2024 Vermont AOT Research & Innovation Symposium

September 25, 2024

Welcome...

Thank you for viewing our 2024 Vermont Research and Innovation Symposium booklet. The booklet will supplement this year's Symposium, held September 25, 2024, at the Barre Auditorium. This is our eighth annual Symposium, which also serves as our State Transportation Innovation Council (STIC) Collaborators and Partners Event. We expect over 120 people in-person and more online to learn about our projects. Symposium project posters, fact sheets, and presentations, when available, are found here, at our website: *https://vtrans.vermont.gov/planning/research/2024-symposium*

This booklet briefly introduces each of the 24 featured projects. They include research and innovations funded both by Vermont Agency of Transportation (VT AOT) sources and other partners. Each has a Vermont impact as described on each project page. Please follow the QR Codes to find additional information for each project.

This booklet contains the 24 projects separated into four separate categories: Planning and Safety; Materials and Structures; Asset Management, Environmental, and Resilience; Electric Vehicles and GHG Plus, two AOT project Champion profiles, and additional pages at the end with Symposium logistics (agendas, map, etc.).

We hope that this introduction to the VT AOT Research Program serves as a useful tool beyond the one-day Symposium. We thank our presenters, researchers, innovators, project Champions and other partners for their efforts with these projects and our event and booklet. Thank you to AOT and FHWA Leadership, all participants, and others for learning more about our program and projects.

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VERMONT
AGENCY OF TRANSPORTATION
RESEARCH PROGRAM

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Validating Collection Methods for and Quantification of Travel Time Delay Through Work Zones Across Vermont (PS1)

Presenters: Karen Sentoff, VHB and Jim Sullivan, UVM TRC

Vermont specifications identify acceptable work zone travel time delays, but they don't consider context, measurement procedures, or how to mitigate them. Can we make recommendations to improve these specifications?

Summary:

This project seeks to validate how we measure and quantify travel-time delays in work zones across Vermont and make recommendations to improve current and future guidance. These recommendations will establish a standard operating procedure for data collection and delay measurement to ensure specification compliance and will support established Work Zone Safety and Mobility Policy goals.

The team reviewed work zone safety and mobility practices in VT as well as other States, looking for standards and delay measurement methods. They collected data with mobile traffic monitoring platforms (MTMPs) across three work zones and established a travel-time delay calculation procedure.

After the construction season, the team will assess the travel-time delay at each site and establish delay thresholds, assess measurement methods, and develop a delay-measuring procedure for VT work zones.

Impact to VT:

This research will make recommendations on criteria for context-sensitive delays in Vermont work zones and identify how we quantify them.

The AOT can use this research to change current and future construction specifications and make updates to the AOT Work Zone Safety and Mobility Guidance. This research will help local agencies practically implement travel-time delay standards for work zones. This will increase mobility and improve the AOT's level of service to the travelling public.

Risk-Based Roadway Departure Crash Assessment (PS2)

Presenter: Mario Dupigny-Giroux, AOT

If we want to reduce fatal and serious injury crashes on rural roads, we must be proactive and predict their locations. How do we identify where roadway departures are likely to take place to construct appropriate treatments statewide?

Summary:

Roadway departures represent over 70% of all VT fatal and serious injury crashes. Unfortunately, these crashes occur in locations not detected by traditional high crash location network screening methods.

This project applied the systemic safety approach to identify roadway features that correlate with roadway departure crashes and classify locations most likely to produce these crashes.

Our team integrated AOT crash, roadway characteristic, traffic volume, and asset data into a single database. We focused on crash types related to lane departure safety and created a crash tree to discern where fatal and serious injury crashes occur. We identified 14 combinations of crash and facility types related to roadway departures. Using statistical modeling, we identified and weighted risk factors, calculated segment risk scores, and prioritized them on a five-level scale.

Our team screened the Vermont roadway network and determined the locations at highest risk of severe roadway departure crashes and created a set of GIS risk-based location maps to visualize our findings. Other AOT offices have taken this data and provided alternate ways to access and view it as well.

Impact to VT:

All roads in Vermont have been assigned risk levels for the likelihood of lane departure crashes. This important step will help combat lane departure crashes and target at-risk locations for safety treatments, which can be implemented during other non-safety projects.

The AOT and municipalities can proactively implement safety mitigation measures where they are most likely to be effective and where lane departures are most likely to be prevented. This will make VT roads safer.

Crowdsourcing and Data Analytics for Near-Miss Statistics (PS3)

Presenters: Arghavan Louhghalam, UMass Lowell, and Mazdak Tootkaboni, UMass Dartmouth

Near-miss traffic statistics are very informative, but hard to capture. This project integrated crowd sourced data with physic-based models to calculate the probability of extreme deceleration and subsequently near-misses.

Summary:

"Near-miss" traffic situations offer essential insights for all stakeholders in road transportation, including individual drivers, traffic planners, fleet managers, and the vehicle insurance industry. However, tracking and quantifying these events is challenging because they are represented by extreme statistics that cannot be captured through simple averaging procedures. The project framework aims at addressing this challenge by integrating the available crowd sourced data with physic-based models.

Extreme deceleration on road segments is identified as an indicator of the likelihood of near-miss events and is probabilistically linked to collision risk across various traffic densities.

The team employed a model-based framework to examine the internal structure of traffic and calculate the probability of deceleration to a full stop on individual road segments, indicating likely near-misses. The team then devised a predictive model to effectively relate the likelihood of near-miss events to expected collision risk, using publicly available data.

The models offer great potential for providing quantitative measures of risk and near-miss events.

