



CENTER FOR ADVANCING RESEARCH IN
Transportation Emissions, Energy, and Health
A USDOT University Transportation Center

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Signature of Submitting Official:

OVERVIEW

The Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH) received a U.S. Department of Transportation (USDOT) grant for a Tier 1 University Transportation Center (UTC) in 2023 under the Bipartisan Infrastructure Legislation (BIL) UTC program. This grant builds on a previous grant awarded from the 2016 Fixing America's Surface Transportation Act UTC Competition. CARTEEH will address transportation emissions, energy, and health with a focus on advancing health equity and the engagement of underserved communities. Under this grant, the CARTEEH consortium has expanded with the addition of two partners who offer expertise on health equity and engagement of disadvantaged communities, the Morehouse School of Medicine and North Dakota State University. These new partners join the existing consortium members, the Texas A&M Transportation Institute (TTI)/Texas A&M University (lead institution), Georgia Institute of Technology, Johns Hopkins University, University of California at Riverside, and the University of Texas at El Paso.

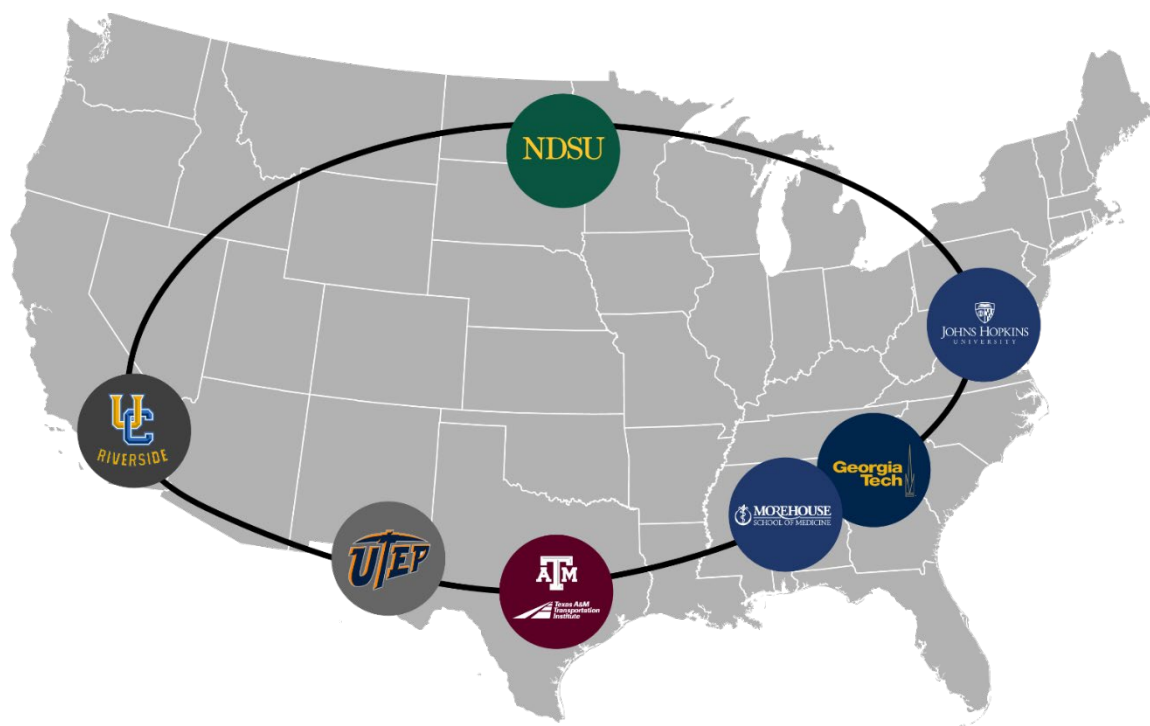


Figure 1. CARTEEH Consortium Members

This is the first full reporting period under the grant and it includes some remaining start-up activities initiated in the previous reporting period, and the continuation and initiation of other center activities.

