



Center for Advancing Research in Transportation Emissions, Energy, and Health

A USDOT University Transportation Center

Agenda

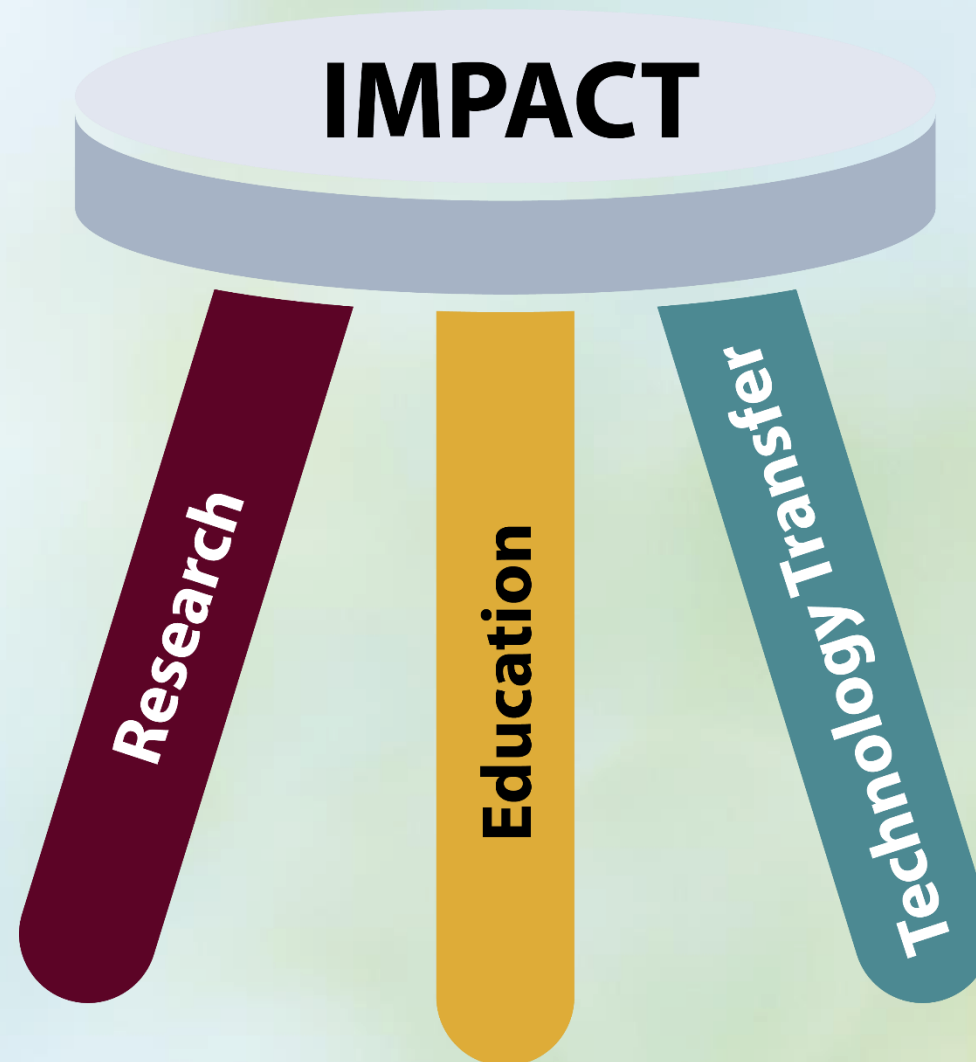
- Overview of CARTEEH's Educational Mission and Programs, Dr. Joe Zietsman, Texas A&M Transportation Institute
- Health-Transportation Education in School STEM Programs, Natasha Wilkerson, Texas A&M University
- CARTEEH Research as a Teaching Tool in Environmental and Occupational Health, Dr. Mary Fox, Johns Hopkins University
- Development of Georgia Tech's Interdisciplinary Transportation, Air Quality and Health Course, Dr. Mike Rodgers, Georgia Tech
- Facilitated Discussion/Q&A