Impact to VT:

Statistics on near-miss events can have significant benefits. It will help identify factors contributing to accidents in Vermont and reveal trends and patterns in drivers' behavior. These insights can help agencies devise proactive safety measures to effectively mitigate the risk of accidents.

Estimating the Effects of Smart Growth Strategies on VMT and GHG Emissions in Vermont (PS4)

Presenter: Karen Sentoff, VHB

This project leveraged big data to understand how compact, mixed-use development affects vehicle miles traveled (VMT), GHG emissions, and other VMT reduction co-benefits compared to more dispersed development patterns.

Summary:

The Vermont Climate Action Plan identifies vehicle miles traveled (VMT) reduction as a key pathway to achieve Global Warming Solutions Act (GWSA) targets. It also recognizes the need to quantify how smart growth strategies can reduce VMT and GHG.

The research team developed a model estimating VMT based on passively collected, location-based services data and built environment factors across Vermont. The project team, with other collaborators and partners, developed future growth scenarios, modeling implications of land use policies and built environment parameters. They also developed an interactive dashboard tool to let decision makers and others explore possibilities.

Scenario evaluations and case studies of Vermont communities revealed key research takeaways: Denser, mixed land uses require job proximity to achieve targeted VMT reductions; Vermont's historical settlement patterns and landscape of denser centers surrounded by more rural areas lends itself inherently to smart growth strategies.

Impact to VT:

The project helps AOT and other collaborators and partners understand how land use policy and future development patterns may help meet GHG emission reduction targets. Further, this project seeks to understand how smart growth development patterns may improve safety outcomes, reduce infrastructure maintenance costs, and provide health benefits in Vermont communities.

Taking a Hard Look: Do Active Transportation Projects Get a Fair Evaluation in Long-Range Regional Transportation Planning? (PS5)

Presenter: Emma Dreyer, UVM

This project dissects long-range regional transportation plans and travel demand models for 60 MPOs across the country. Is active transportation being modeled, considering what factors, and what are the impacts?

Summary:

This project studies the representation of active transportation (including bicycles and pedestrians) in travel demand models used by metropolitan planning organizations in long-range regional planning. The team analyzed the state of how active transportation is being modeled and what factors these models consider, how this impacts future vehicle miles traveled and greenhouse gas emissions estimations for a region, and how this plays into the funding and selection of active transportation infrastructure projects.

This is accomplished by dissecting the long-range regional transportation plan and travel demand model documentation for 60 MPOs across the country, randomly selected and grouped by size and region.

Impact to VT:

Content not provided by researcher(s).

Assessing the Impact of Literature-Based Trip Generation Rates on Truck Activity Modeling: Insights from Chittenden County, Vermont (PS6)

Presenter: Meg Fay, UVM

This project examines the critical role of truck trip generation modeling in metropolitan planning organizations (MPOs) across the United States with insights from applying three models to Chittenden County, VT.

Summary:

Large MPOs adopt varying methodologies for deriving trip generation rates, including "literature-based" rates. It is crucial to understand the impact of using trip generation rates from literature and different study regions on truck activity and its applications.

This study applies three different trip-generation models to Chittenden County, Vermont. The team evaluates the impact of literature rates on trip production for this study area, including trip volume, economic activity related to driving, and spatial distribution.

Impact to VT:

Content not provided by researcher(s).

"We need better transportation": Mobility, Community, and Connection of Latin American migrant workers in Vermont (PS7)

Presenter: Julia Lanz-Duret Hernandez, UVM

This project is a qualitative study focused on Latin American migrant mobility and resource access in Vermont.

Summary:

Transportation systems provide the means for people to reach desired destinations. The ability to travel varies widely, with many travelers facing constraints that cause travel burdens and reduce quality of life. Existing research evaluates outcomes of inferred travel constraints using proxy variables, but these only partially capture peoples' experiences and reasoning. Still less is known about these relationships among vulnerable populations underrepresented in traditional travel surveys.

This qualitative study focused on Latin American migrant mobility and resource access in Vermont. Legal landscape and resource access are major contributors to rural migrant workers' mobility, which in turn contributes to quality of life.

The research team evaluated travel burdens in constrained populations in the US using self-reported and inferred data from a large US survey. These results help inform a deeper evaluation of zero-car rural populations which have a high potential for constraint and travel burden.

All participants without a car reported using informal travel networks to get around. Findings highlight the importance of individual transportation access for migrant workers living in a rural context.

Impact to VT:

Latin American migrants living in Vermont face unique mobility challenges and barriers. Access to a car and informal travel networks are instrumental to migrant mobility in Vermont. Expanding access to permissive driver's licensing laws and investing in organizations and programs that strengthen community ties and improve information dissemination (including native language options) are crucial to improving migrant mobility in Vermont and beyond.

Use of Recycled Asphalt Shingles in Full Depth Reclamation as Mechanical Stabilizer (MS1)

Presenters: Fausto Bisanti and Eshan Dave, UNH

This project will determine feasibility of using recycled asphalt shingles (RAS) in road reconstruction projects and make recommendations on RAS dosages, dosing selection procedures, and RAS stabilized material mechanical properties.

Summary:

Recycled asphalt shingle (RAS) usage has been extensively researched. Annually, approximately 25,000 tons of shingles are produced in Vermont, and State law requires they be recycled.

Many agencies impose restrictions on RAS use in hot- and warm-mixed asphalts. Concerns exist about their use in surface layers of pavement structures, so research is needed to explore their application in lower pavement layers.