On November 9, 2023, CARTEEH consortium partners met at TTI headquarters for a strategic planning meeting to kick off the grant and plan for our activities to be truly impactful and transformational over the coming years. CARTEEH leadership and faculty members in attendance were Dr. Joe Zietsman (Center Director) and Dr. Tara Ramani (Deputy Director)



from TTI, and Dr. Robert Mayberry and Dr. Pamela Daniels (Morehouse School of Medicine), Dr. Jill Hough (North Dakota State University), Dr. Wen-Whai Li and Dr. Mayra Chavez (University of Texas at El Paso), Dr. Michael Rodgers (Georgia Institute of Technology), Dr. Mary Fox (Johns Hopkins University), and Dr. Kanok Boriboonsomsin (University of California at Riverside). The one-day event included a meet and greet with TTI's Agency Director, Greg Winfree, a tour of TTI facilities, and strategic discussions related to CARTEEH's plans, activities, and collaborative projects to achieve success.



Attendees at the CARTEEH Strategic Planning Session in November 2023. Pictured from left to right: Robert Mayberry, Mayra Chavez, Pamela Daniels, Jill Hough, Wen-Whai Li, Joe Zietsman, Tara Ramani, Michael Rodgers, Mary Fox, Sandra Jackson, and Kanok Boriboonsomsin

1. ACCOMPLISHMENTS

Major Goals of the Program

In this new grant, CARTEEH's work will support the United States Department of Transportation's Strategic Plan goals of equity, climate, and sustainability. Equity will be addressed as we tackle the disproportionate impact of air pollution on poorer communities and communities of color, who are also often underserved in terms of access to transportation and health-promoting opportunities. We will also address climate and sustainability issues through the linkages of pollutant emissions to greenhouse gases, climate change, and decarbonization. Our work, which will revolutionize research, education, and technology transfer in this area, will also support the goal of transformation.



The following sections provide a high-level discussion of activities initiated and planned during this reporting period under the goal areas of research, education, and technology transfer, which we will continue to build on during future reporting periods of this grant.

CARTEEH Goal #1: Research Program

Initiation of Collaborative Research Projects

In this reporting period, CARTEEH consortium members initiated the seven collaborative projects (one led by each consortium member) that are detailed in Table 1.

Table 1. Initial Collaborative Projects

Project #1—Electric versus Internal Combustion: What are the Actual Emissions and Health Impacts?	
Lead: Texas A&M Transportation Institute/Texas A&M University	Collaborators: GT, JHU, UCR
<i>Motivation: EVs are changing the transportation landscape. Deployment of electric buses to replace diesel school buses has the potential to reduce exposures of a vulnerable population but must be studied from a comprehensive life-cycle perspective.</i>	
Project #2—Integrated Transportation-Health Modeling Platform for Decision-Support	
Lead: Georgia Institute of Technology	Collaborators: TTI/TAMU, JHU, UCR
<i>Motivation: The “transportation emissions to health” modeling chain is traditionally resource-intensive and computationally complex. This project aims to create a modeling platform that balances analytic rigor with practical feasibility, resulting in a tool that is of practical applicability to transportation stakeholders.</i>	
Project #3—Health Risks for Vulnerable Transit Users	
Lead: John Hopkins University	Collaborators: GT, UTEP, NDSU
<i>Motivation: Transit users are often economically disadvantaged relative to drivers of private vehicles and often face health risks pertaining to air quality and exposure to emissions, as well as other areas. This project will address health disparities by considering the emissions exposure of students who take transit to school in Baltimore.</i>	
Project #4—Transportation and Health Equity: Tools for Community Engagement	
Lead: Morehouse School of Medicine	Collaborators: UTEP, NDSU, TTI/TAMU
<i>Motivation: Engagement of historic and current underserved communities is a critical element of promoting health equity in transportation and promoting community-centered decision-making. This project uses dissemination and implementation research methods for a unique application in the metropolitan Atlanta region to develop an equity framework and community-engagement tools for transportation planners.</i>	
Project #5—Low-Emissions Technologies for Tribal and Rural Communities	
Lead: North Dakota State University	Collaborators: TTI/TAMU, MSM, UCR