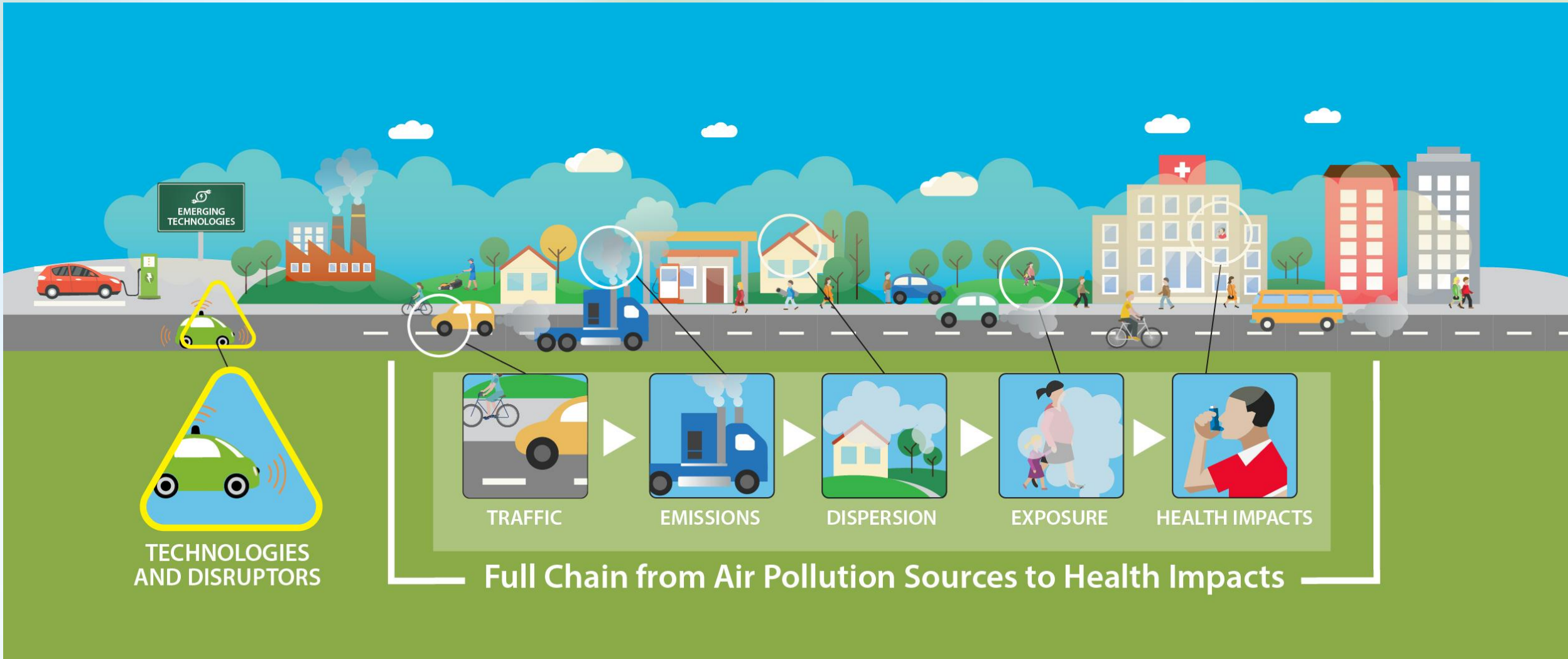
CARTEEH Consortium Members



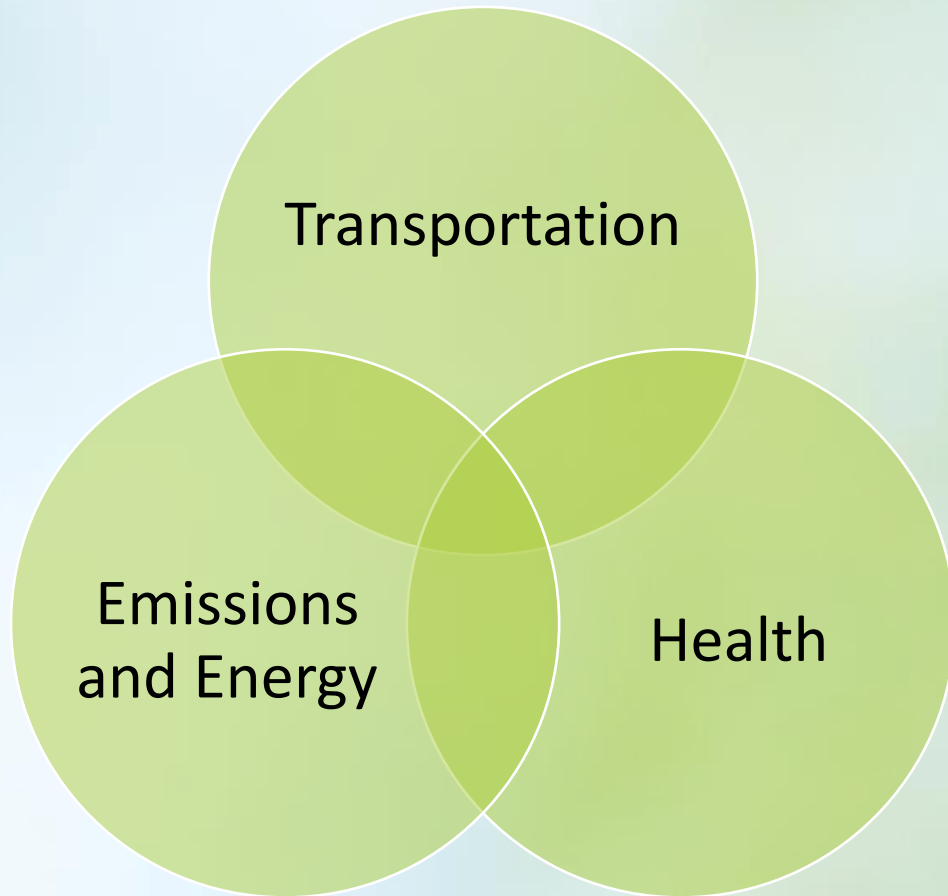
CARTEEH Focus Areas



Transportation Emissions and Health Spectrum



Multi-Disciplinary Approach



- 14 Pathways between health and transportation
- **SMART** Infrastructure to Improve Public Health
 - Sustainable
 - Multi-modal
 - Accessible
 - Resilient
 - Technological

Key Initiative: CARTEEH Curriculum

- Modular, flexible curriculum geared towards university students
 - Syllabus
 - Lecture slides
 - Textbook
- Can be adapted to other audiences
- Related activities
 - K-12 teaching (Dr. Olson)
 - Teaching non-transportation audiences (Dr. Fox)
 - Implemented as a formal course (Dr. Rodgers)

Subject Areas

Basics of Air Quality, Emissions Standards, and Environmental Regulations

Monitoring and Modeling of Traffic Related Air Pollution

Exposure Assessment of Traffic-Related Air Pollution

Health Impacts of Traffic-Related Air Pollution

Health Impact and Burden of Disease Assessment

Policies, Technologies, and Mitigation Approaches

Educational Mission and Future Direction

- Link to our research and technology transfer activities
- Curriculum will continue to form the basis
- Not just traditional transportation fields
- Reach students of all ages - train the future workforce
- Support continuing education
- Decision makers and general public
- Focus on EJ/disadvantaged/underserved/underrepresented communities