Many transportation agencies, including the AOT, prefer using full-depth reclamation (FDR) for rehabilitating asphalt pavements due to cost and environmental benefits. This process reduces the need to transport large quantities of materials off-site. However, stabilizing agents used in FDR tend to be expensive and have high carbon footprints. FDR's cost-effectiveness and environmental benefits could be further enhanced if RAS could have similar stabilizing effects without compromising performance.

This research addresses two critical questions- can RAS be used "as-is" or does it require processing to resize? Also, does RAS provide mechanical stabilization effects to FDR materials?

Impact to VT:

If this project determines RAS meets the physical-mechanical requirements to be reused in full-depth reclamation processes, this would allow AOT to support Vermont's construction waste material recycling initiatives and open a new market for RAS.

Allium Stainless-Clad Steel Reinforcement for Sustainable, Resilient, and Durable Highway Bridges (MS2)

Presenter: Sam McAlpine, Allium Engineering Inc.

Reinforcement corrosion is a primary driver of infrastructure degradation over time. This presentation will focus on the material and manufacturing innovations that enable better, longer lasting structural rebar.

Summary:

Concrete rebar corrosion is a visible problem across New England and especially Vermont. This corrosion problem is widespread and serious, threatening structural integrity of bridges.

This project focuses on low-cost metallic composite reinforcement bars with exceptional corrosion resistance and strength.

Rebar corrosion limits the durability of reinforced concrete structures. In this project, Allium Engineering, Inc. developed a new type of stainless-clad steel reinforcement with a novel laser deposition manufacturing process. The project tested the mechanical and corrosion properties of the material and its applicability to bridges.

The company has continued to develop the technology including experimentation with different stainless-steel grades for the cladding layer. Currently the focus is on establishing and scaling up manufacturing.

Impact to VT:

This project results in a new material for Vermont bridge engineers which allows productive resource investments in building and expanding new infrastructure instead of spending those resources repairing and maintaining existing infrastructure.

This project discovered this material can reduce corrosion by 10X, can be cost-effective, and maintains the structural properties engineers depend on for their designs. The material can save money and improve structural integrity and safety across Vermont.

Performance Concrete Optimized for Cost, Durability, Manufacturability and Sustainability (MS3)

Presenter: Mohammad Abdul Qader, UVM

This project is developing generic mix designs using Vermont aggregates for Performance-Based Concrete that meets performance specifications set by Vermont AOT. The team will present mix designs and test results.

Summary:

Concrete mixes continue to improve and evolve by using low-carbon cements and different aggregate mixes. This project aims to develop generic performance concrete mix designs that use newer cement formulations and locally sourced (Vermont) aggregates.

The generic concrete mixes are optimized to reduce cost and increase durability by employing the maximum packing density technique on locally sourced aggregates and partially replacing cement with lower carbon footprint supplementary cementitious materials.

The project tested twelve mixes using various combinations of low-carbon Portland Limestone Cement (PLC), Ground Glass Pozzolan (GGP), Fine Fly Ash (FFA), and Slag; and aggregates from Vermont-based suppliers. Initial screening selected four candidate mixes for extensive testing, including strength, durability and shrinkage.

All four mixes met the 28-day specifications for strength (4,000 psi), freeze-thaw durability (300 cycles), surface resistivity (10 kΩ-cm) and structural concrete shrinkage 0.042%. 3 of 4 mixes met the 28-day shrinkage specification of 0.032% for bridge decks, with the last one at 0.034%.

Impact to VT:

These generic mixes will help Vermont suppliers deliver high quality concrete at lower cost and with shorter development times.

Residual Strength Assessment of a Fire-Damaged Steel I-girder from a VT-14 Bridge (MS4)

Presenters: Hizb Ullah Sajid, Turner-Fairbank Research Center, Ryan Slein, FHWA

This project will investigate the residual mechanical performance of a severely-distorted steel I-girder that was exposed to a propane fireball for approximately 36-hours in Irasburg, VT on December 4th, 2023.

Summary:

Evaluating the residual capacity of a bridge's superstructure following a fire accident is critical to making rapid decisions to keep the public safe while mitigating disruption. This project investigates the residual mechanical performance of a steel I-girder structure that was exposed to a propane off-gassing fireball that burned for approximately 36 hours because of a 10,000-gallon liquid propane tanker veering off Route 14.

Two 42-foot-long girder lines, connected by cross-frames, were retained and tested. Other testing used the context of if the deck had simply been removed and repaired. Reference specimens were also obtained from steel regions not near the fire to assess baseline mechanical properties. This project utilizes the recently updated FHWA Manual on Heat Straightening, Heat Curving, and Cold Bending of Bridge Components.

Characterizing performance employed several experimental and more traditional methods including geometric laser scanning, surface condition classification, dye penetrant assessment, uniaxial tension testing for mechanical properties, impact testing, chemical analysis, and metallographic analysis.

Impact to VT:

The results obtained from this investigation will provide valuable insights and guidance on bridge repair strategies in the wake of fire accidents. This is particularly important due to the critical nature of bridge infrastructure and high frequency of occurrence of bridge fire accidents.

Understanding the residual steel superstructure integrity can inform other bridge repairs with similar damage.

Advanced, Automated NDE for Bridge Deck Evaluations (MS5)

Presenters: Amir Rezvani, Infratek Solutions Inc. and Jim Lacroix, AOT

This project proved the viability of using high-speed and ground-coupled nondestructive evaluation (NDE) technologies simultaneously in an automated and standardized fashion for bridge inspection.