Motivation: *Often, new technologies and advances in transportation are not readily accessible to all, resulting in their benefits being unavailable to several underserved communities, such as in rural and tribal areas.*

Project #6—Mitigating Freight Emissions in EJ Communities in and Around Ports

Lead: University of California, Riverside

Collaborators: UTEP, MSM, GT

Motivation: *The heavy-duty vehicle sector, associated with freight movement, is outpacing light-duty vehicles in growth and contribution to mobile source emissions. Communities near port areas are shown to be disproportionately impacted by freight emissions.*

Some highlights of progress on each research project is as follows:

- **Electric versus Internal Combustion: What are the Actual Emissions and Health Impacts?** – Researchers at TTI performed a literature review to identify the study target, approach, analysis method, and data needs and is also working to collect data regarding school buses, which is the subject of the case study analysis for this project.
- **Transportation and Health Equity: Tools for Community Engagement** – in this study, the team at Morehouse School of Medicine worked to advance the development of the health equity framework, and met with various Atlanta-based stakeholders such as the Atlanta Neighborhood Planning Unit (NPU) Program Manager and the City of Atlanta’s Department of Transportation’s Strategy and Planning Team. They also worked to review adaptation of the CARTEEH Curriculum and conducted a needs assessment for NPU leaders.
- **Low-Emissions Technologies for Tribal and Rural Communities** – in this study, the lead research team at North Dakota State University conducted a comprehensive literature review of low-emission technologies and their implementations in rural and tribal areas, and a draft survey is being finalized to be distributed to rural and tribal transit agencies to study the interest and adoption rates of electric vehicles and alternative fuel vehicles.
- **Health Risks for Vulnerable Transit Users** – In this period, the study team at Johns Hopkins University worked to get Institutional Review Board (IRB) approval at the Johns Hopkins Bloomberg School of Public Health and Baltimore City Public Schools. Administrative work continues to build the collaboration between JHU and Baltimore City Public Schools (BCPS) and the planned bus sampling and data collection activities are expected to be conducted in Fall 2024.
- **Integrated Transportation-Health Modeling Platform for Decision-Support** - The research team at Georgia Tech worked on the integration of MOVES-MATRIX 4.0 with AERMOD dispersion model to develop hourly pollution profiles using standard AERMET hourly meteorological files for 2024 for the Atlanta Metro Area for use in enhanced exposure modeling work. The team is also currently linking travel demand model output vehicle route traces (path retention for 22 million vehicle trips per day) with AERMOD as a step in the development of multi-model-integration for exposure modeling.
- **Air Quality Monitoring for Vulnerable Communities** – The research team at the University of Texas at El Paso initiated several research tasks including the installation of



air sensors for testing and calibrating the devices prior to field deployment as shown in Figure 1.

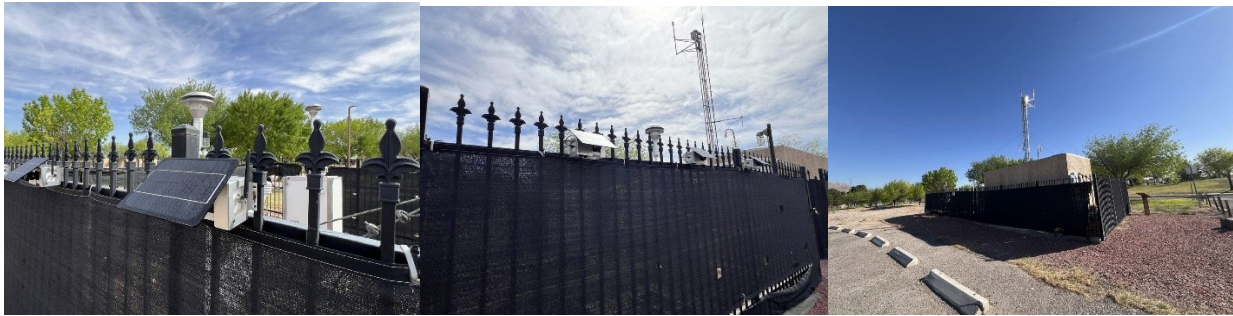


Figure 1. Clarity Air Sensor Installations at State Operated Air Monitoring Sites in Texas for Co-Location Calibration

- **Mitigating Freight Emissions in EJ Communities in and Around Ports** – the study team at University of California-Riverside has conducted preliminary information gathering activities and has been working on adjusting the scope and work plan for the collaborative research project based on the discussion within the CARTEEH consortium.

