

**Quarterly Progress and Performance Indicators Report:**

**Project Number and Title:** 2.12 Evaluation of processed glass aggregate for utilization in transportation projects as a sand borrow

**Research Area:** Thrust 2 New Materials for Longevity and Constructability

**PI:** Mandar Dewoolkar, University of Vermont

**Co-PI(s):** Matthew Scarborough, Gregory Rowangould and Ehsan Ghazanfari, University of Vermont

**Reporting Period:** 07.01.2022 to 09.30.2022

**Submission Date:** 09.30.22

**\*\*\*IMPORTANT:** Please fill out each section fully and reply with N/A for questions/sections with nothing to report. For ease of reporting to the USDOT, please do not remove, or change the order of, any sections/text. You may remove/add each rows in tables as needed. Thank you! \*\*\*  
The report is due on the last day of the reporting period in .doc format to tidc@maine.edu.

**Overview:**

Provide **BRIEF** highlights of activities performed during the reporting period.

- We continued testing deleterious material content control tests on lab-manufactured crushed glass (clean and with known deleterious materials) and explored testing protocols that may help determination of plastic content.
- We began deleterious material content tests on facility produced PGA, testing individual processes and an overall protocol.

**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.

- Testing for separate plastics content will help in limiting plastics content as it will likely be desirable to limit releasing plastic in the environment.
- Applying deleterious material content determinations processes and protocol to facility produced PGA determines if the protocol will be actually applicable to produced PGA.

**Accomplishments:**

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

**Task, Milestone, and Budget Progress:**

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)...

<b>Table 1: Task Progress</b>			
<b>Task Number: Title</b>	<b>Start Date</b>	<b>End Date</b>	<b>% Complete</b>
Task 1: Literature review	01/16/21	06/30/21	95%
Task 2: Collection of PGA and sand borrow specimens	01/16/21	05/31/22	90%
Task 3: Methods for deleterious material content	01/16/21	11/15/22	90%

Task 4: Engineering properties determination, recommendations for design, and specifications	01/16/21	11/15/22	18%
Task 5: Economic analysis	12/01/21	11/15/22	1%
Task 6: Education, outreach and technology transfer	01/16/21	01/15/23	35%
Phase 1 Overall	01/16/21	01/15/23	55%
Phase 2 Overall	TBD	TBD	0%

**Table 2: Milestone Progress**

Milestone #: Description	Corresponding Deliverable	Start Date	End Date
Milestone 1: Literature review	Results compiled and presented to TAC	01/16/21	06/30/21
Milestone 2: Collection of PGA and sand borrow specimens	A brief report/presentation to TAC	01/16/21	05/31/22
Milestone 3: Methods for deleterious material content	Presentation to TAC	01/16/21	11/15/22
Milestone 4.1: Laboratory testing program matrix	Presentation to TAC	01/16/21	11/15/22
Milestone 4.2: Engineering properties of PGA	Report and presentation to TAC	01/16/21	11/15/22
Milestone 4.3: Recommendations for design and specifications	Report and presentation to TAC	07/01/21	11/15/22
Milestone 5.1: Methodology for economic analysis	Presentation to TAC	04/01/21	06/30/21
Milestone 5.2: Results of economic analysis	Report and presentation to TAC	12/01/21	11/15/22
Milestone 6.1: Education	Recruiting and training of graduate (1) and undergraduate (at least 1 per year) students	Throughout the project	
Milestone 6.2: Technology transfer	DOT research days, TIDC conferences, regional ACEC and ASCE meetings and conferences, TRB annual meeting.	Throughout the project	
Milestone 6.3: Final report and presentation on phase 1	Final report to TAC and TIDC, webinar, 1-page information sheet	11/15/22	01/15/23

**Table 3: Budget Progress**

Project Budget	Spend – Project to Date	% Project to Date (include the date)
\$472,977	\$209,794.76	44.36%

**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.*)

**Education and Workforce Development:**

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

1. Did you provide any workforce development or training opportunities to transportation professionals (already in the field)? If so, what was the training? When was it offered? How many people attended? (i.e. The research team provided an in the field training for the SAR technology for 3 maintenance crew members of the MassDOT on 3/31/2021. The members learned how to use the technology and interrupt the data.)

*The graduate student Fiona Nutbeam presented her thesis based on this research on September 9, 2022. Three engineers from VTrans and an engineer from CSWD attended the presentation.*

*Dr. Dewoolkar also made a presentation on this research and presented a poster at the 2022 VTrans Research Symposium on September 14. This symposium was attended by over 50 transportation professionals.*

*A poster on this research was presented at the 2022 Annual TIDC Conference August 10, 2022.*

2. Did you hold meetings with any transportation industry organizations or DOTs? If so, what was the meeting's purpose? When was it offered? How many people attended? (i.e. The research team held a meeting with MaineDOT to update them on the progress of the research findings and how the findings can be implemented on 3/31/2021. 15 DOT maintenance members were present at the meeting.)