Summary:

A lack of data, actionable insights, and visibility into bridge decks' current condition can lead to untimely strategies, unreliable repair estimates, quantities, and decisions.

This project employed automated and standardized NDE methods in high-speed, high-definition, ground-coupled applications to maximize the diversity and quantity of condition data while minimizing time on the bridge. This ensured a safe and accurate assessment of surface and subsurface conditions.

The quality-controlled raw data was then processed using automated data processing techniques, and the results were translated into metrics and contour plots that highlighted accurate surface and subsurface defects and corrosion potential. This solution is also capable of conducting and streamlining high-speed visual inspection and automatically preparing inspection reports for submission to FHWA.

The project outcomes featured bridge-specific condition plots, tabulations, repair quantity estimates and data-driven recommendations, with a focus on underlying deterioration mechanisms.

Impact to VT:

The results of this project could prevent cost overruns in rehabilitation projects by having a more accurate and reliable picture of the bridge decks' condition. The results can also help determine the type of preservation strategies and ideal time to apply them in early stages of the structure lifecycle, when problems are small and inexpensive to fix.

Developing a Framework for Defining Quality and Constructability of Transportation Projects (MS6)

Presenters: Dan D'Angelo, ARA and David Hoyne, GPI

This project will provide an agency feedback and communication framework for collaborators and partners to reduce the number of construction and design change orders and improve bidding competitiveness.

Summary:

Vermont's changing demographics are resulting in an aging contractor workforce and difficulties attracting new employees into construction trades.

Materials, construction equipment, and technology in the transportation industry have changed significantly while project plan content and the quality processes at AOT have not changed over time. AOT is experiencing less competition when bidding projects with corresponding price increases that appear to outpace inflation.

Currently there is no formal process to engage the contracting community to get feedback on plan content, project risk and quality. This research will develop a framework to engage the contracting community to improve partnering and for feedback to AOT (starting with the Structures Program) to better define risk, quality, and constructability.

The project is in the early stage of data collection and analysis. We need your input, please complete our survey using this QR code.

Impact to VT:

The project should help AOT deliver better-quality and more easily-constructed projects quickly at lower costs with more competition. It should reduce administration, construction and maintenance costs due to improved quality and constructability of project plans. The potential benefits of effective communication with contractors, consultants, material suppliers, and other collaborators and partners is immense. The framework supports the Agency's Strategic Plan Goal 5: Modernize and improve government efficiency through innovation, continuous improvement, and quality customer service.

Developing Prediction Models for Pavement Management (AMER1)

Presenter: Mark Woods, AP Tech

This project provided updated pavement condition models needed for AOT's pavement management system to optimize pavement treatment choices using over 20 years of pavement condition data.

Summary:

This project aimed to update existing performance models to better reflect deterioration trends and develop new models for thin overlays and NPMs.

The team conducted a comprehensive review of historical pavement condition and treatment history data. They successfully updated the existing prediction models and developed new ones for AOT's pavement condition indicators, including an International Roughness Index (IRI) index, rutting index, transverse cracking index, structural cracking index, and the National performance measure for cracking. The team generated different models based on underlying structure type and paving surface treatment. The team reviewed historical performance, identified outliers, and reported statistical indicators for each model to assess reliability and compare to pre-existing models.

The project resulted in model recommendations for 140 combinations of base types and treatment families. The team compared new and existing models and the most accurate model was selected to use in the pavement management system (PMS).

The recommended pavement condition prediction models support the Transportation Asset Management Plan (TAMP) and related activities, including predicting pavement performance, setting state and federal condition targets, and financial planning.

Impact to VT:

These updated models will make PMS analysis more accurate and help decision makers analyze funding needs.

Reliable life-cycle planning tools will improve pavement resurfacing and maintenance program cost-effectiveness, which opens funding to other programs, like bridges, capacity, or safety.

Updated models should improve confidence in future pavement construction and maintenance activities, increasing reliability in planning future investment programs.

Simplified Approach to Culvert Inspection Robot Design (AMER2)

Presenters: Evan Trombley & Brandon Gamble, UVM

Approximately 9,600 small culverts in Vermont must be inspected annually. Can we simplify the construction and maintenance of existing robotic culvert inspection systems while improving their performance?

Summary:

This research examined designing, building and using simple low-cost robots for small culvert inspection. Many of the ~9,600 small culverts in Vermont are too small for human inspection. Culvert failures can be expensive and lead to flash flooding and subsurface damage.

This project builds on previous AOT sponsored research that built small culvert inspection robots, i.e. HIVE 1.0 and 2.0. This research seeks to design, build and test new robots that are cheaper, easier to build and maintain, yet more capable than previous variants. The team worked closely with the AOT to evaluate and improve the new designs, then deliver two robots for field testing and usage.

HIVE 2.1 Culvert inspection robot built with low-cost components and with simple design that allows for easy fabrication and maintenance.

During the course of the project, the team developed and built an improved HIVE 2.1 culvert inspection robot and successfully completed preliminary performance tests.

Impact to VT:

This project developed an improved scalable tool for inspecting small culverts in Vermont. This will lead to better use of culvert maintenance resources that can reduce flooding and expensive repairs.

Advancing drinking water treatment residuals (DWTRs) use in stormwater treatment features to enhance phosphorus (P) removal (AMER3)

Presenter: Eric Roy, UVM

Removing phosphorous (P) from stormwater in roadside treatment infrastructure is challenging. Could two sand filters with aluminum-based DWTRs effectively remove P from stormwater?