Development of CARTEEH “Research Thrusts” and Year 2 RFP Planning

During this reporting period, the CARTEEH consortium members worked together to identify more refined themes and thrust areas that could help guide future center activities, including the competitive request for proposals (RFP) anticipated to be issued within the consortium for the next round of projects to be initiated with Year 2 funding. The CARTEEH leadership team met for two follow up brainstorming discussions subsequent to the November 9th meeting to discuss and refine the statements of these thrust areas. These thrust areas, which will be finalized in the next reporting period are tentatively emerging as:

- Integration of Disciplines
- Advancing Health Equity
- Addressing Broader Impacts of Transportation
- Addressing Technologies and Disruptors

Initiation of “Healthy Mobility” Cross-Cutting Project

During this reporting period, the TTI team at CARTEEH began the initial steps towards scoping out a new strategic research project centered around the topic of “healthy mobility”. The idea of this study is to apply some of the foundational work conducted under the previous FAST Act CARTEEH grant related to transportation and health connections, while incorporating new technologies and trends to advance the concept of “healthy mobility”. This initiative was developed during discussions by the CARTEEH Director with a diverse set of stakeholders in both the public and private sectors and will be fleshed out as a new project in the next reporting period.



Research Results Disseminated

Nothing to report.

Plans for Next Reporting Period to Accomplish Research Goal

In the next reporting period, the collaborative projects will be continued, along with progress towards special strategic projects like the “healthy mobility” initiative and issuing the first competitive RFP for additional projects to be funded through the center.

CARTEEH Goal #2: Education and Workforce Development

Under education and workforce development, CARTEEH will continue to mentor the future transportation workforce and train and inform practitioners. Our programs include research assistantships and summer internships for university students and programs for high schoolers and community health workers.

Texas A&M University College of Education Partnership

The partnership with Texas A&M University’s College of Education, specifically the Department of Teaching, Learning, and Culture, continued with the ongoing K-12 partnerships. For public outreach, the team conducted programming during a fall and spring event reaching an estimated 1,200 K-12 students. The first was the supporting three sessions during the December *Expanding Your Horizons Workshop* in College Station, Texas, serving middle school girls. The second was hosting two booths during the April *Texas A&M University Physics and Engineering Festival* that reached K-12 students and families from the local area. Outreach activities include a swine lung display, an investigation with air quality monitors, and discussions on reducing the impacts of air pollution. For curriculum development, the team developed a high school version of the “What is in our air?” curriculum unit including three new lessons to support state science standards. Finally, the team supported an additional 14 schools with curriculum materials reaching an estimated 1,700 students.

CARTEEH Summer Internship

During this reporting period, the CARTEEH team received applications for the annual summer internship program. The internship program kicks off on May 28, 2024, and concludes on August 2, 2024. This program is held jointly with the internship program for the National Center for Infrastructure Transformation (NCIT) and Southern Plains Transportation Center (SPTC) at TTI’s headquarters in Bryan-College Station, Texas. Three upper-level undergraduates interested in transportation emissions, energy, and health have been selected from a pool of applicants. They will spend 10 weeks in the CARTEEH offices this summer, participating in professional development activities, technical tours, and research presentations throughout the summer. Each intern takes on a chosen research topic under the guidance of a TTI researcher serving as their mentor.



Student Involvement

While CARTEEH center activities under the BIL grant are only now being initiated, several students have already been engaged as part of ongoing projects. Currently, CARTEEH projects across the member institutions involved two undergraduate students, two master's students, and four doctoral students during this reporting period.

Plans for Next Reporting Period to Accomplish Education and Workforce Development Goal

For the next reporting period, the team will continue high school curriculum development efforts, conduct the summer internship program, and continue to expand on the involvement of students in CARTEEH center activities.

