Benjamin Foster of Maine DOT and representative from CT DOT Mr. Andrew Mroczkowski took place on March 26, 2021
- As discussed in the March 26th meeting, since there are no sufficient images/photos of waterborne debris near bridges, a risk prediction model is proposed to predict waterborne debris for bridges. The procedure starts from the historical wind/flooding data for areas that might generate debris from fallen trees as shown in Figures 1 and 2. The probabilistic approach is used to quantify the number of tree failures in the areas and their failure probabilities based on the locations of the trees and their species as shown in Figure 3. Scenario based failure analysis of trees and debris generations will be performed for selected bridges in New England states. Figure 4 shows the estimated average debris mass for given log sizes. Velocity and depth in the upstream river are used for prediction of the log sizes and dimensions.
- Preliminary work procedure for prediction of waterborne debris dimensions and their potential impacts on bridges were prepared. A case study was conducted on one sample bridge to illustrate the process.

Figure 1. Satellite plan view of the selected bridge

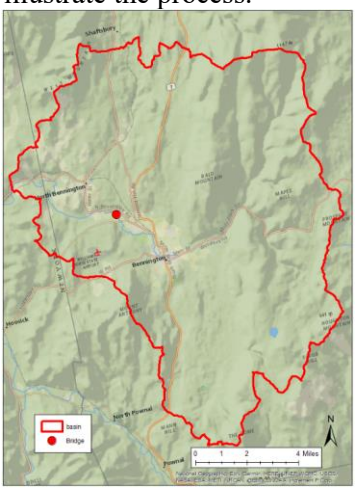
Figure 2. Drainage basin

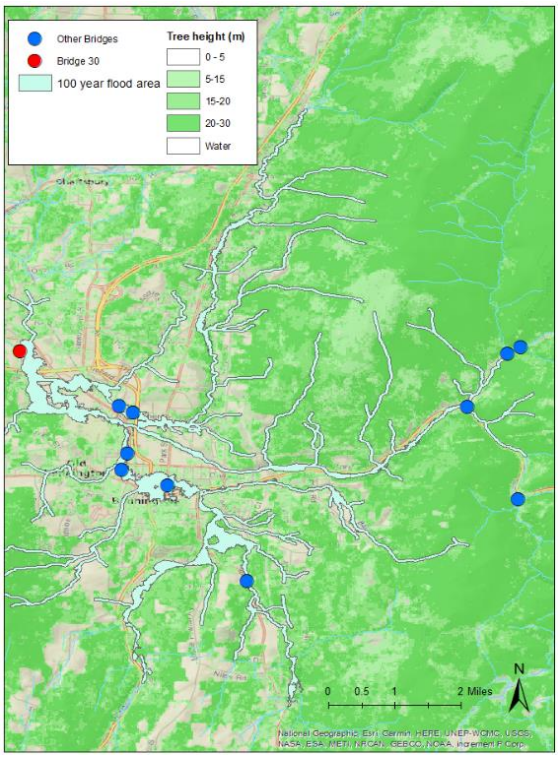

Figure 3. Upstream river area considered and surrounding vegetation

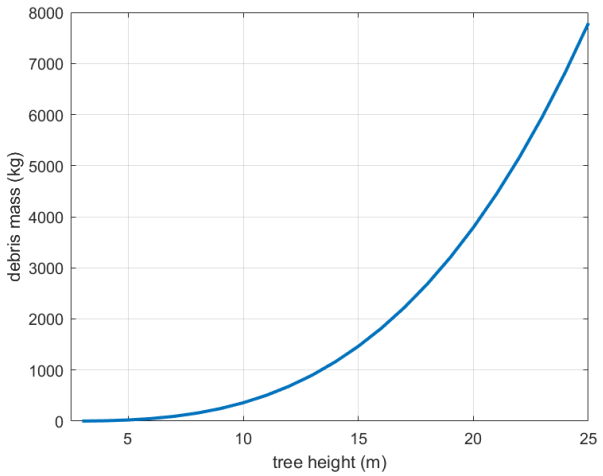

Figure 4. Estimated average debris mass for given log size

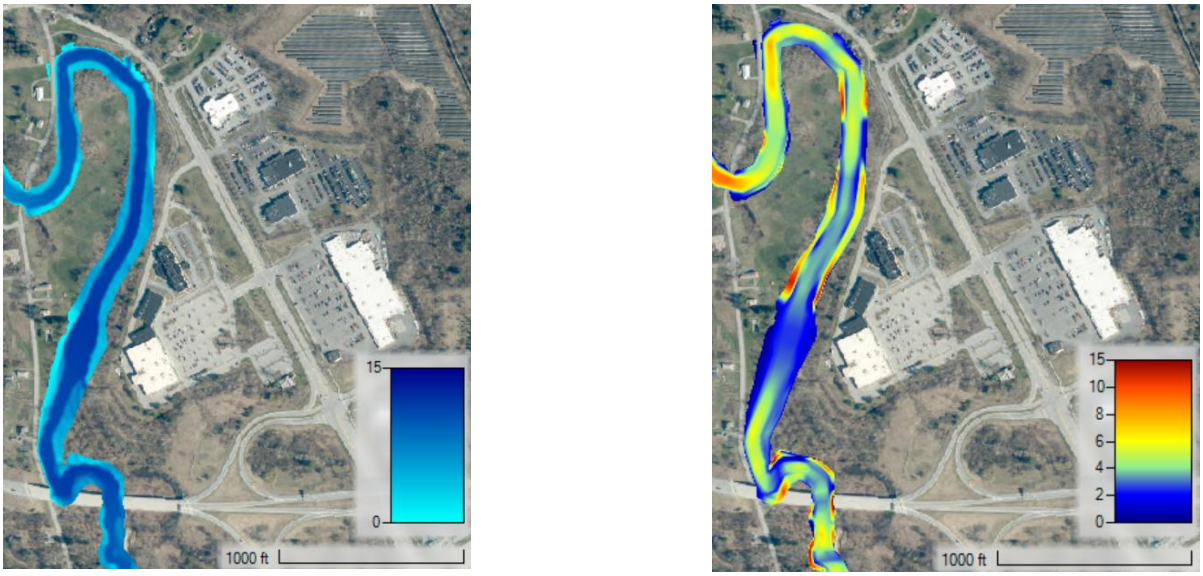

Figure 5. Velocity (left) and depth (right) mapped in immediate bridge upstream area

Provide context as to how these activities are helping achieve the overarching goal(s) of the project…
The overarching goal of the project is to develop efficient waterborne and scour modeling and assessment methodology for bridges during flooding events to improve bridge safety and resilience. Many bridges in the region could experience possible damages from waterborne debris impacts or bridge scour impacts, that could put risks on bridge safety and increase burdens for bridge maintenance. As the initial stage of the project, project PIs have been working with our technical champions from two DOTs as well as Mr. Andrew Mroczkowski from Connecticut DOT to pre-processing the reports and the database that are made available to them. A new prediction model is proposed and will be used for evaluating the debris amounts for extreme weather scenarios. The new prediction model was evaluated on a sample bridge in Vermont to demonstrate the process.

Describe any accomplishments achieved under the project goals…

- Sample bridge information in GIS datasets were obtained to determine the current available data sources from DOTs, including VTrans and Maine DOT;