EDUCATIONAL OUTREACH

Supporting Health-Transportation Education in
Schools

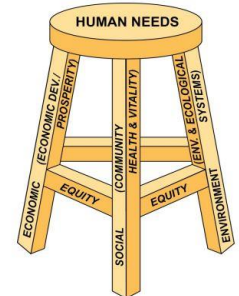
Mission of Educational Outreach

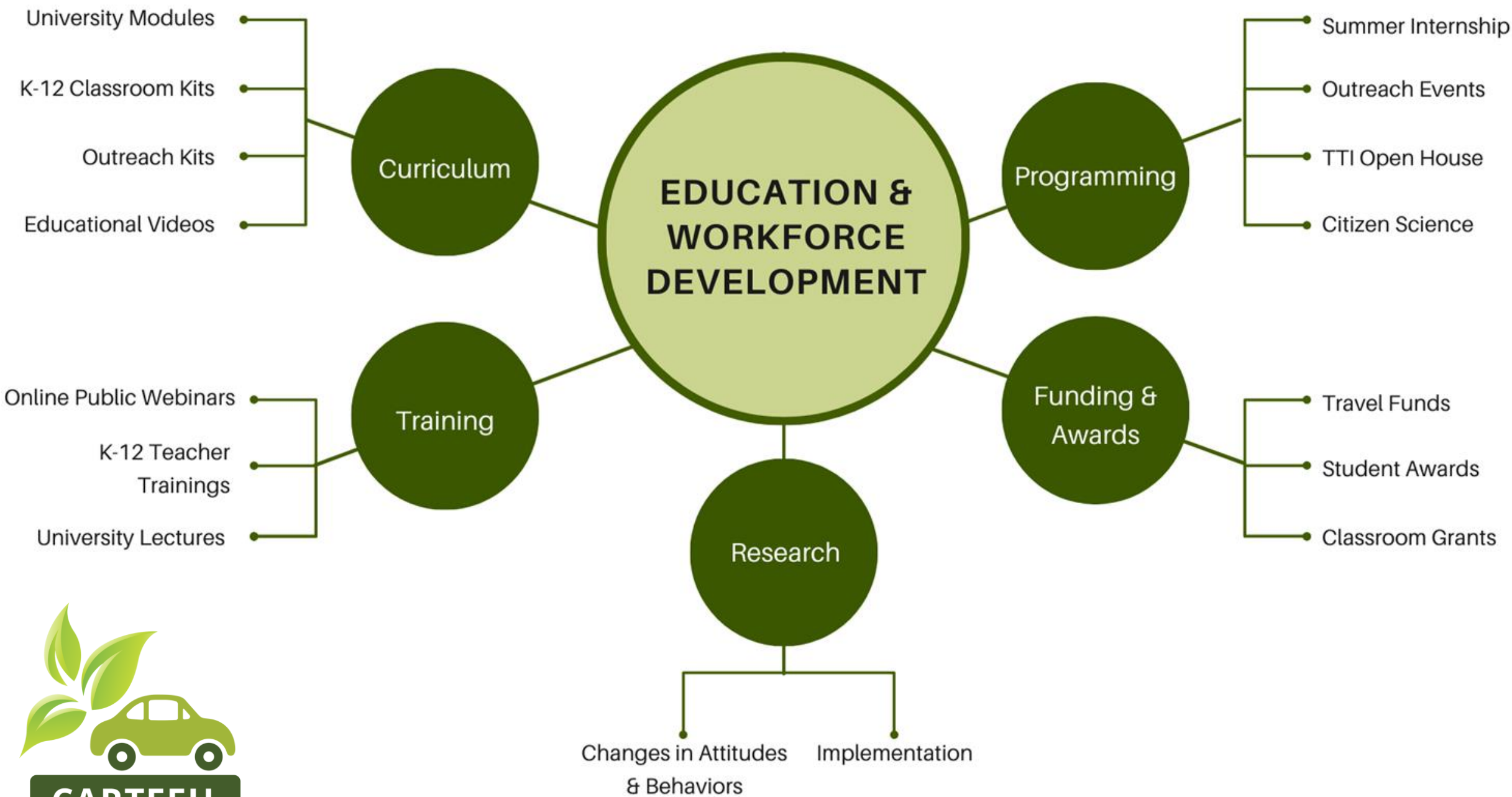


- Preparing future and current **decision-makers** in transportation and public health fields
- Educating **K-12 students** and the **public** on the impact of transportation emissions on human health
- Increasing interest in STEM career pathways



Sustainable Transportation





Focus of 2021 - 2022 School Year



Curriculum

- STEM Outreach Kit for general public
- K-12 Classroom Kit to support science educators

Training

- Develop preservice and teacher training for curriculum

Programming & Funding

- Attend outreach events and workshops
- Provide curriculum and supplies to K-12 schools for implementation

Research

- Submit publication on classroom curriculum
- Develop assessment to measure curriculum outcomes



TEXAS A&M UNIVERSITY
Teaching, Learning
& Culture

Development of STEM Outreach Kit



CARTEEH STEM outreach kit was developed to support public outreach programming.

- Provide engaging, hands-on experiences
- Scalable to support multiple events
- Increase awareness of air pollution and health impacts
- Increase awareness of CARTEEH's research
- Increase interest in STEM pathways



Pilot of STEM Outreach Kit



2: How does air pollution impact human health?



1: What is air pollution and how is it measured?



**Greens Prairie Elementary
STEM Night
October 19, 2021**



3: What can we do to reduce air pollution?

Outcomes of STEM Family Night



Greens Prairie Elementary STEM Night

October 19, 2021

- 200+ student and family participants
- 89% reported increased knowledge on air pollution
- 81% reported increased awareness of CARTEEH
- 79% reported feeling more empowered to reduce air pollution
- 71% reported increased knowledge of how air pollution impacts human health



Development of Classroom Kit



CARTEEH STEM Classroom Kit in development to serve grades 5 - 8.

- Aligned with science standards
- Based on educational research on how people learn
- Scalable to support deployment to schools
- Flexible for various learning environments
- Provides teacher training and support

Pilot of lessons in December during TAMU College of Science Expanding Your Horizons workshop for 6th grade girls.





CARTEEH Research as a Teaching Tool in Environmental and Occupational Health

Mary Fox, PhD, MPH

CARTEEH: Educating the Future
Workforce

Johns Hopkins Bloomberg School of Public Health

Human Health Risk Assessment

Risk assessment is a process in which information is analyzed to determine if a hazard may cause harm.

- Step-wise process
- Multidisciplinary science integration
- Decision-making framework

The goal is to provide the best possible characterization of risk based upon a rigorous evaluation of available information and knowledge.