CARTEEH Goal #3: Technology Transfer and Collaboration

In this reporting period, several activities related to technology transfer and collaboration were initiated and continued by members of the CARTEEH consortium.

Clean Transportation Collaborative

The Clean Transportation Collaborative (CTC) was established during the FAST Act grant to provide a forum for stakeholder interaction and collaboration related to the clean energy transition and electrification of transportation. During this reporting period, activities were focused on realigning the CTC to meet the needs of a changing clean transportation landscape and to realign with CARTEEH's updated research thrusts that will drive center activities moving forward. TTI staff have conducted a stakeholder analysis, developed a series of topics and identified speakers for webinars, developed communication strategies and materials for CTC members, and developed three white papers on the state of MHDV Alternative Fueling Infrastructure, Alternatively Fueled Aviation, and Wireless EV Charging. These materials and the revamped CTC website and events will be released during the next reporting period.

Health Equity Webinar

The Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH) hosted a webinar on **Thursday, October 12, 2023**, titled *Transportation Emissions and Health Equity: Research Perspectives*. This webinar featured a panel of CARTEEH consortium members sharing their research and perspectives on topics at the nexus of transportation emissions and health equity. A link to the webinar recording can be found here <https://youtu.be/wSqPpex3uak>.

CARTEEH Co-Sponsored Events at UC-Riverside

UCR also hosted, with CARTEEH being a co-sponsor, the following events:

- The 2023 Science and Technology Education Partnership Conference (STEPCon 2023) on October 5, 2023, in Riverside, CA. See



<https://www.cert.ucr.edu/news/2023/10/09/inspiring-future-ce-cert-hosts-stepcon-2023>

- The 4th IEEE Forum for Innovative Sustainable Transportation Systems (FISTS 2024) during February 26-28, 2024, in Riverside, CA. See <https://www.cert.ucr.edu/news/2024/03/08/ieee-fists-2024-conference-4th-ieee-forum-innovative-sustainable-transportation>

CARTEEH Symposium Planning and Clean Transportation Research Complex

The CARTEEH team has initiated planning for a symposium to be held in Bryan-College Station tentatively in the Spring of 2025. The event is envisioned to coincide with the grand opening of TTI's Clean Transportation Research Complex (CTRC). The CTRC was created in 2023 as part of a cooperative effort between the Texas A&M Transportation Institute (TTI) and the Texas A&M Engineering Experiment Service (TEES), and much of the preliminary groundwork for this facility was laid through leveraging CARTEEH activities related to vehicle electrification under the FAST Act grant.

The complex's facilities include the Environmental and Emissions Research Facility (EERF) and the Grid Interactions Research Facility (GIRF). The CTRC was created as part of the expansion efforts at the EERF to add capabilities for research efforts in the emerging field of electric vehicles and their impact on the grid. While this facility expansion has been funded by the State of Texas and through a federal grant from the Department of Education, it is expected that the laboratory facilities will be used to support CARTEEH activities and provide equipment for conducting research in the future, including for the TTI-led collaborative project on diesel versus electric school buses.