- Key parameters were determined for statistical analysis of the project for bridge scour and waterborne debris impacts. Major data information includes: 1) dimensions for the accumulated debris, length and width; 2) how are these data related to channel width, water shed area, water speed, and drag coefficient.
- The research team has been conducting literature review on waterborne debris dimensions and analysis.
- The research team contacted more DOTs to obtain more related waterborne debris data and bridge scour data for the entire New England region. CT DOT has provided some reports and data for us to use.
- The research team has obtained the data for the tree species in the area and the flooding information for the rivers, such as the basic flooding elevations.
- The research team has conducted a sample case study of a selected bridge to illustrate the process of estimating the debris size. See Appendix A.

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	Start Date	End Date	% Complete
PHASE I			
Task 1: Literature Review and data collection.	Oct. 20, 2020	Jan. 31, 2021	100%
Task 2: Statistical Analysis	Dec. 1, 2020	Jun. 30, 2021	100%
Task 3: Debris Dimension analysis	Feb. 1, 2020	Sep. 30, 2021	100%
PHASE II			
Task 4: Debris Impact Simulations	Oct. 1, 2021	Mar. 31, 2021	10%
Task 5: Data collection for scour	Oct. 1, 2021	July 31, 2021	0%
Task 6: Scour Simulations	Jan. 1, 2022	Dec. 31, 2022	10%
Task 7: Fragility Analysis	Sep. 1, 2022	May 31, 2022	0%
Task 8: Resilient Options	Jan. 1, 2023	Sep. 30, 2023	0%
Overall Project:	*Oct. 20, 2020*	*Sep. 30, 2023*	

Table 2: Budget Progress

Project Budget	Spend – Project to Date	% Project to Date*
$400,000 for 3 years (including 1:1 Cost share match)	the information will be provided by the Institutional Lead	the information will be provided by the Institutional Lead

Include the date the budget is current to.

Describe any opportunities for training/professional development that have been provided…

None.

Describe any activities involving the dissemination of research results (be sure to include outputs, outcomes, and the ways in which the outcomes/outputs have had an impact during the reporting period. Please use the tables below for any Publications and Presentations in addition to the description of any other technology transfer efforts that took place during the reporting period.)… Use the tables below to complete information about conferences, workshops, publications, etc. ***List all other outputs, outcomes, and impacts after the tables*** *(i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings).*

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
None. The project is new and is in preliminary stage.				