Summary:

Excessive phosphorus (P) in Lake Champlain contributes to harmful and toxic algal blooms that make the water unsafe. The AOT is required to reduce the amount of P from our roadways and infrastructure per the total maximum daily load established for the lake. This includes meeting targets included in the State Phosphorus Control Plan.

Drinking water treatment produces a waste product, also known as drinking water treatment residuals (DWTRs), that is very effective at removing P from water, as demonstrated by previous research.

This project studied two sand filters enhanced with aluminum-based DWTRs with high P sorption capacity to determine stormwater P load reductions in the field. The team monitored 47 rain events over two sites, where we took time-based sub samples of stormwater inflow and outflow from the sand filters and tested these to estimate P loads for each event.

Results demonstrate that DWTR-enhanced systems can effectively remove dissolved P and thereby increase overall P load reduction. Overall, the systems reduced total P loads by 65-84 percent.

Impact to VT:

DWTRs are available at low or no cost and incorporating them into stormwater filters will drastically increase the amount of P removed.

Incorporating DWTRs in more stormwater treatment practices through new projects or retrofitted existing features better position Vermont to meet our P reduction targets.

This research could be applied to other phosphorus contributors and has the potential to cost-effectively improve the overall water quality in Lake Champlain or other water bodies.

Implementing the Vermont Forest Futures Strategic Roadmap (AMER4)

Presenters: Katharine Servidio and Oliver Pierson,
Vermont Department of Forests: Parks and Recreation

The 2024 Vermont Forest Future Strategic Roadmap evaluates how the forest products sector and greater forest economy can thrive in Vermont. This presentation provides an update on roadmap implementation.

Summary:

Vermont's forest economy provides more than 13,000 jobs, $2.1 billion in economic impact, and supports economic activity in the outdoor recreation and tourism sectors.

In February 2024, the Vermont Department of Forests, Parks, and Recreation (FPR) released the Vermont Forest Future Strategic Roadmap. The roadmap assesses the current state of the forest products sector in Vermont and identifies ways to strengthen, modernize, promote, and protect its long-term viability.

Vermont's forest products sector is facing a critical time with many challenges, including rising costs, workforce shortages, climate-related disruptions, and a growing misunderstanding of forest management.

The roadmap identifies 30 actions to address challenges, including nine high-priority short-term actions. A committee now collaborates on implementing these actions and achieving results for forests, the forest economy, and VT communities that depend on forests. This presentation provides an update on roadmap implementation, defines current priorities and partnerships, and explains how to get involved.

Impact to VT:

The roadmap fosters adaptation, innovation, appreciation and resiliency. It provides a guide for translating the vision of our preferred future into actions that will support a strong forest products sector and a thriving forest economy that makes significant economic, recreational, cultural and environmental impacts to Vermont.

Quantifying Bridge Risk using NOAA's Rainfall Data (AMER5)

Presenter: Erik Zuker, HNTB

Extreme rainfall and inland flooding events are top concerns in transportation and understanding them is very difficult. Can we use high-precision rainfall data to better understand and characterize these events?

Summary:

Extreme rainfall and inland flooding events have major implications for transportation. Understanding these events and their potential magnitude is difficult, especially for isolated extreme downpours. This presentation introduces an approach to better understand and characterize these events and their threats.

HNTB's Asset Level Rainfall Analytics Exercise (ALRAE) uses a multi-state, multi-year, high-precision NOAA rainfall dataset to create a "virtual rainfall gauge" that reports rainfall estimates at thousands of bridges. ALRAE can perform forensic analyses of storms and bridge failures/survivals. This presentation shares practical examples of how ALRAE can improve resilience by helping the transportation sector prepare, adapt, and respond to extreme weather. Dashboards visualize and quantify the data to help non-technical users understand and query databases.

Over 40% of flood damage claims from 2017 to 2019 were for properties outside of official mapped flood hazard zones.

NOAA's restructured rainfall dataset has provided new insights on isolated extreme rainfall behavior and overall risk to assets. Recent project efforts have shifted from bridges to an approach where we can assess any asset, location, watershed or roadway.

Impact to VT:

Quantifying rainfall extremes for specific locations both historically and in near real-time could benefit numerous areas of AOT, including increasing transportation network resilience.

This tool can help us understand past demands on bridges and culverts and assess current and proposed design criteria. We can also communicate risk to non-statisticians by quantifying and visualizing observed extremes. Operationally, we could use this to more effectively deploy personnel during and immediately after an extreme event.

Capital Program Greenhouse Gas Reduction Modeling (EVG1)

Presenter: Andrea Wright, Vermont Agency of Transportation

States are required to develop Carbon Reduction Strategies (CRS). VT AOT contracted Cambridge Systematics to draft Vermont's CRS.

Summary:

Vermont's Carbon Reduction Strategy development comprised two phases- estimating GHG emissions and reductions associated with AOT's Capital Program and developing a carbon reduction strategy.

During the first phase, the team developed a methodology to confidently estimate the effects of investments in the AOT Transportation Capital Program. This allowed the AOT to track and report GHG reduction goals.

1. *Measure GHG/carbon impacts*
2. *Identify strategies to reduce GHG*

In phase two, the team assessed future options for policy, program, and funding to cost-effectively reduce GHG emissions in transportation. Researchers then developed an investment strategy to reduce emissions consistent with Federal and State guidance and requirements. Additionally, the team engaged with stakeholders and the public for input and feedback on proposed options.

In November 2023, the State finalized the Vermont Carbon Reduction Strategy and submitted it to FHWA.

Impact to VT:

The details in this project outline the impact of numerous items on GHG emissions in Vermont, too many to list here. To learn more, please visit our poster and website via the QR code.