For policies protecting our: air, food, products, water, worker health, etc.

<https://www.nap.edu/catalog/12209/science-and-decisions-advancing-risk-assessment>



CERTIFICATE PROGRAMS

Risk Sciences and Public Policy Certificate Program

SPONSORED BY: DEPARTMENTS OF ENVIRONMENTAL HEALTH AND ENGINEERING, EPIDEMIOLOGY, AND HEALTH POLICY AND MANAGEMENT

Onsite | Part-Time | 1-3 years

IN THIS SECTION

Home > Academics > Academic Programs > Certificate Programs > Risk Sciences and Public Policy Certificate Program

By Degree

Masters: 63%

Doctoral: 30%

Professional Continuing Education: 7%

Number of Students, 2017 to date

~90 in Environmental Health & Engineering

~15 in Epidemiology

~10 in Health Policy & Management

~10 in International Health, Microbiology,
Biochemistry



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☰ IN THIS SECTION

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Where our students go:

EPA, FDA, USAID

Environment, Communication and Management Consulting

National Academies of Science, Engineering and Medicine

Technology and Pharmaceutical Companies

Cumulative Risk Assessment: Science and Policy

Evaluate “real-life” complex exposures

- Multiple chemicals
- Chemical and non-chemical stressors

Flexible case-specific approaches to regulation, rather than command and control

Will be directed toward holistic risk reduction (systems)

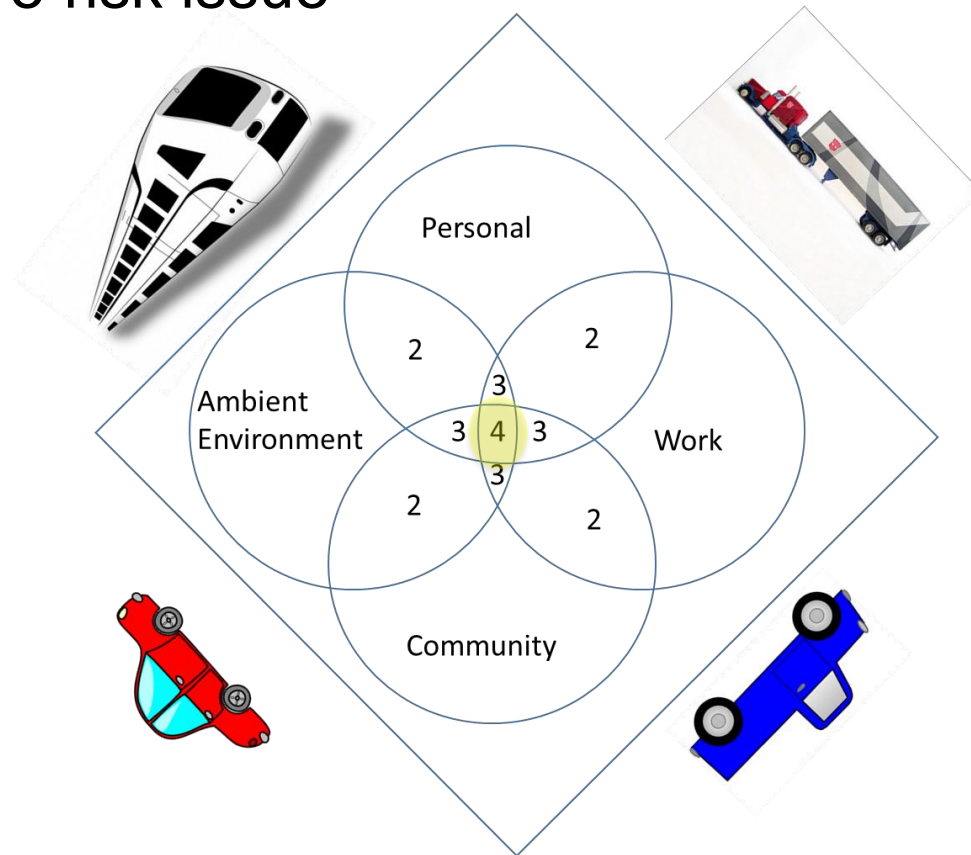
Cumulative Risk Assessment Guidance – Planning and Scoping, US EPA, 1997

Framework for Cumulative Risk Assessment, US EPA 2003



Transportation and health

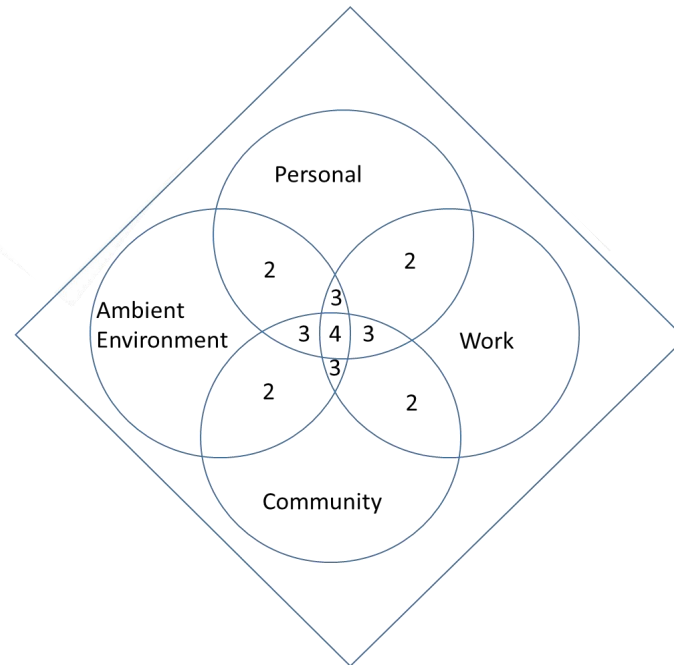
A cumulative risk issue



Health Risk Characterization of Re-fueling for Drivers and Workers

Personal
Portable
sampler
and survey

Ambient
EPA's
National
Air Toxics
Assessment



Work
Survey

Community
US Census
State and
Local Health
Statistics

Patton et al. 2021. Int. J. Environ. Res. Public Health
<https://doi.org/10.3390/ijerph18041872>