*We had a TAC (Technical Advisory Committee) meeting on July 25, 2022. It was attended by four VTrans personnel, one person from VTDEC, and one person from Chittenden Solid Waste District.*

3. Did you host/participant in any K-12 education outreach activities? If so, what was the activity? What was the target age/grade level of the participants? How many students/teachers attended? When was the activity held? (i.e. 25 8<sup>th</sup> graders and 2 teachers visited the concrete lab and created small concrete trinkets like Legos on 3/31/2021. They learned about the different types of fibers that can be used in the concrete.)

*None.*

**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:

<b>Table 4: Presentations at Conferences, Workshops, Seminars, and Other Events</b>					
<b>Type</b>	<b>Title</b>	<b>Citation</b>	<b>Event &amp; Intended Audience</b>	<b>Location</b>	<b>Date(s)</b>
i.e. Conference, Symposium, DOT/AOT presentation, Seminar, etc.	Presentation Title	Full Citation	Name of event (i.e. TIDC 1 <sup>st</sup> Annual Conference) or who was the presentation given to?		
2022 Transportation Infrastructure Durability Conference	Development of Protocols for Determining Deleterious Material Content in Processed Glass Aggregate	Nutbeam, F., Scarborough, M., and Dewoolkar, M. (2022), “Development of Protocols for Determining Deleterious Material Content in Processed Glass Aggregate” Poster presented at 2022 Transportation Infrastructure Durability Conference.	2022 Transportation Infrastructure Durability Conference	Maine	August 9-11, 2022
2022 VTrans Research Symposium	Development of Protocols for Determining Deleterious Material Content in Crushed Recycled Glass	Nutbeam, F., Scarborough, M., and Dewoolkar, M. (2022), “Development of Protocols for Determining Deleterious Material Content in Processed Glass Aggregate” Oral Presentation and Poster Presentation at the 2022 VTrans Research Symposium.	2022 VTrans Research Symposium	Barre, Vermont	September 14, 2022

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 5: Submitted/Accepted Publications, Technical Reports, Theses, Dissertations, 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 (by org. submitted to)
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 it 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. Did industry organizations or DOTs provide cost-share (cash or in-kind) to your research during the reporting period? Who was the organization? Please provide an in-kind support invoice from the organization with your report (this is kept confidential and used for record keeping purposes only).

CSWD provided \$25,000 cash as a match during this period.

*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. This is very important to our Technology Transfer initiatives.*



*PGA produced at the CSWD facility; 550 deg furnace; furnace test lab-manufactured sample*

**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:*

- Examples: New sensing technology was developed. This technology will... A UAV was created to hold new monitoring technology. This will allow maintenance crews to... A new college course was created based on the research findings. This will train future transportation professionals to...

We have made good progress in developing the protocol for deleterious materials content. Because VTrans and VTDEC are engaged in the process from the proposal development phase and through TAC, we anticipate adoption of our developed protocol at least by VTrans and VEDEC.

**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:*

- Example: The developed sensing technology was installed in Bridge A in town, state on 1/1/2021. This installation will... The UAV was successfully used by \_\_\_ Organization to inspect \_\_\_ Bridge in in town, state on 1/1/2021... The newly created college course was taken/completed by \_\_\_ students in the 2021 fall semester.

N/A for this quarter

**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:*

- Example: The developed sensing technology’s successful deployment resulted in the adoption of the technology by the StateDOT. The technology will be installed in all new bridge installments of this type. This adoption will... The new UAV monitoring technology was adopted by \_\_\_ organization to be used for \_\_\_ bridges inspections. This will allow inspectors to... The college course has been adopted by another member university...