Although the impact of many carbon reduction strategies on overall GHG emissions may appear relatively modest, these strategies can have significant benefits in addition to reducing GHG emissions. These important benefits include improvements to local air quality, mobility, and public health.

Evaluation of Battery Electric Vehicle (BEV) Performance in Mountainous Regions and Cold Climates (EVG2)

Presenters: Mike Cross and Majd Khalaf, Norwich University

Real-world ranges of battery electric vehicles (BEVs) directly impact the required charging infrastructure. How does climate, terrain, varying road conditions, and road classification affect the overall performance of BEVs?

Summary:

Researchers from Norwich University are investigating the impact that climate, terrain, varying road conditions, and road classification have on the overall performance (range/energy consumption) of battery electric vehicles (BEVs). The team may also investigate the impact these challenging conditions have on vehicle safety systems and sensors required for semi/full automated vehicle operation.

This project involves operating a Tesla Model Y Long Range AWD in Vermont to collect data on vehicle performance while considering ambient temperature, elevation gain, and vehicle speed. The project will also monitor performance of advanced driver-assistance systems in environments that challenge the efficacy of these systems, including poorly marked rural roads and roads and markings covered with snow.

The real-world range of BEVs will have a direct impact on the charging infrastructure required to provide energy for BEVs, and the results from this study could be used in future efforts to optimize vehicle charger distribution, especially in rural communities. Additionally, this project may guide potential changes or improvements to road markings to accommodate autonomous vehicle implementation in the State.

Impact to VT:

Vermont BEV drivers are faced with non-ideal conditions on a daily basis- Vermont is cold and hilly! The compound effect of cold temperatures, large terrain variations, and multiple road types will lead to reduced range capabilities of BEVs, and this project will tell us just how much.

Results will help teach us how much charging infrastructure is required to support the growing number of BEVs on Vermont roads.

Vehicle Ownership and Use in VT Travel Model (EVG3)

Presenters: Jim Sullivan, UVM TRC, and Karen Sentoff, VHB

Many Vermont policies enacted or being considered are intended to affect vehicle ownership patterns. The State needs a tool to track and forecast vehicle ownership as well as policy implementation.

Summary:

This project leveraged vehicle performance data from the EPA, vehicle registration data from the Vermont DMV, manufacturer's data from the NHTSA Product Information Catalog and Vehicle Listing, travel behavior data from the NHTS, and federal fuel efficiency standards from the C.A.F.E. program to develop a sub-model of vehicle ownership and use in Vermont.

The sub-model allows vehicle-trips in the Vermont Travel Model to be assigned to one of seven specific vehicle classes, characterized by fuel efficiency and emission rates. This enables forecasting of future privately-owned passenger vehicle fleets and statewide fuel use and emissions. The model allows forecast scenarios that examine growth in the fuel efficiency of vehicle classes, shifts in the composition of vehicle classes, and higher fleet turnover rates related to policy changes.

Impact to VT:

This model is the first and only of its kind with the capability to forecast realistic changes in the fleet of privately-owned passenger vehicles in Vermont, including purchasers' shifts to more efficient vehicles in response to purchase incentives, and efficiency improvements of specific models by manufacturers in response to policies like C.A.F.E. standards. This tool will allow AOT and others to assess more accurate forecasts of mobile source fuel use and greenhouse gas emissions.

A Spatial Analysis of the Fuel Economy Rebound Effect in Vermont (EVG4)

Presenter: Narges Ahmadnia, UVM

How do improvements in vehicle fuel efficiency impact the miles people drive and are there significant differences between urban, suburban and rural communities in Vermont?

Summary:

This research evaluates how improvements in vehicle fuel efficiency impacts the miles people drive and uncovers significant differences across urban, suburban and rural communities in Vermont.

By analyzing data from over 132,000 households that did not move between 2018 and 2019, the team found that, on average, a 10% increase in fuel efficiency led to a 1.4% increase in miles driven – a 14% rebound effect. This rebound effect is even more striking in rural areas, where people are more automobile dependent and drive longer distances.

The findings revealed that the expected greenhouse gas (GHG) emission reductions from increasing vehicle fuel-efficiency and vehicle efficiency policies may be overestimated, especially for rural regions.

Impact to VT:

Content not provided by researcher(s).

Electric and Autonomous Vehicles, Housing Location Choice and the Potential Impacts on Travel Demand in Chittenden County (EVG5)

Presenter: Narges Ahmadnia, UVM

What are the effects of remote work, autonomous vehicles, and electric vehicles on housing location choices and travel behavior?

Summary:

This study conducted for the Chittenden County Regional Planning Commission (Vermont's only Metropolitan Planning Organization (MPO)) focused on understanding potential impacts of Autonomous Vehicles (AVs), Electric Vehicles (EVs), and remote work on individuals' housing location choices and travel behavior. The central question they evaluated was if AVs, EVs, and remote work are likely to increase or decrease travel demand in Chittenden County.

This research used the theoretical construct of "housing dissonance" to address this question. This notion encapsulates the prevailing dissatisfaction that individuals encounter with their current housing, including the structure itself and the surrounding community. This analytical framework functions as a perspective through which to investigate how the merging of AVs, EVs, and remote work might have the potential to mitigate this dissatisfaction by reducing travel related constraints on housing location choice, empowering individuals to shift toward living situations that more closely align with their aspirations.

Impact to VT:

AVs can influence travel behavior by reducing the driving burden; time in an AV may not seem as long or burdensome. EVs may reduce the cost of driving and can reduce GHG emissions, which can reduce the desire to move closer to cities.