Courses with CARTEEH content

Methods in Quantitative Risk Assessment (Certificate)
Intermediate methods, computational modeling

Environmental and Occupational Epidemiology
Concepts

Exposure Sciences for Health Risk Assessment
Intermediate data analysis, computational modeling



Concepts and Skills

- Study design
 - Developing a sampling protocol and equipment
 - Survey design
- Data analysis
 - Primary data analysis
 - Secondary data analysis
- Interpretation
 - Evidence integration
 - Risk characterization
 - Policy implications



Wrap-up

Multidisciplinary - health science, exposure science, policy

Transdisciplinary - creating a common framework and language

Influential – risk assessment framework for seeing people, science, systems and policy making



The background is a solid dark blue color. On the left side, there is a large, faint, light blue graphic. The top part of this graphic is a stylized flame or torch, and the bottom part is a stylized globe with latitude and longitude lines. A horizontal light blue band is positioned across the middle of the image, containing the text.

Thanks!

mfox9@jhu.edu



**Georgia
Tech**

CREATING THE NEXT

Development of Georgia Tech's Transportation, Air Quality and Health Course

2021 CARTEEH Symposium on Educating
the Future Workforce

December 9, 2021

Dr. Michael O. Rodgers

CARTEEH and Education

- CARTEEH
 - Center for Advancing Research in **Transportation Emissions, Energy and Health**
 - Inherently Interdisciplinary/Multi-disciplinary
 - Transportation/Emissions Professionals (vehicle activity and vehicular emissions rates)
 - Air Quality Professionals (transformation and dispersion of pollutants)
 - Public Health Professionals (exposure and health effects analysis)
- Survey of offerings found few university courses offering strong technical content across the range of topics.
 - Available technical courses tend offer limited (if any) content in one or more focus areas (e.g. GT CEE 6625 Transportation, Energy and Air Quality had no exposure or health-related content)
 - Courses that covered all areas tended to be overview-type courses lacking strong technical content (e.g. GT PubP 6610 Environmental Issues)

CARTEEH Educational Initiatives

- Model Course Materials (CARTEEH partners lead by TTI)
 - Modular Course Materials
 - Textbook Development
 - Supplemental Lecture Materials
- New Course Pilot Study (Georgia Tech)
 - Focus on Senior-Level Undergraduates
 - Very limited prerequisites (Calculus, Systems) to allow for a broad-range of majors
 - Sufficient technical content to count as a technical-elective for both engineering or science majors
 - Team Teaching
 - Range of instructor expertise
 - Familiarity with knowledge base of undergraduates in different disciplines

Transportation and Health

- Taught twice as a “Special Topic”
 - Spring Semester 2019
 - 26 Students
 - 5 majors
 - Civil and Environmental Engineering, Industrial and Systems Engineering, Biomedical Engineering, Mechanical Engineering, Management
 - Spring Semester 2020
 - 31 Students
 - 7 majors
 - Civil and Environmental Engineering, Industrial and Systems Engineering, Biology, Earth and Atmospheric Sciences, Public Policy, Biomedical Engineering, Chemical and Biochemical Engineering
- Approved as permanent course February 2021
 - CEE 4670 Transportation and Health
 - Currently being taught (Fall 2021)

Instructional Faculty/Teaching Assistants

- Instructors of Record

- Michael O. Rodgers, Ph.D. Georgia Tech, CEE & Public Policy
- Haobing Liu, Ph.D. Research Engineer (now Asst. Professor, University of New Mexico) (Spring 2019)
- Hongyu Lu, GRA, Georgia Tech CEE (Spring 2020, Fall 2021)
- David J. Ederer, MPH, (now Ph.D.), GRA Georgia Tech CEE and CDC (2019 and 2020)

- Guest Lecturers

- Liz York, FAIA, Centers for Disease Control and Prevention
- Andrew Dannenberg, M.D. MPH, University of Washington, College of Public Health
- A.S. Willis Rodgers, Ph.D., Samford University, Department of Psychology
- Michael Garber, MPH, Emory University Rollins School of Public Health

- Additional Materials and Support

- Randall Guensler, Ph.D. , Georgia Tech CEE
- Catherine Ross, Ph.D., Georgia Tech, City and Regional Planning & Center for Quality Growth and Regional Development
- Angshuman Guin, Ph.D., Georgia Tech, CEE
- Franklin Gbologah, Ph.D. Georgia Tech, CEE
- Mary Fox, Ph.D. MPH, Bloomberg School of Public Health, Johns Hopkins University
- Pinar Keskinocak, Ph.D., Georgia Tech Industrial and Systems Engineering & Center for Health and Humanitarian Systems