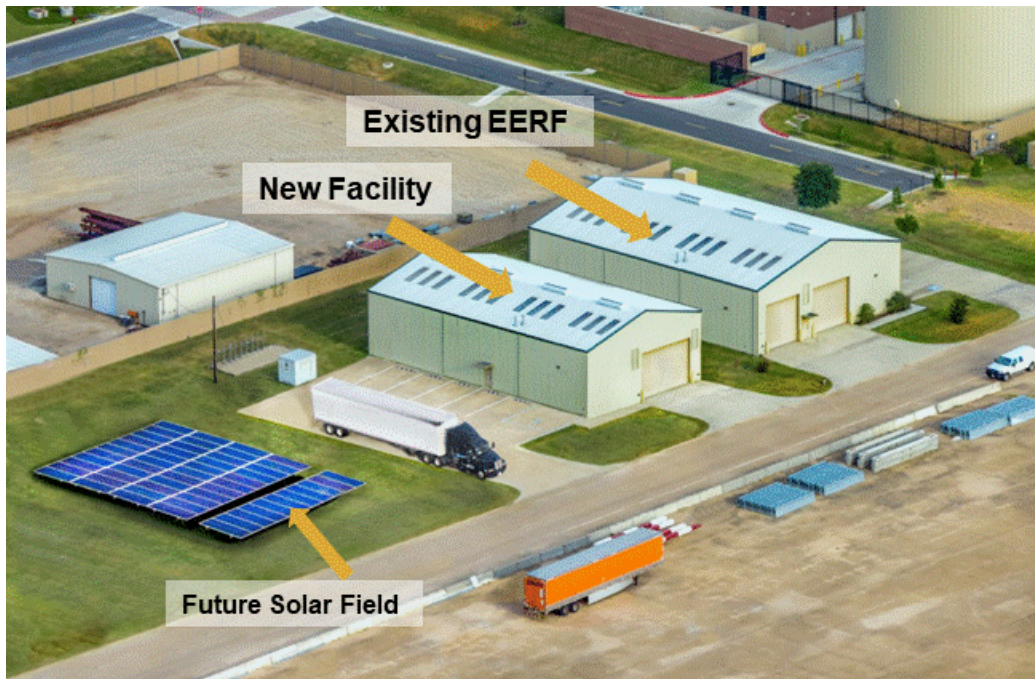


Figure 2. Clean Transportation Research Complex - To be Showcased in CARTEEH's Symposium



Technology Transfer and Collaboration Results Disseminated

The above activities have resulted in outreach and dissemination of CARTEEH’s activities to our stakeholders and mailing lists, and through our conversations at various professional conferences and events.

Plans for Next Reporting Period to Accomplish Technology Transfer and Collaboration Goal

In the next reporting period, we will continue to update and refine our technology transfer outputs and products developed under the FAST Act grant, schedule webinars, and other outreach events, and reestablish the CTC with the new direction for the BIL UTC.

2. PARTICIPANTS AND COLLABORATING ORGANIZATIONS

This reporting period, as the first full reporting period of the grant, had only preliminary outreach and collaboration with several organizations or collaborators. We anticipate a larger list of collaborations to occur in future reporting periods.

Organizations Involved as Partners

The CARTEEH consortium is a seven-member consortium led by the Texas A&M Transportation Institute (TTI)—part of The Texas A&M University System. Other members include The University of Texas at El Paso, Johns Hopkins University, Georgia Technology University, University of California at Riverside, Morehouse School of Medicine, and North Dakota State University. The team members from the various partner universities have begun to collaborate on their projects and are refining plans for other CARTEEH activities.

Other Collaborators and Contacts

The tables below provide a list of organizations (Table 2) and individuals (Table 3) our consortium members interacted with during this reporting period.

Table 2. Organizations Interacted with During the Reporting Period

Organization Name	Location	Contribution
UT Health School of Public Health	El Paso and Houston, Texas	Community engagement and outreach
Baltimore City Public Schools	Baltimore, MD	Collaboration
Science and Technology Education Partnership	Riverside, CA	Collaborate on hosting STEPCon 2023 conference
IEEE Intelligent Transportation Systems Society	USA	Collaborate on hosting FISTS 2024 conference
Atlanta Neighborhood Planning Units	Atlanta, GA	NPU leaders and NPU University



City of Atlanta Department of Transportation- Strategic Planning Team	Atlanta, GA	Strategic Planning on Health Equity and Transportation
North Central Texas Council of Governments	Arlington, TX	Collaboration
Houston-Galveston Area Council	Houston, Texas	Collaboration
Texas Department of Transportation	Austin, Texas	Collaboration
Navistar	San Antonio, Texas	Collaboration
EY- Parthenon	USA	Collaboration
Peterbilt Motors	Denton, Texas	Collaboration
Center for Transportation Studies, University of Minnesota	Minnesota	Tour and Discussions
National Center for Infrastructure Transformation (NCIT)	Prairie View, Texas	Coordination with related UTC
National Center for Sustainable Transportation (NCST)	Davis, California	Coordination with related UTC
Eastern Research Group	Austin, Texas	Collaboration
California Air Resources Board	Sacramento, California	Collaboration on Future Seminar