Remote work opportunities have a less clear effect on housing location choice. Remote work can reduce discontent with travel time and work proximity, but this wasn't a major source of discontent.

Advancing Equitable Electric Vehicle Adoption: Addressing Home Charging Barriers and Costs (EVG6)

Presenter: Parsa Pezeshknejad, UVM

We need to address context-specific barriers to disadvantaged population electric vehicle (EV) adoption. People with fewer economic resources face a critical obstacle—lack of access to home charging.

Summary:

Vermont must address barriers to disadvantaged population electric vehicle (EV) adoption to equitably and effectively decarbonize passenger vehicle transportation.

Differences in EV adoption rates are concerning when they reflect barriers to adoption, particularly when they disproportionately affect vulnerable populations. Research shows that EV owners are more likely to be high income and white as compared to other vehicle owners.

One critical obstacle these populations is a lack of home charging access, which brings significant convenience and cost benefits. People living in multifamily and attached homes, older homes, and renters face unique barriers to installing home chargers, although little is known about how this affects EV adoption or about the additional costs of installing home chargers in these types of homes.

This project evaluates the relationships between EV adoption, home charger installation, and housing characteristics as well as the costs of home charging installation for homes of different types in the City of Burlington, Vermont. The team also investigates the sociodemographic makeup of residents living in homes with greater barriers to home charging.

Impact to VT:

Research indicates home charger installation costs are higher for people living in multifamily homes and identifies several associated factors for lower EV ownership.

Infrastructure investments and programs that address barriers to home charging are important to ensuring Vermont equitably and effectively meets greenhouse gas emissions reduction targets. This project's results can help inform policies targeting increased EV adoption by those facing limited home charging access.

Champion Profiles

Carolyn Cota (MS6)

Carolyn is the current AOT Structures Program Manager, responsible for an average $150 million budget for structures projects and 40 employees. She has worked for the Agency for 39 years. Her career has been spent ensuring that Vermont transportation infrastructure is meeting the needs of our state.

Why are you passionate about this project?

"Through my career with the Agency, I have seen changes in the way we develop our plans and projects," said Cota. "When I first arrived at the Agency, many of our drawings and plans were completed by hand and the use of CADD was just developing. We are now using 3D modeling in the development of our plans and all of our work is completed using CADD. Soon we will be delivering some projects without plans by using just 3D models. I have seen changes in how our projects are reviewed for quality and constructability and how it impacts deliverables. It is critical that we work with our contracting community to ensure that in the future we are delivering projects with lower risks and costs."

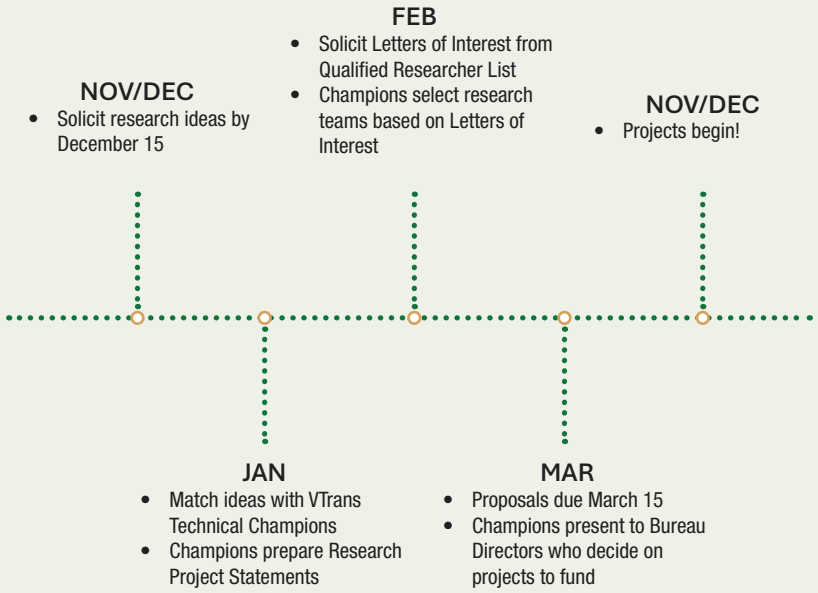
Heather Voisin (AMER3)

Heather is the AOT Green Infrastructure Engineer, where she focuses on stormwater concerns and compliance for projects in development. She has been in this role for nearly five years. Additionally, she oversees the efforts of the Landscape Architect and Project Contamination Engineers. Prior to that, she served as the Agency's Construction Environmental Engineer and worked in the private sector for approximately 12 years.

Why are you passionate about this project?

"This project studies the effectiveness of Drinking Water Treatment Residuals (DWTR) in stormwater treatment features to enhance Phosphorus reduction," said Voisin. "It's exciting for a number of reasons. It has the potential to take a waste product that is regionally available at low or no cost, use it in a new way, and drastically reduce the amount of Phosphorus leaving our projects. This will help us meet the P reductions required by our Phosphorus Control Plan and ultimately help improve the water quality of Lake Champlain and other water bodies with excessive levels of P."

AOT Research Process



FFY 2023 External Research Process Cycle

Do you have a research idea?

Will you Champion your idea that fits an AOT need?

Submit your idea!