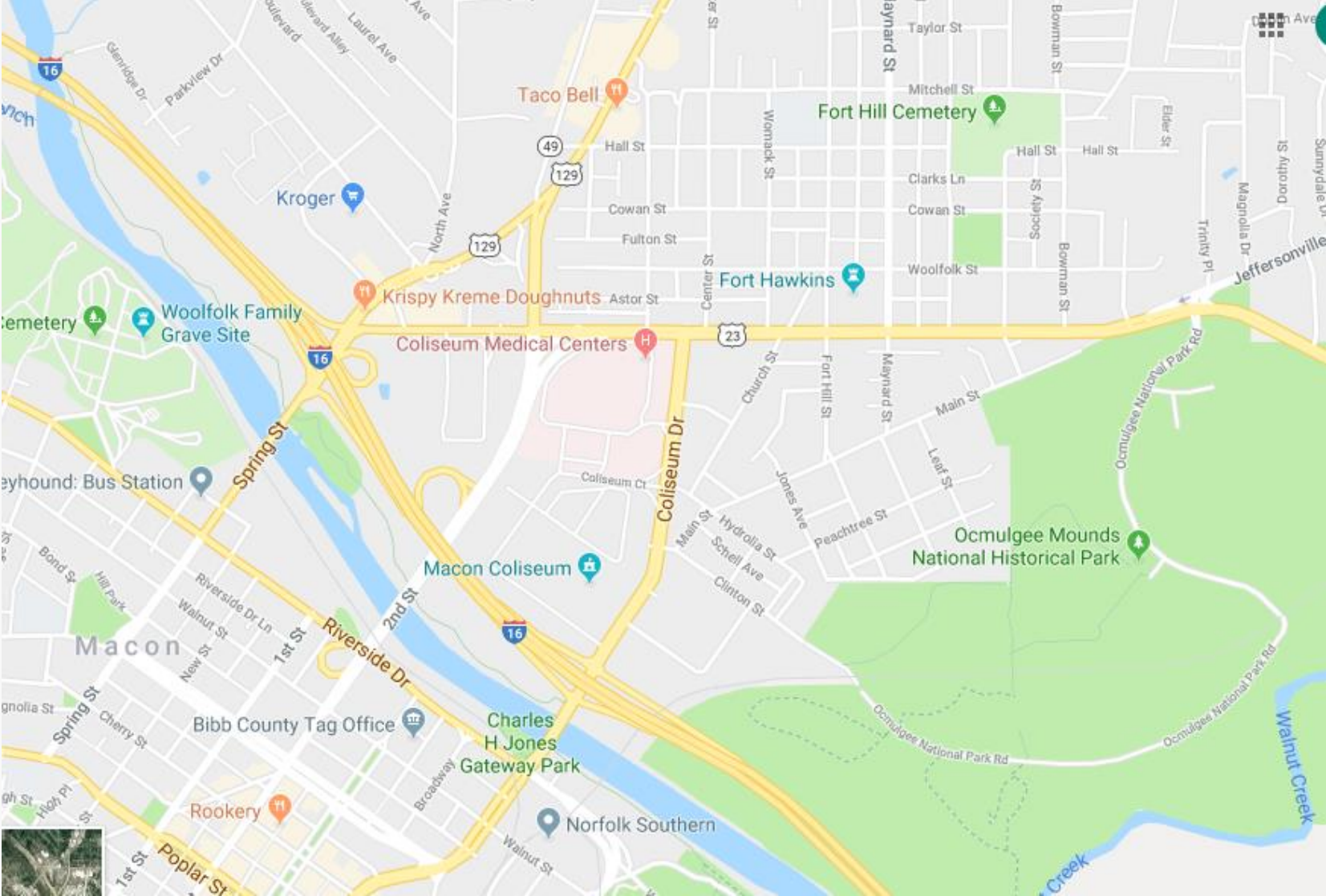
Course Syllabus

- Fundamentals of Transportation & Public Health (2 lectures)
- Air Pollution and Mobile Source Emissions (7 Lectures)
 - History of Air Pollution and Env. Regulation, Human Health Effects
 - Operating Emissions and Fuels
 - Atmospheric Photochemical Oxidant Formation
 - Clean Air Act and Motor Vehicle Emissions Regulations
 - Estimating Mobile Source Activity
 - EPA MOVES Model and GT Fuel & Emissions Calculator
 - Quiz and Time for Project
- Exposure Assessment for Mobile Source Pollution (6 Lectures)
 - Air Pollution Exposure and Assessment Methods
 - Air Pollution Dispersion Modeling (AERMOD)
 - Land Use Modeling and Exposure Surrogates
 - Source Apportionment & Personal Exposure Monitoring
 - Quiz and Time for Project
 - **Project 1 Poster Presentation (Freeway Emissions Modeling)**
- Effects and Impacts of Mobile Source Emissions on Human Health (8 Lectures)
 - Introduction to Air Pollution Epidemiology
 - Descriptive and Analytical Epidemiological Studies
 - Observational Studies & Determination of Associations/Meta-Analysis
 - Established & Emerging Effects of Mobile Source Air Pollution on Human Health
 - Psychological Impacts of Chronic Lung Disease
 - Sensitive Sub-Populations and Differential Effects
 - Quiz and Time for Project
- Policies and Technologies to Mitigate Mobile Source Impacts (6 Lectures)
 - Quantitative Health Impact Assessment
 - Impacts of Health Impacts on Policy and Decision Making
 - Transportation Policy Making Process
 - Cost Effectiveness and Feasibility of Policies
 - Quiz and Time for Project
 - The Three Revolutions and Impacts on Health
- Final: Health Impact Project Presentations

Course Projects

- Project 1 (Emissions Estimation)
 - Each group evaluated the hourly emissions of the primary mobile source air pollutants (**carbon monoxide, nitrogen oxides and fine particulate matter (PM_{2.5})**) over a separate 12-hr period for a segment of interstate highway in the Macon, GA area. These data were collected over a one-week period and include all vehicles passing a cordon line along I-475 and included basic vehicle information (vehicle classification, speed and acceleration).
 - Emissions estimates were made using **MOVES-Matrix** for light duty vehicles and the **Georgia Tech Fuel and Emissions Calculator (FEC)** for heavy duty trucks. The results were presented on a poster during a special class period.
- Project 2 (Exposure and Health Impacts)
 - Each group was asked to estimate average hourly emissions of carbon monoxide and fine particulate matter (PM_{2.5}) over a typical 24-hour period for **selected arterials, an interstate highway and an active rail line** near downtown Macon, GA.
 - These hourly emissions estimates used to estimate exposures to these pollutants for sensitive populations at several nearby **Schools, Hospitals, Nursing Homes and recreational areas** using the **EPA AERMOD** model. Estimated exposures were combined with a Health Impact model to **estimate likely health impacts on these populations**.