Table 3. Individuals Interacted with During the Reporting Period

Name	Affiliation (institution & location)	Contribution
Jayajit Chakraborty	University of California Santa Barbara	Identification of Vulnerable Community
Leah Whigham	UT Health School of Public Health	Community outreach
Juan Aguilera	UT Health School of Public Health	Community outreach
Yun Hang	UT Health School of Public Health	Air quality data analysis
Joanna Pi-Sunyer	Baltimore City Public Schools	Collaboration (ongoing)
Haneen Khreis	University of Cambridge	Follow-up research activities
Oliver Gao	Cornell University	Collaboration
Richard Baldauf	USEPA	Collaboration
Nigel Clark	West Virginia University (Emeritus Appointment)	Collaboration
Karl Ropkins	University of Leeds	Development of future research ideas



3. OUTPUTS

The CARTEEH website (www.carteeh.org) continues to be updated. The TRB Research in Progress (RIP) database has also been updated to include all current CARTEEH projects. The Data Management Plan for the center was also reviewed and approved by USDOT during this reporting period.

Journal Publications

Li, W-W, Chavez M, Williams E, Vazquez L, 2023. Measurements of traffic-related air pollution at a U.S.-Mexico port of entry and its impacts on the nearby community, Discover Environment, (2023) 1:10. Measurements of traffic-related air pollution at a U.S.–Mexico port of entry and its impacts on nearby community | Discover Environment (springer.com)

Aguilera J, Jeon S, Raysoni AU, Rangel A, Li W-W, Whigham L, 2023. Decreased moderate to vigorous physical activity levels are associated with increased traffic-related air pollutants in children with asthma, J. of Environmental Health, 85(2): 16-24

Books or Other Non-Periodical, One-Time Publications:

Nothing to report.

Other Publications, Conference Papers, and Presentations

- Dr. Jeremy Mattson, North Dakota State University presented CARTEEH-related work as part of a TRB Workshop at the TRB Annual Meeting, January 7-11, 2024, in Washington, D.C. He spoke about “Research Needs and Opportunities to Overcome Decarbonization Challenges”.
- Dr. Joe Zietsman, CARTEEH Center Director, presented at the Houston-Galveston Area Council’s Regional Air Quality Planning and Advisory Committee about CARTEEH-related research on February 29, 2024.
- Dr. Mayra Chavez, University of Texas at El Paso, presented “Bridge of the Americas – Air Quality and Dispersion Modeling Study” at the 88th Meeting of the Joint Advisory Committee, February 20, 2024, hosted in Ciudad Juarez, Chihuahua, Mexico.
- Vazquez L, Chavez M, Li W-W, 2024. Enhanced air quality monitoring in the Paso del Norte region using low-cost sensors, accepted for a presentation at the 2024 Air Sensors International Conference, Apr. 30 - May 3, Riverside, CA.
- Vazquez L, Chavez M, Li W-W, 2024. Optimizing data accuracy in low-cost air quality sensors, accepted for a presentation at the 2024 Air Sensors International Conference, Apr. 30 - May 3, Riverside, CA.
- Chavez M, Williams E, Cheu KR, Li W-W, 2024 air quality measurements of PM, NO₂ and O₃ in a near-highway community using mobile monitoring and stationary



continuous monitoring, accepted for a presentation at the 2024 Air Sensors International Conference, Apr. 30 - May 3, Riverside, CA.

- Li, W-W, Chavez*, M, Hernandez Y, Toquinto, F, Vazquez A, 2023, Low-cost PM2.5 measurements in the binational metropolitan area along the U.S.-Mexico border, TCEQ Environmental Fair and Conference, May 14-15, 2023, Austin, TX

Technologies or Techniques

Nothing to report.

Inventions, Patent Applications and/or Licenses

Nothing to report.

4. OUTCOMES

Nothing to report.

5. IMPACTS

Nothing to report.

6. CHANGES/PROBLEMS

Nothing to report.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report.