N/A for this quarter

**Participants and Collaborators:**

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

<b>Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members</b>				
<b>Individual Name &amp; Title</b>	<b>Dates involved</b>	<b>Email Address</b>	<b>Department</b>	<b>Role in Research</b>
Mandar Dewoolkar, Professor & Chair	01/16/21-current	Mandar.Dewoolkar@uvm.edu	Civil and Environmental Engineering	Primary Investigator
Matthew Scarborough, Assistant Professor	01/16/21-current	Matthew.Scarborough@uvm.edu	Civil and Environmental Engineering	Co-Primary Investigator
Gregory Rowangould, Associate Professor	01/16/21-current	Gregory.Rowangould@uvm.edu	Civil and Environmental Engineering	Co-Primary Investigator
Ehsan Ghazanfari, Associate Professor	01/16/21-current	ehsan.ghazanfari@uvm.edu	Civil and Environmental Engineering	Co-Primary Investigator

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 7: Student Participants during the reporting period								
Student Name	Start Date	End Date	Advisor	Email Address	Level	Major	Funding Source	Role in research
				Email is not included in the external report and is only used for internal purposes.	(i.e. UG, MS, PhD)		(i.e. TIDC, Other university funds, , unpaid intern, etc.	What work are they conducting? Please be descriptive. Student research assistant is not enough info.
Fiona Nutbeam	01/16/21	Current	Matthew Scarborough & Mandar Dewoolkar		MS Student	Civil & Environmental Engineering	TIDC	Laboratory work on the determination of deleterious content in PGA
Neha Subedi	09/01/22	Current	Matthew Scarborough & Mandar Dewoolkar		MS Student	Civil & Environmental Engineering	TIDC	Laboratory work on the determination of deleterious content in PGA, geotechnical testing, economic analysis
Sarah Foy	06/01/22	08/15/22	Matthew Scarborough & Mandar Dewoolkar		BS Student	Environmental Engineering	Barrett Foundation Scholarship	Laboratory work on the determination of deleterious content in PGA
Lauren Snow	09/10/22	Current	Mandar Dewoolkar & Matthew Scarborough		BS Student	Environmental Engineering	University funds	Laboratory work on the determination of deleterious content in PGA
Ben Kopacki	09/10/22	Current	Mandar Dewoolkar & Matthew Scarborough		BS Student	Environmental Engineering	University funds	Image analysis for determination of deleterious content in PGA



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 during the reporting period (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 8: 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			

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

**Table 9: Industrial Internships**

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

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

**Table 10: 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		
Chittenden Solid Waste District (CSWD)	1021 Redmond Road, Williston, VT 05495	\$30,000 (over the project period to date)	\$20,200 (over the project period)	X		TAC members
Vermont Agency of Transportation (VTrans)	219 N. Main St, Barre, VT 05641		\$10,000 (over the project period)			TAC members
Vermont Department of Environmental Conservation (VTDEC)	1 National Life Drive, Davis 1, Montpelier, VT 05620-3702					TAC members

Use the table below to list **individuals** that have been involved as partners on this project and their contribution to the project during the reporting period. (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.)

<b>Table 11: Other Collaborators</b>				
<b>Collaborator Name and Title</b>	<b>Contact Information</b>	<b>Organization and Department</b>	<b>Date(s) Involved</b>	<b>Contribution to Research</b>
	For internal use only			(i.e. technical champion, technical advisory board, test samples, on-site equipment, data, etc.)
Arles August Geotechnical Engineer		VTrans	01/16/21 - current	TAC member
Callie Ewald, P.E., Manager, Geotechnical Engineer		VTrans	01/16/21 - current	TAC member
Dr. Ian Anderson, Manager, HMA Materials		VTrans	01/16/21 – current	TAC member
Nick Van Den Berg, Materials Manager		VTrans	01/16/21 – current	TAC member
Dr. Emily Parkany, P.E., Research Manager		VTrans	01/16/21 – current	TAC member
Tanya Miller, Research Engineer		VTrans	01/16/21 – current	TAC member
James Surwilo, Environmental Analyst		VTDEC, Solid Waste Management Program	01/16/21 – 02/08/22	TAC member (recently deceased)
Aric Brown, Environmental Analyst		VTDEC	04/18/22 - current	TAC member

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

<b>Table 12: Course List</b>						
<b>Course Code</b>	<b>Course Title</b>	<b>Level</b>	<b>University</b>	<b>Professor</b>	<b>Semester</b>	<b># of Students</b>
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?
CE 133	Transportation Systems	Undergrad	UVM	Gregory Rowangould	Fall 2022	61

**Changes:**

List any actual or anticipated problems or delays and actions or plans to resolve them (list no-cost extension requests here)...

*VTrans and VTDEC has increased interest in determining specifically the plastic content in PGA. We are therefore focusing on this aspect in the upcoming quarter. This was not anticipated at the project inception.*

List any changes in approach and the reasons for the change...

*VTrans and VTDEC has increased interest in determining specifically the plastic content in PGA. We are therefore focusing on this aspect in the upcoming quarter. This was not anticipated at the project inception. It is not necessarily a challenge, but it is a change in scope to some extent.*

**Planned Activities:**

List the activities planned during the next quarter.

- Continue laboratory testing on PGA, Sand borrow, and lab-manufactured PGA specimens.