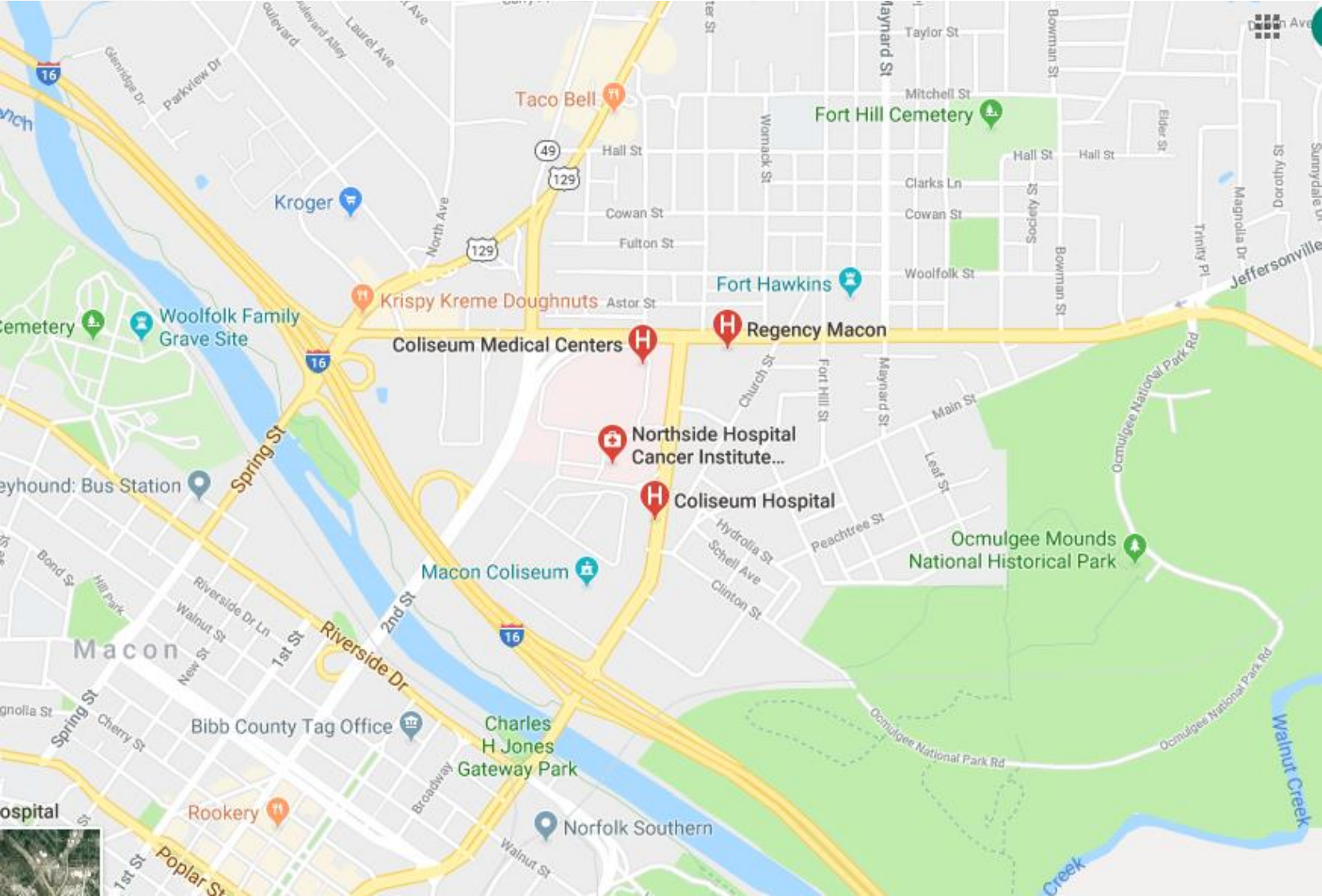
Project 2: Macon Georgia



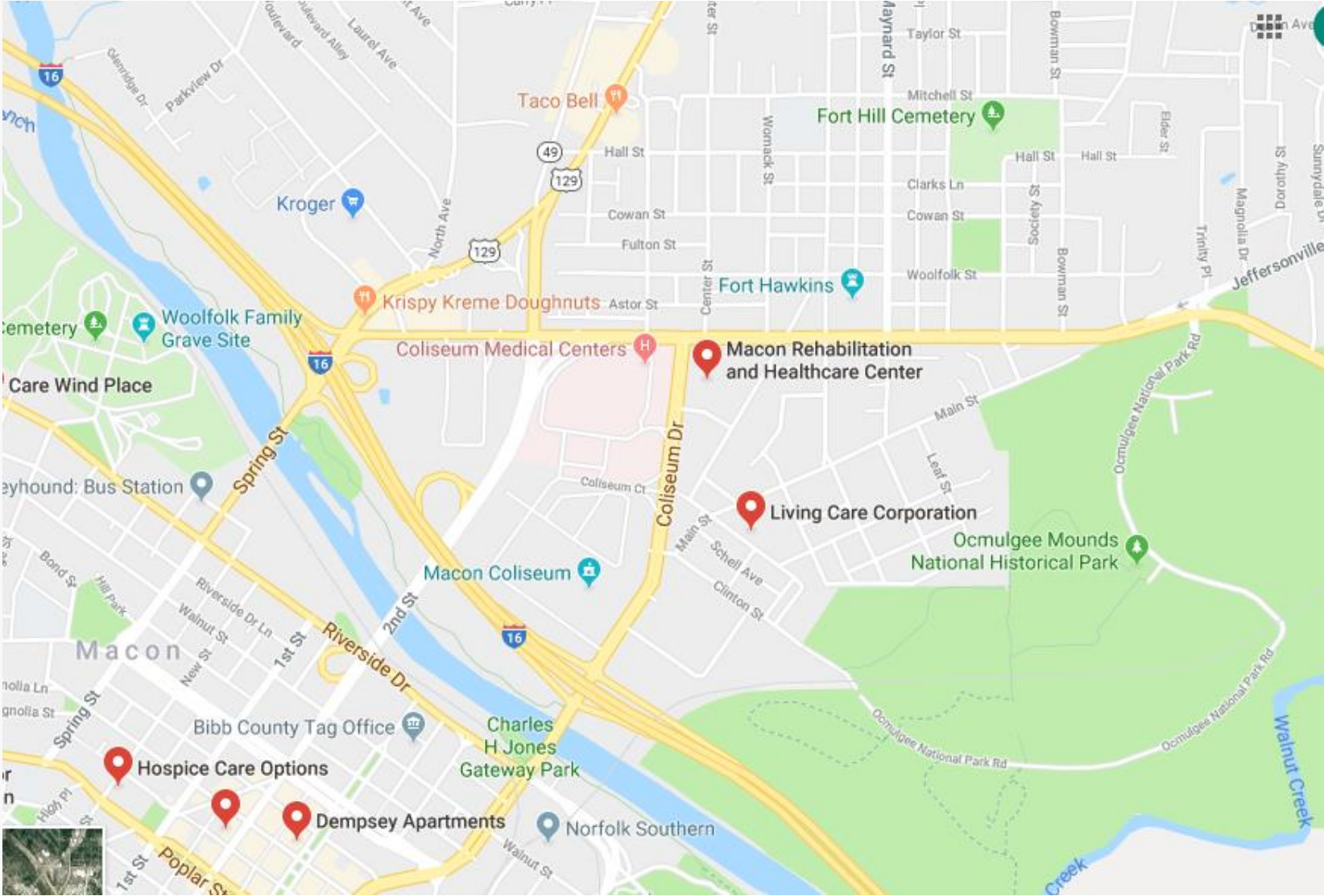
Schools



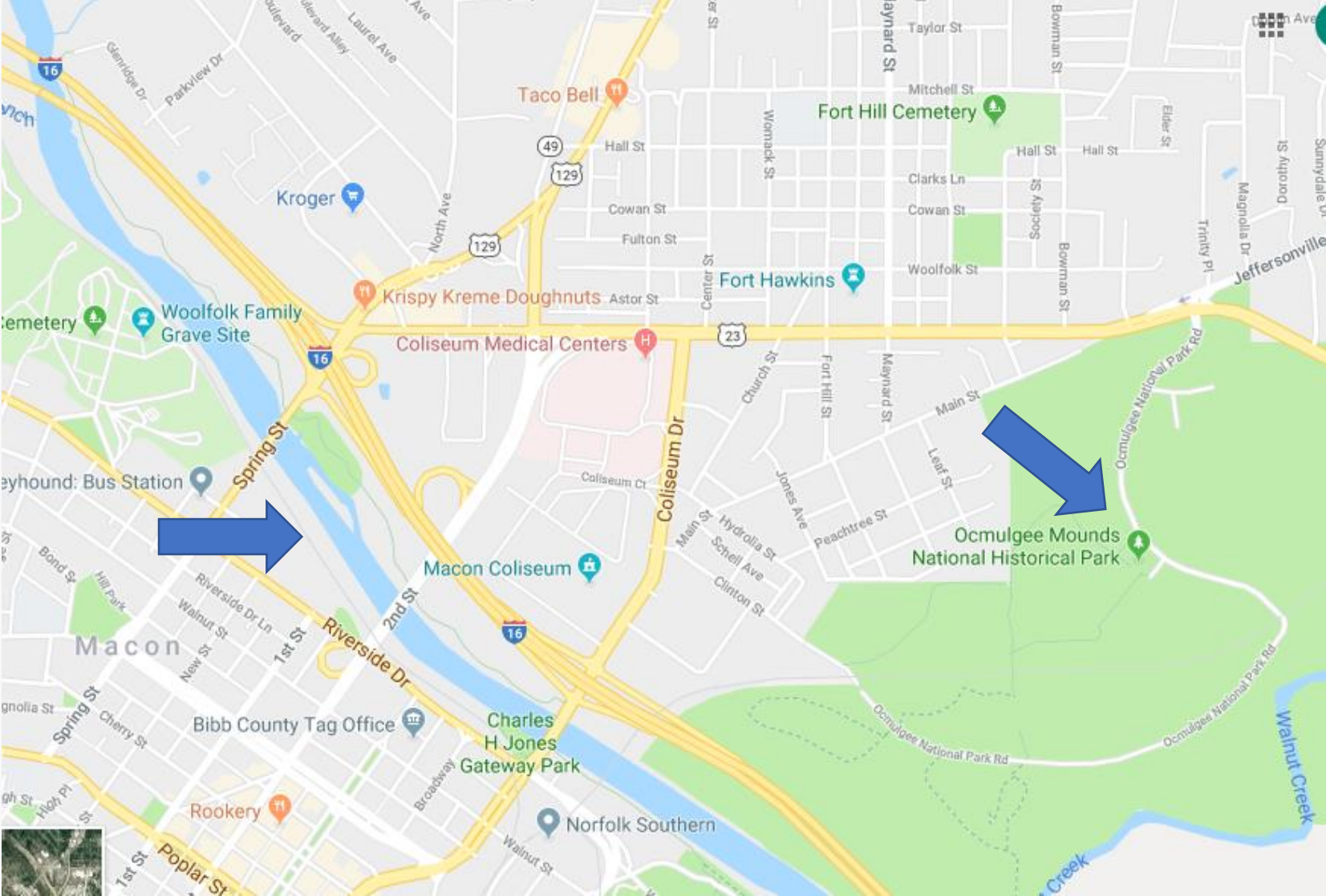
Hospitals



Nursing Homes



Ocmulgee and Riverwalk



Conclusions from Course

- Undergraduate students were able to both learn and apply a variety of contemporary models to estimation of transportation related air pollution impacts
 - MOVES-Matrix (EPA MOVES model)
 - Georgia Tech Fuel and Emissions Calculator
 - EPA AERMOD dispersion model
 - Simple exposure model
 - Health Impact Model (Di, Q. et al., JAMA 2017.17923)
- Highly Rated by Students
- Very Resource Intensive Course to Offer

Following Pilot Study

- Approved as permanent addition to Civil and Environmental Engineering course offerings
- Approved as technical elective for all Georgia Tech undergraduate degrees
- Included as part of newly proposed Public Health Minor at Georgia Tech
 - To be housed in Health Systems program in Industrial and Systems Engineering
 - One of the options for “Health and the Environment” elective
- Currently developing Graduate Version of course in cooperation with the Rollins School of Public Health at Emory University (Pilot Fall 2022).

Questions and Discussion