Go to: *https://vtrans.vermont.gov/planning/research/resources*

Symposium Agenda

September 25, 2024 Agenda, 8am-2:45pm, Barre Auditorium and adjacent Alumni Hall

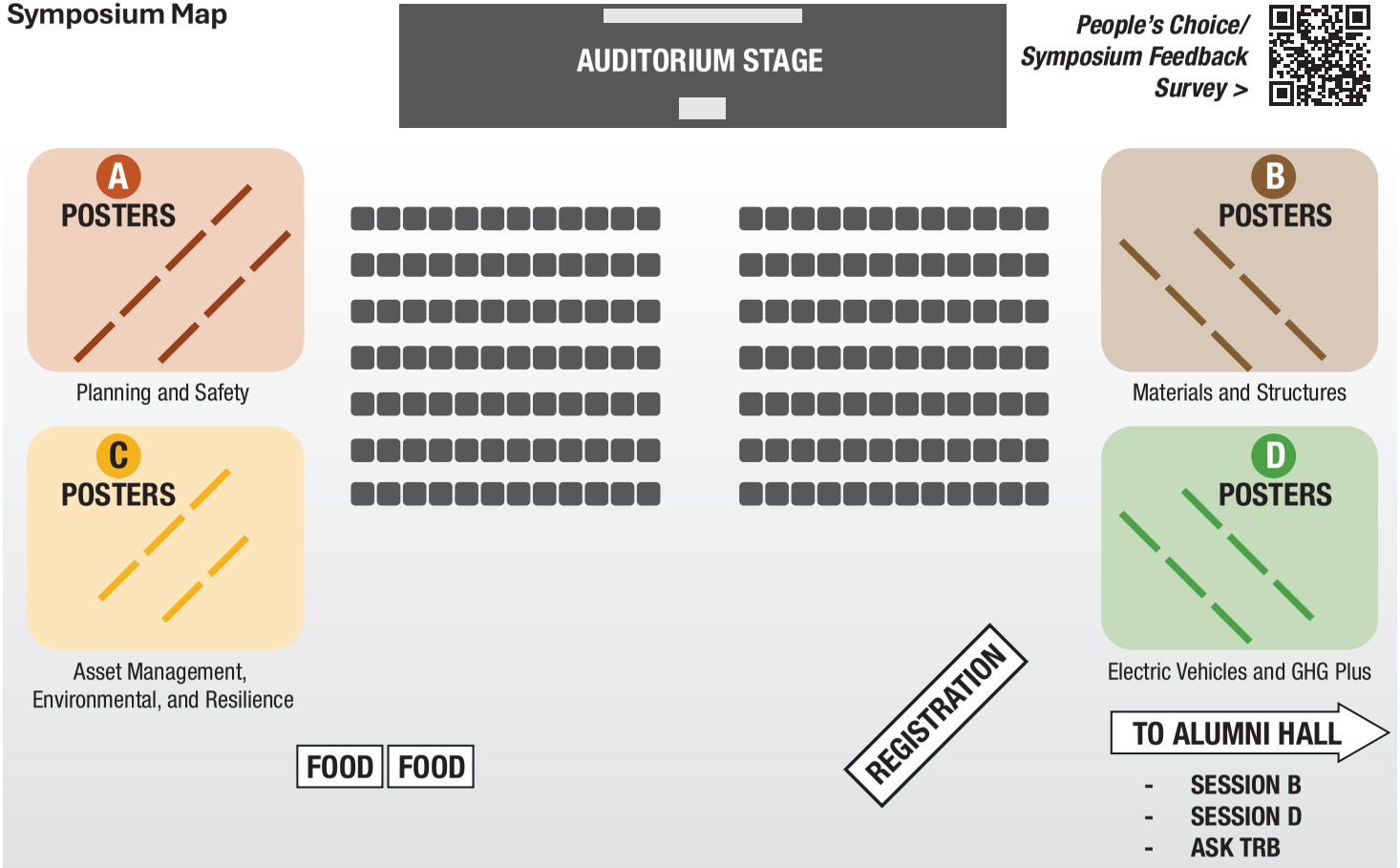
7:45am	Registration starts/Breakfast available
8-8:30am	Posters/Networking (attendees to meet with Presenters standing with their posters)
8:30-9:30am	Technical Sessions A and B A **Planning and Safety,** Barre Auditorium B **Materials and Structures,** Alumni Hall
9:30-10am	Posters/Networking (attendees to meet with Presenters standing with their posters)
10-11:30am	Plenary Session, Barre Auditorium • See below for details
11:30am-12:15pm	Posters/Networking/Lunch
12:15-1:15pm	Technical Sessions C and D C **Asset Management, Environmental, and Resilience,** Barre Auditorium D **EVs and GHG Plus,** Alumni Hall
1:15-1:45pm	Posters/Networking (attendees to meet with Presenters standing with their posters)
1:45-2:45pm	Ask TRB • Please join this informal Q&A with Katherine Kortum, Senior Program Officer, Transportation Research Board

September 25 Plenary Session, 10-11:30am, Barre Auditorium Stage

Moderator: Emily Parkany, Research Manager, VT AOT

10-10:15am	VT AOT Secretary Welcome, FHWA VT Division Administrator Welcome • Michele Boomhower, Policy, Planning, and Intermodal Development Division Director, VT AOT • Randy Warden, Administrator, FHWA VT Division
10:15-11:15am	Agency Innovation Cultures • Keynote Speaker: Todd May, Director of Innovation and Process Improvements, Indiana DOT • AOT Response: Amanda Gilman-Bogie, Continuous Improvement Section Manager, VT AOT • Joint Questions and Answers
11:15-11:20am	Brief Transportation Research Board Overview • Katherine Kortum, Senior Program Officer, Transportation Research Board
11:20-11:30am	Symposium Logistics

Symposium Map



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