Encouraged to add figures that may be useful (especially for the website)…

Insert figures here

Participants and Collaborators:

Use the table below to list all individuals who have worked on the project.

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	**Email Address**	**Department**	**Role in Research**
Dr. Wei Zhang, Associate Professor	wzhang@uconn.edu	Civil & Environmental Engineering, University of Connecticut, Storrs	Principal Investigator (PI)
Dr. Ramesh B. Malla, Professor	Ramesh.Malla@UCONN.EDU	Civil & Environmental Engineering, University of Connecticut, Storrs	Co-Principal Investigator (PI)/ TIDC Institutional Lead, UConn
Dr. Nalini Ravishanker	Ravishanker, Nalini	Statistics, University of Connecticut, Storrs	Co-Principal Investigator (PI)

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

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
William Hughes		Ph.D.	Civil Engr.	Graduate Assistant
Leana Santos		Ph.D.	Civil Engr.	Graduate Assistant
Qin Lu		Ph.D.	Civil Engr.	Graduate Assistant
Matthew Wendland		Undergraduate	Civil Eng.	Student

Use the table below to list any students who worked on this project and graduated during this reporting period.

Table 7: Student Graduates			
Student Name	**Role in Research**	**Degree**	**Graduation Date**

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

Table 8: Research Project Collaborators during the reporting period						
Organization	**Location**	**Contribution to the Project**				
		Financial Support	**In-Kind Support**	**Facilities**	**Collaborative Research**	**Personnel Exchanges**
Vermont Agency of Transportation	Barre, VT		X			X
Maine Department of Transportations	Augusta, ME		X			X

List all other outputs, outcomes, and impacts here (i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings). Please be sure to provide detailed information about each item as with the tables above.

Have other collaborators or contacts been involved? If so, who and how? (This would include collaborations with others within the lead or partner universities; especially interdepartmental or interdisciplinary collaborations.)

Table 9: Other Collaborators			
Collaborator Name and Title	**Contact Information**	**Organization and Department**	**Contribution to Research**
Benjamin Foster, State Bridge & Structures Maintenance Engineer/ Deputy Chief Engineer,	Ben.Foster@maine.gov	Bureau of Maintenance & Operations, Maine Department of Transportation (Maine DOT),	Technical Champion
Mr. Jeff DeGraff, P.E., Hydraulics Project Engineer	Jeff.DeGraff@vermont.gov	Vermont Agency of Transportation (VTrans)	Technical Champion
Mr. Andrew Mroczkowski	Andrew.Mroczkowski@ct.gov	Connecticut DOT	Collaborator

Who is the Technical Champion for this project?
Name: Benjamin Foster, P.E.
Title: Maintenance Engineer/Deputy Chief Engineer
Organization: MaineDOT
Location (City & State): Augusta, ME
Email Address: Ben.Foster@maine.gov

Name: Jeff DeGraff, P.E.
Title: Hydraulics Project Engineer
Organization: VTrans
Location (City & State): Barre, VT
Email Address: Jeff.DeGraff@vermont.gov

Changes:

Discuss any actual or anticipated problems or delays and actions or plans to resolve them…

- As our projects start with Coronavirus outbreak, the University of Connecticut is partially closed and faculty, staff and students are teleworking.
- The data collection process has been slow. Several NE DOTs have not responded to the request sent by the researchers. We have received some information from Maine DOT, VTrans, and CT DOT. However, the images for debris are very limited. That has delayed our tasks related to machine learning to determine water born debris size.
- In order to assume the project, an alternate research framework will be used for predicting the debris generated during extreme weather conditions.

Discuss any changes in approach and the reasons for the change…

- Due to COVID-19 pandemic, currently, all members of the research teams are working remotely online on tasks that are based on analytical and computational in nature.
- Due to the limited pictures of the debris size, we have adopted a risk-based approach.

Planned Activities:

Description of future activities over the coming months.

- Due to COVID-19 pandemic, currently, all members of the research teams are working remotely online on tasks that are based on analytical and computational in nature.
- The research team will continue to spent effort on the needed data collection. They will communicate further with NE DOTs and request for relevant information.
- The research team will continue to interact closely you with our DOT Technical Champions from VTrans and Maine DOT.
- Although the waterborne debris data received from New England area has been very limited, the team will spend substantial effort to get data from nation-wide sources and will work on predictions of the waterborne debris size and other useful parameters.
- The research team will continue to maintain communication with DOTs and industry regarding potential future research topics so that the research will be relevant and of great importance to the DOTs and industry.
- With the new research methodology, the risk prediction models for waterborne debris is formulated. Based on the weather parameters and the areas that will generate debris from fallen trees, the amount and the probability of tree failures will be evaluated for debris evaluations.